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Notes:

Preface

This manual describes the various units of the IBM Personal Computer XT Model 286 and how they interact. It also has information about the basic input/output system (BIOS) and about programming support.

The information in this publication is for reference, and is intended for hardware and program designers, programmers, engineers, and anyone else who needs to understand the design and operation of the IBM Personal Computer XT Model 286.

This manual consists of eight sections:

- The first three sections describe the IBM Personal Computer XT Model 286 including hardware, charts, and register information
- Section 4 describes keyboard operation, the commands to and from the system, and the various keyboard layouts.
- Section 5 contains information about the usage of BIOS and a system BIOS listing.
- Section 6 contains instruction sets for the 80286 microprocessor and the 80287 math coprocessor.
- Section 7 provides information about characters, keystrokes, and colors.
- Section 8 contains information about the compatibility of the IBM Personal Computer XT Model 286 and the rest of the IBM Personal Computer family.

A glossary, bibliography, and index are included.

Prerequisite Publications

Guide to Operations for the IBM Personal Computer XT Model 286

Suggested Reading

- *BASIC* for the IBM Personal Computer
- *Disk Operating System (DOS)*
- *Macro Assembler* for the IBM Personal Computer

Additional Information

The *Technical Directory* lists all the service and technical information that is available for the IBM Personal Computer family of products. To receive a free copy of the *Technical Directory*, call toll free **1-800-IBM-PCTB**, Monday through Friday, 8:00 a.m. to 8:00 p.m. Eastern Time.

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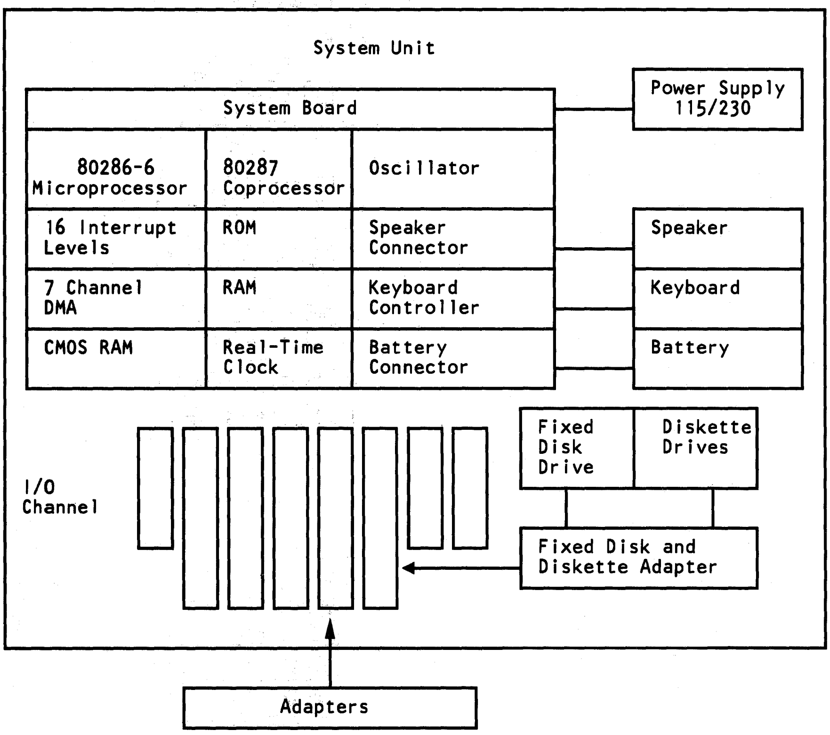


SECTION 1. SYSTEM BOARD

The system board is approximately 22 by 33.8 centimeters (8.5 by 13.2 inches). It uses very large scale integration (VLSI) technology and has the following components:

- Intel 80286 Microprocessor
- System support function:
  - Seven-Channel Direct Memory Access (DMA)
  - Sixteen-level interrupt
  - Three programmable timers
  - System clock
- 64K read-only memory (ROM) subsystem, expandable to 128K.
- A 640K (may be set to 512K) random-access memory (RAM) subsystem
- Eight input/output (I/O) slots:
  - Five with a 98-pin card-edge socket
  - Three with a 62-pin card-edge socket
- Speaker attachment
- Keyboard attachment
- Complementary metal oxide semiconductor (CMOS) memory RAM to maintain system configuration
- Real-Time Clock
- Battery backup for CMOS configuration table and Real-Time Clock

Memory

The system board consists of two 256K-by-9 random access memory module packages, plus two banks of 64K-by-4 random access memory (RAM) modules. Total memory size is 640K, with parity checking.

Microprocessor

The Intel 80286 microprocessor has a 24-bit address, 16-bit memory interface[1], an extensive instruction set, DMA and interrupt support capabilities, a hardware fixed-point multiply and divide, integrated memory management, four-level memory protection, 1G (1,073,741,824 bytes) of virtual address space for each task, and two operating modes: the 8086-compatible real address mode and the protected virtual address mode. More detailed descriptions of the microprocessor may be found in the publications listed in the Bibliography of this manual.

Real Address Mode

In the real address mode, the microprocessor's physical memory is a contiguous array of up to one megabyte. The microprocessor addresses memory by generating 20-bit physical addresses.

The selector portion of the pointer is interpreted as the upper 16 bits of a 20-bit segment address. The lower 4 bits of the 20-bit segment address are always zero. Therefore, segment addresses begin on multiples of 16 bytes.

All segments in the real address mode are 64K in size and may be read, written, or executed. An exception or interrupt can occur if data operands or instructions attempt to wrap around the end of a segment. An example of this is a word with its low-order byte at offset FFFF and its high-order byte at 0000. If, in the real

1 In this manual, the term interface refers to a device that carries signals between functional units.

address mode, the information contained in the segment does not use the full 64K, the unused end of the segment may be overlayed by another segment to reduce physical memory requirements.

Protected (Virtual Address) Mode

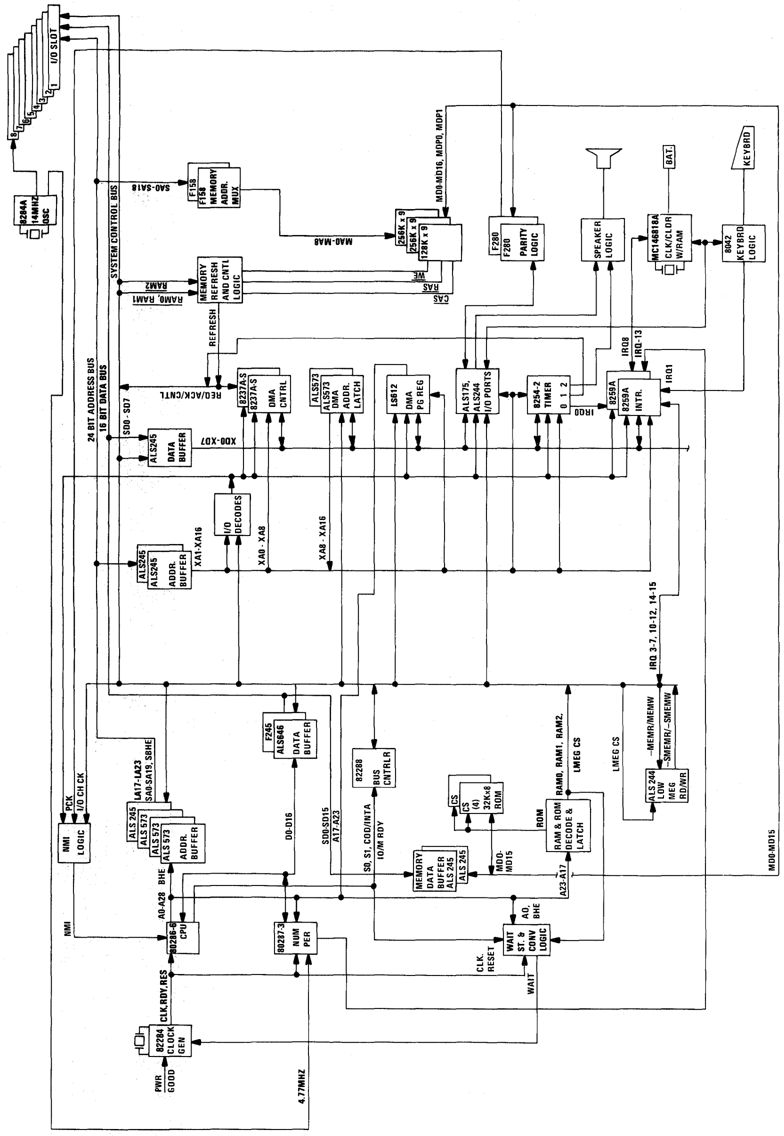
The protected mode offers extended physical and virtual memory address space, memory protection mechanisms, and new operations to support operating systems and virtual memory.

> **Note:** See "BIOS Programming Hints" in Section 5 for special cautions while operating in the protected mode.

The protected mode provides a 1G virtual address space for each task mapped into a 16M physical address space. The virtual address space may be larger than the physical address space, because any use of an address that does not map to a physical memory location will cause a restartable exception.

As in the real address mode, the protected mode uses 32-bit pointers, consisting of 16-bit selector and offset components. The selector, however, specifies an index into a memory resident table rather than the upper 16 bits of a real memory address. The 24-bit base address of the desired segment is obtained from the tables in memory. The 16-bit offset is added to the segment base address to form the physical address. The microprocessor automatically refers to the tables whenever a segment register is loaded with a selector. All instructions that load a segment register will refer to the memory-based tables without additional program support. The memory-based tables contain 8-byte values called *descriptors*.

The following is a block diagram of the system board.



System Performance

The 80286 microprocessor operates at 6 MHz, resulting in a clock cycle time of 167 nanoseconds.

A bus cycle requires two clock cycles, making a 334-nanosecond 16-bit, microprocessor cycle time. Eight-bit bus operations to 8-bit devices take six clock cycles (which include four wait states), resulting in a 1-microsecond microprocessor cycle. Sixteen-bit bus operations to 8-bit devices take 12 clock cycles (which include 10 wait states) resulting in a 2-microsecond microprocessor cycle.

The refresh controller steps one refresh address every 15 microseconds. Each refresh cycle requires eight clock cycles to refresh all of the system's dynamic memory; 256 refresh cycles are required every 4 milliseconds, but the system hardware refreshes every 3.84ms. The following formula determines the percentage of bandwidth used for refresh for the 6 MHz clock.

```
 % Bandwidth used     8 cycles X 256   2048
    for Refresh     = -------------- = ----- = 9%
                      3.84ms/167ns     22994
```

The DMA controller operates at 3 MHz, which results in a clock cycle time of 334 nanoseconds. All DMA data-transfer bus cycles are five clock cycles or 1.66 microseconds. Cycles spent in the transfer of bus control are not included.

System Memory Mapping

The following shows the mapping of the system memory.

Address	Name	Function
000000 to 07FFFF	512K system board memory	First 512K of system board memory
080000 to 09FFFF	128K system board memory	System board memory (512K to 640K) May be disabled with jumper J10.
0A0000 to 0BFFFF	128K video RAM	Reserved for graphics display buffer
0C0000 to 0DFFFF	128K I/O expansion ROM	Reserved for ROM on I/O adapters
0E0000 to 0EFFFF	64K reserved on system board	Duplicated code assignment at address FE0000
0F0000 to 0FFFFF	64K ROM on the system board	Duplicated code assignment at address FF0000
100000 to FDFFFF	Maximum memory 15M	I/O channel memory - 640K to 15M installed on memory expansion options
FE0000 to FEFFFF	64K reserved on system board	Duplicated code assignment at address 0E0000
FF0000 to FFFFFF	64K ROM on the system board	Duplicated code assignment at address 0F0000

System Memory

Direct Memory Access

The system supports seven direct memory access (DMA) channels. Two Intel 8237A-5 DMA Controller chips are used, with four channels for each chip. The DMA channels are assigned as follows:

Controller 1	Controller 2
Ch 0 - Reserved Ch 1 - SDLC Ch 2 - Diskette Ch 3 - LAN	Ch 4 - Cascade for Ctlr 1 Ch 5 - Reserved Ch 6 - Reserved Ch 7 - Reserved

DMA Channels

DMA controller 1 contains channels 0 through 3. These channels support 8-bit data transfers between 8-bit I/O adapters and 8- or 16-bit system memory. Each channel can transfer data throughout the 16M system-address space in 64K blocks.

The following figures show address generation for the DMA channels.

Source	DMA Page Registers	Controller
Address	A23<---------->A16	A15<---------->A0

Address Generation for DMA Channels 0 through 3

> **Note:** The addressing signal, 'byte high enable' (BHE), is generated by inverting address line A0.

DMA controller 1 command code addresses follow.

Hex Address	Register Function
000	CH0 base and current address
001	CH0 base and current word count
002	CH1 base and current address
003	CH1 base and current word count
004	CH2 base and current address
005	CH2 base and current word count
006	CH3 base and current address
007	CH3 base and current word count
008	Read Status Register/Write Command Register
009	Write Request Register
00A	Write Single Mask Register Bit
00B	Write Mode Register
00C	Clear Byte Pointer Flip-Flop
00D	Read Temporary Register/Write Master Clear
00E	Clear Mask Register
00F	Write All Mask Register Bits

DMA Controller 1 (Channels 0-3)

DMA controller 2 contains channels 4 through 7. Channel 4 is used to cascade channels 0 through 3 to the microprocessor. Channels 5, 6, and 7 support 16-bit data transfers between 16-bit I/O adapters and 16-bit system memory. These DMA channels can transfer data throughout the 16M system-address space in 128K blocks. Channels 5, 6, and 7 cannot transfer data on odd-byte boundaries.

Source	DMA Page Registers	Controller
Address	A23<---------->A17	A16<---------->A1

Address Generation for DMA Channels 5 through 7

Note: The addressing signals, BHE and A0, are forced to a logical 0.

The following figure shows the addresses for the page register.

Page Register	I/O Hex Address
DMA Channel 0	0087
DMA Channel 1	0083
DMA Channel 2	0081
DMA Channel 3	0082
DMA Channel 5	008B
DMA Channel 6	0089
DMA Channel 7	008A
Refresh	008F

Page Register Addresses

Addresses for all DMA channels do not increase or decrease through page boundaries (64K for channels 0 through 3, and 128K for channels 5 through 7).

DMA channels 5 through 7 perform 16-bit data transfers. Access can be gained only to 16-bit devices (I/O or memory) during the DMA cycles of channels 5 through 7. Access to the DMA controller, which controls these channels, is through I/O addresses hex 0C0 through 0DF.

DMA controller 2 command code addresses follow.

Hex Address	Register Function
0C0	CH4 base and current address
0C2	CH4 base and current word count
0C4	CH5 base and current address
0C6	CH5 base and current word count
0C8	CH6 base and current address
0CA	CH6 base and current word count
0CC	CH7 base and current address
0CE	CH7 base and current word count
0D0	Read Status Register/Write Command Register
0D2	Write Request Register
0D4	Write Single Mask Register Bit
0D6	Write Mode Register
0D8	Clear Byte Pointer Flip-Flop
0DA	Read Temporary Register/Write Master Clear
0DC	Clear Mask Register
0DE	Write All Mask Register Bits

DMA Controller 2 (DMA Channels 4-7)

All DMA memory transfers made with channels 5 through 7 must occur on even-byte boundaries. When the base address for these channels is programmed, the real address divided by 2 is the data written to the base address register. Also, when the base word count for channels 5 through 7 is programmed, the count is the number of 16-bit words to be transferred. Therefore, DMA channels 5 through 7 can transfer 65,536 words, or 128Kb maximum, for any selected page of memory. These DMA channels divide the 16M memory space into 128K pages. When the DMA page registers for channels 5 through 7 are programmed, data bits D7 through D1 contain the high-order seven address bits (A23 through A17) of the desired memory space. Data bit D0 of the page registers for channels 5 through 7 is not used in the generation of the DMA memory address.

At power-on time, all internal locations, especially the mode registers, should be loaded with some valid value. This is done even if some channels are unused.

System Interrupts

The 80286 microprocessor's non maskable interrupt (NMI) and two 8259A controller chips provide 16 levels of system interrupts.

> **Note:** Any or all interrupts may be masked (including the microprocessor's NMI).

Hardware Interrupt Listing

The following shows the interrupt-level assignments in decreasing priority.

Level		Function
Microprocessor NMI		Parity or I/O Channel Check
Interrupt Controllers		
CTRL 1	CTRL 2	
IRQ 0		Timer Output 0
IRQ 1		Keyboard (Output Buffer Full)
IRQ 2		Interrupt from CTRL 2
	IRQ 8	Realtime Clock Interrupt
	IRQ 9	Software Redirected to INT 0AH
		PC Network *
		PC Network(Alt.) *
	IRQ 10	Reserved
	IRQ 11	Reserved
	IRQ 12	Reserved
	IRQ 13	Coprocessor
	IRQ 14	Fixed Disk Controller
	IRQ 15	Reserved
IRQ 3		Serial Port 2
		BSC
		BSC (Alt.)
		PC Network *
		PC Network (Alt.) *
		SDLC
IRQ 4		Serial Port 1
		BSC
		BSC (Alt.)
		SDLC
IRQ 5		Parallel Port 2
IRQ 6		Diskette Controller
		Fixed Disk and Diskette Drive
IRQ 7		Parallel Port 1
		Data Acquisition and Control **
		GPIB ***
		Voice Communications Adapter ****

* The PC Network is jumper selectable.
** The Data Acquisition Adapter can be set to interrupts 3 through 7. The default interrupt is 7.
*** The GPIB Adapter can be set to interrupts 2 through 7.
**** The Voice Communications Adapter can be set to interrupts 2, 3, 4, or 7 (Interrupt level 7 is recommended).

Hardware Interrupt Listing

Interrupt Sharing

A definition for standardized hardware design has been established that enables multiple adapters to share an interrupt level. This section describes this design and discusses the programming support required.

> **Note:** Since interrupt routines do not exist in ROM for protected mode operations, this design is intended to run only in the microprocessor's real address mode.

Design Overview

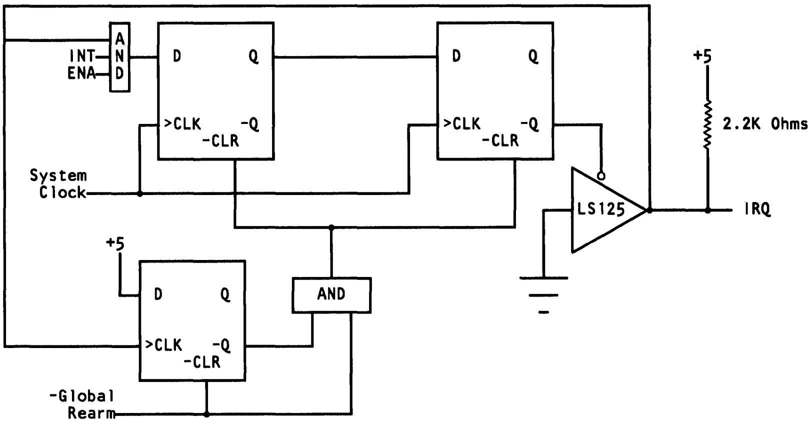
Most interrupt-supporting adapters hold the 'interrupt request' line (IRQ) at a low level and then drive the line high to cause an interrupt. In contrast, the shared-interrupt hardware design allows IRQ to float high through pull-up resistors on each adapter. Each adapter on the line may cause an interrupt by momentarily pulsing the line to a low level. The high-to-low transition arms the 8259A Interrupt Controller; the low-to-high transition generates the interrupt. The duration of this pulse must be between 125 and 1,000 nanoseconds.

The adapters must have an 'interrupt' status bit (INT) and a 'interrupt enable' bit (ENA) that can be controlled and monitored by its software.

Each adapter sharing an interrupt level must monitor the IRQ line. When any adapter drives the line low, all other adapters on that line must be prevented from issuing an interrupt request until they are rearmed.

If an adapter's INT status bit is at a high level when the interrupt sharing logic is rearmed, the adapter must reissue the interrupt. This prevents lost interrupts if two adapters issue an interrupt at the same time and an interrupt handler issues a Global Rearm after servicing one of the adapters.

The following diagram is an example of the shared interrupt logic.



Shared Interrupt Logic Diagram

Program Support

During multitasking, tasks are constantly being activated and deactivated in no particular order. The interrupt-sharing program support described in this section provides for an orderly means to:

- Link a task's interrupt handler to a chain of interrupt handlers
- Share the interrupt level while the task is active
- Unlink the interrupt handler from the chain when the task is deactivated.

Linking to a Chain

Each newly activated task replaces the interrupt vector in low memory with a pointer to its own interrupt handler. The old interrupt vector is used as a forward pointer (FPTR) and is stored at a fixed offset from the new task's interrupt handler.

Sharing the Interrupt Level

When the new task's handler gains control as a result of an interrupt, the handler reads the contents of the adapter's interrupt status register to determine if its adapter caused the interrupt. If it did, the handler services the interrupt, disables the interrupts (CLI), issues a non-specific End of Interrupt (EOI), and then, to rearm the interrupt hardware, writes to address 02F*X*, where *X* corresponds to interrupt levels 3 through 7, and 9 (IRQ9 is 02F2). A write to address 06F*X*, where *X* may be 2 through 7, is required for interrupt levels 10 through 15, respectively. Each adapter in the chain decodes the address which results in a Global Rearm. An adapter is required to decode the least significant 11 bits for this Global Rearm command. The handler then issues a Return From Interrupt (IRET).

If its adapter did not cause the interrupt, the handler passes control to the next interrupt handler in the chain.

Unlinking from the Chain

To unlink from the chain, a task must first locate its handler's position within the chain. By starting at the interrupt vector in low memory, and using the offset of each handler's FPTR to find the entry point of each handler, the chain can be methodically searched until the task finds its own handler. The FPTR of the previous handler in the chain is replaced by the task's FPTR, thus removing the handler from the chain.

Error Recovery

Should the unlinking routine discover that the interrupt chain has been corrupted (an interrupt handler is linked but does not have a valid SIGNATURE), an unlinking error-recovery procedure must be in place. Each application can incorporate its own unlinking error procedure into the unlinking routine. One application may choose to display an error message requiring the operator to either correct the situation or power down the system. Another application may choose an error recovery procedure that restores the original interrupt vector in low memory, and bypasses the corrupt portion of the interrupt chain. This error recovery procedure may not be suitable when adapters that are being serviced by the corrupt handler are actively generating interrupts, since unserviced interrupts lock up that interrupt level.

ROS Considerations

Adapters with their handlers residing in ROS may choose to implement chaining by storing the 4 byte FPTR (plus the FIRST flag if it is sharing interrupt 7 or 15) in on-adapter latches or ports. Adapter ROS without this feature must first test to see that it is the first in the chain. If it is the first in the chain, the adapter can complete the link; if not, the adapter must exit its routine without linking.

Precautions

The following precautions must be taken when designing hardware or programs using shared interrupts:

- Hardware designers should ensure the adapters:
  - Do not power up with the ENA line active or an interrupt pending.
  - Do not generate interrupts that are not serviced by a handler. Generating interrupts when a handler is not active to service the adapter causes the interrupt level to lock up. The design relies on the handler to clear its adapter's interrupt and issue the Global Rearm.
  - Can be disabled so that they do not remain active after their application has terminated.
- Programmers should:
  - Ensure that their programs have a short routine that can be executed with the AUTOEXEC.BAT to disable their adapter's interrupts. This precaution ensures that the adapters are deactivated if the user reboots the system.
  - Treat words as words, not bytes. Remember that data is stored in memory using the Intel format (word 424B is stored as 4B42).

Interrupt Chaining Structure

```
ENTRY:  JMP         SHORT PAST           ; Jump around structure
        FPTR        DD     0             ; Forward Pointer
        SIGNATURE   DW     424BH         ; Used when unlinking to identify
                                         ;  compatible interrupt handlers
        FLAGS       DB                   ; Flags
        FIRST       EQU    80H           ; Flag for being first in chain
        JMP         SHORT  RESET

        RES_BYTES  DB      DUP 7 (0)      ; Future expansion
PAST:   ...                              ; Actual start of code
```

The interrupt chaining structure is a 16-byte format containing FPTR, SIGNATURE, and RES_BYTES. It begins at the third byte from the interrupt handler's entry point. The first instruction of every handler is a short jump around the structure to the start of the routine. Since the position of each interrupt handler's chaining structure is known (except for the handlers on adapter ROS), the FPTRs can be updated when unlinking.

The FIRST flag is used to determine the handler's position in the chain when unlinking when sharing interrupts 7 and 15. The RESET routine, an entry point for the operating system, must disable the adapter's interrupt and RETURN FAR to the operating system.

> **Note:** All handlers designed for interrupt sharing must use 424B as the signature to avoid corrupting the chain.

Examples

In the following examples, notice that interrupts are disabled before control is passed to the next handler on the chain. The next handler receives control as if a hardware interrupt had caused it to receive control. Also, notice that the interrupts are disabled before the non-specific EOI is issued, and not reenabled in the interrupt handler. This ensures that the IRET is executed (at which point the flags are restored and the interrupts reenabled) before another interrupt is serviced, protecting the stack from excessive build up.

Example of an Interrupt Handler

```
YOUR_CARD  EQU      xxxx            ; Location of your card's interrupt
                                    ;  control/status register
ISB        EQU      xx              ; Interrupt bit in your card's interrupt
                                    ;  control status register
REARM      EQU      2F7H            ; Global Rearm location for interrupt
                                    ;  level 7
SPC_EOI    EQU      67H             ; Specific EOI for 8259's interrupt
                                    ;  level 7
EOI        EQU      20H             ; Non-specific EOI
OCR        EQU      20H             ; Location of 8259 operational control
                                    ;  register
IMR        EQU      21H             ; Location of 8259 interrupt mask
                                    ;  register

MYCSEG     SEGMENT  PARA
           ASSUME   CS:MYCSEG,DS:DSEG
ENTRY      PROC     FAR
           JMP      SHORT PAST      ; Entry point of handler
FPTR       DD       0               ; Forward Pointer
SIGNATURE  DW       424BH           ; Used when unlinking to identify
                                    ;  compatible interrupt handlers
FLAGS      DB       0               ; Flags
FIRST      EQU      80H
JMP        SHORT    RESET
RES_BYTES  DB       DUP 7 (0)       ; Future expansion
PAST:      STI                      ; Actual start of handler code
           PUSH     ...             ; Save needed registers
           MOV      DX,YOUR_CARD    ; Select your status register
           IN       AL,DX           ; Read the status register
           TEST     AL,ISB          ; Your card caused the interrupt?
           JNZ      SERVICE         ; Yes, branch to service logic
           TEST     CS:FLAGS,FIRST  ; Are we the first ones in?
           JNZ      EXIT            ; If yes, branch for EOI and Rearm
           POP      ...             ; Restore registers
           CLI                      ; Disable interrupts
           JMP      DWORD PTR CS:FPTR ; Pass control to next guy on chain

SERVICE:   ...                      ; Service the interrupt
EXIT:
           CLI                      ; Disable the interrupts
           MOV      AL,EOI
           OUT      OCR,AL          ; Issue non-specific EOI to 8259
           MOV      DX,REARM        ; Rearm the cards
           OUT      DX,AL
           POP      ...             ; Restore registers
           IRET
RESET:     ...                      ; Disable your card
           RET                      ; Return FAR to operating system
ENTRY      ENDP
           MYCSEG   ENDS
           END      ENTRY
```

Linking Code Example

```
          PUSH     ES
          CLI                          ; Disable interrupts
; Set forward pointer to value of interrupt vector in low memory
          ASSUME   CS:CODESEG,DS:CODESEG
          PUSH     ES
          MOV      AX,350FH            ; DOS get interrupt vector
          INT      21H
          MOV      SI,OFFSET CS:FPTR   ; Get offset of your forward pointer
                                       ;  in an indexable register
          MOV      CS:[SI],BX          ; Store the old interrupt vector
          MOV      CS:[SI+2],ES        ;  in your forward pointer for chaining
          CMP      ES:BYTE PTR[BX],CFH ; Test for IRET
          JNZ      SETVECTR
          MOV      CS:FLAGS,FIRST      ; Set up first in chain flag
SETVECTR: POP      ES
          PUSH     DS
; Make interrupt vector in low memory point to your handler
          MOV      DX,OFFSET ENTRY     ; Make interrupt vector point to your handler
          MOV      AX,SEG ENTRY        ; If DS not = CS, get it
          MOV      DS,AX               ;  and put it in DS
          MOV      AX,250FH            ; DOS set interrupt vector
          INT      21H
          POP      DS
; Unmask (enable) interrupts for your level
          IN       AL,IMR              ; Read interrupt mask register
          JMP      $+2                 ; IO delay
          AND      AL,07FH             ; Unmask interrupt level 7
          OUT      IMR,AL              ; Write new interrupt mask

          MOV      AL,SPC_EOI          ; Issue specific EOI for level 7
          JMP      $+2                 ;  to allow pending level 7 interrupts
OUT      OCR,AL             ;    (if any) to be serviced
          STI                          ; Enable interrupts
          POP      ES                  ;
```

Unlinking Code Example

```
           PUSH     DS
           PUSH     ES
           CLI                          ; Disable interrupts
           MOV      AX,350FH            ; DOS get interrupt vector
           INT      21H                 ; ES:BX points to first of chain
           MOV      CX,ES               ; Pickup segment part of interrupt vector
; Are we the first handler in the chain?
           MOV      AX,CS               ; Get code seg into comparable register
           CMP      BX,OFFSET ENTRY     ; Interrupt vector in low memory
                                        ;  pointing to your handler's offset?
           JNE      UNCHAIN_A            ; No, branch
           CMP      AX,CX               ; Vector pointing to your
                                        ;  handler's segment?
           JNE      UNCHAIN_A            ; No, branch
; Set interrupt vector in low memory to point to the handler
;  pointed to by your pointer

           PUSH     DS
           MOV      DX,WORD PTR CS:FPTR
           MOV      DS,WORD PTR CS FPTR[2]
           MOV      AX,250FH            ; DOS set interrupt vector
           INT      21H
           POP      DS
           JMP      UNCHAIN_X
UNCHAIN_A:     ; BX = FPTR offset, ES = FPTR segment, CX = CS
           CMP      ES:[BX+6],4B42H     ; Is handler using the appropriate
                                        ;  conventions (is SIGNATURE present in
                                        ;   the interrupt chaining structure)?
           JNE      exception           ; No, invoke error exception handler
           LDS      SI,ES:[BX+2]       ; Get FPTR's segment and offset
           CMP      SI,OFFSET ENTRY     ; Is this forward pointer pointing to
                                        ;  your handler's offset?
           JNE      UNCHAIN_B            ; No, branch
           MOV      CX,DS               ; Move to compare
           CMP      AX,CX               ; Is this forward pointer pointing to
                                        ;  your handler's segment?
           JNE      UNCHAIN_B            ; No, branch
; Located your handler in the chain
           MOV      AX,WORD PTR CS:FPTR ; Get your FPTR's offset
           MOV      ES:[BX+2],AX       ; Replace offset of FPTR of handler
                                        ;  that points to you
           MOV      AX,WORD PTR CS:FPTR[2] ; Get your FPTR's segment
           MOV      ES:[BX+4],AX       ; Replace segment of FPTR of handler
                                        ;  that points to you
           MOV      AL,CS:FLAGS         ; Get your flags
           AND      AL,FIRST            ; Isolate FIRST flag
           OR       ES:[BX + 6],AL     ; Set your first flag into prior routine
           JMP      UNCHAIN_X
UNCHAIN_B: MOV      BX,SI                ; Move new offset to BX
           PUSH     DS
           PUSH     ES
           JMP      UNCHAIN_A            ; Examine next handler in chain
UNCHAIN_X: STI                           ; Enable interrupts
           POP      ES
           POP      DS
```

System Timers

The system has three programmable timer/counters, Channels 0 through 2. They are controlled by an Intel 8254-2 Timer/Counter chip, and are defined as follows:

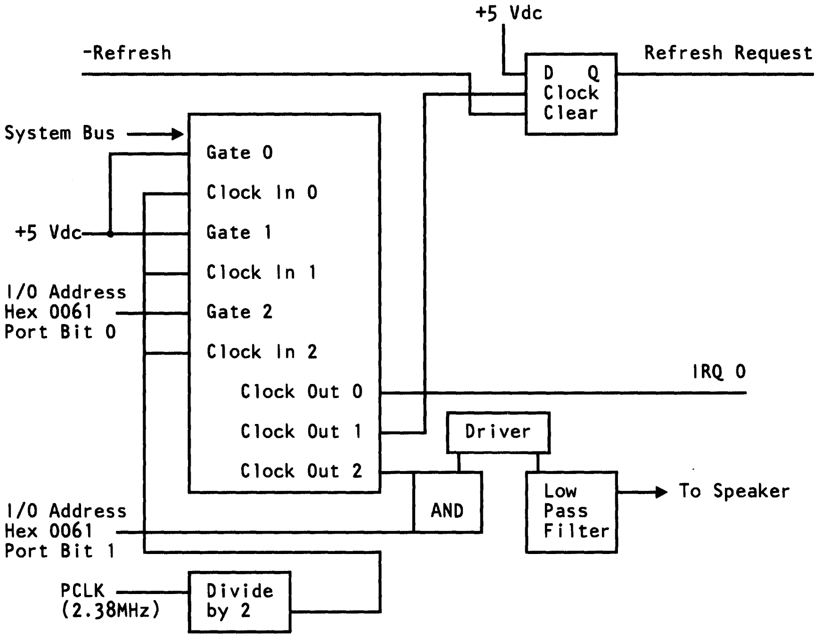
Channel 0	**System Timer**
GATE 0	Tied on
CLK IN 0	1.193182 MHz OSC
CLK OUT 0	8259A IRQ 0

Channel 1	**Refresh Request Generator**
GATE 1	Tied on
CLK IN 1	1.193182 MHz OSC
CLK OUT 1	Request refresh cycle

Note: Channel 1 is programmed as a rate generator to produce a 15-microsecond period signal.

Channel 2	**Tone Generation for Speaker**
GATE 2	Controlled by bit 0 of port hex 61, PPI bit
CLK IN 2	1.193182 MHz OSC
CLK OUT 2	Used to drive the speaker

The 8254-2 Timer/Counter is a programmable interval timer/counter that system programs treat as an arrangement of four external I/O ports. Three ports are treated as counters; the fourth is a control register for mode programming. The following is a system-timer block diagram.



System-Timer Block Diagram

System Clock

The 82284 System Clock Generator is driven by a 12-MHz crystal. Its output 'clock' signal (CLK) is the input to the system microprocessor and the I/O channel.

ROM Subsystem

The system board's ROM subsystem consists of two 32K by 8-bit ROM/EPROM modules in a 32K-by-16-bit arrangement. The code for odd and even addresses resides in separate modules. ROM is assigned at the top of the first and last 1M address space (0F0000 and FF0000). ROM is not parity-checked. Its maximum access time is 170 nanoseconds and its maximum cycle time is 333 nanoseconds.

RAM Subsystem

The system board's RAM subsystem starts at address 000000 of the 16M address space and consists of 640K of read/write (R/W) memory. The 640K memory is composed of two 256K-by-9 random access memory module packages (512K), plus two banks of 64K-by-4 RAM modules (128K). The 64K-by-4 RAM modules may be disabled at jumper J10, located on the system board. Memory access time is 150 nanoseconds and the cycle time is 275 nanoseconds.

Memory refresh requests one memory cycle every 15 microseconds through the timer/counter (channel 1). The RAM initialization program performs the following functions:

- Initializes channel 1 of the timer/counter to the rate generation mode, with a period of 15 microseconds
- Performs a memory write operation to any memory location.

Note: The memory must be accessed or refreshed eight times before it can be used.

I/O Channel

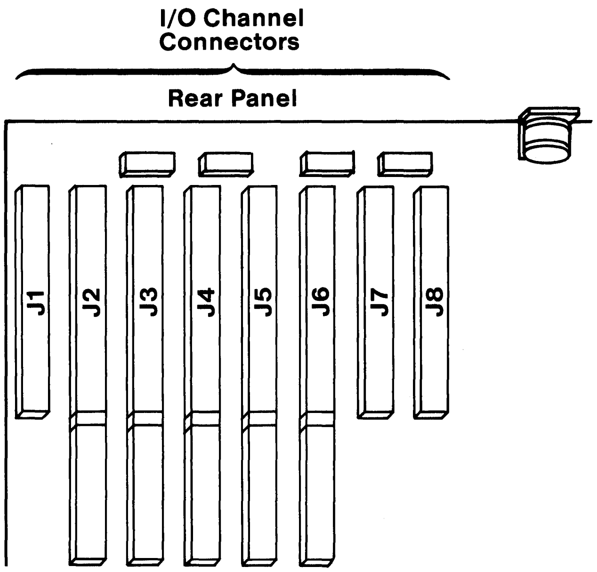
The I/O channel supports:

- I/O address space hex 100 to hex 3FF
- 24-bit memory addresses (16M)
- Selection of data accesses (either 8- or 16-bit)
- Interrupts
- DMA channels
- I/O wait-state generation
- Open-bus structure (allowing multiple microprocessors to share the system's resources, including memory)
- Refresh of system memory from channel microprocessors.

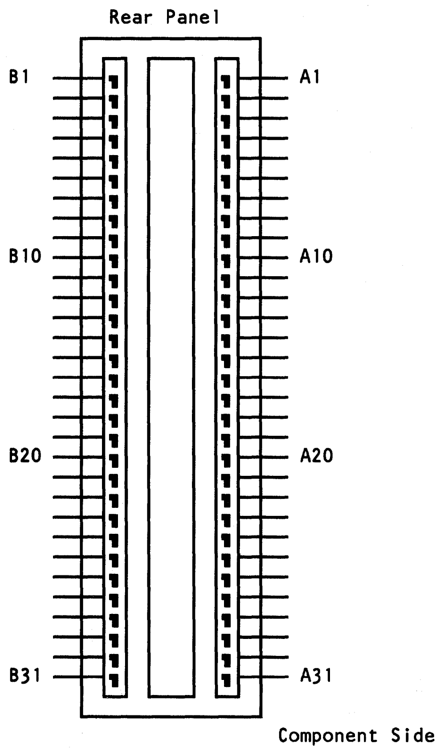
Connectors

The following figure shows the location and the numbering of the I/O channel connectors. These connectors consist of five 98-pin and three 62-pin edge connector sockets.

Note: The three 62-pin positions can support only 62-pin I/O bus adapters.

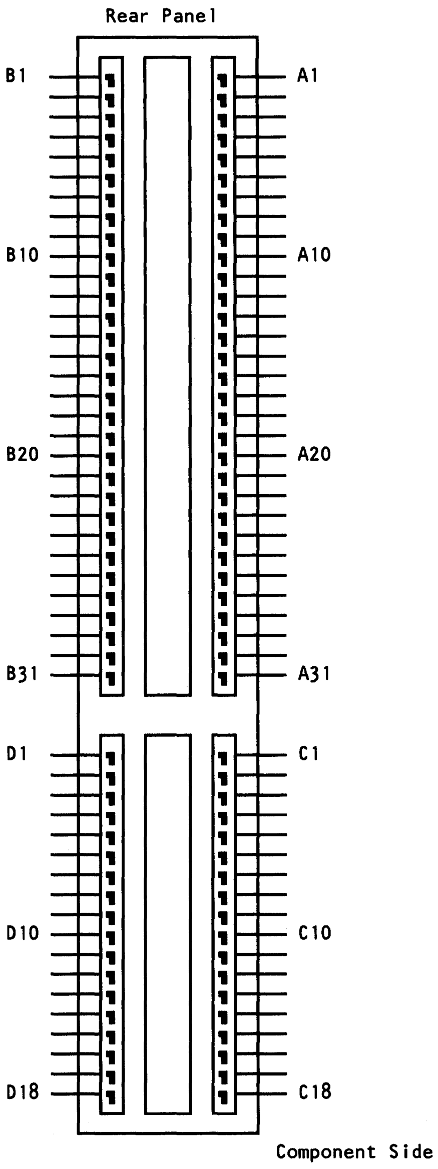


The following figure shows the pin numbering for the 62-pin I/O channel connectors J1, J7 and J8.



I/O Channel Pin Numbering (J1, J7 and J8)

The following figure shows the pin numbering for the 98-pin I/O channel connectors J2 through J6.



I/O Channel Pin Numbering (J2-J6)

The following figures summarize pin assignments for the I/O channel connectors.

I/O Pin	Signal Name	I/O
A1	-I/O CH CK	I
A2	SD7	I/O
A3	SD6	I/O
A4	SD5	I/O
A5	SD4	I/O
A6	SD3	I/O
A7	SD2	I/O
A8	SD1	I/O
A9	SD0	I/O
A10	+I/O CH RDY	I
A11	AEN	O
A12	SA19	I/O
A13	SA18	I/O
A14	SA17	I/O
A15	SA16	I/O
A16	SA15	I/O
A17	SA14	I/O
A18	SA13	I/O
A19	SA12	I/O
A20	SA11	I/O
A21	SA10	I/O
A22	SA9	I/O
A23	SA8	I/O
A24	SA7	I/O
A25	SA6	I/O
A26	SA5	I/O
A27	SA4	I/O
A28	SA3	I/O
A29	SA2	I/O
A30	SA1	I/O
A31	SA0	I/O

I/O Channel (A-Side)

I/O Pin	Signal Name	I/O
B1	GND	Ground
B2	RESET DRV	O
B3	+5 Vdc	Power
B4	IRQ 9	I
B5	-5 Vdc	Power
B6	DRQ2	I
B7	-12 Vdc	Power
B8	OWS	I
B9	+12 Vdc	Power
B10	GND	Ground
B11	-SMEMW	O
B12	-SMEMR	O
B13	-IOW	I/O
B14	-IOR	I/O
B15	-DACK3	O
B16	DRQ3	I
B17	-DACK1	O
B18	DRQ1	I
B19	-REFRESH	I/O
B20	CLK	O
B21	IRQ7	I
B22	IRQ6	I
B23	IRQ5	I
B24	IRQ4	I
B25	IRQ3	I
B26	-DACK2	O
B27	T/C	O
B28	BALE	O
B29	+5Vdc	Power
B30	14.318MHz OSC	O
B31	GND	Ground

I/O Channel (B-Side)

I/O Pin	Signal Name	I/O
C1	-SBHE	I/O
C2	LA23	I/O
C3	LA22	I/O
C4	LA21	I/O
C5	LA20	I/O
C6	LA19	I/O
C7	LA18	I/O
C8	LA17	I/O
C9	-MEMR	I/O
C10	-MEMW	I/O
C11	SD08	I/O
C12	SD09	I/O
C13	SD10	I/O
C14	SD11	I/O
C15	SD12	I/O
C16	SD13	I/O
C17	SD14	I/O
C18	SD15	I/O

I/O Channel (C-Side, J2 through J6 only)

I/O Pin	Signal Name	I/O
D1	-MEM CS16	I
D2	-I/O CS16	I
D3	IRQ10	I
D4	IRQ11	I
D5	IRQ12	I
D6	IRQ15	I
D7	IRQ14	I
D8	-DACK0	O
D9	DRQ0	I
D10	-DACK5	O
D11	DRQ5	I
D12	-DACK6	O
D13	DRQ6	I
D14	-DACK7	O
D15	DRQ7	I
D16	+5 Vdc	POWER
D17	-MASTER	I
D18	GND	GROUND

I/O Channel (D-Side, J2 through J6 only)

I/O Channel Signal Description

The following is a description of the system board's I/O channel signals. All signal lines are TTL compatible. I/O adapters should be designed with a maximum of two low-power Shottky (LS) loads per line and be capable of driving the data and address lines similar to a 74LS245 driver.

SA0 through SA19 (I/O)

Address signals 0 through 19 are used to address memory and I/O devices within the system. These 20 address lines, in addition to LA17 through LA23, allow access of up to 16M of memory. SA0 through SA19 are gated on the system bus when 'buffered address latch enable' signal (BALE) is high and are latched on the falling edge of BALE. These signals are generated by the microprocessor or DMA Controller. They also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

LA17 through LA23 (I/O)

These signals (unlatched) are used to address memory and I/O devices within the system. They give the system up to 16M of addressability. These signals are valid from the leading edge of BALE to the trailing edge of the '-I/O Read' (-IOR) or '-I/O Write' (-IOW) command cycle. These decodes should be latched by I/O adapters on the falling edge of the 'buffered address latch enable' signal (BALE).

These signals also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

CLK (O)

This is the system 'clock' signal. It is a synchronous microprocessor cycle clock with a cycle time of 167 nanoseconds. The clock has a 50% duty cycle. This signal should be used only for synchronization. It is not intended for uses requiring a fixed frequency.

RESET DRV (O)

The 'reset drive' signal is used to reset or initialize system logic at power-up time or during a low voltage condition. This signal is active high.

SD0 through SD15 (I/O)

These signals provide data bits 0 through 15 for the microprocessor, memory, and I/O devices. D0 is the least-significant bit and D15 is the most-significant bit. All 8-bit devices on the I/O channel should use D0 through D7 for communications to the microprocessor. The 16-bit devices will use D0 through D15. To support 8-bit devices, the data on D8 through D15 will be gated to D0 through D7 during 8-bit transfers to these devices; 16-bit microprocessor transfers to 8-bit devices will be converted to two 8-bit transfers.

BALE (O) (buffered)

The 'buffered address latch enable' signal is available to the I/O channel as an indicator of a valid microprocessor or DMA address (when used with 'address enable' signal, AEN). Microprocessor addresses SA0 through SA19 are latched with the falling edge of BALE. BALE is forced high (active) during DMA cycles. From the trailing edge of a command cycle (for example, the trailing edge of -IOR or -IOW) to the leading edge of BALE, the address lines are in transition and are not stable.

-I/O CH CK (I)

The '-I/O channel check' signal provides the system board with parity (error) information about memory or devices on the I/O channel. When this signal is active (low), it indicates a non-correctable system error.

I/O CH RDY (I)

The 'I/O channel ready' signal is pulled low (not ready) by a memory or I/O device to lengthen I/O or memory cycles. Any slow device using this line should drive it low immediately upon detecting its valid address and a Read or Write command. Machine cycles are extended by an integral number of clock cycles (167 nanoseconds). This signal should be held low for no more than 2.5 microseconds.

IRQ3-IRQ7, IRQ9-IRQ12, IRQ14, and IRQ15 (I)

Interrupt requests 3 through 7, 9 through 12, 14, and 15 are used to signal the microprocessor that an I/O device needs attention. The interrupt requests are prioritized, with IRQ9 through IRQ12, IRQ14, and IRQ15 having the highest priority (IRQ9 is the highest), and IRQ3 through IRQ7 having the lowest priority (IRQ7 is the lowest). An interrupt request is generated when an IRQ line is raised from low to high. The line is high until the microprocessor acknowledges the interrupt request (Interrupt Service routine). See the figure on page 1-13 for additional information.

Note: Interrupt requests IRQ0-IRQ2, IRQ8, IRQ13 are used on the system board and are not available on the I/O channel.

-IOR (I/O)

The '-I/O read' signal instructs an I/O device to drive its data onto the data bus. This signal may be driven by the system microprocessor or DMA controller, or by a microprocessor or DMA controller resident on the I/O channel. This signal is active low.

-IOW (I/O)

The '-I/O write' signal instructs an I/O device to read the data off the data bus. It may be driven by any microprocessor or DMA controller in the system. This signal is active low.

-SMEMR (O) -MEMR (I/O)

These signals instruct the memory devices to drive data onto the data bus. -SMEMR is active only when the memory decode is within the low 1M of memory space. -MEMR is active on all memory read cycles. -MEMR may be driven by any microprocessor or DMA controller in the system. -SMEMR is derived from -MEMR and the decode of the low 1M of memory. When a microprocessor on the I/O channel wishes to drive -MEMR, it must have the address lines valid on the bus for one clock cycle before driving -MEMR active. Both signals are active low.

-SMEMW (O) -MEMW (I/O)

These signals instruct the memory devices to store the data present on the data bus. -SMEMW is active only when the memory decode is within the low 1M of the memory space. -MEMW is active on all memory write cycles. -MEMW may be driven by any microprocessor or DMA controller in the system. -SMEMW is derived from -MEMW and the decode of the low 1M of memory. When a microprocessor on the I/O channel wishes to drive -MEMW, it must have the address lines valid on the bus for one clock cycle before driving -MEMW active. Both signals are active low.

DRQ0-DRQ3 and DRQ5-DRQ7 (I)

The 'DMA request' signals 0 through 3 and 5 through 7 are asynchronous channel requests used by peripheral devices and a microprocessor to gain DMA service (or control of the system). They are prioritized, with DRQ0 having the highest priority and DRQ7 the lowest. A request is generated by bringing a DRQ line to an active (high) level. A DRQ line is held high until the corresponding 'DMA acknowledge' (DACK) line goes active. DRQ0 through DRQ3 perform 8-bit DMA transfers; DRQ5 through DRQ7 perform 16-bit transfers. DRQ4 is used on the system board and is not available on the I/O channel.

-DACK0 to -DACK3 and -DACK5 to -DACK7 (O)

-DMA acknowledge 0 through 3 and 5 through 7 are used to acknowledge DMA requests. These signals are active low.

AEN (O)

The 'address enable' signal is used to degate the microprocessor and other devices from the I/O channel to allow DMA transfers to take place. When this line is active, the DMA controller has control of the address bus, the data bus, Read command lines (memory and I/O), and the Write command lines (memory and I/O). This signal is active high.

-REFRESH (I/O)

This signal is used to indicate a refresh cycle and can be driven by a microprocessor on the I/O channel. This signal is active low.

T/C (O)

The 'terminal count' signal provides a high pulse when the terminal count for any DMA channel is reached.

-SBHE (I/O)

The 'system bus high enable' signal indicates a transfer of data on the upper byte of the data bus, SD8 through SD15. Sixteen-bit devices use -SBHE to condition data bus buffers tied to SD8 through SD15. This signal is active low.

-MASTER (I)

This signal is used with a DRQ line to gain control of the system. A processor or DMA controller on the I/O channel may issue a DRQ to a DMA channel in cascade mode and receive a -DACK. Upon receiving the -DACK, a microprocessor may pull -MASTER active (low), which will allow it to control the system address, data, and control lines (a condition known as *tri-state*). After -MASTER is low, the microprocessor must wait one clock cycle before driving the address and data lines, and two clock cycles before issuing a Read or Write command. If this signal is held low for more than 15 microseconds, the system memory may be lost because of a lack of refresh.

-MEM CS16 (I)

The '-memory 16-bit chip select' signal indicates to the system that the present data transfer is a 1 wait-state, 16-bit, memory cycle. It must be derived from the decode of LA17 through LA23. -MEM CS16 is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

-I/O CS16 (I)

The '-I/O 16-bit chip select' signal indicates to the system that the present data transfer is a 16-bit, 1 wait-state, I/O cycle. It is derived from an address decode. -I/O CS16 is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

14.318MHz OSC (0)

The '14.318MHz oscillator' signal is a high-speed clock with a 70-nanosecond period (14.31818 MHz). This signal is not synchronous with the system clock. It has a 50% duty cycle.

0WS (I)

The 'zero wait state' signal tells the microprocessor that it can complete the present bus cycle without inserting any additional wait cycles. In order to run a memory cycle to a 16-bit device without wait cycles, 0WS is derived from an address decode gated with a Read or Write command. 0WS is active low and should be driven with an open collector or tri-state driver capable of sinking 20 mA.

I/O Addresses

The following describes the system board's I/O addresses.

Hex Range	Device
000-01F	DMA Controller 1, 8237A-5
020-03F	Interrupt Controller 1, 8259A, Master
040-05F	Timer, 8254-2
060	8042 (Keyboard)
061	System Board I/O port
064	8042 (Keyboard)
070-07F	Real-Time Clock, NMI (Non-maskable Interrupt) Mask
080-09F	DMA Page Register , 74LS612
0A0-0BF	Interrupt Controller 2, 8259A
0C0-0DF	DMA Controller 2, 8237A-5
0F0	Clear Math Coprocessor Busy
0F1	Reset Math Coprocessor
0F8-0FF	Math Coprocessor
1F0-1F8	Fixed Disk
20C-20D	Reserved
21F	Voice Communications Adapter
278-27F	Parallel Printer Port 2
2B0-2DF	Alternate Enhanced Graphics Adapter
2E1	GPIB (Adapter 0)
2E2 & 2E3	Data Acquisition (Adapter 0)
2F8-2FF	Serial Port 2
300-31F	Prototype Adapter
360-363	PC Network (low address)
364-367	Reserved
368-36B	PC Network (high address)
36C-36F	Reserved
378-37F	Parallel Printer Port 1
380-38F	SDLC, Bisynchronous 2
3A0-3AF	Bisynchronous 1
3B0-3BF	Monochrome Display and Printer Adapter
3C0-3CF	Enhanced Graphics Adapter
3D0-3DF	Color/Graphics Monitor Adapter
3F0-3F7	Diskette Controller
3F8-3FF	Serial Port 1
6E2 & 6E3	Data Acquisition (Adapter 1)
AE2 & AE3	Data Acquisition (Adapter 2)
EE2 & EE3	Data Acquisition (Adapter 3)
22E1	GPIB (Adapter 1)
42E1	GPIB (Adapter 2)
62E1	GPIB (Adapter 3)
82E1	GPIB (Adapter 4)
A2E1	GPIB (Adapter 5)
C2E1	GPIB (Adapter 6)
E2E1	GPIB (Adapter 7)

Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel. The system board decodes up to 10 bits of I/O address information. I/O addresses above 3FF must not conflict with the system board I/O addresses.

I/O Address Map

NMI Controls

During POST, the non-maskable interrupt (NMI) into the 80286 is masked off. The mask bit can be set and reset with system programs as follows:

Mask On (Disable NMI)	Write to I/O address hex 070, with data bit 7 equal to a logical 1.
Mask Off (Enable NMI)	Write to I/O address hex 070, with data bit 7 equal to a logical 0.

Note: At the end of POST, the system enables NMI.

The '-I/O channel check' signal (-I/O CH CK) is used to report noncorrectable errors on RAM adapters on the I/O channel. This check creates an NMI if the NMI is enabled. During POST, the NMI is masked off and -I/O CH CK is disabled. Follow these steps when enabling -I/O CH CK and the NMI.

1. Write data in all I/O RAM-adapter memory locations; this establishes good parity at all locations.

2. Enable -I/O CH CK.

3. Enable the NMI.

Note: All three of these functions are performed by POST.

When a check occurs, an interrupt (NMI) results. Read the status bits to determine the source of the NMI (see the figure, "I/O Address Map" on page 1-38). To determine the location of the failing adapter, write to any memory location within a given adapter. If the parity check was from that adapter, -I/O CH CK is reset to inactive.

I/O Port (Read/Write)

Address hex 061 is a read/write port on the system board.

Input (Read)

The following are the input (read) bit descriptions for this I/O port.

Bit 7 +RAM Parity Check—System board memory parity check.

- **0** No memory parity check error has occurred.
- **1** A memory parity check error has occurred.

  A non-maskable interrupt (NMI) will occur if NMI is enabled. The error bit can be reset by toggling output port hex 061, bit 2, to a 1 and then back to a 0.

Bit 6 +I/O Channel Check—Error on an I/O channel adapter (memory parity error or adapter errors).

- **0** No I/O channel error has occurred.
- **1** An I/O channel error has occurred.

  A non-maskable interrupt (NMI) will occur if NMI is enabled. The error bit can be reset by toggling output port hex 061, bit 3, to a 1 and then back to a 0.

Bit 5 Timer 2 Channel Out—Reflects the level of the Timer 2 output.

Bit 4 Refresh Detect—Toggles every 15 microseconds, indicating normal Refresh activity

Bits 3 to 0 Read the status of bits 3, 2, 1, and 0, respectively, written to output port hex 061.

Output (Write)

The following are the output (write) bit descriptions for the system board I/O port.

Bits 7 to 4	Not used
Bit 3	-Enable I/O Channel Check **0** Enables I/O Channel Check errors. **1** Disables I/O Channel Check errors. During power-up this bit is toggled to a 1, then back to a 0, to clear the I/O channel check flip-flop of previous errors.
Bit 2	-Enable System Board RAM Parity Check **0** Enables system board RAM parity check. **1** Disables system board RAM parity check. During power-up this bit is toggled to a 1, then back to a 0, to clear the RAM parity check flip-flop before BIOS checks the system memory for parity errors.
Bit 1	+Speaker Data—Controls the speaker output (along with Timer 2 Clock output).
Bit 0	+Timer 2 Gate Speaker **0** Disables 8254 Timer 2 clock input (1.19 MHz). **1** Enables 8254 Timer 2 clock input (1.19 MHz).

Diagnostic-Checkpoint Port

I/O address hex 080 is used as a diagnostic-checkpoint port or register. This port corresponds to a read/write register in the DMA page register (74LS612). This port is used by POST during power up.

Coprocessor Controls

The following is a description of the Math Coprocessor controls.

0F0 An 8-bit Out command to port F0 will clear the latched Math Coprocessor '-busy' signal. The '-busy' signal will be latched if the coprocessor asserts its '-error' signal while it is busy. The data output should be zero.

0F1 An 8-bit Out command to port F1 will reset the Math Coprocessor. The data output should be zero.

Other Circuits

Speaker

The system unit has a 2-1/4 inch permanent-magnet speaker, which can be driven from:

- The I/O-port output bit
- The timer/counter's CLK OUT 2
- Both of the above

128K RAM Jumper (J10)

The system board has a three-pin, Berg-strip connector (J10). From the rear of the system to the front, the pins are numbered 1 through 3. Jumper placement across these pins determines whether the last 128K RAM (512KB to 640KB) of system board memory is enabled or disabled.

Pin	Assignments
1	No Connection
2	Ground
3	RAM Select

RAM Jumper Connector (J10)

With the jumper on pins 1 and 2, the 128K RAM is enabled. When the jumper is on pins 2 and 3, the 128K RAM is disabled.

Note: The normal mode is the enabled mode.

Display Switch

Set the slide switch on the system board to select the primary display adapter. Its positions are assigned as follows:

On (toward the front of the system unit): The primary display is attached to the Color/Graphics Monitor Adapter.

Off (toward the rear of the system unit): The primary display is attached to the Monochrome Display and Printer Adapter.

The switch may be set to either position if the primary display is attached to an Enhanced Graphics Adapter.

> **Note:** The primary display is activated when the system is powered on.

Keyboard Controller

The keyboard controller is a single-chip microcomputer (Intel 8042, or EPROM version 8742) that is programmed to support the keyboard serial interface. The keyboard controller receives serial data from the keyboard, checks the parity of the data, translates scan codes, and presents the data to the system as a byte of data in its output buffer. The controller can interrupt the system when data is placed in its output buffer, or wait for the system to poll its status register to determine when data is available.

Data is sent to the keyboard by first polling the controller's status register to determine when the input buffer is ready to accept data and then writing to the input buffer. Each byte of data is sent to the keyboard serially with an odd parity bit automatically inserted. Since the keyboard is required to acknowledge all data transmissions, another byte of data should not be sent to the keyboard until acknowledgement is received for the previous byte sent. The output-buffer-full interrupt may be used for both send and receive routines.

Keyboard Controller Initialization

At power-on, the keyboard controller sets the system flag bit to 0. After a power-on reset or the execution of the Self Test command, the keyboard controller disables the keyboard interface by forcing the 'keyboard clock' line low. The keyboard interface parameters are specified at this time by writing to locations within the 8042 RAM. The keyboard-inhibit function is then disabled by setting the inhibit-override bit in the command byte. A hex 55 is then placed in the output buffer if no errors are detected during the self test. Any value other than hex 55 indicates that the 8042 is defective. The keyboard interface is now enabled by lifting the 'keyboard data' and 'keyboard clock' signal lines, and the system flag is set to 1. The keyboard controller is then ready to accept commands from the system unit microprocessor or receive keyboard data.

The initialization sequence causes the keyboard to establish Mode 2 protocol (see "Data Stream" on page 4-27).

Receiving Data from the Keyboard

The keyboard sends data in a serial format using an 11-bit frame. The first bit is a start bit, and is followed by eight data bits, an odd parity bit, and a stop bit. Data sent is synchronized by a clock supplied by the keyboard. At the end of a transmission, the keyboard controller disables the interface until the system accepts the byte. If the byte of data is received with a parity error, a Resend command is automatically sent to the keyboard. If the keyboard controller is unable to receive the data correctly after a set number of retries, a hex FF is placed in its output buffer, and the parity bit in the status register is set to 1, indicating a receive parity error. The keyboard controller will also time a byte of data from the keyboard. If a keyboard transmission does not end within 2 milliseconds, a hex FF is placed in the keyboard controller's output buffer, and the receive time-out bit in the status register is set. No retries will be attempted on a receive time-out error.

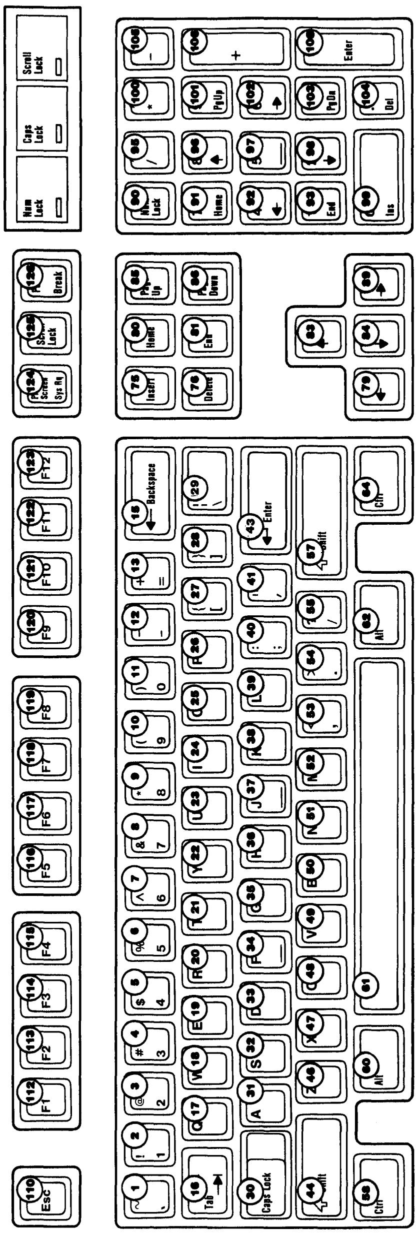
Note: When a receive error occurs in the default mode (bits 5, 6, and 7 of the command byte set to 0), hex 00 is placed in the output buffer instead of hex FF. See

"Commands (I/O Address Hex 64)" on page 1-56 for a detailed description of the command byte.

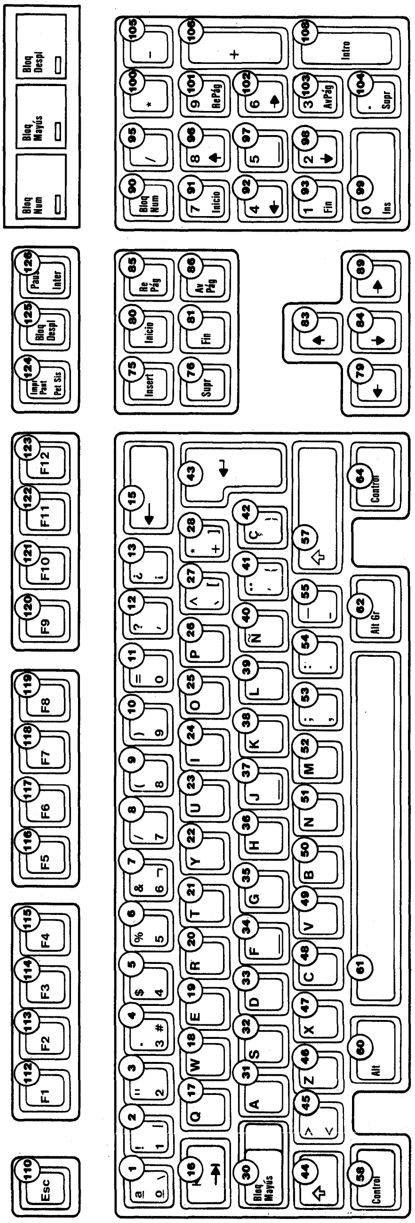
Scan Code Translation

Scan codes received from the keyboard are converted by the keyboard controller before being placed into the controller's output buffer. The following figures show the keyboard layouts. Each key position is numbered for reference.

101-Key Keyboard



102-Key Keyboard



The following figure is the scan-code translation table.

System Scan Code	Keyboard Scan Code	Key (101/102-key)
01	76	110
02	16	2
03	1E	3
04	26	4
05	25	5
06	2E	6
07	36	7
08	3D	8
09	3E	9
0A	46	10
0B	45	11
0C	4E	12
0D	55	13
0E	66	15
0F	0D	16
10	15	17
11	1D	18
12	24	19
13	2D	20
14	2C	21
15	35	22
16	3C	23
17	43	24
18	44	25
19	4D	26
1A	54	27
1B	5B	28
1C	5A	43
1D	14	58
1E	1C	31
1F	1B	32
20	23	33
21	2B	34
22	34	35
23	33	36
24	3B	37
25	42	38
26	4B	39
27	4C	40
28	52	41
29	0E	1
2A	12	44
2B	5D	29 (U.S. only) 42 (except U.S.)
2C	1A	46
2D	22	47
2E	21	48
2F	2A	49

Scan-Code Translation Table (Part 1 of 3)

System Scan Code	Keyboard Scan Code	Key (101/102-key)
30	32	50
31	31	51
32	3A	52
33	41	53
34	49	54
35	4A	55
36	59	57
38	11	60
39	29	61
3A	58	30
3B	05	112
3C	06	113
3D	04	114
3E	0C	115
3F	03	116
40	0B	117
41	83	118
42	0A	119
43	01	120
44	09	121
45	77	90
46	7E	125
47	6C	91
48	75	96
49	7D	101
4A	7B	105
4B	6B	92
4C	73	97
4D	74	102
4E	79	106
4F	69	93
50	72	98
51	7A	103
52	70	99
53	71	104
54	7F or 84	-
56	61	45 (except U.S.)
57	78	122
58	07	123
FF	00	-
E0 2A E0 37	E0 12 E0 7C	124
E0 1C	E0 5A	108
E0 1D	E0 14	64
E0 35	E0 4A	95
E0 37	7C	100
E0 38	E0 11	62
E0 47	E0 6C	80

Scan-Code Translation Table (Part 2 of 3)

System Scan Code	Keyboard Scan Code	Key (101/102-key)
E0 48	F0 47 75	83
E0 49	F0 47 7D	85
E0 4B	F0 47 6B	79
E0 4D	F0 47 74	89
E0 4F	F0 47 69	81
E0 50	F0 47 72	84
E0 51	F0 47 7A	86
E0 52	F0 47 70	75
E0 53	F0 47 71	76
E1 1D 45 E1 9D C5	E1 14 77 E1 F0 14 F0 77	126

Scan-Code Translation Table (Part 3 of 3)

The following scan codes are reserved.

Key	Keyboard Scan Code	System Scan Code
Reserved	60	55
Reserved	61	56
Reserved	78	57
Reserved	07	58
Reserved	0F	59
Reserved	17	5A
Reserved	1F	5B
Reserved	27	5C
Reserved	2F	5D
Reserved	37	5E
Reserved	3F	5F
Reserved	47	60
Reserved	4F	61
Reserved	56	62
Reserved	5E	63
Reserved	08	64
Reserved	10	65
Reserved	18	66
Reserved	20	67
Reserved	28	68
Reserved	30	69
Reserved	38	6A
Reserved	40	6B
Reserved	48	6C
Reserved	50	6D
Reserved	57	6E
Reserved	6F	6F
Reserved	13	70
Reserved	19	71
Reserved	39	72
Reserved	51	73
Reserved	53	74
Reserved	5C	75
Reserved	5F	76
Reserved	62	77
Reserved	63	78
Reserved	64	79
Reserved	65	7A
Reserved	67	7B
Reserved	68	7C
Reserved	6A	7D
Reserved	6D	7E
Reserved	6E	7F

Reserved Scan-Code Translation Table

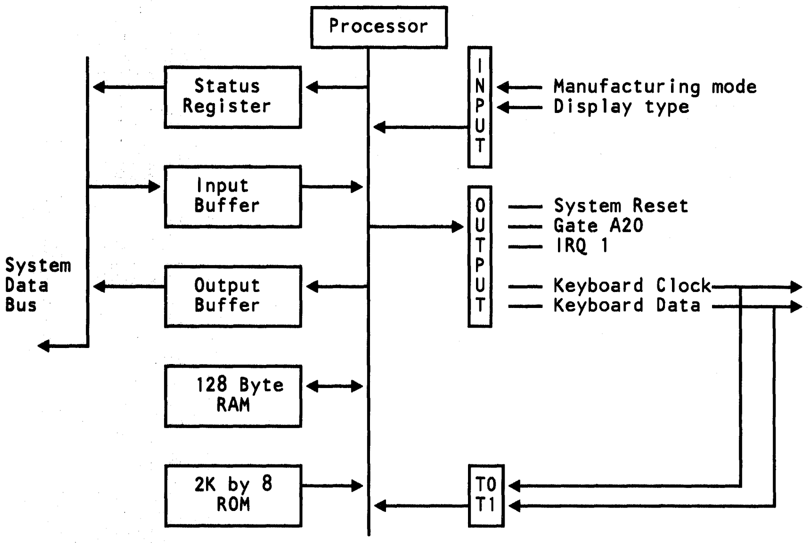
Sending Data to the Keyboard

The keyboard sends data in the same serial format used to receive data from the keyboard. A parity bit is automatically inserted by the keyboard controller. If the keyboard does not start clocking the data from the keyboard controller within 15 milliseconds, or complete that clocking within 2 milliseconds, a hex FE is placed in the keyboard controller's output buffer, and the transmit time-out error bit is set in the status register.

The keyboard is required to respond to all transmissions. The keyboard responds to any valid command and parameter, other than Echo and Resend, with an Acknowledge (ACK) response, hex FA. If the response contains a parity error, the keyboard controller places a hex FE in its output buffer, and the transmit time-out and parity error bits are set in the status register. The keyboard controller is programmed to set a 25-millisecond time limit for the keyboard to respond. If this time limit is exceeded, the keyboard controller places a hex FE in its output buffer and sets the transmit time-out and receive time-out error bits in the status register. No retries are attempted by the keyboard controller for any transmission error.

Keyboard Controller System Interface

The keyboard controller communicates with the system through a status register, an output buffer, and an input buffer. The following figure is a block diagram of the keyboard interface.



Keyboard Controller Interface Block Diagram

Status Register

The status register is an 8-bit read-only register at I/O address hex 64. It has information about the state of the keyboard controller (8042) and interface. It may be read at any time.

Status-Register Bit Definition

Bit 7 Parity Error—A 0 indicates the last byte of data received from the keyboard had odd parity. A 1 indicates the last byte had even parity. The keyboard should send data with odd parity.

Bit 6 Receive Time-Out—A 1 indicates that a transmission was started by the keyboard but did not finish within the programmed receive time-out delay.

Bit 5 Transmit Time-Out—A 1 indicates that a transmission started by the keyboard controller was not properly completed. If the transmit byte was not clocked out within the specified time limit, this will be the only error bit on.

If the transmit byte was clocked out but a response was not received within the programmed time limit, the transmit time-out and receive time-out error bits are set to 1. If the transmit byte was clocked out but the response was received with a parity error, the transmit time-out and parity error bits are set to 1.

Bit 4 Always set to 1.

Bit 3 Command/Data—The keyboard controller's input buffer may be addressed as either I/O address hex 60 or 64. Address hex 60 is defined as the data port, and address hex 64 is defined as the command port. Writing to address hex 64 sets this bit to 1; writing to address hex 60 sets this bit to 0. The controller uses this bit to determine if the byte in its input buffer should be interpreted as a command byte or a data byte.

Bit 2 System Flag—This bit is monitored by the system during the reset routine. If it is a 0, the reset was caused by a power on. The controller sets this bit to 0 at power on and it is set to 1 after a successful self test. This bit can be changed by writing to the system flag bit in the command byte (hex 64).

Bit 1 Input Buffer Full—A 0 indicates that the keyboard controller's input buffer (I/O address hex 60 or 64) is empty. A 1 indicates that data has been written into the buffer but the controller has not read the data. When the controller reads the input buffer, this bit will return to 0.

Bit 0 Output Buffer Full—A 0 indicates that the keyboard controller's output buffer has no data. A 1 indicates that the controller has placed data into its output buffer but the system has not yet read the data. When the system reads the output buffer (I/O address hex 60), this bit will return to a 0.

Output Buffer

The output buffer is an 8-bit read-only register at I/O address hex 60. The keyboard controller uses the output buffer to send scan codes received from the keyboard, and data bytes requested by command, to the system. The output buffer should be read only when the output-buffer-full bit in the status register is 1.

Input Buffer

The input buffer is an 8-bit write-only register at I/O address hex 60 or 64. Writing to address hex 60 sets a flag, which indicates a data write; writing to address hex 64 sets a flag, indicating a command write. Data written to I/O address hex 60 is sent to the keyboard, unless the keyboard controller is expecting a data byte following a controller command. Data should be written to the controller's input buffer only if the input buffer's full bit in the status register is 0. The following are valid keyboard controller commands.

Commands (I/O Address Hex 64)

20 Read Keyboard Controller's Command Byte—The controller sends its current command byte to its output buffer.

60 Write Keyboard Controller's Command Byte—The next byte of data written to I/O address hex 60 is placed in the controller's command byte. Bit definitions of the command byte are as follows:

Bit 7 Reserved—Should be written as a 0.

Bit 6 IBM Personal Computer Compatibility Mode—Writing a 1 to this bit causes the controller to convert the scan codes received from the keyboard to those used by the IBM Personal Computer. This includes converting a 2-byte break sequence to the 1-byte IBM Personal Computer format.

Bit 5 IBM Personal Computer Mode—Writing a 1 to this bit programs the keyboard to support the IBM Personal Computer keyboard interface. In this mode the controller does not check parity or convert scan codes.

Bit 4 Disable Keyboard—Writing a 1 to this bit disables the keyboard interface by driving the 'clock' line low. Data is not sent or received.

Bit 3 Not used.

Bit 2 System Flag—The value written to this bit is placed in the system flag bit of the controller's status register.

Bit 1 Reserved—Should be written as a 0.

Bit 0 Enable Output-Buffer-Full Interrupt—Writing a 1 to this bit causes the controller to generate an interrupt when it places data into its output buffer.

AA Self-Test—This commands the controller to perform internal diagnostic tests. A hex 55 is placed in the output buffer if no errors are detected.

AB Interface Test—This commands the controller to test the 'keyboard clock' and 'keyboard data' lines. The test result is placed in the output buffer as follows:

00	No error detected.
01	The 'keyboard clock' line is stuck low.
02	The 'keyboard clock' line is stuck high.
03	The 'keyboard data' line is stuck low.
04	The 'keyboard data' line is stuck high.

AD Disable Keyboard Feature—This command sets bit 4 of the controller's command byte. This disables the keyboard interface by driving the clock line low. Data will not be sent or received.

AE Enable Keyboard Interface—This command clears bit 4 of the command byte, which releases the keyboard interface.

C0 Read Input Port—This commands the controller to read its input port and place the data in its output buffer. This command should be used only if the output buffer is empty.

D0 Read Output Port—This command causes the controller to read its output port and place the data in its output buffer. This command should be issued only if the output buffer is empty.

D1 Write Output Port—The next byte of data written to I/O address hex 60 is placed in the controller's output port.

> **Note:** Bit 0 of the controller's output port is connected to System Reset. This bit should not be written low as it will reset the microprocessor.

E0 Read Test Inputs—This command causes the controller to read its T0 and T1 inputs. This data is placed in the output buffer. Data bit 0 represents T0, and data bit 1 represents T1.

F0–FF Pulse Output Port—Bits 0 through 3 of the controller's output port may be pulsed low for approximately 6 microseconds. Bits 0 through 3 of this command indicate which bits are to be pulsed. A 0 indicates that the bit should be pulsed, and a 1 indicates the bit should not be modified.

> **Note:** Bit 0 of the controller's output port is connected to System Reset. Pulsing this bit resets the microprocessor.

I/O Ports

The keyboard controller has two I/O ports, one assigned for input and the other for output. Two test inputs are used by the controller to read the state of the keyboard's 'clock' (T0) and 'data' (T1) lines.

The following figures show bit definitions for the input and output ports, and the test-inputs.

Bit 7	Always set to 1
Bit 6	Display switch - Primary display attached to: 0 = Color/Graphics adapter 1 = Monochrome adapter
Bit 5	Manufacturing Jumper 0 = Manufacturing jumper installed 1 = Jumper not installed
Bit 4	Always set to 1
Bit 3	Reserved
Bit 2	Reserved
Bit 1	Reserved
Bit 0	Reserved

Input-Port Bit Definitions

Bit 7	Keyboard data (output)
Bit 6	Keyboard clock (output)
Bit 5	Input buffer empty
Bit 4	Output buffer full
Bit 3	Reserved
Bit 2	Reserved
Bit 1	Gate A20
Bit 0	System reset

Output-Port Bit Definitions

Note: In the real address mode Gate A20 prevents address line A20 from being set, maintaining compatibility with the 8088 microprocessor. When in the protected (virtual address) mode, Gate A20 allows addressing above the 1M range.

T1	Keyboard data (input)
T0	Keyboard clock (input)

Test-Input Bit Definitions

Real-Time Clock CMOS RAM Information

The RTC (Real-time Clock) CMOS RAM chip (Motorola MC146818A) contains the real-time clock and 64 bytes of CMOS RAM. The internal clock circuitry uses 14 bytes of this RAM, and the rest is allocated to configuration information. The following figure shows the CMOS RAM addresses.

Addresses	Description
00 - 0D	* Real-time clock information
0E	* Diagnostic status byte
0F	* Shutdown status byte
10	Diskette drive type byte - drives A and B
11	Reserved
12	Fixed disk types byte - drives C and D
13	Reserved
14	Equipment byte
15	Low base memory byte
16	High base memory byte
17	Low expansion memory byte
18	High expansion memory byte
19	Disk C extended byte
1A	Disk D extended byte
1B - 2D	Reserved
2E - 2F	2-byte CMOS checksum
30	* Low expansion memory byte
31	* High expansion memory byte
32	* Date century byte
33	* Information flags (set during power on)
34 - 3F	Reserved

CMOS RAM Internal Address Map

* These bytes are not included in the checksum calculation and are not part of the configuration record.

Real-Time Clock Information

The following figure describes real-time clock bytes and specifies their addresses.

Byte	Function	Address
0	Seconds	00
1	Second Alarm	01
2	Minutes	02
3	Minute Alarm	03
4	Hours	04
5	Hour Alarm	05
6	Day of Week	06
7	Date of Month	07
8	Month	08
9	Year	09
10	Status Register A	0A
11	Status Register B	0B
12	Status Register C	0C
13	Status Register D	0D

Real-Time Clock Internal Addresses 00 - 0D

Note: The setup program initializes registers A, B, C, and D when the time and date are set. Also Interrupt 1A is the BIOS interface to read/set the time and date. It initializes the status bytes the same as the Setup program.

Status Register A

Bit 7	Update in Progress (UIP)—A 1 indicates the time update cycle is in progress. A 0 indicates the current date and time are available to read.
Bit 6–Bit 4	22-Stage Divider (DV2 through DV0)—These three divider-selection bits identify which time-base frequency is being used. The system initializes the stage divider to 010, which selects a 32.768-kHz time base.
Bit 3–Bit 0	Rate Selection Bits (RS3 through RS0)—These bits allow the selection of a divider output frequency. The system initializes the rate selection bits to 0110, which selects a 1.024-kHz square wave output frequency and a 976.562-microsecond periodic interrupt rate.

Status Register B

Bit 7	Set—A 0 updates the cycle normally by advancing the counts at one-per-second. A 1 aborts any update cycle in progress and the program can initialize the 14 time-bytes without any further updates occurring until a 0 is written to this bit.
Bit 6	Periodic Interrupt Enable (PIE)—This bit is a read/write bit that allows an interrupt to occur at a rate specified by the rate and divider bits in register A. A 1 enables an interrupt, and a 0 disables it. The system initializes this bit to 0.
Bit 5	Alarm Interrupt Enable (AIE)—A 1 enables the alarm interrupt, and a 0 disables it. The system initializes this bit to 0.

Bit 4	Update-Ended Interrupt Enabled (UIE)—A 1 enables the update-ended interrupt, and a 0 disables it. The system initializes this bit to 0.
Bit 3	Square Wave Enabled (SQWE)—A 1 enables the the square-wave frequency as set by the rate selection bits in register A, and a 0 disables the square wave. The system initializes this bit to 0.
Bit 2	Date Mode (DM)—This bit indicates whether the time and date calendar updates are to use binary or binary coded decimal (BCD) formats. A 1 indicates binary, and a 0 indicates BCD. The system initializes this bit to 0.
Bit 1	24/12—This bit indicates whether the hours byte is in the 24-hour or 12-hour mode. A 1 indicates the 24-hour mode and a 0 indicates the 12-hour mode. The system initializes this bit to 1.
Bit 0	Daylight Savings Enabled (DSE)—A 1 enables daylight savings and a 0 disables daylight savings (standard time). The system initializes this bit to 0.

Status Register C

Bit 7–Bit 4	IRQF, PF, AF, UF—These flag bits are read-only and are affected when the AIE, PIE, and UIE bits in register B are set to 1.
Bit 3–Bit 0	Reserved—Should be written as a 0.

Status Register D

Bit 7	Valid RAM Bit (VRB)—This bit is read-only and indicates the status of the power-sense pin (battery level). A 1 indicates battery power to the real-time clock is good. A 0 indicates the battery is dead, so RAM is not valid.

Bits 6–Bit 0	Reserved—Should be written as a 0.

CMOS RAM Configuration Information

The following lists show bit definitions for the CMOS configuration bytes (addresses hex 0E – 3F).

Diagnostic Status Byte (Hex 0E)

Bit 7 Power status of the real-time clock chip—A 0 indicates that the chip has not lost power (battery good), and a 1 indicates that the chip lost power (battery bad).

Bit 6 Configuration Record (Checksum Status Indicator)—A 0 indicates that checksum is good, and a 1 indicates it is bad.

Bit 5 Incorrect Configuration Information—This is a check, at power-on time, of the equipment byte of the configuration record. A 0 indicates that the configuration information is valid, and a 1 indicates it is invalid. Power-on checks require:

- At least one diskette drive to be installed (bit 0 of the equipment byte set to 1).
- The primary display adapter setting in configuration matches the system board's display switch setting and the actual display adapter hardware in the system.

Bit 4 Memory Size Comparison—A 0 indicates that the power-on check determined the same memory size as in the configuration record, and a 1 indicates the memory size is different.

Bit 3 Fixed Disk Adapter/Drive C Initialization Status—A 0 indicates that the adapter and drive are functioning properly and the system can attempt "boot up." A 1 indicates that the adapter

	and/or drive C failed initialization, which prevents the system from attempting to "boot up."
Bit 2	Time Status Indicator (POST validity check)— A 0 indicates that the time is valid, and a 1 indicates that it is invalid.
Bit 1–Bit 0	Reserved

Shutdown Status Byte (Hex 0F)

The bits in this byte are defined by the power on diagnostics. For more information about this byte, refer to "System BIOS".

Diskette Drive Type Byte (Hex 10)

Bit 7–Bit 4 Type of first diskette drive installed:

0000	No drive is present.
0001	Double Sided Diskette Drive (48 TPI).
0010	High Capacity Diskette Drive (96 TPI).
0011	720KB Diskette Drive (3.5 inch).

Note: 0100 through 1111 are reserved.

Bit 3–Bit 0 Type of second diskette drive installed:

0000	No drive is present.
0001	Double Sided Diskette Drive (48 TPI).
0010	High Capacity Diskette Drive (96 TPI).
0011	720KB Diskette Drive (3.5 inch).

Note: 0100 through 1111 are reserved.

Hex address 11 contains a reserved byte.

Fixed Disk Type Byte (Hex 12)

Bit 7–Bit 4 Defines the type of fixed disk drive installed (drive C):

0000 No fixed disk drive is present.

0001 to 1110 Define type 1 through type 14 as shown in the following table (also see BIOS listing at label FD_TBL)

1111 Type 16 through 255. See "Drive C Extended Byte (Hex 19)" on page 1-68.

Bit 3–Bit 0 Defines the type of second fixed disk drive installed (drive D):

0000 No fixed disk drive is present.

0001 to 1110 Define type 1 through type 14 as shown in the following table (also see BIOS listing at label FD_TBL)

1111 Type 16 through 255. See "Drive D Extended Byte (Hex 1A)" on page 1-68.

The following table shows the BIOS fixed disk parameters.

Type	Cylinders	Heads	Write Precomp	Landing Zone
1	306	4	128	305
2	615	4	300	615
3	615	6	300	615
4	940	8	512	940
5	940	6	512	940
6	615	4	None	615
7	462	8	256	511
8	733	5	None	733
9	900	15	None	901
10	820	3	None	820
11	855	5	None	855
12	855	7	None	855
13	306	8	128	319
14	733	7	None	733
15	Extended Parameters (hex 19 and 1A)			

BIOS Fixed Disk Parameters

Hex address 13 contains a reserved byte.

Equipment Byte (Hex 14)

Bit 7–Bit 6	Indicates the number of diskette drives installed: **00** 1 drive **01** 2 drives **10** Reserved **11** Reserved
Bit 5–Bit 4	Primary display **00** Primary display is attached to an adapter that has its own BIOS, such as the Enhanced Graphics Adapter **01** Primary display is in the 40-column mode and attached to the Color/Graphics Monitor Adapter. **10** Primary display is in the 80-column mode and attached to the Color/Graphics Monitor Adapter. **11** Primary display is attached to the Monochrome Display and Printer Adapter.
Bit 3–Bit 2	Not used.
Bit 1	Math Coprocessor presence bit: **0** Math Coprocessor not installed **1** Math Coprocessor installed
Bit 0	Diskette drive presence bit: **0** Diskette drive not installed **1** Diskette drive installed

Note: The equipment byte defines basic equipment in the system for power-on diagnostics.

Low and High Base Memory Bytes (Hex 15 and 16)

Bit 7–Bit 0	Address hex 15—Low-byte base size
Bit 7–Bit 0	Address hex 16—High-byte base size

Valid Sizes:

0200H	512K–system board RAM
0280H	640K–system board RAM.

Low and High Expansion Memory Bytes (Hex 17 and 18)

Bit 7–Bit 0	Address hex 17—Low-byte expansion size
Bit 7-Bit 0	Address hex 18—High-byte expansion size

Valid Sizes:

0200H	512K–Expansion Memory
0400H	1024K–Expansion Memory
0600H	1536K–Expansion Memory
through	
3C00H	15360K–Expansion Memory (15M maximum).

Drive C Extended Byte (Hex 19)

Bit 7–Bit 0 Defines the type of first fixed disk drive installed (drive C):

00000000 through 00001111 are reserved.

00010000 to 11111111 define type 16 through 255 as shown in the following table (see BIOS listing at label FD_TBL).

Drive D Extended Byte (Hex 1A)

Bit 7–Bit 0 Defines the type of second fixed disk drive installed (drive D):

00000000 through 00001111 are reserved.

00010000 to 11111111 define type 16 through 255 as shown in the following table (see BIOS listing at label FD_TBL).

The following table shows the BIOS fixed disk parameters for fixed disk drive types 16 through 24.

Note: Types 25 through 255 are reserved.

Type	Cylinders	Heads	Write Precomp	Landing Zone
16	612	4	All Cylinders	663
17	977	5	300	977
18	977	7	None	977
19	1024	7	512	1023
20	733	5	300	732
21	733	7	300	732
22	733	5	300	733
23	306	4	None	336
24	612	4	305	663
25	Reserved			
.	.			
.	.			
255	Reserved			

BIOS Fixed Disk Parameters (Extended)

Hex addresses 1B through 2D are reserved.

Checksum (Hex 2E and 2F)

Bit 7–Bit 0	Address hex 2E—High byte of checksum
Bit 7–Bit 0	Address hex 2F—Low byte of checksum

Note: Checksum is calculated on addresses hex 10-2D.

Low and High Expansion Memory Bytes (Hex 30 and 31)

Bit 7–Bit 0	Address hex 30—Low-byte expansion size
Bit 7–Bit 0	Address hex 31—High-byte expansion size

Valid Sizes:

0200H	512K–Expansion Memory
0400H	1024K–Expansion Memory
0600H	1536K–Expansion Memory
through	
3C00H	15360K–Expansion Memory (15M maximum).

Note: These bytes reflect the total expansion memory above the 1M address space as determined at power-on time. This expansion memory size can be determined through system interrupt 15 (see the BIOS listing). The base memory at power-on time is determined through the system memory-size-determine interrupt (hex 12).

Date Century Byte (Hex 32)

Bit 7–Bit 0	BCD value for the century (BIOS interface to read and set).

Information Flag (Hex 33)

Bit 7	When set, this bit indicates that the top 128K of base memory is installed.
Bit 6	This bit is set to instruct the Setup utility to put out a first user message after initial setup.
Bit 5–Bit 0	Reserved

Hex addresses 34 through 3F are reserved.

I/O Operations

Writing to RTC CMOS RAM involves two steps:

1. OUT to port hex 70 with the internal CMOS address. Bits D0 - D5 contain the required address.

   Note: Bits D6 and D7 do not go to RTC CMOS RAM. D6 is a "don't care" bit. D7 is the value of the NMI mask: writing a 1 to D7 disables NMI; writing a 0 to D7 enables NMI.

2. OUT to port hex 71 with the data to be written.

Reading CMOS RAM also requires two steps:

1. OUT to port hex 70 with the internal CMOS address. Bits D0 - D5 contain the required address.

   Note: Bits D6 and D7 do not go to RTC CMOS RAM. D6 is a "don't care" bit. D7 is the value of the NMI mask: writing a 1 to D7 disables NMI; writing a 0 to D7 enables NMI.

2. IN from port hex 71, and the data read is returned in the AL register.

Note: Execute the steps in the order shown to ensure acknowledgement of the MC146818A Standby lead during system power-downs.

Specifications

System Unit

Size

- Length: 500 millimeters (19.6 inches)
- Depth: 410 millimeters (16.1 inches)
- Height: 142 millimeters (5.5 inches)

Weight

- 12.7 kilograms (28 pounds)

Power Cables

- Length: 1.8 meters (6 feet)

Environment

- Air Temperature
  - System On: 15.6 to 32.2 degrees C (60 to 90 degrees F)
  - System Off: 10 to 43 degrees C (50 to 110 degrees F)
- Wet Bulb Temperature
  - System On: 22.8 degrees C (73 degrees F)
  - System Off: 26.7 degrees C (80 degrees F)
- Humidity
  - System On: 8% to 80%

- System Off: 20% to 80%

- Altitude
  - Maximum altitude: 2545.1 meters (8350 feet)

Heat Output

- 824 British Thermal Units (BTU) per hour

Noise Level

- Operating (without display or printer) - 46 decibels (dba) maximum noise level.

Electrical

- Range 1 (57-63 Hz)
  - Nominal: 115 Vac
  - Minimum: 90 Vac
  - Maximum: 137 Vac
- Range 2 (47-53 Hz)
  - Nominal: 230 Vac
  - Minimum: 180 Vac
  - Maximum: 265 Vac
- Lithium Battery
  - 6.0 Vdc
  - 1 Ampere/Hour Capacity
  - UL Approved.

Connectors

The system board has the following additional connectors:

- One power supply connector (P1)
- Battery connector (P2)
- Speaker connector (P3)
- Keyboard connector (J9).

The pin assignments for the system board connector (P1) and the power supply connectors P8 and P9, are as follows. Beginning at the rear of the system, the pins on the system board connector are numbered 1 through 12. Power supply connector P8 attaches to system board connector P1, pins 1 through 6. P9 connects to P1, pins 7 through 12.

System Board Connector	Pin	Assignments	Power Supply Connector	Pin
P1	1	Power Good	P8	1
	2	+5 Vdc		2
	3	+12 Vdc		3
	4	-12 Vdc		4
	5	Ground		5
	6	Ground		6
	7	Ground	P9	1
	8	Ground		2
	9	-5 Vdc		3
	10	+5 Vdc		4
	11	+5 Vdc		5
	12	+5 Vdc		6

System Board Connector (P1) to Power Supply Connectors (P8 and P9)

The battery connector, P2, is a four-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the rear of the system. The pin assignments are:

Pin	Assignments
1	+6 Vdc
2	Key
3	Ground
4	Ground

Battery Connector (P2)

The speaker connector, P3, is a four-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the rear of the system. The pin assignments are:

Pin	Function
1	Data out
2	Key
3	Ground
4	+5 Vdc

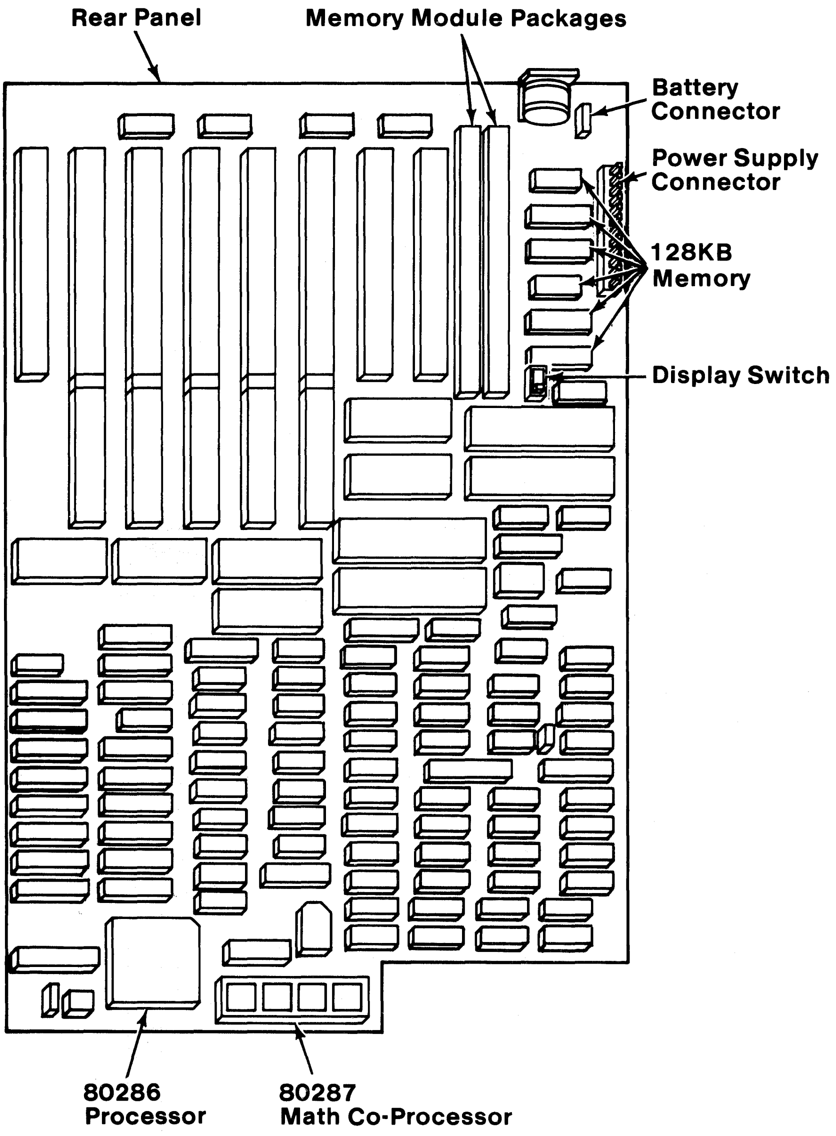
Speaker Connector (P3)

The keyboard connector, J9, is a five-pin, 90-degree Printed Circuit Board (PCB) mounting, DIN connector. For pin numbering, see the "Keyboard" Section. The pin assignments are:

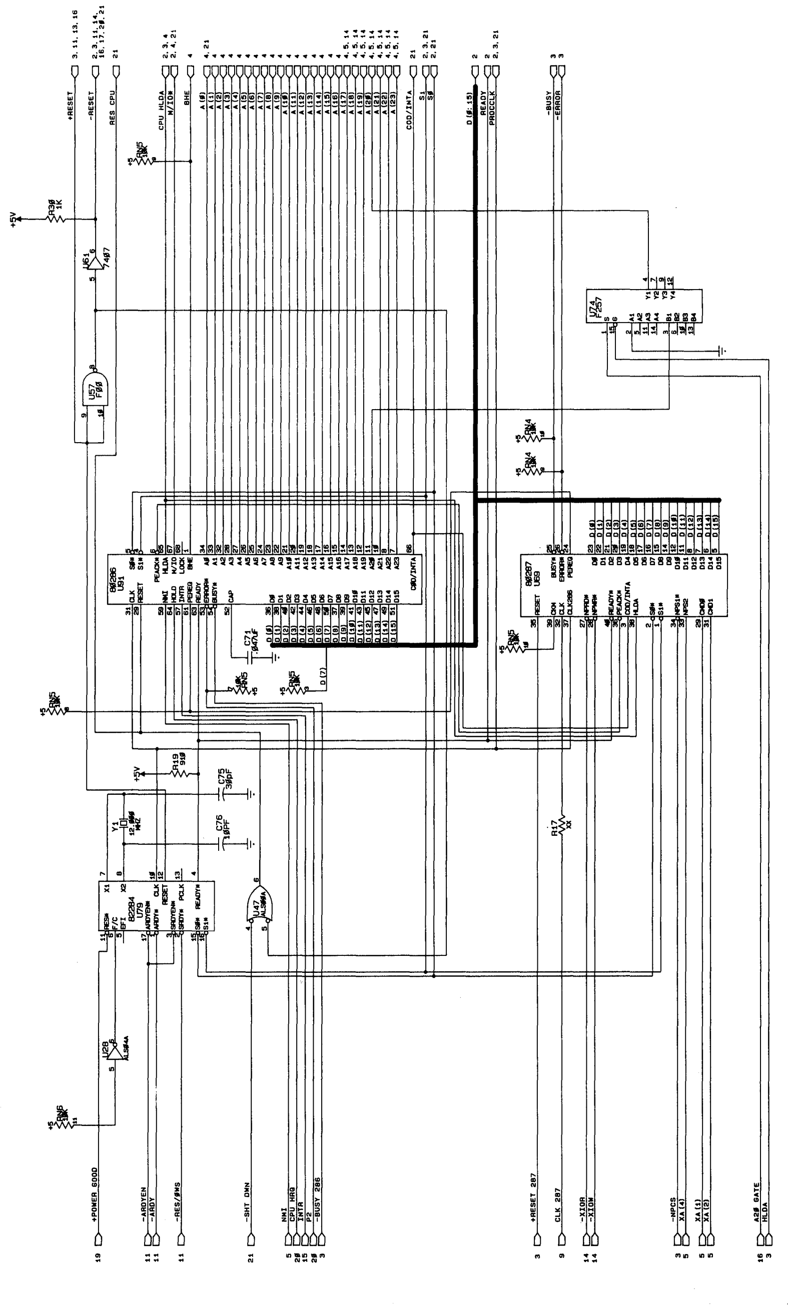
Pin	Assignments
1	Keyboard Clock
2	Keyboard Data
3	Reserved
4	Ground
5	+5 Vdc

Keyboard Connector (J9)

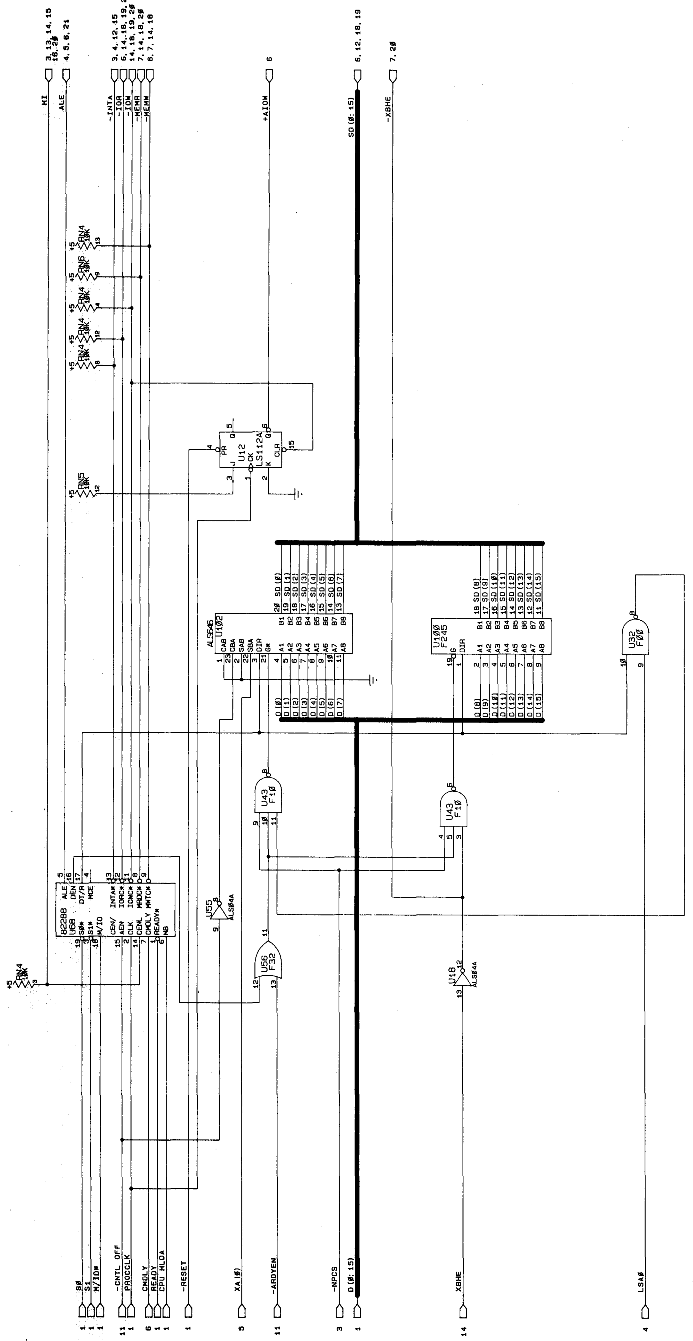
The following figure shows the layout of the system board.



Logic Diagrams



System Board (Sheet 1 of 22)



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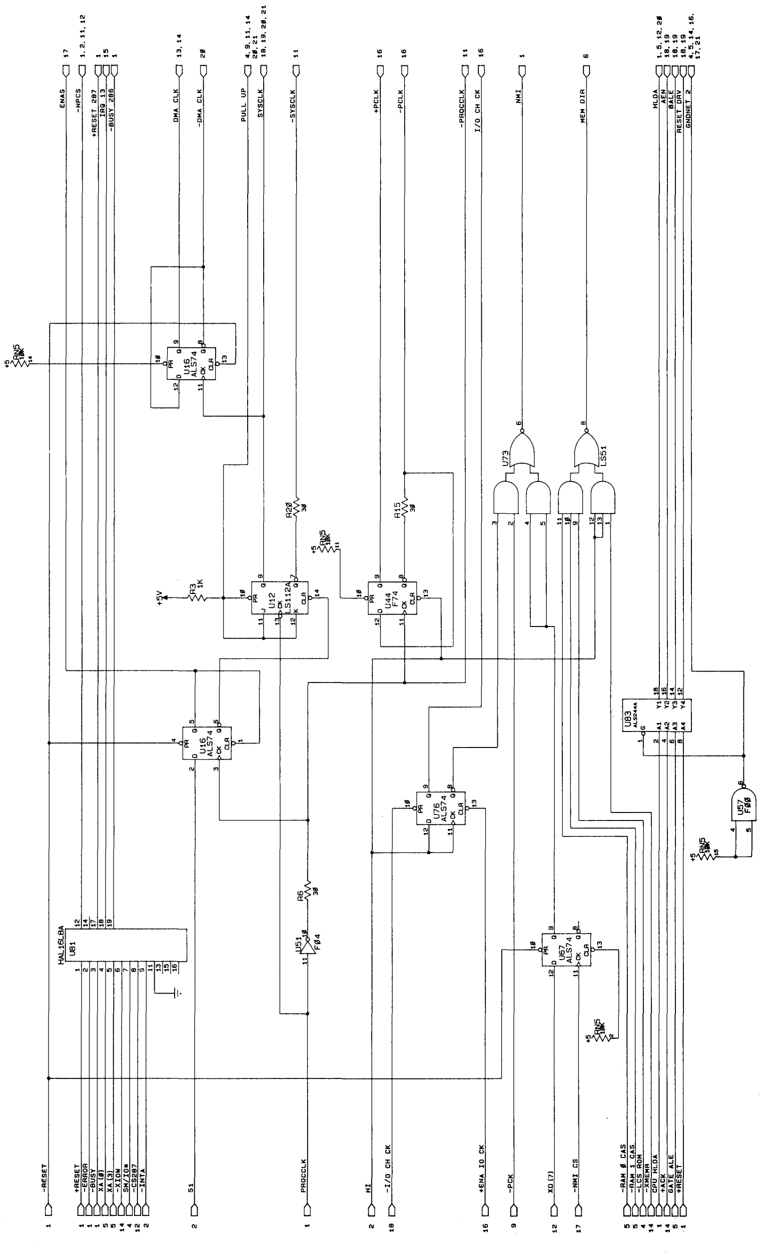

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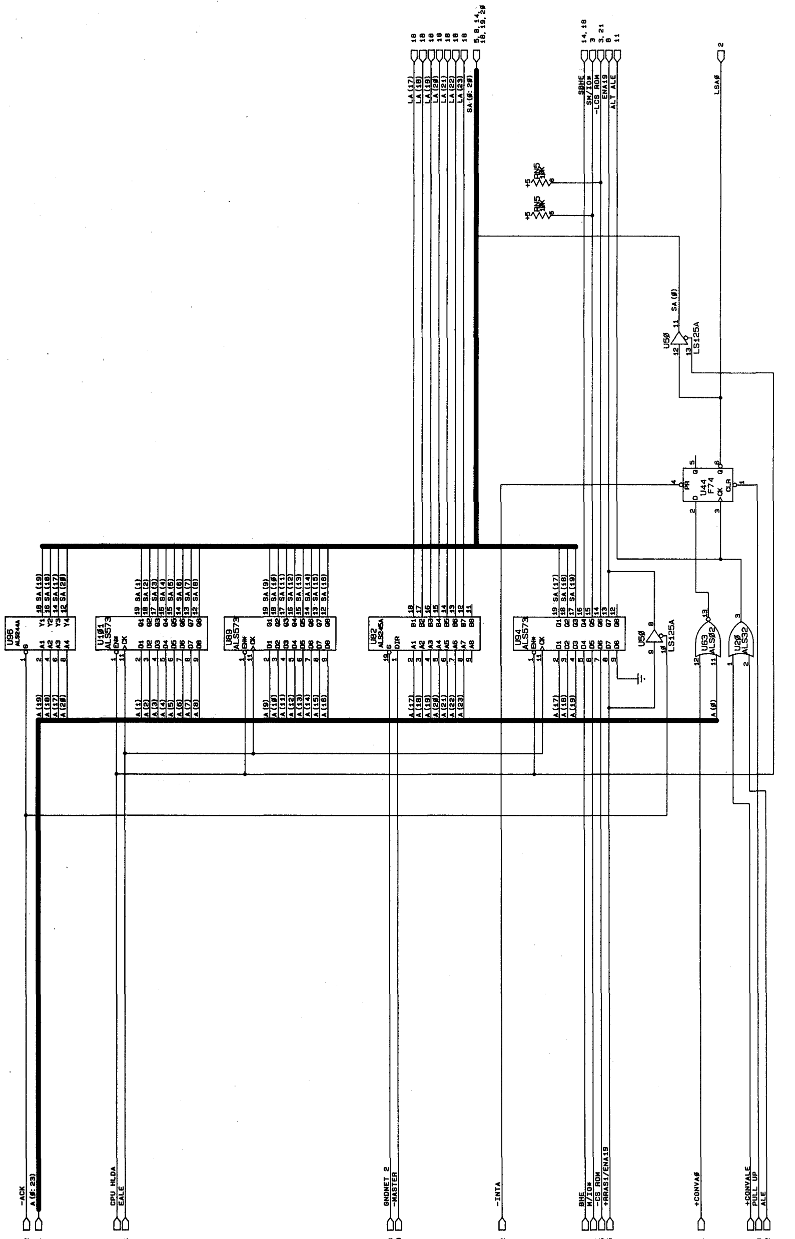

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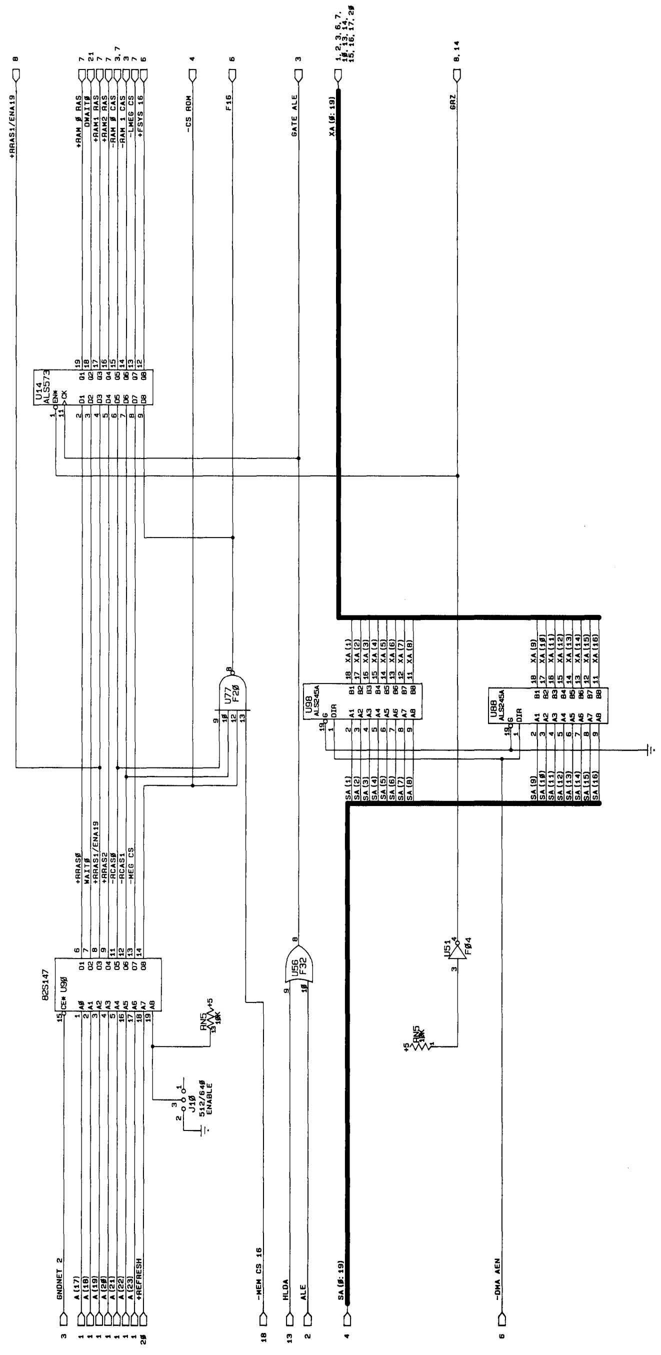

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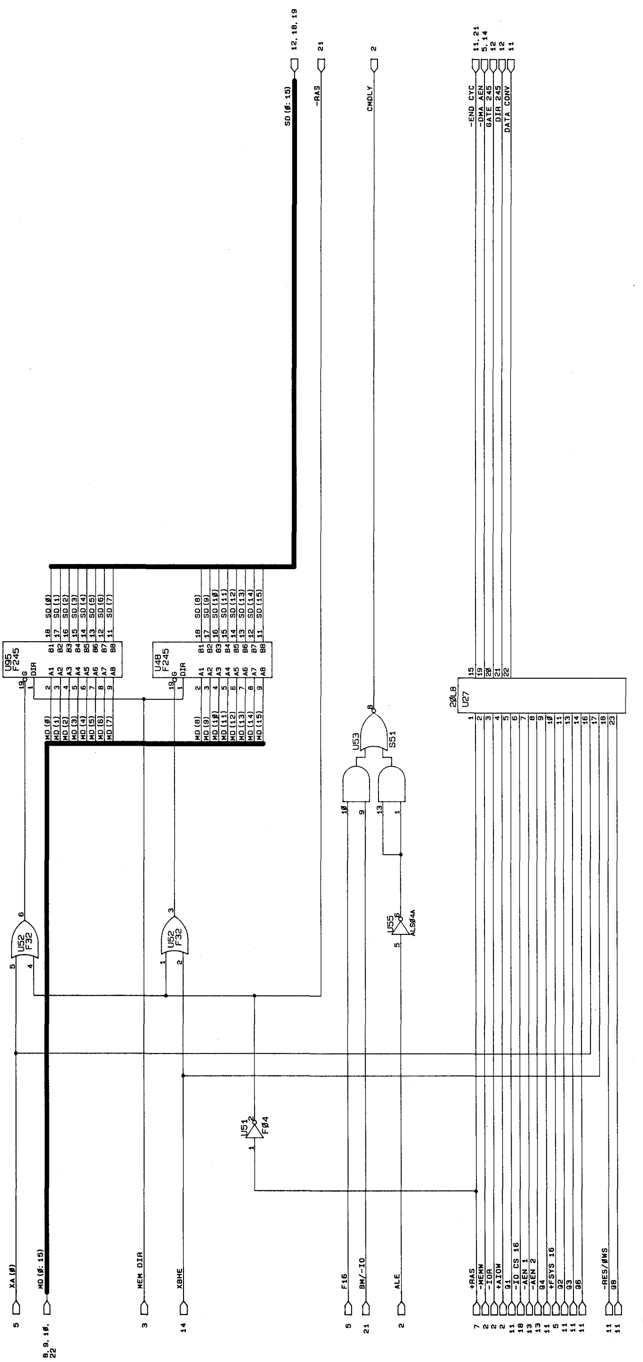

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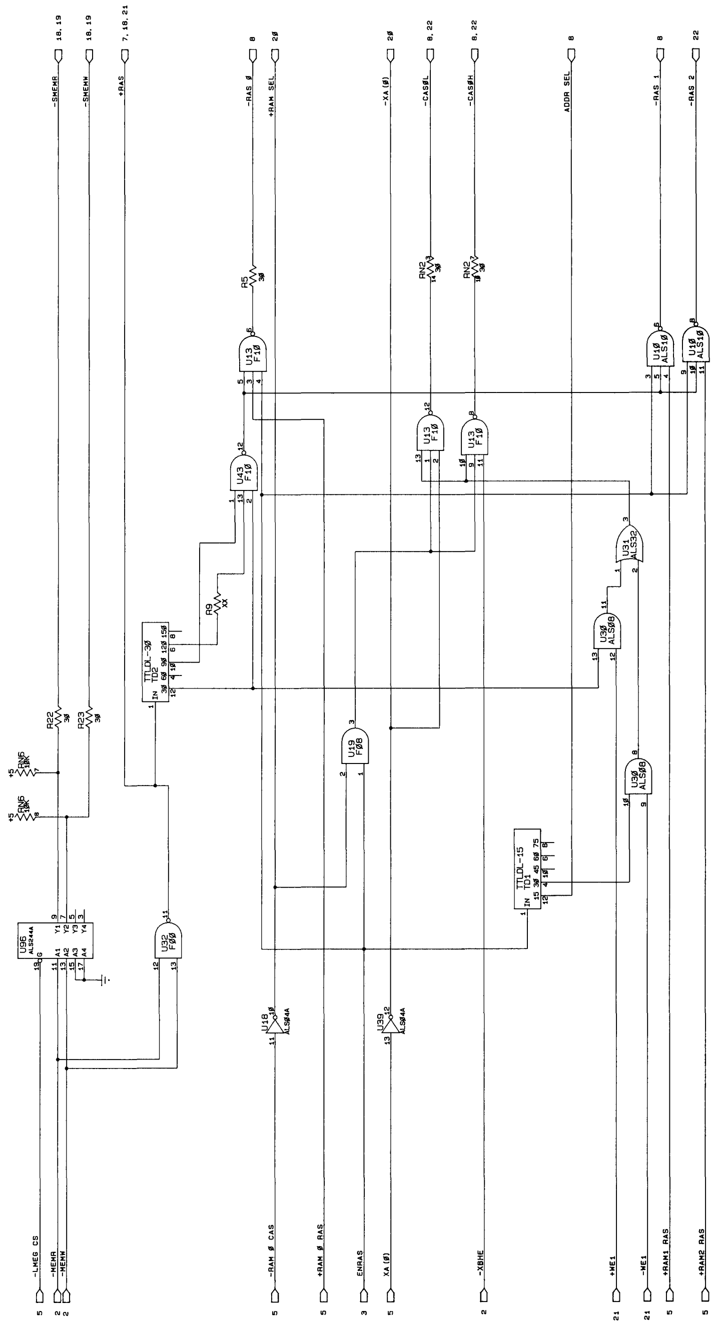

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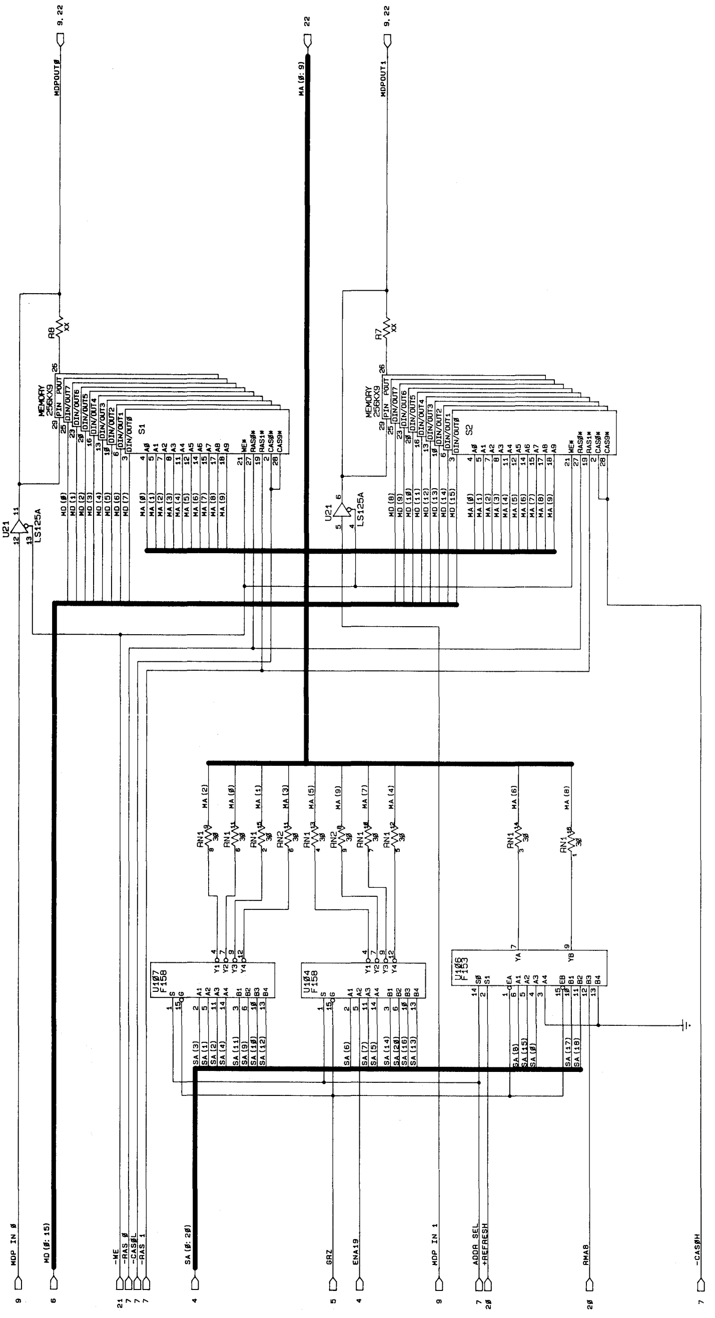

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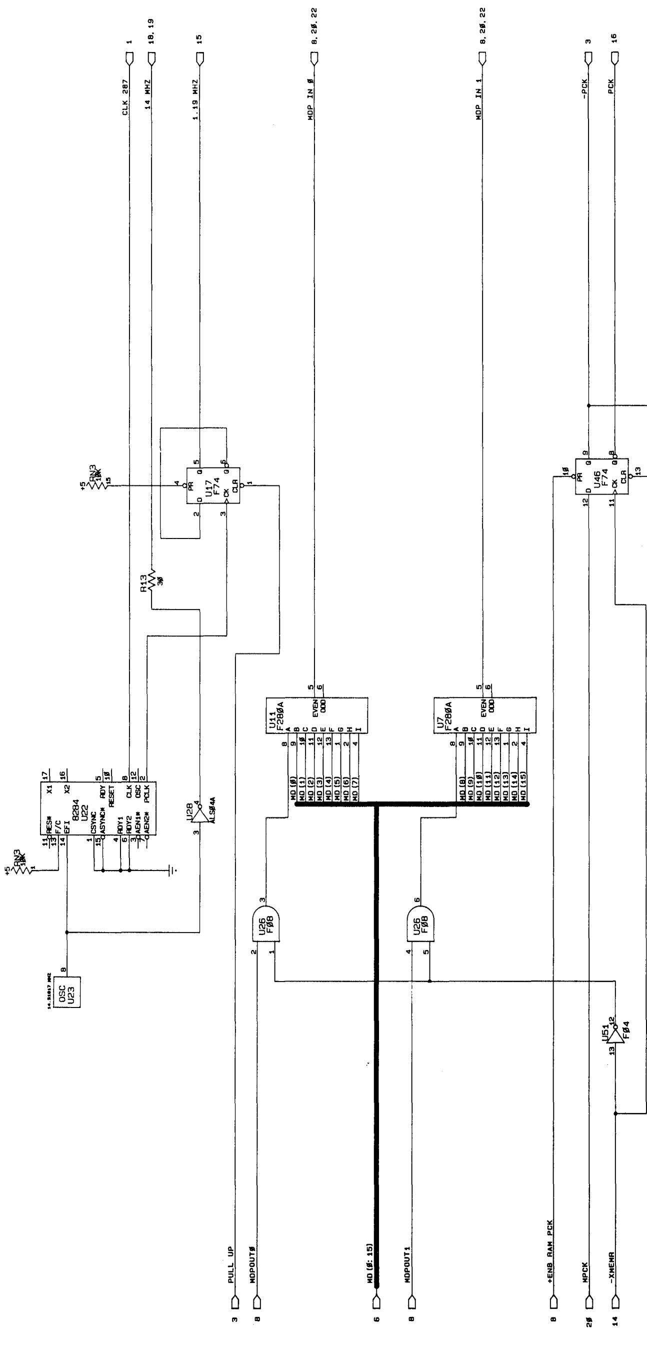

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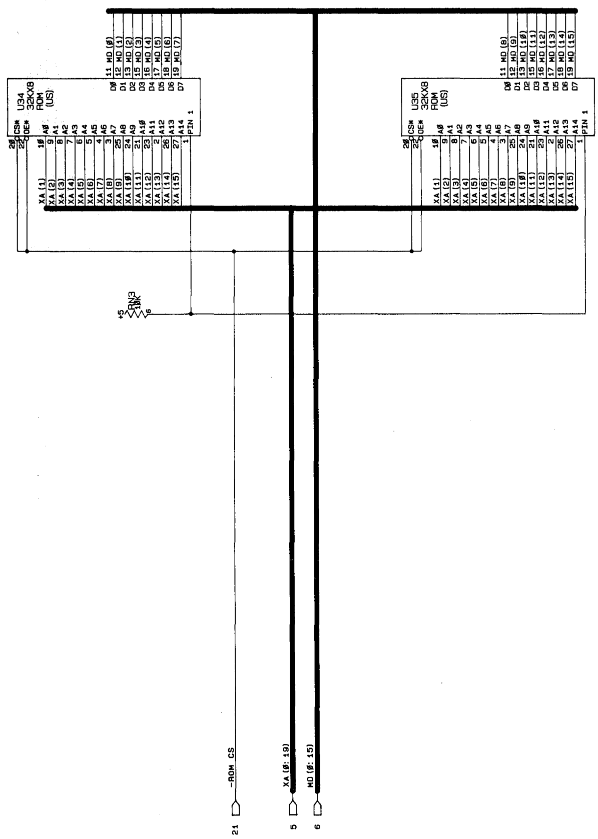

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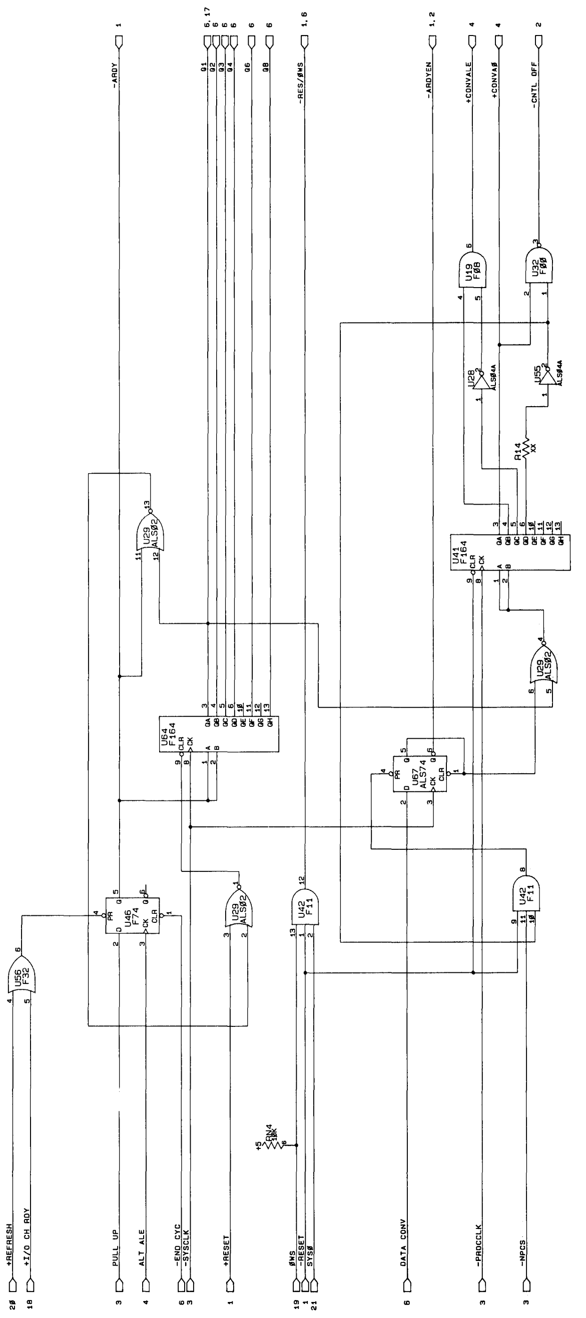

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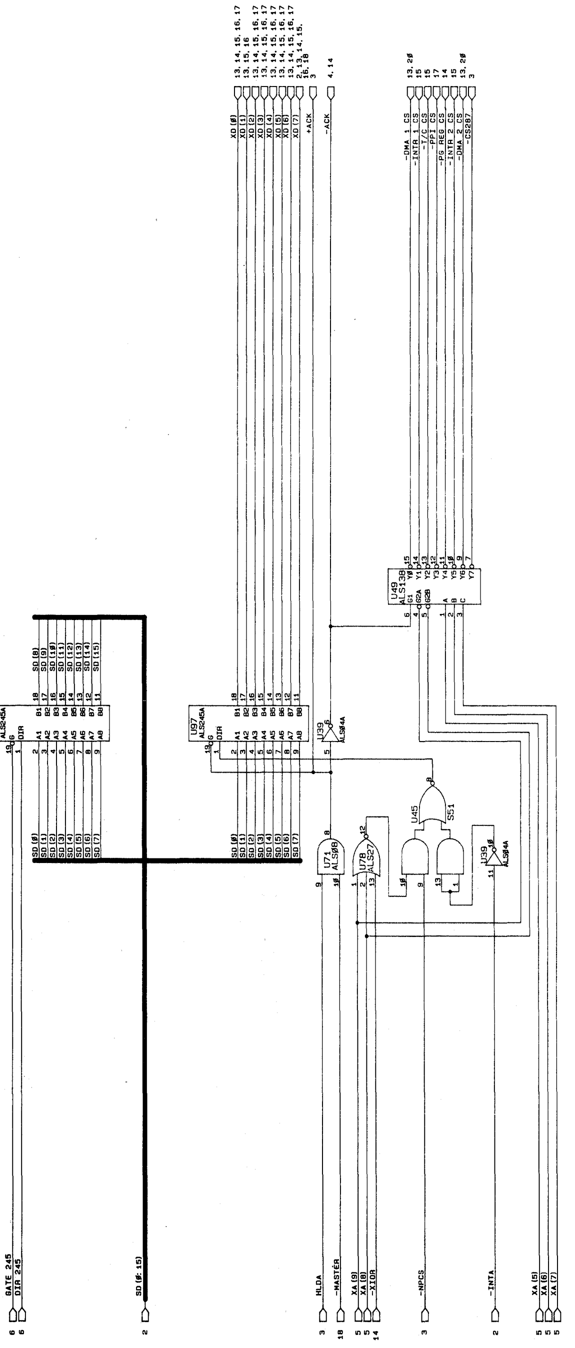

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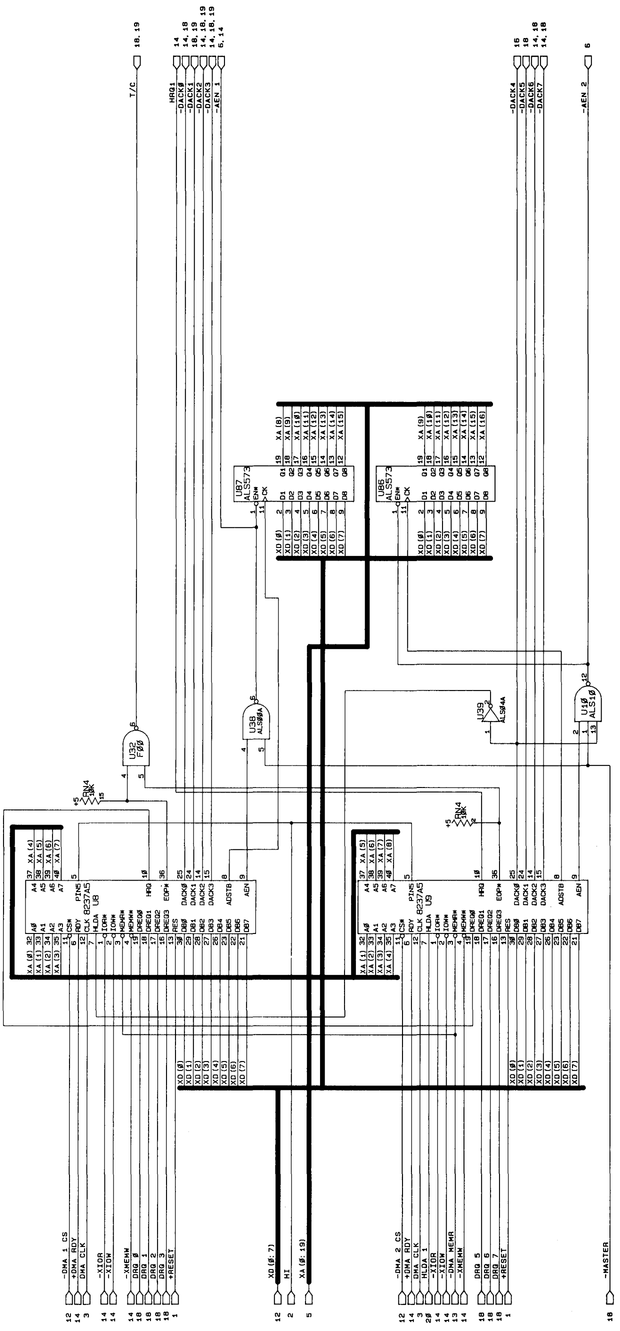

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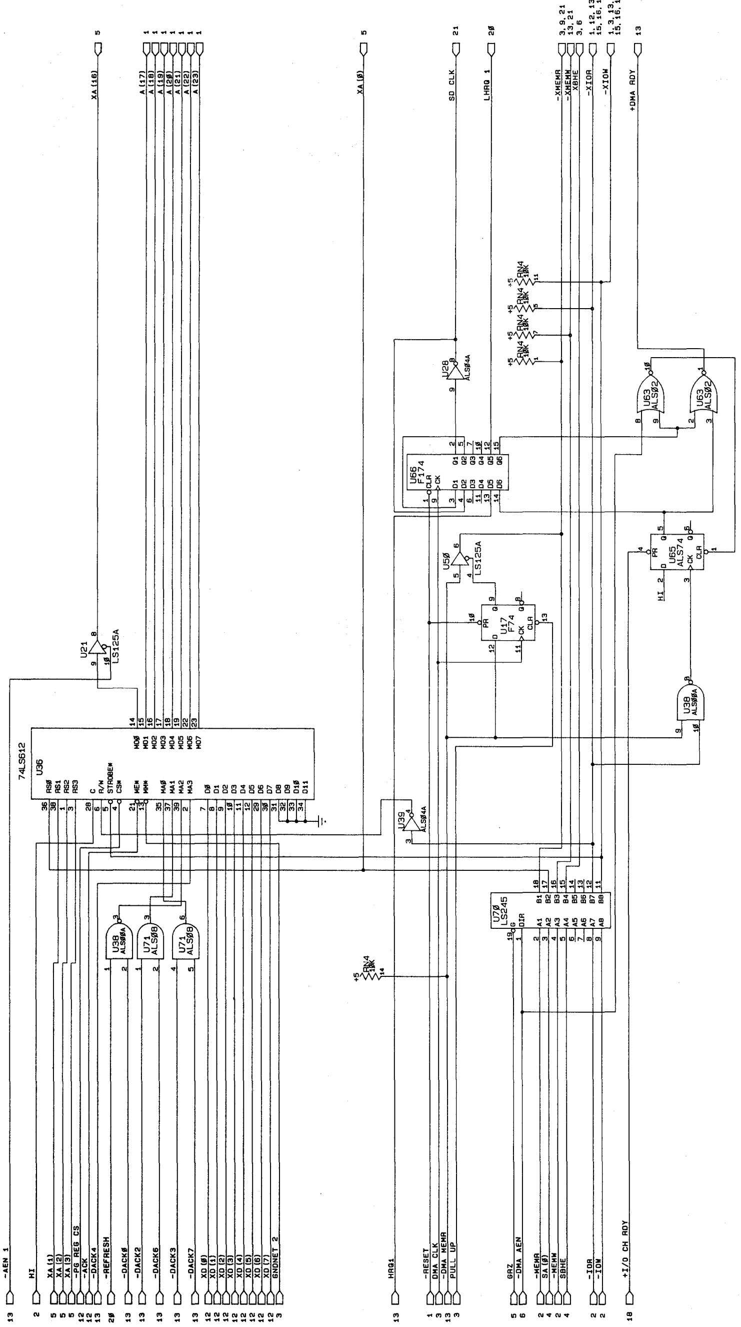

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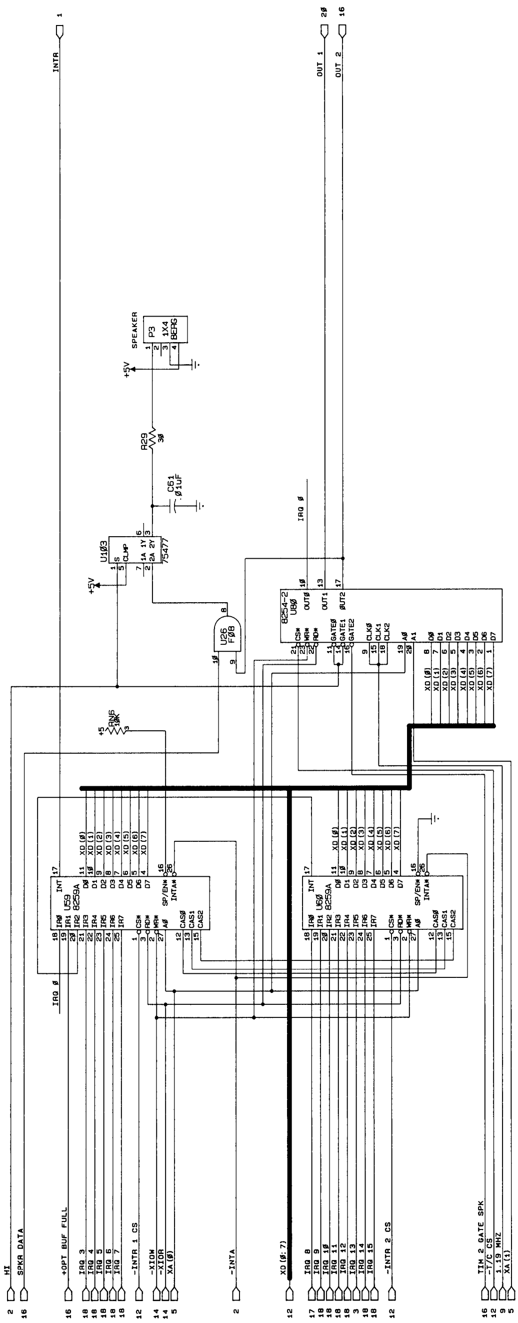

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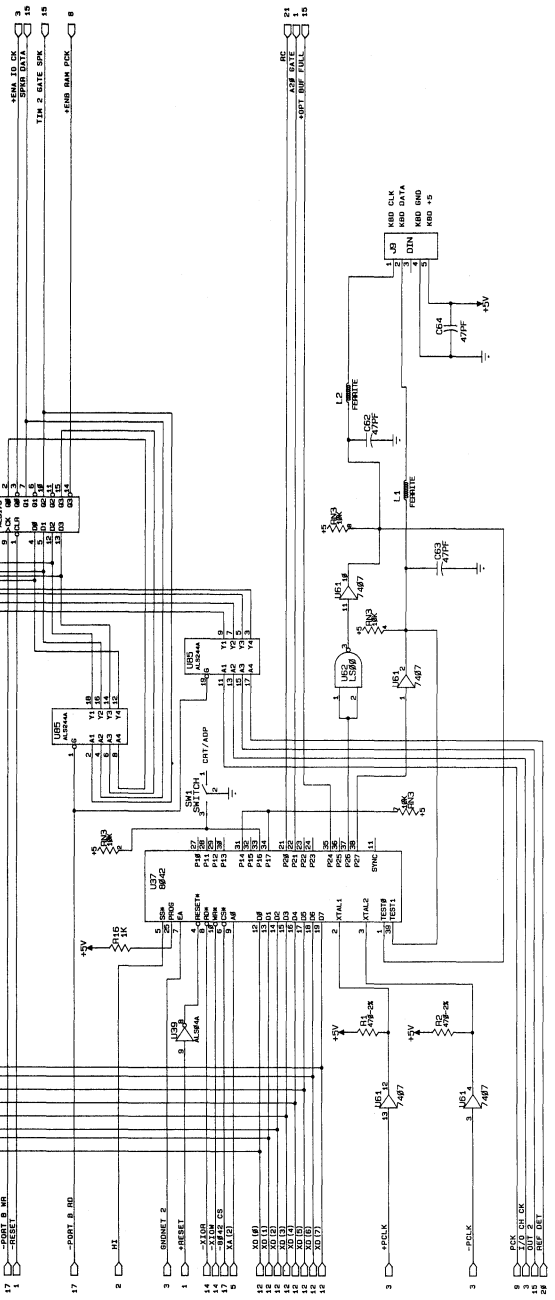

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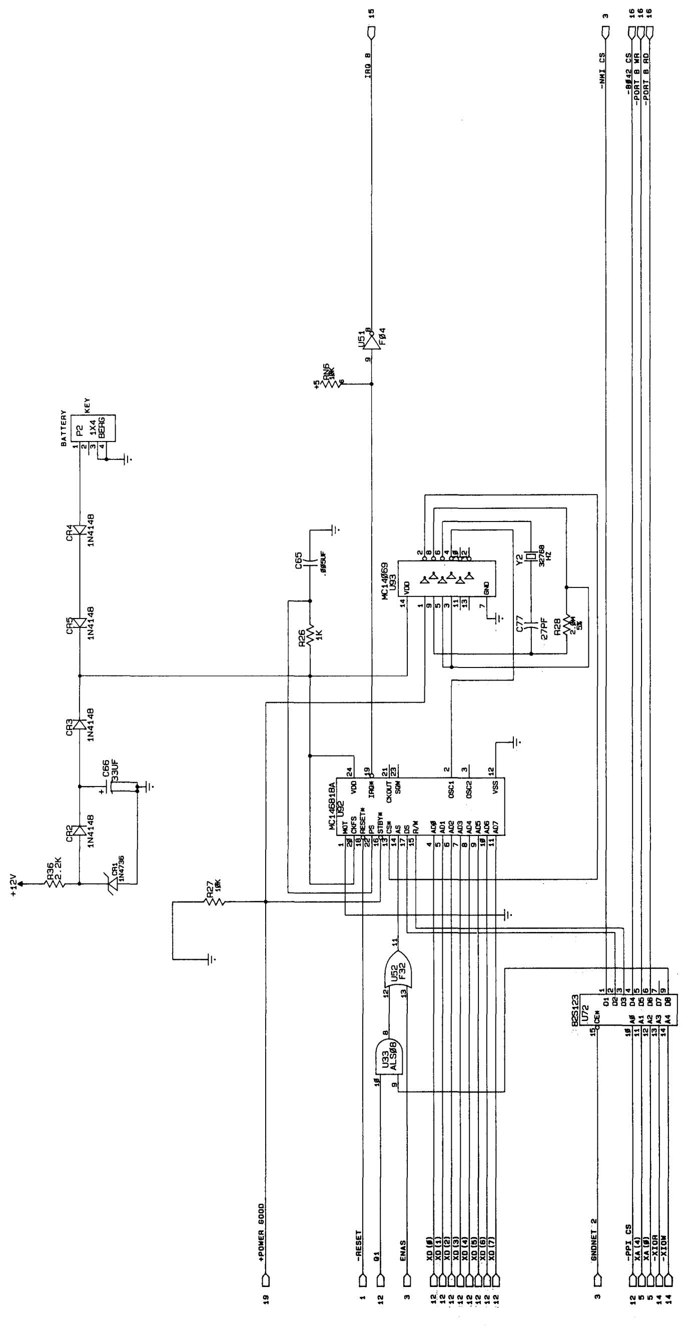

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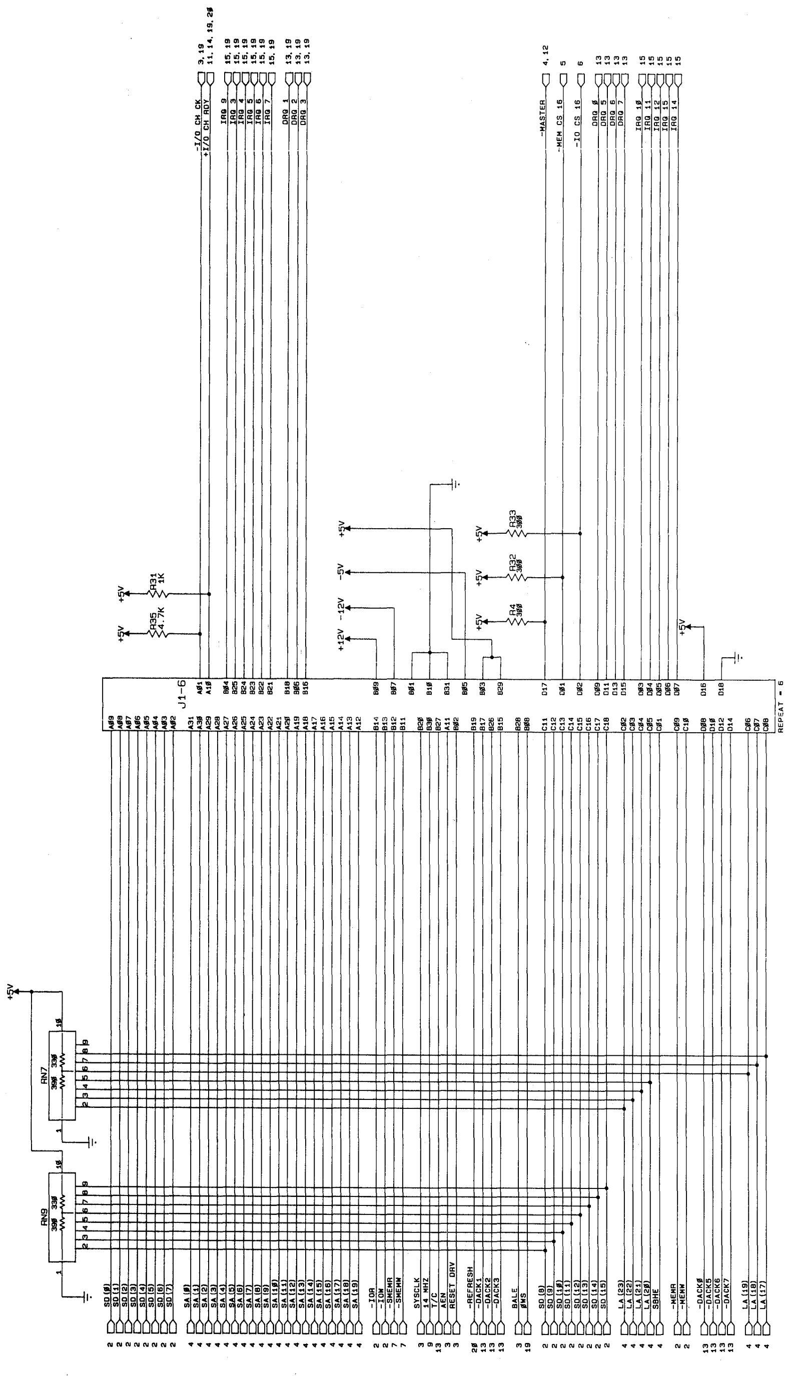

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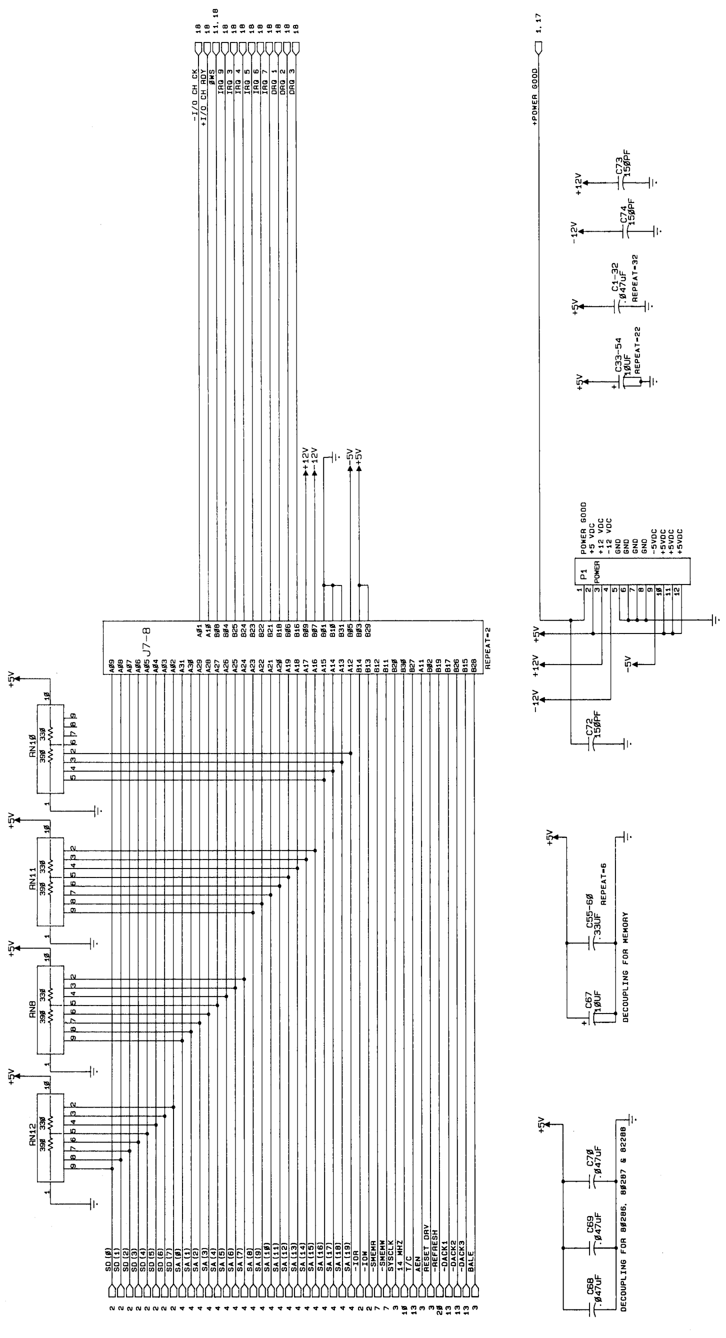

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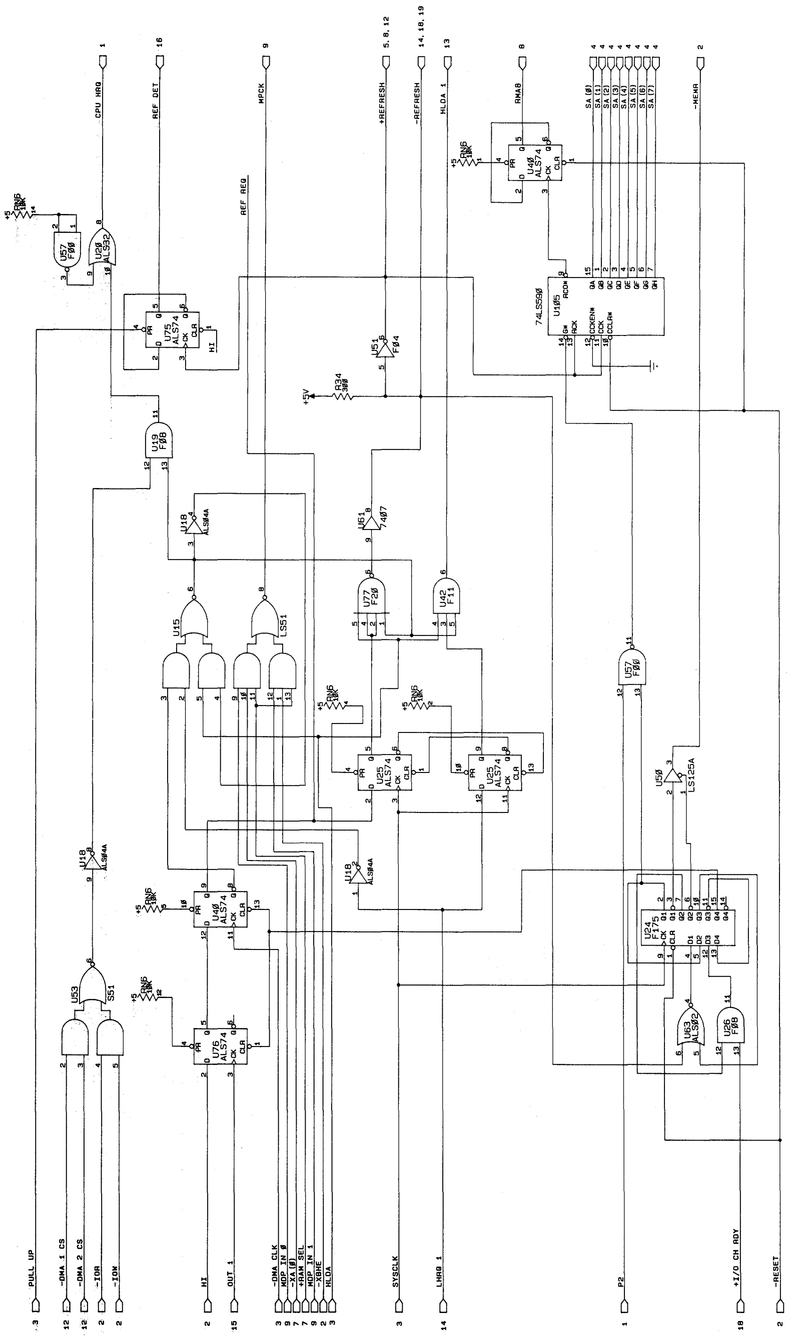
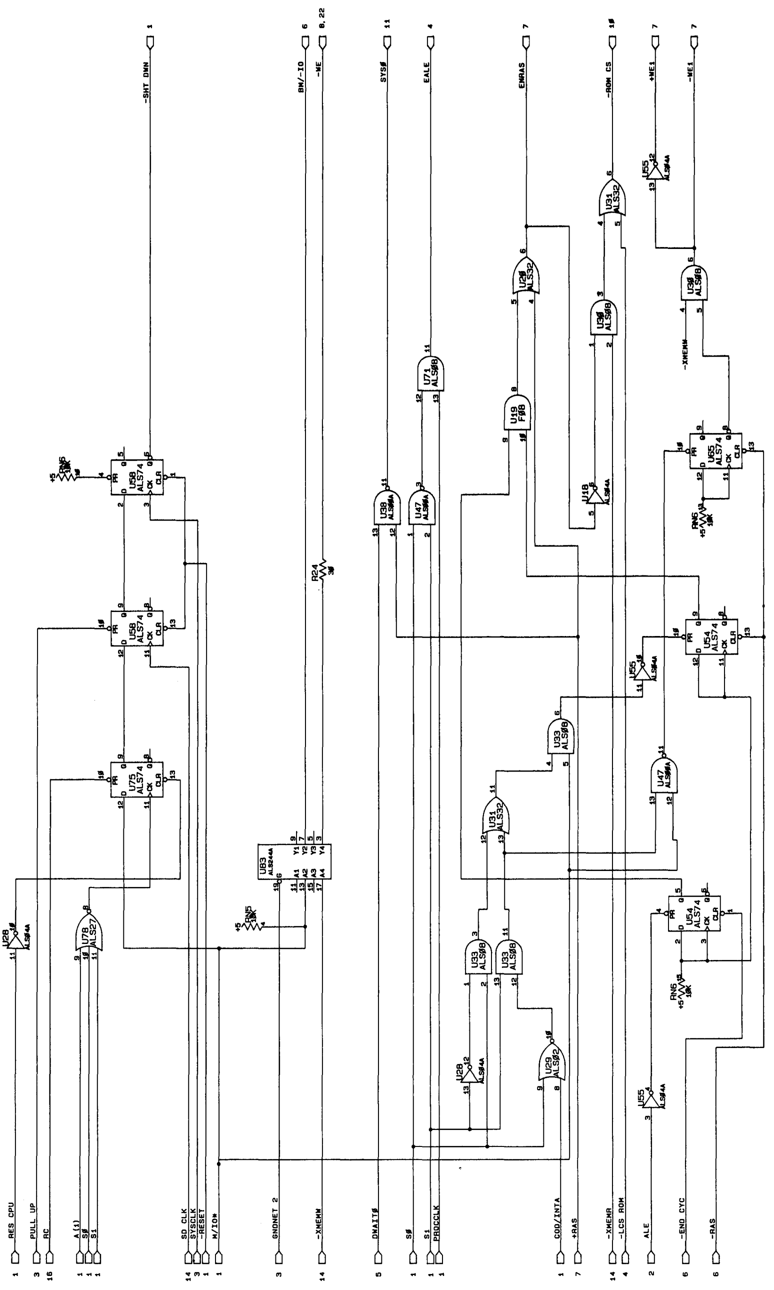
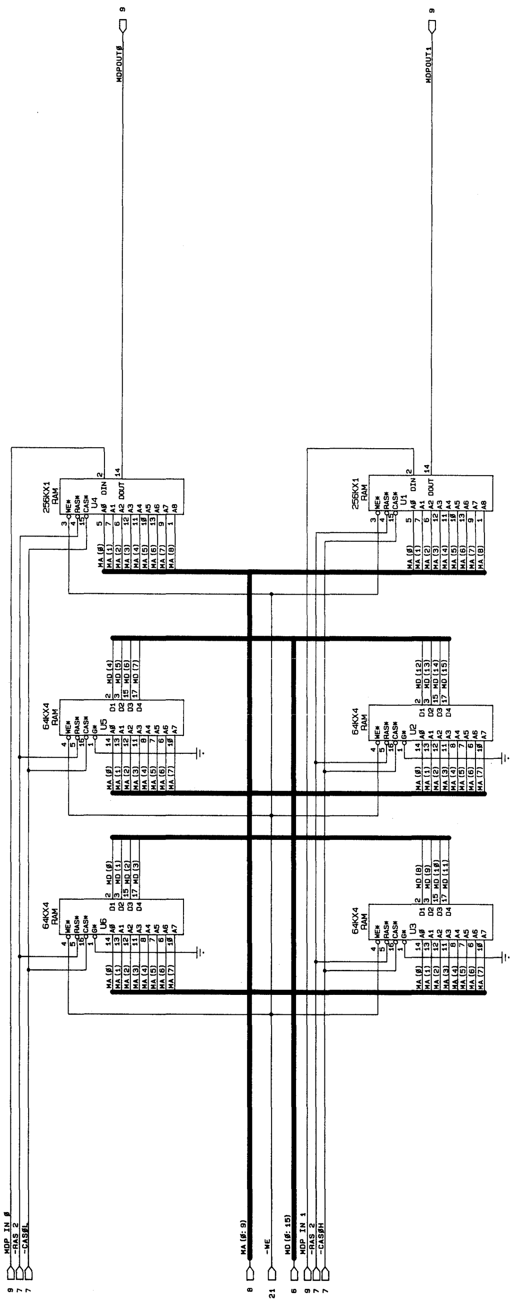


System Board (Sheet 20 of 22)



System Board (Sheet 21 of 22)



System Board (Sheet 22 of 22)

SECTION 2. COPROCESSOR

Notes:

Description

The Math Coprocessor (80287) enables the IBM Personal Computer XT Model 286 to perform high-speed arithmetic, logarithmic functions, and trigonometric operations.

The coprocessor works in parallel with the microprocessor. The parallel operation decreases operating time by allowing the coprocessor to do mathematical calculations while the microprocessor continues to do other functions.

The coprocessor works with seven numeric data types, which are divided into the following three classes:

- Binary integers (3 types)
- Decimal integers (1 type)
- Real numbers (3 types).

Programming Interface

The coprocessor offers extended data types, registers, and instructions to the microprocessor.

The coprocessor has eight 80–bit registers, which provide the equivalent capacity of forty 16–bit registers. This register space allows constants and temporary results to be held in registers during calculations, thus reducing memory access and improving speed as well as bus availability. The register space can be used as a stack or as a fixed register set. When used as a stack, only the top two stack elements are operated on.

The following figure shows representations of large and small numbers in each data type.

Data Type	Bits	Significant Digits (Decimal)	Approximate Range (Decimal)
Word Integer	16	4	$-32{,}768 \leq X \leq +32{,}767$
Short Integer	32	9	$-2\times10^{9} \leq X \leq +2\times10^{9}$
Long Integer	64	18	$-9\times10^{18} \leq X \leq +9\times10^{18}$
Packed Decimal	80	18	$-9..99 \leq X \leq +9..99$ (18 digits)
Short Real *	32	6-7	$8.43\times10^{-37} \leq \|X\| \leq 3.37\times10^{38}$
Long Real *	64	15-16	$4.19\times10^{-307} \leq \|X\| \leq 1.67\times10^{308}$
Temporary Real	80	19	$3.4\times10^{-4932} \leq \|X\| \leq 1.2\times10^{4932}$

Data Types

* The Short Real and Long Real data types correspond to the single and double precision data types.

Hardware Interface

The coprocessor uses a 4.77 MHz clock (generated by a 14.318 MHz clock generator divided by three). The coprocessor is wired so that it functions as an I/O device through I/O port addresses hex 00F8, 00FA, and 00FC. The microprocessor sends OP codes and operands through these I/O ports. The microprocessor also receives and stores results through the same I/O ports. The coprocessor's 'busy' signal informs the microprocessor that it is executing; the microprocessor's Wait instruction forces the microprocessor to wait until the coprocessor is finished executing.

The coprocessor detects six different exception conditions that can occur during instruction execution. If the appropriate exception mask within the coprocessor is not set, the coprocessor sets its error signal. This error signal generates a hardware interrupt (interrupt 13) and causes the 'busy' signal to the coprocessor to be held in the busy state. The 'busy' signal may be cleared by an 8-bit I/O Write command to address hex F0 with D0 through D7 equal to 0.

The power-on self-test code in the system ROM enables IRQ 13 and sets up its vector to point to a routine in ROM. The ROM routine clears the 'busy' signal's latch and then transfers control to the address pointed to by the NMI interrupt vector. This allows code written for any IBM Personal Computer to work on an IBM Personal Computer XT Model 286. The NMI interrupt handler should read the coprocessor's status to determine if the NMI was caused by the coprocessor. If the interrupt was not generated by the coprocessor, control should be passed to the original NMI interrupt handler.

The coprocessor has two operating modes similar to the two modes of the microprocessor. When reset by a power-on reset, system reset, or an I/O write operation to port hex 00F1, the coprocessor is in the real address mode. This mode is compatible with the 8087 Math Coprocessor used in other IBM Personal Computers. The coprocessor can be placed in the protected mode by executing the SETPM ESC instruction. It can be placed back in the real mode by an I/O write operation to port hex 00F1, with D7 through D0 equal to 0.

The coprocessor instruction extensions to the microprocessor can be found in Section 6 of this manual.

Detailed information for the internal functions of the Intel 80287 Coprocessor can be found in books listed in the bibliography.

Notes:

SECTION 3. POWER SUPPLY

Notes:

The system power supply is located *inside* the system unit and provides power for the system board, the adapters, the diskette drives, the fixed disk drive, the keyboard, and the IBM Monochrome Display.

Inputs

The power supply can operate at 110 Vac, 4.6 A or 220/240 Vac, 2.3 A at frequencies of either 60 ±3 Hz or 50 ±3 Hz. The power supply automatically adjusts to input voltages of 110 Vac or 220 Vac. The following figure shows the input requirements.

Range	Voltage (Vac)	Current (Amperes)
115 Vac	Minimum 90 Maximum 137	Maximum 4.6
230 Vac	Minimum 180 Maximum 265	Maximum 2.3

Input Requirements

Outputs

The power supply provides +5, -5, +12, and -12 Vdc. The following figure shows the load current and regulation tolerance for these voltages. The power to the IBM Monochrome Display display is controlled by the power supply.

Warning: The voltage provided to the monochrome display from the power supply is the same as the input line voltage to the power supply. Ensure that the monochrome display is the correct model for the input line voltage.

Nominal Output	Load Current (A) Minimum	Maximum	Regulation Tolerance
+5 Vdc	4.0	20.0	+5% to -4%
-5 Vdc	0.0	0.3	+10% to -8%
+12 Vdc	1.0	4.2	+5% to -4%
-12 Vdc	0.0	0.25	+10% to -9%

DC Load Requirements

DC Output Protection

An overcurrent condition will not damage the power supply.

Output Voltage Sequencing

Under normal conditions, the output voltage levels track within 50 milliseconds of each other when power is applied to, or removed from the power supply, provided at least minimum loading is present.

No-Load Operation

No damage or hazardous conditions occur when primary power is applied with no load on any output level. In such cases, the power supply may switch off, and a power-on reset will be required. The power supply requires a minimum load for proper operation.

Power-Good Signal

The power supply provides a 'power-good' signal to indicate proper operation of the power supply.

When the supply is switched off for a minimum of one second and then switched on, the 'power-good' signal is generated, assuming there are no problems. This signal is a logical AND of the dc output-voltage sense signal and the ac input-voltage sense signal. The 'power-good' signal is also a TTL-compatible high level for normal operation, and a low level for fault conditions. The ac fail signal causes 'power-good' to go to a low level at least one millisecond before any output voltage falls below the regulation limits. The operating point used as a reference for measuring the one millisecond is normal operation at minimum line voltage and maximum load.

The dc output-voltage sense signal holds the 'power-good' signal at a low level when power is switched on until all output voltages have reached their minimum sense levels. The 'power-good' signal has a turn-on delay of at least 100 milliseconds but not longer than 500 milliseconds and is capable of sourcing 2 milliamperes and sinking 10 milliamperes.

The following figure shows the minimum sense levels for the output voltages.

Level (Vdc)	Minimum (Vdc)
+5	+4.5
-5	-4.3
+12	+10.8
-12	-10.2

Sense Level

Connectors

The following figure shows the pin assignments for the power-supply output connectors.

Load Point	Voltage (Vdc)
P8-1	Power Good *
P8-2	+5
P8-3	+12
P8-4	-12
P8-5	Ground
P8-6	Ground
P9-1	Ground
P9-2	Ground
P9-3	-5
P9-4	+5
P9-5	+5
P9-6	+5
P10-1	+12
P10-2	Ground
P10-3	Ground
P10-4	+5
P11-1	+12
P11-2	Ground
P11-3	Ground
P11-4	+5
* see "Power-Good Signal"	

Power Supply Output Connectors

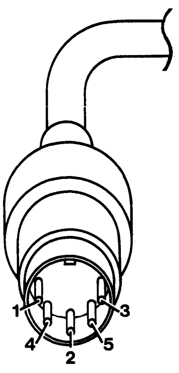
SECTION 4. KEYBOARD

Description

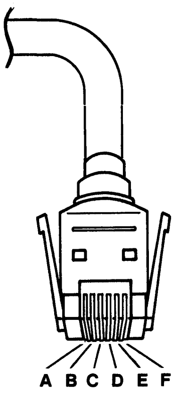
The keyboard has 101 keys (102 in countries outside the U. S.). At system power-on, the keyboard monitors the signals on the 'clock' and 'data' lines and establishes its line protocol. A bidirectional serial interface in the keyboard converts the 'clock' and 'data' signals and sends this information to and from the keyboard through the keyboard cable.

Cabling

The keyboard cable connects to the system with a five-pin DIN connector, and to the keyboard with a six-position SDL connector. The following table shows the pin configuration and signal assignments.



DIN Connector



SDL Connector

DIN Connector Pins	SDL Connector Pins	Signal Name	Signal Type
1	D	+KBD CLK	Input/Output
2	B	+KBD DATA	Input/Output
3	F	Reserved	
4	C	Ground	Ground
5	E	+5.0 Vdc	Power
	A	Not used	
Shield	Shield	Frame Ground	

Sequencing Key-Code Scanning

The keyboard detects all keys pressed, and sends each scan code in the correct sequence. When not serviced by the system, the keyboard stores the scan codes in its buffer.

Keyboard Buffer

A 16-byte first-in-first-out (FIFO) buffer in the keyboard stores the scan codes until the system is ready to receive them.

A buffer-overrun condition occurs when more than 16 bytes are placed in the keyboard buffer. An overrun code replaces the 17th byte. If more keys are pressed before the system allows keyboard output, the additional data is lost.

When the keyboard is allowed to send data, the bytes in the buffer will be sent as in normal operation, and new data entered is detected and sent. Response codes do not occupy a buffer position.

If keystrokes generate a multiple-byte sequence, the entire sequence must fit into the available buffer space or the keystroke is discarded and a buffer-overrun condition occurs.

Keys

With the exception of the Pause key, all keys are *make/break*. The make scan code of a key is sent to the keyboard controller when the key is pressed. When the key is released, its break scan code is sent.

Additionally, except for the Pause key, all keys are *typematic*. When a key is pressed and held down, the keyboard sends the make code for that key, delays 500 milliseconds ± 20%, and begins sending a make code for that key at a rate of 10.9 characters per second ± 20%. The typematic rate and delay can be modified [see "Set Typematic Rate/Delay (Hex F3)" on page 4-11].

If two or more keys are held down, only the last key pressed repeats at the typematic rate. Typematic operation stops when the last key pressed is released, even if other keys are still held down. If a key is pressed and held down while keyboard transmission is inhibited, only the first make code is stored in the buffer. This prevents buffer overflow as a result of typematic action.

Note: Scan code set 3 allows key types to be changed by the system. See "Scan Code Tables (Set 3)" on page 4-24 for the default settings. Commands to change the default settings are listed in "Commands from the System" on page 4-6.

Power-On Routine

The following activities take place when power is first applied to the keyboard.

Power-On Reset

The keyboard logic generates a 'power-on reset' signal (POR) when power is first applied to the keyboard. POR occurs a minimum of 150 milliseconds and a maximum of 2.0 seconds from the time power is first applied to the keyboard.

Basic Assurance Test

The basic assurance test (BAT) consists of a keyboard processor test, a checksum of the read-only memory (ROM), and a random-access memory (RAM) test. During the BAT, activity on the 'clock' and 'data' lines is ignored. The LEDs are turned on at the beginning and off at the end of the BAT. The BAT takes a minimum of 300 milliseconds and a maximum of 500 milliseconds. This is in addition to the time required by the POR.

Upon satisfactory completion of the BAT, a completion code (hex AA) is sent to the system, and keyboard scanning begins. If a BAT failure occurs, the keyboard sends an error code to the system. The keyboard is then disabled pending command input. Completion codes are sent between 450 milliseconds and 2.5 seconds after POR, and between 300 and 500 milliseconds after a Reset command is acknowledged.

Immediately following POR, the keyboard monitors the signals on the keyboard 'clock' and 'data' lines and sets the line protocol.

Commands from the System

The following table shows the commands that the system may send and their hexadecimal values.

Command	Hex Value
Set/Reset Status Indicators	ED
Echo	EE
Invalid Command	EF
Select Alternate Scan Codes	F0
Invalid Command	F1
Read ID	F2
Set Typematic Rate/Delay	F3
Enable	F4
Default Disable	F5
Set Default	F6
Set All Keys - Typematic	F7
- Make/Break	F8
- Make	F9
- Typematic/Make/Break	FA
Set Key Type - Typematic	FB
- Make/Break	FC
- Make	FD
Resend	FE
Reset	FF

The commands may be sent to the keyboard at any time. The keyboard will respond within 20 milliseconds, except when performing the basic assurance test (BAT), or executing a Reset command.

Note: Mode 1 will accept only the 'reset' command.

The commands are described below, in alphabetic order. They have different meanings when issued by the keyboard (see "Commands to the System" on page 4-13).

Default Disable (Hex F5)

The Default Disable command resets all conditions to the power-on default state. The keyboard responds with ACK, clears its output buffer, sets the default key types (scan code set 3 operation only) and typematic rate/delay, and clears the last typematic key. The keyboard stops scanning, and awaits further instructions.

Echo (Hex EE)

Echo is a diagnostic aid. When the keyboard receives this command, it issues a hex EE response and, if the keyboard was previously enabled, continues scanning.

Enable (Hex F4)

Upon receipt of this command, the keyboard responds with ACK, clears its output buffer, clears the last typematic key, and starts scanning.

Invalid Command (Hex EF and F1)

Hex EF and hex F1 are invalid commands and are not supported. If one of these is sent, the keyboard does not acknowledge the command, but returns a Resend command and continues in its prior scanning state. No other activities occur.

Read ID (Hex F2)

This command requests identification information from the keyboard. The keyboard responds with ACK, discontinues scanning, and sends the two keyboard ID bytes. The second byte must follow completion of the first by no more than 500 microseconds. After the output of the second ID byte, the keyboard resumes scanning.

Resend (Hex FE)

The system sends this command when it detects an error in any transmission from the keyboard. It is sent only after a keyboard transmission and before the system allows the next keyboard output. When a Resend is received, the keyboard sends the previous output again (unless the previous output was Resend, in which case the keyboard sends the last byte before the Resend command).

Reset (Hex FF)

The system issues a Reset command to start a program reset and a keyboard internal self test. The keyboard acknowledges the command with an ACK and ensures the system accepts ACK before executing the command. The system signals acceptance of ACK by raising the 'clock' and 'data' lines for a minimum of 500 microseconds. The keyboard is disabled from the time it receives the Reset command until ACK is accepted, or until another command is sent that overrides the previous command.

Following acceptance of ACK, the keyboard is re-initialized and performs the BAT. After returning the completion code, the keyboard defaults to scan code set 2.

Select Alternate Scan Codes (Hex F0)

This command instructs the keyboard to select one of three sets of scan codes. The keyboard acknowledges receipt of this command with ACK, clears both the output buffer and the typematic key (if one is active). The system then sends the option byte and the keyboard responds with another ACK. An option byte value of hex 01 selects scan code set 1, hex 02 selects set 2, and hex 03 selects set 3.

An option byte value of hex 00 causes the keyboard to acknowledge with ACK and send a byte telling the system which scan code set is currently in use.

After establishing the new scan code set, the keyboard returns to the scanning state it was in before receiving the Select Alternate Scan Codes command.

Set All Keys (Hex F7, F8, F9, FA)

These commands instruct the keyboard to set all keys to the type listed below:

Hex Value	Command
F7	Set All Keys - Typematic
F8	Set All Keys - Make/Break
F9	Set All Keys - Make
FA	Set All Keys - Typematic/Make/Break

The keyboard responds with ACK, clears its output buffer, sets all keys to the type indicated by the command, and continues scanning (if it was previously enabled). Although these commands can be sent using any scan code set, they affect only scan code set 3 operation.

Set Default (Hex F6)

The Set Default command resets all conditions to the power-on default state. The keyboard responds with ACK, clears its output buffer, sets the default key types (scan code set 3 operation only) and typematic rate/delay, clears the last typematic key, and continues scanning.

Set Key Type (Hex FB, FC, FD)

These commands instruct the keyboard to set individual keys to the type listed below:

Hex Value	Command
FB	Set Key Type - Typematic
FC	Set Key Type - Make/Break
FD	Set Key Type - Make

The keyboard responds with ACK, clears its output buffer, and prepares to receive key identification. Key identification is accomplished by the system identifying each key by its scan code value as defined in scan code set 3. Only scan code set 3 values are valid for key identification. The type of each identified key is set to the value indicated by the command.

These commands can be sent using any scan code set, but affect only scan code set 3 operation.

Set/Reset Status Indicators (Hex ED)

Three status indicators on the keyboard— Num Lock, Caps Lock, and Scroll Lock—are accessible by the system. The keyboard activates or deactivates these indicators when it receives a valid command-code sequence from the system. The command sequence begins with the command byte (hex ED). The keyboard responds to the command byte with ACK, discontinues scanning, and waits for the option byte from the system. The bit assignments for this option byte are as follows:

Bit	Indicator
0	Scroll Lock Indicator
1	Num Lock Indicator
2	Caps Lock Indicator
3-7	Reserved (must be 0s)

If a bit for an indicator is set to 1, the indicator is turned on. If a bit is set to 0, the indicator is turned off.

The keyboard responds to the option byte with ACK, sets the indicators and, if the keyboard was previously enabled, continues scanning. The state of the indicators will reflect the bits in the option byte and can be activated or deactivated in any combination. If another command is received in place of the option byte, execution of the Set/Reset Mode Indicators command is stopped, with no change to the indicator states, and the new command is processed.

Immediately after power-on, the lights default to the Off state. If the Set Default and Default Disable commands are received, the lamps remain in the state they were in before the command was received.

Set Typematic Rate/Delay (Hex F3)

The system issues the Set Typematic Rate/Delay command to change the typematic rate and delay. The keyboard responds to the command with ACK, stops scanning, and waits for the system to issue the rate/delay value byte. The keyboard responds to the rate/delay value byte with another ACK, sets the rate and delay to the values indicated, and continues scanning (if it was previously enabled). Bits 6 and 5 indicate the delay, and bits 4, 3, 2, 1, and 0 (the least-significant bit) the rate. Bit 7, the most-significant bit, is always 0. The delay is equal to 1 plus the binary value of bits 6 and 5, multiplied by 250 milliseconds $\pm$ 20%.

The period (interval from one typematic output to the next) is determined by the following equation:

Period = $(8 + A) \times (2^B) \times 0.00417$ seconds.
where:
A = binary value of bits 2, 1, and 0.
B = binary value of bits 4 and 3.

The typematic rate (make codes per second) is 1 for each period and are listed in the following table.

Bit	Typematic Rate ± 20%	Bit	Typematic Rate ± 20%
00000	30.0	10000	7.5
00001	26.7	10001	6.7
00010	24.0	10010	6.0
00011	21.8	10011	5.5
00100	20.0	10100	5.0
00101	18.5	10101	4.6
00110	17.1	10110	4.3
00111	16.0	10111	4.0
01000	15.0	11000	3.7
01001	13.3	11001	3.3
01010	12.0	11010	3.0
01011	10.9	11011	2.7
01100	10.0	11100	2.5
01101	9.2	11101	2.3
01110	8.0	11110	2.1
01111	8.0	11111	2.0

The default values for the system keyboard are as follows:

Typematic rate = 10.9 characters per second ± 20%.

Delay = 500 milliseconds ± 20%.

The execution of this command stops without change to the existing rate if another command is received instead of the rate/delay value byte.

Commands to the System

The following table shows the commands that the keyboard may send to the system, and their hexadecimal values.

Command	Hex Value
Key Detection Error/Overrun	00 (Code Sets 2 and 3)
Keyboard ID	83AB
BAT Completion Code	AA
BAT Failure Code	FC
Echo	EE
Acknowledge (ACK)	FA
Resend	FE
Key Detection Error/Overrun	FF (Code Set 1)

The commands the keyboard sends to the system are described below, in alphabetic order. They have different meanings when issued by the system (see "Commands from the System" on page 4-6).

Acknowledge (Hex FA)

The keyboard issues Acknowledge (ACK) to any valid input other than an Echo or Resend command. If the keyboard is interrupted while sending ACK, it discards ACK and accepts and responds to the new command.

BAT Completion Code (Hex AA)

Following satisfactory completion of the BAT, the keyboard sends hex AA. Any other code indicates a failure of the keyboard.

BAT Failure Code (Hex FC)

If a BAT failure occurs, the keyboard sends this code, discontinues scanning, and waits for a system response or reset.

Echo (Hex EE)

The keyboard sends this code in response to an Echo command.

Keyboard ID (Hex 83AB)

The Keyboard ID consists of 2 bytes, hex 83AB. The keyboard responds to the Read ID with ACK, discontinues scanning, and sends the 2 ID bytes. The low byte is sent first followed by the high byte. Following output of Keyboard ID, the keyboard begins scanning.

Key Detection Error (Hex 00 or FF)

The keyboard sends a key detection error character if conditions in the keyboard make it impossible to identify a switch closure. If the keyboard is using scan code set 1, the code is hex FF. For sets 2 and 3, the code is hex 00.

Overrun (Hex 00 or FF)

An overrun character is placed in the keyboard buffer and replaces the last code when the buffer capacity has been exceeded. The code is sent to the system when it reaches the top of the buffer queue. If the keyboard is using scan code set 1, the code is hex FF. For sets 2 and 3, the code is hex 00.

Resend (Hex FE)

The keyboard issues a Resend command following receipt of an invalid input or any input with incorrect parity. If the system sends nothing to the keyboard, no response is required.

Keyboard Scan Codes

The following tables list the key numbers of the three scan code sets and their hexadecimal values. The system defaults to scan set 2, but can be switched to set 1 or set 3 (see "Select Alternate Scan Codes (Hex F0)" on page 4-8).

Scan Code Set 1

In scan code set 1, each key is assigned a base scan code and, in some cases, extra codes to generate artificial shift states in the system. The typematic scan codes are identical to the base scan code for each key.

Scan Code Tables (Set 1)

The following keys send the codes as shown, regardless of any shift states in the keyboard or the system. Refer to "Keyboard Layouts" beginning on page 4-40 to determine the character associated with each key number.

Key Number	Make Code	Break Code
1	29	A9
2	02	82
3	03	83
4	04	84
5	05	85
6	06	86
7	07	87
8	08	88
9	09	89
10	0A	8A
11	0B	8B
12	0C	8C
13	0D	8D
15	0E	8E
16	0F	8F
17	10	90
18	11	91
19	12	92
20	13	93
21	14	94
22	15	95
23	16	96
24	17	97
25	18	98
26	19	99
27	1A	9A
28	1B	9B
29 *	2B	AB
30	3A	BA
31	1E	9E
32	1F	9F
33	20	A0
* 101-key keyboard only.		

Key Number	Make Code	Break Code
34	21	A1
35	22	A2
36	23	A3
37	24	A4
38	25	A5
39	26	A6
40	27	A7
41	28	A8
42 **	2B	AB
43	1C	9C
44	2A	AA
45 **	56	D6
46	2C	AC
47	2D	AD
48	2E	AE
49	2F	AF
50	30	B0
51	31	B1
52	32	B2
53	33	B3
54	34	B4
55	35	B5
57	36	B6
58	1D	9D
60	38	B8
61	39	B9
62	E0 38	E0 B8
64	E0 1D	E0 9D
90	45	C5
91	47	C7
92	4B	CB
93	4F	CF
96	48	C8
97	4C	CC
98	50	D0
99	52	D2
100	37	B7
101	49	C9
102	4D	CD
103	51	D1
104	53	D3
105	4A	CA
106	4E	CE
108	E0 1C	E0 9C
110	01	81
112	3B	BB
113	3C	BC
114	3D	BD
115	3E	BE
116	3F	BF
117	40	C0
118	41	C1
119	42	C2
** 102-key keyboard only.		

Key Number	Make Code	Break Code
120	43	C3
121	44	C4
122	57	D7
123	58	D8
125	46	C6

The remaining keys send a series of codes dependent on the state of the various shift keys (Ctrl, Alt, and Shift), and the state of Num Lock (On or Off). Because the base scan code is identical to that of another key, an extra code (hex E0) has been added to the base code to make it unique.

Key No.	Base Case, or Shift+Num Lock Make/Break	Shift Case Make/Break *	Num Lock on Make/Break
75	E0 52 /E0 D2	E0 AA E0 52 /E0 D2 E0 2A	E0 2A E0 52 /E0 D2 E0 AA
76	E0 53 /E0 D3	E0 AA E0 53 /E0 D3 E0 2A	E0 2A E0 53 /E0 D3 E0 AA
79	E0 4B /E0 CB	E0 AA E0 4B /E0 CB E0 2A	E0 2A E0 4B /E0 CB E0 AA
80	E0 47 /E0 C7	E0 AA E0 47 /E0 C7 E0 2A	E0 2A E0 47 /E0 C7 E0 AA
81	E0 4F /E0 CF	E0 AA E0 4F /E0 CF E0 2A	E0 2A E0 4F /E0 CF E0 AA
83	E0 48 /E0 C8	E0 AA E0 48 /E0 C8 E0 2A	E0 2A E0 48 /E0 C8 E0 AA
84	E0 50 /E0 D0	E0 AA E0 50 /E0 D0 E0 2A	E0 2A E0 50 /E0 D0 E0 AA
85	E0 49 /E0 C9	E0 AA E0 49 /E0 C9 E0 2A	E0 2A E0 49 /E0 C9 E0 AA
86	E0 51 /E0 D1	E0 AA E0 51 /E0 D1 E0 2A	E0 2A E0 51 /E0 D1 E0 AA
89	E0 4D /E0 CD	E0 AA E0 4D /E0 CD E0 2A	E0 2A E0 4D /E0 CD E0 AA
* If the left Shift key is held down, the AA/2A shift make and break is sent with the other scan codes. If the right Shift key is held down, B6/36 is sent. If both Shift keys are down, both sets of codes are sent with the other scan code.			

Key No.	Scan Code Make/Break	Shift Case Make/Break *
95	E0 35/E0 B5	E0 AA E0 35/E0 B5 E0 2A
* If the left Shift key is held down, the AA/2A shift make and break is sent with the other scan codes. If the right Shift key is held down, B6/36 is sent. If both Shift keys are down, both sets of codes are sent with the other scan code.		

Key No.	Scan Code Make/Break	Ctrl Case, Shift Case Make/Break	Alt Case Make/Break
124	E0 2A E0 37 /E0 B7 E0 AA	E0 37/E0 B7	54/D4

Key No.	Make Code	Ctrl Key Pressed
126 *	E1 1D 45 E1 9D C5	E0 46 E0 C6
* This key is not typematic. All associated scan codes occur on the make of the key.		

Scan Code Set 2

In scan code set 2, each key is assigned a unique 8-bit make scan code, which is sent when the key is pressed. Each key also sends a break code when the key is released. The break code consists of 2 bytes, the first of which is the break code prefix, hex F0; the second byte is the same as the make scan code for that key. The typematic scan code for a key is the same as the key's make code.

Scan Code Tables (Set 2)

The following keys send the codes shown, regardless of any shift states in the keyboard or system. Refer to "Keyboard Layouts" beginning on page 4-40 to determine the character associated with each key number.

Key Number	Make Code	Break Code
1	0E	F0 0E
2	16	F0 16
3	1E	F0 1E
4	26	F0 26
5	25	F0 25
6	2E	F0 2E
7	36	F0 36
8	3D	F0 3D
9	3E	F0 3E
10	46	F0 46
11	45	F0 45
12	4E	F0 4E
13	55	F0 55
15	66	F0 66
16	0D	F0 0D
17	15	F0 15
18	1D	F0 1D
19	24	F0 24
20	2D	F0 2D
21	2C	F0 2C
22	35	F0 35
23	3C	F0 3C
24	43	F0 43
25	44	F0 44
26	4D	F0 4D
27	54	F0 54
28	5B	F0 5B
29 *	5D	F0 5D
30	58	F0 58
31	1C	F0 1C
* 101-key keyboard only.		

Key Number	Make Code	Break Code
32	1B	F0 1B
33	23	F0 23
34	2B	F0 2B
35	34	F0 34
36	33	F0 33
37	3B	F0 3B
38	42	F0 42
39	4B	F0 4B
40	4C	F0 4C
41	52	F0 52
42 **	5D	F0 5D
43	5A	F0 5A
44	12	F0 12
45 **	61	F0 61
46	1A	F0 1A
47	22	F0 22
48	21	F0 21
49	2A	F0 2A
50	32	F0 32
51	31	F0 31
52	3A	F0 3A
53	41	F0 41
54	49	F0 49
55	4A	F0 4A
57	59	F0 59
58	14	F0 14
60	11	F0 11
61	29	F0 29
62	E0 11	E0 F0 11
64	E0 14	E0 F0 14
90	77	F0 77
91	6C	F0 6C
92	6B	F0 6B
93	69	F0 69
96	75	F0 75
97	73	F0 73
98	72	F0 72
99	70	F0 70
100	7C	F0 7C
101	7D	F0 7D
102	74	F0 74
103	7A	F0 7A
104	71	F0 71
105	7B	F0 7B
106	79	F0 79
108	E0 5A	E0 F0 5A
110	76	F0 76
112	05	F0 05
113	06	F0 06
114	04	F0 04
115	0C	F0 0C
116	03	F0 03
117	0B	F0 0B
118	83	F0 83
119	0A	F0 0A
** 102-key keyboard only.		

Key Number	Make Code	Break Code
120	01	F0 01
121	09	F0 09
122	78	F0 78
123	07	F0 07
125	7E	F0 7E

The remaining keys send a series of codes dependent on the state of the various shift keys (Ctrl, Alt, and Shift), and the state of Num Lock (On or Off). Because the base scan code is identical to that of another key, an extra code (hex E0) has been added to the base code to make it unique.

Key No.	Base Case, or Shift+Num Lock Make/Break	Shift Case Make/Break *	Num Lock on Make/Break
75	E0 70 /E0 F0 70	E0 F0 12 E0 70 /E0 F0 70 E0 12	E0 12 E0 70 /E0 F0 70 E0 F0 12
76	E0 71 /E0 F0 71	E0 F0 12 E0 71 /E0 F0 71 E0 12	E0 12 E0 71 /E0 F0 71 E0 F0 12
79	E0 6B /E0 F0 6B	E0 F0 12 E0 6B /E0 F0 6B E0 12	E0 12 E0 6B /E0 F0 6B E0 F0 12
80	E0 6C /E0 F0 6C	E0 F0 12 E0 6C /E0 F0 6C E0 12	E0 12 E0 6C /E0 F0 6C E0 F0 12
81	E0 69 /E0 F0 69	E0 F0 12 E0 69 /E0 F0 69 E0 12	E0 12 E0 69 /E0 F0 69 E0 F0 12
83	E0 75 /E0 F0 75	E0 F0 12 E0 75 /E0 F0 75 E0 12	E0 12 E0 75 /E0 F0 75 E0 F0 12
84	E0 72 /E0 F0 72	E0 F0 12 E0 72 /E0 F0 72 E0 12	E0 12 E0 72 /E0 F0 72 E0 F0 12
85	E0 7D /E0 F0 7D	E0 F0 12 E0 7D /E0 F0 7D E0 12	E0 12 E0 7D /E0 F0 7D E0 F0 12
86	E0 7A /E0 F0 7A	E0 F0 12 E0 7A /E0 F0 7A E0 12	E0 12 E0 7A /E0 F0 7A E0 F0 12
89	E0 74 /E0 F0 74	E0 F0 12 E0 74 /E0 F0 74 E0 12	E0 12 E0 74 /E0 F0 74 E0 F0 12
* If the left Shift key is held down, the F0 12/12 shift make and break is sent with the other scan codes. If the right Shift key is held down, F0 59/59 is sent. If both Shift keys are down, both sets of codes are sent with the other scan code.			

Key No.	Scan Code Make/Break	Shift Case Make/Break *
95	E0 4A/E0 F0 4A	E0 F0 12 4A/E0 12 F0 4A
* If the left Shift key is held down, the F0 12/12 shift make and break is sent with the other scan codes. If the right Shift key is held down, F0 59/59 is sent. If both Shift keys are down, both sets of codes are sent with the other scan code.		

Key No.	Scan Code Make/Break	Ctrl Case, Shift Case Make/Break	Alt Case Make/Break
124	E0 12 E0 7C /E0 F0 7C E0 F0 12	E0 7C/E0 F0 7C	84/F0 84

Key No.	Make Code	Ctrl Key Pressed
126 *	E1 14 77 E1 F0 14 F0 77	E0 7E E0 F0 7E
* This key is not typematic. All associated scan codes occur on the make of the key.		

Scan Code Set 3

In scan code set 3, each key is assigned a unique 8-bit make scan code, which is sent when the key is pressed. Each key also sends a break code when the key is released. The break code consists of 2 bytes, the first of which is the break-code prefix, hex F0; the second byte is the same as the make scan code for that key. The typematic scan code for a key is the same as the key's make code. With this scan code set, each key sends only one scan code, and no keys are affected by the state of any other keys.

Scan Code Tables (Set 3)

The following keys send the codes shown, regardless of any shift states in the keyboard or system. Refer to "Keyboard Layouts" beginning on page 4-40 to determine the character associated with each key number.

Key Number	Make Code	Break Code	Default Key State
1	0E	F0 0E	Typematic
2	16	F0 16	Typematic
3	1E	F0 1E	Typematic
4	26	F0 26	Typematic
5	25	F0 25	Typematic
6	2E	F0 2E	Typematic
7	36	F0 36	Typematic
8	3D	F0 3D	Typematic
9	3E	F0 3E	Typematic
10	46	F0 46	Typematic
11	45	F0 45	Typematic
12	4E	F0 4E	Typematic
13	55	F0 55	Typematic
15	66	F0 66	Typematic
16	0D	F0 0D	Typematic
17	15	F0 15	Typematic
18	1D	F0 1D	Typematic
19	24	F0 24	Typematic
20	2D	F0 2D	Typematic
21	2C	F0 2C	Typematic
22	35	F0 35	Typematic
23	3C	F0 3C	Typematic
24	43	F0 43	Typematic
25	44	F0 44	Typematic
26	4D	F0 4D	Typematic
27	54	F0 54	Typematic
28	5B	F0 5B	Typematic

Key Number	Make Code	Break Code	Default Key State
29 *	5C	F0 5C	Typematic
30	14	F0 14	Make/Break
31	1C	F0 1C	Typematic
32	1B	F0 1B	Typematic
33	23	F0 23	Typematic
34	2B	F0 2B	Typematic
35	34	F0 34	Typematic
36	33	F0 33	Typematic
37	3B	F0 3B	Typematic
38	42	F0 42	Typematic
39	4B	F0 4B	Typematic
40	4C	F0 4C	Typematic
41	52	F0 52	Typematic
42 **	53	F0 53	Typematic
43	5A	F0 5A	Typematic
44	12	F0 12	Make/Break
45 **	13	F0 13	Typematic
46	1A	F0 1A	Typematic
47	22	F0 22	Typematic
48	21	F0 21	Typematic
49	2A	F0 2A	Typematic
50	32	F0 32	Typematic
51	31	F0 31	Typematic
52	3A	F0 3A	Typematic
53	41	F0 41	Typematic
54	49	F0 49	Typematic
55	4A	F0 4A	Typematic
57	59	F0 59	Make/Break
58	11	F0 11	Make/Break
60	19	F0 19	Make/Break
61	29	F0 29	Typematic
62	39	F0 39	Make only
64	58	F0 58	Make only
75	67	F0 67	Make only
76	64	F0 64	Typematic
79	61	F0 61	Typematic
80	6E	F0 6E	Make only
81	65	F0 65	Make only
83	63	F0 63	Typematic
84	60	F0 60	Typematic
85	6F	F0 6F	Make only
86	6D	F0 6D	Make only
89	6A	F0 6A	Typematic
90	76	F0 76	Make only
91	6C	F0 6C	Make only
92	6B	F0 6B	Make only
93	69	F0 69	Make only
95	77	F0 77	Make only
96	75	F0 75	Make only
97	73	F0 73	Make only
98	72	F0 72	Make only

* 101-key keyboard only.
** 102-key keyboard only.

SECTION 4

Key Number	Make Code	Break Code	Default Key State
99	70	F0 70	Make only
100	7E	F0 7E	Make only
101	7D	F0 7D	Make only
102	74	F0 74	Make only
103	7A	F0 7A	Make only
104	71	F0 71	Make only
105	84	F0 84	Make only
106	7C	F0 7C	Typematic
108	79	F0 79	Make only
110	08	F0 08	Make only
112	07	F0 07	Make only
113	0F	F0 0F	Make only
114	17	F0 17	Make only
115	1F	F0 1F	Make only
116	27	F0 27	Make only
117	2F	F0 2F	Make only
118	37	F0 37	Make only
119	3F	F0 3F	Make only
120	47	F0 47	Make only
121	4F	F0 4F	Make only
122	56	F0 56	Make only
123	5E	F0 5E	Make only
124	57	F0 57	Make only
125	5F	F0 5F	Make only
126	62	F0 62	Make only

Clock and Data Signals

The keyboard and system communicate over the 'clock' and 'data' lines. The source of each of these lines is an open-collector device on the keyboard that allows either the keyboard or the system to force a line to an inactive (low) level. When no communication is occurring, the 'clock' line is at an active (high) level. The state of the 'data' line is held active(high) by the keyboard.

When the system sends data to the keyboard, it forces the 'data' line to an inactive level and allows the 'clock' line to go to an active level.

An inactive signal will have a value of at least 0, but not greater than +0.7 volts. A signal at the inactive level is a logical 0. An active signal will have a value of at least +2.4, but not greater than +5.5 volts. A signal at the active level is a logical 1. Voltages are measured between a signal source and the dc network ground.

The keyboard 'clock' line provides the clocking signals used to clock serial data to and from the keyboard. If the host system forces the 'clock' line to an inactive level, keyboard transmission is inhibited.

When the keyboard sends data to, or receives data from the system, it generates the 'clock' signal to time the data. The system can prevent the keyboard from sending data by forcing the 'clock' line to an inactive level; the 'data' line may be active or inactive during this time.

During the BAT, the keyboard allows the 'clock' and 'data' lines to go to an active level.

Data Stream

Data transmissions to and from the keyboard consist of an 11-bit data stream (Mode 2) sent serially over the 'data' line. A logical 1 is sent at an active (high) level. The following table shows the functions of the bits.

Bit	Function
1	Start bit (always 0)
2	Data bit 0 (least-significant)
3	Data bit 1
4	Data bit 2
5	Data bit 3
6	Data bit 4
7	Data bit 5
8	Data bit 6
9	Data bit 7 (most-significant)
10	Parity bit (odd parity)
11	Stop bit (always 1)

The parity bit is either 1 or 0, and the 8 data bits, plus the parity bit, always have an odd number of 1's.

> **Note:** Mode 1 is a 9-bit data stream that does not have a parity bit or stop bit and the start bit is always 1.

Keyboard Data Output

When the keyboard is ready to send data, it first checks for a keyboard-inhibit or system request-to-send status on the 'clock' and 'data' lines. If the 'clock' line is inactive (low), data is stored in the keyboard buffer. If the 'clock' line is active (high) and the 'data' line is inactive (request-to-send), data is stored in the keyboard buffer, and the keyboard receives system data.

If the 'clock' and 'data' lines are both active, the keyboard sends the 0 start bit, 8 data bits, the parity bit, and the stop bit. Data will be valid before the trailing edge and beyond the leading edge of the clock pulse. During transmission, the keyboard checks the 'clock' line for an active level at least every 60 milliseconds. If the system lowers the 'clock' line from an active level after the keyboard starts sending data, a condition known as *line contention* occurs, and the keyboard stops sending data. If line contention occurs before the leading edge of the 10th clock signal (parity bit), the keyboard buffer returns the 'clock' and 'data' lines to an active level. If contention does not occur by the 10th clock signal, the keyboard completes the transmission. Following line contention, the system may or may not request the keyboard to resend the data.

Following a transmission, the system can inhibit the keyboard until the system processes the input, or until it requests that a response be sent.

Keyboard Data Input

When the system is ready to send data to the keyboard, it first checks to see if the keyboard is sending data. If the keyboard is sending, but has not reached the 10th 'clock' signal, the system can override the keyboard output by forcing the keyboard 'clock' line to an inactive (low) level. If the keyboard transmission is beyond the 10th 'clock' signal, the system must receive the transmission.

If the keyboard is not sending, or if the system elects to override the keyboard's output, the system forces the keyboard 'clock' line to an inactive level for more than 60 microseconds while preparing to send data. When the system is ready to send the start bit (the 'data' line will be inactive), it allows the 'clock' line to go to an active (high) level.

The keyboard checks the state of the 'clock' line at intervals of no more than 10 milliseconds. If a system request-to-send (RTS) is detected, the keyboard counts 11 bits. After the 10th bit, the keyboard checks for an active level on the 'data' line, and if the line is active, forces it inactive, and counts one more bit. This action signals the system that the keyboard has received its data. Upon receipt of this signal, the system returns to a ready state, in which it can accept keyboard output, or goes to the inhibited state until it is ready.

If the keyboard 'data' line is found at an inactive level following the 10th bit, a framing error has occurred, and the keyboard continues to count until the 'data' line becomes active. The keyboard then makes the 'data' line inactive and sends a Resend.

Each system command or data transmission to the keyboard requires a response from the keyboard before the system can send its next output. The keyboard will respond within 20 milliseconds unless the system prevents keyboard output. If the keyboard response is invalid or has a parity error, the system sends the command or data again. However, the two byte commands require special handling. If hex F3 (Set Typematic Rate/Delay), hex F0 (Select Alternate Scan Codes), or hex ED (Set/Reset Mode Indicators) have been sent and acknowledged, and the value byte has been sent but the response is invalid or has a parity error, the system will resend both the command and the value byte.

Keyboard Encoding and Usage

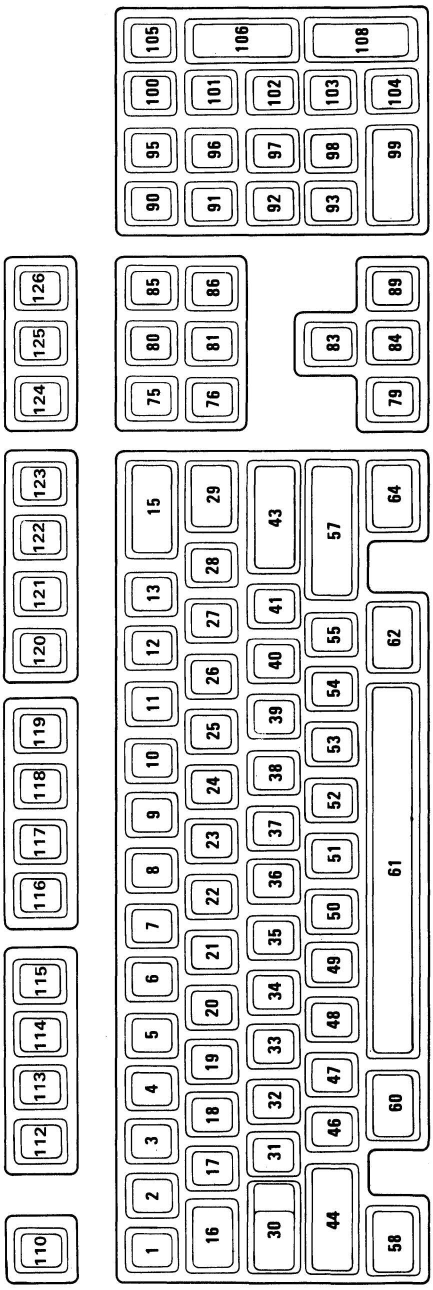
The keyboard routine, provided by IBM in the ROM BIOS, is responsible for converting the keyboard scan codes into what will be termed *Extended ASCII.* The extended ASCII codes returned by the ROM routine are mapped to the U.S. English keyboard layout. Some operating systems may make provisions for alternate keyboard layouts by providing an interrupt replacer, which resides in the read/write memory. This section discusses only the ROM routine.

Extended ASCII encompasses 1-byte character codes, with possible values of 0 to 255, an extended code for certain extended keyboard functions, and functions handled within the keyboard routine or through interrupts.

Character Codes

The character codes described later are passed through the BIOS keyboard routine to the system or application program. A "-1" means the combination is suppressed in the keyboard routine. The codes are returned in the AL register. See "Characters, Keystrokes, and Color" later in this manual for the exact codes.

The following figure shows the keyboard layout and key positions.



Key	Base Case	Uppercase	Ctrl	Alt
1	`	~	-1	(*)
2	1	!	-1	(*)
3	2	@	Nul(000) (*)	(*)
4	3	#	-1	(*)
5	4	$	-1	(*)
6	5	%	-1	(*)
7	6	^	RS(030)	(*)
8	7	&	-1	(*)
9	8	*	-1	(*)
10	9	(	-1	(*)
11	0	)	-1	(*)
12	-	_	US(031)	(*)
13	=	+	-1	(*)
15	Backspace (008)	Backspace (008)	Del(127)	(*)
16	→| (009)	|← (*)	(*)	(*)
17	q	Q	DC1(017)	(*)
18	w	W	ETB(023)	(*)
19	e	E	ENQ(005)	(*)
20	r	R	DC2(018)	(*)
21	t	T	DC4(020)	(*)
22	y	Y	EM(025)	(*)
23	u	U	NAK(021)	(*)
24	i	I	HT(009)	(*)
25	o	O	SI(015)	(*)
26	p	P	DLE(016)	(*)
27	[	{	Esc(027)	(*)
28	]	}	GS(029)	(*)
29	\		FS(028)	(*)
30 Caps Lock	-1	-1	-1	-1
31	a	A	SOH(001)	(*)
32	s	S	DC3(019)	(*)
33	d	D	EOT(004)	(*)
34	f	F	ACK(006)	(*)
35	g	G	BEL(007)	(*)
36	h	H	BS(008)	(*)
37	j	J	LF(010)	(*)
38	k	K	VT(011)	(*)
39	l	L	FF(012)	(*)
40	;	:	-1	(*)
41	'	"	-1	(*)
43	CR(013)	CR(013)	LF(010)	(*)
44 Shift (Left)	-1	-1	-1	-1
46	z	Z	SUB(026)	(*)
47	x	X	CAN(024)	(*)
48	c	C	ETX(003)	(*)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 1 of 2)

Key	Base Case	Uppercase	Ctrl	Alt
49	v	V	SYN(022)	(*)
50	b	B	STX(002)	(*)
51	n	N	SO(014)	(*)
52	m	M	CR(013)	(*)
53	,	<	-1	(*)
54	.	>	-1	(*)
55	/	?	-1	(*)
57 Shift (Right)	-1	-1	-1	-1
58 Ctrl (Left)	-1	-1	-1	-1
60 Alt (Left)	-1	-1	-1	-1
61	Space	Space	Space	Space
62 Alt (Right)	-1	-1	-1	-1
64 Ctrl (Right)	-1	-1	-1	-1
90 Num Lock	-1	-1	-1	-1
95	/	/	(*)	(*)
100	*	*	(*)	(*)
105	-	-	(*)	(*)
106	+	+	(*)	(*)
108	Enter	Enter	LF(010)	(*)
110	Esc	Esc	Esc	(*)
112	Null (*)	Null (*)	Null (*)	Null(*)
113	Null (*)	Null (*)	Null (*)	Null(*)
114	Null (*)	Null (*)	Null (*)	Null(*)
115	Null (*)	Null (*)	Null (*)	Null(*)
116	Null (*)	Null (*)	Null (*)	Null(*)
117	Null (*)	Null (*)	Null (*)	Null(*)
118	Null (*)	Null (*)	Null (*)	Null(*)
119	Null (*)	Null (*)	Null (*)	Null(*)
120	Null (*)	Null (*)	Null (*)	Null(*)
121	Null (*)	Null (*)	Null (*)	Null(*)
122	Null (*)	Null (*)	Null (*)	Null(*)
123	Null (*)	Null (*)	Null (*)	Null(*)
125 Scroll Lock	-1	-1	-1	-1
126	Pause(**)	Pause(**)	Break(**)	Pause(**)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 2 of 2)

The following table lists keys that have meaning only in Num Lock, Shift, or Ctrl states. The Shift key temporarily reverses the current Num Lock state.

Key	Num Lock	Base Case	Alt	Ctrl
91	7	Home (*)	-1	Clear Screen
92	4	← (*)	-1	Reverse Word(*)
93	1	End (*)	-1	Erase to EOL(*)
96	8	↑ (*)	-1	(*)
97	5	(*)	-1	(*)
98	2	↓ (*)	-1	(*)
99	0	Ins	-1	(*)
101	9	Page Up (*)	-1	Top of Text and Home
102	6	→ (*)	-1	Advance Word (*)
103	3	Page Down (*)	-1	Erase to EOS (*)
104	.	Delete (*,**)	(**)	(**)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Special Character Codes

Extended Functions

For certain functions that cannot be represented by a standard ASCII code, an extended code is used. A character code of 000 (null) is returned in AL. This indicates that the system or application program should examine a second code, which will indicate the actual function. Usually, but not always, this second code is the scan code of the primary key that was pressed. This code is returned in AH.

The following table is a list of the extended codes and their functions.

Second Code	Function
1	Alt Esc
3	Nul Character
14	Alt Backspace
15	|← (Back-tab)
16-25	Alt Q, W, E, R, T, Y, U, I, O, P
26-28	Alt [ ] ↵
30-38	Alt A, S, D, F, G, H, J, K, L
39-41	Alt ; ' `
43	Alt \
44-50	Alt Z, X, C, V, B, N, M
51-53	Alt , . /
55	Alt Keypad *
59-68	F1 to F10 Function Keys (Base Case)
71	Home
72	↑ (Cursor Up)
73	Page Up
74	Alt Keypad -
75	← (Cursor Left)
76	Center Cursor
77	→ (Cursor Right)
78	Alt Keypad +
79	End
80	↓ (Cursor Down)
81	Page Down
82	Ins (Insert)
83	Del (Delete)
84-93	Shift F1 to F10
94-103	Ctrl F1 to F10
104-113	Alt F1 to F10
114	Ctrl PrtSc (Start/Stop Echo to Printer)
115	Ctrl ← (Reverse Word)
116	Ctrl → (Advance Word)
117	Ctrl End (Erase to End of Line-EOL)
118	Ctrl PgDn (Erase to End of Screen-EOS)
119	Ctrl Home (Clear Screen and Home)
120-131	Alt 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, -, = keys 2-13
132	Ctrl PgUp (Top 25 Lines of Text and Cursor Home)
133-134	F11, F12
135-136	Shift F11, F12
137-138	Ctrl F11, F12
139-140	Alt F11, F12
141	Ctrl Up/8
142	Ctrl Keypad -
143	Ctrl Keypad 5
144	Ctrl Keypad +
145	Ctrl Down/2
146	Ctrl Ins/0
147	Ctrl Del/.
148	Ctrl Tab
149	Ctrl Keypad /
150	Ctrl Keypad *

Keyboard Extended Functions (Part 1 of 2)

Second Code	Function
151	Alt Home
152	Alt Up
153	Alt Page Up
155	Alt Left
157	Alt Right
159	Alt End
160	Alt Down
161	Alt Page Down
162	Alt Insert
163	Alt Delete
164	Alt Keypad /
165	Alt Tab
166	Alt Enter

Keyboard Extended Functions (Part 2 of 2)

Shift States

Most shift states are handled within the keyboard routine, and are not apparent to the system or application program. In any case, the current status of active shift states is available by calling an entry point in the BIOS keyboard routine. The following keys result in altered shift states:

Shift: This key temporarily shifts keys 1 through 13, 16 through 29, 31 through 41, and 46 through 55, to uppercase (base case if in Caps Lock state). Also, the Shift temporarily reverses the Num Lock or non-Num Lock state of keys 91 through 93, 96, 98, 99, and 101 through 104.

Ctrl: This key temporarily shifts keys 3, 7, 12, 15 through 29, 31 through 39, 43, 46 through 52, 75 through 89, 91 through 93, 95 through 108, 112 through 124 and 126 to the Ctrl state. The Ctrl key is also used with the Alt and Del keys to cause the system-reset function; with the Scroll Lock key to cause the break function; and with the Num Lock key to cause the pause function. The system-reset, break, and pause functions are described under "Special Handling" later in this section.

Alt: This key temporarily shifts keys 1 through 29, 31 through 43, 46 through 55, 75 through 89, 95, 100, and 105 through 124 to the Alt state. The Alt key is also used with the Ctrl and Del keys to cause a system reset.

The Alt key also allows the user to enter any character code from 1 to 255. The user holds down the Alt key and types the decimal value of the characters desired on the numeric keypad (keys 91 through 93, 96 through 99, and 101 through 103). The Alt key is then released. If the number is greater than 255, a modulo-256 value is used. This value is interpreted as a character code and is sent through the keyboard routine to the system or application program. Alt is handled internal to the keyboard routine.

Caps Lock: This key shifts keys 17 through 26, 31 through 39, and 46 through 52 to uppercase. When Caps Lock is pressed again, it reverses the action. Caps Lock is handled internal to the keyboard routine. When Caps Lock is pressed, it changes the Caps Lock Mode indicator. If the indicator was on, it will go off; and if it was off, it will go on.

Scroll Lock: When interpreted by appropriate application programs, this key indicates that the cursor-control keys will cause windowing over the text rather than moving the cursor. When the Scroll Lock key is pressed again, it reverses the action. The keyboard routine simply records the current shift state of the Scroll Lock key. It is the responsibility of the application program to perform the function. When Scroll Lock is pressed, it changes the Scroll Lock Mode indicator. If the indicator was on, it will go off; and if it was off, it will go on.

Num Lock: This key shifts keys 91 through 93, 96 through 99, and 101 through 104 to uppercase. When Num Lock is pressed again, it reverses the action. Num Lock is handled internal to the keyboard routine. When Num Lock is pressed, it changes the Num Lock Mode indicator. If the indicator was on, it will go off; if it was off, it will go on.

Shift Key Priorities and Combinations: If combinations of the Alt, Ctrl, and Shift keys are pressed and only one is valid, the priority is as follows: the Alt key is first, the Ctrl key is second, and the Shift key is third. The only valid combination is Alt and Ctrl, which is used in the system-reset function.

Special Handling

System Reset

The combination of any Alt, Ctrl, and Del keys results in the keyboard routine that starts a system reset or restart. System reset is handled by BIOS.

Break

The combination of the Ctrl and Pause/Break keys results in the keyboard routine signaling interrupt hex 1B. The extended characters AL=hex 00, and AH=hex 00 are also returned.

Pause

The Pause key causes the keyboard interrupt routine to loop, waiting for any character or function key to be pressed. This provides a method of temporarily suspending an operation, such as listing or printing, and then resuming the operation. The method is not apparent to either the system or the application program. The key stroke used to resume operation is discarded. Pause is handled internal to the keyboard routine.

Print Screen

The Print Screen key results in an interrupt invoking the print-screen routine. This routine works in the alphameric or graphics mode, with unrecognizable characters printing as blanks.

System Request

When the System Request (Alt and Print Screen) key is pressed, a hex 8500 is placed in AX, and an interrupt hex 15 is executed. When the SysRq key is released, a hex 8501 is placed in AX, and another interrupt hex 15 is executed. If an application is to use System Request, the following rules must be observed:

```
Save the previous address.

    Overlay interrupt vector hex 15.

    Check AH for a value of hex 85:

        If yes, process may begin.
        If no, go to previous address.
```

The application program must preserve the value in all registers, except AX, upon return. System Request is handled internal to the keyboard routine.

Other Characteristics

The keyboard routine does its own buffering, and the keyboard buffer is large enough to support entries by a fast typist. However, if a key is pressed when the buffer is full, the key will be ignored and the "alarm" will sound.

The keyboard routine also suppresses the typematic action of the following keys: Ctrl, Shift, Alt, Num Lock, Scroll Lock, Caps Lock, and Ins.

During each interrupt hex 09 from the keyboard, an interrupt hex 15, function (AH)=hex 4F is generated by the BIOS after the scan code is read from the keyboard adapter. The scan code is passed in the (AL) register with the carry flag set. This is to allow an operating system to intercept each scan code prior to its being handled by the interrupt hex 09 routine, and have a chance to change or act on the scan code. If the carry flag is changed to 0 on return from interrupt hex 15, the scan code will be ignored by the interrupt handler.

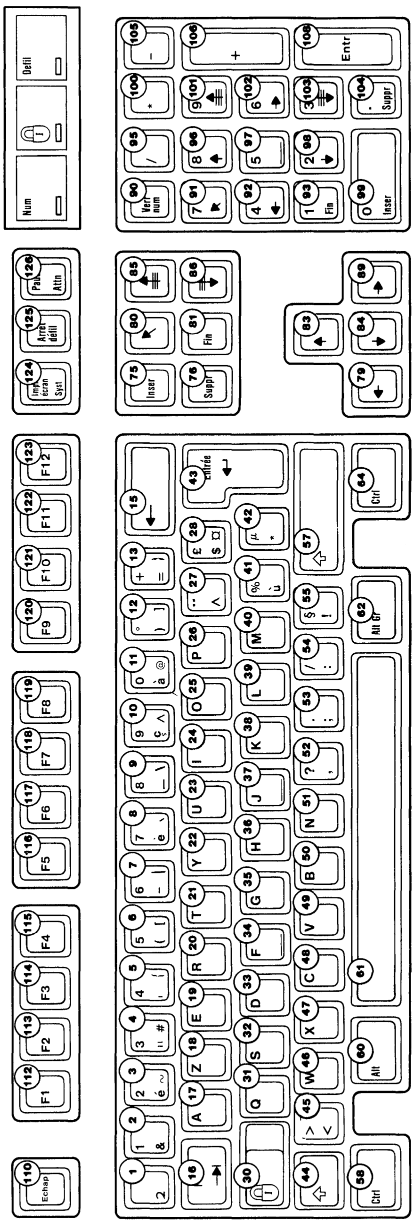
Keyboard Layouts

The keyboard is available in six layouts:

- French
- German
- Italian
- Spanish
- U.K. English
- U.S. English

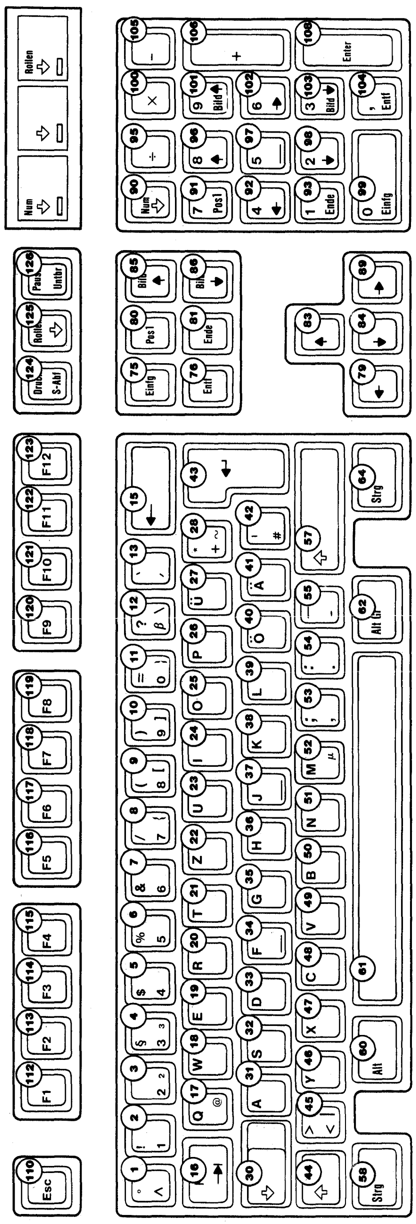
The various layouts are shown in alphabetic order on the following pages. Nomenclature is on both the top and front face of the keybuttons. The number to the upper right designates the keybutton position.

French Keyboard

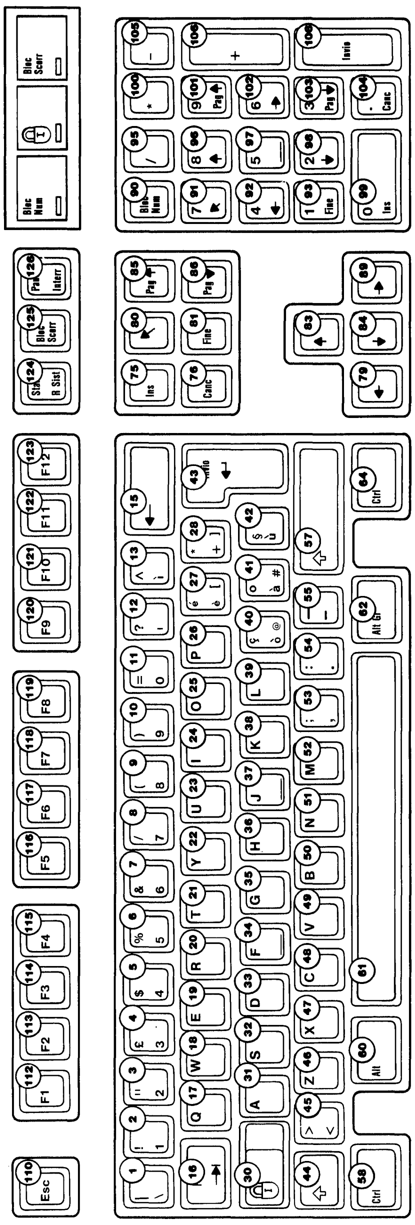


SECTION 4

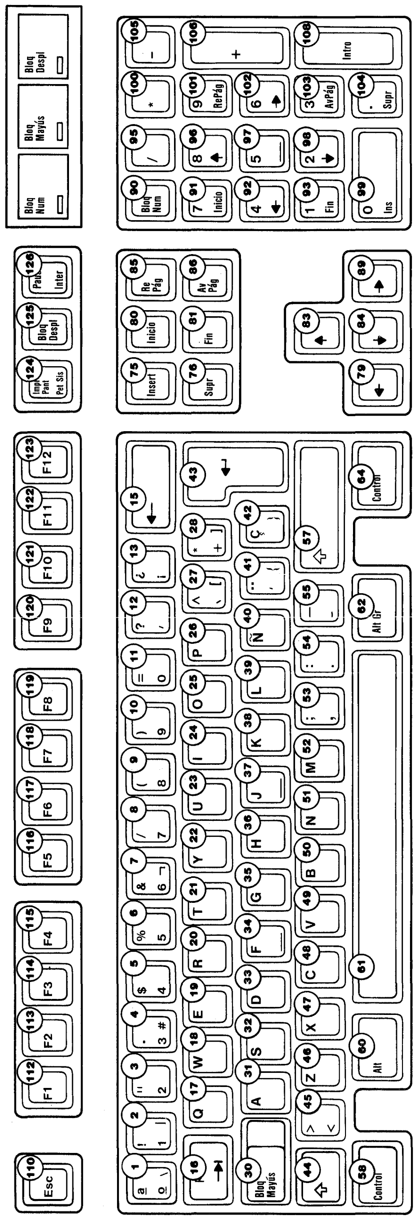
German Keyboard



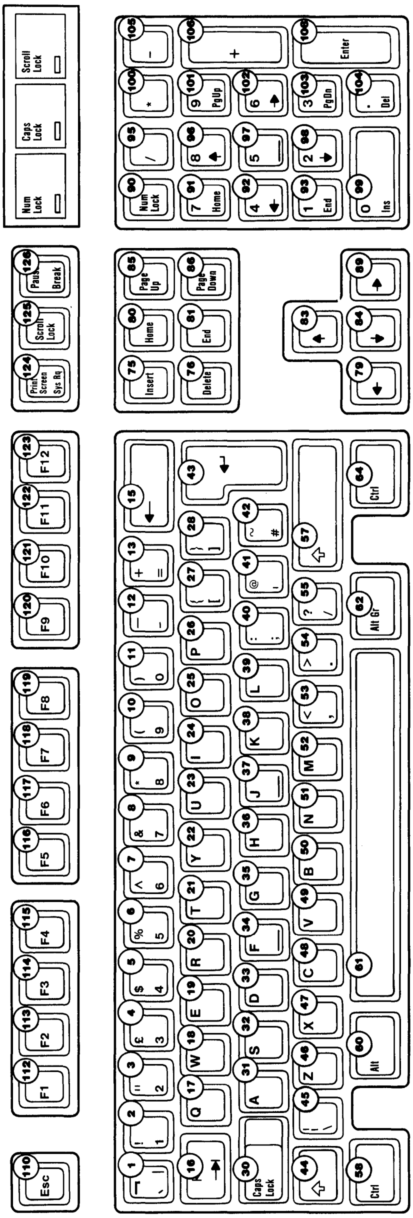
Italian Keyboard



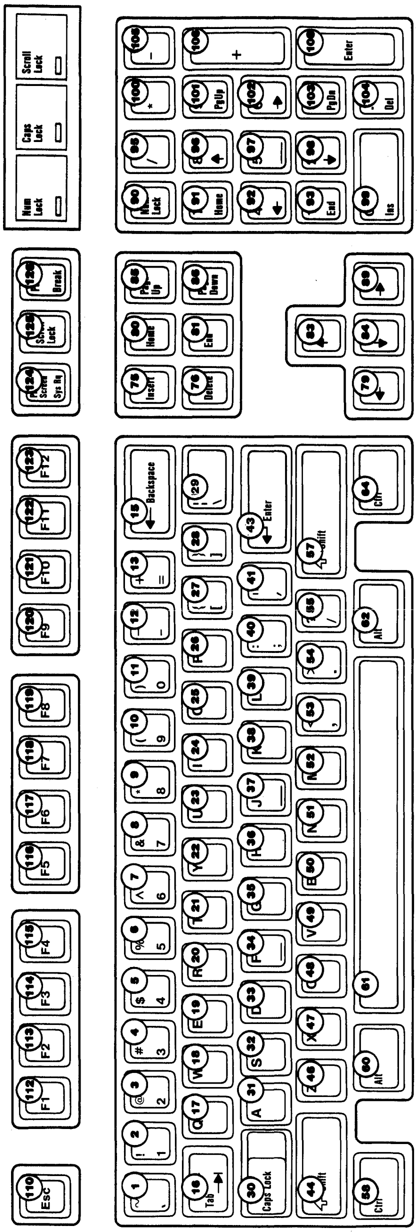
Spanish Keyboard



U.K. English Keyboard



U.S. English Keyboard



Specifications

The specifications for the keyboard are as follows.

Power Requirements

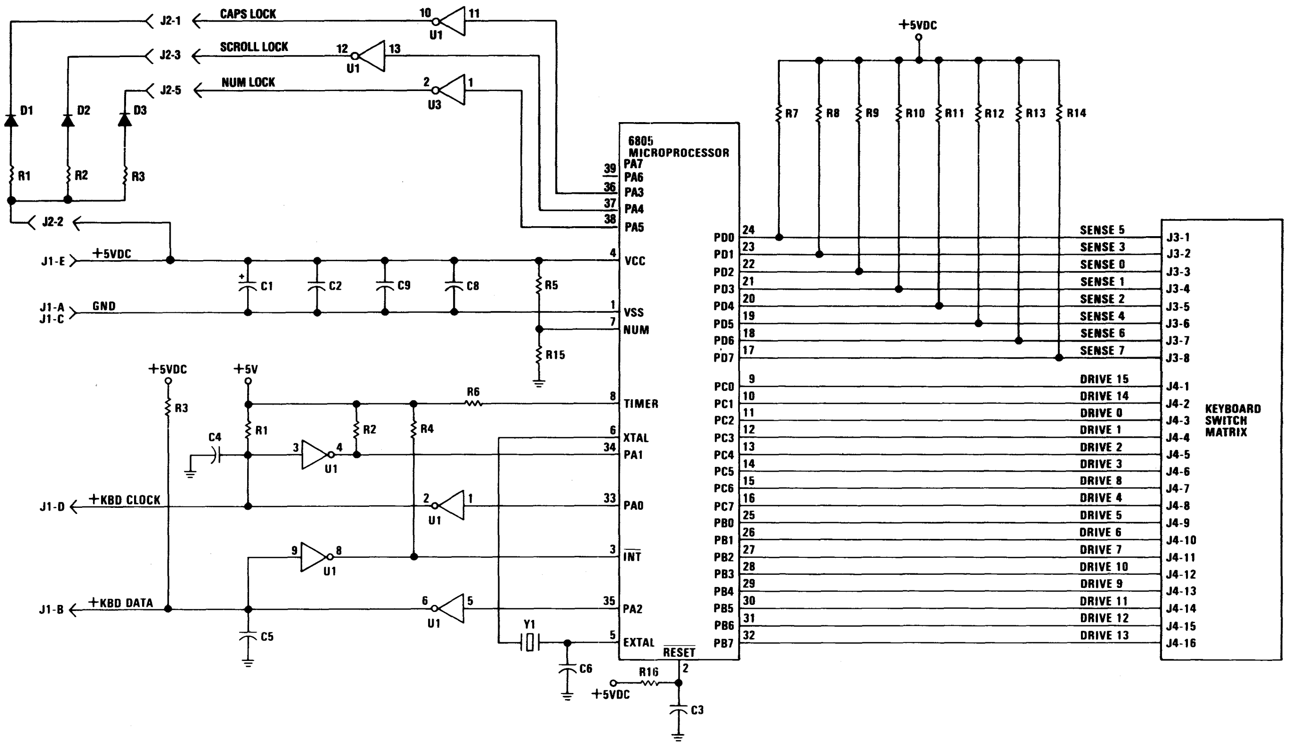
- +5 Vdc ± 10%
- Current cannot exceed 275 mA

Size

- Length: 492 millimeters (19.4 inches)
- Depth: 210 millimeters (8.3 inches)
- Height: 58 millimeters (2.3 inches), legs extended

Weight

2.25 kilograms (5.0 pounds)



101/102-KEY KEYBOARD

SECTION 5. SYSTEM BIOS

Notes:

System BIOS Usage

The basic input/output system (BIOS) resides in ROM on the system board and provides low level control for the major I/O devices in the system and provides system services, such as time-of-day and memory size determination. Additional ROM modules may be placed on option adapters to provide device-level control for that option adapter. BIOS routines enable the assembly language programmer to perform block (disk or diskette) or character-level I/O operations without concern for device address and characteristics.

During POST, a test is made for valid code starting at address hex E0000 and ending at hex EFFFF.

The goal of the BIOS is to provide an operational interface to the system and relieve the programmer of concern about the characteristics of hardware devices. The BIOS interface isolates the user from the hardware, allowing new devices to be added to the system, yet retaining the BIOS level interface to the device. In this manner, hardware modifications and enhancements are not apparent to user programs.

The IBM Personal Computer *Macro Assembler* manual and the IBM Personal Computer *Disk Operating System (DOS)* manual provide useful programming information related to this section. A complete listing of the BIOS is given later in this section.

Access to the BIOS is through program interrupts of the microprocessor in the real mode. Each BIOS entry point is available through its own interrupt. For example, to determine the amount of base RAM available in the system with the microprocessor in the real mode, INT 12H invokes the BIOS routine for determining the memory size and returns the value to the caller.

Parameter Passing

All parameters passed to and from the BIOS routines go through the 80286 registers. The prolog of each BIOS function indicates the registers used on the call and return. For the memory size example, no parameters are passed. The memory size, in 1K increments, is returned in the AX register.

If a BIOS function has several possible operations, the AH register is used at input to indicate the desired operation. For example, to set the time of day, the following code is required:

```
MOV   AH,1                ; function is to set time-of-day
MOV   CX,HIGH_COUNT       ; establish the current time
MOV   DX,LOW_COUNT
INT   1AH                 ; set the time
```

To read the time of day:

```
MOV   AH,0                ; function is to read time-of-day
INT   1AH                 ; read the timer
```

The BIOS routines save all registers except for AX and the flags. Other registers are modified on return only if they are returning a value to the caller. The exact register usage can be seen in the prolog of each BIOS function.

The following figure shows the interrupts with their addresses and functions.

Int	Address	Name	BIOS Entry
0	0-3	Divide by Zero	D11
1	4-7	Single Step	D11
2	8-B	Non-maskable	NMI INT
3	C-F	Breakpoint	D11
4	10-13	Overflow	D11
5	14-17	Print Screen	PRINT_SCREEN
6	18-1B	Reserved	D11
7	1C-1F	Reserved	D11
8	20-23	Time of Day	TIMER_INT
9	24-27	Keyboard	KB_INT
A	28-2B	Reserved	D11
B	2C-2F	Communications	D11
C	30-33	Communications	D11
D	34-37	Alternate Printer	D11
E	38-3B	Diskette	DISK_INT
F	3C-3F	Printer	D11
10	40-43	Video	VIDEO_IO
11	44-47	Equipment Check	EQUIPMENT
12	48-4B	Memory	MEMORY_SIZE_DETERMINE
13	4C-4F	Diskette/Disk	DISKETTE_IO
14	50-53	Communications	RS232_IO
15	54-57	Cassette	CASSETTE IO/System Extensions
16	58-5B	Keyboard	KEYBOARD_IO
17	5C-5F	Printer	PRINTER_IO
18	60-63	Resident BASIC	F600:0000
19	64-67	Bootstrap	BOOTSTRAP
1A	68-6B	Time of Day	TIME_OF_DAY
1B	6C-6F	Keyboard Break	DUMMY_RETURN
1C	70-73	Timer Tick	DUMMY_RETURN
1D	74-77	Video Initialization	VIDEO_PARMS
1E	78-7B	Diskette Parameters	DISK_BASE
1F	7C-7F	Video Graphics Chars	0

80286-2 Program Interrupt Listing (Real Mode Only)

Note: For BIOS index, see the BIOS Quick Reference on page 5-14.

The following figure shows hardware, BASIC, and DOS reserved interrupts.

Interrupt	Address	Function
20	80-83	DOS program terminate
21	84-87	DOS function call
22	88-8B	DOS terminate address
23	8C-8F	DOS Ctrl Break exit address
24	90-93	DOS fatal error vector
25	94-97	DOS absolute disk read
26	98-9B	DOS absolute disk write
27	9C-9F	DOS terminate, fix in storage
28-3F	A0-FF	Reserved for DOS
40-5F	100-17F	Reserved for BIOS
60-67	180-19F	Reserved for user program interrupts
68-6F	1A0-1BF	Not used
70	1C0-1C3	IRQ 8 Realtime clock INT (BIOS entry RTC_INT)
71	1C4-1C7	IRQ 9 (BIOS entry RE_DIRECT)
72	1C8-1CB	IRQ 10 (BIOS entry D11)
73	1CC-1CF	IRQ 11 (BIOS entry D11)
74	1D0-1D3	IRQ 12 (BIOS entry D11)
75	1D4-1D7	IRQ 13 BIOS Redirect to NMI interrupt (BIOS entry INT_287)
76	1D8-1DB	IRQ 14 (BIOS entry D11)
77	1DC-1DF	IRQ 15 (BIOS entry D11)
78-7F	1E0-1FF	Not used
80-85	200-217	Reserved for BASIC
86-F0	218-3C3	Used by BASIC interpreter while BASIC is running
F1-FF	3C4-3FF	Not used

Hardware, Basic, and DOS Interrupts

Vectors with Special Meanings

Interrupt 15—Cassette I/O: This vector points to the following functions:

- Device open
- Device closed
- Program termination
- Event wait
- Joystick support
- System Request key pressed

- Wait
- Move block
- Extended memory size determination
- Processor to protected mode

Additional information about these functions may be found in the BIOS listing.

Interrupt 1B—Keyboard Break Address: This vector points to the code that is executed when the Ctrl and Break keys are pressed. The vector is invoked while responding to a keyboard interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction so that nothing will occur when the Ctrl and Break keys are pressed unless the application program sets a different value.

This routine may retain control with the following considerations:

- The Break may have occurred during interrupt processing, so that one or more End of Interrupt commands must be sent to the 8259 controller.
- All I/O devices should be reset in case an operation was underway at the same time.

Interrupt 1C—Timer Tick: This vector points to the code that will be executed at every system-clock tick. This vector is invoked while responding to the timer interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction, so that nothing will occur unless the application modifies the pointer. The application must save and restore all registers that will be modified. When control is passed to an application with this interrupt, all hardware interrupts from the 8259 interrupt controller are disabled.

Interrupt 1D—Video Parameters: This vector points to a data region containing the parameters required for the initialization of the 6845 on the video adapter. Notice that there are four separate tables, and all four must be reproduced if all modes of operation are to be supported. The power-on routines initialize this vector to point to the parameters contained in the ROM video routines.

Interrupt 1E—Diskette Parameters: This vector points to a data region containing the parameters required for the diskette drive. The power-on routines initialize this vector to point to the parameters contained in the ROM diskette routine. These default parameters represent the specified values for any IBM drives attached to the system. Changing this parameter block may be necessary to reflect the specifications of other drives attached.

Interrupt 1F—Graphics Character Extensions: When operating in graphics modes 320 x 200 or 640 x 200, the read/write character interface will form a character from the ASCII code point, using a set of dot patterns. ROM contains the dot patterns for the first 128 code points. For access to the second 128 code points, this vector must be established to point at a table of up to 1K, where each code point is represented by 8 bytes of graphic information. At power-on time, this vector is initialized to 000:0, and the user must change this vector if the additional code points are required.

Interrupt 40—Reserved: When a Fixed Disk and Diskette Drive Adapter is installed, the BIOS routines use interrupt 40 to revector the diskette pointer.

Interrupt 41 and 46—Fixed Disk Parameters: These vectors point to the parameters for the fixed disk drives, 41 for the first drive and 46 for the second. The power-on routines initialize the vectors to point to the appropriate parameters in the ROM disk routine if CMOS is valid. The drive type codes in CMOS are used to select which parameter set each vector is pointed to. Changing this parameter hook may be necessary to reflect the specifications of other fixed drives attached.

Other Read/Write Memory Usage

The IBM BIOS routines use 256 bytes of memory from absolute hex 400 to hex 4FF. Locations hex 400 to 407 contain the base addresses of any RS-232C adapters installed in the system. Locations hex 408 to 40F contain the base addresses of any printer adapters.

Memory locations hex 300 to hex 3FF are used as a stack area during the power-on initialization and bootstrap, when control is passed to it from power-on. If the user desires the stack to be in a different area, that area must be set by the application.

The following figure shows the reserved memory locations.

Address	Mode	Function
400-4A1	ROM BIOS	See BIOS listing
4A2-4EF		Reserved
4F0-4FF		Reserved as intra-application communication area for any application
500-5FF		Reserved for DOS and BASIC
500	DOS	Print screen status flag store 0=Print screen not active or successful print screen operation 1=Print screen in progress 255=Error encountered during print screen operation
504	DOS	Single drive mode status byte
510-511	BASIC	BASIC's segment address store
512-515	BASIC	Clock interrupt vector segment:offset store
516-519	BASIC	Break key interrupt vector segment:offset store
51A-51D	BASIC	Disk error interrupt vector segment:offset store

Reserved Memory Locations

SECTION 5

The following is the BASIC workspace for DEF SEG (default workspace).

Offset	Length	
2E	2	Line number of current line being executed
347	2	Line number of last error
30	2	Offset into segment of start of program text
358	2	Offset into segment of start of variables (end of program text 1-1)
6A	1	Keyboard buffer contents 0=No characters in buffer 1=Characters in buffer
4E	1	Character color in graphics mode*
*Set to 1, 2, or 3 to get text in colors 1-3. Do not set to 0. The default is 3.		

Basic Workspace Variables

Example

100 PRINT PEEK (&H2E) + 256 x PEEK (&H2F)

L	H
Hex 64	Hex 00

The following is a BIOS memory map.

Starting Address	
00000	BIOS interrupt vectors
001E0	Available interrupt vectors
00400	BIOS data area
00500	User read/write memory
E0000	Read only memory
F0000	BIOS program area

BIOS Memory Map

BIOS Programming Hints

The BIOS code is invoked through program interrupts. The programmer should not "hard code" BIOS addresses into applications. The internal workings and absolute addresses within BIOS are subject to change without notice.

If an error is reported by the disk or diskette code, reset the drive adapter and retry the operation. A specified number of retries should be required for diskette reads to ensure the problem is not due to motor startup.

When altering I/O-port bit values, the programmer should change only those bits necessary to the current task. Upon completion, the original environment should be restored. Failure to adhere to this practice may cause incompatibility with present and future applications.

Additional information for BIOS programming can be found in Section 8 of this manual.

Move Block BIOS

The Move Block BIOS was designed to make use of the memory above the 1M address boundary while operating with IBM DOS. The Block Move is done with the Intel 80286 Microprocessor operating in the protected mode.

Because the interrupts are disabled in the protected mode, Move Block BIOS may demonstrate a data overrun or lost interrupt situation in certain environments.

Communication devices, while receiving data, are sensitive to these interrupt routines; therefore, the timing of communication and the Block Move should be considered. The following table shows the interrupt servicing requirements for communication devices.

Baud Rate	11 Bit (ms)	9 bit (ms)
300	33.33	30.00
1200	8.33	7.50
2400	4.16	7.50
4800	2.08	1.87
9600	1.04	0.93
Times are approximate		

Communication Interrupt Intervals

The following table shows the time required to complete a Block Move.

Block Size	Buffer Addresses	Time in ms
Normal 512 Byte	Both even	0.98
	Even and odd	1.04
	Both odd	1.13
Maximum 64K	Both even	37.0
	Even and odd	55.0
	Both odd	72.0
Time is approximate		

Move Block BIOS Timing

Following are some ways to avoid data overrun errors and loss of interrupts:

- Do not use the Block Move while communicating, or
- Restrict the block size to 512 bytes or less while communicating, or
- Use even address buffers for both the source and the destination to keep the time for a Block Move to a minimum.

Adapters with System-Accessible ROM Modules

The ROM BIOS provides a way to integrate adapters with on-board ROM code into the system. During POST, interrupt vectors are established for the BIOS calls. After the default vectors are in place, a scan for additional ROM modules occurs. At this point, a ROM routine on an adapter may gain control and establish or intercept interrupt vectors to hook themselves into the system.

The absolute addresses hex C8000 through E0000 are scanned in 2K blocks in search of a valid adapter ROM. A valid ROM is defined as follows:

Byte 0	Hex 55
Byte 1	Hex AA

Byte 2	A length indicator representing the number of 512-byte blocks in the ROM
Byte 3	Entry by a CALL FAR

A checksum is also done to test the integrity of the ROM module. Each byte in the defined ROM module is summed modulo hex 100. This sum must be 0 for the module to be valid.

When the POST identifies a valid ROM, it does a CALL FAR to byte 3 of the ROM, which should be executable code. The adapter can now perform its power-on initialization tasks. The adapter's ROM should then return control to the BIOS routines by executing a RETURN FAR.

Quick Reference

```
Address            Publics by Name                 Address            Publics by Value

F000:E729          A1                              F000:0000          POST1
F000:3DE6          ACT_DISP_PAGE                   F000:0008    Abs   K6L
F000:6000          BASIC                           F000:0010    Abs   M4
F000:1A04          BEEP                            F000:0050          START_1
F000:1B2E          BLINK_INT                       F000:039D          C8042
F000:2038          BOOT_STRAP_1                    F000:03A9          OBF_42
F000:0CA3          C21                             F000:0CA3          C21
F000:039D          C8042                           F000:0CA3          POST2
F000:4503          CASSETTE_IO_1                   F000:105F          SHUT3
F000:194F          CMOS_READ                       F000:10C3          SHUT2
F000:196B          CMOS_WRITE                      F000:10C6          SHUT7
F000:1A59          CONFIG_BAD                      F000:10E7          SHUT6
F000:E6F5          CONF_TBL                        F000:1620          SHUT4
F000:FA6E          CRT_CHAR_GEN                    F000:167F          POST3
F000:E020          D1                              F000:194F          CMOS_READ
F000:1BE0          D11                             F000:194F          POST4
F000:E030          D2                              F000:196B          CMOS_WRITE
F000:E040          D2A                             F000:1989          DDS
F000:1989          DDS                             F000:1991          E_MSG
F000:2159          DISKETTE_IO_1                   F000:19B8          P_MSG
F000:EFC7          DISK_BASE                       F000:19C6          ERR_BEEP
F000:2C72          DISK_INT_1                      F000:1A04          BEEP
F000:2E86          DISK_IO                         F000:1A4A          WAITF
F000:2CDD          DISK_SETUP                      F000:1A59          CONFIG_BAD
F000:2C89          DSKETTE_SETUP                   F000:1A6D          XPC_BYTE
F000:FF53          DUMMY_RETURN                    F000:1A7D          PRT_HEX
F000:1C2E          DUMMY_RETURN_1                  F000:1A84          PRT_SEG
F000:E05E          E101                            F000:1A99          PROT_PRT_HEX
F000:E077          E102                            F000:1AC5          ROM_CHECKSUM
F000:E090          E103                            F000:1AD1          ROM_CHECK
F000:E0A9          E104                            F000:1B03          KBD_RESET
F000:E0C2          E105                            F000:1B2E          BLINK_INT
F000:E0DB          E106                            F000:1B3C          SET_TOD
F000:E0F4          E107                            F000:1BE0          D11
F000:E10D          E108                            F000:1C2E          DUMMY_RETURN_1
F000:E126          E109                            F000:1C2F          RE_DIRECT
F000:E13F          E161                            F000:1C38          INT_287
F000:E168          E162                            F000:1C47          PROC_SHUTDOWN
F000:E191          E163                            F000:1C4E          POST5
F000:E1B7          E164                            F000:1D40          SYSINIT1
F000:E1DB          E201                            F000:1ECB          POST6
F000:E1EE          E202                            F000:1ECB          STGTST_CNT
F000:E209          E203                            F000:1FCB          ROM_ERR
F000:E224          E301                            F000:1FF7          XMIT_8042
F000:E239          E302                            F000:2038          BOOT_STRAP_1
F000:E2C6          E303                            F000:2159          DISKETTE_IO_1
F000:E2EA          E304                            F000:2B1D          SEEK
F000:E30E          E401                            F000:2C72          DISK_INT_1
F000:E31E          E501                            F000:2C89          DSKETTE_SETUP
F000:E32E          E601                            F000:2CDD          DISK_SETUP
F000:E343          E602                            F000:2E86          DISK_IO
F000:4475          EQUIPMENT_1                     F000:33B7          HD_INT
F000:19C6          ERR_BEEP                        F000:33DA          KEYBOARD_IO_1
F000:1991          E_MSG                           F000:354F          KB_INT_1
F000:E364          F1780                           F000:35AE          K16
F000:E379          F1781                           F000:3A25          SND_DATA
F000:E38E          F1782                           F000:3AC0          PRINTER_IO_1
F000:E3AC          F1790                           F000:3B4F          RS232_IO_1
F000:E3BF          F1791                           F000:3C64          VIDEO_IO_1
F000:E3D2          F3A                             F000:3C9B          SET_MODE
F000:E25D          F3D                             F000:3D82          SET_CTYPE
F000:E3DF          F3D1                            F000:3DA7          SET_CPOS
F000:E401          FD_TBL                          F000:3DCF          READ_CURSOR
F000:4C76          FILL                            F000:3DE6          ACT_DISP_PAGE
F000:FF5E          FLOPPY                          F000:3E08          SET_COLOR
F000:48DD          GATE_A20                        F000:3E2E          VIDEO_STATE
F000:33B7          HD_INT                          F000:3E4F          SCROLL_UP
F000:FF5A          HRD                             F000:3EED          SCROLL_DOWN
F000:1C38          INT_287                         F000:3F3F          READ_AC_CURRENT
F000:E8E6          K10                             F000:3F9C          WRITE_AC_CURRENT
F000:E98A          K11                             F000:3FCE          WRITE_C_CURRENT
F000:E9C4          K12                             F000:407F          READ_DOT
F000:E9D0          K14                             F000:4090          WRITE_DOT
F000:E92C          K15                             F000:433E          WRITE_TTY
F000:35AE          K16                             F000:43C5          READ_LPEN
F000:E87E          K6                              F000:446B          MEMORY_SIZE_DET_1
F000:0008    Abs   K6L                             F000:4475          EQUIPMENT_1
F000:E886          K7                              F000:447F          NMI_INT_1
F000:E88E          K8                              F000:4503          CASSETTE_IO_1
F000:1B03          KBD_RESET                       F000:4799          SHUT9
F000:354F          KB_INT_1                        F000:48DD          GATE_A20
F000:33DA          KEYBOARD_IO_1                   F000:4999          TIME_OF_DAY_1
F000:0010    Abs   M4                              F000:4B1B          RTC_INT
F000:F0E4          M5                              F000:4B97          PRINT_SCREEN_1
F000:F0EC          M6                              F000:4C2D          TIMER_INT_1
F000:F0F4          M7                              F000:4C76          FILL
F000:446B          MEMORY_SIZE_DET_1               F000:6000          BASIC
F000:E2C3          NMI_INT                         F000:E020          D1
F000:447F          NMI_INT_1                       F000:E030          D2
F000:03A9          OBF_42                          F000:E040          D2A
F000:0000          POST1                           F000:E05E          E101
F000:0CA3          POST2                           F000:E077          E102
F000:167F          POST3                           F000:E090          E103
F000:194F          POST4                           F000:E0A9          E104
F000:1C4E          POST5                           F000:E0C2          E105
F000:1ECB          POST6                           F000:E0DB          E106
F000:3AC0          PRINTER_IO_1                    F000:E0F4          E107
F000:FF54          PRINT_SCREEN                    F000:E10D          E108
F000:4B97          PRINT_SCREEN_1                  F000:E126          E109
F000:1C47          PROC_SHUTDOWN                   F000:E13F          E161
F000:1A99          PROT_PRT_HEX                    F000:E168          E162
F000:1A7D          PRT_HEX                         F000:E191          E163
F000:1A84          PRT_SEG                         F000:E1B7          E164
F000:19B8          P_MSG                           F000:E1DB          E201
F000:FFF0          P_O_R                           F000:E1EE          E202
F000:3F3F          READ_AC_CURRENT                 F000:E209          E203
F000:3DCF          READ_CURSOR                     F000:E224          E301
F000:407F          READ_DOT                        F000:E239          E302
F000:43C5          READ_LPEN                       F000:E25D          F3D
F000:1C2F          RE_DIRECT                       F000:E2C3          NMI_INT
F000:1AD1          ROM_CHECK                       F000:E2C6          E303
F000:1AC5          ROM_CHECKSUM                    F000:E2EA          E304
F000:1FCB          ROM_ERR                         F000:E30E          E401
F000:3B4F          RS232_IO_1                      F000:E31E          E501
F000:4B1B          RTC_INT                         F000:E32E          E601
F000:3EED          SCROLL_DOWN                     F000:E343          E602
F000:3E4F          SCROLL_UP                       F000:E364          F1780
```

```
F000:2B1D       SEEK                                F000:E379       F1781
F000:FF62       SEEKS_1                             F000:E38E       F1782
F000:3E08       SET_COLOR                           F000:E3AC       F1790
F000:3DA7       SET_CPOS                            F000:E3BF       F1791
F000:3D82       SET_CTYPE                           F000:E3D2       F3A
F000:3C9B       SET_MODE                            F000:E3DF       F3D1
F000:1B3C       SET_TOD                             F000:E401       FD_TBL
F000:10C3       SHUT2                               F000:E6F5       CONF_TBL
F000:105F       SHUT3                               F000:E729       A1
F000:1620       SHUT4                               F000:E87E       K6
F000:10E7       SHUT6                               F000:E886       K7
F000:10C6       SHUT7                               F000:E88E       K8
F000:4799       SHUT9                               F000:E8E6       K10
F000:FF23       SLAVE_VECTOR_TABLE                  F000:E92C       K15
F000:3A25       SND_DATA                            F000:E98A       K11
F000:0050       START_1                             F000:E9C4       K12
F000:1ECB       STGTST_CNT                          F000:E9D0       K14
F000:1D40       SYSINIT1                            F000:EFC7       DISK_BASE
F000:4C2D       TIMER_INT_1                         F000:F0A4       VIDEO_PARMS
F000:4999       TIME_OF_DAY_1                       F000:F0E4       M5
F000:FF66       TUTOR                               F000:F0EC       M6
F000:FEF3       VECTOR_TABLE                        F000:F0F4       M7
F000:3C64       VIDEO_IO_1                          F000:FA6E       CRT_CHAR_GEN
F000:F0A4       VIDEO_PARMS                         F000:FEF3       VECTOR_TABLE
F000:3E2E       VIDEO_STATE                         F000:FF23       SLAVE_VECTOR_TABLE
F000:1A4A       WAITF                               F000:FF53       DUMMY_RETURN
F000:3F9C       WRITE_AC_CURRENT                    F000:FF54       PRINT_SCREEN
F000:3FCE       WRITE_C_CURRENT                     F000:FF5A       HRD
F000:4090       WRITE_DOT                           F000:FF5E       FLOPPY
F000:433E       WRITE_TTY                           F000:FF62       SEEKS_1
F000:1FF7       XMIT_8042                           F000:FF66       TUTOR
F000:1A6D       XPC_BYTE                            F000:FFF0       P_O_R
```

THE BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH SOFTWARE INTERRUPTS ONLY. ANY ADDRESSES PRESENT IN THESE LISTINGS ARE INCLUDED ONLY FOR COMPLETENESS, NOT FOR REFERENCE. APPLICATIONS WHICH REFERENCE ANY ABSOLUTE ADDRESSES WITHIN THE CODE SEGMENTS OF BIOS VIOLATE THE STRUCTURE AND DESIGN OF BIOS.

```
PAGE 118,121
TITLE TEST1 ---- 04/21/86  POWER ON SELF TEST (POST)
.286C

;--------------------------------------------------------------------------------------
;                                                                                      :
; BIOS I/O INTERFACE                                                                   :
;                                                                                      :
;       THESE LISTINGS PROVIDE INTERFACE INFORMATION FOR ACCESSING                     :
;       THE BIOS ROUTINES.  THE POWER ON SELF TEST IS INCLUDED.                        :
;                                                                                      :
;       THE  BIOS  ROUTINES  ARE  MEANT  TO  BE  ACCESSED  THROUGH                     :
;       SOFTWARE  INTERRUPTS  ONLY.    ANY  ADDRESSES  PRESENT  IN                     :
;       THESE  LISTINGS  ARE  INCLUDED   ONLY   FOR  COMPLETENESS,                     :
;       NOT  FOR  REFERENCE.   APPLICATIONS  WHICH  REFERENCE  ANY                     :
;       ABSOLUTE  ADDRESSES  WITHIN  THE  CODE  SEGMENTS  OF  BIOS                     :
;       VIOLATE  THE  STRUCTURE  AND  DESIGN  OF  BIOS.                                :
;                                                                                      :
;--------------------------------------------------------------------------------------



;--------------------------------------------------------------------------------------
;   MODULE REFERENCE                                                                   :
;                                                                                      :
;    TEST1.ASM        -->  POST AND MANUFACTURING TEST ROUTINES                        :
;      DSEG.INC       -->   DATA SEGMENTS LOCATIONS                                    :
;      POSTEQU.INC    -->   COMMON EQUATES FOR POST AND BIOS                           :
;      SYSDATA.INC    -->   POWER ON SELF TEST EQUATES FOR PROTECTED MODE              :
;                             POST TEST.01 THROUGH TEST.16                             :
;    TEST2.ASM        -->  POST TEST AND INITIALIZATION ROUTINES                       :
;                             POST TEST.17 THROUGH TEST.22                             :
;    TEST3.ASM        -->  POST EXCEPTION INTERRUPT TESTS                              :
;    TEST4.ASM        -->  POST AND BIOS UTILITY ROUTINES                              :
;                             CMOS_READ       - READ CMOS LOCATION ROUTINE             :
;                             CMOS_WRITE      - WRITE CMOS LOCATION ROUTINE            :
;                             DDS             - LOAD (DS:) WITH DATA SEGMENT           :
;                             E_MSG           - POST ERROR MESSAGE HANDLER             :
;                             MFG_HALT        - MANUFACTURING ERROR TRAP               :
;                             P_MSG           - POST STRING DISPLAY ROUTINE            :
;                             ERR_BEEP        - POST ERROR BEEP PROCEDURE              :
;                             BEEP            - SPEAKER BEEP CONTROL ROUTINE           :
;                             WAITF           - FIXED TIME WAIT ROUTINE                :
;                             CONFIG_BAD      - SET BAD_CONFIG IN CMOS_DIAG            :
;                             XPC_BYTE        - DISPLAY HEX BYTE AS 00 - FF            :
;                             PRT_HEX         - DISPLAY CHARACTER                      :
;                             PRT_SEG         - DISPLAY SEGMENT FORMAT ADDRESS         :
;                             PROT_PRT_HEX    - POST PROTECTED MODE DISPLAY            :
;                             ROM_CHECKSUM    - CHECK ROM MODULES FOR CHECKSUM         :
;                             ROM_CHECK       - ROM SCAN AND INITIALIZE                :
;                             KBD_RESET       - POST KEYBOARD RESET ROUTINE            :
;                             BLINK_INT       - MANUFACTURING TOGGLE BIT ROUTINE       :
;                             SET_TOD         - SET TIMER FROM CMOS RTC                :
;                             D11             - DUMMY INTERRUPT HANDLER    ->INT ??H   :
;                             RE_DIRECT       - HARDWARE INT  9 REDIRECT  (L 2)        :
;                             INT_287         - HARDWARE INT 13 REDIRECT  (287)        :
;                             PROC_SHUTDOWN   - 80286 RESET ROUTINE                    :
;    TEST5.ASM        -->  EXCEPTION INTERRUPT TEST HANDLERS FOR POST TESTS            :
;                             SYSINIT1        - BUILD PROTECTED MODE POINTERS          :
;                             GDT_BLD         - BUILD THE GDT FOR POST                 :
;                             SIDT_BLD        - BUILD THE IDT FOR POST                 :
;    TEST6.ASM        -->  POST TESTS AND SYSTEM BOOT STRAP                            :
;                             STGTST_CNT      - SEGMENT STORAGE TEST                   :
;                             ROM_ERR         - ROM ERROR DISPLAY ROUTINE              :
;                             XMIT_8042       - KEYBOARD DIAGNOSTIC OUTPUT             :
;                             BOOT_STRAP      - BOOT STRAP LOADER           -INT 19H   :
;                                                                                      :
;    DSKETTE.ASM      -->  DISKETTE BIOS                                               :
;                             DISKETTE_IO_1 - INT 13H BIOS ENTRY (40H)     -INT 13H    :
;                             DISK_INT_1    - HARDWARE INTERRUPT HANDLER -INT 0EH      :
;                             DSKETTE_SETUP - POST SETUP DRIVE TYPES                   :
;    DISK.ASM         -->  FIXED DISK BIOS                                             :
;                             DISK_SETUP      - SETUP DISK VECTORS AND TEST            :
;                             DISK_IO         - INT 13H BIOS ENTRY          -INT 13H   :
;                             HD_INT          - HARDWARE INTERRUPT HANDLER -INT 76H    :
;    KYBD.ASM         -->  KEYBOARD BIOS                                               :
;                             KEYBOARD_IO_1 - INT 16H BIOS ENTRY           -INT 16H    :
;                             KB_INT_1      - HARDWARE INTERRUPT           -INT 09H    :
;                             SND_DATA      - KEYBOARD TRANSMISSION                    :
;    PRT.ASM          -->  PRINTER ADAPTER BIOS                             -INT 17H   :
;    RS232.ASM        -->  COMMUNICATIONS BIOS FOR RS232                    -INT 14H   :
;    VIDEO1.ASM       -->  VIDEO BIOS                                       -INT 10H   :
;    BIOS.ASM         -->  BIOS ROUTINES                                               :
;                             MEMORY_SIZE_DET_1 - REAL MODE SIZE            -INT 12H   :
;                             EQUIPMENT_1     - EQUIPMENT DETERMINATION     -INT 11H   :
;                             NMI_INT_1       - NMI HANDLER                 -INT 02H   :
;    BIOS1.ASM        -->  INTERRUPT 15H BIOS ROUTINES                      -INT 15H   :
;                             DEV_OPEN        - NULL DEVICE OPEN HANDLER               :
;                             DEV_CLOSE       - NULL DEVICE CLOSE HANDLER              :
;                             PROG_TERM       - NULL PROGRAM TERMINATION               :
;                             EVENT_WAIT      - RTC EVENT WAIT/TIMEOUT ROUTINE         :
;                             JOY_STICK       - JOYSTICK PORT HANDLER                  :
;                             SYS_REQ         - NULL SYSTEM REQUEST KEY                :
;                             WAIT            - RTC TIMED WAIT ROUTINE                 :
;                             BLOCKMOVE       - EXTENDED MEMORY MOVE INTERFACE         :
;                             GATE_A20        - ADDRESS BIT 20 CONTROL                 :
;                             EXT_MEMORY      - EXTENDED MEMORY SIZE DETERMINE         :
;                             SET_VMODE       - SWITCH PROCESSOR TO VIRTUAL MODE       :
;                             DEVICE_BUSY     - NULL DEVICE BUSY HANDLER               :
;                             INT_COMPLETE    - NULL INTERRUPT COMPLETE HANDLER        :
;    BIOS2.ASM        -->  BIOS INTERRUPT ROUTINES                                     :
;                             TIME_OF_DAY_1 - TIME OF DAY ROUTINES          -INT 1AH   :
;                             RTC_INT       - IRQ LEVEL 8 ALARM HANDLER     -INT 70H   :
;                             PRINT_SCREEN1 - PRINT SCREEN ROUTINE          -INT 05H   :
;                             TIMER_INT_1   - TIMER1 INTERRUPT HANDLER    ->INT 1CH    :
;    ORGS.ASM         -->  COMPATIBILITY MODULE                                        :
;                             POST ERROR MESSAGES                                      :
;                             DISKETTE - DISK - VIDEO DATA TABLES                      :
;--------------------------------------------------------------------------------------
.LIST
```

```
                                  PAGE
                            C     INCLUDE DSEG.INC
                            C     ;----------------------------------------
                            C     ;       80286 INTERRUPT LOCATIONS        ;
                            C     ;       REFERENCED BY POST & BIOS        ;
                            C     ;----------------------------------------
                            C
     0000                   C     ABS0            SEGMENT AT 0                ; ADDRESS= 0000:0000
                            C
     0000 ??                C     @STG_LOC0       DB      ?                   ; START OF INTERRUPT VECTOR TABLE
                            C
     0008                   C                     ORG     4*002H
     0008 ????????          C     @NMI_PTR        DD      ?                   ; NON-MASKABLE INTERRUPT VECTOR
                            C
     0014                   C                     ORG     4*005H
     0014 ????????          C     @INT5_PTR       DD      ?                   ; PRINT SCREEN INTERRUPT VECTOR
                            C
     0020                   C                     ORG     4*008H
     0020 ????????          C     @INT_PTR        DD      ?                   ; HARDWARE INTERRUPT POINTER (8-F)
                            C
     0040                   C                     ORG     4*010H
     0040 ????????          C     @VIDEO_INT      DD      ?                   ; VIDEO I/O INTERRUPT VECTOR
                            C
     004C                   C                     ORG     4*013H
     004C ????????          C     @ORG_VECTOR     DD      ?                   ; DISKETTE/DISK INTERRUPT VECTOR
                            C
     0060                   C                     ORG     4*018H
     0060 ????????          C     @BASIC_PTR      DD      ?                   ; POINTER TO CASSETTE BASIC
                            C
     0074                   C                     ORG     4*01DH
     0074 ????????          C     @PARM_PTR       DD      ?                   ; POINTER TO VIDEO PARAMETERS
                            C
     0078                   C                     ORG     4*01EH
     0078 ????????          C     @DISK_POINTER   DD      ?                   ; POINTER TO DISKETTE PARAMETER TABLE
                            C
     007C                   C                     ORG     4*01FH
     007C ????????          C     @EXT_PTR        DD      ?                   ; POINTER TO GRAPHIC CHARACTERS 128-255
                            C
     0100                   C                     ORG     4*040H
     0100 ????????          C     @DISK_VECTOR    DD      ?                   ; POINTER TO DISKETTE INTERRUPT CODE
                            C
     0104                   C                     ORG     4*041H
     0104 ????????          C     @HF_TBL_VEC     DD      ?                   ; POINTER TO FIRST DISK PARAMETER TABLE
                            C
     0118                   C                     ORG     4*046H
     0118 ????????          C     @HF1_TBL_VEC    DD      ?                   ; POINTER TO SECOND DISK PARAMETER TABLE
                            C
     01C0                   C                     ORG     4*070H
     01C0 ????????          C     @SLAVE_INT_PTR  DD      ?                   ; POINTER TO SLAVE INTERRUPT HANDLER
                            C
     01D8                   C                     ORG     4*076H
     01D8 ????????          C     @HDISK_INT      DD      ?                   ; POINTER TO FIXED DISK INTERRUPT CODE
                            C
     0400                   C                     ORG     0400H
     0400 ????              C     @TOS            DW      ?                   ; STACK -- USED DURING POST ONLY
                            C                                                 ;   USE WILL OVERLAY INTERRUPTS VECTORS
                            C
     0500                   C                     ORG     0500H
     0500                   C     @MFG_TEST_RTN   LABEL   FAR                 ; LOAD LOCATION FOR MANUFACTURING TESTS
                            C
     7C00                   C                     ORG     7C00H
     7C00                   C     @BOOT_LOCN      LABEL   FAR                 ; BOOT STRAP CODE LOAD LOCATION
                            C
     7C00                   C     ABS0            ENDS
```

```
                        C  PAGE
                        C  ;----------------------------------------
                        C  ;        ROM BIOS DATA AREAS            :
                        C  ;----------------------------------------
                        C
0000                    C  DATA            SEGMENT AT 40H          ; ADDRESS= 0040:0000
                        C
0000 ????               C  @RS232_BASE     DW      ?               ; BASE ADDRESSES OF RS232 ADAPTERS
0002 ????               C                  DW      ?               ;  SECOND LOGICAL RS232 ADAPTER
0004 ????               C                  DW      ?               ;   RESERVED
0006 ????               C                  DW      ?               ;   RESERVED
0008 ????               C  @PRINTER_BASE   DW      ?               ; BASE ADDRESSES OF PRINTER ADAPTERS
000A ????               C                  DW      ?               ;  SECOND LOGICAL PRINTER ADAPTER
000C ????               C                  DW      ?               ;  THIRD LOGICAL PRINTER ADAPTER
000E ????               C                  DW      ?               ;   RESERVED
0010 ????               C  @EQUIP_FLAG     DW      ?               ; INSTALLED HARDWARE FLAGS
0012 ??                 C  @MFG_TST        DB      ?               ; INITIALIZATION FLAGS
0013 ????               C  @MEMORY_SIZE    DW      ?               ; BASE MEMORY SIZE IN K BYTES  (X 1024)
0015 ??                 C  @MFG_ERR_FLAG   DB      ?               ; SCRATCHPAD FOR MANUFACTURING
0016 ??                 C                  DB      ?               ;  ERROR CODES
                        C
                        C  ;----------------------------------------
                        C  ;        KEYBOARD DATA AREAS            :
                        C  ;----------------------------------------
                        C
0017 ??                 C  @KB_FLAG        DB      ?               ; KEYBOARD SHIFT STATE AND STATUS FLAGS
0018 ??                 C  @KB_FLAG_1      DB      ?               ; SECOND BYTE OF KEYBOARD STATUS
0019 ??                 C  @ALT_INPUT      DB      ?               ; STORAGE FOR ALTERNATE KEY PAD ENTRY
001A ????               C  @BUFFER_HEAD    DW      ?               ; POINTER TO HEAD OF KEYBOARD BUFFER
001C ????               C  @BUFFER_TAIL    DW      ?               ; POINTER TO TAIL OF KEYBOARD BUFFER
                        C
                        C  ;------     HEAD = TAIL    INDICATES THAT THE BUFFER IS EMPTY
                        C
001E   10 [             C  @KB_BUFFER      DW      16 DUP(?)       ; ROOM FOR 15 SCAN CODE ENTRIES
            ????        C
                 ]      C
                        C
                        C  ;----------------------------------------
                        C  ;        DISKETTE DATA AREAS            :
                        C  ;----------------------------------------
                        C
003E ??                 C  @SEEK_STATUS    DB      ?               ; DRIVE RECALIBRATION STATUS
                        C                                          ; BIT 3-0 = DRIVE 3-0 RECALIBRATION
                        C                                          ; BEFORE NEXT SEEK IF BIT IS = 0
003F ??                 C  @MOTOR_STATUS   DB      ?               ; MOTOR STATUS
                        C                                          ; BIT 3-0 = DRIVE 3-0 CURRENTLY RUNNING
                        C                                          ; BIT 7 = CURRENT OPERATION IS A WRITE
0040 ??                 C  @MOTOR_COUNT    DB      ?               ; TIME OUT COUNTER FOR MOTOR(S) TURN OFF
0041 ??                 C  @DSKETTE_STATUS DB      ?               ; RETURN CODE STATUS BYTE
                        C                                          ; CMD_BLOCK  IN STACK FOR DISK OPERATION
0042   07 [             C  @NEC_STATUS     DB      7 DUP(?)        ; STATUS BYTES FROM DISKETTE OPERATION
            ??          C
                ]       C
                        C
                        C
                        C  ;----------------------------------------
                        C  ;        VIDEO DISPLAY DATA AREA        :
                        C  ;----------------------------------------
                        C
0049 ??                 C  @CRT_MODE       DB      ?               ; CURRENT DISPLAY MODE (TYPE)
004A ????               C  @CRT_COLS       DW      ?               ; NUMBER OF COLUMNS ON SCREEN
004C ????               C  @CRT_LEN        DW      ?               ; LENGTH OF REGEN BUFFER IN BYTES
004E ????               C  @CRT_START      DW      ?               ; STARTING ADDRESS IN REGEN BUFFER
0050   08 [             C  @CURSOR_POSN    DW      8 DUP(?)        ; CURSOR FOR EACH OF UP TO 8 PAGES
            ????        C
                 ]      C
                        C
0060 ????               C  @CURSOR_MODE    DW      ?               ; CURRENT CURSOR MODE SETTING
0062 ??                 C  @ACTIVE_PAGE    DB      ?               ; CURRENT PAGE BEING DISPLAYED
0063 ????               C  @ADDR_6845      DW      ?               ; BASE ADDRESS FOR ACTIVE DISPLAY CARD
0065 ??                 C  @CRT_MODE_SET   DB      ?               ; CURRENT SETTING OF THE 3X8 REGISTER
0066 ??                 C  @CRT_PALETTE    DB      ?               ; CURRENT PALETTE SETTING - COLOR CARD
                        C
                        C  ;----------------------------------------
                        C  ;        POST AND BIOS WORK DATA AREA   :
                        C  ;----------------------------------------
                        C
                        C                                          ; STACK SAVE, etc.
0067 ????               C  @IO_ROM_INIT    DW      ?               ; POINTER TO ROM INITIALIZATION ROUTINE
0069 ????               C  @IO_ROM_SEG     DW      ?               ; POINTER TO I/O ROM SEGMENT
006B ??                 C  @INTR_FLAG      DB      ?               ; FLAG INDICATING AN INTERRUPT HAPPENED
                        C
                        C  ;----------------------------------------
                        C  ;        TIMER DATA AREA                :
                        C  ;----------------------------------------
                        C
006C ????               C  @TIMER_LOW      DW      ?               ; LOW WORD OF TIMER COUNT
006E ????               C  @TIMER_HIGH     DW      ?               ; HIGH WORD OF TIMER COUNT
0070 ??                 C  @TIMER_OFL      DB      ?               ; TIMER HAS ROLLED OVER SINCE LAST READ
                        C
                        C  ;----------------------------------------
                        C  ;        SYSTEM DATA AREA               :
                        C  ;----------------------------------------
                        C
0071 ??                 C  @BIOS_BREAK     DB      ?               ; BIT 7=1 IF BREAK KEY HAS BEEN PRESSED
0072 ????               C  @RESET_FLAG     DW      ?               ; WORD=1234H IF KEYBOARD RESET UNDERWAY
                        C
                        C  ;----------------------------------------
                        C  ;        FIXED DISK DATA AREAS          :
                        C  ;----------------------------------------
                        C
0074 ??                 C  @DISK_STATUS1   DB      ?               ; FIXED DISK STATUS
0075 ??                 C  @HF_NUM         DB      ?               ; COUNT OF FIXED DISK DRIVES
0076 ??                 C  @CONTROL_BYTE   DB      ?               ; HEAD CONTROL BYTE
0077 ??                 C  @PORT_OFF       DB      ?               ;  RESERVED (PORT OFFSET)
```

```
                       C  PAGE
                       C  ;----------------------------------------
                       C  ;        TIME-OUT VARIABLES              :
                       C  ;----------------------------------------
                       C
 0078 ??               C  @PRINT_TIM_OUT  DB      ?        ; TIME OUT COUNTERS FOR PRINTER RESPONSE
 0079 ??               C                  DB      ?        ;  SECOND LOGICAL PRINTER ADAPTER
 007A ??               C                  DB      ?        ;  THIRD LOGICAL PRINTER ADAPTER
 007B ??               C                  DB      ?        ;   RESERVED
 007C ??               C  @RS232_TIM_OUT  DB      ?        ; TIME OUT COUNTERS FOR RS232 RESPONSE
 007D ??               C                  DB      ?        ;  SECOND LOGICAL RS232 ADAPTER
 007E ??               C                  DB      ?        ;   RESERVED
 007F ??               C                  DB      ?        ;   RESERVED
                       C
                       C  ;----------------------------------------
                       C  ;        ADDITIONAL KEYBOARD DATA AREA   :
                       C  ;----------------------------------------
                       C
                       C                                   ; BUFFER LOCATION WITHIN SEGMENT 40H
 0080 ????             C  @BUFFER_START   DW      ?        ; OFFSET OF KEYBOARD BUFFER START
 0082 ????             C  @BUFFER_END     DW      ?        ; OFFSET OF END OF BUFFER
                       C
                       C  ;----------------------------------------
                       C  ;        EGA/PGA DISPLAY WORK AREA       :
                       C  ;----------------------------------------
                       C
 0084 ??               C  @ROWS           DB      ?        ; ROWS ON THE ACTIVE SCREEN (LESS 1)
 0085 ????             C  @POINTS         DW      ?        ; BYTES PER CHARACTER
 0087 ??               C  @INFO           DB      ?        ; MODE OPTIONS
 0088 ??               C  @INFO_3         DB      ?        ; FEATURE BIT SWITCHES
 0089 ??               C                  DB      ?        ; RESERVED FOR DISPLAY ADAPTERS
 008A ??               C                  DB      ?        ; RESERVED FOR DISPLAY ADAPTERS
                       C
                       C  ;----------------------------------------
                       C  ;        ADDITIONAL MEDIA DATA           :
                       C  ;----------------------------------------
                       C
 008B ??               C  @LASTRATE       DB      ?        ; LAST DISKETTE DATA RATE SELECTED
 008C ??               C  @HF_STATUS      DB      ?        ; STATUS REGISTER
 008D ??               C  @HF_ERROR       DB      ?        ; ERROR REGISTER
 008E ??               C  @HF_INT_FLAG    DB      ?        ; FIXED DISK INTERRUPT FLAG
 008F ??               C  @HF_CNTRL       DB      ?        ; COMBO FIXED DISK/DISKETTE CARD BIT 0=1
 0090 ??               C  @DSK_STATE      DB      ?        ; DRIVE 0 MEDIA STATE
 0091 ??               C                  DB      ?        ; DRIVE 1 MEDIA STATE
 0092 ??               C                  DB      ?        ; DRIVE 0 OPERATION START STATE
 0093 ??               C                  DB      ?        ; DRIVE 1 OPERATION START STATE
 0094 ??               C  @DSK_TRK        DB      ?        ; DRIVE 0 PRESENT CYLINDER
 0095 ??               C                  DB      ?        ; DRIVE 1 PRESENT CYLINDER
                       C
                       C  ;----------------------------------------
                       C  ;        ADDITIONAL KEYBOARD FLAGS       :
                       C  ;----------------------------------------
                       C
 0096 ??               C  @KB_FLAG_3      DB      ?        ; KEYBOARD MODE STATE AND TYPE FLAGS
 0097 ??               C  @KB_FLAG_2      DB      ?        ; KEYBOARD LED FLAGS
                       C
                       C  ;----------------------------------------
                       C  ;        REAL TIME CLOCK DATA AREA       :
                       C  ;----------------------------------------
                       C
 0098 ????             C  @USER_FLAG      DW      ?        ; OFFSET ADDRESS OF USERS WAIT FLAG
 009A ????             C  @USER_FLAG_SEG  DW      ?        ; SEGMENT ADDRESS OF USER WAIT FLAG
 009C ????             C  @RTC_LOW        DW      ?        ; LOW WORD OF USER WAIT FLAG
 009E ????             C  @RTC_HIGH       DW      ?        ; HIGH WORD OF USER WAIT FLAG
 00A0 ??               C  @RTC_WAIT_FLAG  DB      ?        ; WAIT ACTIVE FLAG (01=BUSY, 80=POSTED)
                       C                                   ;                  (00=POST ACKNOWLEDGED)
                       C  ;----------------------------------------
                       C  ;        AREA FOR NETWORK ADAPTER        :
                       C  ;----------------------------------------
                       C
 00A1    07 [          C  @NET            DB      7 DUP(?) ; RESERVED FOR NETWORK ADAPTERS
              ??       C
                  ]    C
                       C
                       C  ;----------------------------------------
                       C  ;        EGA/PGA PALETTE POINTER         :
                       C  ;----------------------------------------
                       C
 00A8 ????????         C  @SAVE_PTR       DD      ?        ; POINTER TO EGA PARAMETER CONTROL BLOCK
                       C
                       C                                   ; RESERVED
                       C  ;----------------------------------------
                       C  ;        DATA AREA - PRINT SCREEN        :
                       C  ;----------------------------------------
                       C
 0100                  C                  ORG     100H     ; ADDRESS= 0040:0100   (REF 0050:0000)
                       C
 0100 ??               C  @STATUS_BYTE    DB      ?        ; PRINT SCREEN STATUS BYTE
                       C                                   ;  00=READY/OK,  01=BUSY,  FF=ERROR
                       C
 0101                  C  DATA            ENDS             ; END OF BIOS DATA SEGMENT

                          .LIST
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                           PAGE
                         C INCLUDE POSTEQU.INC
                         C ;---------------------------------------
                         C ;        EQUATES USED BY POST AND BIOS   :
                         C ;---------------------------------------
                         C
 = 00FC                  C MODEL_BYTE       EQU     0FCH          ; SYSTEM MODEL BYTE
 = 0002                  C SUB_MODEL_BYTE   EQU     002H          ; SYSTEM SUB-MODEL TYPE
 = 0000                  C BIOS_LEVEL       EQU     000H          ; BIOS REVISION LEVEL
 = F780                  C RATE_UPPER       EQU     0F780H        ; UPPER LIMIT + 13%
 = F9FD                  C RATE_LOWER       EQU     0F9FDH        ; LOWER LIMIT - 20%
                         C
                         C ;--------- 8042 KEYBOARD INTERFACE AND DIAGNOSTIC CONTROL REGISTERS ------------
 = 0060                  C PORT_A           EQU     060H          ; 8042 KEYBOARD SCAN CODE/CONTROL PORT
 = 0061                  C PORT_B           EQU     061H          ; PORT B READ/WRITE DIAGNOSTIC REGISTER
 = 00F3                  C RAM_PAR_ON       EQU     11110011B     ; AND MASK FOR PARITY CHECKING ENABLE ON
 = 000C                  C RAM_PAR_OFF      EQU     00001100B     ; OR MASK FOR PARITY CHECKING ENABLE OFF
 = 00C0                  C PARITY_ERR       EQU     11000000B     ; R/W MEMORY - I/O CHANNEL PARITY ERROR
 = 0001                  C GATE2            EQU     00000001B     ; TIMER 2 INPUT GATE CLOCK BIT
 = 0002                  C SPK2             EQU     00000010B     ; SPEAKER OUTPUT DATA ENABLE BIT
 = 0010                  C REFRESH_BIT      EQU     00010000B     ; REFRESH TEST BIT
 = 0020                  C OUT2             EQU     00100000B     ; SPEAKER TIMER OUT2 INPUT BIT
 = 0040                  C IO_CHECK         EQU     01000000B     ; I/O (MEMORY) CHECK OCCURRED BIT MASK
 = 0080                  C PARITY_CHECK     EQU     10000000B     ; MEMORY PARITY CHECK OCCURRED BIT MASK
 = 0064                  C STATUS_PORT      EQU     064H          ; 8042 STATUS PORT
 = 0001                  C OUT_BUF_FULL     EQU     00000001B     ;   0 = +OUTPUT BUFFER FULL
 = 0002                  C INPT_BUF_FULL    EQU     00000010B     ;   1 = +INPUT BUFFER FULL
 = 0004                  C SYS_FLAG         EQU     00000100B     ;   2 = -SYSTEM FLAG -POST/-SELF TEST
 = 0008                  C CMD_DATA         EQU     00001000B     ;   3 = -COMMAND/+DATA
 = 0010                  C KYBD_INH         EQU     00010000B     ;   4 = +KEYBOARD INHIBITED
 = 0020                  C TRANS_TMOUT      EQU     00100000B     ;   5 = +TRANSMIT TIMEOUT
 = 0040                  C RCV_TMOUT        EQU     01000000B     ;   6 = +RECEIVE TIME OUT
 = 0080                  C PARITY_EVEN      EQU     10000000B     ;   7 = +PARITY IS EVEN
                         C
                         C ;--------- 8042 INPUT PORT BIT DEFINITION SAVED IN @MFG_TST --------------------
 = 0008                  C BASE_MEM8        EQU     00001000B     ; BASE PLANAR R/W MEMORY EXTENSION 640/X
 = 0010                  C BASE_MEM         EQU     00010000B     ; BASE PLANAR R/W MEMORY SIZE 256/512
 = 0020                  C MFG_LOOP         EQU     00100000B     ; LOOP POST JUMPER BIT FOR MANUFACTURING
 = 0040                  C DSP_JMP          EQU     01000000B     ; DISPLAY TYPE SWITCH JUMPER BIT
 = 0080                  C KEY_BD_INHIB     EQU     10000000B     ; KEYBOARD INHIBIT SWITCH BIT
                         C
                         C ;--------- 8042 COMMANDS -------------------------------------------------------
 = 0060                  C WRITE_8042_LOC   EQU     060H          ; WRITE 8042 COMMAND BYTE
 = 00AA                  C SELF_TEST        EQU     0AAH          ; 8042 SELF TEST
 = 00AB                  C INTR_FACE_CK     EQU     0ABH          ; CHECK 8042 INTERFACE COMMAND
 = 00AD                  C DIS_KBD          EQU     0ADH          ; DISABLE KEYBOARD COMMAND
 = 00AE                  C ENA_KBD          EQU     0AEH          ; ENABLE KEYBOARD COMMAND
 = 00C0                  C READ_8042_INPUT  EQU     0C0H          ; READ 8042 INPUT PORT
 = 00DD                  C DISABLE_BIT20    EQU     0DDH          ; DISABLE ADDRESS LINE BIT 20
 = 00DF                  C ENABLE_BIT20     EQU     0DFH          ; ENABLE ADDRESS LINE BIT 20
 = 00E0                  C KYBD_CLK_DATA    EQU     0E0H          ; GET KEYBOARD CLOCK AND DATA COMMAND
 = 00FE                  C SHUT_CMD         EQU     0FEH          ; CAUSE A SHUTDOWN COMMAND
 = 0001                  C KYBD_CLK         EQU     001H          ; KEYBOARD CLOCK BIT 0
                         C
                         C ;---------- KEYBOARD/LED COMMANDS ----------------------------------------------
 = 00FF                  C KB_RESET         EQU     0FFH          ; SELF DIAGNOSTIC COMMAND
 = 00FE                  C KB_RESEND        EQU     0FEH          ; RESEND COMMAND
 = 00FA                  C KB_MAKE_BREAK    EQU     0FAH          ; TYPAMATIC COMMAND
 = 00F4                  C KB_ENABLE        EQU     0F4H          ; KEYBOARD ENABLE
 = 00F3                  C KB_TYPA_RD       EQU     0F3H          ; TYPAMATIC RATE/DELAY COMMAND
 = 00F2                  C KB_READ_ID       EQU     0F2H          ; READ KEYBOARD ID COMMAND
 = 00EE                  C KB_ECHO          EQU     0EEH          ; ECHO COMMAND
 = 00ED                  C LED_CMD          EQU     0EDH          ; LED WRITE COMMAND
                         C
                         C ;---------- 8042 KEYBOARD RESPONSE ---------------------------------------------
 = 00FF                  C KB_OVER_RUN      EQU     0FFH          ; OVER RUN SCAN CODE
 = 00FE                  C KB_RESEND        EQU     0FEH          ; RESEND REQUEST
 = 00FA                  C KB_ACK           EQU     0FAH          ; ACKNOWLEDGE FROM TRANSMISSION
 = 00F0                  C KB_BREAK         EQU     0F0H          ; KEYBOARD BREAK CODE
 = 00AA                  C KB_OK            EQU     0AAH          ; RESPONSE FROM SELF DIAGNOSTIC
                         C
                         C ;---------- KEYBOARD SCAN CODES ------------------------------------------------
 = 0045                  C NUM_KEY          EQU     69            ; SCAN CODE FOR  NUMBER LOCK KEY
 = 0046                  C SCROLL_KEY       EQU     70            ; SCAN CODE FOR  SCROLL LOCK KEY
 = 0038                  C ALT_KEY          EQU     56            ; SCAN CODE FOR  ALTERNATE SHIFT KEY
 = 001D                  C CTL_KEY          EQU     29            ; SCAN CODE FOR  CONTROL KEY
 = 003A                  C CAPS_KEY         EQU     58            ; SCAN CODE FOR  SHIFT LOCK KEY
 = 0053                  C DEL_KEY          EQU     83            ; SCAN CODE FOR  DELETE KEY
 = 0052                  C INS_KEY          EQU     82            ; SCAN CODE FOR  INSERT KEY
 = 002A                  C LEFT_KEY         EQU     42            ; SCAN CODE FOR  LEFT SHIFT
 = 0036                  C RIGHT_KEY        EQU     54            ; SCAN CODE FOR  RIGHT SHIFT
 = 0054                  C SYS_KEY          EQU     84            ; SCAN CODE FOR  SYSTEM KEY
                         C
                         C ;---------- ENHANCED KEYBOARD SCAN CODES ---------------------------------------
 = 00AB                  C ID_1             EQU     0ABH          ; 1ST ID CHARACTER FOR KBX
 = 0041                  C ID_2             EQU     041H          ; 2ND ID CHARACTER FOR KBX
 = 0054                  C ID_2A            EQU     054H          ; ALTERNATE 2ND ID CHAR FOR KBX
 = 0057                  C F11_M            EQU     87            ; F11 KEY MAKE
 = 0058                  C F12_M            EQU     88            ; F12 KEY MAKE
 = 00E0                  C MC_E0            EQU     224           ; GENERAL MARKER CODE
 = 00E1                  C MC_E1            EQU     225           ; PAUSE KEY MARKER CODE
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                       C  PAGE
                       C  ;---------- FLAG EQUATES WITHIN  @KB_FLAG -------------------------------------
 = 0001                C  RIGHT_SHIFT      EQU     00000001B       ; RIGHT SHIFT KEY DEPRESSED
 = 0002                C  LEFT_SHIFT       EQU     00000010B       ; LEFT SHIFT KEY DEPRESSED
 = 0004                C  CTL_SHIFT        EQU     00000100B       ; CONTROL SHIFT KEY DEPRESSED
 = 0008                C  ALT_SHIFT        EQU     00001000B       ; ALTERNATE SHIFT KEY DEPRESSED
 = 0010                C  SCROLL_STATE     EQU     00010000B       ; SCROLL LOCK STATE IS ACTIVE
 = 0020                C  NUM_STATE        EQU     00100000B       ; NUM LOCK STATE IS ACTIVE
 = 0040                C  CAPS_STATE       EQU     01000000B       ; CAPS LOCK STATE IS ACTIVE
 = 0080                C  INS_STATE        EQU     10000000B       ; INSERT STATE IS ACTIVE
                       C
                       C  ;---------- FLAG EQUATES WITHIN  @KB_FLAG_1 -----------------------------------
 = 0001                C  L_CTL_SHIFT      EQU     00000001B       ; LEFT CTL KEY DOWN
 = 0002                C  L_ALT_SHIFT      EQU     00000010B       ; LEFT ALT KEY DOWN
 = 0004                C  SYS_SHIFT        EQU     00000100B       ; SYSTEM KEY DEPRESSED AND HELD
 = 0008                C  HOLD_STATE       EQU     00001000B       ; SUSPEND KEY HAS BEEN TOGGLED
 = 0010                C  SCROLL_SHIFT     EQU     00010000B       ; SCROLL LOCK KEY IS DEPRESSED
 = 0020                C  NUM_SHIFT        EQU     00100000B       ; NUM LOCK KEY IS DEPRESSED
 = 0040                C  CAPS_SHIFT       EQU     01000000B       ; CAPS LOCK KEY IS DEPRESSED
 = 0080                C  INS_SHIFT        EQU     10000000B       ; INSERT KEY IS DEPRESSED
                       C
                       C  ;---------- FLAGS EQUATES WITHIN  @KB_FLAG_2 ----------------------------------
 = 0007                C  KB_LEDS          EQU     00000111B       ; KEYBOARD LED STATE BITS
                       C  ;                        00000001B       ; SCROLL LOCK INDICATOR
                       C  ;                        00000010B       ; NUM LOCK INDICATOR
                       C  ;                        00000100B       ; CAPS LOCK INDICATOR
                       C  ;                EQU     00001000B       ; RESERVED (MUST BE ZERO)
 = 0010                C  KB_FA            EQU     00010000B       ; ACKNOWLEDGMENT RECEIVED
 = 0020                C  KB_FE            EQU     00100000B       ; RESEND RECEIVED FLAG
 = 0040                C  KB_PR_LED        EQU     01000000B       ; MODE INDICATOR UPDATE
 = 0080                C  KB_ERR           EQU     10000000B       ; KEYBOARD TRANSMIT ERROR FLAG
                       C
                       C  ;---------- FLAGS EQUATES WITHIN  @KB_FLAG_3 ----------------------------------
 = 0001                C  LC_E1            EQU     00000001B       ; LAST CODE WAS THE E1 HIDDEN CODE
 = 0002                C  LC_E0            EQU     00000010B       ; LAST CODE WAS THE E0 HIDDEN CODE
 = 0004                C  R_CTL_SHIFT      EQU     00000100B       ; RIGHT CTL KEY DOWN
 = 0008                C  R_ALT_SHIFT      EQU     00001000B       ; RIGHT ALT KEY DOWN
 = 0008                C  GRAPH_ON         EQU     00001000B       ; ALT GRAPHICS KEY DOWN (WT ONLY)
 = 0010                C  KBX              EQU     00010000B       ; ENHANCED KEYBOARD INSTALLED
 = 0020                C  SET_NUM_LK       EQU     00100000B       ; FORCE NUM LOCK IF READ ID AND KBX
 = 0040                C  LC_AB            EQU     01000000B       ; LAST CHARACTER WAS FIRST ID CHARACTER
 = 0080                C  RD_ID            EQU     10000000B       ; DOING A READ ID (MUST BE BIT0)
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                    C  PAGE
                    C  ;----------------------------------------
                    C  ;        CMOS EQUATES FOR THIS SYSTEM      ;
                    C  ;-------------------------------------------------------------------------------
 = 0070             C  CMOS_PORT        EQU     070H            ; I/O ADDRESS OF CMOS ADDRESS PORT
 = 0071             C  CMOS_DATA        EQU     071H            ; I/O ADDRESS OF CMOS DATA PORT
 = 0080             C  NMI              EQU     10000000B       ; DISABLE NMI INTERRUPTS MASK -
                    C                                           ;  HIGH BIT OF CMOS LOCATION ADDRESS
                    C
                    C  ;---------- CMOS TABLE LOCATION ADDRESS'S ## -----------------------------------
 = 0000             C  CMOS_SECONDS     EQU     000H            ; SECONDS
 = 0001             C  CMOS_SEC_ALARM   EQU     001H            ; SECONDS ALARM  ## NOTE:  ALL LOCATIONS
 = 0002             C  CMOS_MINUTES     EQU     002H            ; MINUTES             | IN THE CMOS AREA
 = 0003             C  CMOS_MIN_ALARM   EQU     003H            ; MINUTES ALARM       | ARE IBM USE ONLY
 = 0004             C  CMOS_HOURS       EQU     004H            ; HOURS               | AND  SUBJECT  TO
 = 0005             C  CMOS_HR_ALARM    EQU     005H            ; HOURS ALARM         | CHANGE. ONLY THE
 = 0006             C  CMOS_DAY_WEEK    EQU     006H            ; DAY OF THE WEEK     | POST & BIOS CODE
 = 0007             C  CMOS_DAY_MONTH   EQU     007H            ; DAY OF THE MONTH    | SHOULD  DIRECTLY
 = 0008             C  CMOS_MONTH       EQU     008H            ; MONTH               | ACCESS LOCATIONS
 = 0009             C  CMOS_YEAR        EQU     009H            ; YEAR (TWO DIGITS)   | IN CMOS STORAGE.
 = 000A             C  CMOS_REG_A       EQU     00AH            ; STATUS REGISTER A   '-----------------
 = 000B             C  CMOS_REG_B       EQU     00BH            ; STATUS REGISTER B  ALARM
 = 000C             C  CMOS_REG_C       EQU     00CH            ; STATUS REGISTER C  FLAGS
 = 000D             C  CMOS_REG_D       EQU     00DH            ; STATUS REGISTER D  BATTERY
 = 000E             C  CMOS_DIAG        EQU     00EH            ; POST DIAGNOSTIC STATUS RESULTS BYTE
 = 000F             C  CMOS_SHUT_DOWN   EQU     00FH            ; SHUTDOWN STATUS COMMAND BYTE
 = 0010             C  CMOS_DISKETTE    EQU     010H            ; DISKETTE DRIVE TYPE BYTE              ;
                    C  ;                EQU     011H            ; - RESERVED                            ;C
 = 0012             C  CMOS_DISK        EQU     012H            ; FIXED DISK TYPE BYTE                  ;H
                    C  ;                EQU     013H            ; - RESERVED                            ;E
 = 0014             C  CMOS_EQUIP       EQU     014H            ; EQUIPMENT WORD LOW BYTE               ;C
 = 0015             C  CMOS_B_M_S_LO    EQU     015H            ; BASE MEMORY SIZE - LOW BYTE (X1024)   ;K
 = 0016             C  CMOS_B_M_S_HI    EQU     016H            ; BASE MEMORY SIZE - HIGH BYTE          ;S
 = 0017             C  CMOS_E_M_S_LO    EQU     017H            ; EXPANSION MEMORY SIZE - LOW BYTE      ;U
 = 0018             C  CMOS_E_M_S_HI    EQU     018H            ; EXPANSION MEMORY SIZE - HIGH BYTE     ;M
 = 0019             C  CMOS_DISK_1      EQU     019H            ; FIXED DISK TYPE - DRIVE C EXTENSION   ;E
 = 001A             C  CMOS_DISK_2      EQU     01AH            ; FIXED DISK TYPE - DRIVE D EXTENSION   ;D
                    C  ;                EQU     01BH            ; - 1BH THROUGH 2DH - RESERVED          ;
 = 002E             C  CMOS_CKSUM_HI    EQU     02EH            ; CMOS CHECKSUM - HIGH BYTE             ;*
 = 002F             C  CMOS_CKSUM_LO    EQU     02FH            ; CMOS CHECKSUM - LOW BYTE              ;*
 = 0030             C  CMOS_U_M_S_LO    EQU     030H            ; USABLE MEMORY ABOVE 1 MEG - LOW BYTE
 = 0031             C  CMOS_U_M_S_HI    EQU     031H            ; USABLE MEMORY ABOVE 1 MEG - HIGH BYTE
 = 0032             C  CMOS_CENTURY     EQU     032H            ; DATE CENTURY BYTE (BCD)
 = 0033             C  CMOS_INFO128     EQU     033H            ; 128KB INFORMATION STATUS FLAG BYTE
                    C  ;                EQU     034H            ; - 34H THROUGH 3FH - RESERVED
                    C
                    C  ;---------- CMOS DIAGNOSTIC STATUS ERROR FLAGS WITHIN CMOS_DIAG ---------------
 = 0004             C  CMOS_CLK_FAIL    EQU     00000100B       ; CMOS CLOCK NOT UPDATING OR NOT VALID
 = 0008             C  HF_FAIL          EQU     00001000B       ; FIXED DISK FAILURE ON INITIALIZATION
 = 0010             C  W_MEM_SIZE       EQU     00010000B       ; MEMORY SIZE NOT EQUAL TO CONFIGURATION
 = 0020             C  BAD_CONFIG       EQU     00100000B       ; MINIMUM CONFIG USED INSTEAD OF CMOS
 = 0040             C  BAD_CKSUM        EQU     01000000B       ; CHECKSUM ERROR
 = 0080             C  BAD_BAT          EQU     10000000B       ; DEAD BATTERY - CMOS LOST POWER
                    C
                    C  ;---------- CMOS INFORMATION FLAGS ---------------------------------------------
 = 0080             C  M640K            EQU     10000000B       ; 512K -> 640K OPTION INSTALLED  (128K)
                    C  ;                EQU     01000000B       ; FLAG USED BY CMOS SETUP UTILITY
                    C
                    C
                    C  ;---------- DISKETTE EQUATES ---------------------------------------------------
 = 0001             C  DUAL             EQU     00000001B       ; MASK FOR COMBO/DSP ADAPTER
 = 0080             C  INT_FLAG         EQU     10000000B       ; INTERRUPT OCCURRENCE FLAG
 = 0080             C  DSK_CHG          EQU     10000000B       ; DISKETTE CHANGE FLAG MASK BIT
 = 0010             C  DETERMINED       EQU     00010000B       ; SET STATE DETERMINED IN STATE BITS
 = 0010             C  HOME             EQU     00010000B       ; TRACK 0 MASK
 = 0004             C  SENSE_DRV_ST     EQU     00000100B       ; SENSE DRIVE STATUS COMMAND
 = 0030             C  TRK_SLAP         EQU     030H            ; CRASH STOP (48 TPI DRIVES)
 = 000A             C  QUIET_SEEK       EQU     00AH            ; SEEK TO TRACK 10
 = 0002             C  MAX_DRV          EQU     2               ; MAX NUMBER OF DRIVES
 = 000F             C  HD12_SETTLE      EQU     15              ; 1.2 M HEAD SETTLE TIME
 = 0014             C  HD320_SETTLE     EQU     20              ; 320 K HEAD SETTLE TIME
 = 0025             C  MOTOR_WAIT       EQU     37              ; 2 SECONDS OF COUNTS FOR MOTOR TURN OFF
                    C
                    C  ;---------- DISKETTE ERRORS ----------------------------------------------------
 = 0080             C  TIME_OUT         EQU     080H            ; ATTACHMENT FAILED TO RESPOND
 = 0040             C  BAD_SEEK         EQU     040H            ; SEEK OPERATION FAILED
 = 0020             C  BAD_NEC          EQU     020H            ; DISKETTE CONTROLLER HAS FAILED
 = 0010             C  BAD_CRC          EQU     010H            ; BAD CRC ON DISKETTE READ
 = 000C             C  MED_NOT_FND      EQU     00CH            ; MEDIA TYPE NOT FOUND
 = 0009             C  DMA_BOUNDARY     EQU     009H            ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
 = 0008             C  BAD_DMA          EQU     008H            ; DMA OVERRUN ON OPERATION
 = 0006             C  MEDIA_CHANGE     EQU     006H            ; MEDIA REMOVED ON DUAL ATTACH CARD
 = 0004             C  RECORD_NOT_FND   EQU     004H            ; REQUESTED SECTOR NOT FOUND
 = 0003             C  WRITE_PROTECT    EQU     003H            ; WRITE ATTEMPTED ON WRITE PROTECT DISK
 = 0002             C  BAD_ADDR_MARK    EQU     002H            ; ADDRESS MARK NOT FOUND
 = 0001             C  BAD_CMD          EQU     001H            ; BAD COMMAND PASSED TO DISKETTE I/O
                    C
                    C  ;---------- DISK CHANGE LINE EQUATES -------------------------------------------
 = 0001             C  NOCHGLN          EQU     001H            ; NO DISK CHANGE LINE AVAILABLE
 = 0002             C  CHGLN            EQU     002H            ; DISK CHANGE LINE AVAILABLE
                    C
                    C  ;---------- MEDIA/DRIVE STATE INDICATORS ---------------------------------------
 = 0001             C  TRK_CAPA         EQU     00000001B       ; 80 TRACK CAPABILITY
 = 0002             C  FMT_CAPA         EQU     00000010B       ; MULTIPLE FORMAT CAPABILITY (1.2M)
 = 0004             C  DRV_DET          EQU     00000100B       ; DRIVE DETERMINED
 = 0010             C  MED_DET          EQU     00010000B       ; MEDIA DETERMINED BIT
 = 0020             C  DBL_STEP         EQU     00100000B       ; DOUBLE STEP BIT
 = 00C0             C  RATE_MSK         EQU     11000000B       ; MASK FOR CLEARING ALL BUT RATE
 = 0000             C  RATE_500         EQU     00000000B       ; 500 KBS DATA RATE
 = 0040             C  RATE_300         EQU     01000000B       ; 300 KBS DATA RATE
 = 0080             C  RATE_250         EQU     10000000B       ; 250 KBS DATA RATE
 = 000C             C  STRT_MSK         EQU     00001100B       ; OPERATION START RATE MASK
 = 00C0             C  SEND_MSK         EQU     11000000B       ; MASK FOR SEND RATE BITS
                    C
                    C  ;---------- MEDIA/DRIVE STATE INDICATORS COMPATIBILITY ------------------------
 = 0000             C  M3D3U            EQU     00000000B       ; 360 MEDIA/DRIVE NOT ESTABLISHED
 = 0001             C  M3D1U            EQU     00000001B       ; 360 MEDIA,1.2DRIVE NOT ESTABLISHED
 = 0002             C  M1D1U            EQU     00000010B       ; 1.2 MEDIA/DRIVE NOT ESTABLISHED
 = 0007             C  MED_UNK          EQU     00000111B       ; NONE OF THE ABOVE
```

```
                  C  PAGE
                  C  ;---------- INTERRUPT EQUATES ----------------------------------------------------
 = 0020           C  EOI             EQU     020H            ; END OF INTERRUPT COMMAND TO 8259
 = 0020           C  INTA00          EQU     020H            ; 8259 PORT
 = 0021           C  INTA01          EQU     021H            ; 8259 PORT
 = 00A0           C  INTB00          EQU     0A0H            ; 2ND 8259
 = 00A1           C  INTB01          EQU     0A1H            ;
 = 0070           C  INT_TYPE        EQU     070H            ; START OF 8259 INTERRUPT TABLE LOCATION
 = 0010           C  INT_VIDEO       EQU     010H            ; VIDEO VECTOR
                  C  ;-------------------------------------------------------------------------------
 = 0008           C  DMA08           EQU     008H            ; DMA STATUS REGISTER PORT ADDRESS
 = 0000           C  DMA             EQU     000H            ; DMA CH.0 ADDRESS REGISTER PORT ADDRESS
 = 00D0           C  DMA18           EQU     0D0H            ; 2ND DMA STATUS PORT ADDRESS
 = 00C0           C  DMA1            EQU     0C0H            ; 2ND DMA CH.0 ADDRESS REGISTER ADDRESS
                  C  ;-------------------------------------------------------------------------------
 = 0040           C  TIMER           EQU     040H            ; 8254 TIMER - BASE ADDRESS
                  C
                  C  ;--------- MANUFACTURING PORT --------------------------------------------------
 = 0080           C  MFG_PORT        EQU     80H             ; MANUFACTURING AND POST CHECKPOINT PORT
                  C                                          ;  DMA CHANNEL 0 PAGE REGISTER ADDRESS
                  C
                  C  ;--------- MANUFACTURING BIT DEFINITION FOR @MFG_ERR_FLAG+1 --------------------
 = 0001           C  MEM_FAIL        EQU     00000001B       ; STORAGE TEST FAILED          (ERROR 20X)
 = 0002           C  PRO_FAIL        EQU     00000010B       ; VIRTUAL MODE TEST FAILED     (ERROR 104)
 = 0004           C  LMCS_FAIL       EQU     00000100B       ; LOW MEG CHIP SELECT FAILED (ERROR 109)
 = 0008           C  KYCLK_FAIL      EQU     00001000B       ; KEYBOARD CLOCK TEST FAILED (ERROR 304)
 = 0010           C  KY_SYS_FAIL     EQU     00010000B       ; KEYBOARD OR SYSTEM FAILED  (ERROR 303)
 = 0020           C  KYBD_FAIL       EQU     00100000B       ; KEYBOARD FAILED              (ERROR 301)
 = 0040           C  DSK_FAIL        EQU     01000000B       ; DISKETTE TEST FAILED         (ERROR 601)
 = 0080           C  KEY_FAIL        EQU     10000000B       ; KEYBOARD LOCKED              (ERROR 302)
                  C
                  C  ;-------------------------------------------------------------------------------
 = 0081           C  DMA_PAGE        EQU     081H            ; START OF DMA PAGE REGISTERS
 = 008F           C  LAST_DMA_PAGE   EQU     08FH            ; LAST DMA PAGE REGISTER
                  C
                  C  ;-------------------------------------------------------------------------------
 = 00F0           C  X287            EQU     0F0H            ; MATH COPROCESSOR CONTROL PORT
                  C
                  C  ;-------------------------------------------------------------------------------
 = 0000           C  POST_SS         EQU     00000H          ; POST STACK SEGMENT
 = 8000           C  POST_SP         EQU     08000H          ; POST STACK POINTER
                  C
                  C  ;-------------------------------------------------------------------------------
 = 000D           C  CR              EQU     000DH           ; CARRIAGE RETURN CHARACTER
 = 000A           C  LF              EQU     000AH           ; LINE FEED CHARACTER
 = 0008           C  RVRT            EQU     00001000B       ; VIDEO VERTICAL RETRACE BIT
 = 0001           C  RHRZ            EQU     00000001B       ; VIDEO HORIZONTAL RETRACE BIT
 = 0100           C  H               EQU     256             ; HIGH BYTE FACTOR (X 100H)
 = 0101           C  X               EQU     H+1             ; HIGH AND LOW BYTE FACTOR (X 101H)

                     .LIST
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SECTION 5

```
                                    PAGE
                                C   INCLUDE SYSDATA.INC
                                C   ;--------------------------------------------------------------------------------
                                C   ;       PROTECTED MODE EQUATES FOR POST TESTS AND BIOS ROUTINES                 :
                                C   ;--------------------------------------------------------------------------------
                                C
                                C   ;-----          LENGTH EQUATES FOR PROTECTED MODE TESTS
                                C
 = 0300                         C   SDA_LEN         EQU     00300H          ; SYSTEM DATA AREA LENGTH
 = 0800                         C   SYS_IDT_LEN     EQU     256*8           ; 256 SYSTEM IDT ENTRIES, 8 BYTES EACH
 = 0088                         C   GDT_LEN         EQU     TYPE GDT_DEF    ; GDT STRUCTURE LENGTH
 = 0008                         C   DESC_LEN        EQU     TYPE DATA_DESC  ; LENGTH OF A DESCRIPTOR
 = 1000                         C   MCRT_SIZE       EQU     4*1024          ; MONOCHROME CRT SIZE
 = 4000                         C   CCRT_SIZE       EQU     16*1024         ; COMPATIBLE COLOR CRT SIZE
 = FFFF                         C   ECCRT_SIZE      EQU     0FFFFH          ; SIZE OF EACH PORTION OF THE ENHANCED
 = FFFF                         C   MAX_SEG_LEN     EQU     0FFFFH          ; MAXIMUM SEGMENT LENGTH = 64K
 = 0000                         C   NULL_SEG_LEN    EQU     00000H          ; NULL SEGMENT LENGTH = 0
                                C
                                C   ;-----          LOCATION EQUATES FOR PROTECTED MODE TESTS
                                C
 = D0A0                         C   SYS_IDT_LOC     EQU     0D0A0H          ; THE SYSTEM IDT IS AT THE BOTTOM
 = 0400                         C   SDA_LOC         EQU     00400H          ; SAME AS REAL
 = D8A0                         C   GDT_LOC         EQU     (SYS_IDT_LOC + SYS_IDT_LEN)
 = 0000                         C   MCRT@_LO        EQU     0000H           ; MONOCHROME CRT ADDRESS
 = 000B                         C   MCRT@_HI        EQU     0BH             ; (0B0000H)
 = 8000                         C   CCRT@_LO        EQU     8000H           ; COMPATIBLE COLOR CRT ADDRESS
 = 000B                         C   CCRT@_HI        EQU     0BH             ; (0B8000H)
 = 0000                         C   ECCRT@_LO_LO    EQU     0000H
 = 000A                         C   ECCRT@_LO_HI    EQU     0AH             ; (0A0000H)
 = 0000                         C   ECCRT@_HI_LO    EQU     0000H
 = 000B                         C   ECCRT@_HI_HI    EQU     0BH             ; (0B0000H)
 = 0000                         C   CSEG@_LO        EQU     0000H           ; CODE SEGMENT POST/BIOS
 = 000F                         C   CSEG@_HI        EQU     0FH             ; (0F0000H) FOR TESTS
 = 0000                         C   NSEG@_LO        EQU     0000H           ; ABS0
 = 0000                         C   NSEG@_HI        EQU     00H
                                C
                                C   ;-----  DEFINITIONS FOR ACCESS RIGHTS BYTES
                                C
 = 00F3                         C   CPL3_DATA_ACCESS        EQU     11110011B       ; PRESENT
                                C                                                   ; DPL = 3
                                C                                                   ; CODE/DATA SEGMENT
                                C                                                   ; NOT EXECUTABLE
                                C                                                   ; GROW-UP (OFFSET <= LIMIT)
                                C                                                   ; WRITABLE
                                C                                                   ; ACCESSED
 = 0093                         C   CPL0_DATA_ACCESS        EQU     10010011B       ; DPL = 0
 = 009B                         C   CPL0_CODE_ACCESS        EQU     10011011B       ; CPL 0 - NON-CONFORMING
 = 00E2                         C   LDT_DESC                EQU     11100010B
 = 0081                         C   FREE_TSS                EQU     10000001B
 = 0086                         C   INT_GATE                EQU     10000110B
 = 0087                         C   TRAP_GATE               EQU     10000111B
                                C
 = 0001                         C   VIRTUAL_ENABLE          EQU     0000000000000001B       ; PROTECTED MODE ENABLE
                                C
                                C
                                C   ;-----  THE GLOBAL DESCRIPTOR TABLE DEFINITION FOR POWER ON SELF TESTS
                                C
                                C   GDT_DEF         STRUC
 0000 ???????????????           C                   DQ      ?               ; UNUSED ENTRY
 0008 ???????????????           C   GDT_PTR         DQ      ?               ; THIS ENTRY POINTS TO THIS TABLE
 0010 ???????????????           C   SYS_IDT_PTR     DQ      ?               ; POST INTERRUPT DESCRIPTOR TABLE
 0018 ???????????????           C   RSDA_PTR        DQ      ?               ; THE REAL SYSTEM DATA AREA FOR POST
 0020 ???????????????           C   C_BWCRT_PTR     DQ      ?               ; COMPATIBLE BW CRT FOR POST
 0028 ???????????????           C   C_CCRT_PTR      DQ      ?               ; COMPATIBLE COLOR CRT FOR POST
 0030 ???????????????           C   E_CCRT_PTR      DQ      ?               ; ENHANCED COLOR GRAPHICS CRT (16 BYTES)
 0038 ???????????????           C   E_CCRT_PTR2     DQ      ?
 0040 ???????????????           C   SYS_ROM_CS      DQ      ?               ; CS - POST IDT, ROM RESIDENT
 0048 ???????????????           C   ES_TEMP         DQ      ?               ; DYNAMIC POINTER FOR ES
 0050 ???????????????           C   CS_TEMP         DQ      ?               ; DYNAMIC POINTER FOR CS
 0058 ???????????????           C   SS_TEMP         DQ      ?               ; DYNAMIC POINTER FOR SS
 0060 ???????????????           C   DS_TEMP         DQ      ?               ; DYNAMIC POINTER FOR DS
 0068 ???????????????           C   POST_TR         DQ      ?               ; TR VALUE FOR THIS MACHINE'S TSS
 0070 ???????????????           C   POST_TSS_PTR    DQ      ?
 0078 ???????????????           C   POST_LDTR       DQ      ?               ; LDTR VALUE FOR THIS MACHINE'S LDT
 0080 ???????????????           C   POST_LDT_PTR    DQ      ?
 0088                           C   GDT_DEF         ENDS
                                C
                                C   ;-----  SEGMENT DESCRIPTOR TABLE ENTRY STRUCTURE
                                C
                                C   DATA_DESC       STRUC
 0000 ????                      C   SEG_LIMIT       DW      ?               ; SEGMENT LIMIT (1 - 65535 BYTES)
 0002 ????                      C   BASE_LO_WORD    DW      ?               ; 24 BIT SEGMENT PHYSICAL
 0004 ??                        C   BASE_HI_BYTE    DB      ?               ;       ADDRESS (0 - (16M-1))
 0005 ??                        C   DATA_ACC_RIGHTS DB      ?               ; ACCESS RIGHTS BYTE
 0006 ????                      C   DATA_RESERVED   DW      ?               ; RESERVED - MUST BE 0000 FOR THE 80286
 0008                           C   DATA_DESC       ENDS
                                C
                                C   ;-----  GATE DESCRIPTOR TABLE ENTRY STRUCTURE
                                C
                                C   GATE_DESC       STRUC
 0000 ????                      C   ENTRY_POINT     DW      ?               ; DESTINATION ROUTINE ENTRY POINT
 0002 ????                      C   CS_SELECTOR     DW      ?               ; SELECTOR FOR DESTINATION SEGMENT
 0004 ??                        C   WORD_COUNT      DB      ?               ; NUMBER OF WORDS TO COPY FROM STACK
 0005 ??                        C   GATE_ACC_RIGHTS DB      ?               ; ACCESS RIGHTS BYTE
 0006 ????                      C   GATE_RESERVED   DW      ?               ; RESERVED - MUST BE 0000 FOR THE 80286
 0008                           C   GATE_DESC       ENDS

                                    .LIST
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                         PAGE
0000                     CODE    SEGMENT WORD PUBLIC

                                 PUBLIC  C8042
                                 PUBLIC  OBF_42
                                 PUBLIC  POST1
                                 PUBLIC  START_1

                                 EXTRN   CMOS_READ:NEAR
                                 EXTRN   CMOS_WRITE:NEAR
                                 EXTRN   CONFIG_BAD:NEAR
                                 EXTRN   D11:NEAR
                                 EXTRN   DDS:NEAR
                                 EXTRN   DUMMY_RETURN:NEAR
                                 EXTRN   ERR_BEEP:NEAR
                                 EXTRN   GATE_A20:NEAR
                                 EXTRN   KBD_RESET:NEAR
                                 EXTRN   NMI_INT:NEAR
                                 EXTRN   POST2:NEAR
                                 EXTRN   PRINT_SCREEN:NEAR
                                 EXTRN   PROC_SHUTDOWN:NEAR
                                 EXTRN   ROM_CHECK:NEAR
                                 EXTRN   SHUT2:NEAR
                                 EXTRN   SHUT3:NEAR
                                 EXTRN   SHUT4:NEAR
                                 EXTRN   SHUT6:NEAR
                                 EXTRN   SHUT7:NEAR
                                 EXTRN   SHUT9:NEAR
                                 EXTRN   SLAVE_VECTOR_TABLE:NEAR
                                 EXTRN   STGTST_CNT:NEAR
                                 EXTRN   SYSINIT1:NEAR
                                 EXTRN   VECTOR_TABLE:NEAR
                                 EXTRN   VIDEO_PARMS:BYTE

                                 ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

0000                     POST1   PROC    NEAR

= 0000                   BEGIN   EQU     $
0000 37 38 58 37 34 36           DB      '78X7462COPR. IBM CORP. 1981,1986  '          ;COPYRIGHT NOTICE
     32 43 4F 50 52 2E
     20 49 42 4D 20 43
     4F 52 50 2E 20 31
     39 38 31 2C 31 39
     38 36 20 20
                                 EVEN                                                   ;EVEN BOUNDARY
                                 ;        7 8 X 7 4 6 2   C O P R .   I B M   1 9 8 6   ;EVEN MODULE
                                 ;         7 8 X 7 4 6 3   C O P R .   I B M   1 9 8 6  ;ODD  MODULE
0022 37 37 38 38 58 58           DB      '7788XX77446623  CCOOPPRR..  IIBBMM  11998866' ;COPYRIGHT NOTICE
     37 37 34 34 36 36
     32 33 20 20 43 43
     4F 4F 50 50 52 52
     2E 2E 20 20 49 49
     42 42 4D 4D 20 20
     31 31 39 39 38 38
     36 36
004E 20 20                       DB      '  '                                          ;PAD

                         ;------------------------------------------------
                         ;       INITIAL RELIABILITY TESTS -- (POST1)     :
                         ;------------------------------------------------

                         ;----------------------------------------
                         ; TEST.01                                :
                         ;       80286 PROCESSOR TEST (REAL MODE) :
                         ; DESCRIPTION                            :
                         ;       VERIFY FLAGS, REGISTERS          :
                         ;       AND CONDITIONAL JUMPS.           :
                         ;----------------------------------------

                                 ASSUME  DS:DATA

0050                     START_1:
0050 FA                          CLI                             ; DISABLE INTERRUPTS
0051 B8 D58D                     MOV     AX,0D500H+CMOS_REG_D+NMI; FLAG MASK IN (AH) AND NMI MASK IN (AL)
0054 E6 70                       OUT     CMOS_PORT,AL            ; DISABLE NMI INTERRUPTS, LATCH STANDBY
0056 9E                          SAHF                            ; SET "SF" "ZF" "AF" "PF" "CF" FLAGS ON
0057 73 27                       JNC     ERR02                   ; GO TO ERROR ROUTINE IF "CF" NOT SET
0059 75 25                       JNZ     ERR02                   ; GO TO ERROR ROUTINE IF "ZF" NOT SET
005B 7B 23                       JNP     ERR02                   ; GO TO ERROR ROUTINE IF "PF" NOT SET
005D 79 21                       JNS     ERR02                   ; GO TO ERROR ROUTINE IF "SF" NOT SET
005F 9F                          LAHF                            ; LOAD FLAG IMAGE TO (AH)
0060 B1 05                       MOV     CL,5                    ; LOAD COUNT REGISTER WITH SHIFT COUNT
0062 D2 EC                       SHR     AH,CL                   ; SHIFT "AF" INTO CARRY BIT POSITION
0064 73 1A                       JNC     ERR02                   ; GO TO ERROR ROUTINE IF "AF" NOT SET
0066 B0 40                       MOV     AL,40H                  ; SET THE "OF" FLAG ON
0068 D0 E0                       SHL     AL,1                    ; SETUP FOR TESTING
006A 71 14                       JNO     ERR02                   ; GO TO ERROR ROUTINE IF "OF" NOT SET
006C 32 E4                       XOR     AH,AH                   ; SET (AH) = 0
006E 9E                          SAHF                            ; CLEAR "SF", "CF", "ZF", AND "PF"
006F 76 0F                       JBE     ERR02                   ; GO TO ERROR ROUTINE IF "CF" ON
                                                                 ; GO TO ERROR ROUTINE IF "ZF" ON
0071 78 0D                       JS      ERR02                   ; GO TO ERROR ROUTINE IF "SF" ON
0073 7A 0B                       JP      ERR02                   ; GO TO ERROR ROUTINE IF "PF" ON
0075 9F                          LAHF                            ; LOAD FLAG IMAGE TO (AH)
0076 D2 EC                       SHR     AH,CL                   ; SHIFT "AF" INTO CARRY BIT POSITION
0078 72 06                       JC      ERR02                   ; GO TO ERROR ROUTINE IF ON
007A D0 E4                       SHL     AH,1                    ; CHECK THAT "OF" IS CLEAR
007C 70 02                       JO      ERR02                   ; GO TO ERROR ROUTINE IF ON
007E 74 03                       JZ      C7A                     ; CONTINUE CONFIDENCE TESTS IF "ZF" SET
0080                     ERR02:
0080 F4                          HLT                             ;       ERROR HALT
0081 EB FD                       JMP     ERR02                   ; ERROR LOOP TRAP

0083                     C7A:
0083 B8 ---- R                   MOV     AX,DATA                 ; SET DATA SEGMENT
0086 8E D8                       MOV     DS,AX                   ; INTO THE (DS) SEGMENT REGISTER

                         ;-----  CHECK FOR PROCESSOR SHUTDOWN

0088 E4 64                       IN      AL,STATUS_PORT          ; READ CURRENT KEYBOARD PROCESSOR STATUS
008A A8 04                       TEST    AL,SYS_FLAG             ; CHECK FOR SHUTDOWN IN PROCESS FLAG
008C 75 03                       JNZ     C7B                     ; GO IF YES
008E E9 0123 R                   JMP     SHUT0                   ; ELSE CONTINUE NORMAL POWER ON CODE
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                                PAGE
                                ;-----  CHECK FOR SHUTDOWN 09
0091                            C7B:
0091 B0 8F                              MOV     AL,CMOS_SHUT_DOWN+NMI   ; CMOS ADDRESS FOR SHUTDOWN BYTE
0093 E6 70                              OUT     CMOS_PORT,AL
0095 EB 00                              JMP     $+2                     ; I/O DELAY
0097 E4 71                              IN      AL,CMOS_DATA            ; GET REQUEST NUMBER
0099 3C 09                              CMP     AL,09H                  ; WAS IT SHUTDOWN REQUEST 9?
009B 86 C4                              XCHG    AL,AH                   ; SAVE THE SHUTDOWN REQUEST
009D 74 41                              JE      C7C                     ; BYPASS INITIALIZING INTERRUPT CHIPS

                                ;-----  CHECK FOR SHUTDOWN 0A

009F 80 FC 0A                           CMP     AH,0AH                  ; WAS IT SHUTDOWN REQUEST A?
00A2 74 3C                              JE      C7C                     ; BYPASS INITIALIZING INTERRUPT CHIPS

00A4 2A C0                              SUB     AL,AL                   ; INSURE MATH PROCESSOR RESET
00A6 E6 F1                              OUT     X287+1,AL

                                ;-----------------------------------------------------
                                ;    RE-INITIALIZE THE 8259 INTERRUPT #1 CONTROLLER CHIP :
                                ;-----------------------------------------------------
00A8 B0 11                              MOV     AL,11H                  ; ICW1 - EDGE, MASTER, ICW4
00AA E6 20                              OUT     INTA00,AL
00AC EB 00                              JMP     $+2                     ; WAIT STATE FOR I/O
00AE B0 08                              MOV     AL,08H                  ; SETUP ICW2 - INTERRUPT TYPE 8H (8-F)
00B0 E6 21                              OUT     INTA01,AL
00B2 EB 00                              JMP     $+2                     ; WAIT STATE FOR I/O
00B4 B0 04                              MOV     AL,04H                  ; SETUP ICW3 - MASTER LEVEL 2
00B6 E6 21                              OUT     INTA01,AL               ;
00B8 EB 00                              JMP     $+2                     ; I/O WAIT STATE
00BA B0 01                              MOV     AL,01H                  ; SETUP ICW4 - MASTER,8086 MODE
00BC E6 21                              OUT     INTA01,AL               ;
00BE EB 00                              JMP     $+2                     ; WAIT STATE FOR I/O
00C0 B0 FF                              MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
00C2 E6 21                              OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTERRUPTS)
                                ;-----------------------------------------------------
                                ;    RE-INITIALIZE THE 8259 INTERRUPT #2 CONTROLLER CHIP  :
                                ;-----------------------------------------------------
00C4 B0 11                              MOV     AL,11H                  ; ICW1 - EDGE, SLAVE ICW4
00C6 E6 A0                              OUT     INTB00,AL
00C8 EB 00                              JMP     $+2                     ; WAIT STATE FOR I/O
00CA B0 70                              MOV     AL,INT_TYPE             ; SETUP ICW2 - INTERRUPT TYPE 70 (70-7F)
00CC E6 A1                              OUT     INTB01,AL
00CE B0 02                              MOV     AL,02H                  ; SETUP ICW3 - SLAVE LEVEL 2
00D0 EB 00                              JMP     $+2
00D2 E6 A1                              OUT     INTB01,AL
00D4 EB 00                              JMP     $+2                     ; I/O DELAY
00D6 B0 01                              MOV     AL,01H                  ; SETUP ICW4 - 8086 MODE, SLAVE
00D8 E6 A1                              OUT     INTB01,AL
00DA EB 00                              JMP     $+2                     ; WAIT STATE FOR I/O
00DC B0 FF                              MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
00DE E6 A1                              OUT     INTB01,AL
                                ;-----------------------------------------------------------------------------
                                ;  SHUTDOWN - RESTART                                                         :
                                ;       RETURN CONTROL AFTER A SHUTDOWN COMMAND IS ISSUED                     :
                                ;  DESCRIPTION                                                                :
                                ;       A TEST IS MADE FOR THE SYSTEM FLAG BEING SET.  IF THE SYSTEM FLAG IS  :
                                ;       SET, THE SHUTDOWN BYTE IN CMOS IS USED TO DETERMINE WHERE CONTROL IS  :
                                ;       RETURNED.                                                             :
                                ;                                                                             :
                                ;       CMOS = 0   SOFT RESET OR UNEXPECTED SHUTDOWN                          :
                                ;       CMOS = 1   SHUT DOWN AFTER MEMORY SIZE                                :
                                ;       CMOS = 2   SHUT DOWN AFTER MEMORY TEST                                :
                                ;       CMOS = 3   SHUT DOWN WITH MEMORY ERROR                                :
                                ;       CMOS = 4   SHUT DOWN WITH BOOT LOADER REQUEST                         :
                                ;       CMOS = 5   JMP DWORD REQUEST - (INTERRUPT CHIPS & 287 ARE INITIALIZED) :
                                ;       CMOS = 6   PROTECTED MODE TEST3 PASSED                                :
                                ;       CMOS = 7   PROTECTED MODE TEST3 FAILED                                :
                                ;       CMOS = 8   PROTECTED MODE TEST1 FAILED                                :
                                ;       CMOS = 9   BLOCK MOVE SHUTDOWN REQUEST                                :
                                ;       CMOS = A   JMP DWORD REQUEST - (W/O INTERRUPT CHIPS INITIALIZED)      :
                                ;                                                                             :
                                ;          NOTES:  RETURNS ARE MADE WITH INTERRUPTS AND NMI DISABLED.         :
                                ;                  USER MUST RESTORE SS:SP (POST DEFAULT SET = 0000:0400),    :
                                ;                  ENABLE NON-MASKABLE INTERRUPTS (NMI) WITH AN OUT TO        :
                                ;                  PORT 70H WITH HIGH ORDER BIT OFF, AND THEN ISSUE A         :
                                ;                  STI TO ENABLE INTERRUPTS.  FOR SHUTDOWN (5) THE USER       :
                                ;                  MUST ALSO RESTORE THE INTERRUPT MASK REGISTERS.            :
                                ;-----------------------------------------------------------------------------

                                ;-----  CHECK FROM WHERE
00E0                            C7C:
00E0 B0 8F                              MOV     AL,CMOS_SHUT_DOWN+NMI   ; CLEAR CMOS BYTE
00E2 E6 70                              OUT     CMOS_PORT,AL
00E4 90                                 NOP                             ; I/O DELAY
00E5 2A C0                              SUB     AL,AL                   ; SET BYTE TO 0
00E7 E6 71                              OUT     CMOS_DATA,AL
00E9 86 E0                              XCHG    AH,AL
00EB 3C 0A                              CMP     AL,0AH                  ; COMPARE WITH MAXIMUM TABLE ENTRIES
00ED 77 34                              JA      SHUT0                   ; SKIP TO POST IF GREATER THAN MAXIMUM
00EF BE 0103 R                          MOV     SI,OFFSET BRANCH        ; POINT TO THE START OF THE BRANCH TABLE
00F2 03 F0                              ADD     SI,AX
00F4 03 F0                              ADD     SI,AX                   ; POINT TO BRANCH ADDRESS
00F6 2E: 8B 1C                          MOV     BX,CS:[SI]              ; MOVE BRANCH TO ADDRESS TO BX REGISTER

                                ;-----  SET TEMPORARY STACK FOR POST

00F9 B8 ---- R                          MOV     AX,ABS0                 ; SET STACK SEGMENT TO ABS0 SEGMENT
00FC 8E D0                              MOV     SS,AX
00FE BC 0400 R                          MOV     SP,OFFSET @TOS          ; SET STACK POINTER TO END OF VECTORS
0101 FF E3                              JMP     BX                      ; JUMP BACK TO RETURN ROUTINE

0103 0123 R                     BRANCH: DW      SHUT0                   ; NORMAL POWER UP/UNEXPECTED SHUTDOWN
0105 0992 R                             DW      SHUT1                   ; SHUT DOWN AFTER MEMORY SIZE
0107 0000 E                             DW      SHUT2                   ; SHUT DOWN AFTER MEMORY TEST
0109 0000 E                             DW      SHUT3                   ; SHUT DOWN WITH MEMORY ERROR
010B 0000 E                             DW      SHUT4                   ; SHUT DOWN WITH BOOT_LOADER REQUEST
010D 0119 R                             DW      SHUT5                   ; JMP DWORD REQUEST WITH INTERRUPT INIT
010F 0000 E                             DW      SHUT6                   ; PROTECTED MODE TEST7 PASSED
0111 0000 E                             DW      SHUT7                   ; PROTECTED MODE TEST7 FAILED
0113 0795 R                             DW      SHUT8                   ; PROTECTED MODE TEST1 FAILED
0115 0000 E                             DW      SHUT9                   ; BLOCK MOVE SHUTDOWN REQUEST
0117 011F R                             DW      SHUTA                   ; JMP DWORD REQUEST (W/O INTERRUPT INIT)
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                           PAGE
                           ;-----  @IO_ROM_INIT MUST BE INITIALIZED BY THE USER FOR VECTORED REQUESTS

0119                       SHUT5:
0119 E4 60                         IN      AL,PORT_A               ; FLUSH THE KEYBOARD BUFFER
011B B0 20                         MOV     AL,EOI                  ; FLUSH LAST TIMER REQUEST IF PENDING
011D E6 20                         OUT     INTA00,AL               ;  - TO ALLOW TIMER INTERRUPTS
011F                       SHUTA:
011F FF 2E 0067 R                  JMP     DWORD PTR @IO_ROM_INIT  ; FAR JUMP TO USER DEFINED LOCATION
                                                                   ;  AFTER SHUTDOWN TO REAL MODE CODE
                                                                   ;  WITH INTERRUPTS AND NMI DISABLED
                           ;-----  CHECKPOINT 01

0123                       SHUT0:
0123 B0 01                         MOV     AL,01H                  ;        <><><><><><><><><><><><>
0125 E6 80                         OUT     MFG_PORT,AL             ;        <><> CHECKPOINT  01 <><>

                           ;-----  READ/WRITE/TEST THE 80286 REGISTERS WITH ONE'S AND ZERO'S

0127 B8 FFFF                       MOV     AX,0FFFFH               ; SETUP ONE'S PATTERN IN (AX)
012A F9                            STC                             ; SET CARRY FLAG
012B 73 21                         JNC     ERR01                   ; GO IF NO CARRY
012D                       C8:
012D 8E D8                         MOV     DS,AX                   ; WRITE PATTERN TO ALL REGISTERS
012F 8C DB                         MOV     BX,DS
0131 8E C3                         MOV     ES,BX
0133 8C C1                         MOV     CX,ES
0135 8E D1                         MOV     SS,CX
0137 8C D2                         MOV     DX,SS
0139 8B E2                         MOV     SP,DX
013B 8B EC                         MOV     BP,SP
013D 8B F5                         MOV     SI,BP
013F 8B FE                         MOV     DI,SI
0141 73 07                         JNC     C9
0143 33 C7                         XOR     AX,DI                   ; PATTERN MAKE IT THROUGH ALL REGISTERS
0145 75 07                         JNZ     ERR01                   ; NO - GO TO ERROR ROUTINE
0147 F8                            CLC                             ; CLEAR CARRY FLAG
0148 EB E3                         JMP     C8
014A                       C9:                                     ; TST1A
014A 0B C7                         OR      AX,DI                   ; ZERO PATTERN MAKE IT THROUGH ?
014C 74 01                         JZ      C10A                    ; YES - GO TO NEXT TEST
014E                       ERR01:
014E F4                            HLT                             ; HALT SYSTEM

                           ;-----  INSURE THAT CMOS CLOCK INTERRUPTS ARE DISABLED
014F                       C10A:
014F B0 8B                         MOV     AL,(CMOS_REG_B+NMI)     ; ADDRESS CMOS ALARM BYTE WITH NMI=OFF
0151 E6 70                         OUT     CMOS_PORT,AL            ;
0153 90                            NOP                             ; I/O DELAY
0154 E4 71                         IN      AL,CMOS_DATA            ; READ DATA TO OPEN STANDBY LATCH
0156 B8 8B8B                       MOV     AX,X*(CMOS_REG_B+NMI)   ; ADDRESS TO BOTH (AH) AND (AL)
0159 E6 70                         OUT     CMOS_PORT,AL            ; ADDRESS CMOS ALARM BYTE WITH NMI=OFF
015B 90                            NOP                             ; I/O DELAY
015C E4 71                         IN      AL,CMOS_DATA            ; GET THE CURRENT CONTROL REGISTER
015E 24 07                         AND     AL,00000111B            ; CLEAR SET,PIE,AIE, AND SQWE BITS
0160 86 C4                         XCHG    AL,AH                   ; SAVE IT
0162 E6 70                         OUT     CMOS_PORT,AL
0164 86 C4                         XCHG    AL,AH
0166 E6 71                         OUT     CMOS_DATA,AL

0168 B0 8C                         MOV     AL,CMOS_REG_C+NMI       ; ADDRESS CMOS FLAGS BYTE WITH NMI=OFF
016A 90                            NOP                             ; I/O DELAY
016B E6 70                         OUT     CMOS_PORT,AL
016D 90                            NOP                             ; I/O DELAY
016E E4 71                         IN      AL,CMOS_DATA            ; READ STATUS TO CLEAR PENDING INTERRUPT

                           ;-----  RESET VIDEO
0170 B0 00                         MOV     AL,0                    ; CLEAR DATA BYTE TO DISABLE VIDEO
0172 BA 03D8                       MOV     DX,03D8H                ; GET COLOR MODE CONTROL PORT ADDRESS
0175 EE                            OUT     DX,AL                   ; DISABLE COLOR VIDEO
0176 FE C0                         INC     AL                      ; MONOCHROME MODE RESET MASK
0178 B2 B8                         MOV     DL,0B8H                 ; GET ADDRESS OF MONOCHROME MODE CONTROL
017A EE                            OUT     DX,AL                   ; DISABLE B/W VIDEO, ENABLE HIGH RES
017B B2 BA                         MOV     DL,0BAH                 ; ADDRESS OF MONOCHROME STATUS REGISTER
017D EC                            IN      AL,DX                   ; READ STATUS TO DISABLE EGA VIDEO
017E B2 DA                         MOV     DL,0DAH                 ; ADDRESS OF COLOR MODE STATUS REGISTER
0180 EC                            IN      AL,DX                   ; READ STATUS TO DISABLE EGA VIDEO
0181 B0 00                         MOV     AL,0                    ; SELECT ATTRIBUTE PALETTE REGISTER 0
0183 B2 C0                         MOV     DL,0C0H                 ; WRITE 0 TO ATTRIBUTE ADDRESS REGISTER
0185 EE                            OUT     DX,AL                   ; TO DISABLE EGA VIDEO
0186 B0 FC                         MOV     AL,11111100B            ; DISABLE PARITY CHECKERS
0188 E6 61                         OUT     PORT_B,AL

                           ;----------------------------------------
                           ; TEST.02                               :
                           ;       ROM CHECKSUM TEST I             :
                           ; DESCRIPTION                           :
                           ;       A CHECKSUM IS DONE FOR THE 32K  :
                           ;       READ ONLY MEMORY MODULES (TWO)  :
                           ;       CONTAINING POST, BASIC AND BIOS.:
                           ;----------------------------------------

                           ;-----  CHECKPOINT 02

018A B0 02                         MOV     AL,02H                  ;        <><><><><><><><><><><><>
018C E6 80                         OUT     MFG_PORT,AL             ;        <><> CHECKPOINT  02 <><>

                                   ASSUME  SS:CODE
018E 8C C8                         MOV     AX,CS                   ; SETUP SS SEGMENT REGISTER
0190 8E D0                         MOV     SS,AX
0192 8E D8                         MOV     DS,AX                   ; SET UP DATA SEGMENT TO POINT TO
0194 33 F6                         XOR     SI,SI                   ; ROM ADDRESS START
0196 33 DB                         XOR     BX,BX                   ; CLEAR CHECK REGISTER
0198 B5 80                         MOV     CH,080H                 ; COUNT FOR 32K WORDS
019A                       C11:
019A AD                            LODSW                           ; MOVE TWO BYTES INTO AX -- SI=SI+2
019B 02 DC                         ADD     BL,AH                   ; ADD ODD BYTE AT DS:SI+1 TO CHECKSUM
019D 02 D8                         ADD     BL,AL                   ; ADD EVEN BYTE AT DS:SI TO CHECKSUM
019F E2 F9                         LOOP    C11                     ; LOOP COUNT FOR 65K BYTES (32K WORDS)
01A1 73 02                         JNC     C11E                    ;  EXIT IF "LOOP" RESET THE CARRY FLAG
                                                                   ;  (NOTE: MODEL BYTE MUST NOT = ZERO)
01A3 74 01                         JZ      C11A                    ; CONTINUE IF CHECKSUM VALID (ZERO)
01A5                       C11E:
01A5 F4                            HLT                             ; ELSE HALT IF CHECKSUM PROBLEM
```

```
                              ;----------------------------------------
                              ; TEST.03                                :
                              ;       VERIFY CMOS SHUTDOWN BYTE        :
                              ; DESCRIPTION                            :
                              ;       ROLLING BIT WRITTEN AND          :
                              ;       VERIFIED AT SHUTDOWN ADDRESS.    :
                              ;----------------------------------------

                              ;-----  VERIFY AND CLEAR SHUTDOWN FLAG

 01A6                         C11A:
 01A6  B0 03                          MOV     AL,03H                  ;       <><><><><><><><><><><><><>
 01A8  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  03 <><>

 01AA  B9 0009                        MOV     CX,09H                  ; LOOP COUNT
 01AD  B4 01                          MOV     AH,1                    ; START WITH BIT 0
 01AF                         C11B:
 01AF  B0 8F                          MOV     AL,CMOS_SHUT_DOWN+NMI
 01B1  E6 70                          OUT     CMOS_PORT,AL
 01B3  8A C4                          MOV     AL,AH                   ; OUTPUT ROLLING BIT
 01B5  E6 71                          OUT     CMOS_DATA,AL
 01B7  B0 8F                          MOV     AL,CMOS_SHUT_DOWN+NMI   ; READ CMOS
 01B9  90                             NOP                             ; I/O DELAY
 01BA  E6 70                          OUT     CMOS_PORT,AL
 01BC  90                             NOP                             ; I/O DELAY
 01BD  E4 71                          IN      AL,CMOS_DATA
 01BF  3A C4                          CMP     AL,AH                   ; MUST BE THE SAME
 01C1  75 8B                          JNZ     ERR01                   ; ERROR IF NOT
 01C3  D0 D4                          RCL     AH,1                    ; ROLL A BIT THROUGH SHUTDOWN BYTE
 01C5  E2 E8                          LOOP    C11B                    ; LOOP TILL DONE

                              ;----------------------------------------
                              ; TEST.04                                :
                              ;       8254 CHECK TIMER 1               :
                              ; DESCRIPTION                            :
                              ;       SET TIMER COUNT TO               :
                              ;       CHECK THAT TIMER 1 ALL BITS ON   :
                              ;----------------------------------------

                                      ASSUME  DS:DATA
 01C7  B8 ---- R                      MOV     AX,DATA                 ; SET DATA SEGMENT
 01CA  8E D8                          MOV     DS,AX
 01CC  B0 04                          MOV     AL,04H                  ;       <><><><><><><><><><><><><>
 01CE  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  04 <><>

                              ;-----  DISABLE DMA CONTROLLER
                                                                      ; (AL) ALREADY = 04H
 01D0  E6 08                          OUT     DMA08,AL                ; DISABLE DMA CONTROLLER 1
 01D2  E6 D0                          OUT     DMA18,AL                ; DISABLE DMA CONTROLLER 2

                              ;-----  VERIFY THAT TIMER 1 FUNCTIONS OK

 01D4  8B 16 0072 R                   MOV     DX,@RESET_FLAG          ; SAVE RESET FLAG WHILE REFRESH IS OFF
 01D8  B0 54                          MOV     AL,54H                  ; SELECT TIMER 1,LSB,MODE 2
 01DA  E6 43                          OUT     TIMER+3,AL
 01DC  EB 00                          JMP     $+2                     ; I/O DELAY
 01DE  B0 12                          MOV     AL,18                   ; SET INITIAL TIMER COUNT TO 18
 01E0  E6 41                          OUT     TIMER+1,AL
 01E2  B7 05                          MOV     BH,05H                  ; LOOP COUNT
 01E4                         C12:                                    ; TIMER1_BITS_ON
 01E4  B0 40                          MOV     AL,40H                  ; LATCH TIMER 1 COUNT
 01E6  EB 00                          JMP     $+2                     ; I/O DELAY
 01E8  E6 43                          OUT     TIMER+3,AL
 01EA  80 FB 1F                       CMP     BL,01FH                 ; YES - SEE IF ALL BITS GO ON
 01ED  74 0B                          JE      C13                     ; TIMER1_BITS_OFF
 01EF  E4 41                          IN      AL,TIMER+1              ; READ TIMER 1 COUNT
 01F1  0A D8                          OR      BL,AL                   ; ALL BITS ON IN TIMER
 01F3  E2 EF                          LOOP    C12                     ; TIMER1_BITS_ON
 01F5  FE CF                          DEC     BH
 01F7  75 EB                          JNZ     C12                     ; TRY AGAIN
 01F9  F4                             HLT                             ; TIMER 1 FAILURE, HALT SYSTEM
                                                                      ; TIMER1_BITS_OFF
                              ;----------------------------------------
                              ; TEST.05                                :
                              ;       8254 CHECK TIMER 1 ALL BIT OFF   :
                              ; DESCRIPTION                            :
                              ;       SET TIMER COUNT                  :
                              ;       CHECK THAT TIMER 1 ALL BITS OFF  :
                              ;----------------------------------------

                              ;-----  CHECKPOINT 05

 01FA  B0 05                  C13:    MOV     AL,05H                  ;       <><><><><><><><><><><><><>
 01FC  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  05 <><>

 01FE  8A C3                          MOV     AL,BL                   ; SET TIMER 1 COUNT
 0200  2B C9                          SUB     CX,CX
 0202  E6 41                          OUT     TIMER+1,AL
 0204  B7 05                          MOV     BH,05H                  ; SET TRY AGAIN COUNT
 0206                         C14:                                    ; TIMER_LOOP
 0206  B0 40                          MOV     AL,40H                  ; LATCH TIMER 1 COUNT
 0208  E6 43                          OUT     TIMER+3,AL
 020A  EB 00                          JMP     $+2                     ; DELAY FOR TIMER
 020C  EB 00                          JMP     $+2                     ; ADDED DELAY FOR TIMER
 020E  E4 41                          IN      AL,TIMER+1              ; READ TIMER 1 COUNT
 0210  22 D8                          AND     BL,AL
 0212  74 07                          JZ      C15                     ; GO TO WRAP DMA REGISTER TESTS
 0214  E2 F0                          LOOP    C14                     ; TIMER_LOOP
 0216  FE CF                          DEC     BH
 0218  75 EC                          JNZ     C14
 021A  F4                             HLT                             ; HALT SYSTEM

                              ;----------------------------------------
                              ; TEST.06                                :
                              ;       8237 DMA 0 INITIALIZATION        :
                              ;       CHANNEL REGISTER TEST            :
                              ; DESCRIPTION                            :
                              ;       DISABLE THE 8237 DMA CONTROLLER.:
                              ;       WRITE/READ THE CURRENT ADDRESS   :
                              ;       AND WORD COUNT REGISTERS FOR     :
                              ;       ALL CHANNELS.                    :
                              ;----------------------------------------


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                          ;-----  CHECKPOINT 06
021B                      C15:
021B B8 ---- R                    MOV    AX,DATA              ; SET DATA SEGMENT
021E 8E D8                        MOV    DS,AX
0220 B0 06                        MOV    AL,06H               ;        <><><><><><><><><><><><>
0222 E6 80                        OUT    MFG_PORT,AL          ;        <><> CHECKPOINT  06 <><>
0224 89 16 0072 R                 MOV    @RESET_FLAG,DX       ; RESTORE SOFT RESET FLAG
0228 E6 0D                        OUT    DMA+0DH,AL           ; SEND MASTER CLEAR TO DMA

                          ;-----  WRAP DMA 0 CHANNEL ADDRESS AND COUNT REGISTERS

022A B0 FF                        MOV    AL,0FFH              ; WRITE PATTERN "FF" TO ALL REGISTERS
022C 8A D8                C16:    MOV    BL,AL                ; SAVE PATTERN FOR COMPARE
022E 8A F8                        MOV    BH,AL
0230 B9 0008                      MOV    CX,8                 ; SETUP LOOP COUNT
0233 BA 0000                      MOV    DX,DMA               ; SETUP I/O PORT ADDRESS OF REGISTER
0236 EE                   C17:    OUT    DX,AL                ; WRITE PATTERN TO REGISTER, LSB
0237 EB 00                        JMP    $+2                  ; I/O DELAY
0239 EE                           OUT    DX,AL                ; MSB OF 16 BIT REGISTER
023A B0 01                        MOV    AL,01H               ; AL TO ANOTHER PATTERN BEFORE READ
023C EB 00                        JMP    $+2                  ; I/O DELAY
023E EC                           IN     AL,DX                ; READ 16-BIT DMA CH REG, LSB  2ST DMA
023F EB 00                        JMP    $+2                  ; I/O DELAY
0241 8A E0                        MOV    AH,AL                ; SAVE LSB OF 16-BIT REGISTER
0243 EC                           IN     AL,DX                ; READ MSB OF DMA CHANNEL REGISTER
0244 3B D8                        CMP    BX,AX                ; PATTERN READ AS WRITTEN?
0246 74 01                        JE     C18                  ; YES - CHECK NEXT REGISTER
0248 F4                           HLT                         ; NO - HALT THE SYSTEM
0249                      C18:                                ; NXT_DMA_CH
0249 42                           INC    DX                   ; SET I/O PORT TO NEXT CHANNEL REGISTER
024A E2 EA                        LOOP   C17                  ; WRITE PATTERN TO NEXT REGISTER
024C FE C0                        INC    AL                   ; SET PATTERN TO 0
024E 74 DC                        JZ     C16                  ; YES CONTINUE

                          ;-----  WRITE DMA WITH 55 PATTERN

0250 80 FB 55                     CMP    BL,055H              ; CHECK IF "55" PATTERN DONE
0253 74 09                        JZ     C19                  ; GO IF YES
0255 80 FB AA                     CMP    BL,0AAH              ; CHECK IF "AA" PATTERN DONE
0258 74 08                        JZ     C20                  ; GO IF YES
025A B0 55                        MOV    AL,055H
025C EB CE                        JMP    C16

                          ;-----  WRITE DMA WITH AA PATTERN

025E B0 AA                C19:    MOV    AL,0AAH
0260 EB CA                        JMP    C16

                          ;----------------------------------------
                          ; TEST.07                                :
                          ;       8237 DMA 1 INITIALIZATION        :
                          ;       CHANNEL REGISTER TEST            :
                          ; DESCRIPTION                            :
                          ;       DISABLE 8237 DMA CONTROLLER 1.   :
                          ;       WRITE/READ THE CURRENT DMA 1     :
                          ;       ADDRESS AND WORD COUNT           :
                          ;       REGISTERS FOR ALL CHANNELS.      :
                          ;----------------------------------------

                          ;-----  CHECKPOINT 07 - DMA 1

0262 B0 07                C20:    MOV    AL,07H               ;        <><><><><><><><><><><><>
0264 E6 80                        OUT    MFG_PORT,AL          ;        <><> CHECKPOINT  07 <><>
0266 E6 DA                        OUT    DMA1+0DH*2,AL        ; SEND MASTER CLEAR TO 2ND DMA

                          ;-----  WRAP DMA 1 CHANNEL ADDRESS AND COUNT REGISTERS

0268 B0 FF                        MOV    AL,0FFH              ; WRITE PATTERN FF TO ALL REGISTERS
026A 8A D8                C16A:   MOV    BL,AL                ; SAVE PATTERN FOR COMPARE
026C 8A F8                        MOV    BH,AL
026E B9 0008                      MOV    CX,8                 ; SETUP LOOP COUNT
0271 BA 00C0                      MOV    DX,DMA1              ; SETUP I/O PORT ADDRESS OF REGISTER
0274 EE                   C17A:   OUT    DX,AL                ; WRITE PATTERN TO REGISTER, LSB
0275 EB 00                        JMP    $+2                  ; I/O DELAY
0277 EE                           OUT    DX,AL                ; MSB OF 16 BIT REGISTER
0278 B0 01                        MOV    AL,01H               ; AL TO ANOTHER PAT BEFORE RD
027A EB 00                        JMP    $+2                  ; I/O DELAY
027C EC                           IN     AL,DX                ; READ 16-BIT DMA CH REG, LSB  2ST DMA
027D EB 00                        JMP    $+2                  ; I/O DELAY
027F 8A E0                        MOV    AH,AL                ; SAVE LSB OF 16-BIT REGISTER
0281 EC                           IN     AL,DX                ; READ MSB OF DMA CH REGISTER
0282 3B D8                        CMP    BX,AX                ; PATTERN READ AS WRITTEN?
0284 74 01                        JE     C18A                 ; YES - CHECK NEXT REGISTER
0286 F4                           HLT                         ; NO - HALT THE SYSTEM
0287                      C18A:                               ; NXT_DMA_CH
0287 83 C2 02                     ADD    DX,2                 ; SET I/O PORT TO NEXT CHANNEL REGISTER
028A E2 E8                        LOOP   C17A                 ; WRITE PATTERN TO NEXT REGISTER
028C FE C0                        INC    AL                   ; SET PATTERN TO 0
028E 74 DA                        JZ     C16A                 ; YES CONTINUE

                          ;-----  WRITE DMA WITH 55 PATTERN

0290 80 FB 55                     CMP    BL,55H               ; CHECK IF 55 PATTERN DONE
0293 74 09                        JZ     C20A                 ; GO IF YES
0295 80 FB AA                     CMP    BL,0AAH              ; CHECK IF AA PATTERN DONE
0298 74 08                        JZ     C21                  ; GO IF YES
029A B0 55                        MOV    AL,55H
029C EB CC                        JMP    C16A

                          ;-----  WRITE DMA WITH AA PATTERN

029E B0 AA                C20A:   MOV    AL,0AAH
02A0 EB C8                        JMP    C16A

                          ;-----  INITIALIZE AND START MEMORY REFRESH

02A2                      C21:
02A2 8B 1E 0072 R                 MOV    BX,@RESET_FLAG       ; GET THE RESET FLAG
02A6 A3 0010 R                    MOV    @EQUIP_FLAG,AX       ; DO A DUMMY MEMORY WRITE BEFORE REFRESH
02A9 B0 12                        MOV    AL,18                ; START REFRESH TIMER
02AB E6 41                        OUT    TIMER+1,AL

                          ;-----  SET DMA COMMAND

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02AD 2A C0                      SUB     AL,AL                   ; DACK SENSE LOW,DREQ SENSE HIGH
02AF E6 08                      OUT     DMA+8,AL                ; LATE WRITE, FIXED PRIORITY, NORMAL
                                                                ; TIMING, CONTROLLER ENABLE, CH0 ADDRESS
                                                                ; HOLD DISABLE, MEMORY TO MEMORY DISABLE
02B1 E6 D0                      OUT     DMA18,AL                ; SAME TO SECOND CONTROLLER

                        ;-----  MODE SET ALL DMA CHANNELS

02B3 B0 40                      MOV     AL,40H                  ; SET MODE FOR CHANNEL 0
02B5 E6 0B                      OUT     DMA+0BH,AL
02B7 B0 C0                      MOV     AL,0C0H                 ; SET CASCADE MODE ON CHANNEL 4
02B9 E6 D6                      OUT     DMA18+06H,AL
02BB EB 00                      JMP     $+2                     ; I/O DELAY
02BD B0 41                      MOV     AL,41H                  ; SET MODE FOR CHANNEL 1
02BF E6 0B                      OUT     DMA+0BH,AL
02C1 E6 D6                      OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 5
02C3 EB 00                      JMP     $+2                     ; I/O DELAY
02C5 B0 42                      MOV     AL,42H                  ; SET MODE FOR CHANNEL 2
02C7 E6 0B                      OUT     DMA+0BH,AL
02C9 E6 D6                      OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 6
02CB EB 00                      JMP     $+2                     ; I/O DELAY
02CD B0 43                      MOV     AL,43H                  ; SET MODE FOR CHANNEL 3
02CF E6 0B                      OUT     DMA+0BH,AL
02D1 E6 D6                      OUT     DMA18+06H,AL            ; SET MODE FOR CHANNEL 7

                        ;-----  RESTORE RESET FLAG

02D3 89 1E 0072 R               MOV     @RESET_FLAG,BX

                        ;----------------------------------------
                        ; TEST.08                               :
                        ;       DMA PAGE REGISTER TEST          :
                        ; DESCRIPTION                           :
                        ;       WRITE/READ ALL PAGE REGISTERS   :
                        ;----------------------------------------

                        ;-----  CHECKPOINT 08

02D7 B0 08                      MOV     AL,08H                  ;       <><><><><><><><><><><><><>
02D9 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  08 <><>
02DB 2A C0                      SUB     AL,AL
02DD BA 0081                    MOV     DX,DMA_PAGE
02E0 B9 00FF                    MOV     CX,0FFH                 ; DO ALL DATA PATTERNS
02E3 EE                 C22A:   OUT     DX,AL
02E4 42                         INC     DX
02E5 FE C0                      INC     AL
02E7 81 FA 008F                 CMP     DX,8FH                  ; TEST DMA PAGES 81 THROUGH 8EH
02EB 75 F6                      JNZ     C22A
02ED 86 E0                      XCHG    AH,AL                   ; SAVE CURRENT DATA PATTERN
02EF FE CC                      DEC     AH                      ; CHECK LAST WRITTEN
02F1 4A                         DEC     DX                      ;
02F2 2A C0              C22B:   SUB     AL,AL                   ; CHANGE DATA BEFORE READ
02F4 EC                         IN      AL,DX
02F5 3A C4                      CMP     AL,AH                   ; DATA AS WRITTEN?
02F7 75 30                      JNZ     C26                     ; GO ERROR HALT IF NOT
02F9 FE CC                      DEC     AH
02FB 4A                         DEC     DX
02FC 81 FA 0080                 CMP     DX,MFG_PORT             ; CONTINUE TILL PORT 80
0300 75 F0                      JNZ     C22B
0302 FE C4                      INC     AH                      ; NEXT PATTERN TO RIPPLE
0304 8A C4                      MOV     AL,AH
0306 E2 DB                      LOOP    C22A

                        ;-----  TEST LAST DMA PAGE REGISTER (USED FOR ADDRESS LINES DURING REFRESH)

0308 B0 CC                      MOV     AL,0CCH                 ; WRITE AN CC TO PAGE REGISTERS
030A BA 008F            C22:    MOV     DX,LAST_DMA_PAGE
030D 8A E0                      MOV     AH,AL                   ; SAVE THE DATA PATTERN
030F EE                         OUT     DX,AL                   ; OUTPUT PAGE REGISTER

                        ;-----  VERIFY PAGE REGISTER 8F

0310 2A C0                      SUB     AL,AL                   ; CHANGE DATA PATTERN BEFORE READ
0312 EC                         IN      AL,DX                   ; GET THE DATA FROM PAGE REGISTER
0313 3A C4                      CMP     AL,AH
0315 75 12                      JNZ     C26                     ; GO IF ERROR
0317 80 FC CC                   CMP     AH,0CCH
031A 75 04                      JNZ     C25                     ; GO IF ERROR
031C B0 33                      MOV     AL,033H                 ; SET UP DATA PATTERN OF 33
031E EB EA                      JMP     C22                     ; DO DATA 33
0320                    C25:
0320 80 FC 00                   CMP     AH,0                    ; CHECK DONE
0323 74 05                      JZ      C27                     ; GO IF YES
0325 2A C0                      SUB     AL,AL                   ; SET UP FOR DATA PATTERN 00
0327 EB E1                      JMP     C22                     ; DO DATA 0

                        ;-----  ERROR HALT
0329                    C26:
0329 F4                         HLT                             ; HALT SYSTEM

                        ;----------------------------------------
                        ; TEST.09                               :
                        ;       STORAGE REFRESH TEST            :
                        ; DESCRIPTION                           :
                        ;       VERIFY REFRESH IS OCCURRING     :
                        ;----------------------------------------

                        ;-----  CHECKPOINT 09 - TEST MEMORY REFRESH

032A                    C27:
032A B0 09                      MOV     AL,09H                  ;       <><><><><><><><><><><><><>
032C E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  09 <><>
032E 2B C9                      SUB     CX,CX                   ;
0330                    C28:
0330 E4 61                      IN      AL,PORT_B               ; INSURE REFRESH BIT IS TOGGLING
0332 A8 10                      TEST    AL,REFRESH_BIT
0334 E1 FA                      LOOPZ   C28                     ; INSURE REFRESH IS OFF
0336 E3 F1                      JCXZ    C26                     ; ERROR HALT IF TIMEOUT
0338                    C29:
0338 E4 61                      IN      AL,PORT_B
033A A8 10                      TEST    AL,REFRESH_BIT          ; INSURE REFRESH IS ON
033C E0 FA                      LOOPNZ  C29
033E E3 E9                      JCXZ    C26                     ; ERROR HALT IF NO REFRESH BIT
```

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                              ;---------------------------------------
                              ; TEST.10                               :
                              ;        8042 INTERFACE TEST            :
                              ;        READ CONFIGURATION JUMPERS     :
                              ; DESCRIPTION                           :
                              ;        ISSUE A SELF TEST TO THE 8042. :
                              ;        INSURE A 55H IS RECEIVED.      :
                              ;        READ MANUFACTURING AND DISPLAY :
                              ;        JUMPERS AND SAVE IN MFG_TEST.  :
                              ;---------------------------------------

                              ;-----  CHECKPOINT 0A

 0340  B0 0A                          MOV     AL,0AH                  ;       <><><><><><><><><><><><><><>
 0342  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0A <><>

                              ;-----  SOFT RESET (HANDLE ALL POSSIBLE CONDITIONS)

 0344  2B C9                          SUB     CX,CX                   ; 100 MILLISECONDS FOR THIS LOOP
 0346  E4 64                  TST1:   IN      AL,STATUS_PORT          ; CHECK FOR INPUT BUFFER FULL
 0348  8A E0                          MOV     AH,AL
 034A  F6 C4 01                       TEST    AH,OUT_BUF_FULL
 034D  74 02                          JZ      TST2                    ; GO IF NOT
 034F  E4 60                          IN      AL,PORT_A               ; FLUSH
 0351  F6 C4 02               TST2:   TEST    AH,INPT_BUF_FULL        ; IS THE OUTPUT BUFFER ALSO FULL?
 0354  E0 F0                          LOOPNZ  TST1                    ; TRY AGAIN
 0356  74 01                          JZ      TST4                    ; CONTINUE IF OK

 0358  F4                     ERR0:   HLT                             ; HALT SYSTEM IF BUFFER FULL

                              ;-----  ISSUE A RESET TO THE 8042

 0359  B0 0B                  TST4:   MOV     AL,0BH                  ;       <><><><><><><><><><><><><><>
 035B  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0B <><>

 035D  B0 AA                          MOV     AL,SELF_TEST            ; SELF TEST COMMAND
 035F  BC 03F5 R                      MOV     SP,OFFSET C8042A        ; SET RETURN ADDRESS
 0362  EB 39                          JMP     SHORT C8042
 0364  A8 01                  TST4_B: TEST    AL,OUT_BUF_FULL         ; IS THE OUTPUT BUFFER FULL?
 0366  74 02                          JZ      TST4_A                  ; GO IF NOT
 0368  E4 60                          IN      AL,PORT_A               ; FLUSH
 036A  BC 03F7 R              TST4_A: MOV     SP,OFFSET OBF_42A       ; SET RETURN ADDRESS
 036D  EB 3A                          JMP     SHORT OBF_42            ; GO WAIT FOR BUFFER
 036F  E4 60                  TST4_C: IN      AL,PORT_A               ; GET THE ENDING RESPONSE
 0371  3C 55                          CMP     AL,55H

 0373  B0 0C                          MOV     AL,0CH                  ;       <><><><><><><><><><><><><><>
 0375  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0C <><>

 0377  75 DF                          JNZ     ERR0                    ; GO IF NOT OK

                              ;-----  GET THE SWITCH SETTINGS

 0379  B0 C0                          MOV     AL,READ_8042_INPUT      ; READ INPUT COMMAND
 037B  BC 03FB R                      MOV     SP,OFFSET C8042C        ; SET RETURN ADDRESS
 037E  EB 1D                          JMP     SHORT C8042             ; ISSUE COMMAND
 0380  BC 03FD R              E30B:   MOV     SP,OFFSET OBF_42B       ; SET RETURN ADDRESS
 0383  EB 24                          JMP     SHORT OBF_42            ; GO WAIT FOR RESPONSE
 0385  E4 60                  E30C:   IN      AL,PORT_A               ; GET THE SWITCH
 0387  E6 82                          OUT     DMA_PAGE+1,AL           ; SAVE TEMPORARY

                              ;-----  WRITE BYTE 0 OF 8042 MEMORY

 0389  B0 60                          MOV     AL,WRITE_8042_LOC       ; WRITE BYTE COMMAND
 038B  BC 03F9 R                      MOV     SP,OFFSET C8042B        ; SET RETURN ADDRESS
 038E  EB 0D                          JMP     SHORT C8042             ; ISSUE THE COMMAND
 0390  74 05                  TST4_D: JZ      TST4_D1                 ; CONTINUE IF COMMAND ACCEPTED

 0392  B0 0D                          MOV     AL,0DH                  ;       <><><><><><><><><><><><><><>
 0394  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0D <><>
 0396  F4                             HLT
 0397                         TST4_D1:
 0397  B0 5D                          MOV     AL,5DH                  ; ENABLE OUTPUT BUFFER FULL INTERRUPT,
 0399  E6 60                          OUT     PORT_A,AL               ; DISABLE KEYBOARD, SET SYSTEM FLAG,
 039B  EB 1D                          JMP     SHORT E30A              ; PC 1 COMPATIBILITY, INHIBIT OVERRIDE

                              ;-----  ISSUE THE COMMAND TO THE 8042

 039D  FA                     C8042:  CLI                             ; NO INTERRUPTS ALLOWED
 039E  E6 64                          OUT     STATUS_PORT,AL          ; SEND COMMAND IN AL REGISTER
 03A0  2B C9                          SUB     CX,CX                   ; LOOP COUNT
 03A2  E4 64                  C42_1:  IN      AL,STATUS_PORT          ; WAIT FOR THE COMMAND ACCEPTED
 03A4  A8 02                          TEST    AL,INPT_BUF_FULL
 03A6  E0 FA                          LOOPNZ  C42_1
 03A8  C3                             RET

                              ;-----  WAIT FOR 8042 RESPONSE

 03A9  2B C9                  OBF_42: SUB     CX,CX
 03AB  B3 06                          MOV     BL,6                    ; 200MS/PER LOOP * 6  =1200 MS +
 03AD  E4 64                  C42_2:  IN      AL,STATUS_PORT          ; CHECK FOR RESPONSE
 03AF  A8 01                          TEST    AL,OUT_BUF_FULL
 03B1  75 06                          JNZ     C42_3                   ; GO IF RESPONSE
 03B3  E2 F8                          LOOP    C42_2                   ; TRY AGAIN
 03B5  FE CB                          DEC     BL                      ; DECREMENT LOOP COUNT
 03B7  75 F4                          JNZ     C42_2
 03B9  C3                     C42_3:  RET                             ; RETURN TO CALLER

                              ;---------------------------------------
                              ; TEST.11                               :
                              ;        BASE 64K READ/WRITE MEMORY TEST :
                              ; DESCRIPTION                           :
                              ;        WRITE/READ/VERIFY DATA PATTERNS :
                              ;        AA,55,FF,01, AND 00 TO 1 ST 64K :
                              ;        OF STORAGE. VERIFY STORAGE     :
                              ;        ADDRESSABILITY.                :
                              ;---------------------------------------

                              ;-----  FILL MEMORY WITH DATA

 03BA  B0 0E                  E30A:   MOV     AL,0EH                  ;       <><><><><><><><><><><><><><>
 03BC  E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  0E <><>

```

SECTION 5

```
03BE B8 ---- R                  MOV     AX,DATA                 ; GET THE SYSTEM SEGMENT
03C1 8E D8                      MOV     DS,AX                   ;  OF DATA
03C3 8B 1E 0072 R               MOV     BX,@RESET_FLAG          ; SAVE @RESET_FLAG IN BX
03C7 FC                         CLD                             ; SET DIRECTION FLAG TO INCREMENT
03C8 B9 8000                    MOV     CX,2000H*4              ; SET FOR 32K WORDS
03CB 2B FF                      SUB     DI,DI                   ; FIRST 16K
03CD 2B F6                      SUB     SI,SI
03CF 2B C0                      SUB     AX,AX
03D1 8E D8                      MOV     DS,AX
03D3 8E C0                      MOV     ES,AX
03D5 81 FB 1234                 CMP     BX,1234H                ; WARM START?
03D9 75 03                      JNZ     E30A_0                  ; GO IF NOT
03DB E9 0587 R                  JMP     CLR_STG

                        ;-----  GET THE INPUT BUFFER (SWITCH SETTINGS)

03DE B0 0F              E30A_0: MOV     AL,0FH                  ;       <><><><><><><><><><><><>
03E0 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  OF <><>

03E2 B0 80                      MOV     AL,PARITY_CHECK         ; SET BASE MEMORY PARITY
03E4 E6 87                      OUT     DMA_PAGE+6,AL           ; USE AS TEMPORARY SAVE
03E6 BC 03F3 R                  MOV     SP,OFFSET C2            ; SET RETURN ADDRESS
03E9 E9 0000 E                  JMP     STGTST_CNT
03EC 8B D8              C30:    MOV     BX,AX                   ; SAVE FAILING BIT PATTERN
03EE 75 0F                      JNZ     C31
03F0 E9 0592 R                  JMP     C33                     ; STORAGE OK, CONTINUE

                        ;-----  TEMPORARY STACK FOR POST ROUTINES

03F3 03EC R             C2      DW      C30
03F5 0364 R             C8042A  DW      TST4_B
03F7 036F R             OBF_42A DW      TST4_C
03F9 0390 R             C8042B  DW      TST4_D
03FB 0380 R             C8042C  DW      E30B
03FD 0385 R             OBF_42B DW      E30C

                        ;------------------------------------------
                        ; BASE 64K STORAGE FAILURE
                        ;   DISPLAY THE CHECKPOINT (MFG CHECKPOINT)
                        ;     AND XOR EXPECTED WITH READ IN MFG_PORT
                        ;   DISPLAY CHECKPOINT IN MFG_PORT+3
                        ;   DISPLAY XOR'D DATA HIGH BYTE MFG_PORT+1
                        ;     LOW BYTE IN MFG_PORT+2
                        ;   A READ/WRITE SCOPE LOOP OF THE FIRST
                        ;   WORD FOR POSSIBLE ADDRESS LINE FAILURES
                        ;------------------------------------------

03FF 8A C7              C31:    MOV     AL,BH                   ; SAVE HIGH BYTE
0401 E6 81                      OUT     MFG_PORT+1,AL
0403 8A C3                      MOV     AL,BL                   ; SAVE LOW BYTE
0405 E6 82                      OUT     MFG_PORT+2,AL

                        ;-----  CHECK FOR VIDEO ROM

0407 B9 C000                    MOV     CX,0C000H               ; START OF I/O ROM
040A 8E D9              M1:     MOV     DS,CX                   ; POINT TO SEGMENT
040C 2B DB                      SUB     BX,BX                   ; GET THE FIRST 2 LOCATIONS
040E 8B 07                      MOV     AX,[BX]
0410 EB 00                      JMP     $+2                     ; BUS SETTLE
0412 3D AA55                    CMP     AX,0AA55H               ; IS THE VIDEO ROM PRESENT?
0415 74 0C                      JZ      Z5                      ; GO IF YES
0417 81 C1 0080                 ADD     CX,080H                 ; POINT TO NEXT 2K BLOCK
041B 81 F9 C800                 CMP     CX,0C800H               ; TOP OF VIDEO ROM AREA YET?
041F 7C E9                      JL      M1                      ; TRY AGAIN
0421 23 C9                      AND     CX,CX                   ; SET NON ZERO FLAG
0423 75 03              Z5:     JNZ     C32                     ; GO IF NOT
0425 E9 0514 R                  JMP     C31_0                   ; BYPASS ERROR DISPLAY IF VIDEO ROM

                        ;-----------------------------------------------------
                        ; SET VIDEO MODE TO DISPLAY MEMORY ERROR
                        ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO
                        ;       TO DISPLAY FIRST 64K STORAGE ERRORS.
                        ; BOTH COLOR AND MONOCHROME ATTACHMENTS ARE INITIALIZED.
                        ;-----------------------------------------------------

                        ;-----  INITIALIZE COLOR/MONOCHROME

0428 BA 03D8            C32:    MOV     DX,3D8H                 ; CONTROL REGISTER ADDRESS OF COLOR CARD
042B 2A C0                      SUB     AL,AL                   ; MODE SET
042D EE                         OUT     DX,AL

042E BA 03B8                    MOV     DX,03B8H                ; CONTROL REGISTER ADDRESS OF B/W CARD
0431 B0 01                      MOV     AL,1                    ; MODE SET FOR CARD
0433 EE                         OUT     DX,AL                   ; RESET VIDEO
0434 83 EA 04                   SUB     DX,4                    ; BACK TO BASE REGISTER

= 0010                  M4      EQU     10H

0437 BB 0030 E                  MOV     BX,OFFSET VIDEO_PARMS+M4*3  ; POINT TO VIDEO PARAMETERS
                                ASSUME  DS:CODE
043A B9 0010            Z_2:    MOV     CX,M4                   ; COUNT OF MONOCHROME VIDEO PARAMETERS

                        ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

043D 32 E4                      XOR     AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                        ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE

043F 8A C4              M10:    MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
0441 EE                         OUT     DX,AL
0442 42                         INC     DX                      ; POINT TO DATA PORT
0443 FE C4                      INC     AH                      ; NEXT REGISTER VALUE
0445 2E: 8A 07                  MOV     AL,CS:[BX]              ; GET TABLE VALUE
0448 EE                         OUT     DX,AL                   ; OUT TO CHIP
0449 43                         INC     BX                      ; NEXT IN TABLE
044A 4A                         DEC     DX                      ; BACK TO POINTER REGISTER
044B E2 F2                      LOOP    M10                     ; DO THE WHOLE TABLE
044D 8A E2                      MOV     AH,DL                   ; CHECK IF COLOR CARD DONE
044F 80 E4 F0                   AND     AH,0F0H                 ; STRIP UNWANTED BITS
0452 80 FC D0                   CMP     AH,0D0H                 ; IS IT THE COLOR CARD?
0455 74 08                      JZ      Z_3                     ; CONTINUE IF COLOR
0457 BB 0000 E                  MOV     BX,OFFSET VIDEO_PARMS   ; POINT TO VIDEO PARAMETERS
045A BA 03D4                    MOV     DX,3D4H                 ; COLOR BASE
045D EB DB                      JMP     Z_2                     ; CONTINUE
```

```

                             ;-----  FILL REGEN AREA WITH BLANK

045F 33 FF                   Z_3:    XOR     DI,DI                   ; SET UP POINTER FOR REGEN
0461 B8 B000                         MOV     AX,0B000H               ; SET UP ES TO VIDEO REGEN
0464 8E C0                           MOV     ES,AX

0466 B9 0800                         MOV     CX,2048                 ; NUMBER OF WORDS IN MONOCHROME CARD
0469 B8 0720                         MOV     AX,' '+7*H              ; FILL CHARACTER FOR ALPHA + ATTRIBUTE
046C F3/ AB                          REP     STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS

046E 33 FF                           XOR     DI,DI                   ; CLEAR COLOR VIDEO BUFFER MEMORY
0470 BB B800                         MOV     BX,0B800H               ; SET UP ES TO COLOR VIDEO MEMORY
0473 8E C3                           MOV     ES,BX
0475 B9 2000                         MOV     CX,8192
0478 F3/ AB                          REP     STOSW                   ; FILL WITH BLANKS

                             ;-----  ENABLE VIDEO AND CORRECT PORT SETTING

047A BA 03B8                         MOV     DX,3B8H
047D B0 29                           MOV     AL,29H
047F EE                              OUT     DX,AL                   ; SET VIDEO ENABLE PORT

                             ;-----  SET UP OVERSCAN REGISTER

0480 42                              INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
0481 B0 30                           MOV     AL,30H                  ; VALUE 30H FOR ALL MODES EXCEPT 640X200
0483 EE                              OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT

                             ;-----  ENABLE COLOR VIDEO AND CORRECT PORT SETTING

0484 BA 03D8                         MOV     DX,3D8H
0487 B0 28                           MOV     AL,28H
0489 EE                              OUT     DX,AL                   ; SET VIDEO ENABLE PORT

                             ;-----  SET UP OVERSCAN REGISTER

048A 42                              INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
048B B0 30                           MOV     AL,30H                  ; VALUE 30H FOR ALL MODES EXCEPT 640X200
048D EE                              OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT

                             ;-----  DISPLAY FAILING CHECKPOINT AND

048E 8C C8                           MOV     AX,CS                   ; SET STACK SEGMENT TO CODE SEGMENT
0490 8E D0                           MOV     SS,AX

0492 BB B000                         MOV     BX,0B000H
0495 8E DB                           MOV     DS,BX                   ; SET DS TO B/W DISPLAY BUFFER

0497 B0 30                   Z_0:    MOV     AL,'0'                  ; DISPLAY BANK 000000
0499 B9 0006                         MOV     CX,6
049C 2B FF                           SUB     DI,DI                   ; START AT 0
049E 88 05                   Z:      MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04A0 47                              INC     DI                      ; POINT TO NEXT POSITION
04A1 47                              INC     DI
04A2 E2 FA                           LOOP    Z

04A4 80 FF B8                        CMP     BH,0B8H                 ; CHECK THAT COLOR BUFFER WRITTEN
04A7 74 0C                           JZ      Z_1
04A9 2B FF                           SUB     DT,DI                   ; POINT TO START OF BUFFER

04AB B7 B0                           MOV     BH,0B0H
04AD 8E C3                           MOV     ES,BX                   ; ES = MONOCHROME
04AF B7 B8                           MOV     BH,0B8H                 ; SET SEGMENT TO COLOR
04B1 8E DB                           MOV     DS,BX                   ; DS = COLOR
04B3 EB E2                           JMP     Z_0

                             ;-----  PRINT FAILING BIT PATTERN

04B5 B0 20                   Z_1:    MOV     AL,' '                  ; DISPLAY A BLANK
04B7 88 05                           MOV     [DI],AL                 ; WRITE TO COLOR BUFFER
04B9 26: 88 05                       MOV     ES:[DI],AL              ; WRITE TO MONOCHROME REGEN BUFFER
04BC 47                              INC     DI                      ; POINT TO NEXT POSITION
04BD 47                              INC     DI
04BE E4 81                           IN      AL,MFG_PORT+1           ; GET THE HIGH BYTE OF FAILING PATTERN
04C0 B1 04                           MOV     CL,4                    ; SHIFT COUNT
04C2 D2 E8                           SHR     AL,CL                   ; NIBBLE SWAP
04C4 BC 057F R                       MOV     SP,OFFSET Z1_0
04C7 EB 1B                           JMP     SHORT PR

04C9 E4 81                   Z1:     IN      AL,MFG_PORT+1
04CB 24 0F                           AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
04CD BC 0581 R                       MOV     SP,OFFSET Z2_0
04D0 EB 12                           JMP     SHORT PR
04D2 E4 82                   Z2:     IN      AL,MFG_PORT+2           ; GET THE HIGH BYTE OF FAILING PATTERN
04D4 B1 04                           MOV     CL,4                    ; SHIFT COUNT
04D6 D2 E8                           SHR     AL,CL                   ; NIBBLE SWAP
04D8 BC 0583 R                       MOV     SP,OFFSET Z3_0
04DB EB 07                           JMP     SHORT PR
04DD E4 82                   Z3:     IN      AL,MFG_PORT+2
04DF 24 0F                           AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
04E1 BC 0585 R                       MOV     SP,OFFSET Z4_0          ; RETURN TO Z4:

                             ;-----  CONVERT AND PRINT
                                                                     ; CONVERT 00-0F TO ASCII CHARACTER
04E4 04 90                   PR:     ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
04E6 27                              DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
04E7 14 40                           ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
04E9 27                              DAA                             ; ADJUST HIGH NIBBLE TO ASCII RANGE

04EA 88 05                           MOV     [DI],AL                 ; WRITE TO COLOR BUFFER
04EC 26: 88 05                       MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04EF 47                              INC     DI                      ; POINT TO NEXT POSITION
04F0 47                              INC     DI
04F1 C3                              RET

                             ;-----  DISPLAY 201 ERROR

04F2 B0 20                   Z4:     MOV     AL,' '                  ; DISPLAY A BLANK
04F4 88 05                           MOV     [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04F6 26: 88 05                       MOV     ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
04F9 47                              INC     DI                      ; POINT TO NEXT POSITION
04FA 47                              INC     DI
04FB B0 32                           MOV     AL,'2'                  ; DISPLAY 201 ERROR
```

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04FD 88 05                              MOV      [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
04FF 26: 88 05                          MOV      ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
0502 47                                 INC      DI                      ; POINT TO NEXT POSITION
0503 47                                 INC      DI
0504 B0 30                              MOV      AL,'0'
0506 88 05                              MOV      [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
0508 26: 88 05                          MOV      ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER
050B 47                                 INC      DI                      ; POINT TO NEXT POSITION
050C 47                                 INC      DI
050D B0 31                              MOV      AL,'1'
050F 88 05                              MOV      [DI],AL                 ; WRITE TO DISPLAY REGEN BUFFER
0511 26: 88 05                          MOV      ES:[DI],AL              ; WRITE TO MONOCHROME BUFFER

                              ;-----    ROLL ERROR CODE IN MFG_PORT --> FIRST THE CHECKPOINT

0514 B0 DD                    C31_0:    MOV      AL,0DDH                 ;       <><><><><><><><><><><><>
0516 E6 80                              OUT      MFG_PORT,AL             ;       <><> CHECKPOINT  DD <><>
0518 E6 83                              OUT      MFG_PORT+3,AL           ; ALSO DISPLAY CHECK POINT IN PORT 83
051A 2B C9                              SUB      CX,CX
051C                          C31_A:

051C 2B C0                              SUB      AX,AX                   ; SETUP SEGMENT
051E 8E D8                              MOV      DS,AX
0520 B8 AA55                            MOV      AX,0AA55H               ; WRITE AN AA55
0523 2B FF                              SUB      DI,DI
0525 89 05                              MOV      [DI],AX
0527 8B 05                              MOV      AX,[DI]                 ; READ THE FIRST WORD
0529 E2 F1                              LOOP     C31_A                   ; DISPLAY CHECKPOINT LONGER
052B                          C31_B:
052B 89 05                              MOV      [DI],AX
052D 8B 05                              MOV      AX,[DI]
052F E2 FA                              LOOP     C31_B
0531                          C31_C:
0531 89 05                              MOV      [DI],AX
0533 8B 05                              MOV      AX,[DI]
0535 E2 FA                              LOOP     C31_C
0537                          C31_D:
0537 89 05                              MOV      [DI],AX
0539 8B 05                              MOV      AX,[DI]
053B E2 FA                              LOOP     C31_D
053D                          C31_E:
053D 89 05                              MOV      [DI],AX
053F 8B 05                              MOV      AX,[DI]
0541 E2 FA                              LOOP     C31_E

                              ;-----    ROLL ERROR CODE IN MFG_PORT --> NEXT THE HIGH BYTE

0543 E4 81                              IN       AL,MFG_PORT+1           ; XOR OF FAILING BIT PATTERN
0545 E6 80                              OUT      MFG_PORT,AL             ; HIGH BYTE
0547                          C31_G:
0547 B8 AA55                            MOV      AX,0AA55H               ; WRITE AN AA55
054A 89 05                              MOV      [DI],AX
054C 8B 05                              MOV      AX,[DI]                 ; READ THE FIRST WORD
054E E2 F7                              LOOP     C31_G
0550                          C31_H:
0550 89 05                              MOV      [DI],AX
0552 8B 05                              MOV      AX,[DI]
0554 E2 FA                              LOOP     C31_H
0556                          C31_I:
0556 89 05                              MOV      [DI],AX
0558 8B 05                              MOV      AX,[DI]
055A E2 FA                              LOOP     C31_I

                              ;-----    ROLL ERROR CODE IN MFG_PORT --> THEN THE LOW BYTE

055C E4 82                              IN       AL,MFG_PORT+2           ; LOW BYTE
055E E6 80                              OUT      MFG_PORT,AL
0560 B8 AA55                            MOV      AX,0AA55H               ; WRITE AN AA55
0563 2B FF                    C31_K:    SUB      DI,DI
0565 89 05                              MOV      [DI],AX
0567 8B 05                              MOV      AX,[DI]                 ; READ THE FIRST WORD
0569 E2 F8                              LOOP     C31_K
056B                          C31_L:
056B 89 05                              MOV      [DI],AX
056D 8B 05                              MOV      AX,[DI]
056F E2 FA                              LOOP     C31_L
0571                          C31_M:
0571 89 05                              MOV      [DI],AX
0573 8B 05                              MOV      AX,[DI]
0575 E2 FA                              LOOP     C31_M
0577                          C31_N:
0577 89 05                              MOV      [DI],AX
0579 8B 05                              MOV      AX,[DI]
057B E2 FA                              LOOP     C31_N
057D EB 95                              JMP      C31_0                   ; DO AGAIN

057F 04C9 R                   Z1_0      DW       Z1                      ; TEMPORARY STACK
0581 04D2 R                   Z2_0      DW       Z2                      ; TEMPORARY STACK
0583 04DD R                   Z3_0      DW       Z3                      ; TEMPORARY STACK
0585 04F2 R                   Z4_0      DW       Z4                      ; TEMPORARY STACK


                              ;-----    CLEAR STORAGE ENTRY


0587                          CLR_STG:
                                        ASSUME   DS:DATA
0587 F3/ AB                             REP      STOSW                   ; STORE 32K WORDS OF 0000
0589 B8 ---- R                          MOV      AX,DATA                 ; RESTORE DATA SEGMENT
058C 8E D8                              MOV      DS,AX
058E 89 1E 0072 R                       MOV      @RESET_FLAG,BX          ; RESTORE RESET FLAG

                              ;-----    SETUP STACK SEGMENT AND SP

0592                          C33:
0592 B8 ---- R                          MOV      AX,DATA                 ; SET DATA SEGMENT
0595 8E D8                              MOV      DS,AX
0597 BC 0000                            MOV      SP,POST_SS              ; GET STACK VALUE
059A 8E D4                              MOV      SS,SP                   ; SET THE STACK UP
059C BC 8000                            MOV      SP,POST_SP              ; STACK IS READY TO GO

                              ;-----    INITIALIZE DISPLAY ROW COUNT

059F C6 06 0084 R 18                    MOV      @ROWS,25-1              ; SET ROWS FOR PRINT SCREEN DEFAULT
```

```

05A4 B0 11                            MOV     AL,11H                  ;       <><><><><><><><><><><><><>
05A6 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  11 <><>

                            ;-----    VERIFY SPEED/REFRESH CLOCK RATES  ( ERROR = 1 LONG AND 1 SHORT BEEP )

05A8 32 DB                            XOR     BL,BL                   ; CLEAR REFRESH CYCLE REPEAT COUNT
05AA 33 C9                            XOR     CX,CX                   ; INITIALIZE SPEED RATE REGISTER
                                      EVEN                            ; PLACE ON EVEN WORD BOUNDARY
05AC                        C34:
05AC E4 61                            IN      AL,PORT_B               ; READ REFRESH BIT REGISTER
05AE A8 10                            TEST    AL,REFRESH_BIT          ; MASK FOR BIT
05B0 E1 FA                            LOOPZ   C34                     ; DECREMENT LOOP COUNTER TILL ON
05B2                        C35:
05B2 E4 61                            IN      AL,PORT_B               ; READ REFRESH BIT REGISTER
05B4 A8 10                            TEST    AL,REFRESH_BIT          ; MASK FOR BIT
05B6 E0 FA                            LOOPNZ  C35                     ; DECREMENT LOOP COUNTER TILL OFF

05B8 FE CB                            DEC     BL                      ; DECREMENT REFRESH CYCLE REPEAT COUNT
05BA 75 F0                            JNZ     C34                     ; REPEAT TILL CYCLE COUNT DONE

05BC 81 F9 F780                       CMP     CX,RATE_UPPER           ; CHECK FOR RATE BELOW UPPER LIMIT
05C0 73 07                            JAE     C36                     ; SKIP ERROR BEEP IF BELOW MAXIMUM
05C2                        C36E:
05C2 BA 0101                          MOV     DX,0101H                ; GET BEEP COUNTS FOR REFRESH ERROR
05C5 E8 0000 E                        CALL    ERR_BEEP                ; CALL TO POST ERROR BEEP ROUTINES
05C8 F4                               HLT                             ; HALT SYSTEM - BAD REFRESH RATE
05C9                        C36:
05C9 81 F9 F9FD                       CMP     CX,RATE_LOWER           ; CHECK FOR RATE ABOVE LOWER LIMIT
05CD 77 F3                            JA      C36E                    ; GO TO ERROR BEEP IF BELOW MINIMUM

                            ;-----    GET THE INPUT BUFFER (SWITCH SETTINGS)

05CF E4 82                            IN      AL,DMA_PAGE+1           ; GET THE SWITCH SETTINGS
05D1 24 F8                            AND     AL,KEY_BD_INHIB+DSP_JMP+MFG_LOOP+BASE_MEM+BASE_MEM8 ; STRIP BITS
05D3 A2 0012 R                        MOV     @MFG_TST,AL             ; SAVE SETTINGS
05D6 2A C0                            SUB     AL,AL                   ; RESET DMA_PAGE
05D8 E6 82                            OUT     DMA_PAGE+1,AL

                            ;----------------------------------------
                            ; TEST.11A                               :
                            ;         VERIFY 286 LGDT/SGDT LIDT/SIDT :
                            ;         INSTRUCTIONS                   :
                            ; DESCRIPTION                            :
                            ;         LOAD GDT AND IDT REGISTERS WITH :
                            ;         AA,55,00 AND VERIFY CORRECT.   :
                            ;----------------------------------------

                            ;-----    VERIFY STATUS INDICATE COMPATIBILITY (REAL) MODE

                                      SMSW    AX                      ; GET THE CURRENT STATUS WORD
05DA 0F 01 E0             +           DB      00FH,001H,0E0H
05DD A9 000F                          TEST    AX,0FH                  ; PE/MP/EM/TS BITS SHOULD BE ZERO
05E0 75 34                            JNZ     ERR_PROT                ; GO IF STATUS NOT REAL MODE

                            ;-----    TEST PROTECTED MODE REGISTERS

05E2 B0 12                            MOV     AL,12H                  ;       <><><><><><><><><><><><><>
05E4 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  12 <><>

05E6 1E                               PUSH    DS                      ; SET ES TO SAME SEGMENT AS DS
05E7 07                               POP     ES
05E8 BF D0A0                          MOV     DI,SYS_IDT_LOC          ; USE THIS AREA TO BUILD TEST PATTERN
05EB B9 0003                          MOV     CX,3
05EE B8 AAAA                          MOV     AX,0AAAAH               ; FIRST PATTERN
05F1 E8 0619 R                        CALL    WRT_PAT
05F4 B8 5555                          MOV     AX,05555H
05F7 E8 0619 R                        CALL    WRT_PAT                 ; WRITE NEXT PATTERN
05FA 2B C0                            SUB     AX,AX                   ; WRITE 0
05FC E8 0619 R                        CALL    WRT_PAT

                            ;-----    TEST 286 CONTROL FLAGS

05FF FD                               STD                             ; SET DIRECTION FLAG FOR DECREMENT
0600 9C                               PUSHF                           ; GET THE FLAGS
0601 58                               POP     AX
0602 A9 0200                          TEST    AX,0200H                ; INTERRUPT FLAG SHOULD BE OFF
0605 75 0F                            JNZ     ERR_PROT                ; GO IF NOT
0607 A9 0400                          TEST    AX,0400H                ; CHECK DIRECTION FLAG
060A 74 0A                            JZ      ERR_PROT                ; GO IF NOT SET
060C FC                               CLD                             ; CLEAR DIRECTION FLAG
060D 9C                               PUSHF                           ; INSURE DIRECTION FLAG IS RESET
060E 58                               POP     AX
060F A9 0400                          TEST    AX,0400H
0612 75 02                            JNZ     ERR_PROT                ; GO IF NOT

0614 EB 3D                            JMP     SHORT C37A              ; TEST OK CONTINUE
0616                        ERR_PROT:
0616 F4                               HLT                             ; PROTECTED MODE REGISTER FAILURE
0617 EB FD                            JMP     SHORT ERR_PROT          ; INSURE NO BREAKOUT OF HALT

                            ;-----    WRITE TO 286 REGISTERS

0619 B9 0003                WRT_PAT:MOV     CX,3
061C F3/ AB                           REP     STOSW                   ; STORE 6 BYTES OF PATTERN
061E BD D0A0                          MOV     BP,SYS_IDT_LOC
                                      SEGOV   ES                      ; LOAD THE IDT
0621 26                   +           DB      026H
                                      LIDT    [BP]                    ; REGISTER FROM THIS AREA
0622 0F                   +           DB      00FH
0623                      + ??0001    LABEL   BYTE
0623 8B 5E 00             +           MOV     BX,WORD PTR [BP]
0626                      + ??0002    LABEL   BYTE
0623                      +           ORG     OFFSET CS:??0001
0623 01                   +           DB      001H
0626                      +           ORG     OFFSET CS:??0002
0626 BD D0A0                          MOV     BP,SYS_IDT_LOC
                                      SEGOV   ES                      ; LOAD THE GDT
0629 26                   +           DB      026H
                                      LGDT    [BP]                    ; FROM THE SAME AREA
062A 0F                   +           DB      00FH
062B                      + ??0004    LABEL   BYTE
062B 8B 56 00             +           MOV     DX,WORD PTR [BP]
062E                      + ??0005    LABEL   BYTE
```

SECTION 5

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062B                     +          ORG     OFFSET CS:??0004
062B 01                  +          DB      001H
062E                     +          ORG     OFFSET CS:??0005

                         ;-----     READ AND VERIFY 286 REGISTERS

062E BD D8A0                        MOV     BP,GDT_LOC              ; STORE THE REGISTERS HERE
                                    SEGOV   ES
0631 26                  +          DB      026H
                                    SIDT    [BP]                    ; GET THE IDT REGISTERS
0632 0F                  +          DB      00FH
0633                     + ??0007   LABEL   BYTE
0633 8B 4E 00            +          MOV     CX,[BP]
0636                     + ??0008   LABEL   BYTE
0633                     +          ORG     OFFSET CS:??0007
0633 01                  +          DB      001H
0636                     +          ORG     OFFSET CS:??0008
0636 BD D8A5                        MOV     BP,GDT_LOC+5
                                    SEGOV   ES
0639 26                  +          DB      026H
                                    SGDT    [BP]                    ; GET THE GDT REGISTERS
063A 0F                  +          DB      00FH
063B                     + ??000A   LABEL   BYTE
063B 03 46 00            +          ADD     AX,[BP]
063E                     + ??000B   LABEL   BYTE
063B                     +          ORG     OFFSET CS:??000A
063B 01                  +          DB      001H
063E                     +          ORG     OFFSET CS:??000B
063E BF D0A0                        MOV     DI,SYS_IDT_LOC
0641 8B 05                          MOV     AX,[DI]                 ; GET THE PATTERN WRITTEN
0643 B9 0005                        MOV     CX,5                    ; CHECK ALL REGISTERS
0646 BE D8A0                        MOV     SI,GDT_LOC              ; POINT TO THE BEGINNING
0649 26: 3B 04           C37B:      CMP     AX,ES:[SI]
064C 75 C8                          JNZ     ERR_PROT                ; HALT IF ERROR
064E 46                             INC     SI                      ; POINT TO NEXT WORD
064F 46                             INC     SI
0650 E2 F7                          LOOP    C37B                    ; CONTINUE TILL DONE
0652 C3                             RET

                         ;-------------------------------------------------------
                         ;          INITIALIZE THE 8259 INTERRUPT #1 CONTROLLER CHIP :
                         ;-------------------------------------------------------
0653                     C37A:
0653 2A C0                          SUB     AL,AL                   ; RESET MATH PROCESSOR
0655 E6 F1                          OUT     X287+1,AL
0657 B0 11                          MOV     AL,11H                  ; ICW1 - EDGE, MASTER, ICW4
0659 E6 20                          OUT     INTA00,AL
065B EB 00                          JMP     $+2                     ; I/O DELAY
065D B0 08                          MOV     AL,8                    ; SETUP ICW2 - INTERRUPT TYPE 8 (8-F)
065F E6 21                          OUT     INTA01,AL
0661 EB 00                          JMP     $+2                     ; I/O DELAY

0663 B0 04                          MOV     AL,04H                  ; SETUP ICW3 - MASTER LEVEL 2
0665 E6 21                          OUT     INTA01,AL
0667 EB 00                          JMP     $+2                     ; I/O DELAY
0669 B0 01                          MOV     AL,01H                  ; SETUP ICW4 - MASTER,8086 MODE
066B E6 21                          OUT     INTA01,AL
066D EB 00                          JMP     $+2                     ; I/O DELAY
066F B0 FF                          MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
0671 E6 21                          OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTERRUPTS)

                         ;-------------------------------------------------------
                         ;          INITIALIZE THE 8259 INTERRUPT #2 CONTROLLER CHIP  :
                         ;-------------------------------------------------------

0673 B0 13                          MOV     AL,13H                  ;       <><><><><><><><><><><><>
0675 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  13 <><>

0677 B0 11                          MOV     AL,11H                  ; ICW1 - EDGE, SLAVE ICW4
0679 E6 A0                          OUT     INTB00,AL
067B EB 00                          JMP     $+2                     ; I/O DELAY
067D B0 70                          MOV     AL,INT_TYPE             ; SETUP ICW2 - INTERRUPT TYPE 70 (70-7F)
067F E6 A1                          OUT     INTB01,AL
0681 B0 02                          MOV     AL,02H                  ; SETUP ICW3 - SLAVE LEVEL 2
0683 EB 00                          JMP     $+2
0685 E6 A1                          OUT     INTB01,AL
0687 EB 00                          JMP     $+2                     ; I/O DELAY
0689 B0 01                          MOV     AL,01H                  ; SETUP ICW4 - 8086 MODE, SLAVE
068B E6 A1                          OUT     INTB01,AL
068D EB 00                          JMP     $+2                     ; I/O DELAY
068F B0 FF                          MOV     AL,0FFH                 ; MASK ALL INTERRUPTS OFF
0691 E6 A1                          OUT     INTB01,AL

                         ;-----     SET UP THE INTERRUPT VECTORS TO TEMPORARY INTERRUPT

0693 B0 14                          MOV     AL,14H                  ;       <><><><><><><><><><><><>
0695 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  14 <><>

0697 B9 0078                        MOV     CX,78H                  ; FILL ALL INTERRUPT LOCATIONS
069A 2B FF                          SUB     DI,DI                   ; FIRST INTERRUPT LOCATION
069C 8E C7                          MOV     ES,DI                   ; SET (ES) ALSO
069E B8 0000 E           D3:        MOV     AX,OFFSET D11           ; GET ADDRESS OF INTERRUPT OFFSET
06A1 AB                             STOSW                           ; PLACE IN INTERRUPT VECTOR LOCATION
06A2 8C C8                          MOV     AX,CS                   ; GET THE CURRENT CODE SEGMENT
06A4 AB                             STOSW                           ; PLACE CODE SEGMENT IN VECTOR LOCATION
06A5 E2 F7                          LOOP    D3

                         ;-----     ESTABLISH BIOS SUBROUTINE CALL INTERRUPT VECTORS

06A7 B0 15                          MOV     AL,15H                  ;       <><><><><><><><><><><><>
06A9 E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  15 <><>


06AB BF 0040 R                      MOV     DI,OFFSET @VIDEO_INT    ; SET VIDEO INTERRUPT AREA
06AE 0E                             PUSH    CS
06AF 1F                             POP     DS                      ; SET UP ADDRESS OF VECTOR TABLE
                         ;          MOV     AX,DS                   ; SET AX=SEGMENT
06B0 BE 0010 E                      MOV     SI,OFFSET VECTOR_TABLE+16 ;START WITH VIDEO ENTRY
06B3 B9 0010                        MOV     CX,16

06B6 A5                  D3A:       MOVSW                           ; MOVE VECTOR TABLE TO LOW MEMORY
06B7 47                             INC     DI
06B8 47                             INC     DI                      ; SKIP SEGMENT POINTER
06B9 E2 FB                          LOOP    D3A
```

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                              ;--------------------------------------
                              ; TEST.12                             :
                              ;         VERIFY CMOS CHECKSUM/BATTERY OK :
                              ; DESCRIPTION                         :
                              ;         DETERMINE IF CONFIG RECORD  :
                              ;         CAN BE USED FOR INITIALIZATION. :
                              ;--------------------------------------

                                      ASSUME  DS:DATA
06BB E8 0000 E                        CALL    DDS                       ; SET THE DATA SEGMENT

06BE B0 16                            MOV     AL,16H                    ;       <><><><><><><><><><><><><>
06C0 E6 80                            OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  16 <><>

                              ;-----  IS THE BATTERY LOW THIS POWER UP?

06C2 B0 8D                            MOV     AL,CMOS_REG_D+NMI         ; CHECK BATTERY CONDITION
06C4 E8 0000 E                        CALL    CMOS_READ                 ; READ THE BATTERY STATUS
06C7 A8 80                            TEST    AL,10000000B              ; IS THE BATTERY LOW?
06C9 74 0B                            JZ      CMOS1A                    ; ERROR IF YES

06CB B0 8E                            MOV     AL,CMOS_DIAG+NMI          ; GET THE OLD STATUS
06CD E8 0000 E                        CALL    CMOS_READ                 ; FROM DIAGNOSTIC STATUS BYTE
06D0 A8 80                            TEST    AL,BAD_BAT                ; HAS CUSTOMER SETUP BEEN EXECUTED?
06D2 74 15                            JZ      CMOS1                     ; GO CHECK CHECKSUM IF YES

06D4 EB 64                            JMP     SHORT CMOS4               ; CONTINUE WITHOUT CONFIGURATION

                              ;-----  SET DEFECTIVE BATTERY FLAG

06D6 B0 17                    CMOS1A: MOV     AL,17H                    ;       <><><><><><><><><><><><><>
06D8 E6 80                            OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  17 <><>

06DA B8 8E8E                          MOV     AX,X*(CMOS_DIAG+NMI)      ; CMOS DIAGNOSTIC STATUS BYTE
06DD E8 0000 E                        CALL    CMOS_READ                 ; GET THE CURRENT STATUS
06E0 0C 80                            OR      AL,BAD_BAT                ; SET THE DEAD BATTERY FLAG
06E2 86 C4                            XCHG    AL,AH                     ; SAVE
06E4 E8 0000 E                        CALL    CMOS_WRITE                ; OUTPUT THE STATUS
06E7 EB 51                            JMP     SHORT  CMOS4              ; GO TO MINIMUM CONFIGURATION

                              ;-----  VERIFY CHECKSUM

06E9 B8 8E8E                  CMOS1:  MOV     AX,X*(CMOS_DIAG+NMI)      ; CLEAR OLD STATUS
06EC E8 0000 E                        CALL    CMOS_READ                 ; GET THE CURRENT STATUS
06EF 81 3E 0072 R 1234                CMP     @RESET_FLAG,1234H         ; IS THIS A SOFT RESET
06F5 75 04                            JNZ     CMOS1_A                   ; GO IF NOT

06F7 24 10                            AND     AL,W_MEM_SIZE             ; CLEAR ALL BUT THE CMOS/POR MEMORY SIZE
06F9 EB 02                            JMP     SHORT CMOS1_B
06FB                          CMOS1_A:
06FB 2A C0                            SUB     AL,AL                     ; CLEAR STATUS IF POWER ON RESET
06FD                          CMOS1_B:
06FD 86 C4                            XCHG    AL,AH                     ; SAVE THE CURRENT STATUS
06FF E8 0000 E                        CALL    CMOS_WRITE

0702 2B DB                            SUB     BX,BX
0704 2B C9                            SUB     CX,CX
0706 B1 90                            MOV     CL,CMOS_DISKETTE+NMI      ; SET START OF CMOS CHECKSUMED AREA
0708 B5 AE                            MOV     CH,CMOS_CKSUM_HI+NMI      ; SET END OF CMOS CHECKSUMED AREA +1
                                                                        ;  (FIRST BYTE OF CHECKSUM)
070A 8A C1                    CMOS2:  MOV     AL,CL
070C E8 0000 E                        CALL    CMOS_READ                 ; ADDRESS THE BEGINNING
070F 2A E4                            SUB     AH,AH                     ; INSURE AH=0
0711 03 D8                            ADD     BX,AX                     ; ADD TO CURRENT VALUE
0713 FE C1                            INC     CL                        ; POINT TO NEXT BYTE ADDRESS IN CMOS
0715 3A E9                            CMP     CH,CL                     ; FINISHED?  (AT CHECKSUM BYTE HIGH)
0717 75 F1                            JNZ     CMOS2                     ; GO IF NOT
0719 0B DB                            OR      BX,BX                     ; BX MUST NOT BE 0
071B 74 10                            JZ      CMOS3                     ; CMOS BAD IF CHECKSUM=0
071D B0 AE                            MOV     AL,CMOS_CKSUM_HI+NMI      ; GET THE CHECK SUM HIGH BYTE
071F E8 0000 E                        CALL    CMOS_READ                 ; FIRST BYTE OF CHECKSUM
0722 8A E0                            MOV     AH,AL                     ; SAVE IT
0724 B0 AF                            MOV     AL,CMOS_CKSUM_LO+NMI      ; SECOND BYTE OF CHECKSUM
0726 E8 0000 E                        CALL    CMOS_READ
0729 3B C3                            CMP     AX,BX                     ; IS THE CHECKSUM OK
072B 74 0D                            JZ      CMOS4                     ; GO IF YES

                              ;-----  SET CMOS CHECKSUM ERROR

072D B8 8E8E                  CMOS3:  MOV     AX,X*(CMOS_DIAG+NMI)      ; ADDRESS DIAGNOSTIC STATUS
0730 E8 0000 E                        CALL    CMOS_READ                 ; GET THE CURRENT STATUS
0733 0C 40                            OR      AL,BAD_CKSUM              ; SET BAD CHECKSUM FLAG
0735 86 C4                            XCHG    AL,AH                     ; SAVE IT
0737 E8 0000 E                        CALL    CMOS_WRITE                ; SET FLAG

                              ;-----  INSURE CMOS DIVIDERS SET

073A                          CMOS4:
073A B8 8A8A                          MOV     AX,X*(CMOS_REG_A+NMI)     ; ADDRESS CMOS REGISTER A
073D E8 0000 E                        CALL    CMOS_READ                 ; GET CURRENT DIVISORS
0740 24 0F                            AND     AL,00FH                   ; LOOK AT PERIODIC RATE BITS
0742 75 07                            JNZ     CMOS9                     ; EXIT IF SET TO SOMETHING USEFUL

0744 B0 26                            MOV     AL,26H                    ; ELSE SET THE STANDARD DEFAULT USED BY
0746 86 C4                            XCHG    AL,AH                     ;  BIOS FOR THE 976.56 US RATE
0748 E8 0000 E                        CALL    CMOS_WRITE                ;  FOR THE PERIODIC CLOCK
074B                          CMOS9:
074B B0 18                            MOV     AL,18H                    ;       <><><><><><><><><><><><><>
074D E6 80                            OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  18 <><>

                              ;-----  ENABLE PROTECTED MODE

074F E4 61                            IN      AL,PORT_B                 ; DISABLE MEMORY AND I/O PARITY CHECKS
0751 0C 0C                            OR      AL,RAM_PAR_OFF
0753 E6 61                            OUT     PORT_B,AL

                              ;-----  SET RETURN ADDRESS BYTE IN CMOS

0755 B0 19                            MOV     AL,19H                    ;       <><><><><><><><><><><><><>
0757 E6 80                            OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  19 <><>

0759 B8 018F                          MOV     AX,1*H+(CMOS_SHUT_DOWN+NMI)  ; SET THE RETURN ADDRESS FOR
075C E8 0000 E                        CALL    CMOS_WRITE                ; THE FIRST SHUTDOWN RETURN ADDRESS
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075F BC 0000                            MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
0762 8E D4                              MOV     SS,SP
0764 BC 8000                            MOV     SP,POST_SP
0767 E8 0000 E                          CALL    SYSINIT1                ; CALL THE DESCRIPTOR TABLE BUILDER
                                                                        ; AND REAL-TO-PROTECTED MODE SWITCHER

076A B0 1A                              MOV     AL,1AH                  ;       <><><><><><><><><><><><><>
076C E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1A <><>

                                ;-----  SET TEMPORARY STACK

076E 6A 08                              PUSH    BYTE PTR GDT_PTR        ; SET (DS:) SELECTOR TO GDT SEGMENT
0770 1F                                 POP     DS
0771 C7 06 005A 0000                    MOV     DS:SS_TEMP.BASE_LO_WORD,0
0777 C6 06 005C 00                      MOV     BYTE PTR DS:(SS_TEMP.BASE_HI_BYTE),0
077C BE 0058                            MOV     SI,SS_TEMP
077F 8E D6                              MOV     SS,SI
0781 BC FFFD                            MOV     SP,MAX_SEG_LEN-2

                                ;--------------------------------------------------------------------------------
                                ; TEST.13                                                                        :
                                ;  PROTECTED MODE TEST AND MEMORY SIZE DETERMINE  ( 0 --> 640K )                 :
                                ;                                                                                :
                                ; DESCRIPTION:                                                                   :
                                ;       THIS ROUTINE RUNS IN PROTECTED MODE IN ORDER TO ADDRESS ALL OF STORAGE.  :
                                ;       IT CHECKS THE MACHINE STATUS WORD (MSW) FOR PROTECTED MODE AND THE BASE  :
                                ;       MEMORY SIZE IS DETERMINED AND SAVED.  BIT 4 OF THE CMOS DIAGNOSTIC       :
                                ;       STATUS BYTE IS SET IF 512K --> 640K MEMORY IS INSTALLED.                 :
                                ;       DURING A POWER UP SEQUENCE THE MEMORY SIZE DETERMINE IS DONE WITH        :
                                ;       PLANAR AND I/O PARITY CHECKS DISABLED.  DURING A SOFT RESET THE MEMORY   :
                                ;       SIZE DETERMINE WILL CHECK FOR PARITY ERRORS.                             :
                                ;--------------------------------------------------------------------------------

                                ;-----  INSURE PROTECTED MODE

                                        SMSW    AX                      ; GET THE MACHINE STATUS WORD
0784 0F 01 E0                  +        DB      00FH,001H,0E0H
0787 A9 0001                            TEST    AX,VIRTUAL_ENABLE       ; ARE WE IN PROTECTED MODE
078A 75 0C                              JNZ     VIR_OK

078C B8 088F                    SHUT_8: MOV     AX,8*H+(CMOS_SHUT_DOWN+NMI)     ; SET THE RETURN ADDRESS
078F E8 0000 E                          CALL    CMOS_WRITE              ; AND SET SHUTDOWN 8
0792 E9 0000 E                          JMP     PROC_SHUTDOWN           ; CAUSE A SHUTDOWN

                                ;-----  VIRTUAL MODE ERROR HALT

0795 F4                         SHUT8:  HLT
0796 EB FD                              JMP     SHUT8                   ; ERROR HALT

                                ;-----  64K SEGMENT LIMIT

0798 C7 06 0048 FFFF            VIR_OK: MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN

                                ;-----  CPL0, DATA ACCESS RIGHTS

079E C6 06 004D 93                      MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                                ;-----  START WITH SEGMENT ADDRESS 01-0000 (SECOND 64K)

07A3 C6 06 004C 01                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),01H
07A8 C7 06 004A 0000                    MOV     DS:ES_TEMP.BASE_LO_WORD,0H

07AE B0 1B                              MOV     AL,1BH                  ;       <><><><><><><><><><><><><>
07B0 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1B <><>

07B2 BB 0040                            MOV     BX,16*4                 ; SET THE FIRST 64K DONE

                                ;-----  START STORAGE SIZE/CLEAR

07B5                            NOT_DONE:
07B5 6A 48                              PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
07B7 07                                 POP     ES                      ; POINT TO SEGMENT TO TEST
07B8 E8 07D4 R                          CALL    HOW_BIG                 ; DO THE FIRST 64K
07BB 74 03                              JZ      NOT_FIN                 ; CHECK IF TOP OF MEMORY
07BD E9 0872 R                          JMP     DONE

07C0                            NOT_FIN:
07C0 83 C3 40                           ADD     BX,16*4                 ; BUMP MEMORY COUNT BY 64K

                                ;-----  DO NEXT 64K (0X0000) BLOCK

07C3 FE 06 004C                         INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                                ;-----  CHECK FOR END OF FIRST 640K (END OF BASE MEMORY)

07C7 80 3E 004C 0A                      CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0AH
07CC 75 E7                              JNZ     NOT_DONE                ; GO IF NOT
07CE E8 084F R                          CALL    HOW_BIG_END             ; GO SET MEMORY SIZE
07D1 E9 0872 R                          JMP     DONE

                                ;-----  FILL/CHECK LOOP

07D4                            HOW_BIG:
07D4 2B FF                              SUB     DI,DI
07D6 B8 AA55                            MOV     AX,0AA55H               ; TEST PATTERN
07D9 8B C8                              MOV     CX,AX                   ; SAVE PATTERN
07DB 26: 89 05                          MOV     ES:[DI],AX              ; WRITE PATTERN TO MEMORY
07DE B0 0F                              MOV     AL,0FH                  ; PUT SOMETHING IN AL
07E0 26: 8B 05                          MOV     AX,ES:[DI]              ; GET PATTERN
07E3 26: 89 05                          MOV     ES:[DI],AX              ; INSURE NO PARITY I/O CHECK
07E6 33 C1                              XOR     AX,CX                   ; COMPARE PATTERNS
07E8 75 65                              JNZ     HOW_BIG_END             ; GO END IF NO COMPARE

07EA 1E                                 PUSH    DS
07EB 6A 18                              PUSH    BYTE PTR RSDA_PTR       ; POINT TO SYSTEM DATA AREA
07ED 1F                                 POP     DS                      ; GET (DS:)

                                ;-----  IS THIS A SOFT RESET

07EE 81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; SOFT RESET
07F4 1F                                 POP     DS                      ; RESTORE DS
07F5 75 36                              JNZ     HOW_BIG_2               ; GO IF NOT SOFT RESET

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                                ;-----  INSURE NO PARITY WITH PARITY BITS OFF

07F7 26: C7 05 0101                     MOV     WORD PTR ES:[DI],0101H  ; TURN OFF BOTH PARITY BITS

07FC E4 61                              IN      AL,PORT_B
07FE 0C 0C                              OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
0800 E6 61                              OUT     PORT_B,AL
0802 24 F3                              AND     AL,RAM_PAR_ON
0804 E6 61                              OUT     PORT_B,AL
0806 6A FF                              PUSH    BYTE PTR 0FFH           ; PLACE 0FFFFH IN STACK (BUS BITS ON)
0808 58                                 POP     AX                      ; DELAY - CAUSING BUS BITS ON
0809 26: 8B 05                          MOV     AX,ES:[DI]              ; CHECK PARITY

080C E4 61                              IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
080E 24 C0                              AND     AL,PARITY_ERR
0810 26: 89 05                          MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
0813 75 3A                              JNZ     HOW_BIG_END             ; GO IF PLANAR OR I/O PARITY CHECK

                                ;-----  CHECK ALL BITS WRITE OK

0815 26: C7 05 FFFF                     MOV     WORD PTR ES:[DI],0FFFFH ; TURN ON ALL BITS
081A 26: 8B 05                          MOV     AX,ES:[DI]              ; CHECK FOR FFFFH
081D 50                                 PUSH    AX                      ; SAVE RESULTS
081E E4 61                              IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
0820 24 C0                              AND     AL,PARITY_ERR
0822 26: 89 05                          MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
0825 58                                 POP     AX                      ; GET RESULTS
0826 75 27                              JNZ     HOW_BIG_END             ; GO IF PARITY CHECK
0828 3D FFFF                            CMP     AX,0FFFFH
082B 75 22                              JNZ     HOW_BIG_END

                                ;-----  CHECK 64K BLOCK FOR PARITY CHECK

082D                            HOW_BIG_2:
082D 2B C0                              SUB     AX,AX                   ; WRITE ZEROS
082F B9 8000                            MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
0832 F3/ AB                             REP     STOSW                   ; FILL 32K WORDS

0834 1E                                 PUSH    DS
0835 06                                 PUSH    ES
0836 06                                 PUSH    ES                      ; GET ES TO DS
0837 1F                                 POP     DS
0838 B9 8000                            MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
083B 2B F6                              SUB     SI,SI
083D F3/ AD                             REP     LODSW
083F 2B FF                              SUB     DI,DI                   ; SET TO BEGINNING OF BLOCK
0841 E4 61                              IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
0843 24 C0                              AND     AL,PARITY_ERR
0845 26: C7 05 0000                     MOV     WORD PTR ES:[DI],0      ; CLEAR POSSIBLE PARITY ERROR
084A 07                                 POP     ES                      ; RESTORE SEGMENTS
084B 1F                                 POP     DS
084C 75 01                              JNZ     HOW_BIG_END             ; GO IF PLANAR OR I/O PARITY CHECK

084E C3                                 RET

084F                            HOW_BIG_END:
084F 9C                                 PUSHF                           ; SAVE THE CURRENT FLAGS
0850 B0 1C                              MOV     AL,1CH                  ;       <><><><><><><><><><><>
0852 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1C <><>

                                ;-----  SET OR RESET 512 TO 640 INSTALLED FLAG

0854 B8 B3B3                            MOV     AX,X*(CMOS_INFO128+NMI) ; SET/RESET 640K STATUS FLAG
0857 E8 0000 E                          CALL    CMOS_READ               ; GET THE DIAGNOSTIC STATUS
085A 0C 80                              OR      AL,M640K
085C 81 FB 0200                         CMP     BX,512                  ; CHECK MEMORY SIZE
0860 77 02                              JA      K640                    ; SET FLAG FOR 512 -> 640 INSTALLED
0862 24 7F                              AND     AL,NOT M640K
0864                            K640:
0864 86 C4                              XCHG    AL,AH                   ; SAVE THE STATUS
0866 E8 0000 E                          CALL    CMOS_WRITE              ; RESTORE THE STATUS

0869 6A 18                              PUSH    BYTE PTR RSDA_PTR       ; RESTORE THE DATA SEGMENT
086B 1F                                 POP     DS
086C 89 1E 0013 R                       MOV     @MEMORY_SIZE,BX         ; SAVE MEMORY SIZE
0870 9D                                 POPF                            ; RESTORE THE FLAG REGISTER
0871 C3                                 RET

                                ;--------------------------------------------------------------------------
                                ; TEST.13A                                                                :
                                ;  PROTECTED MODE TEST AND MEMORY SIZE DETERMINE  ( ABOVE 1024K )         :
                                ;                                                                         :
                                ; DESCRIPTION:                                                            :
                                ;       THIS ROUTINE RUNS IN PROTECTED MODE IN ORDER TO ADDRESS ABOVE 1 MEG.  :
                                ;       THE MEMORY SIZE IS DETERMINED AND SAVED IN CMOS.                  :
                                ;       DURING A POWER UP SEQUENCE THE MEMORY SIZE DETERMINE IS DONE WITH :
                                ;       PLANAR AND I/O PARITY CHECKS DISABLED.  DURING A SOFT RESET THE MEMORY :
                                ;       SIZE DETERMINE WILL CHECK FOR PARITY ERRORS.                      :
                                ;--------------------------------------------------------------------------

0872                            DONE:
0872 6A 08                              PUSH    BYTE PTR GDT_PTR        ; POINT DS TO THE DESCRIPTOR TABLE
0874 1F                                 POP     DS

                                ;-----  START WITH SEGMENT ADDRESS 10-0000 (ONE MEG AND ABOVE)

0875 C6 06 004C 10                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H
087A C7 06 004A 0000                    MOV     DS:ES_TEMP.BASE_LO_WORD,0H

0880 B0 1D                              MOV     AL,1DH                  ;       <><><><><><><><><><><>
0882 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1D <><>

0884 2B DB                              SUB     BX,BX                   ; START WITH COUNT 0

                                ;-----  START STORAGE SIZE/CLEAR

0886                            NOT_DONE1:
0886 6A 48                              PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0888 07                                 POP     ES                      ; POINT TO SEGMENT TO TEST
0889 E8 08A5 R                          CALL    HOW_BIG1                ; DO THE FIRST 64K
088C 74 03                              JZ      DONEA                   ; CHECK IF TOP

088E E9 092C R                          JMP     DONE1                   ; GO IF TOP
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0891 83 C3 40              DONEA:  ADD     BX,16*4                 ; BUMP MEMORY COUNT BY 64K

                           ;-----  DO NEXT 64K (XX0000) BLOCK

0894 FE 06 004C                    INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                           ;-----  CHECK FOR TOP OF MEMORY (FE0000)

0898 80 3E 004C FE                 CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0FEH ; LAST OF MEMORY?
089D 75 E7                         JNZ     NOT_DONE1                               ; GO IF NOT
089F E8 0919 R                     CALL    HOW_BIG_END1                            ; GO SET MEMORY SIZE
08A2 E9 092C R                     JMP     DONE1

                           ;-----  FILL/CHECK LOOP

08A5                       HOW_BIG1:
08A5 2B FF                         SUB     DI,DI
08A7 B8 AA55                       MOV     AX,0AA55H               ; TEST PATTERN
08AA 8B C8                         MOV     CX,AX                   ; SAVE PATTERN
08AC 26: 89 05                     MOV     ES:[DI],AX              ; SEND PATTERN TO MEMORY
08AF B0 0F                         MOV     AL,0FH                  ; PUT SOMETHING IN AL
08B1 26: 8B 05                     MOV     AX,ES:[DI]              ; GET PATTERN
08B4 26: 89 05                     MOV     ES:[DI],AX              ; INSURE NO PARITY I/O CHECK
08B7 33 C1                         XOR     AX,CX                   ; COMPARE PATTERNS
08B9 75 5E                         JNZ     HOW_BIG_END1            ; GO END IF NO COMPARE

                           ;-----  IS THIS A SOFT RESET

08BB 1E                            PUSH    DS
08BC 6A 18                         PUSH    BYTE PTR RSDA_PTR       ; POINT TO SYSTEM DATA AREA
08BE 1F                            POP     DS
08BF 81 3E 0072 R 1234             CMP     @RESET_FLAG,1234H       ; SOFT RESET
08C5 1F                            POP     DS                      ; RESTORE DS
08C6 75 2F                         JNZ     HOW_BIG_2A              ; GO IF NOT SOFT RESET

                           ;-----  CHECK PARITY WITH PARITY BITS OFF

08C8 26: C7 05 0101                MOV     WORD PTR ES:[DI],0101H  ; TURN OFF BOTH PARITY BITS
08CD 6A FF                         PUSH    BYTE PTR 0FFH           ; PLACE 0FFFFH IN STACK (BUS BITS ON)
08CF 58                            POP     AX                      ; DELAY - CAUSING BUS BITS ON
08D0 26: 8B 05                     MOV     AX,ES:[DI]              ; CHECK PARITY

08D3 E4 61                         IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
08D5 24 C0                         AND     AL,PARITY_ERR
08D7 26: 89 05                     MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
08DA 75 3D                         JNZ     HOW_BIG_END1            ; GO IF PLANAR OR I/O PARITY CHECK

                           ;-----  CHECK ALL BITS

08DC 26: C7 05 FFFF                MOV     WORD PTR ES:[DI],0FFFFH ; TURN ON ALL BITS
08E1 6A 00                         PUSH    BYTE PTR 0              ; PLACE 00000H IN STACK (BUS BITS OFF)
08E3 58                            POP     AX                      ; DELAY - CAUSING BUS BITS OFF
08E4 26: 8B 05                     MOV     AX,ES:[DI]              ; CHECK FOR FFFFH
08E7 50                            PUSH    AX                      ; SAVE RESULTS
08E8 E4 61                         IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
08EA 24 C0                         AND     AL,PARITY_ERR
08EC 26: 89 05                     MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY ERROR
08EF 58                            POP     AX                      ; GET RESULTS
08F0 75 27                         JNZ     HOW_BIG_END1            ; GO IF PLANAR OR I/O PARITY CHECK
08F2 3D FFFF                       CMP     AX,0FFFFH
08F5 75 22                         JNZ     HOW_BIG_END1

                           ;-----  CLEAR 64K BLOCK OF MEMORY

08F7                       HOW_BIG_2A:
08F7 2B C0                         SUB     AX,AX                   ; WRITE ZEROS
08F9 B9 8000                       MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
08FC F3/ AB                        REP     STOSW                   ; FILL 32K WORDS

                           ;-----  CHECK 64K BLOCK FOR PARITY CHECK (VALID TEST DURING SOFT RESET ONLY)

08FE 1E                            PUSH    DS
08FF 06                            PUSH    ES
0900 06                            PUSH    ES                      ; GET ES TO DS
0901 1F                            POP     DS
0902 B9 8000                       MOV     CX,2000H*4              ; SET COUNT FOR 32K WORDS
0905 2B F6                         SUB     SI,SI
0907 F3/ AD                        REP     LODSW
0909 2B FF                         SUB     DI,DI                   ; SET TO BEGINNING OF BLOCK
090B E4 61                         IN      AL,PORT_B               ; CHECK FOR PLANAR OR I/O PARITY CHECK
090D 24 C0                         AND     AL,PARITY_ERR
090F 26: C7 05 0000                MOV     WORD PTR ES:[DI],0      ; CLEAR POSSIBLE PARITY ERROR
0914 07                            POP     ES                      ; RESTORE SEGMENT
0915 1F                            POP     DS
0916 75 01                         JNZ     HOW_BIG_END1            ; GO IF PLANAR OR I/O PARITY CHECK

0918 C3                            RET

0919                       HOW_BIG_END1:
0919 B0 1E                         MOV     AL,1EH                  ;       <><><><><><><><><><><><><>
091B E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1E <><>

                           ;-----  SET EXPANSION MEMORY SIZE DETERMINED IN CMOS

091D B0 B0                         MOV     AL,CMOS_U_M_S_LO+NMI    ; ADDRESS LOW BYTE
091F 8A E3                         MOV     AH,BL                   ; GET LOW MEMORY SIZE
0921 E8 0000 E                     CALL    CMOS_WRITE              ; SET LOW BYTE
0924 B0 B1                         MOV     AL,CMOS_U_M_S_HI+NMI    ; ADDRESS HI BYTE
0926 8A E7                         MOV     AH,BH                   ; GET THE HIGH MEMORY SIZE
0928 E8 0000 E                     CALL    CMOS_WRITE              ; PLACE IN CMOS
092B C3                            RET

                           ;-----  TEST ADDRESS LINES 19 - 23

092C B0 1F                 DONE1:  MOV     AL,1FH                  ;       <><><><><><><><><><><><><>
092E E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  1F <><>
0930 C6 06 004C 00                 MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),00H
0935 2B FF                         SUB     DI,DI                   ; SET LOCATION POINTER TO ZERO
0937 BA FFFF                       MOV     DX,0FFFFH               ; WRITE FFFF AT ADDRESS 0
093A E8 0969 R                     CALL    SD0
093D 2B D2                         SUB     DX,DX                   ; WRITE 0

093F C6 06 004C 08                 MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),08H
0944 E8 0969 R                     CALL    SD0
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0947 C6 06 004C 10                   MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H
094C E8 0969 R                       CALL    SDO
094F C6 06 004C 20                   MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),20H
0954 E8 0969 R                       CALL    SDO
0957 C6 06 004C 40                   MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),40H
095C E8 0969 R                       CALL    SDO
095F C6 06 004C 80                   MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),80H
0964 E8 0969 R                       CALL    SDO

0967 EB 18                           JMP     SHORT SD2               ; TEST PASSED CONTINUE

0969                         SDO:
0969 6A 48                           PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
096B 07                              POP     ES                      ; POINT TO SEGMENT TO TEST
096C 26: 89 15                       MOV     ES:[DI],DX              ; WRITE THE PATTERN

096F C6 06 004C 00                   MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),00H

0974 6A 48                           PUSH    BYTE PTR ES_TEMP        ; POINT ES TO DATA
0976 07                              POP     ES                      ; POINT TO SEGMENT TO TEST
0977 26: 83 3D FF                    CMP     WORD PTR ES:[DI],0FFFFH ; DID LOCATION 0 CHANGE?
097B 74 03                           JZ      SD1                     ; CONTINUE IF NOT
097D E9 078C R                       JMP     SHUT_8                  ; GO HALT IF YES
0980                         SD1:
0980 C3                              RET

                             ;----- CAUSE A SHUTDOWN

0981 B0 20                   SD2:    MOV     AL,20H                  ;       <><><><><><><><><><><><><>
0983 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  20 <><>
0985 E4 61                           IN      AL,PORT_B
0987 0C 0C                           OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
0989 E6 61                           OUT     PORT_B,AL
098B 24 F3                           AND     AL,RAM_PAR_ON
098D E6 61                           OUT     PORT_B,AL
098F E9 0000 E                       JMP     PROC_SHUTDOWN           ; CAUSE A SHUTDOWN (RETURN VIA JUMP)

                             ;--------------------------------------
                             ; RETURN 1 FROM SHUTDOWN               :
                             ;--------------------------------------

0992 B0 21                   SHUT1:  MOV     AL,21H                  ;       <><><><><><><><><><><><><>
0994 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  21 <><>
0996 BC ---- R                       MOV     SP,ABSO                 ; SET REAL MODE STACK
0999 8E D4                           MOV     SS,SP
099B BC 0400 R                       MOV     SP,OFFSET @TOS

                             ;----- SET DIVIDE 0 VECTOR OFFSET

099E 2B FF                           SUB     DI,DI                   ; POINT TO FIRST INTERRUPT LOCATION
09A0 8E C7                           MOV     ES,DI                   ; SET ES TO ABSO SEGMENT
09A2 B8 0000 E                       MOV     AX,OFFSET D11           ; GET ADDRESS OF INTERRUPT OFFSET
09A5 AB                              STOSW                           ; PLACE OFFSET IF NULL HANDLER IN VECTOR

09A6 E8 0000 E                       CALL    DDS                     ; SET UP THE REAL DATA AREA

                             ;----- GET THE CONFIGURATION FROM CMOS

09A9 B8 8E8E                         MOV     AX,X*(CMOS_DIAG+NMI)    ; CHECK CMOS GOOD
09AC E8 0000 E                       CALL    CMOS_READ               ; GET THE STATUS
09AF A8 C0                           TEST    AL,BAD_BAT+BAD_CKSUM    ; VALID CMOS ?
09B1 74 03                           JZ      M_OK                    ; GO IF YES
09B3 E9 0A3C R                       JMP     BAD_MOS                 ; GO IF NOT
09B6                         M_OK:
09B6 24 DF                           AND     AL,0DFH                 ; CLEAR THE MINIMUM CONFIG BIT
09B8 86 C4                           XCHG    AL,AH                   ; SAVE THE STATUS BYTE
09BA E8 0000 E                       CALL    CMOS_WRITE              ; BACK INTO CMOS

                             ;----- CHECK FOR CMOS RUN IN MODE

09BD 81 3E 0072 R 1234               CMP     @RESET_FLAG,1234H       ; CHECK FOR SOFT RESET
09C3 74 10                           JE      M_OK_64                 ; BYPASS IF SOFT RESET

09C5 B0 96                           MOV     AL,CMOS_B_M_S_HI+NMI    ; GET THE BASE MEMORY SIZE HIGH BYTE
09C7 E8 0000 E                       CALL    CMOS_READ
09CA 24 C0                           AND     AL,0C0H                 ; MASK FOR MANUFACTURING TEST BITS
09CC 3C C0                           CMP     AL,0C0H                 ; CHECK FOR MANUFACTURING TEST MODE SET
09CE 75 05                           JNE     M_OK_64                 ; SKIP IF NOT MANUFACTURING LINE TEST

09D0 C6 06 0072 R 64                 MOV     BYTE PTR @RESET_FLAG,64H; ELSE SET THE MFG TEST FLAG

                             ;----- INSURE CONFIGURATION HAS CORRECT VIDEO TYPE

09D5                         M_OK_64:
09D5 B0 94                           MOV     AL,CMOS_EQUIP+NMI       ; GET THE EQUIPMENT BYTE
09D7 E8 0000 E                       CALL    CMOS_READ
09DA 8A E0                           MOV     AH,AL                   ; SAVE VIDEO TYPE
09DC A8 30                           TEST    AL,030H                 ; ANY VIDEO?
09DE 75 31                           JNZ     MOS_OK_1                ; CONTINUE
09E0 E8 09EE R                       CALL    CHK_VIDEO               ; INSURE VIDEO ROM PRESENT
09E3 74 4C                           JZ      MOS_OK                  ; CONTINUE

09E5 F6 06 0012 R 20                 TEST    @MFG_TST,MFG_LOOP       ; EXCEPT IF MFG JUMPER IS INSTALLED
09EA 74 6F                           JZ      NORMAL_CONFIG           ; GO IF INSTALLED

09EC EB 4E                           JMP     SHORT BAD_MOS           ; GO DEFAULT

                             ;----- ROUTINE CHECK FOR VIDEO FEATURE ROM PRESENT

09EE                         CHK_VIDEO:
09EE B9 C000                         MOV     CX,0C000H               ; START OF FEATURE I/O ROM
09F1                         CHK_VIDEO1:
09F1 50                              PUSH    AX                      ; SAVE THE CONFIGURATION
09F2 1E                              PUSH    DS                      ; SAVE THE DATA SEGMENT
09F3 57                              PUSH    DI                      ; SAVE COMPARE REGISTER
09F4 8E D9                           MOV     DS,CX                   ; GET ROM SEGMENT
09F6 BF AA55                         MOV     DI,0AA55H               ; GET THE PRESENCE SIGNATURE
09F9 2B DB                           SUB     BX,BX                   ; CLEAR INDEX POINTER
09FB 8B 07                           MOV     AX,[BX]                 ; GET THE FIRST 2 LOCATIONS
09FD 3B C7                           CMP     AX,DI                   ; IS THE VIDEO FEATURE ROM PRESENT?
09FF 5F                              POP     DI                      ; RESTORE WORK REGISTER
0A00 1F                              POP     DS                      ; RESTORE DATA SEGMENT
0A01 58                              POP     AX                      ; GET THE CONFIGURATION
0A02 74 0C                           JZ      CHK_VIDEO2              ; GO IF VIDEO ROM INSTALLED
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0A04 81 C1 0080                         ADD     CX,080H                 ; POINT TO NEXT 2K BLOCK
0A08 81 F9 C800                         CMP     CX,0C800H               ; TOP OF VIDEO ROM AREA YET?
0A0C 7C E3                              JL      CHK_VIDEO1              ; TRY AGAIN
0A0E 23 C9                              AND     CX,CX                   ; SET NON ZERO FLAG
0A10                            CHK_VIDEO2:
0A10 C3                                 RET                             ; RETURN TO CALLER

                                ;-----  CMOS VIDEO BITS NON ZERO (CHECK FOR PRIMARY DISPLAY AND NO VIDEO ROM)

0A11                            MOS_OK_1:
0A11 E8 09EE R                          CALL    CHK_VIDEO               ; IS THE VIDEO ROM INSTALLED?
0A14 74 26                              JZ      BAD_MOS                 ; WRONG CONFIGURATION IN CONFIG BYTE

0A16 8A C4                              MOV     AL,AH                   ; RESTORE CONFIGURATION
0A18 F6 06 0012 R 40                    TEST    @MFG_TST,DSP_JMP        ; CHECK FOR DISPLAY JUMPER
0A1D 74 0A                              JZ      MOS_OK_2                ; GO IF COLOR CARD IS PRIMARY DISPLAY

                                ;-----  MONOCHROME CARD IS PRIMARY DISPLAY     (NO JUMPER INSTALLED)

0A1F 24 30                              AND     AL,30H                  ; INSURE MONOCHROME IS PRIMARY
0A21 3C 30                              CMP     AL,30H                  ; CONFIGURATION OK?
0A23 75 17                              JNZ     BAD_MOS                 ; GO IF NOT
0A25 8A C4                              MOV     AL,AH                   ; RESTORE CONFIGURATION
0A27 EB 08                              JMP     SHORT MOS_OK            ; USE THE CONFIGURATION BYTE FOR DISPLAY

                                ;-----  COLOR CARD

0A29                            MOS_OK_2:
0A29 24 30                              AND     AL,30H                  ; STRIP UNWANTED BITS
0A2B 3C 30                              CMP     AL,30H                  ; MUST NOT BE MONO WITH JUMPER INSTALLED
0A2D 8A C4                              MOV     AL,AH                   ; RESTORE CONFIGURATION
0A2F 74 0B                              JZ      BAD_MOS                 ; GO IF YES

                                ;-----  CONFIGURATION MUST HAVE AT LEAST ONE DISKETTE

0A31 A8 01                      MOS_OK: TEST    AL,01H                  ; MUST HAVE AT LEAST ONE DISKETTE
0A33 75 26                              JNZ     NORMAL_CONFIG           ; GO SET CONFIGURATION IF OK
0A35 F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; EXCEPT IF MFG JUMPER IS INSTALLED
0A3A 74 1F                              JZ      NORMAL_CONFIG           ; GO IF INSTALLED

                                ;-----  MINIMUM CONFIGURATION WITH BAD CMOS OR NON VALID VIDEO

0A3C                            BAD_MOS:
0A3C B8 008E                            MOV     AX,CMOS_DIAG+NMI        ; GET THE DIAGNOSTIC STATUS
0A3F E8 0000 E                          CALL    CMOS_READ
0A42 A8 C0                              TEST    AL,BAD_BAT+BAD_CKSUM    ; WAS BATTERY DEFECTIVE OR BAD CHECKSUM
0A44 75 03                              JNZ     BAD_MOS1                ; GO IF YES

0A46 E8 0000 E                          CALL    CONFIG_BAD              ; SET THE MINIMUM CONFIGURATION FLAG
0A49                            BAD_MOS1:
0A49 E8 09EE R                          CALL    CHK_VIDEO               ; CHECK FOR VIDEO ROM
0A4C B0 01                              MOV     AL,01H                  ; DISKETTE ONLY
0A4E 74 0B                              JZ      NORMAL_CONFIG           ; GO IF VIDEO ROM PRESENT

0A50 F6 06 0012 R 40                    TEST    @MFG_TST,DSP_JMP        ; CHECK FOR DISPLAY JUMPER
0A55 B0 11                              MOV     AL,11H                  ; DEFAULT TO 40X25 COLOR
0A57 74 02                              JZ      NORMAL_CONFIG           ; GO IF JUMPER IS INSTALLED

0A59 B0 31                              MOV     AL,31H                  ; DISKETTE / B/W DISPLAY 80X25

                                ;----------------------------------------
                                ;       CONFIGURATION AND MFG MODE      :
                                ;----------------------------------------

0A5B                            NORMAL_CONFIG:
0A5B F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; IS THE MANUFACTURING JUMPER INSTALLED
0A60 75 02                              JNZ     NORM1                   ; GO IF NOT
0A62 24 3E                              AND     AL,03EH                 ; STRIP DISKETTE FOR MFG TEST

0A64 2A E4                      NORM1:  SUB     AH,AH
0A66 A3 0010 R                          MOV     @EQUIP_FLAG,AX          ; SAVE SWITCH INFORMATION
0A69 81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; BYPASS IF SOFT RESET
0A6F 74 2C                              JZ      E6

                                ;-----  GET THE FIRST SELF TEST RESULTS FROM KEYBOARD

0A71 B0 60                              MOV     AL,WRITE_8042_LOC       ; ENABLE KEYBOARD
0A73 E8 039D R                          CALL    C8042                   ; ISSUE WRITE BYTE COMMAND
0A76 B0 4D                              MOV     AL,4DH                  ; ENABLE OUTPUT BUFFER FULL INTERRUPT,
                                                                        ; SET SYSTEM FLAG, PC 1 COMPATIBILITY,
0A78 E6 60                              OUT     PORT_A,AL               ; INHIBIT OVERRIDE, ENABLE KEYBOARD

0A7A 2B C9                              SUB     CX,CX                   ; WAIT FOR COMMAND ACCEPTED
0A7C E8 03A2 R                          CALL    C42_1

0A7F B9 7FFF                            MOV     CX,07FFFH               ; SET LOOP COUNT FOR APPROXIMATELY 100MS
                                                                        ; TO RESPOND
0A82 E4 64                      TST6:   IN      AL,STATUS_PORT          ; WAIT FOR OUTPUT BUFFER FULL
0A84 A8 01                              TEST    AL,OUT_BUF_FULL
0A86 E1 FA                              LOOPZ   TST6                    ; TRY AGAIN IF NOT

0A88 9C                                 PUSHF                           ; SAVE FLAGS
0A89 B0 AD                              MOV     AL,DIS_KBD              ; DISABLE KEYBOARD
0A8B E8 039D R                          CALL    C8042                   ; ISSUE THE COMMAND
0A8E 9D                                 POPF                            ; RESTORE FLAGS
0A8F 74 0C                              JZ      E6                      ; CONTINUE WITHOUT RESULTS

0A91 E4 60                              IN      AL,PORT_A               ; GET INPUT FROM KEYBOARD
0A93 A2 0072 R                          MOV     BYTE PTR @RESET_FLAG,AL ; TEMPORARY SAVE FOR AA RECEIVED

                                ;-----  CHECK FOR MFG REQUEST

0A96 3C 65                              CMP     AL,065H                 ; LOAD MANUFACTURING TEST REQUEST?
0A98 75 03                              JNE     E6                      ; CONTINUE IF NOT
0A9A E9 0C34 R                          JMP     MFG_BOOT                ; ELSE GO TO MANUFACTURING BOOTSTRAP
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                                        ;--------------------------------------------------------
                                        ; TEST.14                                               :
                                        ;       INITIALIZE AND START CRT CONTROLLER (6845)      :
                                        ;       TEST VIDEO READ/WRITE STORAGE.                  :
                                        ; DESCRIPTION                                           :
                                        ;       RESET THE VIDEO ENABLE SIGNAL.                  :
                                        ;       SELECT ALPHANUMERIC MODE, 40 * 25, B & W.       :
                                        ;       READ/WRITE DATA PATTERNS TO MEMORY. CHECK       :
                                        ;       STORAGE ADDRESSABILITY.                         :
                                        ; ERROR = 1 LONG AND 2 SHORT BEEPS                      :
                                        ;--------------------------------------------------------

 0A9D A1 0010 R                         E6:     MOV     AX,@EQUIP_FLAG          ; GET SENSE INFORMATION
 0AA0 50                                        PUSH    AX                      ; SAVE IT
 0AA1 B0 30                                     MOV     AL,30H                  ; FORCE MONOCHROME TYPE
 0AA3 A3 0010 R                                 MOV     @EQUIP_FLAG,AX          ; INTO EQUIPMENT FLAG
 0AA6 2B C0                                     SUB     AX,AX                   ; MODE SET COMMAND FOR DEFAULT MODE
 0AA8 CD 10                                     INT     INT_VIDEO               ; SEND INITIALIZATION TO B/W CARD
 0AAA B0 20                                     MOV     AL,20H                  ; FORCE COLOR AT 80 BY 25
 0AAC A3 0010 R                                 MOV     @EQUIP_FLAG,AX          ; INTO EQUIPMENT FLAG TO CLEAR BUFFERS
 0AAF B8 0003                                   MOV     AX,0003H                ; AND INITIALIZATION COLOR CARD 80X25
 0AB2 CD 10                                     INT     INT_VIDEO               ; MODE SET 80 X 25
 0AB4 B8 0001                                   MOV     AX,0001H                ; SET COLOR 40 X 25 MODE
 0AB7 CD 10                                     INT     INT_VIDEO               ; SET DEFAULT COLOR MODE
 0AB9 58                                        POP     AX                      ; RECOVER REAL SWITCH INFORMATION
 0ABA A3 0010 R                                 MOV     @EQUIP_FLAG,AX          ; RESTORE IT
 0ABD 24 30                                     AND     AL,30H                  ; ISOLATE VIDEO SWITCHES
 0ABF 75 11                                     JNZ     E7                      ; VIDEO SWITCHES SET TO 0?
 0AC1 1E                                        PUSH    DS                      ; SAVE THE DATA SEGMENT
 0AC2 50                                        PUSH    AX
 0AC3 2B C0                                     SUB     AX,AX                   ; SET DATA SEGMENT TO 0
 0AC5 8E D8                                     MOV     DS,AX
 0AC7 BF 0040 R                                 MOV     DI,OFFSET @VIDEO_INT    ; SET INTERRUPT 10H TO DUMMY
 0ACA C7 05 0000 E                              MOV     WORD PTR [DI],OFFSET DUMMY_RETURN  ; RETURN IF NO VIDEO CARD
 0ACE 58                                        POP     AX                      ; RESTORE REGISTERS
 0ACF 1F                                        POP     DS
 0AD0 EB 7F                                     JMP     SHORT E18_1             ; BYPASS VIDEO TEST
 0AD2                                   E7:
 0AD2 3C 30                                     CMP     AL,30H                  ; B/W CARD ATTACHED?
 0AD4 74 08                                     JE      E8                      ; YES - SET MODE FOR B/W CARD
 0AD6 FE C4                                     INC     AH                      ; SET COLOR MODE FOR COLOR CARD
 0AD8 3C 20                                     CMP     AL,20H                  ; 80X25 MODE SELECTED?
 0ADA 75 02                                     JNE     E8                      ; NO - SET MODE FOR 40X25
 0ADC B4 03                                     MOV     AH,3                    ; SET MODE FOR 80X25
 0ADE                                   E8:
 0ADE 86 E0                                     XCHG    AH,AL
 0AE0 50                                        PUSH    AX                      ; SAVE VIDEO MODE ON STACK
 0AE1 2A E4                                     SUB     AH,AH                   ; INITIALIZE TO ALPHANUMERIC MD
 0AE3 CD 10                                     INT     INT_VIDEO               ; CALL VIDEO_IO
 0AE5 58                                        POP     AX                      ; RESTORE VIDEO SENSE SWITCHES IN AH
 0AE6 50                                        PUSH    AX                      ; SAVE VALUE
 0AE7 BB B000                                   MOV     BX,0B000H               ; STARTING VIDEO MEMORY ADDRESS B/W CARD
 0AEA BA 03B8                                   MOV     DX,3B8H                 ; MODE REGISTER FOR B/W
 0AED B9 0800                                   MOV     CX,2048                 ; MEMORY WORD COUNT FOR B/W CARD
 0AF0 80 FC 30                                  CMP     AH,30H                  ; B/W VIDEO CARD ATTACHED?
 0AF3 74 07                                     JE      E9                      ; YES - GO TEST VIDEO STORAGE
 0AF5 B7 B8                                     MOV     BH,0B8H                 ; STARTING MEMORY ADDRESS FOR COLOR CARD
 0AF7 BA 03D8                                   MOV     DX,3D8H                 ; MODE REGISTER FOR COLOR CARD
 0AFA B5 20                                     MOV     CH,20H                  ; MEMORY WORD COUNT FOR COLOR CARD
 0AFC                                   E9:
 0AFC A0 0065 R                                 MOV     AL,@CRT_MODE_SET        ; GET CURRENT MODE SET VALUE
 0AFF 24 37                                     AND     AL,037H                 ; SET VIDEO BIT OFF
 0B01 EE                                        OUT     DX,AL                   ; DISABLE VIDEO FOR COLOR CARD
 0B02 8E C3                                     MOV     ES,BX                   ; POINT ES TO VIDEO MEMORY
 0B04 8E DB                                     MOV     DS,BX                   ; POINT DS TO VIDEO MEMORY
 0B06 D1 C9                                     ROR     CX,1                    ; DIVIDE BY 2 FOR WORD COUNT
 0B08 E8 0000 E                                 CALL    STGTST_CNT              ; GO TEST VIDEO READ/WRITE STORAGE
 0B0B 75 7B                                     JNE     E17                     ; R/W MEMORY FAILURE - BEEP SPEAKER

                                        ;------------------------------------------------
                                        ; TEST.15                                       :
                                        ;       SETUP VIDEO DATA ON SCREEN FOR VIDEO    :
                                        ;       LINE TEST.                              :
                                        ; DESCRIPTION                                   :
                                        ;       ENABLE VIDEO SIGNAL AND SET MODE.       :
                                        ;       DISPLAY A HORIZONTAL BAR ON SCREEN.     :
                                        ;------------------------------------------------

 0B0D B0 22                                     MOV     AL,22H                  ;       <><><><><><><><><><><><>
 0B0F E6 80                                     OUT     MFG_PORT,AL             ;       <><> CHECKPOINT 22 <><>
 0B11 58                                        POP     AX                      ; GET VIDEO SENSE SWITCHES (AH)
 0B12 50                                        PUSH    AX                      ; SAVE IT
 0B13 B4 00                                     MOV     AH,0                    ; ENABLE VIDEO AND SET MODE
 0B15 CD 10                                     INT     INT_VIDEO               ; VIDEO
 0B17 B8 7020                                   MOV     AX,7020H                ; WRITE BLANKS IN REVERSE VIDEO
 0B1A 2B FF                                     SUB     DI,DI                   ; SETUP STARTING LOCATION
 0B1C B9 0028                                   MOV     CX,40                   ; NUMBER OF BLANKS TO DISPLAY
 0B1F F3/ AB                                    REP     STOSW                   ; WRITE VIDEO STORAGE

                                        ;--------------------------------------
                                        ; TEST.16                             :
                                        ;       CRT INTERFACE LINES TEST      :
                                        ; DESCRIPTION                         :
                                        ;       SENSE ON/OFF TRANSITION OF THE :
                                        ;       VIDEO ENABLE AND HORIZONTAL   :
                                        ;       SYNC LINES.                   :
                                        ;--------------------------------------

 0B21 58                                        POP     AX                      ; GET VIDEO SENSE SWITCH INFORMATION
 0B22 50                                        PUSH    AX                      ; SAVE IT
 0B23 80 FC 30                                  CMP     AH,30H                  ; B/W CARD ATTACHED?
 0B26 BA 03BA                                   MOV     DX,03BAH                ; SETUP ADDRESS OF B/W STATUS PORT
 0B29 74 03                                     JE      E11                     ; YES - GO TEST LINES
 0B2B BA 03DA                                   MOV     DX,03DAH                ; COLOR CARD IS ATTACHED
 0B2E                                   E11:
 0B2E B4 08                                     MOV     AH,8
 0B30                                   E12:
 0B30 2B C9                                     SUB     CX,CX
 0B32 EC                                E13:    IN      AL,DX                   ; READ CRT STATUS PORT
 0B33 22 C4                                     AND     AL,AH                   ; CHECK VIDEO/HORIZONTAL LINE
 0B35 75 04                                     JNZ     E14                     ; ITS ON - CHECK IF IT GOES OFF
 0B37 E2 F9                                     LOOP    E13                     ; LOOP UNTIL ON OR TIMEOUT
 0B39 EB 4D                                     JMP     SHORT E17               ; GO PRINT ERROR MESSAGE
```

```
0B3B                         E14:
0B3B 2B C9                           SUB     CX,CX
0B3D EC                      E15:    IN      AL,DX                   ; READ CRT STATUS PORT
0B3E 22 C4                           AND     AL,AH                   ; CHECK VIDEO/HORIZONTAL LINE
0B40 74 04                           JZ      E16                     ; ITS ON - CHECK NEXT LINE
0B42 E2 F9                           LOOP    E15                     ; LOOP IF ON UNTIL IT GOES OFF
0B44 EB 42                           JMP     SHORT E17               ; GO ERROR BEEP

                             ;-----  CHECK HORIZONTAL LINE

0B46 B1 03                   E16:    MOV     CL,3                    ; GET NEXT BIT TO CHECK
0B48 D2 EC                           SHR     AH,CL
0B4A 75 E4                           JNZ     E12                     ; CONTINUE
0B4C                         E18:
0B4C 58                              POP     AX                      ; GET VIDEO SENSE SWITCHES (AH)
0B4D B4 00                           MOV     AH,0                    ; SET MODE AND DISPLAY CURSOR
0B4F CD 10                           INT     INT_VIDEO               ; CALL VIDEO I/O PROCEDURE

                             ;-----  CHECK FOR THE ADVANCED VIDEO CARD

                                     ASSUME  DS:ABS0
0B51 BA 0000                 E18_1:  MOV     DX,0                    ; SET DS TO VECTORS SEGMENT
0B54 8E DA                           MOV     DS,DX                   ; RESET SEGMENT VALUE
0B56 C7 06 007E R 0000               MOV     WORD PTR @EXT_PTR+2,0   ; FOR GRAPHIC CHARS 128 - 255
0B5C BA C000                         MOV     DX,0C000H               ; SET THE LOW SEGMENT VALUE
0B5F                         E18A:
0B5F B0 23                           MOV     AL,23H                  ;       <><><><><><><><><><><><>
0B61 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  23 <><>
0B63 8E DA                           MOV     DS,DX
0B65 57                              PUSH    DI                      ; SAVE WORK REGISTER
0B66 BF AA55                         MOV     DI,0AA55H               ; PRESENCE SIGNATURE
0B69 2B DB                           SUB     BX,BX                   ; CLEAR POINTER
0B6B 8B 07                           MOV     AX,[BX]                 ; GET FIRST 2 LOCATIONS
0B6D 3B C7                           CMP     AX,DI                   ; PRESENT?
0B6F 5F                              POP     DI                      ; RECOVER REGISTER
0B70 75 05                           JNZ     E18B                    ; NO? GO LOOK FOR OTHER MODULES

0B72 E8 0000 E                       CALL    ROM_CHECK               ; GO SCAN MODULE
0B75 EB 04                           JMP     SHORT E18C
0B77                         E18B:
0B77 81 C2 0080                      ADD     DX,0080H                ; POINT TO NEXT 2K BLOCK
0B7B                         E18C:
0B7B 81 FA C800                      CMP     DX,0C800H               ; TOP OF VIDEO ROM AREA YET?
0B7F 7C DE                           JL      E18A                    ; GO SCAN FOR ANOTHER MODULE

0B81 B0 24                           MOV     AL,24H                  ;       <><><><><><><><><><><><>
0B83 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  24 <><>

0B85 E9 0000 E                       JMP     POST2                   ; GO TO NEXT TEST

                                     ASSUME  DS:DATA

                             ;-----  CRT ERROR SET MFG CHECKPOINT AND ERROR BEEP

0B88 E8 0000 E               E17:    CALL    DDS                     ; POINT TO DATA

                             ;-----  CHECKPOINT 0C = MONOCHROME FAILED

0B8B C6 06 0015 R 0C                 MOV     @MFG_ERR_FLAG,0CH       ; <><> CRT ERROR CHECKPOINT  0C <><>
0B90 80 3E 0072 R 64                 CMP     BYTE PTR @RESET_FLAG,064H ; IS THIS A MFG REQUEST?
0B95 74 0D                           JZ      E19                     ; BY PASS ERROR BEEP IF YES
0B97 F6 06 0012 R 20                 TEST    @MFG_TST,MFG_LOOP       ; IS THE MFG LOOP JUMPER INSTALLED?
0B9C 74 06                           JZ      E19                     ; BY PASS ERROR BEEP IF YES
0B9E BA 0102                         MOV     DX,102H
0BA1 E8 0000 E                       CALL    ERR_BEEP                ; GO BEEP SPEAKER
0BA4                         E19:
0BA4 1E                              PUSH    DS
0BA5 A1 0010 R                       MOV     AX,@EQUIP_FLAG          ; GET THE CURRENT VIDEO
0BA8 24 30                           AND     AL,30H                  ; STRIP OTHER BITS
0BAA 3C 30                           CMP     AL,30H                  ; IS IT MONOCHROME ?
0BAC 74 30                           JZ      TRY_COLOR               ; GO IF YES

                             ;-----  COLOR FAILED TRY MONOCHROME - CHECKPOINT 0D = COLOR FAILED

0BAE C6 06 0015 R 0D                 MOV     @MFG_ERR_FLAG,0DH       ; <><> CRT ERROR CHECKPOINT  0D <><>

0BB3 BA 03B8                         MOV     DX,3B8H                 ; DISABLE B/W
0BB6 B0 01                           MOV     AL,1
0BB8 EE                              OUT     DX,AL                   ; OUTPUT THE DISABLE
0BB9 BB B000                         MOV     BX,0B000H               ; CHECK FOR MONOCHROME VIDEO MEMORY
0BBC 8E DB                           MOV     DS,BX
0BBE B8 AA55                         MOV     AX,0AA55H               ; WRITE AN AA55
0BC1 2B DB                           SUB     BX,BX                   ; TO THE FIRST LOCATION
0BC3 89 07                           MOV     [BX],AX
0BC5 EB 00                           JMP     $+2                     ; ALLOW BUS TO SETTLE
0BC7 8B 07                           MOV     AX,[BX]                 ; READ THE FIRST LOCATION
0BC9 3D AA55                         CMP     AX,0AA55H               ; IS THE MONOCHROME VIDEO CARD THERE?
0BCC 1F                              POP     DS                      ; RESTORE THE DATA SEGMENT
0BCD 75 55                           JNZ     E17_3                   ; GO IF NOT
0BCF 81 0E 0010 R 0030               OR      @EQUIP_FLAG,30H         ; TURN ON MONOCHROME BITS IN EQUIP FLAG
0BD5 A1 0010 R                       MOV     AX,@EQUIP_FLAG          ; ENABLE VIDEO
0BD8 2A E4                           SUB     AH,AH
0BDA CD 10                           INT     INT_VIDEO
0BDC EB 34                           JMP     SHORT E17_1             ; CONTINUE

                             ;-----  MONOCHROME FAILED TRY COLOR

0BDE                         TRY_COLOR:
0BDE B0 01                           MOV     AL,01H                  ; SET MODE COLOR 40X25
0BE0 2A E4                           SUB     AH,AH
0BE2 CD 10                           INT     INT_VIDEO
0BE4 BA 03D8                         MOV     DX,3D8H                 ; DISABLE COLOR
0BE7 B0 00                           MOV     AL,0
0BE9 EE                              OUT     DX,AL                   ; OUTPUT THE DISABLE
0BEA BB B800                         MOV     BX,0B800H               ; CHECK FOR COLOR VIDEO MEMORY
0BED 8E DB                           MOV     DS,BX
0BEF B8 AA55                         MOV     AX,0AA55H               ; WRITE AN AA55
0BF2 2B DB                           SUB     BX,BX                   ; TO THE FIRST LOCATION
0BF4 89 07                           MOV     [BX],AX
0BF6 EB 00                           JMP     $+2                     ; ALLOW BUS TO SETTLE
0BF8 8B 07                           MOV     AX,[BX]                 ; READ THE FIRST LOCATION
0BFA 3D AA55                         CMP     AX,0AA55H               ; IS THE COLOR VIDEO CARD THERE?
0BFD 1F                              POP     DS                      ; RESTORE THE DATA SEGMENT
0BFE 75 24                           JNZ     E17_3                   ; GO IF NOT
```

```
0C00 81 26 0010 R FFCF                AND     @EQUIP_FLAG,0FFCFH      ; TURN OFF VIDEO BITS
0C06 81 0E 0010 R 0010                OR      @EQUIP_FLAG,10H         ; SET COLOR 40X24
0C0C B0 01                            MOV     AL,01H
0C0E 2A E4                            SUB     AH,AH
0C10 CD 10                            INT     INT_VIDEO
0C12                          E17_1:
0C12 58                               POP     AX                      ; SET NEW VIDEO TYPE ON STACK
0C13 A1 0010 R                        MOV     AX,@EQUIP_FLAG
0C16 24 30                            AND     AL,30H
0C18 3C 30                            CMP     AL,30H                  ; IS IT THE B/W?
0C1A 2A C0                            SUB     AL,AL
0C1C 74 02                            JZ      E17_2                   ; GO IF YES
0C1E FE C0                            INC     AL                      ; INITIALIZE FOR 40X25
0C20                          E17_2:
0C20 50                               PUSH    AX
0C21                          E17_4:
0C21 E9 0B4C R                        JMP     E18

                              ;-----  BOTH VIDEO CARDS FAILED SET DUMMY RETURN IF RETRACE FAILURE

0C24                          E17_3:
0C24 1E                               PUSH    DS
0C25 2B C0                            SUB     AX,AX                   ; SET DS SEGMENT TO 0
0C27 8E D8                            MOV     DS,AX
0C29 BF 0040 R                        MOV     DI,OFFSET @VIDEO_INT    ; SET INTERRUPT 10H TO DUMMY
0C2C C7 05 0000 E                     MOV     WORD PTR [DI],OFFSET DUMMY_RETURN  ; RETURN IF NO VIDEO CARD
0C30 1F                               POP     DS
0C31 E9 0B51 R                        JMP     E18_1                   ; BYPASS REST OF VIDEO TEST
```

```
                              PAGE
                              ;--------------------------------------------------------------------------
                              ; MANUFACTURING BOOT TEST CODE ROUTINE                                     :
                              ;       LOAD A BLOCK OF TEST CODE THROUGH THE KEYBOARD PORT FOR MANUFACTURING :
                              ;       TESTS.                                                             :
                              ;       THIS ROUTINE WILL LOAD A TEST (MAX LENGTH=FAFFH) THROUGH THE KEYBOARD :
                              ;       PORT. CODE WILL BE LOADED AT LOCATION  0000:0500.  AFTER LOADING,  :
                              ;       CONTROL WILL BE TRANSFERRED TO LOCATION  0000:0500.   THE STACK WILL :
                              ;       BE LOCATED AT 0000:0400.  THIS ROUTINE ASSUMES THAT THE FIRST 2 BYTES :
                              ;       TRANSFERRED CONTAIN THE COUNT OF BYTES TO BE LOADED                :
                              ;        (BYTE 1=COUNT LOW, BYTE 2=COUNT HI.)                              :
                              ;--------------------------------------------------------------------------

                              ;-----  DEGATE ADDRESS LINE 20

0C34                          MFG_BOOT:
0C34 B4 DD                             MOV      AH,DISABLE_BIT20          ; DEGATE COMMAND FOR ADDRESS LINE 20
0C36 E8 0000 E                         CALL     GATE_A20                  ; ISSUE TO KEYBOARD ADAPTER AND CLI

                              ;-----  SETUP HARDWARE INTERRUPT VECTOR TABLE LEVEL 0-7 AND SOFTWARE INTERRUPTS

0C39 68 ---- R                         PUSH     ABS0                      ; SET ES SEGMENT REGISTER TO ABS0
0C3C 07                                POP      ES
0C3D B9 0018                           MOV      CX,24                     ; GET VECTOR COUNT
0C40 8C C8                             MOV      AX,CS                     ; GET THE CURRENT CODE SEGMENT VALUE
0C42 8E D8                             MOV      DS,AX                     ; SETUP DS SEGMENT REGISTER TO
0C44 BE 0000 E                         MOV      SI,OFFSET VECTOR_TABLE    ; POINT TO THE ROUTINE ADDRESS TABLE
0C47 BF 0020 R                         MOV      DI,OFFSET @INT_PTR        ; SET DESTINATION TO FIRST USED VECTOR
0C4A                          MFG_B1:
0C4A A5                                MOVSW                              ; MOVE ONE ROUTINE OFFSET ADDRESS
0C4B AB                                STOSW                              ; INSERT CODE SEGMENT VALUE
0C4C E2 FC                             LOOP     MFG_B1                    ; MOVE THE NUMBER OF ENTRIES REQUIRED

                              ;-----  SETUP HARDWARE INTERRUPT VECTORS LEVEL 8-15 (VECTORS START AT INT 70 H)

0C4E B9 0008                           MOV      CX,08                     ; GET VECTOR COUNT
0C51 BE 0000 E                         MOV      SI,OFFSET SLAVE_VECTOR_TABLE
0C54 BF 01C0 R                         MOV      DI,OFFSET @SLAVE_INT_PTR
0C57                          MFG_B2:
0C57 A5                                MOVSW                              ; MOVE ONE ROUTINE OFFSET ADDRESS
0C58 AB                                STOSW                              ; INSERT CODE SEGMENT VALUE
0C59 E2 FC                             LOOP     MFG_B2

                              ;-----  SET UP OTHER INTERRUPTS AS NECESSARY

                                       ASSUME   DS:ABS0,ES:ABS0
0C5B 06                                PUSH     ES                                          ; ES= ABS0
0C5C 1F                                POP      DS                                          ; SET DS TO ABS0
0C5D C7 06 0008 R 0000 E               MOV      WORD PTR @NMI_PTR,OFFSET NMI_INT            ; NMI INTERRUPT
0C63 C7 06 0014 R 0000 E               MOV      WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN      ; PRINT SCREEN
0C69 C7 06 0062 R F600                 MOV      WORD PTR @BASIC_PTR+2,0F600H                ; CASSETTE BASIC SEGMENT

                              ;-----  ENABLE KEYBOARD PORT

0C6F B0 60                             MOV      AL,60H                    ; WRITE 8042 MEMORY LOCATION 0
0C71 E8 039D R                         CALL     C8042                     ; ISSUE THE COMMAND
0C74 B0 09                             MOV      AL,00001001B              ; SET INHIBIT OVERRIDE/ENABLE OBF
0C76 E6 60                             OUT      PORT_A,AL                 ;   INTERRUPT AND NOT PC COMPATIBLE

0C78 E8 0C9A R                         CALL     MFG_B4                    ; GET COUNT LOW
0C7B 8A F8                             MOV      BH,AL                     ; SAVE IT
0C7D E8 0C9A R                         CALL     MFG_B4                    ; GET COUNT HI
0C80 8A E8                             MOV      CH,AL
0C82 8A CF                             MOV      CL,BH                     ; CX NOW HAS COUNT
0C84 FC                                CLD                                ; SET DIRECTION FLAG TO INCREMENT
0C85 BF 0500 R                         MOV      DI,OFFSET @MFG_TEST_RTN   ; SET TARGET OFFSET (DS=0000)
0C88                          MFG_B3:
0C88 E4 64                             IN       AL,STATUS_PORT            ; GET 8042 STATUS PORT
0C8A A8 01                             TEST     AL,OUT_BUF_FULL           ; KEYBOARD REQUEST PENDING?
0C8C 74 FA                             JZ       MFG_B3                    ; LOOP TILL DATA PRESENT
0C8E E4 60                             IN       AL,PORT_A                 ; GET DATA
0C90 AA                                STOSB                              ; STORE IT
0C91 E6 80                             OUT      MFG_PORT,AL               ; DISPLAY CHARACTER AT MFG PORT
0C93 E2 F3                             LOOP     MFG_B3                    ; LOOP TILL ALL BYTES READ

0C95 EA 0500 ---- R                    JMP      @MFG_TEST_RTN             ; FAR JUMP TO CODE THAT WAS JUST LOADED

0C9A                          MFG_B4:
0C9A E4 64                             IN       AL,STATUS_PORT            ; CHECK FOR OUTPUT BUFFER FULL
0C9C A8 01                             TEST     AL,OUT_BUF_FULL           ;   HANG HERE IF NO DATA AVAILABLE
0C9E E1 FA                             LOOPZ    MFG_B4

0CA0 E4 60                             IN       AL,PORT_A                 ; GET THE COUNT
0CA2 C3                                RET

0CA3                          POST1    ENDP
0CA3                          CODE     ENDS
                                       END
```

```
                        PAGE 118,121
                        TITLE TEST2 ---- 01/24/85  POST TESTS AND INITIALIZATION ROUTINES
                        .286C
                        .287
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC
                                PUBLIC  C21
                                PUBLIC  POST2
                                PUBLIC  SHUT2
                                PUBLIC  SHUT3
                                PUBLIC  SHUT4
                                PUBLIC  SHUT6
                                PUBLIC  SHUT7

                                EXTRN   BLINK_INT:NEAR
                                EXTRN   C8042:NEAR
                                EXTRN   CMOS_READ:NEAR
                                EXTRN   CMOS_WRITE:NEAR
                                EXTRN   CONFIG_BAD:NEAR
                                EXTRN   D1:NEAR
                                EXTRN   D2:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   DISK_SETUP:NEAR
                                EXTRN   DSKETTE_SETUP:NEAR
                                EXTRN   ERR_BEEP:NEAR
                                EXTRN   E_MSG:NEAR
                                EXTRN   F3D:NEAR
                                EXTRN   F3D1:NEAR
                                EXTRN   GATE_A20:NEAR
                                EXTRN   HD_INT:NEAR
                                EXTRN   KBD_RESET:NEAR
                                EXTRN   NMI_INT:NEAR
                                EXTRN   OBF_42:NEAR
                                EXTRN   POST3:NEAR
                                EXTRN   PRINT_SCREEN:NEAR
                                EXTRN   PROC_SHUTDOWN:NEAR
                                EXTRN   PROT_PRT_HEX:NEAR
                                EXTRN   PRT_HEX:NEAR
                                EXTRN   P_MSG:NEAR
                                EXTRN   ROM_CHECK:NEAR
                                EXTRN   ROM_CHECKSUM:NEAR
                                EXTRN   SEEK:NEAR
                                EXTRN   SET_TOD:NEAR
                                EXTRN   SLAVE_VECTOR_TABLE:NEAR
                                EXTRN   SND_DATA:NEAR
                                EXTRN   START_1:NEAR
                                EXTRN   STGTST_CNT:NEAR
                                EXTRN   SYSINIT1:NEAR
                                EXTRN   VECTOR_TABLE:NEAR
                                EXTRN   WAITF:NEAR
                                EXTRN   XPC_BYTE:NEAR

                                EXTRN   E101:NEAR               ; 101 ERROR CODE - INTERRUPT FAILURE
                                EXTRN   E102:NEAR               ; 102 ERROR CODE - TIMER FAILURE
                                EXTRN   E103:NEAR               ; 103 ERROR CODE - TIMER INTERRUPT
                                EXTRN   E104:NEAR               ; 104 ERROR CODE - PROTECTED MODE ERROR
                                EXTRN   E105:NEAR               ; 105 ERROR CODE - 8042 COMMAND FAILURE
                                EXTRN   E106:NEAR               ; 106 ERROR CODE - CONVERTING LOGIC
                                EXTRN   E107:NEAR               ; 107 ERROR CODE - NMI ERROR
                                EXTRN   E108:NEAR               ; 108 ERROR CODE - TIMER BUS ERROR
                                EXTRN   E109:NEAR               ; 109 ERROR CODE - MEMORY SELECT ERROR
                                EXTRN   E161:NEAR               ; 161 ERROR CODE - BAD BATTERY
                                EXTRN   E162:NEAR               ; 162 ERROR CODE - CMOS CHECKSUM/CONFIG
                                EXTRN   E163:NEAR               ; 163 ERROR CODE - BAD REAL TIME CLOCK
                                EXTRN   E164:NEAR               ; 164 ERROR CODE - MEMORY SIZE WRONG
                                EXTRN   E201:NEAR               ; 201 ERROR CODE - MEMORY DATA ERROR
                                EXTRN   E202:NEAR               ; 202 ERROR CODE - MEMORY ADDRESS ERROR
                                EXTRN   E203:NEAR               ; 203 ERROR CODE - SEGMENT ADDRESS ERROR
                                EXTRN   E301:NEAR               ; 301 ERROR CODE - KEYBOARD ERROR
                                EXTRN   E302:NEAR               ; 302 ERROR CODE - LOCK IS ON
                                EXTRN   E303:NEAR               ; 303 ERROR CODE - KEYBOARD/PLANAR ERROR
                                EXTRN   E304:NEAR               ; 304 ERROR CODE - KEYBOARD/PLANAR ERROR
                                EXTRN   E401:NEAR               ; 401 ERROR CODE - MONOCHROME ADAPTER
                                EXTRN   E501:NEAR               ; 501 ERROR CODE - COLOR ADAPTER
                                EXTRN   E601:NEAR               ; 601 ERROR CODE - DISKETTE ADAPTER

                        ;-------------------------------------------------------
                        ; TEST.17                                               :
                        ;       8259 INTERRUPT CONTROLLER TEST                  :
                        ; DESCRIPTION                                           :
                        ;       READ/WRITE THE INTERRUPT MASK REGISTER (IMR)    :
                        ;       WITH ALL ONES AND ZEROES. ENABLE SYSTEM         :
                        ;       INTERRUPTS.  MASK DEVICE INTERRUPTS OFF. CHECK  :
                        ;       FOR HOT INTERRUPTS (UNEXPECTED).                :
                        ;-------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA

0000                    POST2   PROC    NEAR

0000  B0 0A             C21:    MOV     AL,10                   ; LINE FEED ON DISPLAY
0002  E8 0000 E                 CALL    PRT_HEX
0005  E8 0000 E                 CALL    DDS                     ;SET DATA SEGMENT

                        ;-----  CLEAR ERROR FLAG REGISTER (BP) <=> 0 FLAGS ERROR

0008  2B ED                     SUB     BP,BP                   ; CLEAR (BP) REGISTER AS ERROR FLAG REG

                        ;-----  TEST THE INTERRUPT MASK REGISTER REGISTERS

000A  FA                C21A:   CLI                             ; TURN OFF INTERRUPTS
000B  B0 00                     MOV     AL,0                    ; SET INTERRUPT MASK REGISTER TO ZERO
000D  E6 21                     OUT     INTA01,AL
000F  E6 A1                     OUT     INTB01,AL               ; SEND TO 2ND INTERRUPT CONTROLLER ALSO
0011  EB 00                     JMP     $+2
0013  E4 21                     IN      AL,INTA01               ; READ INTERRUPT MASK REGISTER
0015  8A E0                     MOV     AH,AL                   ; SAVE RESULTS
0017  E4 A1                     IN      AL,INTB01               ; READ 2ND INTERRUPT MASK REGISTER

0019  0A E0                     OR      AH,AL                   ; BOTH IMR = 0?
001B  75 2C                     JNZ     D6                      ; GO TO ERR ROUTINE IF NOT 0

001D  B0 25                     MOV     AL,25H                  ;       <><><><><><><><><><><><>
001F  E6 80                     OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  25 <><>
```

SECTION 5

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0021 B0 FF                      MOV    AL,0FFH                 ; DISABLE DEVICE INTERRUPTS
0023 E6 21                      OUT    INTA01,AL               ; WRITE TO INTERRUPT MASK REGISTER
0025 E6 A1                      OUT    INTB01,AL               ; WRITE TO 2ND INTERRUPT MASK REGISTER
0027 EB 00                      JMP    $+2                     ; I/O DELAY
0029 E4 21                      IN     AL,INTA01               ; READ INTERRUPT MASK REGISTER
002B 8A E0                      MOV    AH,AL                   ; SAVE RESULTS
002D E4 A1                      IN     AL,INTB01               ; READ 2ND INTERRUPT MASK REGISTER

002F 05 0001                    ADD    AX,1                    ; ALL IMR BITS ON?
0032 75 15                      JNZ    D6                      ; NO - GO TO ERR ROUTINE

                        ;-----  CHECK FOR HOT INTERRUPTS

                        ;-----  INTERRUPTS ARE MASKED OFF.  CHECK THAT NO INTERRUPTS OCCUR.

0034 A2 006B R                  MOV    @INTR_FLAG,AL           ; CLEAR INTERRUPT FLAG

0037 B0 26                      MOV    AL,26H                  ;       <><><><><><><><><><><><>
0039 E6 80                      OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  26 <><>

003B FB                         STI                            ; ENABLE EXTERNAL INTERRUPTS
003C B9 19E4                    MOV    CX,6628                 ; WAIT 100 MILLISECONDS FOR ANY
003F E8 0000 E                  CALL   WAITF                   ;  INTERRUPTS THAT OCCUR
0042 80 3E 006B R 00            CMP    @INTR_FLAG,00H          ; DID ANY INTERRUPTS OCCUR?
0047 74 0D                      JZ     D7                      ; NO - GO TO NEXT TEST

0049 C6 06 0015 R 05    D6:     MOV    @MFG_ERR_FLAG,05H       ;       <><><><><><><><><><><><>
                                                               ;       <><> CHECKPOINT   5 <><>
004E BE 0000 E                  MOV    SI,OFFSET E101          ; DISPLAY 101 ERROR
0051 E8 0000 E          D6A:    CALL   E_MSG
0054 FA                         CLI
0055 F4                         HLT                            ; HALT THE SYSTEM

                        ;-----  CHECK THE CONVERTING LOGIC

0056 B0 27              D7:     MOV    AL,27H                  ;       <><><><><><><><><><><><>
0058 E6 80                      OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  27 <><>

005A B8 AA55                    MOV    AX,0AA55H
005D E7 82                      OUT    MFG_PORT+2,AX           ; WRITE A WORD
005F E4 82                      IN     AL,MFG_PORT+2           ;  GET THE FIRST BYTE
0061 86 C4                      XCHG   AL,AH                   ;  SAVE IT
0063 E4 83                      IN     AL,MFG_PORT+3           ;  GET THE SECOND BYTE
0065 3D 55AA                    CMP    AX,55AAH                ; IS IT OK?
0068 74 05                      JZ     D7_A                    ; GO IF YES

006A BE 0000 E                  MOV    SI,OFFSET E106          ; DISPLAY 106 ERROR
006D EB E2                      JMP    D6A

                        ;-----  CHECK FOR HOT NMI INTERRUPTS WITHOUT I/O-MEMORY PARITY ENABLED

006F                    D7_A:
006F B0 0F                      MOV    AL,CMOS_SHUT_DOWN       ; TURN ON NMI
0071 E6 70                      OUT    CMOS_PORT,AL            ; ADDRESS DEFAULT READ ONLY REGISTER
0073 B9 0007                    MOV    CX,7                    ; DELAY COUNT FOR 100 MICROSECONDS
0076 E8 0000 E                  CALL   WAITF                   ; WAIT FOR HOT NMI TO PROCESS
0079 B0 8F                      MOV    AL,CMOS_SHUT_DOWN+NMI   ; TURN NMI ENABLE BACK OFF
007B E6 70                      OUT    CMOS_PORT,AL
007D 80 3E 006B R 00            CMP    @INTR_FLAG,00H          ; DID ANY INTERRUPTS OCCUR?
0082 74 09                      JZ     D7_C                    ; CONTINUE IF NOT

0084 B0 28                      MOV    AL,28H                  ;       <><><><><><><><><><><><>
0086 E6 80                      OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  28 <><>

0088 BE 0000 E                  MOV    SI,OFFSET E107          ; DISPLAY 107 ERROR
008B EB C4                      JMP    D6A

                        ;-----  TEST THE DATA BUS TO TIMER 2

008D B0 29              D7_C:   MOV    AL,29H                  ;       <><><><><><><><><><><><>
008F E6 80                      OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  29 <><>
0091 E4 61                      IN     AL,PORT_B               ; GET CURRENT SETTING OF PORT
0093 8A E0                      MOV    AH,AL                   ; SAVE THAT SETTING
0095 24 FC                      AND    AL,0FCH                 ; INSURE SPEAKER OFF
0097 E6 61                      OUT    PORT_B,AL

0099 B0 B0                      MOV    AL,10110000B            ; SELECT TIM 2,LSB,MSB,BINARY,MODE 0
009B E6 43                      OUT    TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
009D EB 00                      JMP    $+2                     ; I/O DELAY
009F B8 AA55                    MOV    AX,0AA55H               ; WRITE AN AA55
00A2 E6 42                      OUT    TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
00A4 EB 00                      JMP    $+2                     ; I/O DELAY
00A6 8A C4                      MOV    AL,AH
00A8 E6 42                      OUT    TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
00AA EB 00                      JMP    $+2                     ; I/O DELAY
00AC E4 42                      IN     AL,TIMER+2              ; GET THE LSB
00AE 86 E0                      XCHG   AH,AL                   ; SAVE IT
00B0 EB 00                      JMP    $+2                     ; I/O DELAY
00B2 E4 42                      IN     AL,TIMER+2              ; GET THE MSB
00B4 3D 55AA                    CMP    AX,055AAH               ; BUS OK?
00B7 74 05                      JZ     D7_D                    ; GO IF OK

00B9 BE 0000 E                  MOV    SI,OFFSET E108          ; DISPLAY 108 ERROR
00BC EB 93                      JMP    D6A

                        ;------------------------------------------------------
                        ; TEST.18                                              :
                        ;       8254 TIMER CHECKOUT                            :
                        ; DESCRIPTION                                          :
                        ;       VERIFY THAT THE SYSTEM TIMER (0) DOESN'T COUNT :
                        ;       TOO FAST OR TOO SLOW.                          :
                        ;------------------------------------------------------

00BE B0 2A              D7_D:   MOV    AL,2AH                  ;       <><><><><><><><><><><><>
00C0 E6 80                      OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  2A <><>
00C2 FA                         CLI                            ;
00C3 B0 FE                      MOV    AL,0FEH                 ; MASK ALL INTERRUPTS EXCEPT LEVEL 0
00C5 E6 21                      OUT    INTA01,AL               ; WRITE THE 8259 IMR
00C7 B0 10                      MOV    AL,00010000B            ; SELECT TIM 0, LSB, MODE 0, BINARY
00C9 E6 43                      OUT    TIMER+3,AL              ; WRITE TIMER CONTROL MODE REGISTER
00CB B9 002C                    MOV    CX,2CH                  ; SET PROGRAM LOOP COUNT

00CE EB 00                      JMP    $+2                     ; I/O DELAY
```

```
0000 8A C1                        MOV     AL,CL                   ; SET TIMER 0 COUNT REGISTER
00D2 E6 40                        OUT     TIMER+0,AL              ; WRITE TIMER 0 COUNT REGISTER
00D4 FB                           STI
00D5 F6 06 006B R 01      D8:     TEST    @INTR_FLAG,01H
                                                                  ; DID TIMER 0 INTERRUPT OCCUR?
00DA 75 0D                        JNZ     D9                      ; CHECK TIMER OPERATION FOR SLOW TIME
00DC E2 F7                        LOOP    D8                      ; WAIT FOR INTERRUPT FOR SPECIFIED TIME

00DE C6 06 0015 R 02              MOV     @MFG_ERR_FLAG,02H       ;       <><><><><><><><><><><><><><>
                                                                  ;       <><> TIMER CHECKPOINT (2) <><>

00E3 BE 0000 E            D8_A:   MOV     SI,OFFSET E102          ; DISPLAY 102 ERROR
00E6 E9 0051 R                    JMP     D6A                     ; TIMER 0 INTERRUPT DID NOT OCCUR= ERROR


00E9 B0 2B                D9:     MOV     AL,2BH                  ;       <><><><><><><><><><><><>
00EB E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2B <><>

00ED FA                           CLI
00EE B1 0C                        MOV     CL,12                   ; SET PROGRAM LOOP COUNT
00F0 B0 FF                        MOV     AL,0FFH                 ; WRITE TIMER 0 COUNT REGISTER
00F2 E6 40                        OUT     TIMER+0,AL
00F4 C6 06 006B R 00              MOV     @INTR_FLAG,0            ; RESET INTERRUPT RECEIVED FLAG
00F9 B0 FE                        MOV     AL,0FEH                 ; RE-ENABLE TIMER 0 INTERRUPTS
00FB E6 21                        OUT     INTA01,AL
00FD FB                           STI
00FE F6 06 006B R 01      D10:    TEST    @INTR_FLAG,01H          ; DID TIMER 0 INTERRUPT OCCUR?
0103 75 DE                        JNZ     D8_A                    ; YES - TIMER COUNTING TOO FAST, ERROR
0105 E2 F7                        LOOP    D10                     ; WAIT FOR INTERRUPT FOR SPECIFIED TIME

                          ;-----  WAIT FOR INTERRUPT

0107 2B C9                        SUB     CX,CX

0109 B0 2C                        MOV     AL,2CH                  ;       <><><><><><><><><><><><>
010B E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2C <><>
010D                      D110:
010D F6 06 006B R 01              TEST    @INTR_FLAG,01H          ; DID TIMER 0 INTERRUPT OCCUR?
0112 75 08                        JNZ     D12                     ; GO IF YES
0114 E2 F7                        LOOP    D110                    ; TRY AGAIN

0116 BE 0000 E                    MOV     SI,OFFSET E103          ; DISPLAY 103 ERROR
0119 E9 0051 R                    JMP     D6A                     ; ERROR IF NOT

                          ;-----  SETUP TIMER 0 TO MODE 3

011C FA                   D12:    CLI
011D B0 FF                        MOV     AL,0FFH                 ; DISABLE ALL DEVICE INTERRUPTS
011F E6 21                        OUT     INTA01,AL
0121 B0 36                        MOV     AL,36H                  ; SELECT TIMER 0,LSB,MSB,MODE 3
0123 E6 43                        OUT     TIMER+3,AL              ; WRITE TIMER MODE REGISTER
0125 EB 00                        JMP     $+2                     ; I/O DELAY
0127 B0 00                        MOV     AL,0
0129 E6 40                        OUT     TIMER+0,AL              ; WRITE LSB TO TIMER 0 REGISTER
012B EB 00                        JMP     $+2                     ; I/O DELAY
012D E6 40                        OUT     TIMER+0,AL              ; WRITE MSB TO TIMER 0 REGISTER

                          ;-----  CHECK 8042 FOR LAST COMMAND ACCEPTED

012F 2B C9                        SUB     CX,CX                   ; SET WAIT TIME
0131 B0 2D                        MOV     AL,2DH                  ;       <><><><><><><><><><><><>
0133 E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2D <><>
0135 E4 64                D13:    IN      AL,STATUS_PORT          ; GET THE 8042 STATUS
0137 A8 02                        TEST    AL,INPT_BUF_FULL        ; HAS THE LAST COMMAND BEEN ACCEPTED?
0139 74 08                        JZ      E19                     ; GO IF YES
013B E2 F8                        LOOP    D13                     ; TRY AGAIN

                          ;-----  ERROR EXIT (MESSAGE 105)

013D BE 0000 E                    MOV     SI,OFFSET E105          ; PRINT 105 ERROR
0140 E9 0051 R                    JMP     D6A                     ; GO ERROR HALT


                          ;--------------------------------------------------------------------
                          ; TEST.19                                                            :
                          ;       ADDITIONAL READ/WRITE STORAGE TEST                           :
                          ;       ++++ MUST RUN IN PROTECTED MODE ++++                         :
                          ; DESCRIPTION                                                        :
                          ;       WRITE/READ DATA PATTERNS TO ANY READ/WRITE STORAGE AFTER THE :
                          ;       FIRST 64K.  STORAGE ADDRESSABILITY IS CHECKED.               :
                          ;--------------------------------------------------------------------


                                  ASSUME  DS:DATA
0143                      E19:
0143 E8 0000 E                    CALL    DDS                     ; SET DATA SEGMENT
0146 B0 2F                        MOV     AL,2FH                  ;       <><><><><><><><><><><><>
0148 E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  2F <><>

014A 81 3E 0072 R 1234            CMP     @RESET_FLAG,1234H       ; WARM START?
0150 75 03                        JNE     E19A                    ; GO IF NOT
0152 E9 0420 R                    JMP     SHUT2                   ; GO TO NEXT TEST IF WARM START

                          ;-----  SET SHUTDOWN RETURN 2

0155 B0 30                E19A:   MOV     AL,30H                  ;       <><><><><><><><><><><><>
0157 E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  30 <><>

0159 B8 028F                      MOV     AX,2*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
015C E8 0000 E                    CALL    CMOS_WRITE              ; SECOND ENTRY IN SHUTDOWN TABLE

                          ;-----  ENABLE PROTECTED MODE

015F BC 0000                      MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
0162 8E D4                        MOV     SS,SP
0164 BC 8000                      MOV     SP,POST_SP

0167 E8 0000 E                    CALL    SYSINIT1                ; GO ENABLE PROTECTED MODE

016A B0 31                        MOV     AL,31H                  ;       <><><><><><><><><><><><>
016C E6 80                        OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  31 <><>

                          ;-----  SET TEMPORARY STACK

016E 6A 08                        PUSH    BYTE PTR GDT_PTR
0170 07                           POP     ES
```

SECTION 5

```
0171 26: C7 06 005A 0000          MOV     ES:SS_TEMP.BASE_LO_WORD,0
0178 26: C6 06 005C 00            MOV     BYTE PTR ES:(SS_TEMP.BASE_HI_BYTE),0
017E BE 0058                      MOV     SI,SS_TEMP
0181 8E D6                        MOV     SS,SI
0183 BC FFFD                      MOV     SP,MAX_SEG_LEN-2

                          ;-----  DATA SEGMENT TO SYSTEM DATA AREA

0186 6A 18                        PUSH    BYTE PTR RSDA_PTR        ; POINT TO DATA AREA
0188 1F                           POP     DS

0189 B0 80                        MOV     AL,PARITY_CHECK          ; SET CHECK PARITY
018B E6 87                        OUT     DMA_PAGE+6,AL            ; SAVE WHICH CHECK TO USE

                          ;-----  PRINT 64 K BYTES OK

018D B8 0040                      MOV     AX,64                    ; STARTING AMOUNT OF MEMORY OK
0190 E8 09A0 R                    CALL    PRT_OK                   ; POST 65K OK MESSAGE

                          ;-----  GET THE MEMORY SIZE DETERMINED (PREPARE BX AND DX FOR BAD CMOS)

0193 B8 B0B1                      MOV     AX,(CMOS_U_M_S_LO+NMI)*H+CMOS_U_M_S_HI+NMI
0196 E8 0000 E                    CALL    CMOS_READ                ; HIGH BYTE
0199 86 E0                        XCHG    AH,AL                    ; SAVE HIGH BYTE
019B E8 0000 E                    CALL    CMOS_READ                ; LOW BYTE
019E 8B 1E 0013 R                 MOV     BX,@MEMORY_SIZE          ; LOAD THE BASE MEMORY SIZE
01A2 8B D3                        MOV     DX,BX                    ; SAVE BASE MEMORY SIZE
01A4 03 D8                        ADD     BX,AX                    ; SET TOTAL MEMORY SIZE

                          ;-----  IS CMOS GOOD?

01A6 B0 8E                        MOV     AL,CMOS_DIAG+NMI         ; DETERMINE THE CONDITION OF CMOS
01A8 E8 0000 E                    CALL    CMOS_READ                ; GET THE CMOS STATUS

01AB A8 C0                        TEST    AL,BAD_BAT+BAD_CKSUM     ; CMOS OK?
01AD 74 02                        JZ      E20B0                    ; GO IF YES
01AF EB 5B                        JMP     SHORT E20C               ; DEFAULT IF NOT

                          ;-----  GET THE BASE 0->640K MEMORY SIZE FROM CONFIGURATION IN CMOS

01B1                      E20B0:
01B1 B8 9596                      MOV     AX,(CMOS_B_M_S_LO+NMI)*H+CMOS_B_M_S_HI+NMI
01B4 E8 0000 E                    CALL    CMOS_READ                ; HIGH BYTE
01B7 24 3F                        AND     AL,03FH                  ; MASK OFF THE MANUFACTURING TEST BITS
01B9 86 E0                        XCHG    AH,AL                    ; SAVE HIGH BYTE
01BB E8 0000 E                    CALL    CMOS_READ                ; LOW BYTE OF BASE MEMORY SIZE
01BE 3B D0                        CMP     DX,AX                    ; IS MEMORY SIZE GREATER THAN CONFIG?
01C0 74 13                        JZ      E20B1                    ; GO IF EQUAL

                          ;-----  SET MEMORY SIZE DETERMINE NOT EQUAL TO CONFIGURATION

01C2 50                           PUSH    AX                       ; SAVE AX
01C3 B8 8E8E                      MOV     AX,X*(CMOS_DIAG+NMI)     ; ADDRESS THE STATUS BYTE
01C6 E8 0000 E                    CALL    CMOS_READ                ; GET THE STATUS
01C9 0C 10                        OR      AL,W_MEM_SIZE            ; SET CMOS FLAG
01CB 86 C4                        XCHG    AL,AH                    ; SAVE AL AND GET ADDRESS
01CD E8 0000 E                    CALL    CMOS_WRITE               ; WRITE UPDATED STATUS
01D0 58                           POP     AX                       ; RESTORE AX
01D1 3B D0                        CMP     DX,AX                    ; IS MEMORY SIZE GREATER THAN CONFIG ?
01D3 77 37                        JA      E20C                     ; DEFAULT TO MEMORY SIZE DETERMINED ?
01D5                      E20B1:
01D5 8B D8                        MOV     BX,AX                    ; SET BASE MEMORY SIZE IN TOTAL REGISTER
01D7 8B D0                        MOV     DX,AX                    ; SAVE IN BASE SIZE REGISTER

                          ;-----  CHECK MEMORY SIZE ABOVE 640K FROM CONFIGURATION

01D9 B8 9798                      MOV     AX,(CMOS_E_M_S_LO+NMI)*H+(CMOS_E_M_S_HI+NMI)
01DC E8 0000 E                    CALL    CMOS_READ                ; HIGH BYTE
01DF 86 E0                        XCHG    AH,AL                    ; SAVE HIGH BYTE
01E1 E8 0000 E                    CALL    CMOS_READ                ; LOW BYTE
01E4 8B C8                        MOV     CX,AX                    ; SAVE THE ABOVE 640K MEMORY SIZE
                          ;-----  ABOVE 640K SIZE FROM MEMORY SIZE DETERMINE
                          ;-----  CX=CONFIG  AX=MEMORY SIZE DETERMINE
01E6 B8 B0B1                      MOV     AX,(CMOS_U_M_S_LO+NMI)*H+(CMOS_U_M_S_HI+NMI)
01E9 E8 0000 E                    CALL    CMOS_READ                ; HIGH BYTE
01EC 86 E0                        XCHG    AH,AL                    ; SAVE HIGH BYTE
01EE E8 0000 E                    CALL    CMOS_READ                ; LOW BYTE
                          ;------ WHICH IS GREATER - AX = MEMORY SIZE DETERMINE
                          ;------ CX = CONFIGURATION (ABOVE 640) BX = SIZE (BELOW 640)

01F1 3B C8                        CMP     CX,AX                    ; IS CONFIGURATION EQUAL TO DETERMINED?
01F3 74 0F                        JZ      SET_MEM1                 ; GO IF EQUAL

                          ;-----  SET MEMORY SIZE DETERMINE NOT EQUAL TO CONFIGURATION

01F5 50                           PUSH    AX                       ; SAVE AX
01F6 B8 8E8E                      MOV     AX,X*(CMOS_DIAG+NMI)     ; ADDRESS THE STATUS BYTE
01F9 E8 0000 E                    CALL    CMOS_READ                ; GET THE STATUS
01FC 0C 10                        OR      AL,W_MEM_SIZE            ; SET CMOS FLAG
01FE 86 C4                        XCHG    AL,AH                    ; SAVE AL
0200 E8 0000 E                    CALL    CMOS_WRITE               ; UPDATE STATUS BYTE
0203 58                           POP     AX                       ; RESTORE AX

0204                      SET_MEM1:
0204 3B C8                        CMP     CX,AX                    ; IS CONFIG GREATER THAN DETERMINED?
0206 77 02                        JA      SET_MEM                  ;  GO IF YES
0208 8B C8                        MOV     CX,AX                    ; USE MEMORY SIZE DETERMINE IF NOT
020A                      SET_MEM:
020A 03 D9                        ADD     BX,CX                    ; SET TOTAL MEMORY SIZE
020C                      E20C:
020C 81 FA 0201                   CMP     DX,513                   ; CHECK IF BASE MEMORY LESS 512K
0210 72 0D                        JB      NO_640                   ; GO IF YES

0212 B8 B3B3                      MOV     AX,X*(CMOS_INFO128+NMI)  ; SET 640K BASE MEMORY BIT
0215 E8 0000 E                    CALL    CMOS_READ                ; GET THE CURRENT STATUS
0218 0C 80                        OR      AL,M640K                 ; TURN ON 640K BIT IF NOT ALREADY ON
021A 86 C4                        XCHG    AL,AH                    ; SAVE THE CURRENT DIAGNOSTIC STATUS
021C E8 0000 E                    CALL    CMOS_WRITE               ; RESTORE THE STATUS
021F                      NO_640:
021F 89 1E 0017 R                 MOV     WORD PTR @KB_FLAG,BX     ; SAVE TOTAL SIZE FOR LATER TESTING
0223 C1 EB 06                     SHR     BX,6                     ; DIVIDE BY 64
0226 4B                           DEC     BX                       ; 1ST 64K ALREADY DONE
0227 C1 EA 06                     SHR     DX,6                     ; DIVIDE BY 64 FOR BASE

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```
                                ;-----  SAVE COUNTS IN STACK FOR BOTH MEMORY AND ADDRESSING TESTS

 022A 52                                PUSH    DX                      ; SAVE BASE MEMORY SIZE COUNT
 022B 6A 40                             PUSH    BYTE PTR 64             ; SAVE STARTING AMOUNT OF MEMORY OK
 022D 53                                PUSH    BX                      ; SAVE COUNT OF 64K BLOCKS TO BE TESTED

 022E 52                                PUSH    DX                      ; SAVE BASE MEMORY SIZE COUNT
 022F 6A 40                             PUSH    BYTE PTR 64             ; SAVE STARTING AMOUNT OF MEMORY OK
 0231 53                                PUSH    BX                      ; SAVE COUNT OF 64K BLOCKS TO BE TESTED

                                ;-----  MODIFY DESCRIPTOR TABLES

 0232 6A 08                             PUSH    BYTE PTR GDT_PTR        ; MODIFY THE DESCRIPTOR TABLE
 0234 07                                POP     ES

                                ;-----  SET TEMPORARY ES DESCRIPTOR 64K SEGMENT LIMIT STARTING AT 000000

 0235 26: C7 06 0048 FFFF               MOV     ES:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
 023C 26: C7 06 004A 0000               MOV     ES:ES_TEMP.BASE_LO_WORD,0
 0243 26: C6 06 004C 00                 MOV     BYTE PTR ES:(ES_TEMP.BASE_HI_BYTE),0          ; FIRST 65K
 0249 26: C6 06 004D 93                 MOV     BYTE PTR ES:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                                ;-----  SET TEMPORARY DS DESCRIPTOR 64K SEGMENT LIMIT AT FIRST 65K BLOCK

 024F 26: C7 06 0060 FFFF               MOV     ES:DS_TEMP.SEG_LIMIT,MAX_SEG_LEN
 0256 26: C7 06 0062 0000               MOV     ES:DS_TEMP.BASE_LO_WORD,0
 025D 26: C6 06 0064 00                 MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0
 0263 26: C6 06 0065 93                 MOV     BYTE PTR ES:(DS_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                                ;-----  TEMPORARY SEGMENT SAVE IN DMA PAGE REGISTER FOR SECOND 65K BLOCK

 0269 2A C0                             SUB     AL,AL                   ; INITIALIZE VALUES TO 010000
 026B E6 85                             OUT     DMA_PAGE+4,AL           ; HIGH BYTE OF LOW WORD OF SEGMENT
 026D E6 86                             OUT     DMA_PAGE+5,AL           ; LOW BYTE OF LOW WORD OF SEGMENT
 026F FE C0                             INC     AL                      ; SET HIGH BYTE OF SEGMENT WORD
 0271 E6 84                             OUT     DMA_PAGE+3,AL           ; HIGH BYTE OF SEGMENT


                                ;-----  MEMORY TEST LOOP - POINT TO NEXT BLOCK OF 32K WORDS (64K)

 0273                           E21:                                    ;       MEMORY TEST LOOP
 0273 6A 08                             PUSH    BYTE PTR GDT_PTR        ; POINT TO START OF DESCRIPTOR TABLE
 0275 1F                                POP     DS
 0276 FE 06 0064                        INC     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE)      ; POINT TO NEXT BLOCK
 027A FE 06 004C                        INC     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE)

                                ;-----  CHECK FOR END OF 256K PLANAR MEMORY

 027E 80 3E 0064 04                     CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),04H
 0283 72 04                             JB      E21_0                   ; GO IF STILL FIRST 256K OF BASE MEMORY

 0285 B0 C0                             MOV     AL,PARITY_CHECK+IO_CHECK; CHECK FOR ANY TYPE OF PARITY ERROR
 0287 E6 87                             OUT     DMA_PAGE+6,AL           ; AFTER FIRST 256K

                                ;-----  CHECK END OF FIRST 640K OR ABOVE (END OF MAXIMUM BASE MEMORY)
 0289                           E21_0:
 0289 80 3E 0064 0A                     CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),0AH
 028E 77 16                             JA      NEXT                    ; CONTINUE IF ABOVE 1 MEG

                                ;-----  CHECK FOR END OF BASE MEMORY TO BE TESTED

 0290 59                                POP     CX                      ; GET COUNT
 0291 5B                                POP     BX                      ; GET COUNT TESTED
 0292 58                                POP     AX                      ; RECOVER COUNT OF BASE MEMORY BLOCKS
 0293 50                                PUSH    AX                      ; SAVE BASE COUNT
 0294 53                                PUSH    BX                      ; SAVE TESTED COUNT
 0295 51                                PUSH    CX                      ; SAVE TOTAL COUNT
 0296 38 06 0064                        CMP     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),AL           ; MAX BASE COUNT
 029A 72 0A                             JB      NEXT                    ; CONTINUE IF NOT DONE WITH BASE MEMORY

                                ;-----  DO ADDITIONAL STORAGE ABOVE 1 MEG

 029C C6 06 0064 10                     MOV     BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE),10H
 02A1 C6 06 004C 10                     MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),10H

                                ;-----  SAVE BASE_HI_BYTE IN DMA PAGE REGISTERS 3

 02A6 A0 0064                   NEXT:   MOV     AL,BYTE PTR DS:(DS_TEMP.BASE_HI_BYTE)
 02A9 E6 84                             OUT     DMA_PAGE+3,AL           ; SAVE THE HIGH BYTE OF SEGMENT
                                                                        ;  FOR POSSIBLE ERROR

                                ;-----  CHECK FOR TOP OF MEMORY (FE0000) 16 MEG

 02AB 80 3E 004C FE                     CMP     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0FEH ; TOP OF MEMORY?
 02B0 74 29                             JE      KB_LOOP3                                ; EXIT NEXT TEST IF DONE

                                ;-----  SET ES AND DS REGISTERS TO MEMORY BLOCK

 02B2 6A 60                             PUSH    BYTE PTR DS_TEMP
 02B4 1F                                POP     DS
 02B5 6A 48                             PUSH    BYTE PTR ES_TEMP
 02B7 07                                POP     ES

 02B8 B0 31                             MOV     AL,31H                  ;       <><><><><><><><><><><><>
 02BA E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  31 <><>

 02BC B9 8000                           MOV     CX,8000H                ; SET COUNT FOR 32K WORDS
 02BF E8 0000 E                         CALL    STGTST_CNT
 02C2 74 03                             JZ      N1                      ; SKIP IF OK
 02C4 E9 0367 R                         JMP     E21A                    ; GO PRINT ERROR
 02C7                           N1:
 02C7 59                                POP     CX                      ; POP CX TO GET AX
 02C8 58                                POP     AX                      ; RECOVER TESTED MEMORY

                                ;-----  WRITE THE CURRENT SIZE FOR (ADDRESS LINE 23-17 TEST) USED LATER

 02C9 2B FF                             SUB     DI,DI                   ; POINT TO BEGINNING OR A BLOCK
 02CB AB                                STOSW                           ; WRITE THE CURRENT SIZE
                                                                        ;  AT THE STARTING ADDRESS
 02CC 05 0040                           ADD     AX,64                   ; ADVANCE COUNT TO NEXT BLOCK
 02CF 50                                PUSH    AX                      ; SAVE TESTED MEMORY
 02D0 51                                PUSH    CX                      ; SAVE LOOP COUNT

 02D1 E8 09A0 R                         CALL    PRT_OK                  ; DISPLAY "0XXXX OK" MESSAGE
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02D4 59                             POP     CX                      ; RECOVER 64K BLOCK COUNT
02D5 49                             DEC     CX                      ; DECREMENT BLOCK COUNT FOR LOOP
02D6 E3 03                          JCXZ    KB_LOOP3                ; CONTINUE TO NEXT TEST IF DONE

02D8 51                             PUSH    CX                      ; SAVE LOOP COUNT
02D9 EB 98                          JMP     E21                     ; LOOP TILL ALL MEMORY CHECKED

02DB                        KB_LOOP3:                               ;       END MAIN TEST LOOP
02DB 58                             POP     AX                      ; CLEAR MAXIMUM BLOCK COUNT
02DC 58                             POP     AX                      ; CLEAR BASE SIZE COUNT FROM STACK
                                                                    ; ADDRESS TEST VALUES ARE IN STACK
                            ;-----  ADDRESS LINE 16-23 TEST
                                                                    ;       LET FIRST PASS BE SEEN
02DD B9 40BB                        MOV     CX,16571                ; COUNT FOR 250 MS FIXED TIME DELAY
02E0 E8 0000 E                      CALL    WAITF                   ; ALLOW SIX DISPLAY REFRESH CYCLES

                            ;-----  INITIALIZE DS DESCRIPTOR

02E3 6A 08                          PUSH    BYTE PTR GDT_PTR
02E5 07                             POP     ES
02E6 26: C6 06 0064 00              MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0
02EC 26: C7 06 0062 0000            MOV     ES:DS_TEMP.BASE_LO_WORD,0

                            ;-----  TEMPORARY SEGMENT SAVE IN DMA PAGE REGISTER

02F3 2A C0                          SUB     AL,AL
02F5 E6 85                          OUT     DMA_PAGE+4,AL           ; HIGH BYTE OF LOW WORD OF SEGMENT
02F7 E6 86                          OUT     DMA_PAGE+5,AL           ; LOW BYTE OF LOW WORD OF SEGMENT
02F9 B0 01                          MOV     AL,01H                  ; SET HIGH BYTE OF SEGMENT WORD
02FB E6 84                          OUT     DMA_PAGE+3,AL           ; HIGH BYTE OF SEGMENT

                            ;-----  POINT TO NEXT BLOCK OF 64K

02FD                        E21_A:
02FD B0 33                          MOV     AL,33H                  ;       <><><><><><><><><><><><><>
02FF E6 80                          OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  33 <><>
0301 26: 80 06 0064 01              ADD     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),01

                            ;-----  CHECK FOR END OF BASE MEMORY TO BE TESTED

0307 26: 80 3E 0064 0A              CMP     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),0AH
030D 77 13                          JA      NEXT_A                  ; CONTINUE IF ABOVE 1 MEG

030F 59                             POP     CX                      ; GET COUNT
0310 5B                             POP     BX                      ; GET COUNT TESTED
0311 58                             POP     AX                      ; RECOVER COUNT OF BASE MEMORY BLOCKS
0312 50                             PUSH    AX                      ; SAVE BASE COUNT
0313 53                             PUSH    BX                      ; SAVE TESTED COUNT
0314 51                             PUSH    CX                      ; SAVE TOTAL COUNT
0315 26: 38 06 0064                 CMP     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),AL         ; MAX BASE COUNT
031A 72 06                          JB      NEXT_A                  ; CONTINUE IF NOT DONE WITH BASE MEMORY

                            ;-----  DO ADDITIONAL STORAGE ABOVE 1 MEG

031C                        NEXT_A2:
031C 26: C6 06 0064 10              MOV     BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE),10H
0322                        NEXT_A:
0322 26: A0 0064                    MOV     AL,BYTE PTR ES:(DS_TEMP.BASE_HI_BYTE)

                            ;-----  DMA PAGE REGISTERS 3
                                                                    ; SAVE THE HIGH BYTE OF SEGMENT
0326 E6 84                          OUT     DMA_PAGE+3,AL           ;  FOR POSSIBLE ERROR

                            ;-----  CHECK FOR TOP OF MEMORY (FE0000) 16 MEG

0328 3C FE                          CMP     AL,0FEH                 ; TOP OF MEMORY?
032A 74 34                          JZ      KB_LOOP_3               ; GO NEXT TEST IF IT IS

                            ;-----  SET DS REGISTER

032C 6A 60                          PUSH    BYTE PTR DS_TEMP
032E 1F                             POP     DS
032F 2B FF                          SUB     DI,DI                   ; POINT TO START OF BLOCK
0331 8B 15                          MOV     DX,DS:[DI]              ; GET THE VALUE OF THIS BLOCK
0333 8B F7                          MOV     SI,DI                   ; SET SI FOR POSSIBLE ERROR
0335 2B C0                          SUB     AX,AX                   ; CLEAR MEMORY LOCATION
0337 89 05                          MOV     [DI],AX

                            ;-----  ALLOW DISPLAY TIME TO DISPLAY MESSAGE AND REFRESH TO RUN

0339 B9 1A69                        MOV     CX,6761                 ; COUNT FOR 102 MS FIXED TIME DELAY
033C E8 0000 E                      CALL    WAITF                   ; ALLOW FIVE DISPLAY REFRESH CYCLES
033F 59                             POP     CX                      ; GET THE LOOP COUNT
0340 58                             POP     AX                      ; RECOVER TESTED MEMORY
0341 50                             PUSH    AX                      ; SAVE TESTED MEMORY
0342 51                             PUSH    CX                      ; SAVE LOOP COUNT
0343 3B C2                          CMP     AX,DX                   ; DOES THE BLOCK ID MATCH
0345 8B C2                          MOV     AX,DX                   ; GET THE BLOCK ID FOR POSSIBLE ERROR
0347 75 1E                          JNZ     E21A                    ; GO PRINT ERROR

                            ;-----  CHECK FOR CHECK PARITY

0349 E4 61                          IN      AL,PORT_B               ; CHECK FOR I/O OR PARITY CHECK
034B 24 C0                          AND     AL,PARITY_ERR           ; STRIP UNWANTED BITS
034D 75 18                          JNZ     E21A                    ; EXIT IF PARITY ERROR

034F 59                             POP     CX                      ; POP CX TO GET AX
0350 58                             POP     AX                      ; RECOVER TESTED MEMORY
0351 05 0040                        ADD     AX,64                   ; 64K INCREMENTS
0354 50                             PUSH    AX                      ; SAVE TESTED MEMORY
0355 51                             PUSH    CX                      ; SAVE LOOP COUNT
0356 E8 09A0 R                      CALL    PRT_OK                  ; DISPLAY OK MESSAGE
0359 59                             POP     CX                      ; RECOVER 64K BLOCK COUNT
035A 49                             DEC     CX                      ; LOOP TILL ALL MEMORY CHECKED
035B E3 03                          JCXZ    KB_LOOP_3               ; CONTINUE

035D 51                             PUSH    CX                      ; SAVE LOOP COUNT
035E EB 9D                          JMP     E21_A                   ; CONTINUE TILL DONE
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                               PAGE
                               ;-----  BACK TO REAL MODE - MEMORY TESTS DONE

      0360                     KB_LOOP_3:
      0360  B0 34                      MOV     AL,34H                  ;       <><><><><><><><><><><><><>
      0362  E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  34 <><>
                                                                       ; BACK TO REAL MODE
      0364  E9 0000 E                  JMP     PROC_SHUTDOWN           ; NEXT TEST VIA JUMP TABLE (SHUT2)


                               ;-----  PRINT FAILING ADDRESS AND XOR'ED PATTERN IF DATA COMPARE ERROR
                               ;-----  USE DMA PAGE REGISTERS AS TEMPORARY SAVE AREA FOR ERROR
                               ;       SET SHUTDOWN 3

      0367  E6 82              E21A:   OUT     DMA_PAGE+1,AL           ; SAVE FAILING BIT PATTERN (LOW BYTE)
      0369  8A C4                      MOV     AL,AH                   ; SAVE HIGH BYTE
      036B  E6 83                      OUT     DMA_PAGE+2,AL
      036D  8B C6                      MOV     AX,SI                   ; GET THE FAILING OFFSET
      036F  E6 86                      OUT     DMA_PAGE+5,AL
      0371  86 E0                      XCHG    AH,AL
      0373  E6 85                      OUT     DMA_PAGE+4,AL

                               ;-----  CLEAR I/O CHANNEL CHECK OR R/W PARITY CHECK

      0375  2B F6                      SUB     SI,SI                   ; WRITE TO FAILING BLOCK
      0377  AB                         STOSW
      0378  E4 61                      IN      AL,PORT_B               ; GET PARITY CHECK LATCHES
      037A  E6 88                      OUT     DMA_PAGE+7,AL           ; SAVE FOR ERROR HANDLER
      037C  0C 0C                      OR      AL,RAM_PAR_OFF          ; TOGGLE I/O-PARITY CHECK ENABLE
      037E  E6 61                      OUT     PORT_B,AL               ;  TO RESET CHECKS
      0380  24 F3                      AND     AL,RAM_PAR_ON
      0382  E6 61                      OUT     PORT_B,AL

                               ;-----  GET THE LAST OF GOOD MEMORY

      0384  58                         POP     AX                      ; CLEAR BLOCK COUNT
      0385  58                         POP     AX                      ; GET THE LAST OF GOOD MEMORY
      0386  5B                         POP     BX                      ; GET BASE MEMORY COUNTER
      0387  C1 E3 06                   SHL     BX,6                    ; CONVERT TO MEMORY SIZE COUNTS
      038A  2B C3                      SUB     AX,BX                   ; COMPARE LAST GOOD MEMORY WITH BASE
      038C  73 17                      JAE     E211                    ; IF ABOVE OR EQUAL, USE REMAINDER IN
                                                                       ;  CMOS_U_M_S_(H/L)
                               ;-----  ELSE SET BASE MEMORY SIZE

      038E  6A 18                      PUSH    BYTE PTR RSDA_PTR       ; SET THE DATA SEGMENT
      0390  1F                         POP     DS                      ; IN PROTECTED MODE

      0391  03 C3                      ADD     AX,BX                   ; CONVERT BACK TO LAST WORKING MEMORY
      0393  A3 0013 R                  MOV     @MEMORY_SIZE,AX         ; TO INDICATE HOW MUCH MEMORY WORKING

                               ;-----  RESET 512K --> 640K OPTION IF SET

      0396  B8 B3B3                    MOV     AX,X*(CMOS_INFO128+NMI) ; ADDRESS OPTIONS INFORMATION BYTE
      0399  E8 0000 E                  CALL    CMOS_READ               ; READ THE MEMORY INFORMATION FLAG
      039C  24 7F                      AND     AL,NOT M640K            ; SET 640K OPTION OFF
      039E  86 C4                      XCHG    AL,AH                   ; MOVE TO WORK REGISTER
      03A0  E8 0000 E                  CALL    CMOS_WRITE              ; UPDATE STATUS IF IT WAS ON
      03A3  33 C0                      XOR     AX,AX                   ; CLEAR VALUE FOR EXTENSION MEMORY
      03A5                     E211:
      03A5  8B C8                      MOV     CX,AX                   ; SAVE ADJUSTED MEMORY SIZE
      03A7  B0 B1                      MOV     AL,CMOS_U_M_S_HI+NMI
      03A9  E8 0000 E                  CALL    CMOS_WRITE              ; SAVE THE HIGH BYTE MEMORY SIZE
      03AC  8A E1                      MOV     AH,CL                   ; GET THE LOW BYTE
      03AE  B0 B0                      MOV     AL,CMOS_U_M_S_LO+NMI    ; DO THE LOW BYTE
      03B0  E8 0000 E                  CALL    CMOS_WRITE              ; WRITE IT

                               ;-----  SET SHUTDOWN 3

      03B3  B8 038F                    MOV     AX,3*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN RETURN
      03B6  E8 0000 E                  CALL    CMOS_WRITE                      ; SET RETURN 3

                               ;-----  SHUTDOWN

      03B9  E9 0000 E                  JMP     PROC_SHUTDOWN
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SECTION 5

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                                        PAGE
                                        ;--------------------------------------------------------------------
                                        ; MEMORY ERROR REPORTING          (R/W/ MEMORY OR PARITY ERRORS)     :
                                        ;                                                                    :
                                        ; DESCRIPTION FOR ERRORS 201 (CMP ERROR OR PARITY)                   :
                                        ;                      OR 202 (ADDRESS LINE 0-15 ERROR)              :
                                        ;                                                                    :
                                        ;       "AABBCC DDEE 201" (OR 202)                                   :
                                        ;                           AA=HIGH BYTE OF 24 BIT ADDRESS           :
                                        ;                           BB=MIDDLE BYTE OF 24 BIT ADDRESS         :
                                        ;                           CC=LOW BYTE OF 24 BIT ADDRESS            :
                                        ;                           DD=HIGH BYTE OF XOR FAILING BIT PATTERN  :
                                        ;                           EE=LOW BYTE OF XOR FAILING BIT PATTERN   :
                                        ;                                                                    :
                                        ; DESCRIPTION FOR ERROR 202 (ADDRESS LINE 00-15)                     :
                                        ;       A WORD OF FFFF IS WRITTEN AT THE FIRST WORD AND LAST WORD    :
                                        ;       OF EACH 64K BLOCK WITH ZEROS AT ALL OTHER LOCATIONS OF THE   :
                                        ;       BLOCK.  A SCAN OF THE BLOCK IS MADE TO INSURE ADDRESS LINE   :
                                        ;       0-15 ARE FUNCTIONING.                                        :
                                        ;                                                                    :
                                        ; DESCRIPTION FOR ERROR 203 (ADDRESS LINE 16-23)                     :
                                        ;       AT THE LAST PASS OF THE STORAGE TEST, FOR EACH BLOCK OF      :
                                        ;       64K, THE CURRENT STORAGE SIZE (ID) IS WRITTEN AT THE FIRST   :
                                        ;       WORD OF EACH BLOCK. IT IS USED TO FIND ADDRESSING FAILURES.  :
                                        ;                                                                    :
                                        ;       "AABBCC DDEE 203"                                            :
                                        ;                           SAME AS ABOVE EXCEPT FOR DDEE            :
                                        ;                                                                    :
                                        ; GENERAL DESCRIPTION FOR BLOCK ID (DDEE WILL NOW CONTAINED THE ID)  :
                                        ;       DD=HIGH BYTE OF BLOCK ID                                     :
                                        ;       EE=LOW BYTE OF BLOCK ID                                      :
                                        ;                                                                    :
                                        ;       BLOCK ID        ADDRESS RANGE                                :
                                        ;       0000            000000 --> 00FFFF                            :
                                        ;       0040            010000 --> 01FFFF                            :
                                        ;       //                                                           :
                                        ;       0200            090000 --> 09FFFF (512->576K) IF 640K BASE   :
                                        ;                       100000 --> 10FFFF (1024->1088K) IF 512K BASE :
                                        ;                                                                    :
                                        ; EXAMPLE (640K BASE MEMORY + 512K I/O MEMORY = 1152K TOTAL)         :
                                        ;       NOTE: THE CORRECT BLOCK ID FOR THIS FAILURE IS 0280 HEX.     :
                                        ;             DUE TO AN ADDRESS FAILURE THE BLOCK ID+128K OVERLAYED :
                                        ;             THE CORRECT BLOCK ID.                                  :
                                        ;                                                                    :
                                        ;       00640K OK        <-- LAST OK MEMORY                          :
                                        ;       10000 0300 202   <-- ERROR DUE TO ADDRESS FAILURE            :
                                        ;                                                                    :
                                        ; IF A PARITY LATCH WAS SET THE CORRESPONDING MESSAGE WILL DISPLAY.  :
                                        ;                                                                    :
                                        ;       "PARITY CHECK 1" (OR 2)                                      :
                                        ;                                                                    :
                                        ; DMA PAGE REGISTERS ARE USED AS TEMPORARY SAVE AREAS FOR SEGMENT    :
                                        ; DESCRIPTOR VALUES.                                                 :
                                        ;--------------------------------------------------------------------

 03BC                                   SHUT3:                                  ;         ENTRY FROM PROCESSOR SHUTDOWN 3
 03BC E8 0000 E                                 CALL    DDS                     ; SET REAL MODE DATA SEGMENT

                                                                                ;         <><> MEMORY FAILED  <><>
 03BF C6 06 0016 R 01                           MOV     @MFG_ERR_FLAG+1,MEM_FAIL; CLEAR AND SET MANUFACTURING ERROR FLAG
 03C4 B0 0D                                     MOV     AL,CR                   ; CARRIAGE RETURN
 03C6 E8 0000 E                                 CALL    PRT_HEX
 03C9 B0 0A                                     MOV     AL,LF                   ; LINE FEED
 03CB E8 0000 E                                 CALL    PRT_HEX
 03CE E4 84                                     IN      AL,DMA_PAGE+3           ; GET THE HIGH BYTE OF 24 BIT ADDRESS
 03D0 E8 0000 E                                 CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
 03D3 E4 85                                     IN      AL,DMA_PAGE+4           ; GET THE MIDDLE BYTE OF 24 BIT ADDRESS
 03D5 E8 0000 E                                 CALL    XPC_BYTE
 03D8 E4 86                                     IN      AL,DMA_PAGE+5           ; GET THE LOW BYTE OF 24 BIT ADDRESS
 03DA E8 0000 E                                 CALL    XPC_BYTE
 03DD B0 20                                     MOV     AL,' '                  ; SPACE TO MESSAGE
 03DF E8 0000 E                                 CALL    PRT_HEX
 03E2 E4 83                                     IN      AL,DMA_PAGE+2           ; GET HIGH BYTE FAILING BIT PATTERN
 03E4 E8 0000 E                                 CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
 03E7 E4 82                                     IN      AL,DMA_PAGE+1           ; GET LOW BYTE FAILING BIT PATTERN
 03E9 E8 0000 E                                 CALL    XPC_BYTE                ; CONVERT AND PRINT CODE

                                        ;-----  CHECK FOR ADDRESS ERROR

 03EC E4 80                                     IN      AL,MFG_PORT             ; GET THE CHECKPOINT
 03EE 3C 33                                     CMP     AL,33H                  ; IS IT AN ADDRESS FAILURE?
 03F0 BE 0000 E                                 MOV     SI,OFFSET E203          ; LOAD ADDRESS ERROR 16->23
 03F3 74 0A                                     JZ      ERR2                    ; GO IF YES

 03F5 BE 0000 E                                 MOV     SI,OFFSET E202          ; LOAD ADDRESS ERROR 00->15
 03F8 3C 32                                     CMP     AL,32H                  ; GO IF YES
 03FA 74 03                                     JZ      ERR2

 03FC BE 0000 E                                 MOV     SI,OFFSET E201          ; SETUP ADDRESS OF ERROR MESSAGE
 03FF                                   ERR2:
 03FF E8 0000 E                                 CALL    E_MSG                   ; PRINT ERROR MESSAGE
 0402 E4 88                                     IN      AL,DMA_PAGE+7           ; GET THE PORT_B VALUE

                                        ;-----  DISPLAY "PARITY CHECK ?" ERROR MESSAGES

 0404 A8 80                                     TEST    AL,PARITY_CHECK         ; CHECK FOR PLANAR ERROR
 0406 74 0B                                     JZ      NMI_M1                  ; SKIP IF NOT

 0408 50                                        PUSH    AX                      ; SAVE STATUS
 0409 E8 0990 R                                 CALL    PADING                  ; INSERT BLANKS
 040C BE 0000 E                                 MOV     SI,OFFSET D1            ; PLANAR ERROR, ADDRESS "PARITY CHECK 1"
 040F E8 0000 E                                 CALL    P_MSG                   ; DISPLAY "PARITY CHECK 1" MESSAGE
 0412 58                                        POP     AX                      ; AND RECOVER STATUS
 0413                                   NMI_M1:
 0413 A8 40                                     TEST    AL,IO_CHECK             ; I/O PARITY CHECK ?
 0415 74 09                                     JZ      NMI_M2                  ; SKIP IF CORRECT ERROR DISPLAYED

 0417 E8 0990 R                                 CALL    PADING                  ; INSERT BLANKS
 041A BE 0000 E                                 MOV     SI,OFFSET D2            ; ADDRESS OF "PARITY CHECK 2" MESSAGE
 041D E8 0000 E                                 CALL    P_MSG                   ; DISPLAY "PARITY CHECK 2" ERROR
 0420                                   NMI_M2:
                                                                                ; CONTINUE TESTING SYSTEM ....
```

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                                  PAGE
                                  ;-----  ENTRY FROM SHUTDOWN

 0420                             SHUT2:

                                  ;-------------------------------------------------------
                                  ; TEST.20                                              :
                                  ;       ADDITIONAL PROTECTED (VIRTUAL MODE) TEST       :
                                  ; DESCRIPTION                                          :
                                  ;       THE PROCESSOR IS PUT IN PROTECTED MODE AND     :
                                  ;       THE FOLLOWING FUNCTIONS ARE VERIFIED           :
                                  ;                                                      :
                                  ;       1. VERIFY PROTECTED MODE                       :
                                  ;          THE MACHINE STATUS IS CHECK FOR VIRTUAL MODE :
                                  ;       2. PROGRAMMED INTERRUPT TEST                   :
                                  ;          AN PROGRAMMED INTERRUPT 32 IS ISSUED AND    :
                                  ;          AND VERIFIED                                :
                                  ;       3. EXCEPTION INTERRUPT 13 TEST                 :
                                  ;          A DESCRIPTOR SEGMENT LIMIT IS SET TO ZERO   :
                                  ;          AND A WRITE TO THAT SEGMENT IS ATTEMPTED    :
                                  ;          AN EXCEPTION 13 IS EXPECTED AND VERIFIED    :
                                  ;       4. LDT/SDT LTR/STR TEST                        :
                                  ;          LOAD LDT REGISTER AND VERIFY CORRECT        :
                                  ;          LOAD TASK REGISTER AND VERIFY CORRECT       :
                                  ;          THEY ARE VERIFIED VIA THE STORE INSTRUCTION :
                                  ;       5. THE CONTROL FLAGS OF THE 286 FOR DIRECTION  :
                                  ;          ARE VERIFIED VIA THE STD AND CLD COMMANDS   :
                                  ;          IN PROTECTED MODE                           :
                                  ;       6. BOUND INSTRUCTION TEST (EXCEPTION INT 5)    :
                                  ;          CREATE A SIGNED ARRAY INDEX WITHIN AND      :
                                  ;          OUTSIDE THE LIMITS.  CHECK THAT NO EXC INT  :
                                  ;          IF WITHIN LIMIT AND THAT AN EXC INT 5       :
                                  ;          OCCURS IF OUTSIDE THE LIMITS.               :
                                  ;       7. PUSH ALL POP ALL TEST                       :
                                  ;          SET GENERAL PURPOSE REGISTERS TO DIFFERENT  :
                                  ;          VALUES, ISSUE A PUSH ALL, CLEAR THE REGISTERS:
                                  ;          THEN ISSUE A POP ALL AND VERIFY CORRECT.    :
                                  ;       8. CHECK THE VERR/VERW INSTRUCTIONS            :
                                  ;          THE ACCESS BYTE IS SET TO READ ONLY THEN TO :
                                  ;          A WRITE ONLY AND THE VERR/VERW INSTRUCTIONS :
                                  ;          ARE VERIFIED.                               :
                                  ;       9. CAUSE AN INTERRUPT 13 VIA A WRITE TO A      :
                                  ;          READ ONLY SEGMENT                           :
                                  ;      10. VERIFY THE ARPL INSTRUCTION FUNCTIONS       :
                                  ;          SET THE RPL FIELD OF A SELECTOR AND         :
                                  ;          VERIFY THAT CURRENT SELECTOR RPL IS SET     :
                                  ;          CORRECTLY.                                  :
                                  ;      11. VERIFY THE LAR INSTRUCTION FUNCTIONS        :
                                  ;      12. VERIFY THE LSL INSTRUCTION FUNCTIONS        :
                                  ;      13. LOW MEG CHIP SELECT TEST                    :
                                  ;-------------------------------------------------------

 0420  E9 0000 E                          JMP     POST3                   ; GO TEST THE 286 PROTECTED MODE

                                  ;-----  FAILURE ENTRY FROM A SHUTDOWN

 0423  E8 0000 E                  SHUT7:  CALL    DDS                     ; ESTABLISH THE DATA SEGMENT
 0426  E4 80                              IN      AL,MFG_PORT             ; CHECK FOR CHIP SELECT ERROR
 0428  3C 35                              CMP     AL,35H
 042A  BE 0000 E                          MOV     SI,OFFSET E109          ; PRINT ERROR 109
 042D  74 0D                              JZ      SHUT7B                  ; GO IF NOT
 042F  BE 0000 E                  SHUT7A: MOV     SI,OFFSET E104          ; PROTECTED MODE FAILED

 0432  80 0E 0016 R 02                    OR      @MFG_ERR_FLAG+1,PRO_FAIL;       <><><><><><><><><><><><><><><>
                                                                          ;       <><> VIRTUAL MODE FAILED  <><>

 0437  E8 0000 E                          CALL    E_MSG                   ; PRINT MESSAGE
 043A  EB 08                              JMP     SHORT SHUT6
 043C  E8 0000 E                  SHUT7B: CALL    E_MSG                   ; PRINT MESSAGE

 043F  80 0E 0016 R 04                    OR      @MFG_ERR_FLAG+1,LMCS_FAIL;      <><><><><><><><><><><><><><><>
                                                                          ;       <><> LOW MEG CHIP SELECT  <><>

                                  ;-----  PROTECTED MODE TEST PASSED ENTRY FROM A SHUTDOWN

 0444  E8 0000 E                  SHUT6:  CALL    DDS                     ; PROTECTED MODE TEST PASSED
 0447  2B C0                              SUB     AX,AX                   ; CLEAR KEYBOARD STATE FLAGS
 0449  A3 0017 R                          MOV     WORD PTR @KB_FLAG,AX
 044C  B9 000E                            MOV     CX,0EH                  ; CLEAR PAGE REGISTERS
 044F  BA 0082                            MOV     DX,DMA_PAGE+1
 0452                             CLR_LOOP:
 0452  2A C0                              SUB     AL,AL
 0454  EE                                 OUT     DX,AL
 0455  42                                 INC     DX
 0456  E2 FA                              LOOP    CLR_LOOP

                                  ;---------------------------------------------
                                  ; TEST.21                                    :
                                  ;       KEYBOARD TEST                        :
                                  ; DESCRIPTION                                :
                                  ;       RESET THE KEYBOARD AND CHECK THAT SCAN :
                                  ;       CODE "AA" IS RETURNED TO THE PROCESSOR. :
                                  ;       CHECK FOR STUCK KEYS.                :
                                  ;---------------------------------------------

 0458  B0 35                              MOV     AL,35H                  ;       <><><><><><><><><><><><>
 045A  E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  35 <><>

 045C  F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; MANUFACTURING BURN IN TEST MODE?
 0461  75 03                              JNZ     F7_A
 0463  E9 0516 R                          JMP     F7                      ; YES - SKIP KEYBOARD TEST
 0466  80 3E 0072 R 64            F7_A:   CMP     BYTE PTR @RESET_FLAG,064H ; MANUFACTURING RUN IN MODE?
 046B  75 03                              JNZ     F7_B
 046D  E9 0516 R                          JMP     F7                      ; YES - SKIP KEYBOARD TEST
 0470  B0 36                      F7_B:   MOV     AL,36H                  ;       <><><><><><><><><><><><>
 0472  E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  36 <><>
 0474  FA                                 CLI
 0475  81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; SOFT RESET?
 047B  74 17                              JZ      G10
 047D  80 3E 0072 R AA                    CMP     BYTE PTR @RESET_FLAG,KB_OK ; CHECK FOR AA ALREADY RECEIVED
 0482  74 10                              JZ      G10                     ; GO IF YES
 0484  B0 AE                              MOV     AL,ENA_KBD
 0486  E8 0000 E                          CALL    C8042                   ; ENABLE KEYBOARD
 0489  B7 04                              MOV     BH,4                    ; TRY 4 TIMES
```

SECTION 5

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048B E8 0000 E          LOOP1:  CALL    OBF_42                  ; CHECK FOR OUTPUT BUFFER FULL
048E 75 04                      JNZ     G10                     ; GO IF BUFFER FULL
0490 FE CF                      DEC     BH
0492 75 F7                      JNZ     LOOP1
0494 B0 AD              G10:    MOV     AL,DIS_KBD              ; DISABLE KEYBOARD
0496 E8 0000 E                  CALL    C8042
0499 E4 60                      IN      AL,PORT_A               ; FLUSH
049B B0 E0                      MOV     AL,KYBD_CLK_DATA        ; GET THE CLOCK AND DATA LINES
049D E8 0000 E                  CALL    C8042
04A0 E8 0000 E                  CALL    OBF_42                  ; WAIT FOR OUTPUT BUFFER FULL
04A3 E4 60                      IN      AL,PORT_A               ; GET THE RESULTS
04A5 A8 01                      TEST    AL,KYBD_CLK             ; KEYBOARD CLOCK MUST BE LOW
04A7 74 0A                      JZ      G11

04A9 80 0E 0016 R 08            OR      @MFG_ERR_FLAG+1,KYCLK_FAIL ;    <><><><><><><><><><><><><><>
                                                                ;       <><> KEYBOARD CLOCK HIGH  <><>
04AE BE 0000 E                  MOV     SI,OFFSET E304          ; DISPLAY 304 ERROR
04B1 EB 60                      JMP     SHORT F6D               ; REPORT ERROR
04B3 E8 0000 E          G11:    CALL    KBD_RESET               ; ISSUE RESET TO KEYBOARD
04B6 E3 29                      JCXZ    F6                      ; PRINT ERROR MESSAGE IF NO INTERRUPT
04B8 B0 37                      MOV     AL,37H                  ;       <><><><><><><><><><><><>
04BA E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  37 <><>
04BC 80 FB AA                   CMP     BL,KB_OK                ; SCAN CODE AS EXPECTED?
04BF 75 20                      JNE     F6                      ; NO - DISPLAY ERROR MESSAGE

                        ;-----  CHECK FOR STUCK KEYS

04C1 B0 38                      MOV     AL,38H                  ;       <><><><><><><><><><><><>
04C3 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  38 <><>

04C5 B0 AE                      MOV     AL,ENA_KBD              ; ASSURE KEYBOARD ENABLED
04C7 E8 0000 E                  CALL    C8042                   ; ISSUE THE COMMAND
04CA B9 19E4                    MOV     CX,6628                 ; COUNT FOR 100 MILLISECONDS
04CD E8 0000 E                  CALL    WAITF                   ; DELAY FOR A WHILE
04D0 E4 64                      IN      AL,STATUS_PORT          ; CHECK FOR STUCK KEYS
04D2 A8 01                      TEST    AL,OUT_BUF_FULL         ; OUT BUFFER FULL?
04D4 74 40                      JE      F7                      ; YES - CONTINUE TESTING

04D6 B0 39                      MOV     AL,39H                  ;       <><><><><><><><><><><><>
04D8 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  39 <><>

04DA E4 60                      IN      AL,PORT_A               ; GET THE SCAN CODE
04DC E8 0000 E                  CALL    XPC_BYTE                ; CONVERT AND PRINT
04DF EB 2A                      JMP     SHORT F6C               ; CONTINUE

                        ;-----  KEYBOARD ERROR TRY TO DETERMINE IF 8042 INTERFACE IS WORKING

04E1 FA                 F6:     CLI
04E2 B0 AB                      MOV     AL,INTR_FACE_CK         ; COMMAND TO 8042
04E4 E6 64                      OUT     STATUS_PORT,AL
04E6 2B C9                      SUB     CX,CX
04E8 B7 05                      MOV     BH,05                   ; WAIT FOR OUTPUT BUFFER FULL
04EA E4 64              F6A:    IN      AL,STATUS_PORT
04EC A8 01                      TEST    AL,OUT_BUF_FULL         ; 8042 FINISHED TEST?
04EE E1 FA                      LOOPZ   F6A
04F0 75 09                      JNZ     F6B                     ; GO CHECK RESULTS
04F2 FE CF                      DEC     BH
04F4 75 F4                      JNZ     F6A                     ; TRY AGAIN
04F6 BE 0000 E                  MOV     SI,OFFSET E303          ; INDICATE PLANAR FAILURE
04F9 EB 18                      JMP     SHORT F6D               ;    (REMOVE KEYBOARD TRY AGAIN)
04FB E4 60              F6B:    IN      AL,PORT_A               ; GET THE RESULTS OF INTERFACE TEST
04FD 3C 00                      CMP     AL,0                    ; IS THE INTERFACE OK?
04FF 74 0A                      JZ      F6C
0501 80 0E 0016 R 10            OR      @MFG_ERR_FLAG+1,KY_SYS_FAIL ;   <><><><><><><><><><><><>
                                                                ;       <><> KEYBOARD/SYSTEM  <><>
0506 BE 0000 E                  MOV     SI,OFFSET E303          ; PLANAR FAILURE
0509 EB 08                      JMP     SHORT F6D               ; GO IF YES
050B BE 0000 E          F6C:    MOV     SI,OFFSET E301          ; GET MESSAGE ADDRESS

050E 80 0E 0016 R 20            OR      @MFG_ERR_FLAG+1,KYBD_FAIL;      <><><><><><><><><><><><><><>
                                                                ;       <><> KEYBOARD FAILED  <><>

0513 E8 0000 E          F6D:    CALL    E_MSG                   ; PRINT MESSAGE ON SCREEN

                        ;-----  INITIALIZE 8042 TO HONOR KEY LOCK

0516 B0 3A              F7:     MOV     AL,3AH                  ;       <><><><><><><><><><><><>
0518 E6 80                      OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3A <><>

051A B0 FF                      MOV     AL,0FFH                 ; DISABLE INTERRUPTS
051C E6 21                      OUT     INTA01,AL
051E FA                         CLI
051F B0 60                      MOV     AL,WRITE_8042_LOC       ; WRITE 8042 MEMORY COMMAND
0521 E8 0000 E                  CALL    C8042                   ; ISSUE THE COMMAND
0524 B0 45                      MOV     AL,45H                  ; SET SYSTEM FLAG - OUTBUF INTERRUPT -
0526 E6 60                      OUT     PORT_A,AL               ; PC 1 COMPATIBILITY
                                                                ; RESET INHIBIT OVER RIDE
                        ;-----  DEGATE ADDRESS LINE 20

0528 B4 DD                      MOV     AH,DISABLE_BIT20        ; SET COMMAND IN AH
052A E8 0000 E                  CALL    GATE_A20                ; ISSUE THE COMMAND

                        ;-----  SETUP HARDWARE INTERRUPT VECTOR TABLE LEVEL 0-7

052D 2B C0                      SUB     AX,AX
052F 8E C0                      MOV     ES,AX
0531 B9 0008                    MOV     CX,08                   ; GET VECTOR COUNT
0534 0E                         PUSH    CS                      ; SETUP DS SEGMENT REGISTER
0535 1F                         POP     DS
0536 BE 0000 E                  MOV     SI,OFFSET VECTOR_TABLE
0539 BF 0020 R                  MOV     DI,OFFSET @INT_PTR
053C A5                 F7A:    MOVSW
053D 47                         INC     DI                      ; SKIP OVER SEGMENT
053E 47                         INC     DI
053F E2 FB                      LOOP    F7A

                        ;-----  SETUP HARDWARE INTERRUPT VECTORS LEVEL 8-15 (VECTORS START AT INT 70H)

                                ASSUME  ES:ABS0
0541 2B C0                      SUB     AX,AX
0543 8E C0                      MOV     ES,AX
0545 B9 0008                    MOV     CX,08                   ; GET VECTOR COUNT
0548 0E                         PUSH    CS                      ; SETUP DS SEGMENT REGISTER
0549 1F                         POP     DS
```

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054A BE 0000 E                          MOV     SI,OFFSET SLAVE_VECTOR_TABLE
054D BF 01C0 R                          MOV     DI,OFFSET @SLAVE_INT_PTR
0550 A5                         F7A1:   MOVSW
0551 47                                 INC     DI                      ; SKIP OVER SEGMENT
0552 47                                 INC     DI
0553 E2 FB                              LOOP    F7A1

                                ;-----  SET UP OTHER INTERRUPTS AS NECESSARY

                                        ASSUME  DS:ABS0
0555 2B C0                              SUB     AX,AX                   ; DS=0
0557 8E D8                              MOV     DS,AX
0559 C7 06 0008 R 0000 E                MOV     WORD PTR @NMI_PTR,OFFSET NMI_INT ; NMI INTERRUPT
055F C7 06 0014 R 0000 E                MOV     WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN   ; PRINT SCREEN
0565 C7 06 0062 R F600                  MOV     WORD PTR @BASIC_PTR+2,0F600H     ; SEGMENT FOR CASSETTE BASIC

                                ;-----  ZERO RESERVED VECTORS

056B BF 0180                            MOV     DI,60H*4                ; FILL INTERRUPT 60 THRU 67 WITH ZERO
056E B9 0010                            MOV     CX,16                   ; CLEAR 16 WORDS
0571 C7 05 0000                 F7A2:   MOV     WORD PTR DS:[DI],0
0575 83 C7 02                           ADD     DI,2                    ; POINT TO NEXT LOCATION
0578 E2 F7                              LOOP    F7A2

                                ;-----  SETUP TIMER 0 TO BLINK LED IF MANUFACTURING TEST MODE

                                        ASSUME  DS:DATA
057A E8 0000 E                          CALL    DDS                     ; ESTABLISH DATA SEGMENT

057D F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; MFG. TEST MODE?
0582 75 0B                              JNZ     F9
0584 26: C7 06 0020 R 0000 E            MOV     WORD PTR ES:@INT_PTR,OFFSET BLINK_INT ; SETUP TIMER TO BLINK LED
058B B0 FE                              MOV     AL,0FEH                 ; ENABLE TIMER INTERRUPT
058D E6 21                              OUT     INTA01,AL
058F FB                         F9:     STI                             ; ALLOW INTERRUPTS

                                ;-----  ISSUE A RESET TO THE HARD FILE IF SOFT RESET

0590 81 3E 0072 R 1234                  CMP     @RESET_FLAG,1234H       ; SOFT RESET?
0596 75 0E                              JNZ     F9A                     ; CONTINUE IF NOT
0598 B9 00FF                            MOV     CX,0FFH
059B BA 03F6                            MOV     DX,03F6H
059E B0 04                              MOV     AL,04H                  ; RESET
05A0 EE                                 OUT     DX,AL
05A1 E2 FE                      F9_A:   LOOP    F9_A                    ; HOLD RESET
05A3 2A C0                              SUB     AL,AL
05A5 EE                                 OUT     DX,AL                   ; REMOVE RESET

                                ;---------------------------------------------------------------
                                ; TEST.23                                                       :
                                ;       DISKETTE ATTACHMENT TEST                                :
                                ; DESCRIPTION                                                   :
                                ;       CHECK IF IPL DISKETTE DRIVE IS ATTACHED TO SYSTEM.  IF  :
                                ;       ATTACHED, VERIFY STATUS OF NEC FDC AFTER A RESET. ISSUE :
                                ;       A RECALIBRATE AND SEEK COMMAND TO FDC AND CHECK STATUS. :
                                ;       COMPLETE SYSTEM INITIALIZATION THEN PASS CONTROL TO THE :
                                ;       BOOT LOADER PROGRAM.                                    :
                                ;---------------------------------------------------------------

05A6 B0 3C                      F9A:    MOV     AL,3CH                  ;       <><><><><><><><><><><><><>
05A8 E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3C <><>

05AA B0 02                              MOV     AL,02H                  ; SET DATA RATE TO 250 K BITS PER SECOND
05AC BA 03F7                            MOV     DX,3F7H
05AF EE                                 OUT     DX,AL
05B0 F6 06 0010 R 01                    TEST    BYTE PTR @EQUIP_FLAG,1H ; DISKETTE PRESENT?
05B5 74 55                              JZ      F15
05B7 F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; MFG JUMPER INSTALLED?
05BC 74 4E                              JZ      F15                     ; GO IF YES
05BE                            F10:                                    ; DISK_TEST:
05BE E4 21                              IN      AL,INTA01
05C0 EB 00                              JMP     $+2                     ; I/O DELAY
05C2 24 BF                              AND     AL,0BFH                 ; ENABLE DISKETTE INTERRUPTS
05C4 E6 21                              OUT     INTA01,AL
05C6 B4 00                              MOV     AH,0                    ; RESET NEC FDC
05C8 8A D4                              MOV     DL,AH                   ; SET FOR DRIVE 0
05CA CD 13                              INT     13H                     ; VERIFY STATUS AFTER RESET
05CC F6 C4 FF                           TEST    AH,0FFH                 ; STATUS OK?
05CF 75 25                              JNZ     F13                     ; NO - FDC FAILED

                                ;-----  TURN DRIVE 0 MOTOR ON

05D1 BA 03F2                            MOV     DX,03F2H                ; GET ADDRESS OF FDC CARD
05D4 B0 1C                              MOV     AL,1CH                  ; TURN MOTOR ON, ENABLE DMA, INTERRUPTS
05D6 EE                                 OUT     DX,AL                   ; WRITE FDC CONTROL REGISTER
05D7 2B C9                              SUB     CX,CX                   ; WAITF COUNT FOR 0.988 SECONDS
05D9 E8 0000 E                          CALL    WAITF                   ; WAIT 1 SECOND FOR MOTOR

05DC 33 FF                              XOR     DI,DI                   ; SELECT DRIVE 0
05DE B5 01                              MOV     CH,1                    ; SELECT TRACK 1
05E0 C6 06 003E R 00                    MOV     @SEEK_STATUS,0          ; INSURE RECALIBRATE
05E5 80 0E 00A0 R 01                    OR      @RTC_WAIT_FLAG,01       ; NO REAL TIME CLOCK, USE WAIT LOOP
05EA E8 0000 E                          CALL    SEEK                    ; RECALIBRATE DISKETTE
05ED 72 07                              JC      F13                     ; GO TO ERR SUBROUTINE IF ERR
05EF B5 22                              MOV     CH,34                   ; SELECT TRACK 34
05F1 E8 0000 E                          CALL    SEEK                    ; SEEK TO TRACK 34
05F4 73 0B                              JNC     F14                     ; OK, TURN MOTOR OFF
05F6                            F13:                                    ; DSK_ERR:
05F6 80 0E 0016 R 40                    OR      @MFG_ERR_FLAG+1,DSK_FAIL;       <><><><><><><><><><><><><>
                                                                        ;       <><> DISKETTE FAILED  <><>
05FB BE 0000 E                          MOV     SI,OFFSET E601          ; GET ADDRESS OF MESSAGE
05FE E8 0000 E                          CALL    E_MSG                   ; GO PRINT ERROR MESSAGE

                                ;-----  TURN DRIVE 0 MOTOR OFF

0601                            F14:                                    ; DR0_OFF:
0601 80 26 00A0 R FE                    AND     @RTC_WAIT_FLAG,0FEH     ; ALLOW FOR RTC WAIT
0606 B0 0C                              MOV     AL,0CH                  ; TURN DRIVE 0 MOTOR OFF
0608 BA 03F2                            MOV     DX,03F2H                ; FDC CONTROLLER ADDRESS
060B EE                                 OUT     DX,AL
```

SECTION 5

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                                PAGE
                                ;----- SETUP KEYBOARD PARAMETERS

060C C6 06 006B R 00            F15:    MOV     @INTR_FLAG,00H          ; SET STRAY INTERRUPT FLAG = 00
0611 BE 001E R                          MOV     SI,OFFSET @KB_BUFFER    ; SETUP KEYBOARD PARAMETERS
0614 89 36 001A R                       MOV     @BUFFER_HEAD,SI
0618 89 36 001C R                       MOV     @BUFFER_TAIL,SI
061C 89 36 0080 R                       MOV     @BUFFER_START,SI
0620 83 C6 20                           ADD     SI,32                   ; DEFAULT BUFFER OF 32 BYTES
0623 89 36 0082 R                       MOV     @BUFFER_END,SI

                                ;----- SET PRINTER TIMEOUT DEFAULT

0627 BF 0078 R                          MOV     DI,OFFSET @PRINT_TIM_OUT; SET DEFAULT PRINTER TIMEOUT
062A 1E                                 PUSH    DS
062B 07                                 POP     ES
062C B8 1414                            MOV     AX,1414H                ; DEFAULT=20
062F AB                                 STOSW
0630 AB                                 STOSW

                                ;----- SET RS232 DEFAULT

0631 B8 0101                            MOV     AX,0101H                ; RS232 DEFAULT=01
0634 AB                                 STOSW
0635 AB                                 STOSW

                                ;----- ENABLE TIMER INTERRUPTS

0636 E4 21                              IN      AL,INTA01
0638 24 FE                              AND     AL,0FEH                 ; ENABLE TIMER INTERRUPTS
063A EB 00                              JMP     $+2                     ; I/O DELAY
063C E6 21                              OUT     INTA01,AL

                                ;----- CHECK CMOS BATTERY AND CHECKSUM

063E F6 06 0012 R 20                    TEST    @MFG_TST,MFG_LOOP       ; MFG JUMPER?
0643 75 03                              JNZ     B1_OK                   ; GO IF NOT
0645 E9 072E R                          JMP     F15C                    ; BYPASS IF YES
0648                            B1_OK:
0648 B0 8E                              MOV     AL,CMOS_DIAG+NMI        ; ADDRESS DIAGNOSTIC STATUS BYTE
064A E8 0000 E                          CALL    CMOS_READ               ; READ IT FROM CMOS

064D BE 0000 E                          MOV     SI,OFFSET E161          ; LOAD BAD BATTERY MESSAGE 161
0650 A8 80                              TEST    AL,BAD_BAT              ; BATTERY BAD?
0652 75 07                              JNZ     B1_ER                   ; DISPLAY ERROR IF BAD

0654 BE 0000 E                          MOV     SI,OFFSET E162          ; LOAD CHECKSUM BAD MESSAGE 162
0657 A8 60                              TEST    AL,BAD_CKSUM+BAD_CONFIG ; CHECK FOR CHECKSUM OR NO DISKETTE
0659 74 09                              JZ      C_OK                    ; SKIP AND CONTINUE TESTING CMOS CLOCK
065B                            B1_ER:
065B E8 0000 E                          CALL    E_MSG                   ; ELSE DISPLAY ERROR MESSAGE
065E 81 CD 8000                         OR      BP,08000H               ; FLAG "SET SYSTEM OPTIONS" DISPLAYED
0662 EB 45                              JMP     SHORT H_OK1A            ; SKIP CLOCK TESTING IF ERROR

                                ;----- TEST CLOCK UPDATING

0664 B3 04                      C_OK:   MOV     BL,04H                  ; OUTER LOOP COUNT
0666 2B C9                      D_OK:   SUB     CX,CX                   ; INNER LOOP COUNT
0668 B0 8A                      E_OK:   MOV     AL,CMOS_REG_A+NMI       ; GET THE CLOCK UPDATE BYTE
066A E8 0000 E                          CALL    CMOS_READ
066D A8 80                              TEST    AL,80H                  ; CHECK FOR UPDATE IN PROGRESS
066F 75 1B                              JNZ     G_OK                    ; GO IF YES
0671 E2 F5                              LOOP    E_OK                    ; TRY AGAIN
0673 FE CB                              DEC     BL                      ; DEC OUTER LOOP
0675 75 EF                              JNZ     D_OK                    ; TRY AGAIN
0677 BE 0000 E                  F_OK:   MOV     SI,OFFSET E163          ; PRINT MESSAGE
067A E8 0000 E                          CALL    E_MSG

                                ;----- SET CMOS DIAGNOSTIC STATUS TO 04 (CLOCK ERROR)

067D B8 0E8E                            MOV     AX,X*CMOS_DIAG+NMI      ; SET CLOCK ERROR
0680 E8 0000 E                          CALL    CMOS_READ               ; GET THE CURRENT STATUS
0683 0C 04                              OR      AL,CMOS_CLK_FAIL        ; SET NEW STATUS
0685 86 C4                              XCHG    AL,AH                   ; GET STATUS ADDRESS AND SAVE NEW STATUS
0687 E8 0000 E                          CALL    CMOS_WRITE              ; MOVE NEW DIAGNOSTIC STATUS TO CMOS
068A EB 0E                              JMP     SHORT H_OK              ; CONTINUE

                                ;----- CHECK CLOCK UPDATE

068C B9 0320                    G_OK:   MOV     CX,800                  ; LOOP COUNT
068F B0 8A                      I_OK:   MOV     AL,CMOS_REG_A+NMI       ; CHECK FOR OPPOSITE STATE
0691 E8 0000 E                          CALL    CMOS_READ
0694 A8 80                              TEST    AL,80H
0696 E0 F7                              LOOPNZ  I_OK                    ; TRY AGAIN
0698 E3 DD                              JCXZ    F_OK                    ; PRINT ERROR IF TIMEOUT

                                ;----- CHECK MEMORY SIZE DETERMINED = CONFIGURATION

069A                            H_OK:
069A B0 8E                              MOV     AL,CMOS_DIAG+NMI        ; GET THE STATUS BYTE
069C E8 0000 E                          CALL    CMOS_READ
069F A8 10                              TEST    AL,W_MEM_SIZE           ; WAS THE CONFIG= MEM_SIZE_DETERMINED?
06A1 74 06                              JZ      H_OK1A                  ; GO IF YES

                                ;----- MEMORY SIZE ERROR

06A3 BE 0000 E                          MOV     SI,OFFSET E164          ; PRINT SIZE ERROR
06A6 E8 0000 E                          CALL    E_MSG                   ; DISPLAY ERROR

                                ;----- CHECK FOR CRT ADAPTER ERROR

06A9 80 3E 0015 R 0C            H_OK1A: CMP     @MFG_ERR_FLAG,0CH       ; CHECK FOR MONOCHROME CRT ERROR
06AE BE 0000 E                          MOV     SI,OFFSET E401          ; LOAD MONOCHROME CRT ERROR
06B1 74 0A                              JZ      H_OK1B                  ; GO IF YES

06B3 80 3E 0015 R 0D                    CMP     @MFG_ERR_FLAG,0DH       ; CHECK FOR COLOR CRT ADAPTER ERROR
06B8 75 06                              JNZ     J_OK                    ; CONTINUE IF NOT
06BA BE 0000 E                          MOV     SI,OFFSET E501          ; CRT ADAPTER ERROR MESSAGE
06BD                            H_OK1B:
06BD E8 0000 E                          CALL    E_MSG
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                              PAGE
                              ;-----  CHECK FOR MULTIPLE DATA RATE CAPABILITY

06C0                          J_OK:
06C0 BA 03F1                          MOV     DX,03F1H                ; D/S/P DIAGNOSTIC REGISTER
06C3 EC                               IN      AL,DX                   ; READ D/S/P TYPE CODE
06C4 24 F8                            AND     AL,11111000B            ; KEEP ONLY UNIQUE CODE FOR D/S/P
06C6 3C 50                            CMP     AL,01010000B            ; D/S/P CARD - MULTIPLE DATA RATE ?
06C8 74 46                            JZ      J_OK3                   ; IF SO JUMP

06CA BA 05F7                          MOV     DX,05F7H                ; FIXED DISK DIAGNOSTIC REGISTER
06CD EC                               IN      AL,DX                   ; READ FIXED DISK TYPE CODE
06CE 24 F0                            AND     AL,11110000B            ; KEEP ONLY UNIQUE CODE FOR F/D
06D0 3C A0                            CMP     AL,10100000B            ; FIXED DISK ADAPTER ?
06D2 74 2F                            JZ      J_FAIL                  ; MUST BE COMBO ELSE ERROR

06D4 B3 0F                            MOV     BL,0FH                  ; OUTER LOOP COUNT WAIT FOR BUSY OFF
06D6 2B C9                            SUB     CX,CX
06D8 BA 01F7                          MOV     DX,01F7H                ; HARD FILE STATUS PORT
06DB                          J_OK1:
06DB EC                               IN      AL,DX                   ; GET THE STATUS
06DC A8 80                            TEST    AL,080H                 ; IS THE CONTROLLER BUSY?
06DE 74 0C                            JZ      J_OK2                   ; CONTINUE IF NOT
06E0 E2 F9                            LOOP    J_OK1                   ; TRY AGAIN
06E2 FE CB                            DEC     BL                      ; DECREMENT OUTER LOOP
06E4 75 F5                            JNZ     J_OK1                   ; TRY AGAIN IF NOT ZERO
06E6 24 0C                            AND     AL,0CH                  ; BITS 2 & 3 = 0 IF MULTI DATA CAPABLE
06E8 74 26                            JZ      J_OK3                   ; GO IF YES
06EA EB 17                            JMP     SHORT J_FAIL            ; NO MULTIPLE DATA RATE CAPABILITY
06EC                          J_OK2:
06EC BA 01F4                          MOV     DX,1F4H                 ; VERIFY MULTIPLE DATA RATE CAPABLE
06EF B0 55                            MOV     AL,055H                 ;  WRITE TO THE CYLINDER BYTE
06F1 EE                               OUT     DX,AL
06F2 EB 00                            JMP     $+2                     ; I/O DELAY
06F4 EC                               IN      AL,DX                   ; CHECK DATA WRITTEN = DATA READ
06F5 3C 55                            CMP     AL,055H
06F7 75 0A                            JNZ     J_FAIL                  ; GO IF NOT
06F9 B0 AA                            MOV     AL,0AAH                 ; WRITE ANOTHER PATTERN
06FB EE                               OUT     DX,AL
06FC EB 00                            JMP     $+2                     ; I/O DELAY
06FE EC                               IN      AL,DX
06FF 3C AA                            CMP     AL,0AAH                 ; IS DATA PATTERN THE SAME?
0701 74 0D                            JZ      J_OK3                   ; GO IF SO

0703                          J_FAIL:
0703 80 0E 0016 R 40                  OR      @MFG_ERR_FLAG+1,DSK_FAIL;       <><><><><><><><><><><><><>
                                                                      ;       <><> DISKETTE FAILED  <><>
0708 BE 0000 E                        MOV     SI,OFFSET E601          ; GET ADDRESS OF MESSAGE
070B E8 0000 E                        CALL    E_MSG                   ; GO PRINT ERROR MESSAGE
070E EB 1E                            JMP     SHORT F15C              ; SKIP SETUP IF ERROR

0710                          J_OK3:
0710 80 0E 008B R 01                  OR      @LASTRATE,DUAL          ; TURN ON DSP/COMBO FLAG

                              ;-----  INITIALIZE FLOPPY FOR DRIVE TYPE

0715 B0 3D                            MOV     AL,3DH                  ;       <><><><><><><><><><><><>
0717 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3D <><>
0719 E8 0000 E                        CALL    DSKETTE_SETUP           ; INITIALIZE FLOPPY

                              ;-----  CHECK FOR 2ND DISKETTE DRIVE

071C E8 0000 E                        CALL    DDS                     ; INSURE DATA SEGMENT
071F 8A 26 0091 R                     MOV     AH,@DSK_STATE+1         ; GET STATE OF SECOND DRIVE
0723 0A E4                            OR      AH,AH                   ; IS THERE A DRIVE 2 ATTACHED?
0725 74 07                            JZ      F15C                    ; SKIP IF NOT
0727 80 0E 0010 R 40                  OR      BYTE PTR @EQUIP_FLAG,40H; ELSE SET SECOND DRIVE INSTALLED
072C B4 FF                            MOV     AH,0FFH                 ; SET TEST MASK FOR DRIVE PRESENT
072E                          F15C:
072E B0 8E                            MOV     AL,CMOS_DIAG+NMI        ; GET THE CMOS DIAGNOSTIC STATUS
0730 E8 0000 E                        CALL    CMOS_READ
0733 A8 C0                            TEST    AL,BAD_BAT+BAD_CKSUM    ; BATTERY/CHECKSUM OK
0735 75 22                            JNZ     ROM_SCAN1               ; BYPASS DISK SETUP IF NOT

0737 B0 90                            MOV     AL,CMOS_DISKETTE+NMI    ; ADDRESS DISKETTE TYPE BYTE
0739 E8 0000 E                        CALL    CMOS_READ               ; GET DISKETTE TYPES
073C 24 0F                            AND     AL,00FH                 ; LOOK AT SECOND DRIVE TYPE DEFINED
073E 3A C4                            CMP     AL,AH                   ; ARE BOTH INDICATORS ZERO
0740 74 07                            JE      F15D                    ; SKIP IF NO SECOND DRIVE

0742 22 C4                            AND     AL,AH                   ; ARE BOTH INDICATORS NON-ZERO
0744 75 03                            JNZ     F15D                    ; SKIP IF DRIVE FOUND AND DEFINED

0746 E8 0000 E                        CALL    CONFIG_BAD              ; SET BAD_CONFIG IN CMOS_DIAG

                              ;-----  INITIALIZE HARD FILE

0749                          F15D:
0749 B0 3E                            MOV     AL,3EH                  ;       <><><><><><><><><><><><>
074B E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3E <><>

074D B0 92                            MOV     AL,CMOS_DISK+NMI        ; INSURE CMOS DEFINES TYPE OF FIXED DISK
074F E8 0000 E                        CALL    CMOS_READ
0752 3C 00                            CMP     AL,0H                   ; INSURE TYPE IS DEFINED
0754 74 03                            JZ      ROM_SCAN1               ; BYPASS DISK SETUP IF NOT

0756 E8 0000 E                        CALL    DISK_SETUP              ; INITIALIZE HARD FILE(S)

                              ;--------------------------------------------------------
                              ; TEST.22                                                 :
                              ; CHECK FOR OPTIONAL ROM FROM C800->E000 IN 2K BLOCKS     :
                              ;       (A VALID MODULE HAS '55AA' IN THE FIRST 2 LOCATIONS:
                              ;       LENGTH INDICATOR (LENGTH/512) IN THE 3RD LOCATION :
                              ;       AND TEST/INIT. CODE STARTING IN THE 4TH LOCATION) :
                              ;--------------------------------------------------------

0759                          ROM_SCAN1:
0759 FB                               STI                             ; ALLOW INTERRUPTS
075A B0 3B                            MOV     AL,3BH                  ;       <><><><><><><><><><><><>
075C E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  3B <><>
075E E8 0000 E                        CALL    DDS                     ; SET REAL MODE DATA SEGMENT
0761 B0 0A                            MOV     AL,10                   ; LINE FEED ON DISPLAY
0763 E8 0000 E                        CALL    PRT_HEX

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0766                            ROM_SCAN:

                                ;-----  SET DMA MASK AND REQUEST REGISTERS

0766 2A C0                              SUB     AL,AL
0768 E6 D2                              OUT     DMA18+2,AL              ; SEND ZERO TO MASK REGISTER
076A EB 00                              JMP     $+2
076C E6 D4                              OUT     DMA18+4,AL              ; SEND ZERO TO REQUEST REGISTER
076E BA C800                            MOV     DX,0C800H               ; SET BEGINNING ADDRESS
0771                            ROM_SCAN2:
0771 8E DA                              MOV     DS,DX
0773 57                                 PUSH    DI                      ; SAVE WORK REGISTER
0774 BF AA55                            MOV     DI,0AA55H               ; GET TEST PATTERN
0777 2B DB                              SUB     BX,BX                   ; SET BX=0000
0779 8B 07                              MOV     AX,[BX]                 ; GET 1ST WORD FROM MODULE
077B 3B C7                              CMP     AX,DI                   ; = TO ID WORD?
077D 5F                                 POP     DI                      ; RECOVER WORK REGISTER
077E 75 05                              JNZ     NEXT_ROM                ; PROCEED TO NEXT ROM IF NOT
0780 E8 0000 E                          CALL    ROM_CHECK               ; GO CHECK OUT MODULE
0783 EB 04                              JMP     SHORT ARE_WE_DONE       ; CHECK FOR END OF ROM SPACE
0785                            NEXT_ROM:
0785 81 C2 0080                         ADD     DX,0080H                ; POINT TO NEXT 2K ADDRESS
0789                            ARE_WE_DONE:
0789 81 FA E000                         CMP     DX,0E000H               ; AT E0000 YET?
078D 7C E2                              JL      ROM_SCAN2               ; GO CHECK ANOTHER ADD. IF NOT

                                ;-----  TEST FOR KEYBOARD LOCKED

078F E8 0000 E                          CALL    DDS                     ; SET DATA SEGMENT
0792 E4 64                              IN      AL,STATUS_PORT          ; IS KEYBOARD UNLOCKED?
0794 24 10                              AND     AL,KYBD_INH
0796 74 02                              JZ      KEY1                    ; NO - SET ERROR FLAGS AND PRINT MESSAGE
0798 EB 0B                              JMP     SHORT KEY10             ; GO IF OFF
079A                            KEY1:
079A 80 0E 0016 R 80                    OR      @MFG_ERR_FLAG+1,KEY_FAIL;       <><><><><><><><><><><><><><>
                                                                        ;       <><> KEYBOARD IS LOCKED <><>
                                        ASSUME  DS:DATA
079F BE 0000 E                          MOV     SI,OFFSET E302          ; PRINT LOCKED MESSAGE  (302)
07A2 E8 0000 E                          CALL    E_MSG
07A5                            KEY10:
                                        ;===================
                                ;-----   SETUP @PRINTER_BASE
                                        ;===================

07A5 BF 09D6 R                          MOV     DI,OFFSET F4            ; OFFSET OF PRINTER ADDRESS TABLE
07A8 BE 0000                            MOV     SI,0
07AB                            F16:
07AB 2E: 8B 15                          MOV     DX,CS:[DI]              ; GET PRINTER BASE ADDRESS
07AE B0 AA                              MOV     AL,0AAH                 ; WRITE DATA TO PORT A
07B0 EE                                 OUT     DX,AL
07B1 EB 00                              JMP     $+2                     ; I/O DELAY
07B3 1E                                 PUSH    DS                      ; BUS SETTLING
07B4 EC                                 IN      AL,DX                   ; READ PORT A
07B5 1F                                 POP     DS
07B6 3C AA                              CMP     AL,0AAH                 ; DATA PATTERN SAME
07B8 75 06                              JNE     F17                     ; NO - CHECK NEXT PRINTER CARD
07BA 89 94 0008 R                       MOV     @PRINTER_BASE[SI],DX    ; YES - STORE PRINTER BASE ADDRESS
07BE 46                                 INC     SI                      ; INCREMENT TO NEXT WORD
07BF 46                                 INC     SI
07C0                            F17:
07C0 47                                 INC     DI                      ; POINT TO NEXT BASE ADDRESS
07C1 47                                 INC     DI
07C2 81 FF 09DC R                       CMP     DI,OFFSET F4E           ; ALL POSSIBLE ADDRESSES CHECKED?
07C6 75 E3                              JNE     F16                     ; PRT_BASE
                                        ;=============
                                ;-----  SETUP RS232
                                        ;=============

07C8 BB 0000                            MOV     BX,0                    ; POINTER TO RS232 TABLE
07CB BA 03FA                            MOV     DX,3FAH                 ; CHECK IF RS232 CARD 1 ATTACHED ?
07CE EC                                 IN      AL,DX                   ; READ INTERRUPT ID REGISTER
07CF A8 F8                              TEST    AL,0F8H
07D1 75 08                              JNZ     F18
07D3 C7 87 0000 R 03F8                  MOV     @RS232_BASE[BX],3F8H    ; SETUP RS232 CARD #1 ADDRESS
07D9 43                                 INC     BX
07DA 43                                 INC     BX
07DB BA 02FA                    F18:    MOV     DX,2FAH                 ; CHECK IF RS232 CARD 2 ATTACHED
07DE EC                                 IN      AL,DX                   ; READ INTERRUPT ID REGISTER
07DF A8 F8                              TEST    AL,0F8H
07E1 75 08                              JNZ     F19                     ; BASE_END
07E3 C7 87 0000 R 02F8                  MOV     @RS232_BASE[BX],2F8H    ; SETUP RS232 CARD #2
07E9 43                                 INC     BX
07EA 43                                 INC     BX
                                        ;==============================================================
                                ;-----  SET UP @EQUIP_FLAG TO INDICATE NUMBER OF PRINTERS AND RS232 CARDS
                                        ;==============================================================
07EB                            F19:                                    ; BASE_END:
07EB 8B C6                              MOV     AX,SI                   ; SI HAS 2* NUMBER OF RS232
07ED B1 03                              MOV     CL,3                    ; SHIFT COUNT
07EF D2 C8                              ROR     AL,CL                   ; ROTATE RIGHT 3 POSITIONS
07F1 0A C3                              OR      AL,BL                   ; OR IN THE PRINTER COUNT
07F3 A2 0011 R                          MOV     BYTE PTR @EQUIP_FLAG+1,AL       ; STORE AS SECOND BYTE

                                ;-----  INSURE CMOS CLOCK HAS VALID HOURS.MINUTES.SECONDS

07F6 E8 0000 E                          CALL    SET_TOD                 ; INSURE CMOS CLOCK IS VALID

                                ;-----  ENABLE HARDWARE INTERRUPT IF MATH PROCESSOR (80287)

07F9 B0 40                              MOV     AL,40H                  ;       <><><><><><><><><><><>
07FB E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  40 <><>

07FD BF 0067 R                          MOV     DI,OFFSET @IO_ROM_INIT  ; ADDRESS WORK STORAGE LOCATION
0800 33 C0                              XOR     AX,AX                   ; CLEAR WORK REGISTER  (AH)= 0 (NO 287)
0802 89 05                              MOV     WORD PTR [DI],AX        ; CLEAR THE WORK LOCATION
0804 DB E3                              FNINIT                          ; INITIALIZE THE 80287 WITH NO WAIT
0806 EB 00                              JMP     $+2                     ; DELAY
0808 D9 3D                              FNSTCW  WORD PTR [DI]           ; WRITE THE CURRENT 80287 CONTROL WORD
080A 60                                 PUSHA                           ; TIME FOR 80287 TO RESPOND
080B 61                                 POPA
080C 81 25 1F3F                         AND     WORD PTR [DI],01F3FH    ; CLEAR UNUSED 80287 BITS
0810 81 3D 033F                         CMP     WORD PTR [DI],0033FH    ; IS THE 80287 INSTALLED?
0814 75 13                              JNE     NO_287                  ; GO IF MATH PROCESSOR IS NOT INSTALLED
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0816 9B DD 3D                            FSTSW   WORD PTR [DI]           ; STORE THE STATUS WORD (WITH WAIT)
0819 60                                  PUSHA                           ; TIME FOR 80287 TO RESPOND
081A 61                                  POPA
081B F7 05 B8BF                          TEST    WORD PTR [DI],0B8BFH    ; ALL BITS SHOULD BE OFF (OR ERROR)
081F 75 08                               JNZ     NO_287                  ; GO IF NOT INSTALLED

0821 E4 A1                               IN      AL,INTB01               ; GET THE SLAVE INTERRUPT MASK
0823 24 DF                               AND     AL,0DFH                 ; ENABLE 80287 INTERRUPTS
0825 B4 02                               MOV     AH,002H                 ; SET WORK REGISTER FOR 80287 FOUND
0827 E6 A1                               OUT     INTB01,AL
0829                             NO_287:
0829 A0 0010 R                           MOV     AL,BYTE PTR @EQUIP_FLAG ; GET LOW EQUIPMENT FLAG
082C 24 02                               AND     AL,002H                 ; STRIP OFF OTHER BITS
082E 3A C4                               CMP     AL,AH                   ; DOES CMOS MATCH HARDWARE ?
0830 74 08                               JE      OK_287                  ; SKIP IF EQUIPMENT FLAG CORRECT

0832 80 36 0010 R 02                     XOR     BYTE PTR @EQUIP_FLAG,2H ; ELSE SET 80287 BIT TO CORRECT VALUE
0837 E8 0000 E                           CALL    CONFIG_BAD              ; AND SET THE CONFIGURATION ERROR FLAG
083A                             OK_287:
                                 ;-----  SET KEYBOARD STATE FLAGS

083A C7 06 0017 R 0000                   MOV     WORD PTR @KB_FLAG,0     ; RESET ALL KEYBOARD STATUS FLAGS

                                 ;-----  ENABLE KEYBOARD/TIMER INTERRUPTS

0840 E4 21                               IN      AL,INTA01
0842 24 FC                               AND     AL,0FCH                 ; ENABLE TIMER AND KEYBOARD INTERRUPTS
0844 EB 00                               JMP     $+2                     ; I/O DELAY
0846 E6 21                               OUT     INTA01,AL
0848 C6 06 0015 R 00                     MOV     @MFG_ERR_FLAG,0         ; CLEAR MFG ERROR FLAG

                                 ;-----  READ KEYBOARD ID TO INITIALIZE KEYBOARD TYPE AND NUM LOCK STATE

084D C6 06 0096 R A0                     MOV     @KB_FLAG_3,RD_ID+SET_NUM_LK      ; SET READ ID COMMAND FOR KBX
0852 B0 F2                               MOV     AL,KB_READ_ID           ; GET THIS SYSTEMS KEYBOARD ID REQUEST
0854 E8 0000 E                           CALL    SND_DATA                ; USE KEYBOARD TRANSMISSION ROUTINE
0857 B9 067A                             MOV     CX,T658                 ; SET DELAY COUNT TO 25 MILLISECONDS
085A E8 0000 E                           CALL    WAITF                   ; WAIT FOR READ ID RESPONSE (20 MS)
085D 80 26 0096 R 1F                     AND     @KB_FLAG_3,NOT RD_ID+LC_AB+SET_NUM_LK    ; RESET READ ID COMMAND

                                 ;-----  CHECK FOR SECOND FIXED DISK PRESENT BUT NOT DEFINED

0862 80 3E 0075 R 02                     CMP     @HF_NUM,2               ; CHECK FOR TWO DRIVES DEFINED BY CMOS
0867 74 13                               JE      F15G                    ; SKIP TEST IF TWO DRIVES DEFINED

0869 B4 10                               MOV     AH,010H                 ; GET TEST DRIVE READY COMMAND
086B B2 81                               MOV     DL,081H                 ; POINT TO SECOND FIXED DISK
086D FE 06 0075 R                        INC     @HF_NUM                 ; TELL BIOS IT HAS TWO DRIVES
0871 CD 13                               INT     13H                     ; CHECK READY THROUGH BIOS
0873 FE 0E 0075 R                        DEC     @HF_NUM                 ; RESTORE CORRECT COUNT (RETAIN CY)
0877 72 03                               JC      F15G                    ; SKIP IF SECOND DRIVE NOT READY
                                                                         ;        SECOND DRIVE NOT DEFINED
0879 E8 0000 E                           CALL    CONFIG_BAD              ; SET CONFIGURATION BAD
087C                             F15G:
                                 ;----------------------------------------
                                 ;  TEST FOR ANY ERRORS (BP NOT ZERO)    :
                                 ;----------------------------------------

087C 0B ED                               OR      BP,BP                   ; CHECK (BP)= NON-ZERO  (ERROR HAPPENED)
087E 74 55                               JE      F15A_0                  ; SKIP PAUSE IF NO ERROR

0880 80 3E 0072 R 64                     CMP     BYTE PTR @RESET_FLAG,64H; MFG RUN IN MODE?
0885 BA 0002                             MOV     DX,2                    ; 2 SHORT BEEP COUNT FOR ERROR(S)
0888 75 0E                               JNZ     ERR_WAIT                ; GO IF NOT

                                 ;-----  MFG RUN IN MODE -> SET ERROR FLAG

088A C6 06 0015 R AA                     MOV     @MFG_ERR_FLAG,0AAH      ; INDICATE ERROR
088F E4 64                               IN      AL,STATUS_PORT          ; CHECK KEY LOCK STATUS
0891 24 10                               AND     AL,KYBD_INH             ; IS THE KEYBOARD LOCKED
0893 75 40                               JNZ     F15A_0                  ; CONTINUE MFG MODE IF NOT LOCKED
                                                                         ;  ELSE
0895 BA 0005                             MOV     DX,5                    ; 5 SHORT BEEPS FOR MFG SETUP ERROR
0898                             ERR_WAIT:
0898 E8 0000 E                           CALL    ERR_BEEP                ; BEEPS FOR ERROR(S)
089B B0 0E                               MOV     AL,CMOS_DIAG            ; ADDRESS CMOS
089D E8 0000 E                           CALL    CMOS_READ               ; GET THE DIAGNOSTIC STATUS BYTE
08A0 A8 20                               TEST    AL,BAD_CONFIG           ; CHECK FOR BAD HARDWARE CONFIGURATION
08A2 74 0C                               JZ      ERR_WKEY                ; SKIP IF NOT SET

08A4 F7 C5 8000                          TEST    BP,08000H               ; ELSE CHECK FOR E161/E162 POSTED
08A8 75 06                               JNZ     ERR_WKEY                ; SKIP IF DISPLAYED BEFORE NOW

08AA BE 0000 E                           MOV     SI,OFFSET E162          ; ELSE DISPLAY "OPTIONS NOT SET"
08AD E8 0000 E                           CALL    P_MSG                   ; WITH NON HALTING ROUTINE

                                 ;-----  CHECK FOR "UNLOCK SYSTEM UNIT KEYLOCK" MESSAGE REQUIRED

08B0                             ERR_WKEY:
08B0 E4 64                               IN      AL,STATUS_PORT          ; CHECK IF RESUME MESSAGE NEEDED
08B2 24 10                               AND     AL,KYBD_INH             ; IS THE KEYBOARD LOCKED
08B4 75 06                               JNZ     ERR_WAIT2               ; SKIP LOCK MESSAGE IF NOT

08B6 BE 0000 E                           MOV     SI,OFFSET F3D1          ; ERROR MESSAGE FOR KEYBOARD LOCKED
08B9 E8 0000 E                           CALL    P_MSG

                                 ;-----  DISPLAY '(RESUME = "F1" KEY)' FOR ERRORS

08BC                             ERR_WAIT2:
08BC BE 0000 E                           MOV     SI,OFFSET F3D           ; RESUME ERROR MESSAGE
08BF E8 0000 E                           CALL    P_MSG

                                 ;-----  INITIALIZE PRINTER  (ALTERNATE DISPLAY DEVICE)

08C2 B4 01                               MOV     AH,1                    ;
08C4 2B D2                               SUB     DX,DX                   ; FIRST PRINTER
08C6 CD 17                               INT     17H                     ;
08C8                             ERR_WAIT1:
08C8 B0 3F                               MOV     AL,3FH                  ;        <><><><><><><><><><><>
08CA E6 80                               OUT     MFG_PORT,AL             ;        <><> CHECKPOINT  3F <><>
08CC B4 00                               MOV     AH,00
08CE CD 16                               INT     16H                     ; WAIT FOR 'F1' KEY
08D0 80 FC 3B                            CMP     AH,3BH
08D3 75 F3                               JNE     ERR_WAIT1
```

SECTION 5

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08D5                       F15A_0:
08D5 F6 06 0012 R 20               TEST    @MFG_TST,MFG_LOOP       ; MFG BURN IN MODE
08DA 75 03                         JNZ     F15A                    ; GO IF NOT
08DC E9 0000 E                     JMP     START_1                 ; GO LOOP POST
08DF 80 3E 0072 R 64       F15A:   CMP     BYTE PTR @RESET_FLAG,64H; MFG RUN IN?
08E4 74 06                         JZ      F15B                    ; BYPASS BEEP IF YES

08E6 BA 0001                       MOV     DX,1                    ; 1 SHORT BEEP (NO ERRORS)
08E9 E8 0000 E                     CALL    ERR_BEEP
                                   ;===============
                           ;-----  SET TIME OF DAY
                                   ;===============

08EC E8 0000 E             F15B:   CALL    SET_TOD

                           ;-----  CLEAR DISPLAY SCREEN

08EF 2A E4                         SUB     AH,AH                   ; CLEAR FLAGS
08F1 A0 0049 R                     MOV     AL,@CRT_MODE
08F4 CD 10                         INT     10H                     ; CLEAR SCREEN

                           ;-----  CLEAR DESCRIPTOR TABLES

08F6 B9 01F4               F20:    MOV     CX,0500                 ; CLEAR 1K
08F9 BF D0A0                       MOV     DI,SYS_IDT_LOC          ; POINT ES TO START OF DESCRIPTORS
08FC 2B C0                         SUB     AX,AX
08FE 8E C0                         MOV     ES,AX
0900 26: 89 05             F20_A:  MOV     ES:[DI],AX              ; CLEAR
0903 83 C7 02                      ADD     DI,2                    ; POINT TO NEXT LOCATION
0906 E2 F8                         LOOP    F20_A                   ; CONTINUE TILL DONE

                           ;-----  SET POST SYSTEM STACK

0908 B8 ---- R                     MOV     AX,ABS0                 ; GET THE POST STACK SEGMENT
090B 8E D0                         MOV     SS,AX
090D BC 0400 R                     MOV     SP,OFFSET @TOS

                           ;-----  ENSURE THAT MASTER LEVEL 2 ENABLED

0910 E4 21                         IN      AL,INTA01               ; GET THE CURRENT MASK
0912 24 FB                         AND     AL,0FBH
0914 EB 00                         JMP     $+2                     ; I/O DELAY
0916 E6 21                         OUT     INTA01,AL

                           ;-----  TEST FOR MFG RUN-IN TEST

0918 80 3E 0072 R 64               CMP     BYTE PTR @RESET_FLAG,64H; IS THE THE MFG RUN-IN TEST?
091D 75 02                         JNZ     END_287                 ; GO IF NOT
091F EB 5C                         JMP     SHORT SHUT4             ; BOOT LOAD IF YES

                           ;-----  UNMASK SLAVE HARDWARE INTERRUPT 9 (LEVEL 71)
0921                       END_287:
0921 E4 A1                         IN      AL,INTB01               ; GET THE CURRENT MASK
0923 24 FD                         AND     AL,0FDH
0925 EB 00                         JMP     $+2                     ; I/O DELAY
0927 E6 A1                         OUT     INTB01,AL               ; SET NEW MASK

                           ;-------------------------------------------------------------
                           ; TEST FOR SYSTEM CODE AT SEGMENT E000:0
                           ;   FIRST WORD = AA55H
                           ;   LAST BYTE = CHECKSUM
                           ;   ENTRY POINT = FIRST BYTE + 3
                           ; IF TEST IS SUCCESSFUL A CALL FAR TO THE ENTRY POINT IS EXECUTED
                           ;-------------------------------------------------------------
0929 B0 41                         MOV     AL,41H                  ;       <><><><><><><><><><><><><>
092B E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  41 <><>

092D B0 8F                         MOV     AL,CMOS_SHUT_DOWN+NMI   ; INSURE NMI OFF AND CMOS AT DEFAULT
092F E6 70                         OUT     CMOS_PORT,AL

                           ENDIF

0931 C6 06 0072 R 00               MOV     BYTE PTR @RESET_FLAG,0  ; CLEAR FLAG
0936 B8 E000                       MOV     AX,0E000H               ; SEGMENT OF SYSTEM CODE
0939 8E C0                         MOV     ES,AX
093B 2B FF                         SUB     DI,DI
093D 26: 8B 05                     MOV     AX,ES:[DI]              ; CHECK FOR AA55
0940 53                            PUSH    BX                      ; BUS SETTLE
0941 5B                            POP     BX
0942 3D AA55                       CMP     AX,0AA55H
0945 9C                            PUSHF                           ; SAVE FLAGS
0946 26: 89 05                     MOV     ES:[DI],AX              ; CLEAR POSSIBLE PARITY CHECK
0949 E4 61                         IN      AL,PORT_B
094B 0C 0C                         OR      AL,RAM_PAR_OFF          ; TOGGLE I/O-PARITY CHECK ENABLES
094D E6 61                         OUT     PORT_B,AL
094F 24 F3                         AND     AL,RAM_PAR_ON
0951 E6 61                         OUT     PORT_B,AL
0953 9D                            POPF                            ; RESTORE FLAGS
0954 75 27                         JNZ     SHUT4                   ; CONTINUE

                           ;-----  CHECKSUM SYSTEM CODE

0956 1E                            PUSH    DS
0957 06                            PUSH    ES                      ; SET SEGMENT TO TEST
0958 1F                            POP     DS
0959 2B DB                         SUB     BX,BX                   ; STARTING OFFSET
095B E8 0000 E                     CALL    ROM_CHECKSUM
095E 1F                            POP     DS                      ; RESTORE DATA SEGMENT
095F 75 1C                         JNZ     SHUT4                   ; GO IF CHECKSUM NOT OK

                           ;-----  ENABLE NMI AND I/O-MEMORY PARITY CHECKS

0961 B0 0F                         MOV     AL,CMOS_SHUT_DOWN       ; ENABLE NMI AND SET DEFAULT ADDRESS
0963 E6 70                         OUT     CMOS_PORT,AL

0965 E4 61                         IN      AL,PORT_B               ; ENABLE PARITY
0967 24 F3                         AND     AL,RAM_PAR_ON           ; ENABLE MEMORY PARITY CHECK / I/O CHECK
0969 E6 61                         OUT     PORT_B,AL

096B C7 06 0067 R 0003             MOV     @IO_ROM_INIT,0003H      ; SET THE OFFSET
0971 8C 06 0069 R                  MOV     @IO_ROM_SEG,ES          ; SET THE SEGMENT

0975 B0 42                         MOV     AL,42H                  ;       <><><><><><><><><><><><><>
0977 E6 80                         OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  42 <><>
```

```

                              ;-----  EXIT TO SYSTEM CODE

0979 FF 1E 0067 R                     CALL    DWORD PTR @IO_ROM_INIT  ; GO TO SYSTEM CODE
                                                              ; VIA CALL THROUGH DATA AREA LOCATION

                              ;-----  ENABLE NMI INTERRUPTS + ENTRY FROM SHUTDOWN WITH BOOT REQUEST

097D B0 0F                    SHUT4:  MOV     AL,CMOS_SHUT_DOWN       ; ENABLE NMI AND READ DEFAULT ADDRESS
097F E8 0000 E                        CALL    CMOS_READ               ; OPEN STANDBY LATCH
0982 E4 61                            IN      AL,PORT_B               ; ENABLE PARITY
0984 24 F3                            AND     AL,RAM_PAR_ON           ; ENABLE MEMORY PARITY CHECK / I/O CHECK
0986 E6 61                            OUT     PORT_B,AL

0988 B0 43                            MOV     AL,43H                  ;       <><><><><><><><><><><><>
098A E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  43 <><>
098C FB                               STI                             ; ENABLE INTERRUPTS IF DISABLED

098D CD 19                            INT     19H                     ; GO TO BOOT LOADER

098F F4                               HLT


0990                          PADING  PROC    NEAR                    ;       INSERT PADDING
0990 B9 000F                          MOV     CX,15                   ; GET BLANK CHARACTER COUNT
0993                          PAD1:
0993 B0 20                            MOV     AL,' '                  ; GET FILL SPACE
0995 E8 0000 E                        CALL    PRT_HEX                 ; WRITE A SPACE
0998 E2 F9                            LOOP    PAD1                    ; LOOP TILL INSERT DONE
099A B0 2D                            MOV     AL,'-'                  ; GET DASH CHARACTER
099C E8 0000 E                        CALL    PRT_HEX                 ; WRITE TO DISPLAY
099F C3                               RET
09A0                          PADING  ENDP


09A0                          PRT_OK  PROC    NEAR                    ;       PRINT "00000 KB OK"
09A0 50                               PUSH    AX                      ; SAVE WORK REGISTER
09A1 BB 000A                          MOV     BX,10                   ; SET DECIMAL CONVERT

                              ;-----  CONVERT AND SAVE

09A4 B9 0005                          MOV     CX,5                    ; OF 5 NIBBLES XX,XXX KB
09A7 2B FF                            SUB     DI,DI                   ; DISPLAY REGEN BUFFER POSITION
09A9                          PRT_DIV:
09A9 33 D2                            XOR     DX,DX
09AB F7 F3                            DIV     BX                      ; DIVIDE BY 10
09AD 80 CA 30                         OR      DL,30H                  ; MAKE INTO ASCII
09B0 52                               PUSH    DX                      ; SAVE
09B1 E2 F6                            LOOP    PRT_DIV

                              ;-----  DISPLAY LAST OK MEMORY

09B3 B9 0005                          MOV     CX,5
09B6                          PRT_DEC:
09B6 58                               POP     AX                      ; RECOVER A NUMBER
09B7 E8 0000 E                        CALL    PROT_PRT_HEX
09BA 47                               INC     DI                      ; POINT TO DISPLAY REGEN BUFFER
09BB E2 F9                            LOOP    PRT_DEC
09BD B9 0007                          MOV     CX,OFFSET F3B_PAD-OFFSET F3B    ; LOAD MESSAGE LENGTH
09C0 BE 09CF R                        MOV     SI,OFFSET F3B           ; POINT TO PRINT ' KB OK',' ' MESSAGE
09C3                          PRT_LOOP:
09C3 2E: 8A 04                        MOV     AL,CS:[SI]
09C6 46                               INC     SI
09C7 E8 0000 E                        CALL    PROT_PRT_HEX
09CA 47                               INC     DI                      ; INCREMENT BUFF PTR
09CB E2 F6                            LOOP    PRT_LOOP
09CD 58                               POP     AX                      ; RECOVER WORK REGISTERS
09CE C3                               RET

09CF 20 4B 42 20 4F 4B        F3B     DB      ' KB OK'                ; OK MESSAGE
09D5 20                       F3B_OK  DB      ' '                     ; PAD A SPACE
= 09D6                        F3B_PAD EQU     $
                              .LIST
09D6                          PRT_OK  ENDP


                              ;-------------------------
                              ;       PRINTER TABLE    :
                              ;-------------------------

09D6 03BC                     F4      DW      03BCH                   ; ADDRESS OF MONOCHROME PARALLEL ADAPTER
09D8 0378                             DW      0378H                   ; BASE ADDRESS STANDARD PARALLEL ADAPTER
09DA 0278                             DW      0278H                   ; ADDRESS OF ALTERNATE PARALLEL ADAPTER
09DC                          F4E     LABEL   WORD

09DC                          POST2   ENDP
09DC                          CODE    ENDS
                                      END
                              PAGE 118,121
                              TITLE TEST3 ---- 06/10/85  POST EXCEPTION INTERRUPT TESTS
                              .286C
                              .LIST
                              ;--------------------------------------------------------
                              ; TEST.20                                                :
                              ;       ADDITIONAL PROTECTED (VIRTUAL MODE) TEST         :
                              ; DESCRIPTION                                            :
                              ;       THE PROCESSOR IS PUT IN PROTECTED MODE AND       :
                              ;       THE FOLLOWING FUNCTIONS ARE VERIFIED             :
                              ;                                                        :
                              ;       1. VERIFY PROTECTED MODE                         :
                              ;          THE MACHINE STATUS IS CHECK FOR VIRTUAL MODE  :
                              ;       2. PROGRAMMED INTERRUPT TEST                     :
                              ;          AN PROGRAMMED INTERRUPT 32 IS ISSUED AND      :
                              ;          AND VERIFIED                                  :
                              ;       3. EXCEPTION INTERRUPT 13 TEST                   :
                              ;          A DESCRIPTOR SEGMENT LIMIT IS SET TO ZERO     :
                              ;          AND A WRITE TO THAT SEGMENT IS ATTEMPTED      :
                              ;          AN EXCEPTION 13 IS EXPECTED AND VERIFIED      :
                              ;       4. LDT/SDT LTR/STR TEST                          :
                              ;          LOAD LDT REGISTER AND VERIFY CORRECT          :
                              ;          LOAD TASK REGISTER AND VERIFY CORRECT         :
                              ;          THEY ARE VERIFIED VIA THE STORE INSTRUCTION   :
                              ;       5. THE CONTROL FLAGS OF THE 286 FOR DIRECTION    :
                              ;          ARE VERIFIED VIA THE STD AND CLD COMMANDS     :
                              ;          IN PROTECTED MODE                             :
                              ;       6. BOUND INSTRUCTION TEST (EXCEPTION INT 5)      :
                              ;          CREATE A SIGNED ARRAY INDEX WITHIN AND        :
                              ;          OUTSIDE THE LIMITS.  CHECK THAT NO EXC INT    :
                              ;          IF WITHIN LIMIT AND THAT AN EXC INT 5         :
                              ;          OCCURS IF OUTSIDE THE LIMITS.                 :
                              ;       7. PUSH ALL POP ALL TEST                         :
                              ;          SET GENERAL PURPOSE REGISTERS TO DIFFERENT    :
                              ;          VALUES ISSUE A PUSH ALL, CLEAR THE REGISTERS  :
                              ;          ISSUE A POP ALL AND VERIFY CORRECT.           :
                              ;       8. CHECK THE VERR/VERW INSTRUCTIONS              :
                              ;          THE ACCESS BYTE IS SET TO READ ONLY THEN TO   :
                              ;          A WRITE ONLY AND THE VERR/VERW INSTRUCTIONS   :
                              ;          ARE VERIFIED.                                 :
                              ;       9. CAUSE AN INTERRUPT 13 VIA A WRITE TO A        :
                              ;          READ ONLY SEGMENT                             :
                              ;      10. VERIFY THE ARPL INSTRUCTION FUNCTIONS         :
                              ;          SET THE RPL FIELD OF A SELECTOR AND           :
                              ;          VERIFY THAT CURRENT SELECTOR RPL IS SET       :
                              ;          CORRECTLY.                                    :
                              ;      11. VERIFY THE LAR INSTRUCTION FUNCTIONS          :
                              ;      12. VERIFY THE LSL INSTRUCTION FUNCTIONS          :
                              ;      13. LOW MEG CHIP SELECT TEST                      :
                              ;--------------------------------------------------------

 0000                         CODE    SEGMENT BYTE PUBLIC

                                      PUBLIC  POST3

                                      EXTRN   CMOS_WRITE:NEAR
                                      EXTRN   DDS:NEAR
                                      EXTRN   PROC_SHUTDOWN:NEAR
                                      EXTRN   SYSINIT1:NEAR

                                      ASSUME  CS:CODE
 0000                         POST3   PROC
 0000 E8 0000 E                       CALL    DDS                     ; SET DATA SEGMENT
 0003 B0 F0                           MOV     AL,0F0H                 ;       <><><><><><><><><><><>
 0005 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F0 <><>

                              ;-----  SET SHUTDOWN RETURN 7

 0007 B8 078F                         MOV     AX,7*H+CMOS_SHUT_DOWN+NMI       ; ADDRESS FOR SHUTDOWN BYTE
 000A E8 0000 E                       CALL    CMOS_WRITE              ; SET ERROR EXIT (DOUBLE EXCEPTION?)

                              ;-----  ENABLE PROTECTED MODE

 000D BC 0000                         MOV     SP,POST_SS              ; SET STACK FOR SYSINIT1
 0010 8E D4                           MOV     SS,SP
 0012 BC 8000                         MOV     SP,POST_SP
 0015 E8 0000 E                       CALL    SYSINIT1                ; GO ENABLE PROTECTED MODE

                              ;-----  SET TEMPORARY STACK

 0018 B8 0008                         MOV     AX,GDT_PTR
 001B 8E C0                           MOV     ES,AX
 001D 8E D8                           MOV     DS,AX
 001F 26: C7 06 005A 0000             MOV     ES:SS_TEMP.BASE_LO_WORD,0
 0026 26: C6 06 005C 00               MOV     BYTE PTR ES:(SS_TEMP.BASE_HI_BYTE),0
 002C BE 0058                         MOV     SI,SS_TEMP
 002F 8E D6                           MOV     SS,SI
 0031 BC FFFD                         MOV     SP,MAX_SEG_LEN-2

                              ;-----  VERIFY PROTECTED MODE

                                      SMSW    AX                      ; GET THE MACHINE STATUS WORD
 0034 0F 01 E0              +         DB      00FH,001H,0E0H
 0037 A9 0001                         TEST    AX,VIRTUAL_ENABLE       ; ARE WE IN PROTECTED MODE
 003A 75 03                           JNZ     T7_1
 003C E9 02CD R                       JMP     ERROR_EXIT              ; ERROR IF NOT

 003F B0 F1                   T7_1:   MOV     AL,0F1H                 ;       <><><><><><><><><><><>
 0041 E6 80                           OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F1 <><>

                              ;-----  INTERRUPT TEST (PROGRAMMED INTERRUPT 32)

 0043 B0 B0                           MOV     AL,0B0H                 ; SET EXCEPTION FLAG
 0045 E6 8B                           OUT     DMA_PAGE+0AH,AL         ;   FOR INTERRUPT 10
 0047 CD 20                           INT     32                      ; INTERRUPT
 0049 2B C9                           SUB     CX,CX                   ; WAIT FOR INTERRUPT
 004B E4 8B                   LOOP1:  IN      AL,DMA_PAGE+0AH
 004D 22 C0                           AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
 004F E0 FA                           LOOPNZ  LOOP1
 0051 74 03                           JZ      T7_2
 0053 E9 02CD R                       JMP     ERROR_EXIT              ; MISSING INTERRUPT

                              ;-----  CAUSE AN EXCEPTION INTERRUPT (GENERAL PROTECTION INTERRUPT 13D)

```

```
0056 B0 F2                  T7_2:     MOV     AL,0F2H                 ;       <><><><><><><><><><><><>
0058 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F2 <><>
005A B0 9D                            MOV     AL,9DH                  ; SET INTERRUPT 13 FLAG
005C E6 8B                            OUT     DMA_PAGE+0AH,AL         ; FOR THE INTERRUPT HANDLER

                            ;-----    MODIFY DESCRIPTOR TABLES
                            ;-----     SET TEMPORARY ES DESCRIPTOR TO SEGMENT LIMIT

005E C7 06 0048 0000                  MOV     DS:ES_TEMP.SEG_LIMIT,0  ; SET SEGMENT TO 0

                            ;-----    CPL0, DATA ACCESS RIGHTS

0064 C6 06 004D 93                    MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
0069 C6 06 004C 01                    MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),01   ; DO ALL TESTS ON 2ND 64K
006E C7 06 004A 0000                  MOV     WORD PTR DS:(ES_TEMP.BASE_LO_WORD),0

0074 6A 48                            PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER
0076 07                               POP     ES

                            ;-----    CAUSE AN EXCEPTION 13 INTERRUPT

0077 2B FF                            SUB     DI,DI
0079 26: 8B 05                        MOV     AX,ES:[DI]              ; THIS SHOULD CAUSE AND EXCEPTION
007C 2B C9                            SUB     CX,CX                   ; WAIT FOR INTERRUPT
007E E4 8B                  LOOP2:    IN      AL,DMA_PAGE+0AH
0080 22 C0                            AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
0082 E0 FA                            LOOPNZ  LOOP2
0084 74 03                            JZ      T7_3                    ; CONTINUE IF INTERRUPT
0086 E9 02CD R                        JMP     ERROR_EXIT              ; MISSING INTERRUPT

                            ;----------------------------------------
                            ;                                        ;
                            ;         VERIFY 286 LDT/SDT LTR/STR     ;
                            ;         INSTRUCTIONS                   ;
                            ; DESCRIPTION                            ;
                            ;         LOAD LDT  REGISTERS WITH A     ;
                            ;         DESCRIPTOR AND VERIFY CORRECT  ;
                            ;----------------------------------------

                            ;-----    WRITE TO 286 LDT REGISTER
0089                        T7_3:
0089 B0 F3                            MOV     AL,0F3H                 ;       <><><><><><><><><><><><>
008B E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F3 <><>
008D BF 0078                          MOV     DI,POST_LDTR
                                      LLDT    DI                      ; REGISTER FROM THIS AREA
0090 0F                     +         DB      00FH
0091                        + ??0000  LABEL   BYTE
0091 8B D7                  +         MOV     DX,DI
0093                        + ??0001  LABEL   BYTE
0091                        +         ORG     OFFSET CS:??0000
0091 00                     +         DB      000H
0093                        +         ORG     OFFSET CS:??0001

                            ;-----    READ AND VERIFY 286 LDT SELECTOR

0093 2B C0                            SUB     AX,AX                   ; CLEAR AX
                                      SLDT    AX                      ; GET THE LDT SELECTOR
0095 0F                     +         DB      00FH
0096                        + ??0002  LABEL   BYTE
0096 03 C0                  +         ADD     AX,AX
0098                        + ??0003  LABEL   BYTE
0096                        +         ORG     OFFSET CS:??0002
0096 00                     +         DB      000H
0098                        +         ORG     OFFSET CS:??0003
0098 25 00F8                          AND     AX,0F8H                 ; STRIP TI/RPL
009B 3D 0078                          CMP     AX,POST_LDTR            ; CORRECT SELECTOR?
009E 75 1B                            JNZ     ERROR                   ; GO IF NOT

                            ;-----    WRITE TO 286 TR

00A0 BF 0068                          MOV     DI,POST_TR
                                      LTR     DI                      ; REGISTER FROM THIS AREA
00A3 0F                     +         DB      00FH
00A4                        + ??0004  LABEL   BYTE
00A4 8B DF                  +         MOV     BX,DI
00A6                        + ??0005  LABEL   BYTE
00A4                        +         ORG     OFFSET CS:??0004
00A4 00                     +         DB      000H
00A6                        +         ORG     OFFSET CS:??0005

                            ;-----    VERIFY 286 TR REGISTERS

00A6 2B C0                            SUB     AX,AX
                                      STR     AX                      ; GET THE TR  REGISTER
00A8 0F                     +         DB      00FH
00A9                        + ??0006  LABEL   BYTE
00A9 8B C8                  +         MOV     CX,AX
00AB                        + ??0007  LABEL   BYTE
00A9                        +         ORG     OFFSET CS:??0006
00A9 00                     +         DB      000H
00AB                        +         ORG     OFFSET CS:??0007
00AB 25 00F8                          AND     AX,0F8H
00AE 3D 0068                          CMP     AX,POST_TR              ; CORRECT SELECTOR?
00B1 75 08                            JNZ     ERROR

                            ;-----    TEST 286 CONTROL FLAGS

00B3 FD                               STD                             ; SET DIRECTION FLAG FOR DECREMENT
00B4 9C                               PUSHF                           ; GET THE FLAGS
00B5 58                               POP     AX
00B6 A9 0200                          TEST    AX,0200H                ; INTERRUPT FLAG SHOULD BE OFF
00B9 74 03                            JZ      T7_4                    ; CONTINUE IF OFF
00BB E9 02CD R              ERROR:    JMP     ERROR_EXIT              ; GO IF NOT
00BE                        T7_4:
00BE A9 0400                          TEST    AX,0400H                ; CHECK DIRECTION FLAG
00C1 75 03                            JNZ     T7_5
00C3 E9 02CD R                        JMP     ERROR_EXIT              ; GO IF NOT SET
00C6                        T7_5:
00C6 FC                               CLD                             ; CLEAR DIRECTION FLAG
00C7 9C                               PUSHF                           ; INSURE DIRECTION FLAG IS RESET
00C8 58                               POP     AX
00C9 A9 0400                          TEST    AX,0400H
00CC 74 03                            JZ      T7_6
00CE E9 02CD R                        JMP     ERROR_EXIT              ; GO IF NOT
```

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                                ;----------------------------------------
                                ;       VERIFY 286 BOUND INSTRUCTION    :
                                ; DESCRIPTION                           :
                                ;       CREATE A SIGNED ARRAY INDEX     :
                                ;       WITHIN AND OUTSIDE THE LIMITS   :
                                ;       (EXPECT INT 5)                  :
                                ;----------------------------------------

 00D1 B0 F4                     T7_6:   MOV     AL,0F4H                 ;       <><><><><><><><><><><>
 00D3 E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F4 <><>
 00D5 6A 48                             PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER
 00D7 07                                POP     ES

                                ;-----  CHECK BOUND FUNCTIONS CORRECTLY

 00D8 2B FF                             SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
 00DA 26: C7 05 0000                    MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO ZERO
 00DF 26: C7 45 02 7FFF                 MOV     WORD PTR ES:[DI+2],07FFFH ; SET SECOND TO 07FFFH
 00E5 B0 95                             MOV     AL,095H                 ; SET INTERRUPT 5 FLAG
 00E7 E6 8B                             OUT     DMA_PAGE+0AH,AL
 00E9 B8 1000                           MOV     AX,1000H                ; SET AX WITHIN BOUNDS
 00EC 26: 62 05                         BOUND   AX,DWORD PTR ES:[DI]    ; USE THE ES SEGMENT POINTER
 00EF 2B C9                             SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
 00F1 E2 FE                     LOOPA:  LOOP    LOOPA
 00F3 E4 8B                             IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
 00F5 3C 00                             CMP     AL,0                    ; DID AN INTERRUPT OCCUR?
 00F7 75 03                             JNZ     T7_7                    ; CONTINUE IF NOT
 00F9 E9 02CD R                         JMP     ERROR_EXIT              ; GO IF YES

                                ;-----  CHECK LOW BOUND WORD CAUSES INTERRUPT 5

 00FC                           T7_7:
 00FC 2B FF                             SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
 00FE 26: C7 05 3FF0                    MOV     WORD PTR ES:[DI],03FF0H ; SET FIRST WORD TO 03FF0H
 0103 B8 1000                           MOV     AX,1000H                ; SET AX OUT OF BOUNDS
 0106 26: 62 05                         BOUND   AX,DWORD PTR ES:[DI]
 0109 2B C9                             SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
 010B                           LOOPB:
 010B E4 8B                             IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
 010D 3C 00                             CMP     AL,0H                   ; DID AN INTERRUPT OCCUR?
 010F E0 FA                             LOOPNZ  LOOPB                   ; TRY AGAIN
 0111 74 03                             JZ      T7_8                    ; CONTINUE IF INTERRUPT
 0113 E9 02CD R                         JMP     ERROR_EXIT              ; GO IF NO INTERRUPT

                                ;-----  CHECK HIGH BOUND WORD CAUSES INTERRUPT 5

 0116 B0 95                     T7_8:   MOV     AL,95H                  ; SET FLAG FOR INTERRUPT
 0118 E6 8B                             OUT     DMA_PAGE+0AH,AL

 011A 2B FF                             SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
 011C 26: C7 05 0000                    MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO 0
 0121 26: C7 45 02 0FFF                 MOV     WORD PTR ES:[DI+2],0FFFH; SET SECOND TO 0FFFH
 0127 B8 1000                           MOV     AX,1000H                ; SET AX OUT OF BOUNDS
 012A 26: 62 05                         BOUND   AX,DWORD PTR ES:[DI]
 012D 2B C9                             SUB     CX,CX                   ; WAIT FOR POSSIBLE INTERRUPT
 012F                           LOOPC:
 012F E4 8B                             IN      AL,DMA_PAGE+0AH         ; GET THE RESULTS
 0131 3C 00                             CMP     AL,0H                   ; DID AN INTERRUPT OCCUR?
 0133 E0 FA                             LOOPNZ  LOOPC                   ; TRY AGAIN
 0135 74 03                             JZ      T7_9
 0137 E9 02CD R                         JMP     ERROR_EXIT              ; GO IF NO INTERRUPT

                                ;-----------------------------------------------------
                                ;       VERIFY PUSH ALL AND POP ALL INSTRUCTIONS:
                                ; DESCRIPTION                                        :
                                ;       SET REGISTERS TO A KNOWN VALUE AND           :
                                ;       PUSH ALL.  RESET THE REGISTERS, POP ALL      :
                                ;       AND VERIFY                                   :
                                ;-----------------------------------------------------

 013A B0 F5                     T7_9:   MOV     AL,0F5H                 ;       <><><><><><><><><><><>
 013C E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F5 <><>
 013E B8 0001                           MOV     AX,01                   ; SET AX=1
 0141 8B D8                             MOV     BX,AX                   ; SET BX=2
 0143 43                                INC     BX
 0144 8B CB                             MOV     CX,BX                   ; SET CX=3
 0146 41                                INC     CX
 0147 8B D1                             MOV     DX,CX
 0149 42                                INC     DX                      ; SET DX=4
 014A 8B FA                             MOV     DI,DX
 014C 47                                INC     DI                      ; SET DI=5
 014D 8B F7                             MOV     SI,DI
 014F 46                                INC     SI                      ; SET SI=6
 0150 55                                PUSH    BP                      ; SAVE THE (BP) ERROR FLAG REGISTER
 0151 8B EE                             MOV     BP,SI                   ; SET BP=7
 0153 45                                INC     BP
 0154 60                                PUSHA                           ; ISSUE THE PUSH ALL COMMAND
 0155 2B C0                             SUB     AX,AX                   ; CLEAR ALL REGISTERS
 0157 8B D8                             MOV     BX,AX
 0159 8B C8                             MOV     CX,AX
 015B 8B D0                             MOV     DX,AX
 015D 8B F8                             MOV     DI,AX
 015F 8B F0                             MOV     SI,AX
 0161 8B E8                             MOV     BP,AX
 0163 61                                POPA                            ; GET THE REGISTERS BACK
 0164 83 FD 07                          CMP     BP,07                   ; BP SHOULD BE 7
 0167 5D                                POP     BP                      ; RESTORE (BP) ERROR FLAG REGISTER
 0168 75 1E                             JNZ     ERROR_EXIT1             ; GO IF NOT
 016A 3D 0001                           CMP     AX,01                   ; AX SHOULD BE 1
 016D 75 19                             JNZ     ERROR_EXIT1             ; GO IF NOT
 016F 83 FB 02                          CMP     BX,02                   ; BX SHOULD BE 2
 0172 75 14                             JNZ     ERROR_EXIT1             ; GO IF NOT
 0174 83 F9 03                          CMP     CX,03                   ; CX SHOULD BE 3
 0177 75 0F                             JNZ     ERROR_EXIT1             ; GO IF NOT
 0179 83 FA 04                          CMP     DX,04                   ; DX SHOULD BE 4
 017C 75 0A                             JNZ     ERROR_EXIT1             ; GO IF NOT
 017E 83 FF 05                          CMP     DI,05                   ; DI SHOULD BE 5
 0181 75 05                             JNZ     ERROR_EXIT1             ; GO IF NOT
 0183 83 FE 06                          CMP     SI,06                   ; SI SHOULD BE 6
 0186 74 03                             JZ      T7_10                   ; CONTINUE IF IT IS

                                ;-----  ERROR EXIT

 0188                           ERROR_EXIT1:
 0188 E9 02CD R                         JMP     ERROR_EXIT
```

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                                ;-----------------------------------------------
                                ;       VERIFY ACCESS RIGHTS FUNCTION CORRECTLY :
                                ; DESCRIPTION                                   :
                                ;       SET ACCESS RIGHTS OF DESCRIPTOR TO      :
                                ;       READ ONLY.  VERIFY THE VERW/VERR INSTR  :
                                ;       ACCESS A READ ONLY WITH A WRITE AND     :
                                ;       VERIFY AN EXCEPTION INTERRUPT 13        :
                                ;-----------------------------------------------

018B B0 F6                      T7_10:  MOV     AL,0F6H                 ;       <><><><><><><><><><><><><>
018D E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F6 <><>
018F C7 06 0048 FFFF                    MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN        ; SET SEGMENT TO OFFFFH
0195 C6 06 004C 00                      MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),0    ; SET THE ADDRESS
019A C7 06 004A F000                    MOV     DS:ES_TEMP.BASE_LO_WORD,0F000H
01A0 B8 0048                            MOV     AX,ES_TEMP              ; LOAD ES REGISTER
01A3 8E C0                              MOV     ES,AX                   ; THIS SEGMENT SHOULD BE WRITEABLE

                                ;-----  INSURE ACCESS RIGHTS MAY BE WRITTEN

                                        SEGOV   DS                      ; SET SEGMENT OVERRIDE TO START OF TABLE
01A5 3E                       +         DB      03EH
                                        VERW    AX                      ; CHECK THE ACCESS RIGHTS OF ES_TEMP
01A6 0F                       +         DB      00FH
01A7                          + ??0009  LABEL   BYTE
01A7 8B E8                    +         MOV     BP,AX
01A9                          + ??000A  LABEL   BYTE
01A7                          +         ORG     OFFSET CS:??0009
01A7 00                       +         DB      000H
01A9                          +         ORG     OFFSET CS:??000A
01A9 75 DD                              JNZ     ERROR_EXIT1             ; ERROR IF SEGMENT CAN NOT WRITE

                                ;-----  SET ACCESS RIGHTS TO READ ONLY

01AB C6 06 004D 91                      MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),91H
01B0 B8 0048                            MOV     AX,ES_TEMP              ; LOAD ES REGISTER
01B3 8E C0                              MOV     ES,AX
                                        SEGOV   DS                      ; SET SEGMENT OVERRIDE TO START OF TABLE
01B5 3E                       +         DB      03EH
                                        VERW    AX                      ; CHECK THE ACCESS RIGHTS OF ES_TEMP
01B6 0F                       +         DB      00FH
01B7                          + ??000C  LABEL   BYTE
01B7 8B E8                    +         MOV     BP,AX
01B9                          + ??000D  LABEL   BYTE
01B7                          +         ORG     OFFSET CS:??000C
01B7 00                       +         DB      000H
01B9                          +         ORG     OFFSET CS:??000D
01B9 74 CD                              JZ      ERROR_EXIT1             ; ERROR IF SEGMENT IS WRITEABLE

01BB B8 0048                            MOV     AX,ES_TEMP              ; INSURE THAT SEGMENT IS READABLE
                                        SEGOV   DS
01BE 3E                       +         DB      03EH
                                        VERR    AX
01BF 0F                       +         DB      00FH
01C0                          + ??000F  LABEL   BYTE
01C0 8B E0                    +         MOV     SP,AX
01C2                          + ??0010  LABEL   BYTE
01C0                          +         ORG     OFFSET CS:??000F
01C0 00                       +         DB      000H
01C2                          +         ORG     OFFSET CS:??0010
01C2 75 C4                              JNZ     ERROR_EXIT1             ; GO IF SEGMENT NOT READABLE

                                ;-----  CAUSE AN EXCEPTION 13 INTERRUPT

01C4 B0 9D                              MOV     AL,09DH                 ; SET EXCEPTION FLAG
01C6 E6 8B                              OUT     DMA_PAGE+0AH,AL         ;   FOR INTERRUPT 13
01C8 2B F6                              SUB     SI,SI
01CA 26: C6 04 00                       MOV     BYTE PTR ES:[SI],00     ; WRITE A BYTE THAT SHOULD
01CE 2B C9                              SUB     CX,CX                   ; WAIT FOR INTERRUPT
01D0 E4 8B                      LOOPD:  IN      AL,DMA_PAGE+0AH
01D2 22 C0                              AND     AL,AL                   ; DID THE INTERRUPT OCCUR?
01D4 E0 FA                              LOOPNZ  LOOPD
01D6 75 B0                              JNZ     ERROR_EXIT1             ; MISSING INTERRUPT

                                ;-----  RESTORE THE ACCESS RIGHTS BYTE

01D8 C6 06 004D 93                      MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                                ;-----------------------------------------------
                                ;       VERIFY ADJUST RPL FIELD OF SELECTOR     :
                                ;       INSTRUCTION (ARPL) FUNCTIONS            :
                                ; DESCRIPTION                                   :
                                ;       SET THE RPL FIELD OF A SELECTOR         :
                                ;       AND VERIFY THAT THE ZERO FLAG IS SET    :
                                ;       CORRECTLY AND THAT THE SELECTOR RPL     :
                                ;       FIELD IS SET CORRECTLY                  :
                                ;-----------------------------------------------

01DD B0 F7                              MOV     AL,0F7H                 ;       <><><><><><><><><><><><><>
01DF E6 80                              OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  F7 <><>
01E1 B8 0048                            MOV     AX,ES_TEMP              ; PUT A SELECTOR IN AX
01E4 BB 0060                            MOV     BX,DS_TEMP              ; PUT A SELECTOR IN BX
01E7 0D 0003                            OR      AX,03H                  ; MAKE ACCESS OF AX < BX

                                ;-----  NOTE BX = FIRST OPERAND  AX = SECOND OPERAND

                                        ARPL    AX,BX                   ; ISSUE THE RPL COMMAND
01EA                          + ??0011  LABEL   BYTE
01EA 8B C3                    +         MOV     AX,BX
01EC                          + ??0012  LABEL   BYTE
01EA                          +         ORG     OFFSET CS:??0011
01EA 63                       +         DB      063H
01EC                          +         ORG     OFFSET CS:??0012
01EC 75 9A                              JNZ     ERROR_EXIT1             ; GO IF RPL WAS NOT CHANGED
01EE 80 E3 03                           AND     BL,03H                  ; STRIP UNWANTED BITS
01F1 80 FB 03                           CMP     BL,03H                  ; AS EXPECTED?
01F4 75 92                              JNZ     ERROR_EXIT1             ; GO IF NOT

                                ;-----  CHECK THAT ACCESS RIGHTS DO NOT CHANGE

01F6 BB 0060                            MOV     BX,DS_TEMP              ; PUT A SELECTOR IN BX
01F9 B8 0048                            MOV     AX,ES_TEMP              ; PUT A SELECTOR IN AX
01FC 80 CB 03                           OR      BL,03H                  ; MAKE ACCESS OF BX < AX

                                ;-----  NOTE BX = FIRST OPERAND  AX = SECOND OPERAND
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                                       ARPL    AX,BX                   ; ISSUE THE RPL COMMAND
 01FF                          + ??0013 LABEL  BYTE
 01FF 8B C3                    +        MOV    AX,BX
 0201                          + ??0014 LABEL  BYTE
 01FF                          +        ORG    OFFSET CS:??0013
 01FF 63                       +        DB     063H
 0201                          +        ORG    OFFSET CS:??0014
 0201 74 85                             JZ     ERROR_EXIT1             ; GO IF RPL WAS NOT CHANGED
 0203 80 E3 03                          AND    BL,03H                  ; STRIP UNWANTED BITS
 0206 80 FB 03                          CMP    BL,03H                  ; AS EXPECTED?
 0209 75 2F                             JNZ    ERROR_EXIT2             ; GO IF NOT

                               ;-----  VERIFY THE LAR (LOAD ACCESS RIGHTS) INSTRUCTION

 020B B0 F8                             MOV    AL,0F8H                 ;       <><><><><><><><><><><><><>
 020D E6 80                             OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  F8 <><>

                               ;-----  SET THE DESCRIPTOR TO LEVEL 3

 020F C6 06 004D F3                     MOV    BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL3_DATA_ACCESS
 0214 BB 0048                           MOV    BX,ES_TEMP
 0217 2B C0                             SUB    AX,AX                   ; CLEAR AX

                               ;-----  GET THE CURRENT DESCRIPTORS ACCESS RIGHTS

                                        LAR    AX,BX                   ; ISSUE THE LAR COMMAND
 0219 0F                       +        DB     00FH
 021A                          + ??0015 LABEL  BYTE
 021A 8B C3                    +        MOV    AX,BX
 021C                          + ??0016 LABEL  BYTE
 021A                          +        ORG    OFFSET CS:??0015
 021A 02                       +        DB     002H
 021C                          +        ORG    OFFSET CS:??0016

                               ;-----  INSURE THE DESCRIPTOR WAS VISIBLE

 021C 75 1C                             JNZ    ERROR_EXIT2             ; GO IF LAR WAS NOT CHANGED

                               ;-----  THE DESCRIPTORS ACCESS RIGHTS MUST BE 3

 021E 80 FC F3                          CMP    AH,CPL3_DATA_ACCESS     ; AS EXPECTED?
 0221 75 17                             JNZ    ERROR_EXIT2             ; GO IF NOT

                               ;-----  VERIFY THE LSL (LOAD SEGMENT LIMITS) INSTRUCTION

 0223 B0 F9                             MOV    AL,0F9H                 ;       <><><><><><><><><><><><><>
 0225 E6 80                             OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  F9 <><>
 0227 C7 06 0048 AAAA                   MOV    DS:ES_TEMP.SEG_LIMIT,0AAAAH     ; SET SEGMENT LIMIT TO 0AAAAH

 022D C6 06 004D 93                     MOV    BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
 0232 B8 0048                           MOV    AX,ES_TEMP              ; LOAD ES REGISTER
                                        LSL    BX,AX                   ; GET THE DESCRIPTOR SEGMENT LIMIT
 0235 0F                       +        DB     00FH
 0236                          + ??0017 LABEL  BYTE
 0236 8B D8                    +        MOV    BX,AX
 0238                          + ??0018 LABEL  BYTE
 0236                          +        ORG    OFFSET CS:??0017
 0236 03                       +        DB     003H
 0238                          +        ORG    OFFSET CS:??0018
 0238 74 03                             JZ     R07                     ; GO IF OK

 023A                          ERROR_EXIT2:

 023A E9 02CD R                         JMP    ERROR_EXIT              ; GO IF NOT SUCCESSFUL

 023D 81 FB AAAA               R07:     CMP    BX,0AAAAH               ; INSURE CORRECT SEGMENT LIMIT
 0241 C7 06 0048 5555                   MOV    DS:ES_TEMP.SEG_LIMIT,05555H     ;SET THE SEGMENT LIMIT TO 05555H
 0247 B8 0048                           MOV    AX,ES_TEMP
                                        LSL    BX,AX                   ; GET THE DESCRIPTOR SEGMENT LIMIT
 024A 0F                       +        DB     00FH
 024B                          + ??0019 LABEL  BYTE
 024B 8B D8                    +        MOV    BX,AX
 024D                          + ??001A LABEL  BYTE
 024B                          +        ORG    OFFSET CS:??0019
 024B 03                       +        DB     003H
 024D                          +        ORG    OFFSET CS:??001A
 024D 75 EB                             JNZ    ERROR_EXIT2             ; GO IF NOT SUCCESSFUL

 024F 81 FB 5555                        CMP    BX,05555H               ; INSURE CORRECT SEGMENT LIMIT
 0253 75 E5                             JNZ    ERROR_EXIT2             ; GO IF NOT

                               ;-------------------------------------------------------
                               ; LOW MEG CHIP SELECT TEST                              :
                               ;  TEST THAT A WRITE TO ADDRESS 1B0000 DOES NOT WRITE   :
                               ;  TO B000:0, OR 1B8000 DOES NOT WRITE TO B800:0        :
                               ;-------------------------------------------------------

 0255 B0 FA                             MOV    AL,0FAH                 ;       <><><><><><><><><><><><><>
 0257 E6 80                             OUT    MFG_PORT,AL             ;       <><> CHECKPOINT  FA <><>
 0259 6A 08                             PUSH   BYTE PTR GDT_PTR        ; MODIFY THE DESCRIPTOR TABLE
 025B 1F                                POP    DS

                               ;-----  SET TEMPORARY ES DESCRIPTOR 64K SEGMENT LIMIT/CPL0 DATA ACCESS

 025C C7 06 0048 FFFF                   MOV    DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
 0262 C6 06 004D 93                     MOV    BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS

                               ;-----  START WITH SEGMENT 1B0000

 0267 C6 06 004C 1B                     MOV    BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),1BH
 026C C7 06 004A 0000                   MOV    DS:ES_TEMP.BASE_LO_WORD,0
 0272 6A 48                             PUSH   BYTE PTR  ES_TEMP       ; LOAD ES REGISTER
 0274 07                                POP    ES
 0275 2B FF                             SUB    DI,DI                   ; POINT TO FIRST LOCATION
 0277 26: C7 05 AA55                    MOV    WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN

                               ;-----  DO FOR SEGMENT 1B8000

 027C C7 06 004A 8000                   MOV    DS:ES_TEMP.BASE_LO_WORD,8000H
 0282 6A 48                             PUSH   BYTE PTR ES_TEMP        ; LOAD ES REGISTER
 0284 07                                POP    ES
 0285 26: C7 05 AA55                    MOV    WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN

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                                   ;-----  DO FOR SEGMENT 1A0000

      028A C6 06 004C 1A                   MOV     BYTE PTR DS:(ES_TEMP.BASE_HI_BYTE),1AH
      028F C7 06 004A 0000                 MOV     DS:ES_TEMP.BASE_LO_WORD,0
      0295 6A 48                           PUSH    BYTE PTR ES_TEMP          ; LOAD ES REGISTER
      0297 07                              POP     ES
      0298 26: C7 05 AA55                  MOV     WORD PTR ES:[DI],0AA55H ; WRITE A TEST PATTERN

                                   ;-----  B/W VIDEO CARD

      029D 6A 20                           PUSH    BYTE PTR  C_BWCRT_PTR
      029F 1F                              POP     DS                        ; SET DS TO B/W DISPLAY REGEN BUFFER
      02A0 8B 05                           MOV     AX,DS:[DI]                ; GET THE WORD FROM B/W VIDEO

                                   ;-----  COMPATIBLE COLOR

      02A2 6A 28                           PUSH    BYTE PTR C_CCRT_PTR       ; SET DS TO COMPATIBLE COLOR MEMORY
      02A4 1F                              POP     DS
      02A5 8B 1D                           MOV     BX,DS:[DI]                ; GET THE WORD FROM COLOR MEMORY

                                   ;-----  EGA COLOR

      02A7 6A 30                           PUSH    BYTE PTR E_CCRT_PTR               ; EGA COLOR CRT POINTER LOW 64K
      02A9 1F                              POP     DS
      02AA 8B 0D                           MOV     CX,DS:[DI]

                                   ;-----  TEST FOR ERROR

      02AC 50                              PUSH    AX                        ; SAVE RESULTS
      02AD B0 35                           MOV     AL,35H                    ;       <><><><><><><><><><><><>
      02AF E6 80                           OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  35 <><>
      02B1 58                              POP     AX
      02B2 3D AA55                         CMP     AX,0AA55H
      02B5 74 16                           JZ      ERROR_EXIT
      02B7 81 FB AA55                      CMP     BX,0AA55H
      02BB 74 10                           JZ      ERROR_EXIT
      02BD 81 F9 AA55                      CMP     CX,0AA55H
      02C1 74 0A                           JZ      ERROR_EXIT
      02C3 B0 34                           MOV     AL,34H                    ; RESTORE CHECKPOINT
      02C5 E6 80                           OUT     MFG_PORT,AL               ;       <><> CHECKPOINT  34 <><>

                                   ;-----  SHUTDOWN

      02C7                         NORMAL_EXIT:
      02C7 B8 068F                         MOV     AX,6*H+CMOS_SHUT_DOWN+NMI         ; ADDRESS FOR SHUTDOWN BYTE
      02CA E8 0000 E                       CALL    CMOS_WRITE                        ; SET GOOD ENDING
      02CD                         ERROR_EXIT:
      02CD E9 0000 E                       JMP     PROC_SHUTDOWN

      02D0                         POST3      ENDP

      02D0                         CODE       ENDS
                                              END
```

SECTION 5

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                              PAGE 118,121
                              TITLE TEST4 ---- 06/10/85  POST AND BIOS UTILITY ROUTINES
                              .286C
                              .LIST
 0000                         CODE      SEGMENT BYTE PUBLIC

                                        PUBLIC  BEEP
                                        PUBLIC  BLINK_INT
                                        PUBLIC  CMOS_READ
                                        PUBLIC  CMOS_WRITE
                                        PUBLIC  CONFIG_BAD
                                        PUBLIC  D11
                                        PUBLIC  DDS
                                        PUBLIC  DUMMY_RETURN_1
                                        PUBLIC  ERR_BEEP
                                        PUBLIC  E_MSG
                                        PUBLIC  INT_287
                                        PUBLIC  KBD_RESET
                                        PUBLIC  POST4
                                        PUBLIC  PROT_PRT_HEX
                                        PUBLIC  PROC_SHUTDOWN
                                        PUBLIC  PRT_HEX
                                        PUBLIC  PRT_SEG
                                        PUBLIC  P_MSG
                                        PUBLIC  RE_DIRECT
                                        PUBLIC  ROM_CHECK
                                        PUBLIC  ROM_CHECKSUM
                                        PUBLIC  SET_TOD
                                        PUBLIC  WAITF
                                        PUBLIC  XPC_BYTE

                                        EXTRN   E163:NEAR
                                        EXTRN   OBF_42:NEAR
                                        EXTRN   ROM_ERR:NEAR
                                        EXTRN   XMIT_8042:NEAR

                                        ASSUME  CS:CODE,DS:DATA
 0000                         POST4:
                              ;--- CMOS_READ -----------------------------------------------------------
                              ;                  READ BYTE FROM CMOS SYSTEM CLOCK CONFIGURATION TABLE       :
                              ;                                                                              :
                              ; INPUT: (AL)=   CMOS TABLE ADDRESS TO BE READ                                 :
                              ;                BIT    7 = 0 FOR NMI ENABLED AND 1 FOR NMI DISABLED ON EXIT   :
                              ;                BITS 6-0 = ADDRESS OF TABLE LOCATION TO READ                  :
                              ;                                                                              :
                              ; OUTPUT: (AL)   VALUE AT LOCATION (AL) MOVED INTO (AL).  IF BIT 7 OF (AL) WAS :
                              ;                ON THEN NMI LEFT DISABLED.  DURING THE CMOS READ BOTH NMI AND :
                              ;                NORMAL INTERRUPTS ARE DISABLED TO PROTECT CMOS DATA INTEGRITY. :
                              ;                THE CMOS ADDRESS REGISTER IS POINTED TO A DEFAULT VALUE AND   :
                              ;                THE INTERRUPT FLAG RESTORED TO THE ENTRY STATE ON RETURN.     :
                              ;                ONLY THE (AL) REGISTER AND THE NMI STATE IS CHANGED.          :
                              ;-------------------------------------------------------------------------------

 0000                         CMOS_READ         PROC    NEAR              ;       READ LOCATION (AL) INTO (AL)
 0000  9C                               PUSHF                             ; SAVE INTERRUPT ENABLE STATUS AND FLAGS
 0001  D0 C0                            ROL     AL,1                      ; MOVE NMI BIT TO LOW POSITION
 0003  F9                               STC                               ; FORCE NMI BIT ON IN CARRY FLAG
 0004  D0 D8                            RCR     AL,1                      ; HIGH BIT ON TO DISABLE NMI - OLD IN CY
 0006  FA                               CLI                               ; DISABLE INTERRUPTS
 0007  E6 70                            OUT     CMOS_PORT,AL              ; ADDRESS LOCATION AND DISABLE NMI
 0009  90                               NOP                               ; I/O DELAY
 000A  E4 71                            IN      AL,CMOS_DATA              ; READ THE REQUESTED CMOS LOCATION
 000C  50                               PUSH    AX                        ; SAVE (AH) REGISTER VALUE AND CMOS BYTE
 000D  B0 1E                            MOV     AL,CMOS_SHUT_DOWN*2       ; GET ADDRESS OF DEFAULT LOCATION
 000F  D0 D8                            RCR     AL,1                      ; PUT ORIGINAL NMI MASK BIT INTO ADDRESS
 0011  E6 70                            OUT     CMOS_PORT,AL              ; SET DEFAULT TO READ ONLY REGISTER
 0013  90                               NOP                               ; I/O DELAY
 0014  E4 71                            IN      AL,CMOS_DATA              ; OPEN STANDBY LATCH
 0016  58                               POP     AX                        ; RESTORE (AH) AND (AL)= CMOS BYTE
 0017  0E                               PUSH    CS                        ; *PLACE CODE SEGMENT IN STACK AND
 0018  E8 0039 R                        CALL    CMOS_POPF                 ; *HANDLE POPF FOR B- LEVEL 80286
 001B  C3                               RET                               ; RETURN WITH FLAGS RESTORED

 001C                         CMOS_READ         ENDP

                              ;--- CMOS_WRITE ----------------------------------------------------------
                              ;                  WRITE BYTE TO CMOS SYSTEM CLOCK CONFIGURATION TABLE        :
                              ;                                                                              :
                              ; INPUT: (AL)=   CMOS TABLE ADDRESS TO BE WRITTEN TO                           :
                              ;                BIT    7 = 0 FOR NMI ENABLED AND 1 FOR NMI DISABLED ON EXIT   :
                              ;                BITS 6-0 = ADDRESS OF TABLE LOCATION TO WRITE                 :
                              ;        (AH)=   NEW VALUE TO BE PLACED IN THE ADDRESSED TABLE LOCATION        :
                              ;                                                                              :
                              ; OUTPUT:        VALUE IN (AH) PLACED IN LOCATION (AL) WITH NMI LEFT DISABLED  :
                              ;                IF BIT 7 OF (AL) IS ON.  DURING THE CMOS UPDATE BOTH NMI AND  :
                              ;                NORMAL INTERRUPTS ARE DISABLED TO PROTECT CMOS DATA INTEGRITY. :
                              ;                THE CMOS ADDRESS REGISTER IS POINTED TO A DEFAULT VALUE AND   :
                              ;                THE INTERRUPT FLAG RESTORED TO THE ENTRY STATE ON RETURN.     :
                              ;                ONLY THE CMOS LOCATION AND THE NMI STATE IS CHANGED.          :
                              ;-------------------------------------------------------------------------------

 001C                         CMOS_WRITE        PROC    NEAR              ;       WRITE (AH) TO LOCATION (AL)
 001C  9C                               PUSHF                             ; SAVE INTERRUPT ENABLE STATUS AND FLAGS
 001D  50                               PUSH    AX                        ; SAVE WORK REGISTER VALUES
 001E  D0 C0                            ROL     AL,1                      ; MOVE NMI BIT TO LOW POSITION
 0020  F9                               STC                               ; FORCE NMI BIT ON IN CARRY FLAG
 0021  D0 D8                            RCR     AL,1                      ; HIGH BIT ON TO DISABLE NMI - OLD IN CY
 0023  FA                               CLI                               ; DISABLE INTERRUPTS
 0024  E6 70                            OUT     CMOS_PORT,AL              ; ADDRESS LOCATION AND DISABLE NMI
 0026  8A C4                            MOV     AL,AH                     ; GET THE DATA BYTE TO WRITE
 0028  E6 71                            OUT     CMOS_DATA,AL              ; PLACE IN REQUESTED CMOS LOCATION
 002A  B0 1E                            MOV     AL,CMOS_SHUT_DOWN*2       ; GET ADDRESS OF DEFAULT LOCATION
 002C  D0 D8                            RCR     AL,1                      ; PUT ORIGINAL NMI MASK BIT INTO ADDRESS
 002E  E6 70                            OUT     CMOS_PORT,AL              ; SET DEFAULT TO READ ONLY REGISTER
 0030  90                               NOP                               ; I/O DELAY
 0031  E4 71                            IN      AL,CMOS_DATA              ; OPEN STANDBY LATCH
 0033  58                               POP     AX                        ; RESTORE WORK REGISTERS
 0034  0E                               PUSH    CS                        ; *PLACE CODE SEGMENT IN STACK AND
 0035  E8 0039 R                        CALL    CMOS_POPF                 ; *HANDLE POPF FOR B- LEVEL 80286
 0038  C3                               RET

 0039                         CMOS_WRITE        ENDP
```

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                                PAGE
0039                            CMOS_POPF       PROC    NEAR            ;       POPF FOR LEVEL B- PARTS
0039 CF                                 IRET                            ; RETURN FAR AND RESTORE FLAGS

003A                            CMOS_POPF       ENDP


003A                            DDS     PROC    NEAR                    ;       LOAD (DS) TO DATA AREA
003A 2E: 8E 1E 0040 R                   MOV     DS,CS:DDSDATA           ; PUT SEGMENT VALUE OF DATA AREA INTO DS
003F C3                                 RET                             ; RETURN TO USER WITH (DS)= DATA

0040 ---- R                     DDSDATA DW      DATA                    ; SEGMENT SELECTOR VALUE FOR DATA AREA

0042                            DDS     ENDP

                                ;--- E_MSG -- P_MSG ----------------------------------------------------
                                ;       THIS SUBROUTINE WILL PRINT A MESSAGE ON THE DISPLAY           :
                                ;                                                                     :
                                ; ENTRY REQUIREMENTS:                                                 :
                                ;       SI = OFFSET(ADDRESS) OF MESSAGE BUFFER                        :
                                ;       CX = MESSAGE BYTE COUNT                                       :
                                ;            MAXIMUM MESSAGE LENGTH IS 36 CHARACTERS                  :
                                ;       BP = BIT 0=E161/E162, BIT 1=CONFIG_BAD, 2-15= FIRST MSG OFFSET :
                                ;----------------------------------------------------------------------

0042                            E_MSG   PROC    NEAR
0042 F7 C5 3FFF                         TEST    BP,03FFFH               ; CHECK FOR NOT FIRST ERROR MESSAGE
0046 75 08                              JNZ     E_MSG1                  ; SKIP IF NOT FIRST ERROR MESSAGE

0048 56                                 PUSH    SI                      ; SAVE MESSAGE POINTER
0049 81 E6 3FFF                         AND     SI,03FFFH               ; USE LOW 14 BITS OF MESSAGE OFFSET
004D 0B EE                              OR      BP,SI                   ;  AS FIRST ERROR MESSAGE FLAG
004F 5E                                 POP     SI                      ; (BIT 0 = E161/E162, BIT 1 = BAD_CONFIG
0050                            E_MSG1:
0050 E8 0069 R                          CALL    P_MSG                   ; PRINT MESSAGE
0053 1E                                 PUSH    DS                      ; SAVE CALLERS (DS)
0054 E8 003A R                          CALL    DDS                     ; POINT TO POST/BIOS DATA SEGMENT
0057 F6 06 0010 R 01                    TEST    BYTE PTR @EQUIP_FLAG,01H; LOOP/HALT ON ERROR SWITCH ON ?
005C 74 02                              JZ      MFG_HALT                ; YES - THEN GO TO MANUFACTURING HALT

005E 1F                                 POP     DS                      ; RESTORE CALLERS (DS)
005F C3                                 RET

0060                            MFG_HALT:                               ; MANUFACTURING LOOP MODE ERROR TRAP
0060 FA                                 CLI                             ; DISABLE INTERRUPTS
0061 A0 0015 R                          MOV     AL,@MFG_ERR_FLAG        ; RECOVER ERROR INDICATOR
0064 E6 80                              OUT     MFG_PORT,AL             ; SET INTO MANUFACTURING PORT
0066 F4                                 HLT                             ; HALT SYSTEM
0067 EB F7                              JMP     MFG_HALT                ; HOT NMI TRAP

0069                            E_MSG   ENDP


0069                            P_MSG   PROC    NEAR                    ;       DISPLAY STRING FROM (CS:)
0069 2E: 8A 04                          MOV     AL,CS:[SI]              ; PUT CHARACTER IN (AL)
006C 46                                 INC     SI                      ; POINT TO NEXT CHARACTER
006D 50                                 PUSH    AX                      ; SAVE PRINT CHARACTER
006E E8 012E R                          CALL    PRT_HEX                 ; CALL VIDEO_IO
0071 58                                 POP     AX                      ; RECOVER PRINT CHARACTER
0072 3C 0A                              CMP     AL,LF                   ; WAS IT LINE FEED?
0074 75 F3                              JNE     P_MSG                   ; NO, KEEP PRINTING STRING
0076 C3                                 RET

0077                            P_MSG   ENDP

                                ;--- ERR_BEEP ----------------------------------------------------------
                                ;       THIS PROCEDURE WILL ISSUE LONG TONES (1-3/4 SECONDS) AND ONE OR :
                                ;       MORE SHORT TONES (9/32 SECOND) TO INDICATE A FAILURE ON THE    :
                                ;       PLANAR BOARD, A BAD MEMORY MODULE, OR A PROBLEM WITH THE CRT.  :
                                ; ENTRY PARAMETERS:                                                    :
                                ;       DH = NUMBER OF LONG TONES TO BEEP.                             :
                                ;       DL = NUMBER OF SHORT TONES TO BEEP.                            :
                                ;-----------------------------------------------------------------------

0077                            ERR_BEEP        PROC    NEAR
0077 9C                                 PUSHF                           ; SAVE FLAGS
0078 FA                                 CLI                             ; DISABLE SYSTEM INTERRUPTS
0079 0A F6                              OR      DH,DH                   ; ANY LONG ONES TO BEEP
007B 74 1E                              JZ      G3                      ; NO, DO THE SHORT ONES
007D                            G1:                                     ;       LONG BEEPS
007D B3 70                              MOV     BL,112                  ; COUNTER FOR LONG BEEPS (1-3/4 SECONDS)
007F B9 0500                            MOV     CX,1280                 ; DIVISOR FOR 932 HZ
0082 E8 00B5 R                          CALL    BEEP                    ; DO THE BEEP
0085 B9 C233                            MOV     CX,49715                ; 2/3 SECOND DELAY AFTER LONG BEEP
0088 E8 00FB R                          CALL    WAITF                   ; DELAY BETWEEN BEEPS
008B FE CE                              DEC     DH                      ; ANY MORE LONG BEEPS TO DO
008D 75 EE                              JNZ     G1                      ; LOOP TILL DONE

008F 1E                                 PUSH    DS                      ; SAVE DS REGISTER CONTENTS
0090 E8 003A R                          CALL    DDS
0093 80 3E 0012 R 01                    CMP     @MFG_TST,01H            ; MANUFACTURING TEST MODE?
0098 1F                                 POP     DS                      ; RESTORE ORIGINAL CONTENTS OF (DS)
0099 74 C5                              JE      MFG_HALT                ; YES - STOP BLINKING LED

009B                            G3:                                     ;       SHORT BEEPS
009B B3 12                              MOV     BL,18                   ; COUNTER FOR A SHORT BEEP (9/32)
009D B9 04B8                            MOV     CX,1208                 ; DIVISOR FOR 987 HZ
00A0 E8 00B5 R                          CALL    BEEP                    ; DO THE SOUND
00A3 B9 8178                            MOV     CX,33144                ; 1/2 SECOND DELAY AFTER SHORT BEEP
00A6 E8 00FB R                          CALL    WAITF                   ; DELAY BETWEEN BEEPS
00A9 FE CA                              DEC     DL                      ; DONE WITH SHORT BEEPS COUNT
00AB 75 EE                              JNZ     G3                      ; LOOP TILL DONE

00AD B9 8178                            MOV     CX,33144                ; 1/2 SECOND DELAY AFTER LAST BEEP
00B0 E8 00FB R                          CALL    WAITF                   ; MAKE IT ONE SECOND DELAY BEFORE RETURN
00B3 9D                                 POPF                            ; RESTORE FLAGS TO ORIGINAL SETTINGS
00B4 C3                                 RET                             ; RETURN TO CALLER

00B5                            ERR_BEEP        ENDP
```

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                          PAGE
                          ;--- BEEP ---------------------------------------------------------------
                          ;       ROUTINE TO SOUND THE BEEPER USING TIMER 2 FOR TONE              :
                          ; ENTRY:                                                                :
                          ;       (BL) = DURATION COUNTER  ( 1 FOR 1/64 SECOND )                  :
                          ;       (CX) = FREQUENCY DIVISOR (1193180/FREQUENCY) (1331 FOR 886 HZ)  :
                          ; EXIT:                                                                 :
                          ;       (AX),(BL),(CX) MODIFIED.                                        :
                          ;-----------------------------------------------------------------------

 00B5                     BEEP    PROC    NEAR                    ;       SETUP TIMER 2
 00B5 9C                          PUSHF                           ; SAVE INTERRUPT STATUS
 00B6 FA                          CLI                             ; BLOCK INTERRUPTS DURING UPDATE
 00B7 B0 B6                       MOV     AL,10110110B            ; SELECT TIMER 2,LSB,MSB,BINARY
 00B9 E6 43                       OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
 00BB EB 00                       JMP     $+2                     ; I/O DELAY
 00BD 8A C1                       MOV     AL,CL                   ; DIVISOR FOR HZ (LOW)
 00BF E6 42                       OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
 00C1 EB 00                       JMP     $+2                     ; I/O DELAY
 00C3 8A C5                       MOV     AL,CH                   ; DIVISOR FOR HZ (HIGH)
 00C5 E6 42                       OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
 00C7 E4 61                       IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
 00C9 8A E0                       MOV     AH,AL                   ; SAVE THAT SETTING
 00CB 0C 03                       OR      AL,GATE2+SPK2           ; GATE TIMER 2 AND TURN SPEAKER ON
 00CD E6 61                       OUT     PORT_B,AL               ; AND RESTORE INTERRUPT STATUS
 00CF 9D                          POPF
 00D0                     G7:                                     ;       1/64 SECOND PER COUNT (BL)
 00D0 B9 040B                     MOV     CX,1035                 ; DELAY COUNT FOR 1/64 OF A SECOND
 00D3 E8 00FB R                   CALL    WAITF                   ; GO TO BEEP DELAY 1/64 COUNT
 00D6 FE CB                       DEC     BL                      ; (BL) LENGTH COUNT EXPIRED?
 00D8 75 F6                       JNZ     G7                      ; NO - CONTINUE BEEPING SPEAKER

 00DA 9C                          PUSHF                           ; SAVE INTERRUPT STATUS
 00DB FA                          CLI                             ; BLOCK INTERRUPTS DURING UPDATE
 00DC E4 61                       IN      AL,PORT_B               ; GET CURRENT PORT VALUE
 00DE 0C FC                       OR      AL,NOT (GATE2+SPK2)     ; ISOLATE CURRENT SPEAKER BITS IN CASE
 00E0 22 E0                       AND     AH,AL                   ;  SOMEONE TURNED THEM OFF DURING BEEP
 00E2 8A C4                       MOV     AL,AH                   ; RECOVER VALUE OF PORT
 00E4 24 FC                       AND     AL,NOT (GATE2+SPK2)     ; FORCE SPEAKER DATA OFF
 00E6 E6 61                       OUT     PORT_B,AL               ; AND STOP SPEAKER TIMER
 00E8 9D                          POPF                            ; RESTORE INTERRUPT FLAG STATE
 00E9 B9 040B                     MOV     CX,1035                 ; FORCE 1/64 SECOND DELAY (SHORT)
 00EC E8 00FB R                   CALL    WAITF                   ; MINIMUM DELAY BETWEEN ALL BEEPS
 00EF 9C                          PUSHF                           ; SAVE INTERRUPT STATUS
 00F0 FA                          CLI                             ; BLOCK INTERRUPTS DURING UPDATE
 00F1 E4 61                       IN      AL,PORT_B               ; GET CURRENT PORT VALUE IN CASE
 00F3 24 03                       AND     AL,GATE2+SPK2           ;  SOMEONE TURNED THEM ON
 00F5 0A C4                       OR      AL,AH                   ; RECOVER VALUE OF PORT_B
 00F7 E6 61                       OUT     PORT_B,AL               ; RESTORE SPEAKER STATUS
 00F9 9D                          POPF                            ; RESTORE INTERRUPT FLAG STATE
 00FA C3                          RET

 00FB                     BEEP    ENDP

                          ;--- WAITF --------------------------------------------------------------
                          ;       FIXED TIME WAIT ROUTINE (HARDWARE CONTROLLED - NOT PROCESSOR)   :
                          ;                                                                       :
                          ; ENTRY:                                                                :
                          ;       (CX) = COUNT OF 15.085737 MICROSECOND INTERVALS TO WAIT         :
                          ;              MEMORY REFRESH TIMER 1 OUTPUT USED AS REFERENCE          :
                          ; EXIT:                                                                 :
                          ;              AFTER (CX) TIME COUNT (PLUS OR MINUS 16 MICROSECONDS)    :
                          ;       (CX) = 0                                                        :
                          ;-----------------------------------------------------------------------

 00FB                     WAITF   PROC    NEAR                    ;       DELAY FOR  (CX)*15.085737 US
 00FB 50                          PUSH    AX                      ; SAVE WORK REGISTER (AH)

 00FC                     WAITF1:                                 ;       USE TIMER 1 OUTPUT BITS
 00FC E4 61                       IN      AL,PORT_B               ; READ CURRENT COUNTER OUTPUT STATUS
 00FE 24 10                       AND     AL,REFRESH_BIT          ; MASK FOR REFRESH DETERMINE BIT
 0100 3A C4                       CMP     AL,AH                   ; DID IT JUST CHANGE
 0102 74 F8                       JE      WAITF1                  ; WAIT FOR A CHANGE IN OUTPUT LINE

 0104 8A E0                       MOV     AH,AL                   ; SAVE NEW FLAG STATE
 0106 E2 F4                       LOOP    WAITF1                  ; DECREMENT HALF CYCLES TILL COUNT END

 0108 58                          POP     AX                      ; RESTORE (AH)
 0109 C3                          RET                             ; RETURN  (CX)= 0

 010A                     WAITF   ENDP

                          ;--- CONFIG_BAD ---------------------------------------------------------
                          ;       SET CMOS_DIAG WITH CONFIG ERROR BIT (WITH NMI DISABLED)         :
                          ;       (BP) BIT 14 SET ON TO INDICATE CONFIGURATION ERROR              :
                          ;-----------------------------------------------------------------------

 010A                     CONFIG_BAD      PROC    NEAR
 010A 50                          PUSH    AX
 010B B8 8E8E                     MOV     AX,X*(CMOS_DIAG+NMI)    ; ADDRESS CMOS DIAGNOSTIC STATUS BYTE
 010E E8 0000 R                   CALL    CMOS_READ               ; GET CURRENT VALUE
 0111 0C 20                       OR      AL,BAD_CONFIG           ; SET BAD CONFIGURATION BIT
 0113 86 E0                       XCHG    AH,AL                   ; SETUP FOR WRITE
 0115 E8 001C R                   CALL    CMOS_WRITE              ; UPDATE CMOS WITH BAD CONFIGURATION
 0118 58                          POP     AX
 0119 81 CD 4000                  OR      BP,04000H               ; SET CONFIGURATION BAD FLAG IN (BP)
 011D C3                          RET

 011E                     CONFIG_BAD      ENDP
```

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                                PAGE
                                ;--- XPC_BYTE -- XLATE_PR -- PRT_HEX ----------------------------------
                                ;                                                                     :
                                ;       CONVERT AND PRINT ASCII CODE CHARACTERS                       :
                                ;                                                                     :
                                ;       AL CONTAINS NUMBER TO BE CONVERTED.                           :
                                ;       AX AND BX DESTROYED.                                          :
                                ;----------------------------------------------------------------------

 011E                           XPC_BYTE        PROC    NEAR            ;       DISPLAY TWO HEX DIGITS
 011E  50                               PUSH    AX                      ; SAVE FOR LOW NIBBLE DISPLAY
 011F  C0 E8 04                         SHR     AL,4                    ; NIBBLE SWAP
 0122  E8 0128 R                        CALL    XLAT_PR                 ; DO THE HIGH NIBBLE DISPLAY
 0125  58                               POP     AX                      ; RECOVER THE NIBBLE
 0126  24 0F                            AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
                                                                        ; FALL INTO LOW NIBBLE CONVERSION

 0128                           XLAT_PR PROC    NEAR                    ;       CONVERT 00-0F TO ASCII CHARACTER
 0128  04 90                            ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
 012A  27                               DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
 012B  14 40                            ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
 012D  27                               DAA                             ; ADJUST HIGH NIBBLE TO ASCII RANGE

 012E                           PRT_HEX PROC    NEAR
 012E  B4 0E                            MOV     AH,0EH                  ; DISPLAY CHARACTER IN (AL) COMMAND
 0130  B7 00                            MOV     BH,0
 0132  CD 10                            INT     10H                     ; CALL VIDEO_IO
 0134  C3                               RET

 0135                           PRT_HEX ENDP
 0135                           XLAT_PR ENDP
 0135                           XPC_BYTE        ENDP

                                ;--- PRT_SEG -------------------------------------------------
                                ;       PRINT A SEGMENT VALUE TO LOOK LIKE A 21 BIT ADDRESS     :
                                ;       DX MUST CONTAIN SEGMENT VALUE TO BE PRINTED             :
                                ;-------------------------------------------------------------

 0135                           PRT_SEG PROC    NEAR
 0135  8A C6                            MOV     AL,DH                   ; GET MSB
 0137  E8 011E R                        CALL    XPC_BYTE                ; DISPLAY SEGMENT HIGH BYTE
 013A  8A C2                            MOV     AL,DL                   ; LSB
 013C  E8 011E R                        CALL    XPC_BYTE                ; DISPLAY SEGMENT LOW BYTE
 013F  B0 30                            MOV     AL,'0'                  ; PRINT A '0 '
 0141  E8 012E R                        CALL    PRT_HEX                 ;  TO MAKE LOOK LIKE ADDRESS
 0144  B0 20                            MOV     AL,' '                  ; ADD ENDING SPACE
 0146  E8 012E R                        CALL    PRT_HEX
 0149  C3                               RET

 014A                           PRT_SEG ENDP

                                ;--- PROT_PRT_HEX -----------------------------------------------------
                                ;                                                                     :
                                ;       PUT A CHARACTER TO THE DISPLAY BUFFERS WHEN IN PROTECTED MODE :
                                ;                                                                     :
                                ;       (AL)= ASCII CHARACTER                                         :
                                ;       (DI)= DISPLAY REGEN BUFFER POSITION                           :
                                ;----------------------------------------------------------------------

 014A                           PROT_PRT_HEX    PROC    NEAR
 014A  06                               PUSH    ES                      ; SAVE CURRENT SEGMENT REGISTERS
 014B  57                               PUSH    DI
 014C  D1 E7                            SAL     DI,1                    ; MULTIPLY OFFSET BY TWO

                                ;-----  MONOCHROME VIDEO CARD

 014E  6A 20                            PUSH    BYTE PTR C_BWCRT_PTR    ; GET MONOCHROME BUFFER SEGMENT SELECTOR
 0150  07                               POP     ES                      ; SET (ES) TO B/W DISPLAY BUFFER
 0151  AA                               STOSB                           ; PLACE CHARACTER IN BUFFER
 0152  4F                               DEC     DI                      ; ADJUST POINTER BACK

                                ;-----  ENHANCED GRAPHICS ADAPTER

 0153  6A 30                            PUSH    BYTE PTR E_CCRT_PTR     ; ENHANCED COLOR DISPLAY POINTER LOW 64K
 0155  07                               POP     ES                      ; LOAD SEGMENT SELECTOR
 0156  AA                               STOSB                           ; PLACE CHARACTER IN BUFFER
 0157  4F                               DEC     DI                      ; ADJUST POINTER BACK
 0158  6A 38                            PUSH    BYTE PTR E_CCRT_PTR2    ; ENHANCED COLOR DISPLAY POINTER HI 64K
 015A  07                               POP     ES                      ; LOAD SEGMENT SELECTOR
 015B  AA                               STOSB                           ; PLACE CHARACTER IN BUFFER
 015C  4F                               DEC     DI                      ; ADJUST POINTER BACK

                                ;-----  COMPATIBLE COLOR

 015D  6A 28                            PUSH    BYTE PTR C_CCRT_PTR     ; SET (DS) TO COMPATIBLE COLOR MEMORY
 015F  07                               POP     ES
 0160  53                               PUSH    BX                      ; SAVE WORK REGISTERS
 0161  52                               PUSH    DX
 0162  51                               PUSH    CX
 0163  33 C9                            XOR     CX,CX                   ; TIMEOUT LOOP FOR "BAD" HARDWARE
 0165  BA 03DA                          MOV     DX,03DAH                ; STATUS ADDRESS OF COLOR CARD
 0168  93                               XCHG    AX,BX                   ; SAVE IN (BX) REGISTER
 0169                           PROT_S:
 0169  EC                               IN      AL,DX                   ; GET COLOR CARD STATUS
 016A  A8 09                            TEST    AL,RVRT+RHRZ            ; CHECK FOR VERTICAL RETRACE (OR HORZ)
 016C  E1 FB                            LOOPZ   PROT_S                  ; TIMEOUT LOOP TILL FOUND
 016E  93                               XCHG    AX,BX                   ; RECOVER CHARACTERS
 016F  AA                               STOSB                           ; PLACE CHARACTER IN BUFFER

 0170  59                               POP     CX                      ; RESTORE REGISTERS
 0171  5A                               POP     DX
 0172  5B                               POP     BX
 0173  5F                               POP     DI
 0174  07                               POP     ES
 0175  C3                               RET

 0176                           PROT_PRT_HEX    ENDP
```

```
                                PAGE
                                ;--------------------------------------
                                ;       ROM CHECKSUM SUBROUTINE        :
                                ;--------------------------------------

 0176                           ROM_CHECKSUM    PROC    NEAR
 0176 2B C9                             SUB     CX,CX                   ; NUMBER OF BYTES TO ADD IS 64K

 0178                           ROM_CHECKSUM_CNT:                       ; ENTRY FOR OPTIONAL ROM TEST
 0178 32 C0                             XOR     AL,AL
 017A                           ROM_L:
 017A 02 07                             ADD     AL,[BX]                 ; GET (DS:BX)
 017C 43                                INC     BX                      ; POINT TO NEXT BYTE
 017D E2 FB                             LOOP    ROM_L                   ; ADD ALL BYTES IN ROM MODULE

 017F 0A C0                             OR      AL,AL                   ; SUM = 0?
 0181 C3                                RET

 0182                           ROM_CHECKSUM    ENDP

                                ;---------------------------------------------------------------------
                                ;       THIS ROUTINE CHECKSUMS OPTIONAL ROM MODULES AND              :
                                ;       IF CHECKSUM IS OK, CALLS INITIALIZATION/TEST CODE IN MODULE  :
                                ;---------------------------------------------------------------------

 0182                           ROM_CHECK       PROC    NEAR
 0182 B8 ---- R                         MOV     AX,DATA                 ; POINT ES TO DATA AREA
 0185 8E C0                             MOV     ES,AX
 0187 2A E4                             SUB     AH,AH                   ; ZERO OUT AH
 0189 8A 47 02                          MOV     AL,[BX+2]               ; GET LENGTH INDICATOR
 018C C1 E0 09                          SHL     AX,9                    ; MULTIPLY BY 512
 018F 8B C8                             MOV     CX,AX                   ; SET COUNT
 0191 C1 E8 04                          SHR     AX,4
 0194 03 D0                             ADD     DX,AX                   ; SET POINTER TO NEXT MODULE
 0196 E8 0178 R                         CALL    ROM_CHECKSUM_CNT        ; DO CHECKSUM
 0199 74 05                             JZ      ROM_CHECK_1

 019B E8 0000 E                         CALL    ROM_ERR                 ; POST CHECKSUM ERROR
 019E EB 13                             JMP     SHORT ROM_CHECK_END     ; AND EXIT

 01A0                           ROM_CHECK_1:
 01A0 52                                PUSH    DX                      ; SAVE POINTER
 01A1 26: C7 06 0067 R 0003             MOV     ES:@IO_ROM_INIT,0003H   ; LOAD OFFSET
 01A8 26: 8C 1E 0069 R                  MOV     ES:@IO_ROM_SEG,DS       ; LOAD SEGMENT
 01AD 26: FF 1E 0067 R                  CALL    DWORD PTR ES:@IO_ROM_INIT; CALL INITIALIZE/TEST ROUTINE
 01B2 5A                                POP     DX

 01B3                           ROM_CHECK_END:
 01B3 C3                                RET                             ; RETURN TO CALLER

 01B4                           ROM_CHECK       ENDP

                                ;--- KBD_RESET ---------------------------------------------------------
                                ;       THIS PROCEDURE WILL SEND A SOFTWARE RESET TO THE KEYBOARD.    :
                                ;       SCAN CODE  0AAH  SHOULD BE RETURNED TO THE PROCESSOR.         :
                                ;       SCAN CODE  065H  IS DEFINED FOR MANUFACTURING TEST            :
                                ;----------------------------------------------------------------------

 01B4                           KBD_RESET       PROC    NEAR
 01B4 B0 FF                             MOV     AL,0FFH                 ; SET KEYBOARD RESET COMMAND
 01B6 E8 0000 E                         CALL    XMIT_8042               ; GO ISSUE THE COMMAND
 01B9 E3 23                             JCXZ    G13                     ; EXIT IF ERROR

 01BB 3C FA                             CMP     AL,KB_ACK
 01BD 75 1F                             JNZ     G13

 01BF B0 FD                             MOV     AL,0FDH                 ; ENABLE KEYBOARD INTERRUPTS
 01C1 E6 21                             OUT     INTA01,AL               ; WRITE 8259 INTERRUPT MASK REGISTER
 01C3 C6 06 006B R 00                   MOV     @INTR_FLAG,0            ; RESET INTERRUPT INDICATOR
 01C8 FB                                STI                             ; ENABLE INTERRUPTS
 01C9 B3 0A                             MOV     BL,10                   ; TRY FOR 400 MILLISECONDS
 01CB 2B C9                             SUB     CX,CX                   ; SETUP INTERRUPT TIMEOUT COUNT
 01CD                           G11:
 01CD F6 06 006B R 02                   TEST    @INTR_FLAG,02H          ; DID A KEYBOARD INTERRUPT OCCUR ?
 01D2 75 06                             JNZ     G12                     ; YES - READ SCAN CODE RETURNED
 01D4 E2 F7                             LOOP    G11                     ; NO - LOOP TILL TIMEOUT

 01D6 FE CB                             DEC     BL
 01D8 75 F3                             JNZ     G11                     ; TRY AGAIN
 01DA                           G12:
 01DA E4 60                             IN      AL,PORT_A               ; READ KEYBOARD SCAN CODE
 01DC 8A D8                             MOV     BL,AL                   ; SAVE SCAN CODE JUST READ
 01DE                           G13:
 01DE C3                                RET                             ; RETURN TO CALLER

 01DF                           KBD_RESET       ENDP

                                ;----------------------------------------------------
                                ;       BLINK LED PROCEDURE FOR MFG RUN-IN TESTS    :
                                ;         IF LED IS ON, TURN IT OFF. IF OFF, TURN ON. :
                                ;----------------------------------------------------

 01DF                           BLINK_INT       PROC    NEAR
 01DF FB                                STI
 01E0 50                                PUSH    AX                      ; SAVE AX REGISTER CONTENTS
 01E1 E4 80                             IN      AL,MFG_PORT             ; READ CURRENT VALUE OF MFG_PORT
 01E3 34 40                             XOR     AL,01000000B            ; FLIP CONTROL BIT
 01E5 E6 80                             OUT     MFG_PORT,AL
 01E7 B0 20                             MOV     AL,EOI
 01E9 E6 20                             OUT     INTA00,AL
 01EB 58                                POP     AX                      ; RESTORE AX REGISTER
 01EC CF                                IRET

 01ED                           BLINK_INT       ENDP
```

```
                                PAGE
                                ;--------------------------------------------------------------------------
                                ;       THIS ROUTINE INITIALIZES THE TIMER DATA AREA IN THE ROM BIOS      :
                                ;       DATA AREA.  IT IS CALLED BY THE POWER ON ROUTINES.  IT CONVERTS   :
                                ;       HR:MIN:SEC  FROM CMOS TO TIMER TICS.  IF CMOS IS INVALID, TIMER   :
                                ;       IS SET TO ZERO.                                                   :
                                ;                                                                         :
                                ; INPUT     NONE PASSED TO ROUTINE BY CALLER                              :
                                ;           CMOS LOCATIONS USED FOR TIME                                  :
                                ;                                                                         :
                                ; OUTPUT    @TIMER_LOW                                                    :
                                ;           @TIMER_HIGH                                                   :
                                ;           @TIMER_OFL                                                    :
                                ;           ALL REGISTERS UNCHANGED                                       :
                                ;--------------------------------------------------------------------------
 = 0012                         COUNTS_SEC      EQU     18              ; TIMER DATA CONVERSION EQUATES
 = 0444                         COUNTS_MIN      EQU     1092
 = 0007                         COUNTS_HOUR     EQU     7               ; 65543 - 65536
 = 0080                         UPDATE_TIMER    EQU     10000000B       ; RTC UPDATE IN PROCESS BIT MASK

 01ED                           SET_TOD PROC    NEAR
 01ED 60                                PUSHA
 01EE 1E                                PUSH    DS
 01EF E8 003A R                         CALL    DDS                     ; ESTABLISH SEGMENT
 01F2 2B C0                             SUB     AX,AX
 01F4 A2 0070 R                         MOV     @TIMER_OFL,AL           ; RESET TIMER ROLL OVER INDICATOR
 01F7 A3 006C R                         MOV     @TIMER_LOW,AX           ; AND TIMER COUNT
 01FA A3 006E R                         MOV     @TIMER_HIGH,AX
 01FD B0 8E                             MOV     AL,CMOS_DIAG+NMI        ; CHECK CMOS VALIDITY
 01FF E8 0000 R                         CALL    CMOS_READ               ; READ DIAGNOSTIC LOCATION IN CMOS
 0202 24 C4                             AND     AL,BAD_BAT+BAD_CKSUM+CMOS_CLK_FAIL
                                                                        ; BAD BATTERY, CHKSUM ERROR, CLOCK ERROR
 0204 75 68                             JNZ     POD_DONE                ; CMOS NOT VALID -- TIMER SET TO ZERO
 0206 2B C9                             SUB     CX,CX                   ;
 0208                           UIP:
 0208 B0 8A                             MOV     AL,CMOS_REG_A+NMI       ; ACCESS REGISTER A
 020A E8 0000 R                         CALL    CMOS_READ               ; READ CMOS CLOCK REGISTER A
 020D A8 80                             TEST    AL,UPDATE_TIMER
 020F E1 F7                             LOOPZ   UIP                     ; WAIT TILL UPDATE BIT IS ON

 0211 E3 5B                             JCXZ    POD_DONE                ; CMOS CLOCK STUCK IF TIMEOUT
 0213 2B C9                             SUB     CX,CX                   ;
 0215                           UIPOFF:
 0215 B0 8A                             MOV     AL,CMOS_REG_A+NMI       ; ACCESS REGISTER A
 0217 E8 0000 R                         CALL    CMOS_READ               ; READ CMOS CLOCK REGISTER A
 021A A8 80                             TEST    AL,UPDATE_TIMER
 021C E0 F7                             LOOPNZ  UIPOFF                  ; NEXT WAIT TILL END OF UPDATE

 021E E3 4E                             JCXZ    POD_DONE                ; CMOS CLOCK STUCK IF TIMEOUT

 0220 B0 80                             MOV     AL,CMOS_SECONDS+NMI     ;       TIME JUST UPDATED
 0222 E8 0000 R                         CALL    CMOS_READ               ; ACCESS SECONDS VALUE IN CMOS
 0225 3C 59                             CMP     AL,59H                  ; ARE THE SECONDS WITHIN LIMITS?
 0227 77 48                             JA      TOD_ERROR               ; GO IF NOT

 0229 E8 0287 R                         CALL    CVT_BINARY              ; CONVERT IT TO BINARY
 022C 8B C8                             MOV     CX,AX                   ; MOVE COUNT TO ACCUMULATION REGISTER
 022E C1 E9 02                          SHR     CX,2                    ; ADJUST FOR SYSTEMATIC SECONDS ERROR
 0231 B3 12                             MOV     BL,COUNTS_SEC
 0233 F6 E3                             MUL     BL                      ; COUNT FOR SECONDS
 0235 03 C8                             ADD     CX,AX
 0237 B0 82                             MOV     AL,CMOS_MINUTES+NMI
 0239 E8 0000 R                         CALL    CMOS_READ               ; ACCESS MINUTES VALUE IN CMOS
 023C 3C 59                             CMP     AL,59H                  ; ARE THE MINUTES WITHIN LIMITS?
 023E 77 31                             JA      TOD_ERROR               ; GO IF NOT
 0240 E8 0287 R                         CALL    CVT_BINARY              ; CONVERT IT TO BINARY
 0243 50                                PUSH    AX                      ; SAVE MINUTES COUNT
 0244 D1 E8                             SHR     AX,1                    ; ADJUST FOR SYSTEMATIC MINUTES ERROR
 0246 03 C8                             ADD     CX,AX                   ; ADD ADJUSTMENT TO COUNT
 0248 58                                POP     AX                      ; RECOVER BCD MINUTES VALUE
 0249 BB 0444                           MOV     BX,COUNTS_MIN
 024C F7 E3                             MUL     BX                      ; COUNT FOR MINUTES
 024E 03 C8                             ADD     CX,AX                   ; ADD TO ACCUMULATED VALUE
 0250 B0 84                             MOV     AL,CMOS_HOURS+NMI
 0252 E8 0000 R                         CALL    CMOS_READ               ; ACCESS HOURS VALUE IN CMOS
 0255 3C 23                             CMP     AL,23H                  ; ARE THE HOURS WITHIN LIMITS?
 0257 77 18                             JA      TOD_ERROR               ; GO IF NOT

 0259 E8 0287 R                         CALL    CVT_BINARY              ; CONVERT IT TO BINARY
 025C 8B D0                             MOV     DX,AX
 025E B3 07                             MOV     BL,COUNTS_HOUR
 0260 F6 E3                             MUL     BL                      ; COUNT FOR HOURS
 0262 03 C1                             ADD     AX,CX
 0264 83 D2 00                          ADC     DX,0000H
 0267 89 16 006E R                      MOV     @TIMER_HIGH,DX
 026B A3 006C R                         MOV     @TIMER_LOW,AX
 026E                           POD_DONE:
 026E 1F                                POP     DS
 026F 61                                POPA
 0270 C3                                RET

 0271                           TOD_ERROR:
 0271 1F                                POP     DS                      ; RESTORE SEGMENT
 0272 61                                POPA                            ; RESTORE REGISTERS
 0273 BE 0000 E                         MOV     SI,OFFSET E163          ; DISPLAY CLOCK ERROR
 0276 E8 0042 R                         CALL    E_MSG
 0279 B8 8E8E                           MOV     AX,X*(CMOS_DIAG+NMI)    ; SET CLOCK ERROR IN STATUS
 027C E8 0000 R                         CALL    CMOS_READ               ; READ DIAGNOSTIC CMOS LOCATION
 027F 0C 04                             OR      AL,CMOS_CLK_FAIL        ; SET NEW STATUS WITH CMOS CLOCK ERROR
 0281 86 C4                             XCHG    AL,AH                   ; MOVE NEW STATUS TO WORK REGISTER
 0283 E8 001C R                         CALL    CMOS_WRITE              ; UPDATE STATUS LOCATION
 0286 C3                                RET

 0287                           SET_TOD ENDP

 0287                           CVT_BINARY      PROC    NEAR
 0287 8A E0                             MOV     AH,AL                   ; UNPACK 2 BCD DIGITS IN AL
 0289 C0 EC 04                          SHR     AH,4
 028C 24 0F                             AND     AL,0FH                  ; RESULT IS IN AX
 028E D5 0A                             AAD                             ; CONVERT UNPACKED BCD TO BINARY
 0290 C3                                RET

 0291                           CVT_BINARY      ENDP
```

SECTION 5

```
                                 PAGE
                                 ;--- D11 -- INT  ?? H -- ( IRQ LEVEL ?? ) -----------------------------------
                                 ; TEMPORARY INTERRUPT SERVICE ROUTINE FOR POST                               :
                                 ;                                                                            :
                                 ;       THIS ROUTINE IS ALSO LEFT IN PLACE AFTER THE POWER ON DIAGNOSTICS    :
                                 ;       TO SERVICE UNUSED INTERRUPT VECTORS.  LOCATION "@INTR_FLAG" WILL     :
                                 ;       CONTAIN EITHER:                                                      :
                                 ;        1) LEVEL OF HARDWARE INTERRUPT THAT CAUSED CODE TO BE EXECUTED, OR  :
                                 ;        2) "FF" FOR A NON-HARDWARE INTERRUPT THAT WAS EXECUTED ACCIDENTALLY. :
                                 ;-----------------------------------------------------------------------------

 0291                            D11     PROC    NEAR
 0291  50                                PUSH    AX                      ; SAVE REGISTER AX CONTENTS
 0292  53                                PUSH    BX
 0293  B0 0B                             MOV     AL,0BH                  ; READ IN-SERVICE REGISTER
 0295  E6 20                             OUT     INTA00,AL               ; (FIND OUT WHAT LEVEL BEING
 0297  EB 00                             JMP     $+2                     ;  SERVICED)
 0299  E4 20                             IN      AL,INTA00               ; GET LEVEL
 029B  8A E0                             MOV     AH,AL                   ; SAVE IT
 029D  0A C4                             OR      AL,AH                   ; 00? (NO HARDWARE ISR ACTIVE)
 029F  75 04                             JNZ     HW_INT

 02A1  B4 FF                             MOV     AH,0FFH
 02A3  EB 2F                             JMP     SHORT SET_INTR_FLAG     ; SET FLAG TO "FF" IF NON-HARDWARE
 02A5                            HW_INT:
 02A5  B0 0B                             MOV     AL,0BH                  ; READ IN-SERVICE REGISTER FROM
 02A7  E6 A0                             OUT     INTB00,AL               ; INTERRUPT CHIP #2
 02A9  EB 00                             JMP     $+2                     ; I/O DELAY
 02AB  E4 A0                             IN      AL,INTB00               ; CHECK THE SECOND INTERRUPT CHIP
 02AD  8A F8                             MOV     BH,AL                   ; SAVE IT
 02AF  0A FF                             OR      BH,BH
 02B1  74 10                             JZ      NOT_SEC                 ; CONTINUE IF NOT

 02B3  E4 A1                             IN      AL,INTB01               ; GET SECOND INTERRUPT MASK
 02B5  0A C7                             OR      AL,BH                   ; MASK OFF LEVEL BEING SERVICED
 02B7  EB 00                             JMP     $+2                     ; I/O DELAY
 02B9  E6 A1                             OUT     INTB01,AL
 02BB  B0 20                             MOV     AL,EOI                  ; SEND EOI TO SECOND CHIP
 02BD  EB 00                             JMP     $+2                     ; I/O DELAY
 02BF  E6 A0                             OUT     INTB00,AL
 02C1  EB 0D                             JMP     SHORT IS_SEC
 02C3                            NOT_SEC:
 02C3  E4 21                             IN      AL,INTA01               ; GET CURRENT MASK VALUE
 02C5  EB 00                             JMP     $+2                     ; I/O DELAY
 02C7  80 E4 FB                          AND     AH,0FBH                 ; DO NOT DISABLE SECOND CONTROLLER
 02CA  0A C4                             OR      AL,AH                   ; MASK OFF LEVEL BEING SERVICED
 02CC  E6 21                             OUT     INTA01,AL               ; SET NEW INTERRUPT MASK
 02CE  EB 00                             JMP     $+2                     ; I/O DELAY
 02D0                            IS_SEC:
 02D0  B0 20                             MOV     AL,EOI
 02D2  E6 20                             OUT     INTA00,AL
 02D4                            SET_INTR_FLAG:
 02D4  5B                                POP     BX                      ; RESTORE (BX) FROM STACK
 02D5  1E                                PUSH    DS                      ; SAVE ACTIVE (DS)
 02D6  E8 003A R                         CALL    DDS                     ; SET DATA SEGMENT
 02D9  88 26 006B R                      MOV     @INTR_FLAG,AH           ; SET FLAG
 02DD  1F                                POP     DS
 02DE  58                                POP     AX                      ; RESTORE REGISTER AX CONTENTS
 02DF                            DUMMY_RETURN_1:                         ; NEED IRET FOR VECTOR TABLE
 02DF  CF                                IRET

 02E0                            D11     ENDP

                                 ;--- HARDWARE INT  71 H -- ( IRQ LEVEL  9 ) -- TO INT  0A H -------------------
                                 ; REDIRECT SLAVE INTERRUPT 9 TO INTERRUPT LEVEL 2                            :
                                 ;       THIS ROUTINE FIELDS LEVEL 9 INTERRUPTS AND                           :
                                 ;       CONTROL IS PASSED TO MASTER INTERRUPT LEVEL 2                        :
                                 ;-----------------------------------------------------------------------------

 02E0                            RE_DIRECT PROC  NEAR
 02E0  50                                PUSH    AX                      ; SAVE (AX)
 02E1  B0 20                             MOV     AL,EOI
 02E3  E6 A0                             OUT     INTB00,AL               ; EOI TO SLAVE INTERRUPT CONTROLLER
 02E5  58                                POP     AX                      ; RESTORE (AX)
 02E6  CD 0A                             INT     0AH                     ; GIVE CONTROL TO HARDWARE LEVEL 2

 02E8  CF                                IRET                            ; RETURN

 02E9                            RE_DIRECT ENDP

                                 ;--- HARDWARE INT  75 H -- ( IRQ LEVEL 13 ) ----------------------------------
                                 ; SERVICE X287 INTERRUPTS                                                    :
                                 ;       THIS ROUTINE FIELDS X287 INTERRUPTS AND CONTROL                      :
                                 ;       IS PASSED TO THE NMI INTERRUPT HANDLER FOR                           :
                                 ;       COMPATIBILITY.                                                       :
                                 ;-----------------------------------------------------------------------------

 02E9                            INT_287 PROC    NEAR
 02E9  50                                PUSH    AX                      ; SAVE (AX)
 02EA  32 C0                             XOR     AL,AL
 02EC  E6 F0                             OUT     X287,AL                 ; REMOVE THE INTERRUPT REQUEST

 02EE  B0 20                             MOV     AL,EOI                  ; ENABLE THE INTERRUPT
 02F0  E6 A0                             OUT     INTB00,AL               ;  THE SLAVE
 02F2  E6 20                             OUT     INTA00,AL               ;  THE MASTER
 02F4  58                                POP     AX                      ; RESTORE (AX)
 02F5  CD 02                             INT     02H                     ; GIVE CONTROL TO NMI

 02F7  CF                                IRET                            ; RETURN

 02F8                            INT_287 ENDP

 02F8                            PROC_SHUTDOWN   PROC                    ;        COMMON 80286 SHUTDOWN WAIT

 02F8  B0 FE                             MOV     AL,SHUT_CMD             ; SHUTDOWN COMMAND
 02FA  E6 64                             OUT     STATUS_PORT,AL          ; SEND TO KEYBOARD CONTROL PORT
 02FC                            PROC_S:
 02FC  F4                                HLT                             ; WAIT FOR 80286 RESET
 02FD  EB FD                             JMP     PROC_S                  ; INSURE HALT

 02FF                            PROC_SHUTDOWN   ENDP
 02FF                            CODE    ENDS
                                         END
                                 PAGE 118,121
                                 TITLE TEST5 ---- 06/10/85  EXCEPTION INTERRUPT TEST HANDLERS
                                 .286C
                                 .LIST
 0000                            CODE     SEGMENT BYTE PUBLIC

                                          PUBLIC  POST5
                                          PUBLIC  SYSINIT1

                                 ;----------------------------------------
                                 ;        EXCEPTION INTERRUPT ROUTINE    :
                                 ;----------------------------------------

                                          ASSUME  CS:CODE,DS:ABS0
 0000                            POST5:
 0000                            EXC_00:
 0000  B0 90                              MOV     AL,90H                  ;       <><> SET CHECKPOINT <><>
 0002  E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 0005                            EXC_01:
 0005  B0 91                              MOV     AL,91H                  ;       <><> SET CHECKPOINT <><>
 0007  E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 000A                            EXC_02:
 000A  B0 92                              MOV     AL,92H                  ;       <><> SET CHECKPOINT <><>
 000C  E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 000F                            EXC_03:
 000F  B0 93                              MOV     AL,93H                  ;       <><> SET CHECKPOINT <><>
 0011  E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 0014                            EXC_04:
 0014  B0 94                              MOV     AL,94H                  ;       <><> SET CHECKPOINT <><>
 0016  E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED
 0019                            EXC_05:
 0019  06                                 PUSH    ES
 001A  6A 48                              PUSH    BYTE PTR ES_TEMP        ; LOAD ES REGISTER WITH SELECTOR
 001C  07                                 POP     ES

                                 ;-----   FIX BOUND PARAMETERS

 001D  2B FF                              SUB     DI,DI                   ; POINT BEGINNING OF THE BLOCK
 001F  26: C7 05 0000                     MOV     WORD PTR ES:[DI],0      ; SET FIRST WORD TO ZERO
 0024  26: C7 45 02 7FFF                  MOV     WORD PTR ES:[DI+2],07FFFH ; SET SECOND TO 07FFFH
 002A  07                                 POP     ES
 002B  B0 95                              MOV     AL,95H                  ;       <><> SET CHECKPOINT <><>
 002D  E9 00B2 R                          JMP     TEST_EXC                ; GO TEST IF EXCEPTION WAS EXPECTED

 0030                            EXC_06:
 0030  B0 96                              MOV     AL,96H                  ;       <><> SET CHECKPOINT <><>
 0032  EB 7E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0034                            EXC_07:
 0034  B0 97                              MOV     AL,97H                  ;       <><> SET CHECKPOINT <><>
 0036  EB 7A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0038                            EXC_08:
 0038  B0 98                              MOV     AL,98H                  ;       <><> SET CHECKPOINT <><>
 003A  EB 76                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 003C                            EXC_09:
 003C  B0 99                              MOV     AL,99H                  ;       <><> SET CHECKPOINT <><>
 003E  EB 72                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0040                            EXC_10:
 0040  B0 9A                              MOV     AL,9AH                  ;       <><> SET CHECKPOINT <><>
 0042  EB 6E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0044                            EXC_11:
 0044  B0 9B                              MOV     AL,9BH                  ;       <><> SET CHECKPOINT <><>
 0046  EB 6A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0048                            EXC_12:
 0048  B0 9C                              MOV     AL,9CH                  ;       <><> SET CHECKPOINT <><>
 004A  EB 66                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 004C                            EXC_13:
 004C  B0 9D                              MOV     AL,9DH                  ;       <><> SET CHECKPOINT <><>
 004E  EB 62                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0050                            EXC_14:
 0050  B0 9E                              MOV     AL,9EH                  ;       <><> SET CHECKPOINT <><>
 0052  EB 5E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0054                            EXC_15:
 0054  B0 9F                              MOV     AL,9FH                  ;       <><> SET CHECKPOINT <><>
 0056  EB 5A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0058                            EXC_16:
 0058  B0 A0                              MOV     AL,0A0H                 ;       <><> SET CHECKPOINT <><>
 005A  EB 56                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 005C                            EXC_17:
 005C  B0 A1                              MOV     AL,0A1H                 ;       <><> SET CHECKPOINT <><>
 005E  EB 52                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0060                            EXC_18:
 0060  B0 A2                              MOV     AL,0A2H                 ;       <><> SET CHECKPOINT <><>
 0062  EB 4E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0064                            EXC_19:
 0064  B0 A3                              MOV     AL,0A3H                 ;       <><> SET CHECKPOINT <><>
 0066  EB 4A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0068                            EXC_20:
 0068  B0 A4                              MOV     AL,0A4H                 ;       <><> SET CHECKPOINT <><>
 006A  EB 46                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 006C                            EXC_21:
 006C  B0 A5                              MOV     AL,0A5H                 ;       <><> SET CHECKPOINT <><>
 006E  EB 42                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0070                            EXC_22:
 0070  B0 A6                              MOV     AL,0A6H                 ;       <><> SET CHECKPOINT <><>
 0072  EB 3E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0074                            EXC_23:
 0074  B0 A7                              MOV     AL,0A7H                 ;       <><> SET CHECKPOINT <><>
 0076  EB 3A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0078                            EXC_24:
 0078  B0 A8                              MOV     AL,0A8H                 ;       <><> SET CHECKPOINT <><>
 007A  EB 36                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 007C                            EXC_25:
 007C  B0 A9                              MOV     AL,0A9H                 ;       <><> SET CHECKPOINT <><>
 007E  EB 32                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0080                            EXC_26:
 0080  B0 AA                              MOV     AL,0AAH                 ;       <><> SET CHECKPOINT <><>
 0082  EB 2E                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0084                            EXC_27:
 0084  B0 AB                              MOV     AL,0ABH                 ;       <><> SET CHECKPOINT <><>
 0086  EB 2A                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0088                            EXC_28:
 0088  B0 AC                              MOV     AL,0ACH                 ;       <><> SET CHECKPOINT <><>
 008A  EB 26                              JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED

 008C                          EXC_29:
 008C B0 AD                            MOV     AL,0ADH                 ;       <><> SET CHECKPOINT <><>
 008E EB 22                            JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0090                          EXC_30:
 0090 B0 AE                            MOV     AL,0AEH                 ;       <><> SET CHECKPOINT <><>
 0092 EB 1E                            JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0094                          EXC_31:
 0094 B0 AF                            MOV     AL,0AFH                 ;       <><> SET CHECKPOINT <><>
 0096 EB 1A                            JMP     SHORT  TEST_EXC         ; GO TEST IF EXCEPTION WAS EXPECTED
 0098                          SYS_32:
 0098 B0 B0                            MOV     AL,0B0H                 ;       <><> SET CHECKPOINT <><>
 009A EB 16                            JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
 009C                          SYS_33:
 009C B0 B1                            MOV     AL,0B1H                 ;       <><> SET CHECKPOINT <><>
 009E EB 12                            JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
 00A0                          SYS_34:
 00A0 B0 B2                            MOV     AL,0B2H                 ;       <><> SET CHECKPOINT <><>
 00A2 EB 0E                            JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
 00A4                          SYS_35:
 00A4 B0 B3                            MOV     AL,0B3H                 ;       <><> SET CHECKPOINT <><>
 00A6 EB 0A                            JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
 00A8                          SYS_36:
 00A8 B0 B4                            MOV     AL,0B4H                 ;       <><> SET CHECKPOINT <><>
 00AA EB 06                            JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
 00AC                          SYS_37:
 00AC B0 B5                            MOV     AL,0B5H                 ;       <><> SET CHECKPOINT <><>
 00AE EB 02                            JMP     SHORT  TEST_EXC         ; GO TEST IF INTERRUPT WAS EXPECTED
 00B0                          SYS_38:
 00B0 B0 B6                            MOV     AL,0B6H                 ;       <><> SET CHECKPOINT <><>
                                                                       ; GO TEST IF INTERRUPT WAS EXPECTED

 00B2                          TEST_EXC:
 00B2 E6 80                            OUT     MFG_PORT,AL             ; OUTPUT THE CHECKPOINT
 00B4 3C AF                            CMP     AL,0AFH                 ; CHECK FOR EXCEPTION
 00B6 77 1C                            JA      TEST_EXC0               ; GO IF A SYSTEM INTERRUPT

 00B8 1E                               PUSH    DS                      ; SAVE THE CURRENT DATA SEGMENT
 00B9 6A 08                            PUSH    BYTE PTR GDT_PTR
 00BB 1F                               POP     DS
 00BC C7 06 0048 FFFF                  MOV     DS:ES_TEMP.SEG_LIMIT,MAX_SEG_LEN
 00C2 C6 06 004D 93                    MOV     BYTE PTR DS:(ES_TEMP.DATA_ACC_RIGHTS),CPL0_DATA_ACCESS
 00C7 6A 48                            PUSH    BYTE PTR ES_TEMP
 00C9 07                               POP     ES
 00CA 1F                               POP     DS                      ; RESTORE REGISTERS
 00CB 5A                               POP     DX                      ; CHECK IF CODE SEGMENT SECOND ON STACK
 00CC 59                               POP     CX
 00CD 51                               PUSH    CX
 00CE 83 F9 40                         CMP     CX,SYS_ROM_CS
 00D1 75 01                            JNZ     TEST_EXC0               ; CONTINUE IF ERROR CODE

 00D3 52                               PUSH    DX                      ; PUT SEGMENT BACK ON STACK
 00D4                          TEST_EXC0:
 00D4 86 E0                            XCHG    AH,AL                   ; SAVE THE CHECKPOINT
 00D6 E4 8B                            IN      AL,DMA_PAGE+0AH
 00D8 3A C4                            CMP     AL,AH                   ; WAS THE EXCEPTION EXPECTED?
 00DA 74 0E                            JZ      TEST_EXC3               ; GO IF YES
 00DC                          TEST_EXC1:
 00DC E4 80                            IN      AL,MFG_PORT             ; CHECK THE CURRENT CHECKPOINT
 00DE 3C 3B                            CMP     AL,03BH                 ;  HALT IF CHECKPOINT BELOW 3BH
 00E0 72 01                            JB      TEST_EXC2
 00E2 CF                               IRET

 00E3                          TEST_EXC2:
 00E3 86 E0                            XCHG    AH,AL                   ; OUTPUT THE CURRENT CHECKPOINT
 00E5 E6 80                            OUT     MFG_PORT,AL             ;   <><> CHECKPOINT  90 THRU  B5 <><>
 00E7 F4                               HLT
 00E8 EB F9                            JMP     TEST_EXC2               ; INSURE SYSTEM HALT

 00EA                          TEST_EXC3:
 00EA 2A C0                            SUB     AL,AL                   ; CLEAR DMA PAGE
 00EC E6 8B                            OUT     DMA_PAGE+0AH,AL
 00EE B8 0100                          MOV     AX,0100H                ; FOR BOUND INSTRUCTION EXPECTED (INT 5)
 00F1 CF                               IRET                            ; RETURN


                               ;-----------------------------------------------------------------------
                               ;       THIS BUILDS THE DESCRIPTOR TABLES REQUIRED FOR PROTECTED MODE   :
                               ;               PROCESSOR MUST BE IN REAL MODE                         :
                               ;-----------------------------------------------------------------------
                                       ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

 00F2                          SYSINIT1        PROC    NEAR
 00F2 FA                               CLI                             ; NO INTERRUPTS ALLOWED
 00F3 55                               PUSH    BP                      ; SAVE BP
 00F4 B0 81                            MOV     AL,81H                  ;       <><><><><><><><><><><><>
 00F6 E6 80                            OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  81 <><>
 00F8 E8 0149 R                        CALL    SIDT_BLD
 00FB 8B EF                            MOV     BP,DI                   ; SAVE THE POINTER TO JUST PAST THE IDT
                                                                       ; AS WE HAVE NO SDA, USE THE SIX BYTES
                                                                       ;   HERE TO LOAD THE IDTR.  WE WILL SIDT
                                                                       ;   WHEN WE GET TO SDA INITIALIZATION.
 00FD B8 0800                          MOV     AX,SYS_IDT_LEN          ; SEGMENT LIMIT = LENGTH OF IDT
 0100 AB                               STOSW                           ; STORE THAT AS IDT LIMIT
 0101 B8 D0A0                          MOV     AX,SYS_IDT_LOC          ; IDT ADDRESS
 0104 AB                               STOSW                           ;   AND ACCESS RIGHTS BYTE (UNDEFINED)
 0105 B8 0000                          MOV     AX,0
 0108 AB                               STOSW
                                       SEGOV   ES                      ; LOAD THE IDT
 0109 26                       +       DB      026H
                                       LIDT    [BP]                    ;   REGISTER FROM THIS AREA
 010A 0F                       +       DB      00FH
 010B                          + ??0001 LABEL  BYTE
 010B 8B 5E 00                 +       MOV     BX,WORD PTR [BP]
 010E                          + ??0002 LABEL  BYTE
 010B                          +       ORG     OFFSET CS:??0001
 010B 01                       +       DB      001H
 010E                          +       ORG     OFFSET CS:??0002
 010E 8B FD                            MOV     DI,BP                   ; ES:DI NOW --> END OF IDT AGAIN

                               ;-----  BUILD THE GDT.

 0110 BF D8A0                          MOV     DI,GDT_LOC
 0113 E8 0140 R                        CALL    GDT_BLD
 0116 8B EF                            MOV     BP,DI                   ; SAVE THE ES:DI POINTER
 0118 B8 0088                          MOV     AX,GDT_LEN              ; AX = LENGTH OF THE GDT
```

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0118 AB                      STOSW                         ; PUT THAT IN THE LIMIT FIELD
011C B8 D8A0                 MOV     AX,GDT_LOC            ; AX = LOW WORD OF GDT ADDRESS
011F AB                      STOSW                         ; PUT THAT IN BASE FIELD - LOW
0120 B8 0000                 MOV     AX,0                  ; AX = HIGH BYTE OF ADDRESS, AND
0123 AB                      STOSW                         ;   ACCESS RIGHTS BYTE IS UNDEFINED
                             SEGOV   ES                    ; LOAD THE GDTR
0124 26               +      DB      026H
                             LGDT    [BP]                  ;   FROM THIS AREA
0125 0F               +      DB      00FH
0126                  + ??0004 LABEL BYTE
0126 8B 56 00         +      MOV     DX,WORD PTR [BP]
0129                  + ??0005 LABEL BYTE
0126                  +      ORG     OFFSET CS:??0004
0126 01               +      DB      001H
0129                  +      ORG     OFFSET CS:??0005
0129 8B FD                   MOV     DI,BP                 ; RESTORE THE ES:DI POINTER
012B AB                      STOSW
012C AB                      STOSW
012D 8B FD                   MOV     DI,BP

                      ;----- SWITCH TO VIRTUAL MODE

012F 5D                      POP     BP                    ; RESTORE BP
0130 B8 0001                 MOV     AX,VIRTUAL_ENABLE     ; MACHINE STATUS WORD NEEDED TO
                             LMSW    AX                    ;  SWITCH TO VIRTUAL MODE
0133 0F 01 F0         +      DB      00FH,001H,0F0H

0136 EA                       DB      0EAH                 ; JUMP FAR TO PURGE PRE-FETCH QUEUE
0137 013B R                   DW      OFFSET DONE          ;   TO OFFSET
0139 0040                     DW      SYS_ROM_CS           ;   IN SEGMENT
013B                  DONE:
013B B0 85                   MOV     AL,85H                ;       <><><><><><><><><><><><>
013D E6 80                   OUT     MFG_PORT,AL           ;       <><> CHECKPOINT  82 <><>
013F C3                      RET                           ; SYSTEM INITIALIZATION

0140                  SYSINIT1        ENDP


0140                  GDT_BLD PROC    NEAR
0140 BE 01AF R               MOV     SI,OFFSET GDT_DATA_START          ; DS:SI --> GDT
0143 B9 0044                 MOV     CX,(OFFSET GDT_DATA_END-OFFSET GDT_DATA_START)/2  ; WORD COUNT
0146 F3/ A5                  REP     MOVSW                             ; COPY GDT INTO MEMORY
0148 C3                      RET
0149                  GDT_BLD ENDP


0149                  SIDT_BLD        PROC    NEAR

                      ;----- BUILD THE IDT.  THE IDT WILL CONTAIN VECTORS FOR EXCEPTION HANDLERS

0149 BE 0237 R               MOV     SI,OFFSET SYS_IDT_OFFSETS  ; MAKE DS:SI POINT TO
014C 8C C8                   MOV     AX,CS                 ;    INTERRUPT ENTRY POINTS
014E 8E D8                   MOV     DS,AX
0150 BF D0A0                 MOV     DI,SYS_IDT_LOC        ; POINT TO SYS_IDT_LOC
0153 2B C0                   SUB     AX,AX
0155 8E C0                   MOV     ES,AX                 ;      WHERE THE IDT WILL BE.
0157 BB 0040                 MOV     BX,SYS_ROM_CS         ; CS IS THE SAME FOR ALL INTERRUPTS
015A B6 87                   MOV     DH,TRAP_GATE          ; ACCESS RIGHTS BYTE FOR THE GATE
015C B2 00                   MOV     DL,0                  ; THE WORD COUNT FIELD IS UNUSED
015E B9 0020                 MOV     CX,32                 ; THERE ARE 32 RESERVED INTERRUPTS
0161                  LOW_IDT:                             ; THIS LOOP BUILDS 32 DESCRIPTORS IN THE
                                                           ;   IDT FOR THE RESERVED INTERRUPTS
0161 A5                      MOVSW                         ; GET A ROUTINE ENTRY POINT
                                                           ;   AND PUT IT IN THE OFFSET FIELD
0162 8B C3                   MOV     AX,BX                 ; GET THE SYSTEM CODE SEGMENT SELECTOR
0164 AB                      STOSW                         ;   AND PUT IT IN THE SELECTOR FIELD
0165 8B C2                   MOV     AX,DX                 ; GET THE INTERRUPT GATE BYTE
0167 AB                      STOSW                         ;   AND PUT IN THE ACCESS RIGHTS FIELD
0168 B8 0000                 MOV     AX,0                  ; ZERO OUT
016B AB                      STOSW                         ;   THE RESERVED POSITIONS
016C E2 F3                   LOOP    LOW_IDT               ;     AND REPEAT AS DIRECTED
016E B9 00E0                 MOV     CX,256-32             ; 256 TOTAL - 32 DONE = WHATEVER IS LEFT
0171 BD 0277 R               MOV     BP,OFFSET FREE_INTS   ; THERE IS A COPY OF AN UN-INITIALIZED
                                                           ;   INTERRUPT DESCRIPTOR AT FREE_INTS
0174                  HIGH_IDT:
0174 8B F5                   MOV     SI,BP                 ; DS:SI --> FREE DESCRIPTOR
                                                           ; (ES:DI LEFT OFF AT INT 32)
0176 A5                      MOVSW                         ; MOVE OFFSET OF THE IRET INSTRUCTION
0177 A5                      MOVSW                         ; MOVE THE CS SELECTOR
0178 A5                      MOVSW                         ; MOVE THE ACCESS RIGHTS BYTE
0179 AB                      STOSW                         ; ZERO OUT THE RESERVED WORD
017A E2 F8                   LOOP    HIGH_IDT              ; FILL THE REMAINDER OF THE TABLE

                      ;----- INITIALIZE THE ENTRY POINTS FOR POST TEST

017C 26: C7 06 D1A0 0098 R   MOV     ES:(SYS_IDT_LOC+(032*DESC_LEN).ENTRY_POINT),OFFSET SYS_32
0183 26: C7 06 D1A8 009C R   MOV     ES:(SYS_IDT_LOC+(033*DESC_LEN).ENTRY_POINT),OFFSET SYS_33
018A 26: C7 06 D1B0 00A0 R   MOV     ES:(SYS_IDT_LOC+(034*DESC_LEN).ENTRY_POINT),OFFSET SYS_34
0191 26: C7 06 D1B8 00A4 R   MOV     ES:(SYS_IDT_LOC+(035*DESC_LEN).ENTRY_POINT),OFFSET SYS_35
0198 26: C7 06 D1C0 00A8 R   MOV     ES:(SYS_IDT_LOC+(036*DESC_LEN).ENTRY_POINT),OFFSET SYS_36
019F 26: C7 06 D1C8 00AC R   MOV     ES:(SYS_IDT_LOC+(037*DESC_LEN).ENTRY_POINT),OFFSET SYS_37
01A6 26: C7 06 D1D0 00B0 R   MOV     ES:(SYS_IDT_LOC+(038*DESC_LEN).ENTRY_POINT),OFFSET SYS_38
01AD C3                      RET

01AE                  IRET_ADDR       LABEL   WORD         ; FOR UN-INITIALIZED INTERRUPTS
01AE CF                      IRET                          ; NULL RETURN
```

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                                PAGE
                                ;       THE FOLLOWING DATA DEFINES THE PRE-INITIALIZED GDT FOR POST TESTS.
                                ;       THESE MUST BE INITIALIZED IN THE ORDER IN WHICH THEY APPEAR IN THE
                                ;       GDT_DEF STRUCTURE DEFINITION AS IT IS IN "SYSDATA.INC".

 = 01AF                         GDT_DATA_START  EQU     $

                                ;-----  FIRST ENTRY UNUSABLE  - (UNUSED_ENTRY)

 01AF 0000                              DW      0                       ; SEGMENT LIMIT
 01B1 0000                              DW      0                       ; SEGMENT BASE ADDRESS - LOW WORD
 01B3 00                                DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01B4 00                                DB      0                       ; ACCESS RIGHTS BYTE
 01B5 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  THE GDT ITSELF  - (GDT_PTR)

 01B7 0088                              DW      GDT_LEN                 ; SEGMENT LIMIT
 01B9 D8A0                              DW      GDT_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
 01BB 00                                DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01BC 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01BD 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  THE SYSTEM IDT DESCRIPTOR  - (SYS_IDT_PTR)

 01BF 0800                              DW      SYS_IDT_LEN             ; SEGMENT LIMIT
 01C1 D0A0                              DW      SYS_IDT_LOC             ; SEGMENT BASE ADDRESS - LOW WORD
 01C3 00                                DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01C4 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01C5 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  THE SYSTEM DATA AREA DESCRIPTOR  - (RSDA_PTR)

 01C7 0300                              DW      SDA_LEN                 ; SEGMENT LIMIT
 01C9 0400                              DW      SDA_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
 01CB 00                                DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
 01CC 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01CD 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  COMPATIBLE MONOCHROME DISPLAY REGEN BUFFER  - (C_BWCRT_PTR)

 01CF 1000                              DW      MCRT_SIZE               ; SEGMENT LIMIT
 01D1 0000                              DW      MCRT@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01D3 0B                                DB      MCRT@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01D4 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01D5 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  COMPATIBLE COLOR DISPLAY REGEN BUFFER  - (C_CCRT_PTR)

 01D7 4000                              DW      CCRT_SIZE               ; SEGMENT LIMIT
 01D9 8000                              DW      CCRT@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01DB 0B                                DB      CCRT@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01DC 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01DD 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  ENHANCED GRAPHIC ADAPTER REGEN BUFFER  - (E_CCRT_PRT)

 01DF FFFF                              DW      ECCRT_SIZE              ; SEGMENT LIMIT
 01E1 0000                              DW      ECCRT@_LO_LO            ; SEGMENT BASE ADDRESS - LOW WORD
 01E3 0A                                DB      ECCRT@_LO_HI            ; SEGMENT BASE ADDRESS - HIGH BYTE
 01E4 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01E5 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  SECOND PART OF EGA  - (E_CCRT_PTR2)

 01E7 FFFF                              DW      ECCRT_SIZE              ; SEGMENT LIMIT
 01E9 0000                              DW      ECCRT@_HI_LO            ; SEGMENT BASE ADDRESS - LOW WORD
 01EB 0B                                DB      ECCRT@_HI_HI            ; SEGMENT BASE ADDRESS - HIGH BYTE
 01EC 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01ED 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  CODE SEGMENT FOR POST CODE, SYSTEM IDT  - (SYS_ROM_CS)

 01EF FFFF                              DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 01F1 0000                              DW      CSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01F3 0F                                DB      CSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01F4 9B                                DB      CPL0_CODE_ACCESS        ; ACCESS RIGHTS BYTE
 01F5 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  TEMPORARY DESCRIPTOR FOR ES  - (ES_TEMP)

 01F7 FFFF                              DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 01F9 0000                              DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 01FB 00                                DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 01FC 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 01FD 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  TEMPORARY DESCRIPTOR FOR CS AS A DATA SEGMENT  - (CS_TEMP)

 01FF FFFF                              DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 0201 0000                              DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 0203 00                                DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 0204 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 0205 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  TEMPORARY DESCRIPTOR FOR SS  - (SS_TEMP)

 0207 FFFF                              DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 0209 0000                              DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 020B 00                                DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 020C 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 020D 0000                              DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  TEMPORARY DESCRIPTOR FOR DS  - (DS_TEMP)

 020F FFFF                              DW      MAX_SEG_LEN             ; SEGMENT LIMIT
 0211 0000                              DW      NSEG@_LO                ; SEGMENT BASE ADDRESS - LOW WORD
 0213 00                                DB      NSEG@_HI                ; SEGMENT BASE ADDRESS - HIGH BYTE
 0214 93                                DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
 0215 0000                              DW      0                       ; RESERVED - MUST BE ZERO
```

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                                PAGE
                                ;-----  (POST_TR)
0217                            TR_LOC:
0217 0800                               DW      00800H                  ; SEGMENT LIMIT
0219 C000                               DW      0C000H                  ; SEGMENT BASE ADDRESS - LOW WORD
021B 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
021C 81                                 DB      FREE_TSS                ; ACCESS RIGHTS BYTE
021D 0000                               DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  (POST_TSS_PTR)

021F 0800                               DW      00800H                  ; SEGMENT LIMIT
0221 0217 R                             DW      TR_LOC                  ; SEGMENT BASE ADDRESS - LOW WORD
0223 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
0224 93                                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0225 0000                               DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  (POST_LDTR)
0227                            LDT_LOC:
0227 0088                               DW      GDT_LEN                 ; SEGMENT LIMIT
0229 D000                               DW      0D000H                  ; SEGMENT BASE ADDRESS - LOW WORD
022B 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
022C E2                                 DB      LDT_DESC                ; ACCESS RIGHTS BYTE
022D 0000                               DW      0                       ; RESERVED - MUST BE ZERO

                                ;-----  (POST_LDT_PTR)

022F 0088                               DW      GDT_LEN                 ; SEGMENT LIMIT
0231 0227 R                             DW      LDT_LOC                 ; SEGMENT BASE ADDRESS - LOW WORD
0233 00                                 DB      0                       ; SEGMENT BASE ADDRESS - HIGH BYTE
0234 93                                 DB      CPL0_DATA_ACCESS        ; ACCESS RIGHTS BYTE
0235 0000                               DW      0                       ; RESERVED - MUST BE ZERO

= 0237                          GDT_DATA_END    EQU     $

                                ;-----  END OF PRE-ALLOCATED GDT


                                ;-----  ENTRY POINTS FOR THE FIRST 32 SYSTEM INTERRUPTS

0237                            SYS_IDT_OFFSETS         LABEL   WORD
                                                                        ; INTERRUPTS AS DEFINED
0237 0000 R                             DW      OFFSET EXC_00           ; EXCPT 00 - DIVIDE ERROR
0239 0005 R                             DW      OFFSET EXC_01           ; EXCPT 01 - SINGLE STEP
023B 000A R                             DW      OFFSET EXC_02           ; EXCPT 02 - NMI, SYSTEM REQUEST FOR DI
023D 000F R                             DW      OFFSET EXC_03           ; EXCPT 03 - BREAKPOINT
023F 0014 R                             DW      OFFSET EXC_04           ; EXCPT 04 - INTO DETECT
0241 0019 R                             DW      OFFSET EXC_05           ; EXCPT 05 - BOUND
0243 0030 R                             DW      OFFSET EXC_06           ; EXCPT 06 - INVALID OPCODE
0245 0034 R                             DW      OFFSET EXC_07           ; EXCPT 07 - PROCESSOR EXT NOT AVAIL
0247 0038 R                             DW      OFFSET EXC_08           ; EXCPT 08 - DOUBLE EXCEPTION
0249 003C R                             DW      OFFSET EXC_09           ; EXCPT 09 - PROCESSOR EXT SEGMENT ERR
024B 0040 R                             DW      OFFSET EXC_10           ; EXCPT 10 - TSS BAD IN GATE TRANSFER
024D 0044 R                             DW      OFFSET EXC_11           ; EXCPT 11 - SEGMENT NOT PRESENT
024F 0048 R                             DW      OFFSET EXC_12           ; EXCPT 12 - STACK SEGMENT NOT PRESENT
0251 004C R                             DW      OFFSET EXC_13           ; EXCPT 13 - GENERAL PROTECTION
0253 0050 R                             DW      OFFSET EXC_14
0255 0054 R                             DW      OFFSET EXC_15
0257 0058 R                             DW      OFFSET EXC_16           ; EXCPT 16 - PROCESSOR EXTENSION ERROR
0259 005C R                             DW      OFFSET EXC_17
025B 0060 R                             DW      OFFSET EXC_18
025D 0064 R                             DW      OFFSET EXC_19
025F 0068 R                             DW      OFFSET EXC_20
0261 006C R                             DW      OFFSET EXC_21
0263 0070 R                             DW      OFFSET EXC_22
0265 0074 R                             DW      OFFSET EXC_23
0267 0078 R                             DW      OFFSET EXC_24
0269 007C R                             DW      OFFSET EXC_25
026B 0080 R                             DW      OFFSET EXC_26
026D 0084 R                             DW      OFFSET EXC_27
026F 0088 R                             DW      OFFSET EXC_28
0271 008C R                             DW      OFFSET EXC_29
0273 0090 R                             DW      OFFSET EXC_30
0275 0094 R                             DW      OFFSET EXC_31

                                ;-----  FORMAT INTERRUPT DESCRIPTORS (GATES) 32 - 255

0277 01AE R                     FREE_INTS       DW      OFFSET IRET_ADDR        ; DESTINATION OFFSET
0279 0040                                       DW      SYS_ROM_CS              ; DESTINATION SEGMENT
027B 00 86                                      DB      0,INT_GATE              ; UNUSED AND ACCESS RIGHTS BYTE
027D                            SIDT_BLD        ENDP

027D                            CODE    ENDS
                                        END
```

SECTION 5

```
                                PAGE 118,121
                                TITLE TEST6 ---- 06/10/85  POST TESTS AND SYSTEM BOOT STRAP
                                .286C
                                .LIST
 0000                           CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  BOOT_STRAP_1
                                        PUBLIC  POST6
                                        PUBLIC  STGTST_CNT
                                        PUBLIC  ROM_ERR
                                        PUBLIC  XMIT_8042

                                        EXTRN   CMOS_READ:NEAR
                                        EXTRN   DDS:NEAR
                                        EXTRN   DISK_BASE:NEAR
                                        EXTRN   E602:NEAR
                                        EXTRN   ERR_BEEP:NEAR
                                        EXTRN   E_MSG:NEAR
                                        EXTRN   F3A:NEAR
                                        EXTRN   PRT_SEG:NEAR

                                        ASSUME  CS:CODE,DS:DATA

 0000                           POST6   PROC    NEAR
                                ;--------------------------------------------------------------
                                ; THIS SUBROUTINE PERFORMS A READ/WRITE STORAGE TEST ON A BLOCK :
                                ;       OF STORAGE.                                            :
                                ; ENTRY REQUIREMENTS:                                          :
                                ;       ES = ADDRESS OF STORAGE SEGMENT BEING TESTED           :
                                ;       DS = ADDRESS OF STORAGE SEGMENT BEING TESTED           :
                                ;       CX = WORD COUNT OF STORAGE BLOCK TO BE TESTED          :
                                ; EXIT PARAMETERS:                                             :
                                ;       ZERO FLAG = 0 IF STORAGE ERROR (DATA COMPARE OR PARITY :
                                ;       CHECK). AL=0 DENOTES A PARITY CHECK. ELSE AL=XOR'ED    :
                                ;       BIT PATTERN OF THE EXPECTED DATA PATTERN VS THE ACTUAL :
                                ;       DATA READ.                                             :
                                ; AX,BX,CX,DX,DI, AND SI ARE ALL DESTROYED.                    :
                                ;--------------------------------------------------------------
 0000                           STGTST_CNT      PROC    NEAR
 0000 8B D9                             MOV     BX,CX                   ; SAVE WORD COUNT OF BLOCK TO TEST
 0002 E4 61                             IN      AL,PORT_B
 0004 0C 0C                             OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK LATCHES
 0006 E6 61                             OUT     PORT_B,AL               ; TO RESET ANY PENDING ERROR
 0008 24 F3                             AND     AL,RAM_PAR_ON
 000A E6 61                             OUT     PORT_B,AL

                                ;-----  ROLL A BIT THROUGH THE FIRST WORD

 000C 33 D2                             XOR     DX,DX                   ; CLEAR THE INITIAL DATA PATTERN
 000E B9 0010                           MOV     CX,16                   ; ROLL 16 BIT POSITIONS
 0011 2B FF                             SUB     DI,DI                   ; START AT BEGINNING OF BLOCK
 0013 2B F6                             SUB     SI,SI                   ; INITIALIZE DESTINATION POINTER
 0015 F9                                STC                             ; SET CARRY FLAG ON FOR FIRST BIT
 0016                           C1:
 0016 D1 D2                             RCL     DX,1                    ; MOVE BIT OVER LEFT TO NEXT POSITION
 0018 89 15                             MOV     [DI],DX                 ; STORE DATA PATTERN
 001A 8B 05                             MOV     AX,[DI]                 ; GET THE DATA WRITTEN
 001C 33 C2                             XOR     AX,DX                   ; INSURE DATA AS EXPECTED (CLEAR CARRY)
 001E E1 F6                             LOOPZ   C1                      ; LOOP TILL DONE OR ERROR

 0020 75 66                             JNZ     C13                     ; EXIT IF ERROR

                                ;-----  CHECK CAS LINES FOR HIGH BYTE LOW BYTE

 0022 BA FF00                           MOV     DX,0FF00H               ; TEST DATA - AX= 0000H
 0025 89 05                             MOV     [DI],AX                 ; STORE DATA PATTERN  = 0000H
 0027 88 75 01                          MOV     [DI+1],DH               ; WRITE A BYTE OF FFH AT ODD LOCATION
 002A 8B 05                             MOV     AX,[DI]                 ; GET THE DATA - SHOULD BE 0FF00H
 002C 33 C2                             XOR     AX,DX                   ; CHECK THE FIRST WRITTEN
 002E 75 58                             JNZ     C13                     ; ERROR EXIT IF NOT ZERO

 0030 89 05                             MOV     [DI],AX                 ; STORE DATA PATTERN OF 0000H
 0032 88 35                             MOV     [DI],DH                 ; WRITE A BYTE OF FFH AT EVEN LOCATION
 0034 86 F2                             XCHG    DH,DL                   ; SET DX= 000FFH AND BUS SETTLE
 0036 8B 05                             MOV     AX,[DI]                 ; GET THE DATA
 0038 33 C2                             XOR     AX,DX                   ; CHECK THE FIRST WRITTEN
 003A 75 4C                             JNZ     C13                     ; EXIT IF NOT

                                ;-----  CHECK FOR I/O OR BASE MEMORY ERROR

 003C E4 61                             IN      AL,PORT_B               ; CHECK FOR I/O - PARITY CHECK
 003E 86 C4                             XCHG    AL,AH                   ; SAVE ERROR
 0040 E4 87                             IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
 0042 22 E0                             AND     AH,AL                   ; MASK FOR ERROR EXPECTED

                                ;-----  PARITY ERROR EXIT

 0044 B8 0000                           MOV     AX,0                    ; RESTORE AX TO 0000
 0047 75 3F                             JNZ     C13                     ; EXIT IF PARITY ERROR

 0049 BA AA55                           MOV     DX,0AA55H               ; WRITE THE INITIAL DATA PATTERN
 004C                           C3:
 004C 2B FF                             SUB     DI,DI                   ; START AT BEGINNING OF BLOCK
 004E 2B F6                             SUB     SI,SI                   ; INITIALIZE DESTINATION POINTER
 0050 8B CB                             MOV     CX,BX                   ; SETUP BYTE COUNT FOR LOOP
 0052 8B C2                             MOV     AX,DX                   ; GET THE PATTERN
 0054 F3/ AB                            REP     STOSW                   ; STORE 64K BYTES (32K WORDS)
 0056 8B CB                             MOV     CX,BX                   ; SET COUNT
 0058 2B F6                             SUB     SI,SI                   ; START AT BEGINNING
 005A                           C6:
 005A AD                                LODSW                           ; GET THE FIRST WRITTEN
 005B 33 C2                             XOR     AX,DX                   ; INSURE DATA AS EXPECTED
 005D E1 FB                             LOOPZ   C6                      ; LOOP TILL DONE OR ERROR

 005F 75 27                             JNZ     C13                     ; EXIT IF NOT EXPECTED (ERROR BITS ON)

                                ;-----  CHECK FOR I/O OR BASE MEMORY ERROR

 0061 E4 61                             IN      AL,PORT_B               ; CHECK FOR I/O -PARITY CHECK
 0063 86 C4                             XCHG    AL,AH                   ; SAVE ERROR
 0065 E4 87                             IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
 0067 22 E0                             AND     AH,AL
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                                ;-----  PARITY ERROR EXIT

 0069 B8 0000                           MOV     AX,0                    ; RESTORE AX TO 0000
 006C 75 1A                             JNZ     C13                     ; GO IF YES

                                ;-----  CHECK FOR END OF 64K BLOCK

 006E 23 D2                             AND     DX,DX                   ; ENDING ZERO PATTERN WRITTEN TO MEMORY?
 0070 74 16                             JZ      C13                     ; YES - RETURN TO CALLER WITH AL=0

                                ;-----  SETUP NEXT PATTERN

 0072 81 FA 55AA                        CMP     DX,055AAH               ; CHECK IF LAST PATTERN =55AA
 0076 74 0B                             JZ      C9                      ; GO IF NOT
 0078 81 FA 0101                        CMP     DX,0101H                ; LAST PATTERN 0101?
 007C 74 0B                             JZ      C10                     ; GO IF YES
 007E BA 55AA                           MOV     DX,055AAH               ; WRITE 55AA TO STORAGE
 0081 EB C9                             JMP     C3

                                ;-----  INSURE PARITY BITS ARE NOT STUCK ON

 0083 BA 0101                   C9:     MOV     DX,0101H                ; WRITE 0101 TO STORAGE
 0086 EB C4                             JMP     C3

                                ;-----  EXIT STORAGE TEST
 0088                           C13:
 0088 C3                                RET                             ; ERROR IF ZF NOT SET

                                ;-----  CHECKER BOARD TEST

 0089 2B FF                     C10:    SUB     DI,DI                   ; POINT TO START OF BLOCK
 008B 8B CB                             MOV     CX,BX                   ; GET THE BLOCK COUNT
 008D D1 E9                             SHR     CX,1                    ; DIVIDE BY 2
 008F B8 AAAA                           MOV     AX,1010101010101010B    ; SECOND CHECKER PATTERN
 0092 BE 5555                           MOV     SI,0101010101010101B    ; FIRST CHECKER PATTERN
 0095                           C11:
 0095 96                                XCHG    AX,SI                   ; FIRST CHECKER PATTERN TO AX
 0096 AB                                STOSW                           ; WRITE IT TO MEMORY
 0097 96                                XCHG    AX,SI                   ; SECOND CHECKER PATTERN TO AX
 0098 AB                                STOSW                           ; WRITE IT TO MEMORY
 0099 E2 FA                             LOOP    C11                     ; DO IT FOR CX COUNT

 009B 2B F6                             SUB     SI,SI                   ; POINT TO START OF BLOCK
 009D 8B CB                             MOV     CX,BX                   ; GET THE BLOCK COUNT
 009F D1 E9                             SHR     CX,1                    ; DIVIDE BY 2
 00A1 BF 5555                           MOV     DI,0101010101010101B    ; CHECK CORRECT
 00A4 BA AAAA                           MOV     DX,1010101010101010B
 00A7                           C12:
 00A7 AD                                LODSW                           ; GET THE DATA
 00A8 33 C7                             XOR     AX,DI                   ; CHECK CORRECT
 00AA 75 DC                             JNZ     C13                     ; EXIT IF NOT

 00AC AD                                LODSW                           ; GET NEXT DATA
 00AD 33 C2                             XOR     AX,DX                   ; CHECK SECOND PATTERN
 00AF E1 F6                             LOOPZ   C12                     ; CONTINUE TILL DONE

 00B1 75 D5                             JNZ     C13                     ; ERROR EXIT IF NOT CORRECT

                                ;-----  CHECK FOR I/O OR BASE MEMORY PARITY CHECK

 00B3 E4 61                             IN      AL,PORT_B               ; CHECK FOR I/O-PARITY CHECK
 00B5 86 C4                             XCHG    AL,AH                   ; SAVE ERROR
 00B7 E4 87                             IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
 00B9 22 E0                             AND     AH,AL

                                ;-----  CHECKPOINT 32 FOR ADDRESS LINE 0->15 FAILURE

 00BB B0 32                             MOV     AL,32H                  ;       <><><><><><><><><><><><>
 00BD E6 80                             OUT     MFG_PORT,AL             ;       <><> CHECKPOINT  32 <><>
 00BF B8 0000                           MOV     AX,0                    ; RESTORE AX (SET AX TO ZERO)
 00C2 75 C4                             JNZ     C13                     ; EXIT IF PARITY ERROR

                                ;-----  64K ADDRESS TEST AND FILL WITH ZERO

 00C4 48                                DEC     AX                      ; WRITE FIRST AND LAST LOCATION=FFFF
 00C5 2B FF                             SUB     DI,DI                   ; POINT TO START OF BLOCK
 00C7 8B CB                             MOV     CX,BX                   ; GET THE BLOCK COUNT
 00C9 83 E9 02                          SUB     CX,2                    ; DO ALL LOCATIONS BUT LAST
 00CC AB                                STOSW                           ; WRITE FIRST LOCATION AS FFFFH
 00CD 40                                INC     AX                      ; WRITE ZERO
 00CE F3/ AB                            REP     STOSW                   ; WRITE IT
 00D0 48                                DEC     AX                      ; LAST WORD IS FFFF
 00D1 AB                                STOSW
 00D2 2B F6                             SUB     SI,SI                   ; POINT TO START OF BLOCK
 00D4 8B CB                             MOV     CX,BX                   ; GET THE BLOCK COUNT
 00D6 83 E9 02                          SUB     CX,2
 00D9 AD                                LODSW                           ; GET THE DATA
 00DA 35 FFFF                           XOR     AX,0FFFFH               ; CHECK CORRECT
 00DD 75 A9                             JNZ     C13                     ; EXIT IF NOT
 00DF                           C12A:
 00DF AD                                LODSW                           ; GET NEXT DATA
 00E0 0B C0                             OR      AX,AX                   ; ANY BIT ON ?
 00E2 E1 FB                             LOOPZ   C12A                    ; CONTINUE TILL LAST WORD
 00E4 75 A2                             JNZ     C13                     ; GO IF NOT CORRECT
 00E6 AD                                LODSW                           ; GET LAST WORD
 00E7 35 FFFF                           XOR     AX,0FFFFH               ; S/B FFFF
 00EA 75 9C                             JNZ     C13                     ; EXIT IF NOT

                                ;-----  CLEAR WORD 0 AND FFFE

 00EC 2B FF                             SUB     DI,DI                   ; CLEAR FIRST WORD
 00EE AB                                STOSW
 00EF BF FFFE                           MOV     DI,0FFFEH               ; CLEAR TOP WORD
 00F2 AB                                STOSW

                                ;-----  CHECK FOR I/O OR BASE MEMORY

 00F3 E4 61                             IN      AL,PORT_B               ; CHECK FOR I/O - PARITY CHECK
 00F5 86 C4                             XCHG    AL,AH                   ; SAVE ERROR
 00F7 E4 87                             IN      AL,DMA_PAGE+6           ; CHECK FOR R/W OR I/O ERROR
 00F9 22 E0                             AND     AH,AL
 00FB B8 0000                           MOV     AX,0                    ; SET AX EQUAL ZERO
 00FE EB 88                             JMP     C13                     ; ERROR EXIT IF ZF NOT SET
 0100                           STGTST_CNT      ENDP
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                             PAGE
                             ;-----------------------------------------------------------------------
                             ;  PRINT ADDRESS AND ERROR MESSAGE FOR ROM CHECKSUM ERRORS              :
                             ;-----------------------------------------------------------------------
0100                         ROM_ERR PROC    NEAR
0100 52                              PUSH    DX                      ; SAVE POINTER
0101 06                              PUSH    ES
0102 50                              PUSH    AX
0103 B8 ---- R                       MOV     AX,DATA                 ; SET ES TO DATA SEGMENT
0106 8E C0                           MOV     ES,AX
0108 58                              POP     AX                      ; RESTORE AX
0109 50                              PUSH    AX
010A 8C DA                           MOV     DX,DS                   ; GET ADDRESS POINTER
010C 26: 88 36 0015 R                MOV     ES:@MFG_ERR_FLAG,DH     ;        <><><><><><><><><><><><><><><><>
                                                                     ;        <><> CHECKPOINTS C0->F4 <><>
0111 81 FA C800                      CMP     DX,0C800H               ; DISPLAY CARD IN ERROR?
0115 7C 0D                           JL      ROM_ERR_BEEP            ; GIVE DISPLAY CARD FAIL BEEP
0117 E8 0000 E                       CALL    PRT_SEG                 ; PRINT SEGMENT IN ERROR
011A BE 0000 E                       MOV     SI,OFFSET F3A           ; DISPLAY ERROR MESSAGE
011D E8 0000 E                       CALL    E_MSG
0120                         ROM_ERR_END:
0120 58                              POP     AX
0121 07                              POP     ES
0122 5A                              POP     DX
0123 C3                              RET
0124                         ROM_ERR_BEEP:
0124 BA 0102                         MOV     DX,0102H                ; BEEP 1 LONG, 2 SHORT
0127 E8 0000 E                       CALL    ERR_BEEP
012A EB F4                           JMP     SHORT ROM_ERR_END
012C                         ROM_ERR ENDP
                             ;-------------------------------------------------------------------
                             ; THIS SUBROUTINE SENDS AN OUTPUT COMMAND TO THE KEYBOARD AND       :
                             ;         RECEIVES THE KEYBOARD RESPONSE.                           :
                             ; ENTRY REQUIREMENTS:                                               :
                             ;         AL = COMMAND/DATA TO BE SENT                              :
                             ; EXIT PARAMETERS:                                                  :
                             ;         ZERO FLAG = 1 IF ACK RECEIVED FROM THE KEY BOARD          :
                             ;         AL = RESPONSE                                             :
                             ;-------------------------------------------------------------------
012C                         XMIT_8042 PROC  NEAR

                             ;-----  CHECK INPUT BUFFER FULL

012C 86 E0                           XCHG    AH,AL                   ; SAVE COMMAND
012E 2B C9                           SUB     CX,CX                   ; SET LOOP TIME-OUT
0130                         XMITLOOP:
0130 E4 64                           IN      AL,STATUS_PORT
0132 A8 02                           TEST    AL,INPT_BUF_FULL        ; CHECK INPUT BUFFER FULL
0134 E0 FA                           LOOPNZ  XMITLOOP
0136 E3 34                           JCXZ    SHORT XMIT_EXIT
0138 86 E0                           XCHG    AH,AL                   ; RESTORE COMMAND

                             ;-----  ISSUE THE COMMAND

013A E6 60                           OUT     PORT_A,AL               ; SEND THE COMMAND
013C 2B C9                           SUB     CX,CX                   ; SET LOOP COUNT

                             ;-----  CHECK OUTPUT BUFFER FULL

013E E4 64                   XMIT_1: IN      AL,STATUS_PORT
0140 8A E0                           MOV     AH,AL                   ; SAVE STATUS
0142 A8 01                           TEST    AL,OUT_BUF_FULL         ; CHECK IF 8042 HAS DATA
0144 74 02                           JZ      XMIT_2                  ; GO IF NOT
0146 E4 60                           IN      AL,PORT_A               ; FLUSH DATA
0148 F6 C4 02                XMIT_2: TEST    AH,INPT_BUF_FULL        ; CHECK COMMAND ACCEPTED
014B E0 F1                           LOOPNZ  XMIT_1
014D 75 1D                           JNZ     SHORT XMIT_EXIT         ; NO FLUSH OR COMMAND NOT ACCEPTED

                             ;-----  CHECK OUTPUT BUFFER FULL

014F B3 06                           MOV     BL,6                    ; SET COUNT
0151 2B C9                           SUB     CX,CX                   ; SET LOOP COUNT
0153 E4 64                   XMIT_3: IN      AL,STATUS_PORT
0155 A8 01                           TEST    AL,OUT_BUF_FULL         ; CHECK IF HAS DATA
0157 E1 FA                           LOOPZ   XMIT_3                  ; WAIT TILL DONE
0159 75 08                           JNZ     XMIT_4
015B FE CB                           DEC     BL                      ; DECREMENT OUTER LOOP
015D 75 F4                           JNZ     SHORT XMIT_3            ; TRY AGAIN
015F FE C3                           INC     BL                      ; SET ERROR FLAG
0161 EB 09                           JMP     SHORT XMIT_EXIT         ; 8042 STUCK BUSY

                             ;-----  GET THE DATA

0163 2B C9                   XMIT_4: SUB     CX,CX                   ; ALLOW TIME FOR POSSIBLE
                                                                     ; ERROR -> SYSTEM UNIT OR KEYBOARD
0165 E2 FE                   XMIT_5: LOOP    XMIT_5
0167 E4 60                           IN      AL,PORT_A
0169 83 E9 01                        SUB     CX,01H                  ; SET CX OTHER THAN ZERO
016C                         XMIT_EXIT:
016C C3                              RET
016D                         XMIT_8042 ENDP

                             ;--- BOOT_STRAP -- INT  19 H ---------------------------
                             ; BOOT STRAP LOADER                                     :
                             ;         TRACK 0, SECTOR 1 IS READ INTO THE            :
                             ;         BOOT LOCATION (SEGMENT 0 OFFSET 7C00)         :
                             ;         AND CONTROL IS TRANSFERRED THERE.             :
                             ;                                                       :
                             ;         IF THERE IS A HARDWARE ERROR CONTROL IS       :
                             ;         TRANSFERRED TO THE ROM BASIC ENTRY POINT      :
                             ;-------------------------------------------------------
                                     ASSUME CS:CODE,DS:ABS0,ES:ABS0

016D                         BOOT_STRAP_1    PROC    NEAR

016D B8 ---- R                       MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
0170 8E D8                           MOV     DS,AX
0172 8E C0                           MOV     ES,AX

                             ;-----  RESET THE DISK PARAMETER TABLE VECTOR

0174 C7 06 0078 R 0000 E             MOV     WORD PTR @DISK_POINTER, OFFSET DISK_BASE
017A 8C 0E 007A R                    MOV     WORD PTR @DISK_POINTER+2,CS

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                                 ;-----  CLEAR @BOOT_LOCN

 017E 33 C0                              XOR     AX,AX
 0180 B9 0100                            MOV     CX,256                 ; CLEAR 256 WORDS
 0183 BF 7C00 R                          MOV     DI,OFFSET @BOOT_LOCN
 0186 F3/ AB                             REP     STOSW

                                 ;-----  LOAD SYSTEM FROM DISKETTE -- CX HAS RETRY COUNT

 0188 FB                                 STI
 0189 B9 0004                            MOV     CX,4                   ; SET RETRY COUNT
 018C 51                         H1:     PUSH    CX                     ; IPL SYSTEM
 018D B4 00                              MOV     AH,0                   ; RESET THE DISKETTE SYSTEM
 018F CD 13                              INT     13H                    ; DISKETTE_IO
 0191 72 0F                              JC      H2                     ; IF ERROR, TRY AGAIN

 0193 B8 0201                            MOV     AX,201H                ; READ IN THE SINGLE SECTOR
 0196 2B D2                              SUB     DX,DX                  ; TO THE BOOT LOCATION
 0198 8E C2                              MOV     ES,DX
 019A BB 7C00 R                          MOV     BX,OFFSET @BOOT_LOCN   ; DRIVE 0, HEAD 0
 019D B9 0001                            MOV     CX,1                   ; SECTOR 1, TRACK 0
 01A0 CD 13                              INT     13H                    ; DISKETTE_IO
 01A2 59                         H2:     POP     CX                     ; RECOVER RETRY COUNT
 01A3 73 09                              JNC     H4                     ; CARRY FLAG SET BY UNSUCCESSFUL READ
 01A5 80 FC 80                           CMP     AH,80H                 ; IF TIME OUT, NO RETRY
 01A8 74 22                              JZ      H5                     ; TRY FIXED DISK
 01AA E2 E0                              LOOP    H1                     ; DO IT FOR RETRY TIMES
 01AC EB 1E                              JMP     SHORT H5               ; TRY FIXED DISK

                                 ;-----  BOOT RECORD READ SUCCESSFUL
                                 ;-----  INSURE FIRST BYTE OF LOADED BOOT RECORD IS VALID (NOT ZERO)

 01AE 80 3E 7C00 R 06            H4:     CMP     BYTE PTR @BOOT_LOCN,06H ; CHECK FOR FIRST INSTRUCTION INVALID
 01B3 72 71                              JB      H10                    ; IF BOOT NOT VALID PRINT MESSAGE HALT

                                 ;-----  INSURE DATA PATTERN FIRST 8 WORDS NOT ALL EQUAL

 01B5 BF 7C00 R                          MOV     DI,OFFSET @BOOT_LOCN   ; CHECK DATA PATTERN
 01B8 B9 0008                            MOV     CX,8                   ; CHECK THE NEXT 8 WORDS
 01BB A1 7C00 R                          MOV     AX,WORD PTR @BOOT_LOCN

 01BE 83 C7 02                   H4A:    ADD     DI,2                   ; POINT TO NEXT LOCATION
 01C1 3B 05                              CMP     AX,[DI]                ; CHECK DATA PATTERN FOR A FILL PATTERN
 01C3 E1 F9                              LOOPZ   H4A
 01C5 74 5F                              JZ      H10                    ; BOOT NOT VALID PRINT MESSAGE HALT

 01C7 EA 7C00 ---- R             H4_A:   JMP     @BOOT_LOCN

                                 ;-----  ATTEMPT BOOTSTRAP FROM FIXED DISK

 01CC B0 44                      H5:     MOV     AL,044H                ;        <><><><><><><><><><><><><>
 01CE E6 80                              OUT     MFG_PORT,AL            ;        <><> CHECKPOINT  44 <><>
                                         ASSUME  DS:DATA
 01D0 E8 0000 E                          CALL    DDS
 01D3 F6 06 008B R 01                    TEST    @LASTRATE,DUAL         ; FLOPPY/FIXED DISK CARD INSTALLED
                                         ASSUME  DS:ABS0
 01D8 B8 ---- R                          MOV     AX,ABS0                ; ESTABLISH ADDRESSING
 01DB 8E D8                              MOV     DS,AX
 01DD 74 3D                              JZ      H9                     ; GO IF NOT

                                 ;-----  CHECK FOR FIXED DISK INITIALIZATION ERROR

 01DF B0 0E                              MOV     AL,CMOS_DIAG           ; GET POST POWER ON STATUS (NMI ENABLED)
 01E1 E8 0000 E                          CALL    CMOS_READ              ; FROM DIAGNOSTIC STATUS BYTE
 01E4 A8 08                              TEST    AL,HF_FAIL             ; DID WE HAVE A FIXED DISK FAILURE?
 01E6 75 34                              JNZ     H9                     ; GO IF YES

 01E8 2B C0                              SUB     AX,AX                  ; RESET DISKETTE
 01EA 2B D2                              SUB     DX,DX
 01EC CD 13                              INT     13H
 01EE B9 0003                            MOV     CX,3                   ; RETRY COUNT
 01F1                            H6:
 01F1 51                                 PUSH    CX                     ; SAVE RETRY COUNT
 01F2 BA 0080                            MOV     DX,0080H               ; FIXED DISK ZERO
 01F5 B8 0201                            MOV     AX,0201H               ; READ IN A SINGLE SECTOR
 01F8 2B DB                              SUB     BX,BX
 01FA 8E C3                              MOV     ES,BX
 01FC BB 7C00 R                          MOV     BX,OFFSET @BOOT_LOCN   ; TO THE BOOT LOCATION
 01FF B9 0001                            MOV     CX,1                   ; SECTOR 1, TRACK 0
 0202 CD 13                              INT     13H                    ; FILE I/O CALL
 0204 59                                 POP     CX                     ; RECOVER RETRY COUNT
 0205 72 08                              JC      H8
 0207 81 3E 7DFE R AA55                  CMP     WORD PTR @BOOT_LOCN+510D,0AA55H ; TEST FOR GENERIC BOOT BLOCK
 020D 74 B8                              JZ      H4_A

 020F 51                         H8:     PUSH    CX
 0210 BA 0080                            MOV     DX,0080H               ; FIXED DISK ZERO
 0213 2B C0                              SUB     AX,AX                  ; RESET THE FIXED DISK
 0215 CD 13                              INT     13H                    ; FILE I/O CALL
 0217 59                                 POP     CX                     ; RESTORE LOOP COUNT
 0218 72 08                              JC      H10A                   ; IF ERROR, TRY AGAIN
 021A E2 D5                              LOOP    H6                     ; DO IT FOR RETRY TIMES

                                 ;-----  UNABLE TO IPL FROM THE DISKETTE OR FIXED DISK

 021C B0 45                      H9:     MOV     AL,045H                ;        <><><><><><><><><><><><><>
 021E E6 80                              OUT     MFG_PORT,AL            ;        <><> CHECKPOINT  45 <><>

 0220 CD 18                              INT     18H                    ; GO TO RESIDENT BASIC

                                 ;-----  HARD FILE RESET FAILURE

 0222 E2 EB                      H10A:   LOOP    H8                     ; TRY RESET AGAIN
 0224 EB F6                              JMP     H9                     ; GO TO RESIDENT BASIC

                                 ;-----  IF DISKETTE READ OK BUT BOOT RECORD IS NOT STOP SYSTEM ALLOW SOFT RESET

 0226 BE 0000 E                  H10:    MOV     SI,OFFSET E602         ; PRINT DISKETTE BOOT
 0229 E8 0000 E                          CALL    E_MSG                  ; PRINT MESSAGE
 022C EB FE                      H11:    JMP     H11
 022E                            BOOT_STRAP_1    ENDP
 022E                            POST6       ENDP
 022E                            CODE        ENDS
                                             END
```

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PAGE 118,121
TITLE DSKETTE -- 04/21/86  DISKETTE BIOS
.286C
.LIST
SUBTTL (DSK1.ASM)
.LIST
;-- INT 13 H -----------------------------------------------------------------
; DISKETTE I/O
;       THIS INTERFACE PROVIDES DISK ACCESS TO THE 5.25 INCH 360 KB,
;       1.2 MB, 720 KB, AND 1.44 MB DISKETTE DRIVES.
; INPUT
;       (AH)=00H  RESET DISKETTE SYSTEM
;                 HARD RESET TO NEC, PREPARE COMMAND, RECALIBRATE REQUIRED
;                 ON ALL DRIVES
;-----------------------------------------------------------------------------
;       (AH)=01H  READ THE STATUS OF THE SYSTEM INTO (AH)
;                 @DISKETTE_STATUS FROM LAST OPERATION IS USED
;-----------------------------------------------------------------------------
;       REGISTERS FOR READ/WRITE/VERIFY/FORMAT
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;       (DH) - HEAD NUMBER (0-1 ALLOWED, NOT VALUE CHECKED)
;       (CH) - TRACK NUMBER (NOT VALUE CHECKED)
;                 MEDIA     DRIVE         TRACK NUMBER
;                320/360   320/360            0-39
;                320/360     1.2M             0-39
;                  1.2M      1.2M             0-79
;                  720K      720K             0-79
;                  1.44M     1.44M            0-79
;       (CL) - SECTOR NUMBER (NOT VALUE CHECKED, NOT USED FOR FORMAT)
;                 MEDIA     DRIVE         SECTOR NUMBER
;                320/360   320/360            1-8/9
;                320/360     1.2M             1-8/9
;                  1.2M      1.2M             1-15
;                  720K      720K             1-9
;                  1.44M     1.44M            1-18
;       (AL) - NUMBER OF SECTORS (NOT VALUE CHECKED, NOT USED FOR FORMAT)
;                 MEDIA     DRIVE         MAX NUMBER OF SECTORS
;                320/360   320/360            8/9
;                320/360     1.2M             8/9
;                  1.2M      1.2M             15
;                  720K      720K             9
;                  1.44M     1.44M            18
;
;       (ES:BX) - ADDRESS OF BUFFER (NOT REQUIRED FOR VERIFY)
;
;-----------------------------------------------------------------------------
;       (AH)=02H  READ THE DESIRED SECTORS INTO MEMORY
;-----------------------------------------------------------------------------
;       (AH)=03H  WRITE THE DESIRED SECTORS FROM MEMORY
;-----------------------------------------------------------------------------
;       (AH)=04H  VERIFY THE DESIRED SECTORS
;-----------------------------------------------------------------------------
;       (AH)=05H  FORMAT THE DESIRED TRACK
;                 (ES:BX) MUST POINT TO THE COLLECTION OF DESIRED ADDRESS FIELDS
;                 FOR THE TRACK.  EACH FIELD IS COMPOSED OF 4 BYTES, (C,H,R,N),
;                 WHERE C = TRACK NUMBER, H=HEAD NUMBER, R = SECTOR NUMBER,
;                 N= NUMBER OF BYTES PER SECTOR (00=128,01=256,02=512,03=1024).
;                 THERE MUST BE ONE ENTRY FOR EVERY SECTOR ON THE TRACK.
;                 THIS INFORMATION IS USED TO FIND THE REQUESTED SECTOR DURING
;                 READ/WRITE ACCESS.
;
;                 PRIOR TO FORMATTING A DISKETTE, IF THERE EXISTS MORE THAN
;                 ONE SUPPORTED MEDIA FORMAT TYPE WITHIN THE DRIVE IN QUESTION,
;                 THEN "SET DASD TYPE" (INT 13H, AH = 17H) OR "SET MEDIA TYPE"
;                 (INT 13H, AH = 18H) MUST BE CALLED TO SET THE DISKETTE TYPE
;                 THAT IS TO BE FORMATED. IF "SET DASD TYPE" OR "SET MEDIA TYPE"
;                 IS NOT CALLED, THE FORMAT ROUTINE WILL ASSUME THE MEDIA FORMAT
;                 TO BE THE MAXIMUM CAPACITY OF THE DRIVE.
;
;                 THESE PARAMETERS OF DISK_BASE MUST BE CHANGED IN ORDER TO
;                 FORMAT THE FOLLOWING MEDIAS:
;                 ---------------------------------------------
;                 : MEDIA  :      DRIVE       : PARM 1 : PARM 2 :
;                 ---------------------------------------------
;                 : 320K   : 320K/360K/1.2M :  50H   :   8    :
;                 : 360K   : 320K/360K/1.2M :  50H   :   9    :
;                 : 1.2M   : 1.2M           :  54H   :  15    :
;                 : 720K   : 720K/1.44M     :  50H   :   9    :
;                 : 1.44M  : 1.44M          :  6CH   :  18    :
;                 ---------------------------------------------
;                 NOTES: - PARM 1 = GAP LENGTH FOR FORMAT
;                        - PARM 2 = EOT (LAST SECTOR ON TRACK)
;                        - DISK_BASE IS POINTED TO BY DISK POINTER LOCATED
;                          AT ABSOLUTE ADDRESS 0:78.
;                        - WHEN FORMAT OPERATIONS ARE COMPLETE, THE PARAMETERS
;                          SHOULD BE RESTORED TO THEIR RESPECTIVE INITIAL VALUES
;
;-----------------------------------------------------------------------------
;       (AH)=08H  READ DRIVE PARAMETERS
;       REGISTERS
;         INPUT
;           (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;         OUTPUT
;           (ES:DI) POINTS TO DRIVE PARAMETERS TABLE
;           (CH) - LOW ORDER 8 OF 10 BITS MAXIMUM NUMBER OF TRACKS
;           (CL) - BITS 7 & 6 - HIGH ORDER TWO BITS OF MAXIMUM TRACKS
;                - BITS 5 THRU 0 - MAXIMUM SECTORS PER TRACK
;           (DH) - MAXIMUM HEAD NUMBER
;           (DL) - NUMBER OF DISKETTE DRIVES INSTALLED
;           (BH) - 0
;           (BL) - BITS 7 THRU 4 - 0
;                  BITS 3 THRU 0 - VALID DRIVE TYPE VALUE IN CMOS
;           (AX) - 0
;          UNDER THE FOLLOWING CIRCUMSTANCES:
;           (1) THE DRIVE NUMBER IS INVALID,
;           (2) THE DRIVE TYPE IS UNKNOWN AND CMOS IS NOT PRESENT,
;           (3) THE DRIVE TYPE IS UNKNOWN AND CMOS IS BAD,
;           (4) OR THE DRIVE TYPE IS UNKNOWN AND THE CMOS DRIVE TYPE IS INVALID
;           THEN ES,AX,BX,CX,DH,DI=0 ; DL=NUMBER OF DRIVES.
;           IF NO DRIVES ARE PRESENT THEN: ES,AX,BX,CX,DX,DI=0.
;           @DISKETTE_STATUS = 0 AND CY IS RESET.
;-----------------------------------------------------------------------------
;       (AH)=15H READ DASD TYPE
;       OUTPUT REGISTERS
;       (AH) - ON RETURN IF CARRY FLAG NOT SET, OTHERWISE ERROR
;                 00 - DRIVE NOT PRESENT
;                 01 - DISKETTE, NO CHANGE LINE AVAILABLE
;                 02 - DISKETTE, CHANGE LINE AVAILABLE
;                 03 - RESERVED
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;
;-----------------------------------------------------------------------
;       (AH)=16H DISK CHANGE LINE STATUS
;       OUTPUT REGISTERS
;       (AH) - 00 - DISK CHANGE LINE NOT ACTIVE
;              06 - DISK CHANGE LINE ACTIVE & CARRY BIT ON
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;
;-----------------------------------------------------------------------
;       (AH)=17H SET DASD TYPE FOR FORMAT
;       INPUT REGISTERS
;       (AL) -    00 - NOT USED
;                 01 - DISKETTE 320/360K IN 360K DRIVE
;                 02 - DISKETTE 360K IN 1.2M DRIVE
;                 03 - DISKETTE 1.2M IN 1.2M DRIVE
;                 04 - DISKETTE 720K IN 720K DRIVE
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED;
;               DO NOT USE WHEN DISKETTE ATTACH CARD USED)
;-----------------------------------------------------------------------
;       (AH)=18H SET MEDIA TYPE FOR FORMAT
;       INPUT REGISTERS
;       (CH) - LOW ORDER 8 OF 10 BITS MAXIMUM NUMBER OF TRACKS
;       (CL) - BITS 7 & 6 - HIGH ORDER TWO BITS OF MAXIMUM TRACKS
;            - BITS 5 THRU 0 - MAXIMUM SECTORS PER TRACK
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;       OUTPUT REGISTERS
;       (ES:DI) - POINTER TO DRIVE PARAMETERS TABLE FOR THIS MEDIA TYPE,
;                 UNCHANGED IF (AH) IS NON-ZERO
;       (AH) - 00H, CY = 0, TRACK AND SECTORS/TRACK COMBINATION IS SUPPORTED
;            - 01H, CY = 1, FUNCTION IS NOT AVAILABLE
;            - 0CH, CY = 1, TRACK AND SECTORS/TRACK COMBINATION IS NOT SUPPORTED
;                           OR DRIVE TYPE UNKNOWN
;            - 80H, CY = 1, TIME OUT (DISKETTE NOT PRESENT)
;-----------------------------------------------------------------------
;       DISK CHANGE STATUS IS ONLY CHECKED WHEN A MEDIA SPECIFIED IS OTHER
;       THAN 360 KB DRIVE.  IF THE DISK CHANGE LINE IS FOUND TO BE
;       ACTIVE THE FOLLOWING ACTIONS TAKE PLACE:
;               ATTEMPT TO RESET DISK CHANGE LINE TO INACTIVE STATE.
;               IF ATTEMPT SUCCEEDS SET DASD TYPE FOR FORMAT AND RETURN DISK
;               CHANGE ERROR CODE
;               IF ATTEMPT FAILS RETURN TIMEOUT ERROR CODE AND SET DASD TYPE
;               TO A PREDETERMINED STATE INDICATING MEDIA TYPE UNKNOWN.
;       IF THE DISK CHANGE LINE IN INACTIVE PERFORM SET DASD TYPE FOR FORMAT.
;
; DATA VARIABLE -- @DISK_POINTER
;       DOUBLE WORD POINTER TO THE CURRENT SET OF DISKETTE PARAMETERS
;-----------------------------------------------------------------------
; OUTPUT FOR ALL FUNCTIONS
;       AH = STATUS OF OPERATION
;               STATUS BITS ARE DEFINED IN THE EQUATES FOR @DISKETTE_STATUS
;               VARIABLE IN THE DATA SEGMENT OF THIS MODULE
;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN, EXCEPT FOR READ DASD
;               TYPE AH=(15)).
;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)
;       FOR READ/WRITE/VERIFY
;               AL = COUNT OF SECTORS TRANSFERRED
;               DS,BX,DX,CX PRESERVED
;       NOTE: IF AN ERROR IS REPORTED BY THE DISKETTE CODE, THE APPROPRIATE
;               ACTION IS TO RESET THE DISKETTE, THEN RETRY THE OPERATION.
;               ON READ ACCESSES, NO MOTOR START DELAY IS TAKEN, SO THAT
;               THREE RETRIES ARE REQUIRED ON READS TO ENSURE THAT THE
;               PROBLEM IS NOT DUE TO MOTOR START-UP.
;-----------------------------------------------------------------------
.LIST
; DISKETTE STATE MACHINE - ABSOLUTE ADDRESS 40:90 (DRIVE A) & 91 (DRIVE B)
.LIST
;   -----------------------------------------------------------------
;   I      I      I      I      I      I      I      I      I
;   I  7   I  6   I  5   I  4   I  3   I  2   I  1   I  0   I
;   I      I      I      I      I      I      I      I      I
;   -----------------------------------------------------------------
;      I      I      I      I      I      I      I      I
;      I      I      I      I      I      --------------
;      I      I      I      I      I             I
;      I      I      I      I   RESERVED         I
;      I      I      I      I             PRESENT STATE
;      I      I      I      I          000: 360K IN 360K DRIVE UNESTABLISHED
;      I      I      I      I          001: 360K IN 1.2M DRIVE UNESTABLISHED
;      I      I      I      I          010: 1.2M IN 1.2M DRIVE UNESTABLISHED
;      I      I      I      I          011: 360K IN 360K DRIVE ESTABLISHED
;      I      I      I      I          100: 360K IN 1.2M DRIVE ESTABLISHED
;      I      I      I      I          101: 1.2M IN 1.2M DRIVE ESTABLISHED
;      I      I      I      I          110: RESERVED
;      I      I      I      I          111: NONE OF THE ABOVE
;      I      I      I      I
;      I      I      I      ------> MEDIA/DRIVE ESTABLISHED
;      I      I      I
;      I      I      --------------> DOUBLE STEPPING REQUIRED (360K IN 1.2M
;      I      I                      DRIVE)
;      I      I
;      ------------------------------> DATA TRANSFER RATE FOR THIS DRIVE:
;
;                                        00: 500 KBS
;                                        01: 300 KBS
;                                        10: 250 KBS
;                                        11: RESERVED
;

.LIST
;-----------------------------------------------------------------------
; STATE OPERATION STARTED - ABSOLUTE ADDRESS 40:92 (DRIVE A) & 93 (DRIVE B)
;-----------------------------------------------------------------------
; PRESENT CYLINDER NUMBER - ABSOLUTE ADDRESS 40:94 (DRIVE A) & 95 (DRIVE B)
;-----------------------------------------------------------------------
SUBTTL (DSK2.ASM)
```

```
                             PAGE

                             MD_STRUC          STRUC
0000 ??                      MD_SPEC1          DB      ?         ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0001 ??                      MD_SPEC2          DB      ?         ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0002 ??                      MD_OFF_TIM        DB      ?         ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0003 ??                      MD_BYT_SEC        DB      ?         ; 512 BYTES/SECTOR
0004 ??                      MD_SEC_TRK        DB      ?         ; EOT ( LAST SECTOR ON TRACK)
0005 ??                      MD_GAP            DB      ?         ; GAP LENGTH
0006 ??                      MD_DTL            DB      ?         ; DTL
0007 ??                      MD_GAP3           DB      ?         ; GAP LENGTH FOR FORMAT
0008 ??                      MD_FIL_BYT        DB      ?         ; FILL BYTE FOR FORMAT
0009 ??                      MD_HD_TIM         DB      ?         ; HEAD SETTLE TIME (MILLISECONDS)
000A ??                      MD_STR_TIM        DB      ?         ; MOTOR START TIME (1/8 SECONDS)
000B ??                      MD_MAX_TRK        DB      ?         ; MAX. TRACK NUMBER
000C ??                      MD_RATE           DB      ?         ; DATA TRANSFER RATE
000D                         MD_STRUC          ENDS

= 007F                       BIT7OFF           EQU     7FH
= 0080                       BIT7ON            EQU     80H

                                     PUBLIC  DISK_INT_1
                                     PUBLIC  SEEK
                                     PUBLIC  DSKETTE_SETUP
                                     PUBLIC  DISKETTE_IO_1

                                     EXTRN   CMOS_READ:NEAR
                                     EXTRN   DDS:NEAR
                                     EXTRN   DISK_BASE:NEAR
                                     EXTRN   WAITF:NEAR


0000                         CODE    SEGMENT BYTE PUBLIC

                                     ASSUME  CS:CODE,DS:DATA,ES:DATA


                             ;-------------------------------------------------------------
                             ;       DRIVE TYPE TABLE                                    :
                             ;-------------------------------------------------------------
0000 01                      DR_TYPE           DB      01                ; DRIVE TYPE, MEDIA TABLE
0001 0012 R                                    DW      OFFSET MD_TBL1
0003 82                                        DB      02+BIT7ON
0004 001F R                                    DW      OFFSET MD_TBL2
0006 02                      DR_DEFAULT        DB      02
0007 002C R                                    DW      OFFSET MD_TBL3
0009 03                                        DB      03
000A 0039 R                                    DW      OFFSET MD_TBL4
000C 84                                        DB      04+BIT7ON
000D 0046 R                                    DW      OFFSET MD_TBL5
000F 04                                        DB      04
0010 0053 R                                    DW      OFFSET MD_TBL6
= 0012                       DR_TYPE_E         =$                        ; END OF TABLE
= 0006                       DR_CNT            EQU     (DR_TYPE_E-DR_TYPE)/3

                             ;-------------------------------------------------------------
                             ;       MEDIA/DRIVE PARAMETER TABLES                        :
                             ;-------------------------------------------------------------


                             ;-------------------------------------------------------------
                             ;       360 KB MEDIA IN 360 KB DRIVE                        :
                             ;-------------------------------------------------------------

0012                         MD_TBL1           LABEL BYTE
0012 DF                              DB        11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0013 02                              DB        2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0014 25                              DB        MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0015 02                              DB        2               ; 512 BYTES/SECTOR
0016 09                              DB        09              ; EOT ( LAST SECTOR ON TRACK)
0017 2A                              DB        02AH            ; GAP LENGTH
0018 FF                              DB        0FFH            ; DTL
0019 50                              DB        050H            ; GAP LENGTH FOR FORMAT
001A F6                              DB        0F6H            ; FILL BYTE FOR FORMAT
001B 0F                              DB        15              ; HEAD SETTLE TIME (MILLISECONDS)
001C 08                              DB        8               ; MOTOR START TIME (1/8 SECONDS)
001D 27                              DB        39              ; MAX. TRACK NUMBER
001E 80                              DB        RATE_250        ; DATA TRANSFER RATE

                             ;-------------------------------------------------------------
                             ;       360 KB MEDIA IN 1.2 MB DRIVE                        :
                             ;-------------------------------------------------------------

001F                         MD_TBL2           LABEL BYTE
001F DF                              DB        11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0020 02                              DB        2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0021 25                              DB        MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0022 02                              DB        2               ; 512 BYTES/SECTOR
0023 09                              DB        09              ; EOT ( LAST SECTOR ON TRACK)
0024 2A                              DB        02AH            ; GAP LENGTH
0025 FF                              DB        0FFH            ; DTL
0026 50                              DB        050H            ; GAP LENGTH FOR FORMAT
0027 F6                              DB        0F6H            ; FILL BYTE FOR FORMAT
0028 0F                              DB        15              ; HEAD SETTLE TIME (MILLISECONDS)
0029 08                              DB        8               ; MOTOR START TIME (1/8 SECONDS)
002A 27                              DB        39              ; MAX. TRACK NUMBER
002B 40                              DB        RATE_300        ; DATA TRANSFER RATE

                             ;-------------------------------------------------------------
                             ;       1.2 MB MEDIA IN 1.2 MB DRIVE                        :
                             ;-------------------------------------------------------------

002C                         MD_TBL3           LABEL BYTE
002C DF                              DB        11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
002D 02                              DB        2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
002E 25                              DB        MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
002F 02                              DB        2               ; 512 BYTES/SECTOR
0030 0F                              DB        15              ; EOT ( LAST SECTOR ON TRACK)
0031 1B                              DB        01BH            ; GAP LENGTH
0032 FF                              DB        0FFH            ; DTL
0033 54                              DB        054H            ; GAP LENGTH FOR FORMAT
0034 F6                              DB        0F6H            ; FILL BYTE FOR FORMAT
0035 0F                              DB        15              ; HEAD SETTLE TIME (MILLISECONDS)
0036 08                              DB        8               ; MOTOR START TIME (1/8 SECONDS)
0037 4F                              DB        79              ; MAX. TRACK NUMBER
0038 00                              DB        RATE_500        ; DATA TRANSFER RATE
```

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                              ;-------------------------------------------------------------------
                              ;       720 KB MEDIA IN 720 KB DRIVE                              :
                              ;-------------------------------------------------------------------

0039                          MD_TBL4         LABEL BYTE
0039 DF                               DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
003A 02                               DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
003B 25                               DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
003C 02                               DB      2               ; 512 BYTES/SECTOR
003D 09                               DB      09              ; EOT ( LAST SECTOR ON TRACK)
003E 2A                               DB      02AH            ; GAP LENGTH
003F FF                               DB      0FFH            ; DTL
0040 50                               DB      050H            ; GAP LENGTH FOR FORMAT
0041 F6                               DB      0F6H            ; FILL BYTE FOR FORMAT
0042 0F                               DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0043 08                               DB      8               ; MOTOR START TIME (1/8 SECONDS)
0044 4F                               DB      79              ; MAX. TRACK NUMBER
0045 80                               DB      RATE_250        ; DATA TRANSFER RATE

                              ;-------------------------------------------------------------------
                              ;       720 KB MEDIA IN 1.44 MB DRIVE                             :
                              ;-------------------------------------------------------------------

0046                          MD_TBL5         LABEL BYTE
0046 DF                               DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0047 02                               DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0048 25                               DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0049 02                               DB      2               ; 512 BYTES/SECTOR
004A 09                               DB      09              ; EOT ( LAST SECTOR ON TRACK)
004B 2A                               DB      02AH            ; GAP LENGTH
004C FF                               DB      0FFH            ; DTL
004D 50                               DB      050H            ; GAP LENGTH FOR FORMAT
004E F6                               DB      0F6H            ; FILL BYTE FOR FORMAT
004F 0F                               DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0050 08                               DB      8               ; MOTOR START TIME (1/8 SECONDS)
0051 4F                               DB      79              ; MAX. TRACK NUMBER
0052 80                               DB      RATE_250        ; DATA TRANSFER RATE

                              ;-------------------------------------------------------------------
                              ;       1.44 MB MEDIA IN 1.44 MB DRIVE                            :
                              ;-------------------------------------------------------------------

0053                          MD_TBL6         LABEL BYTE
0053 AF                               DB      10101111B       ; SRT=A, HD UNLOAD=0F - 1ST SPECIFY BYTE
0054 02                               DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0055 25                               DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0056 02                               DB      2               ; 512 BYTES/SECTOR
0057 12                               DB      18              ; EOT ( LAST SECTOR ON TRACK)
0058 1B                               DB      01BH            ; GAP LENGTH
0059 FF                               DB      0FFH            ; DTL
005A 6C                               DB      06CH            ; GAP LENGTH FOR FORMAT
005B F6                               DB      0F6H            ; FILL BYTE FOR FORMAT
005C 0F                               DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
005D 08                               DB      8               ; MOTOR START TIME (1/8 SECONDS)
005E 4F                               DB      79              ; MAX. TRACK NUMBER
005F 00                               DB      RATE_500        ; DATA TRANSFER RATE


0060                          DISKETTE_IO_1   PROC    FAR             ;>>> ENTRY POINT FOR ORG 0EC59H

0060 FB                               STI                             ; INTERRUPTS BACK ON
0061 55                               PUSH    BP                      ; USER REGISTER
0062 57                               PUSH    DI                      ; USER REGISTER
0063 52                               PUSH    DX                      ; HEAD #, DRIVE # OR USER REGISTER
0064 53                               PUSH    BX                      ; BUFFER OFFSET PARAMETER OR REGISTER
0065 51                               PUSH    CX                      ; TRACK #-SECTOR # OR USER REGISTER
0066 8B EC                            MOV     BP,SP                   ; BP     => PARAMETER LIST DEP. ON AH
                                                                      ; [BP]    = SECTOR #
                                                                      ; [BP+1]  = TRACK #
                                                                      ; [BP+2]  = BUFFER OFFSET
                                                                      ; FOR RETURN OF DRIVE PARAMETERS:
                                                                      ; CL/[BP] = BITS 7&6 HI BITS OF MAX CYL
                                                                      ;           BITS 0-5 MAX SECTORS/TRACK
                                                                      ; CH/[BP+1] = LOW 8 BITS OF MAX CYL.
                                                                      ; BL/[BP+2] = BITS 7-4 = 0
                                                                      ;             BITS 3-0 = VALID CMOS TYPE
                                                                      ; BH/[BP+3] = 0
                                                                      ; DL/[BP+4] = # DRIVES INSTALLED
                                                                      ; DH/[BP+5] = MAX HEAD #
                                                                      ; DI/[BP+6] = OFFSET TO DISK BASE
0068 1E                               PUSH    DS                      ; BUFFER SEGMENT PARM OR USER REGISTER
0069 56                               PUSH    SI                      ; USER REGISTERS
006A E8 0000 E                        CALL    DDS                     ; SEGMENT OF BIOS DATA AREA TO DS
006D 80 FC 19                         CMP     AH,(FNC_TAE-FNC_TAB)/2  ; CHECK FOR > LARGEST FUNCTION
0070 72 02                            JB      OK_FUNC                 ; FUNCTION OK
0072 B4 14                            MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION

0074                          OK_FUNC:
0074 80 FC 01                         CMP     AH,1                    ; RESET OR STATUS ?
0077 76 0C                            JBE     OK_DRV                  ; IF RESET OR STATUS DRIVE ALWAYS OK
0079 80 FC 08                         CMP     AH,8                    ; READ DRIVE PARMS ?
007C 74 07                            JZ      OK_DRV                  ; IF SO DRIVE CHECKED LATER
007E 80 FA 01                         CMP     DL,1                    ; DRIVES 0 AND 1 OK
0081 76 02                            JBE     OK_DRV                  ; IF 0 OR 1 THEN JUMP
0083 B4 14                            MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION

0085                          OK_DRV:
0085 8A CC                            MOV     CL,AH                   ; CL = FUNCTION
0087 32 ED                            XOR     CH,CH                   ; CX = FUNCTION
0089 D0 E1                            SHL     CL,1                    ; FUNCTION TIMES 2
008B BB 00B5 R                        MOV     BX,OFFSET FNC_TAB       ; LOAD START OF FUNCTION TABLE
008E 03 D9                            ADD     BX,CX                   ; ADD OFFSET INTO TABLE => ROUTINE
0090 8A E6                            MOV     AH,DH                   ; AX = HEAD #,# OF SECTORS OR DASD TYPE
0092 32 F6                            XOR     DH,DH                   ; DX = DRIVE #
0094 8B F0                            MOV     SI,AX                   ; SI = HEAD #,# OF SECTORS OR DASD TYPE
0096 8B FA                            MOV     DI,DX                   ; DI = DRIVE #
0098 8A 26 0041 R                     MOV     AH,@DSKETTE_STATUS      ; LOAD STATUS TO AH FOR STATUS FUNCTION
009C C6 06 0041 R 00                  MOV     @DSKETTE_STATUS,0       ; INITIALIZE FOR ALL OTHERS

                              ;       THROUGHOUT THE DISKETTE BIOS, THE FOLLOWING INFORMATION IS CONTAINED IN
                              ;       THE FOLLOWING MEMORY LOCATIONS AND REGISTERS. NOT ALL DISKETTE BIOS
                              ;       FUNCTIONS REQUIRE ALL OF THESE PARAMETERS.
                              ;
```

```
                                ;               DI      : DRIVE #
                                ;               SI-HI   : HEAD #
                                ;               SI-LOW : # OF SECTORS OR DASD TYPE FOR FORMAT
                                ;               ES      : BUFFER SEGMENT
                                ;               [BP]    : SECTOR #
                                ;               [BP+1]  : TRACK #
                                ;               [BP+2]  : BUFFER OFFSET
                                ;
                                ;       ACROSS CALLS TO SUBROUTINES THE CARRY FLAG (CY=1), WHERE INDICATED IN
                                ;       SUBROUTINE PROLOGUES, REPRESENTS AN EXCEPTION RETURN (NORMALLY AN ERROR
                                ;       CONDITION). IN MOST CASES, WHEN CY = 1, @DSKETTE_STATUS CONTAINS THE
                                ;       SPECIFIC ERROR CODE.
                                                                ; (AH) = @DSKETTE_STATUS
 00A1 2E: FF 17                         CALL    WORD PTR CS:[BX]        ; CALL THE REQUESTED FUNCTION

 00A4 5E                                POP     SI                      ; RESTORE ALL REGISTERS
 00A5 1F                                POP     DS
 00A6 59                                POP     CX
 00A7 5B                                POP     BX
 00A8 5A                                POP     DX
 00A9 5F                                POP     DI
 00AA 8B EC                             MOV     BP,SP
 00AC 50                                PUSH    AX
 00AD 9C                                PUSHF
 00AE 58                                POP     AX
 00AF 89 46 06                          MOV     [BP+6],AX
 00B2 58                                POP     AX
 00B3 5D                                POP     BP
 00B4 CF                                IRET

                                ;----------------------------------------------------------------
 00B5 00E7 R                    FNC_TAB DW      DISK_RESET              ; AH = 00H; RESET
 00B7 013C R                            DW      DISK_STATUS             ; AH = 01H; STATUS
 00B9 0148 R                            DW      DISK_READ               ; AH = 02H; READ
 00BB 0154 R                            DW      DISK_WRITE              ; AH = 03H; WRITE
 00BD 0160 R                            DW      DISK_VERF               ; AH = 04H; VERIFY
 00BF 016C R                            DW      DISK_FORMAT             ; AH = 05H; FORMAT
 00C1 01C6 R                            DW      FNC_ERR                 ; AH = 06H; INVALID
 00C3 01C6 R                            DW      FNC_ERR                 ; AH = 07H; INVALID
 00C5 01D0 R                            DW      DISK_PARMS              ; AH = 08H; READ DRIVE PARAMETERS
 00C7 01C6 R                            DW      FNC_ERR                 ; AH = 09H; INVALID
 00C9 01C6 R                            DW      FNC_ERR                 ; AH = 0AH; INVALID
 00CB 01C6 R                            DW      FNC_ERR                 ; AH = 0BH; INVALID
 00CD 01C6 R                            DW      FNC_ERR                 ; AH = 0CH; INVALID
 00CF 01C6 R                            DW      FNC_ERR                 ; AH = 0DH; INVALID
 00D1 01C6 R                            DW      FNC_ERR                 ; AH = 0EH; INVALID
 00D3 01C6 R                            DW      FNC_ERR                 ; AH = 0FH; INVALID
 00D5 01C6 R                            DW      FNC_ERR                 ; AH = 10H; INVALID
 00D7 01C6 R                            DW      FNC_ERR                 ; AH = 11H; INVALID
 00D9 01C6 R                            DW      FNC_ERR                 ; AH = 12H; INVALID
 00DB 01C6 R                            DW      FNC_ERR                 ; AH = 13H; INVALID
 00DD 01C6 R                            DW      FNC_ERR                 ; AH = 14H; INVALID
 00DF 0289 R                            DW      DISK_TYPE               ; AH = 15H; READ DASD TYPE
 00E1 02AB R                            DW      DISK_CHANGE             ; AH = 16H; CHANGE STATUS
 00E3 02D6 R                            DW      FORMAT_SET              ; AH = 17H; SET DASD TYPE
 00E5 0337 R                            DW      SET_MEDIA               ; AH = 18H; SET MEDIA TYPE
 = 00E7                         FNC_TAE EQU     $                       ; END
 00E7                           DISKETTE_IO_1   ENDP
                                ;----------------------------------------------------------------
                                ; DISK_RESET    (AH = 00H)                                      :
                                ;       RESET THE DISKETTE SYSTEM.                              :
                                ;                                                               :
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                                ;----------------------------------------------------------------
 00E7                           DISK_RESET      PROC    NEAR
 00E7 BA 03F2                           MOV     DX,03F2H                ; ADAPTER CONTROL PORT
 00EA FA                                CLI                             ; NO INTERRUPTS
 00EB A0 003F R                         MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
 00EE 24 3F                             AND     AL,00111111B            ; KEEP SELECTED AND MOTOR ON BITS
 00F0 C0 C0 04                          ROL     AL,4                    ; MOTOR VALUE TO HIGH NIBBLE
                                                                        ; DRIVE SELECT TO LOW NIBBLE
 00F3 0C 08                             OR      AL,00001000B            ; TURN ON INTERRUPT ENABLE
 00F5 EE                                OUT     DX,AL                   ; RESET THE ADAPTER
 00F6 C6 06 003E R 00                   MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
 00FB EB 00                             JMP     $+2                     ; WAIT FOR I/O
 00FD EB 00                             JMP     $+2                     ; WAIT FOR I/O (TO INSURE MINIMUM
                                                                        ;   PULSE WIDTH)
 00FF 0C 04                             OR      AL,00000100B            ; TURN OFF RESET BIT
 0101 EE                                OUT     DX,AL                   ; RESET THE ADAPTER
 0102 FB                                STI                             ; ENABLE THE INTERRUPTS
 0103 E8 0AC1 R                         CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
 0106 72 2D                             JC      DR_ERR                  ; IF ERROR, RETURN IT
 0108 B9 00C0                           MOV     CX,11000000B            ; CL = EXPECTED @NEC_STATUS

 010B                           NXT_DRV:
 010B 51                                PUSH    CX                      ; SAVE FOR CALL
 010C B8 0134 R                         MOV     AX,OFFSET DR_POP_ERR    ; LOAD NEC_OUTPUT ERROR ADDRESS
 010F 50                                PUSH    AX                      ; "
 0110 B4 08                             MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
 0112 E8 09F8 R                         CALL    NEC_OUTPUT
 0115 58                                POP     AX                      ; THROW AWAY ERROR RETURN
 0116 E8 0AE9 R                         CALL    RESULTS                 ; READ IN THE RESULTS
 0119 59                                POP     CX                      ; RESTORE AFTER CALL
 011A 72 19                             JC      DR_ERR                  ; ERROR RETURN
 011C 3A 0E 0042 R                      CMP     CL,@NEC_STATUS          ; TEST FOR DRIVE READY TRANSITION
 0120 75 13                             JNZ     DR_ERR                  ; EVERYTHING OK
 0122 FE C1                             INC     CL                      ; NEXT EXPECTED @NEC_STATUS
 0124 80 F9 C3                          CMP     CL,11000011B            ; ALL POSSIBLE DRIVES CLEARED
 0127 76 E2                             JBE     NXT_DRV                 ; FALL THRU IF 11000100B OR >

 0129 E8 03D8 R                         CALL    SEND_SPEC               ; SEND SPECIFY COMMAND TO NEC

 012C                           RESBAC:
 012C E8 0854 R                         CALL    SETUP_END               ; VARIOUS CLEANUPS
 012F 8B DE                             MOV     BX,SI                   ; GET SAVED AL TO BL
 0131 8A C3                             MOV     AL,BL                   ; PUT BACK FOR RETURN
 0133 C3                                RET

 0134                           DR_POP_ERR:
 0134 59                                POP     CX                      ; CLEAR STACK
 0135                           DR_ERR:                                 ;
 0135 80 0E 0041 R 20                   OR      @DSKETTE_STATUS,BAD_NEC ; SET ERROR CODE
 013A EB F0                             JMP     SHORT RESBAC            ; RETURN FROM RESET
 013C                           DISK_RESET      ENDP
```

```

                         ;----------------------------------------------------------------
                         ; DISK_STATUS  (AH = 01H)                                       ;
                         ;       DISKETTE STATUS.                                        ;
                         ; ON ENTRY:      AH = STATUS OF PREVIOUS OPERATION              ;
                         ;                                                               ;
                         ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION ;
                         ;----------------------------------------------------------------
013C                     DISK_STATUS     PROC    NEAR
013C 88 26 0041 R                MOV     @DSKETTE_STATUS,AH      ; PUT BACK FOR SETUP_END
0140 E8 0854 R                   CALL    SETUP_END               ; VARIOUS CLEANUPS
0143 8B DE                       MOV     BX,SI                   ; GET SAVED AL TO BL
0145 8A C3                       MOV     AL,BL                   ; PUT BACK FOR RETURN
0147 C3                          RET
0148                     DISK_STATUS     ENDP
                         ;----------------------------------------------------------------
                         ; DISK_READ  (AH = 02H)                                         ;
                         ;       DISKETTE READ.                                          ;
                         ; ON ENTRY:      DI     = DRIVE #                               ;
                         ;                SI-HI  = HEAD #                                ;
                         ;                SI-LOW = # OF SECTORS                          ;
                         ;                ES     = BUFFER SEGMENT                        ;
                         ;                [BP]   = SECTOR #                              ;
                         ;                [BP+1] = TRACK #                               ;
                         ;                [BP+2] = BUFFER OFFSET                         ;
                         ;                                                               ;
                         ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION ;
                         ;----------------------------------------------------------------
0148                     DISK_READ       PROC    NEAR
0148 80 26 003F R 7F             AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
014D B8 E646                     MOV     AX,0E646H               ; AX = NEC COMMAND, DMA COMMAND
0150 E8 04AE R                   CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
0153 C3                          RET
0154                     DISK_READ       ENDP
                         ;----------------------------------------------------------------
                         ; DISK_WRITE  (AH = 03H)                                        ;
                         ;       DISKETTE WRITE.                                         ;
                         ; ON ENTRY:      DI     = DRIVE #                               ;
                         ;                SI-HI  = HEAD #                                ;
                         ;                SI-LOW = # OF SECTORS                          ;
                         ;                ES     = BUFFER SEGMENT                        ;
                         ;                [BP]   = SECTOR #                              ;
                         ;                [BP+1] = TRACK #                               ;
                         ;                [BP+2] = BUFFER OFFSET                         ;
                         ;                                                               ;
                         ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION ;
                         ;----------------------------------------------------------------
0154                     DISK_WRITE      PROC    NEAR
0154 B8 C54A                     MOV     AX,0C54AH               ; AX = NEC COMMAND, DMA COMMAND
0157 80 0E 003F R 80             OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
015C E8 04AE R                   CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
015F C3                          RET
0160                     DISK_WRITE      ENDP
                         ;----------------------------------------------------------------
                         ; DISK_VERF  (AH = 04H)                                         ;
                         ;       DISKETTE VERIFY.                                        ;
                         ; ON ENTRY:      DI     = DRIVE #                               ;
                         ;                SI-HI  = HEAD #                                ;
                         ;                SI-LOW = # OF SECTORS                          ;
                         ;                ES     = BUFFER SEGMENT                        ;
                         ;                [BP]   = SECTOR #                              ;
                         ;                [BP+1] = TRACK #                               ;
                         ;                [BP+2] = BUFFER OFFSET                         ;
                         ;                                                               ;
                         ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION ;
                         ;----------------------------------------------------------------
0160                     DISK_VERF       PROC    NEAR
0160 80 26 003F R 7F             AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
0165 B8 E642                     MOV     AX,0E642H               ; AX = NEC COMMAND, DMA COMMAND
0168 E8 04AE R                   CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
016B C3                          RET
016C                     DISK_VERF       ENDP
                         ;----------------------------------------------------------------
                         ; DISK_FORMAT  (AH = 05H)                                       ;
                         ;       DISKETTE FORMAT.                                        ;
                         ; ON ENTRY:      DI     = DRIVE #                               ;
                         ;                SI-HI  = HEAD #                                ;
                         ;                SI-LOW = # OF SECTORS                          ;
                         ;                ES     = BUFFER SEGMENT                        ;
                         ;                [BP]   = SECTOR #                              ;
                         ;                [BP+1] = TRACK #                               ;
                         ;                [BP+2] = BUFFER OFFSET                         ;
                         ;                @DISK_POINTER POINTS TO THE PARAMETER TABLE OF ;
                         ;                         THIS DRIVE                            ;
                         ;                                                               ;
                         ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION ;
                         ;----------------------------------------------------------------
016C                     DISK_FORMAT     PROC    NEAR
016C E8 040F R                   CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
016F E8 059B R                   CALL    FMT_INIT                ; ESTABLISH STATE IF UNESTABLISHED
0172 80 0E 003F R 80             OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
0177 E8 05E9 R                   CALL    MED_CHANGE              ; CHECK MEDIA CHANGE AND RESET IF SO
017A 72 3F                       JC      FM_DON                  ; MEDIA CHANGED, SKIP
017C E8 03D8 R                   CALL    SEND_SPEC               ; SEND SPECIFY COMMAND TO NEC
017F E8 063D R                   CALL    CHK_LASTRATE            ; ZF=1 ATTEMPT RATE IS SAME AS LAST RATE
0182 74 03                       JZ      FM_WR                   ; YES, SKIP SPECIFY COMMAND
0184 E8 0624 R                   CALL    SEND_RATE               ; SEND DATA RATE TO CONTROLLER
0187                     FM_WR:
0187 E8 06AD R                   CALL    FMTDMA_SET              ; SET UP THE DMA FOR FORMAT
018A 72 2F                       JC      FM_DON                  ; RETURN WITH ERROR
018C B4 4D                       MOV     AH,04DH                 ; ESTABLISH THE FORMAT COMMAND
018E E8 0700 R                   CALL    NEC_INIT                ; INITIALIZE THE NEC
0191 72 28                       JC      FM_DON                  ; ERROR - EXIT
0193 B8 01BB R                   MOV     AX,OFFSET FM_DON        ; LOAD ERROR ADDRESS
0196 50                          PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
0197 B2 03                       MOV     DL,3                    ; BYTES/SECTOR VALUE TO NEC
0199 E8 0905 R                   CALL    GET_PARM
019C E8 09F8 R                   CALL    NEC_OUTPUT
019F B2 04                       MOV     DL,4                    ; SECTORS/TRACK VALUE TO NEC
01A1 E8 0905 R                   CALL    GET_PARM
01A4 E8 09F8 R                   CALL    NEC_OUTPUT
01A7 B2 07                       MOV     DL,7                    ; GAP LENGTH VALUE TO NEC
01A9 E8 0905 R                   CALL    GET_PARM
01AC E8 09F8 R                   CALL    NEC_OUTPUT
```

SECTION 5

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01AF B2 08                        MOV     DL,8                    ; FILLER BYTE TO NEC
01B1 E8 0905 R                    CALL    GET_PARM
01B4 E8 09F8 R                    CALL    NEC_OUTPUT
01B7 58                           POP     AX                      ; THROW AWAY ERROR
01B8 E8 075B R                    CALL    NEC_TERM                ; TERMINATE, RECEIVE STATUS, ETC.
01BB                      FM_DON:
01BB E8 0435 R                    CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
01BE E8 0854 R                    CALL    SETUP_END               ; VARIOUS CLEANUPS
01C1 8B DE                        MOV     BX,SI                   ; GET SAVED AL TO BL
01C3 8A C3                        MOV     AL,BL                   ; PUT BACK FOR RETURN
01C5 C3                           RET
01C6                      DISK_FORMAT     ENDP

                          ;----------------------------------------------------------------
                          ; FNC_ERR                                                        :
                          ;       INVALID FUNCTION REQUESTED OR INVALID DRIVE;             :
                          ;       SET BAD COMMAND IN STATUS.                               :
                          ;                                                                :
                          ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                          ;----------------------------------------------------------------
01C6                      FNC_ERR PROC    NEAR                    ; INVALID FUNCTION REQUEST
01C6 8B C6                        MOV     AX,SI                   ; RESTORE AL
01C8 B4 01                        MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR
01CA 88 26 0041 R                 MOV     @DSKETTE_STATUS,AH      ; STORE IN DATA AREA
01CE F9                           STC                             ; SET CARRY INDICATING ERROR
01CF C3                           RET
01D0                      FNC_ERR ENDP
                          ;----------------------------------------------------------------
                          ; DISK_PARMS   (AH = 08H)                                       :
                          ;       READ DRIVE PARAMETERS.                                   :
                          ; ON ENTRY:                                                      :
                          ;       DI = DRIVE #                                             :
                          ; ON EXIT:                                                       :
                          ;       CL/[BP]   = BITS 7 & 6 HIGH 2 BITS OF MAX CYLINDER       :
                          ;                   BITS 0-5 MAX SECTORS/TRACK                   :
                          ;       CH/[BP+1] = LOW 8 BITS OF MAX CYLINDER                   :
                          ;       BL/[BP+2] = BITS 7-4 = 0                                 :
                          ;                   BITS 3-0 = VALID CMOS DRIVE TYPE             :
                          ;       BH/[BP+3] = 0                                            :
                          ;       DL/[BP+4] = # DRIVES INSTALLED                           :
                          ;       DH/[BP+5] = MAX HEAD #                                   :
                          ;       DI/[BP+6] = OFFSET OF MEDIA/DRIVE PARAMETER TABLE        :
                          ;       ES        = SEGMENT OF MEDIA/DRIVE PARAMETER TABLE       :
                          ;       AX        = 0                                            :
                          ;                                                                :
                          ; NOTE : THE ABOVE INFORMATION IS STORED IN THE USERS STACK AT   :
                          ;        THE LOCATIONS WHERE THE MAIN ROUTINE WILL POP THEM      :
                          ;        INTO THE APPROPRIATE REGISTERS BEFORE RETURNING TO THE :
                          ;        CALLER.                                                 :
                          ;----------------------------------------------------------------
01D0                      DISK_PARMS      PROC    NEAR
01D0 E8 040F R                    CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
01D3 C7 46 02 0000                MOV     WORD PTR [BP+2],0       ; DRIVE TYPE = 0
01D8 A1 0010 R                    MOV     AX,@EQUIP_FLAG          ; LOAD EQUIPMENT FLAG FOR # DISKETTES
01DB 24 C1                        AND     AL,11000001B            ; KEEP DISKETTE DRIVE BITS
01DD B2 02                        MOV     DL,2                    ; DISKETTE DRIVES = 2
01DF 3C 41                        CMP     AL,01000001B            ; 2 DRIVES INSTALLED ?
01E1 74 06                        JZ      STO_DL                  ; IF YES JUMP

01E3 FE CA                        DEC     DL                      ; DISKETTE DRIVES = 1
01E5 3C 01                        CMP     AL,00000001B            ; 1 DRIVE INSTALLED ?
01E7 75 6A                        JNZ     NON_DRV                 ; IF NO JUMP

01E9 88 56 04             STO_DL: MOV     [BP+4],DL               ; STORE NUMBER OF DRIVES
01EC 83 FF 01                     CMP     DI,1                    ; CHECK FOR VALID DRIVE
01EF 77 66                        JA      NON_DRV1                ; DRIVE INVALID
01F1 C6 46 05 01                  MOV     BYTE PTR[BP+5],1        ; MAXIMUM HEAD NUMBER = 1
01F5 E8 08EC R                    CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
01F8 72 16                        JC      CHK_EST                 ; ON CMOS BAD CHECK ESTABLISHED
01FA 0A C0                        OR      AL,AL                   ; TEST FOR NO DRIVE TYPE
01FC 74 12                        JZ      CHK_EST                 ; JUMP IF SO
01FE E8 03B8 R                    CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
0201 72 0D                        JC      CHK_EST                 ; TYPE NOT IN TABLE (POSSIBLE BAD CMOS)
0203 88 46 02                     MOV     [BP+2],AL               ; STORE VALID CMOS DRIVE TYPE
0206 2E: 8A 4F 04                 MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
020A 2E: 8A 6F 0B                 MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER
020E EB 32                        JMP     SHORT STO_CX            ; CMOS GOOD, USE CMOS

0210                      CHK_EST:
0210 8A A5 0090 R                 MOV     AH,@DSK_STATE[DI]       ; LOAD STATE FOR THIS DRIVE
0214 F6 C4 10                     TEST    AH,MED_DET              ; CHECK FOR ESTABLISHED STATE
0217 74 3E                        JZ      NON_DRV1                ; CMOS BAD/INVALID AND UNESTABLISHED

0219                      USE_EST:
0219 80 E4 C0                     AND     AH,RATE_MSK             ; ISOLATE STATE
021C 80 FC 80                     CMP     AH,RATE_250             ; RATE 250 ?
021F 75 54                        JNE     USE_EST2                ; NO, GO CHECK OTHER RATE

                          ;--- DATA RATE IS 250 KBS, TRY 360 KB TABLE FIRST

0221 B0 01                        MOV     AL,01                   ; DRIVE TYPE 1 (360KB)
0223 E8 03B8 R                    CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
0226 2E: 8A 4F 04                 MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
022A 2E: 8A 6F 0B                 MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER
022E F6 85 0090 R 01              TEST    @DSK_STATE[DI],TRK_CAPA ; 80 TRACK ?
0233 74 0D                        JZ      STO_CX                  ; MUST BE 360KB DRIVE

                          ;--- IT IS 1.44 MB DRIVE

0235                      PARM144:
0235 B0 04                        MOV     AL,04                   ; DRIVE TYPE 4 (1.44MB)
0237 E8 03B8 R                    CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
023A 2E: 8A 4F 04                 MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
023E 2E: 8A 6F 0B                 MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER

0242                      STO_CX:
0242 89 4E 00                     MOV     [BP],CX                 ; SAVE IN STACK FOR RETURN
0245 89 5E 06                     MOV     [BP+6],BX               ; ADDRESS OF MEDIA/DRIVE PARM TABLE
0248 8C C8                        MOV     AX,CS                   ; SEGMENT MEDIA/DRIVE PARAMETER TABLE
024A 8E C0                        MOV     ES,AX                   ; ES IS SEGMENT OF TABLE

024C E8 0435 R            DP_OUT: CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
024F 33 C0                        XOR     AX,AX                   ; CLEAR
0251 F8                           CLC
0252 C3                           RET
```

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                                  ;----- NO DRIVE PRESENT HANDLER

     0253                         NON_DRV:
     0253 C6 46 04 00                     MOV     BYTE PTR [BP+4],0       ; CLEAR NUMBER OF DRIVES

     0257                         NON_DRV1:
     0257 81 FF 0080                      CMP     DI,80H                  ; CHECK FOR FIXED MEDIA TYPE REQUEST
     025B 72 09                           JB      NON_DRV2                ; CONTINUE IF NOT REQUEST FALL THROUGH

                                  ;----- FIXED DISK REQUEST FALL THROUGH ERROR

     025D E8 0435 R                       CALL    XLAT_OLD                ; ELSE TRANSLATE TO COMPATIBLE MODE
     0260 8B C6                           MOV     AX,SI                   ; RESTORE AL
     0262 B4 01                           MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR
     0264 F9                              STC                             ; SET ERROR RETURN CODE
     0265 C3                              RET

     0266                         NON_DRV2:
     0266 33 C0                           XOR     AX,AX                   ; CLEAR PARMS IF NO DRIVES OR CMOS BAD
     0268 89 46 00                        MOV     [BP],AX                 ; TRACKS, SECTORS/TRACK = 0
     026B 88 66 05                        MOV     [BP+5],AH               ; HEAD = 0
     026E 89 46 06                        MOV     [BP+6],AX               ; OFFSET TO DISK_BASE = 0
     0271 8E C0                           MOV     ES,AX                   ; ES IS SEGMENT OF TABLE
     0273 EB D7                           JMP     SHORT DP_OUT

                                  ;--- DATA RATE IS EITHER 300 KBS OR 500 KBS, TRY 1.2 MB TABLE FIRST

     0275                         USE_EST2:
     0275 B0 02                           MOV     AL,02                   ; DRIVE TYPE 2 (1.2MB)
     0277 E8 03B8 R                       CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
     027A 2E: 8A 4F 04                    MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
     027E 2E: 8A 6F 0B                    MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER
     0282 80 FC 40                        CMP     AH,RATE_300             ; RATE 300 ?
     0285 74 BB                           JE      STO_CX                  ; MUST BE 1.2MB DRIVE
     0287 EB AC                           JMP     SHORT PARM144           ; ELSE, IT IS 1.44MB DRIVE

     0289                         DISK_PARMS      ENDP


                                  ;----------------------------------------------------------------
                                  ; DISK_TYPE  (AH = 15H)                                         :
                                  ;       THIS ROUTINE RETURNS THE TYPE OF MEDIA INSTALLED.       :
                                  ;  ON ENTRY:    DI = DRIVE #                                    :
                                  ;                                                               :
                                  ;  ON EXIT:     AH = DRIVE TYPE, CY=0                           :
                                  ;----------------------------------------------------------------
     0289                         DISK_TYPE       PROC    NEAR
     0289 E8 040F R                       CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
     028C 8A 85 0090 R                    MOV     AL,@DSK_STATE[DI]       ; GET PRESENT STATE INFORMATION
     0290 0A C0                           OR      AL,AL                   ; CHECK FOR NO DRIVE
     0292 74 13                           JZ      NO_DRV                  ;
     0294 B4 01                           MOV     AH,NOCHGLN              ; NO CHANGE LINE FOR 40 TRACK DRIVE
     0296 A8 01                           TEST    AL,TRK_CAPA             ; IS THIS DRIVE AN 80 TRACK DRIVE?
     0298 74 02                           JZ      DT_BACK                 ; IF NO JUMP
     029A B4 02                           MOV     AH,CHGLN                ; CHANGE LINE FOR 80 TRACK DRIVE

     029C                         DT_BACK:
     029C 50                              PUSH    AX                      ; SAVE RETURN VALUE
     029D E8 0435 R                       CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
     02A0 58                              POP     AX                      ; RESTORE RETURN VALUE
     02A1 F8                              CLC                             ; NO ERROR
     02A2 8B DE                           MOV     BX,SI                   ; GET SAVED AL TO BL
     02A4 8A C3                           MOV     AL,BL                   ; PUT BACK FOR RETURN
     02A6 C3                              RET
     02A7                         NO_DRV:
     02A7 32 E4                           XOR     AH,AH                   ; NO DRIVE PRESENT OR UNKNOWN
     02A9 EB F1                           JMP     SHORT DT_BACK
     02AB                         DISK_TYPE ENDP

                                  ;----------------------------------------------------------------
                                  ; DISK_CHANGE  (AH = 16H)                                       :
                                  ;       THIS ROUTINE RETURNS THE STATE OF THE DISK CHANGE LINE. :
                                  ;                                                               :
                                  ; ON ENTRY:     DI = DRIVE #                                    :
                                  ;                                                               :
                                  ; ON EXIT:      AH = @DSKETTE_STATUS                            :
                                  ;                    00 - DISK CHANGE LINE INACTIVE, CY = 0     :
                                  ;                    06 - DISK CHANGE LINE ACTIVE, CY = 1       :
                                  ;----------------------------------------------------------------
     02AB                         DISK_CHANGE     PROC    NEAR
     02AB E8 040F R                       CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
     02AE 8A 85 0090 R                    MOV     AL,@DSK_STATE[DI]       ; GET MEDIA STATE INFORMATION
     02B2 0A C0                           OR      AL,AL                   ; DRIVE PRESENT ?
     02B4 74 19                           JZ      DC_NON                  ; JUMP IF NO DRIVE
     02B6 A8 01                           TEST    AL,TRK_CAPA             ; 80 TRACK DRIVE ?
     02B8 74 05                           JZ      SETIT                   ; IF SO , CHECK CHANGE LINE

     02BA E8 0B28 R               DC0:    CALL    READ_DSKCHNG            ; GO CHECK STATE OF DISK CHANGE LINE
     02BD 74 05                           JZ      FINIS                   ; CHANGE LINE NOT ACTIVE

     02BF C6 06 0041 R 06         SETIT:  MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; INDICATE MEDIA REMOVED

     02C4 E8 0435 R               FINIS:  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
     02C7 E8 0854 R                       CALL    SETUP_END               ; VARIOUS CLEANUPS
     02CA 8B DE                           MOV     BX,SI                   ; GET SAVED AL TO BL
     02CC 8A C3                           MOV     AL,BL                   ; PUT BACK FOR RETURN
     02CE C3                              RET

     02CF                         DC_NON:
     02CF 80 0E 0041 R 80                 OR      @DSKETTE_STATUS,TIME_OUT        ; SET TIMEOUT, NO DRIVE
     02D4 EB EE                           JMP     SHORT FINIS
     02D6                         DISK_CHANGE     ENDP


                                  ;----------------------------------------------------------------
                                  ; FORMAT_SET  (AH = 17H)                                        :
                                  ;       THIS ROUTINE IS USED TO ESTABLISH THE TYPE OF           :
                                  ;       MEDIA TO BE USED FOR THE FOLLOWING FORMAT OPERATION.    :
                                  ;                                                               :
                                  ; ON ENTRY:     SI LOW = DASD TYPE FOR FORMAT                   :
                                  ;               DI     = DRIVE #                                :
                                  ;                                                               :
                                  ; ON EXIT:      @DSKETTE_STATUS REFLECTS STATUS                 :
                                  ;               AH = @DSKETTE_STATUS                            :
                                  ;               CY = 1 IF ERROR                                 :
                                  ;----------------------------------------------------------------
```

SECTION 5

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02D6                            FORMAT_SET      PROC    NEAR
02D6 E8 040F R                          CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
02D9 56                                 PUSH    SI                      ; SAVE DASD TYPE
02DA 8B C6                              MOV     AX,SI                   ; AH = ? , AL = DASD TYPE
02DC 32 E4                              XOR     AH,AH                   ; AH = 0 , AL = DASD TYPE
02DE 8B F0                              MOV     SI,AX                   ; SI = DASD TYPE
02E0 80 A5 0090 R 0F                    AND     @DSK_STATE[DI],NOT MED_DET+DBL_STEP+RATE_MSK    ; CLEAR STATE
02E5 4E                                 DEC     SI                      ; CHECK FOR 320/360K MEDIA & DRIVE
02E6 75 07                              JNZ     NOT_320                 ; BYPASS IF NOT
02E8 80 8D 0090 R 90                    OR      @DSK_STATE[DI],MED_DET+RATE_250 ; SET TO 320/360
02ED EB 37                              JMP     SHORT S0

02EF                            NOT_320:
02EF E8 05E9 R                          CALL    MED_CHANGE              ; CHECK FOR TIME_OUT
02F2 80 3E 0041 R 80                    CMP     @DSKETTE_STATUS,TIME_OUT
02F7 74 2D                              JZ      S0                      ; IF TIME OUT TELL CALLER

02F9 4E                         S3:     DEC     SI                      ; CHECK FOR 320/360K IN 1.2M DRIVE
02FA 75 07                              JNZ     NOT_320_12              ; BYPASS IF NOT
02FC 80 8D 0090 R 70                    OR      @DSK_STATE[DI],MED_DET+DBL_STEP+RATE_300 ; SET STATE
0301 EB 23                              JMP     SHORT S0

0303                            NOT_320_12:
0303 4E                                 DEC     SI                      ; CHECK FOR 1.2M MEDIA IN 1.2M DRIVE
0304 75 07                              JNZ     NOT_12                  ; BYPASS IF NOT
0306 80 8D 0090 R 10                    OR      @DSK_STATE[DI],MED_DET+RATE_500  ; SET STATE VARIABLE
030B EB 19                              JMP     SHORT S0                ; RETURN TO CALLER

030D                            NOT_12:
030D 4E                                 DEC     SI                      ; CHECK FOR SET DASD TYPE 04
030E 75 20                              JNZ     FS_ERR                  ; BAD COMMAND EXIT IF NOT VALID TYPE

0310 F6 85 0090 R 04                    TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
0315 74 09                              JZ      ASSUME                  ; IF STILL NOT DETERMINED ASSUME
0317 B0 50                              MOV     AL,MED_DET+RATE_300
0319 F6 85 0090 R 02                    TEST    @DSK_STATE[DI],FMT_CAPA ; MULTIPLE FORMAT CAPABILITY ?
031E 75 02                              JNZ     OR_IT_IN                ; IF 1.2 M THEN DATA RATE 300

0320                            ASSUME:
0320 B0 90                              MOV     AL,MED_DET+RATE_250     ; SET UP

0322                            OR_IT_IN:
0322 08 85 0090 R                       OR      @DSK_STATE[DI],AL       ; OR IN THE CORRECT STATE

0326 E8 0435 R                  S0:     CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0329 E8 0854 R                          CALL    SETUP_END               ; VARIOUS CLEANUPS
032C 5B                                 POP     BX                      ; GET SAVED AL TO BL
032D 8A C3                              MOV     AL,BL                   ; PUT BACK FOR RETURN
032F C3                                 RET

0330                            FS_ERR:
0330 C6 06 0041 R 01                    MOV     @DSKETTE_STATUS,BAD_CMD ; UNKNOWN STATE,BAD COMMAND
0335 EB EF                              JMP     SHORT S0

0337                            FORMAT_SET      ENDP


                                ;--------------------------------------------------------------
                                ; SET_MEDIA  (AH = 18H)                                        :
                                ;       THIS ROUTINE SETS THE TYPE OF MEDIA AND DATA RATE      :
                                ;       TO BE USED FOR THE FOLLOWING FORMAT OPERATION.         :
                                ; ON ENTRY:                                                    :
                                ;       [BP]    = SECTOR PER TRACK                             :
                                ;       [BP+1]  = TRACK #                                      :
                                ;       DI      = DRIVE #                                      :
                                ; ON EXIT:                                                     :
                                ;       @DSKETTE_STATUS REFLECTS STATUS                        :
                                ;       IF NO ERROR:                                           :
                                ;           AH = 0                                             :
                                ;           CY = 0                                             :
                                ;           ES = SEGMENT OF MEDIA/DRIVE PARAMETER TABLE        :
                                ;           DI/[BP+6] = OFFSET OF MEDIA/DRIVE PARAMETER TABLE  :
                                ;       IF ERROR:                                              :
                                ;           AH = @DSKETTE_STATUS                               :
                                ;           CY = 1                                             :
                                ;--------------------------------------------------------------
0337                            SET_MEDIA       PROC    NEAR
0337 E8 040F R                          CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
033A F6 85 0090 R 01                    TEST    @DSK_STATE[DI],TRK_CAPA ; CHECK FOR CHANGE LINE AVAILABLE
033F 74 0F                              JZ      SM_CMOS                 ; JUMP IF 40 TRACK DRIVE
0341 E8 05E9 R                          CALL    MED_CHANGE              ; RESET CHANGE LINE
0344 80 3E 0041 R 80                    CMP     @DSKETTE_STATUS,TIME_OUT ; IF TIME OUT TELL CALLER
0349 74 66                              JE      SM_RTN
034B C6 06 0041 R 00                    MOV     @DSKETTE_STATUS,0       ; CLEAR STATUS
0350                            SM_CMOS:
0350 E8 08EC R                          CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
0353 72 38                              JC      MD_NOT_FND              ; ERROR IN CMOS
0355 0A C0                              OR      AL,AL                   ; TEST FOR NO DRIVE
0357 74 58                              JZ      SM_RTN                  ; RETURN IF SO
0359 E8 03B8 R                          CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
035C 72 2F                              JC      MD_NOT_FND              ; TYPE NOT IN TABLE (BAD CMOS)
035E 57                                 PUSH    DI                      ; SAVE REG.
035F 33 DB                              XOR     BX,BX                   ; BX = INDEX TO DR_TYPE TABLE
0361 B9 0006                            MOV     CX,DR_CNT               ; CX = LOOP COUNT
0364                            DR_SEARCH:
0364 2E: 8A A7 0000 R                   MOV     AH,CS:DR_TYPE[BX]       ; GET DRIVE TYPE
0369 80 E4 7F                           AND     AH,BIT7OFF              ; MASK OUT MSB
036C 3A C4                              CMP     AL,AH                   ; DRIVE TYPE MATCH ?
036E 75 17                              JNE     NXT_MD                  ; NO, CHECK NEXT DRIVE TYPE

0370 2E: 8B BF 0001 R                   MOV     DI,CS:WORD PTR DR_TYPE[BX+1] ; DI = MEDIA/DRIVE PARAMETER TABLE

0375 2E: 8A 65 04                       MOV     AH,CS:[DI].MD_SEC_TRK   ; GET SECTOR/TRACK
0379 38 66 00                           CMP     [BP],AH                 ; MATCH ?
037C 75 09                              JNE     NXT_MD                  ; NO, CHECK NEXT MEDIA
037E 2E: 8A 65 0B                       MOV     AH,CS:[DI].MD_MAX_TRK   ; GET MAX. TRACK #
0382 38 66 01                           CMP     [BP+1],AH               ; MATCH ?
0385 74 0D                              JE      MD_FND                  ; YES, GO GET RATE
0387                            NXT_MD:
0387 83 C3 03                           ADD     BX,3                    ; CHECK NEXT DRIVE TYPE
038A E2 D8                              LOOP    DR_SEARCH
038C 5F                                 POP     DI                      ; RESTORE REG.
038D                            MD_NOT_FND:
038D C6 06 0041 R 0C                    MOV     @DSKETTE_STATUS,MED_NOT_FND     ; ERROR, MEDIA TYPE NOT FOUND
0392 EB 1D                              JMP     SHORT SM_RTN            ; RETURN
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0394                    MD_FND:
0394 2E: 8A 45 0C               MOV     AL,CS:[DI].MD_RATE      ; GET RATE
0398 3C 40                      CMP     AL,RATE_300             ; DOUBLE STEP REQUIRED FOR RATE 300
039A 75 02                      JNE     MD_SET
039C 0C 20                      OR      AL,DBL_STEP
039E                    MD_SET:
039E 89 7E 06                   MOV     [BP+6],DI               ; SAVE TABLE POINTER IN STACK
03A1 0C 10                      OR      AL,MED_DET              ; SET MESIA ESTABLISHED
03A3 5F                         POP     DI                      ; RESTORE REG.
03A4 80 A5 0090 R 0F            AND     @DSK_STATE[DI],NOT MED_DET+DBL_STEP+RATE_MSK    ; CLEAR STATE
03A9 08 85 0090 R               OR      @DSK_STATE[DI],AL       ; SET STATE
03AD 8C C8                      MOV     AX,CS                   ; SEGMENT MEDIA/DRIVE PARAMETER TABLE
03AF 8E C0                      MOV     ES,AX                   ; ES IS SEGMENT OF TABLE
03B1                    SM_RTN:
03B1 E8 0435 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
03B4 E8 0854 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
03B7 C3                         RET
03B8                    SET_MEDIA       ENDP


                        ;-------------------------------------------------------------
                        ; DR_TYPE_CHECK                                               :
                        ;       CHECK IF THE GIVEN DRIVE TYPE IN REGISTER (AL)        :
                        ;       IS SUPPORTED IN BIOS DRIVE TYPE TABLE                 :
                        ; ON ENTRY:                                                   :
                        ;       AL = DRIVE TYPE                                       :
                        ; ON EXIT:                                                    :
                        ;       CS = SEGMENT OF MEDIA/DRIVE PARAMETER TABLE (CODE)    :
                        ;       CY = 0   DRIVE TYPE SUPPORTED                         :
                        ;            BX = OFFSET TO MEDIA/DRIVE PARAMETER TABLE       :
                        ;       CY = 1   DRIVE TYPE NOT SUPPORTED                     :
                        ; REGISTERS ALTERED: BX                                       :
                        ;-------------------------------------------------------------
03B8                    DR_TYPE_CHECK   PROC    NEAR
03B8 50                         PUSH    AX
03B9 51                         PUSH    CX
03BA 33 DB                      XOR     BX,BX                   ; BX = INDEX TO DR_TYPE TABLE
03BC B9 0006                    MOV     CX,DR_CNT               ; CX = LOOP COUNT
03BF                    TYPE_CHK:
03BF 2E: 8A A7 0000 R           MOV     AH,CS:DR_TYPE[BX]       ; GET DRIVE TYPE
03C4 3A C4                      CMP     AL,AH                   ; DRIVE TYPE MATCH ?
03C6 74 08                      JE      DR_TYPE_VALID           ; YES, RETURN WITH CARRY RESET
03C8 83 C3 03                   ADD     BX,3                    ; CHECK NEXT DRIVE TYPE
03CB E2 F2                      LOOP    TYPE_CHK
03CD F9                         STC                             ; DRIVE TYPE NOT FOUND IN TABLE
03CE EB 05                      JMP     SHORT TYPE_RTN
03D0                    DR_TYPE_VALID:
03D0 2E: 8B 9F 0001 R           MOV     BX,CS:WORD PTR DR_TYPE[BX+1]    ; BX = MEDIA TABLE
03D5                    TYPE_RTN:
03D5 59                         POP     CX
03D6 58                         POP     AX
03D7 C3                         RET
03D8                    DR_TYPE_CHECK   ENDP


                        ;-------------------------------------------------------------
                        ; SEND_SPEC                                                   :
                        ;       SEND THE SPECIFY COMMAND TO CONTROLLER USING DATA FROM :
                        ;       THE DRIVE PARAMETER TABLE POINTED BY @DISK_POINTER    :
                        ; ON ENTRY:     @DISK_POINTER = DRIVE PARAMETER TABLE         :
                        ; ON EXIT :     NONE                                          :
                        ; REGISTERS ALTERED: CX, DX                                   :
                        ;-------------------------------------------------------------
03D8                    SEND_SPEC       PROC    NEAR
03D8 50                         PUSH    AX                      ; SAVE AX
03D9 B8 03F3 R                  MOV     AX,OFFSET SPECBAC       ; LOAD ERROR ADDRESS
03DC 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
03DD B4 03                      MOV     AH,03H                  ; SPECIFY COMMAND
03DF E8 09F8 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03E2 2A D2                      SUB     DL,DL                   ; FIRST SPECIFY BYTE
03E4 E8 0905 R                  CALL    GET_PARM                ; GET PARAMETER TO AH
03E7 E8 09F8 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03EA B2 01                      MOV     DL,1                    ; SECOND SPECIFY BYTE
03EC E8 0905 R                  CALL    GET_PARM                ; GET PARAMETER TO AH
03EF E8 09F8 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03F2 58                         POP     AX                      ; POP ERROR RETURN
03F3                    SPECBAC:
03F3 58                         POP     AX                      ; RESTORE ORIGINAL AX VALUE
03F4 C3                         RET
03F5                    SEND_SPEC       ENDP


                        ;-------------------------------------------------------------
                        ; SEND_SPEC_MD                                                :
                        ;       SEND THE SPECIFY COMMAND TO CONTROLLER USING DATA FROM :
                        ;       THE MEDIA/DRIVE PARAMETER TABLE POINTED BY (CS:BX)    :
                        ; ON ENTRY:     CS:BX = MEDIA/DRIVE PARAMETER TABLE           :
                        ; ON EXIT :     NONE                                          :
                        ; REGISTERS ALTERED: AX                                       :
                        ;-------------------------------------------------------------
03F5                    SEND_SPEC_MD    PROC    NEAR
03F5 50                         PUSH    AX                      ; SAVE RATE DATA
03F6 B8 040D R                  MOV     AX,OFFSET SPEC_ESBAC    ; LOAD ERROR ADDRESS
03F9 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
03FA B4 03                      MOV     AH,03H                  ; SPECIFY COMMAND
03FC E8 09F8 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03FF 2E: 8A 27                  MOV     AH,CS:[BX].MD_SPEC1     ; GET 1ST SPECIFY BYTE
0402 E8 09F8 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
0405 2E: 8A 67 01               MOV     AH,CS:[BX].MD_SPEC2     ; GET SECOND SPECIFY BYTE
0409 E8 09F8 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
040C 58                         POP     AX                      ; POP ERROR RETURN
040D                    SPEC_ESBAC:
040D 58                         POP     AX                      ; RESTORE RATE
040E C3                         RET
040F                    SEND_SPEC_MD    ENDP
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SECTION 5

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                              PAGE
                              ;---------------------------------------------------------------
                              ; XLAT_NEW                                                     :
                              ;       TRANSLATES DISKETTE STATE LOCATIONS FROM COMPATIBLE    :
                              ;       MODE TO NEW ARCHITECTURE.                              :
                              ;                                                              :
                              ; ON ENTRY:     DI : DRIVE                                     :
                              ;---------------------------------------------------------------
040F                          XLAT_NEW        PROC    NEAR                    ;
040F 83 FF 01                         CMP     DI,1                    ; VALID DRIVE ?
0412 77 1C                            JA      XN_OUT                  ; IF INVALID BACK
0414 80 BD 0090 R 00                  CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
0419 74 16                            JZ      DO_DET                  ; IF NO DRIVE ATTEMPT DETERMINE
041B 8B CF                            MOV     CX,DI                   ; CX = DRIVE NUMBER
041D C0 E1 02                         SHL     CL,2                    ; CL = SHIFT COUNT, A=0, B=4
0420 A0 008F R                        MOV     AL,@HF_CNTRL            ; DRIVE INFORMATION
0423 D2 C8                            ROR     AL,CL                   ; TO LOW NIBBLE
0425 24 07                            AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
0427 80 A5 0090 R F8                  AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA
042C 08 85 0090 R                     OR      @DSK_STATE[DI],AL       ; UPDATE DRIVE STATE
0430                          XN_OUT:
0430 C3                               RET                             ;

0431                          DO_DET:
0431 E8 0B32 R                        CALL    DRIVE_DET               ; TRY TO DETERMINE
0434 C3                               RET

0435                          XLAT_NEW        ENDP
                              ;---------------------------------------------------------------
                              ; XLAT_OLD                                                     :
                              ;       TRANSLATES DISKETTE STATE LOCATIONS FROM NEW           :
                              ;       ARCHITECTURE TO COMPATIBLE MODE.                       :
                              ;                                                              :
                              ; ON ENTRY:     DI : DRIVE                                     :
                              ;---------------------------------------------------------------
0435                          XLAT_OLD        PROC    NEAR
0435 83 FF 01                         CMP     DI,1                    ; VALID DRIVE ?
0438 77 73                            JA      XO_OUT                  ; IF INVALID BACK
043A 80 BD 0090 R 00                  CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
043F 74 6C                            JZ      XO_OUT                  ; IF NO DRIVE TRANSLATE DONE

                              ;-----  TEST FOR SAVED DRIVE INFORMATION ALREADY SET

0441 8B CF                            MOV     CX,DI                   ; CX = DRIVE NUMBER
0443 C0 E1 02                         SHL     CL,2                    ; CL = SHIFT COUNT, A=0, B=4
0446 B4 02                            MOV     AH,FMT_CAPA             ; LOAD MULTI DATA RATE BIT MASK
0448 D2 CC                            ROR     AH,CL                   ; ROTATE BY MASK
044A 84 26 008F R                     TEST    @HF_CNTRL,AH            ; MULTI-DATA RATE DETERMINED ?
044E 75 16                            JNZ     SAVE_SET                ; IF SO, NO NEED TO RE-SAVE

                              ;-----  ERASE DRIVE BITS IN @HF_CNTRL FOR THIS DRIVE

0450 B4 07                            MOV     AH,DRV_DET+FMT_CAPA+TRK_CAPA    ; MASK TO KEEP
0452 D2 CC                            ROR     AH,CL                   ; FIX MASK TO KEEP
0454 F6 D4                            NOT     AH                      ; TRANSLATE MASK
0456 20 26 008F R                     AND     @HF_CNTRL,AH            ; KEEP BITS FROM OTHER DRIVE INTACT

                              ;-----  ACCESS CURRENT DRIVE BITS AND STORE IN @HF_CNTRL

045A 8A 85 0090 R                     MOV     AL,@DSK_STATE[DI]       ; ACCESS STATE
045E 24 07                            AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
0460 D2 C8                            ROR     AL,CL                   ; FIX FOR THIS DRIVE
0462 08 06 008F R                     OR      @HF_CNTRL,AL            ; UPDATE SAVED DRIVE STATE

                              ;-----  TRANSLATE TO COMPATIBILITY MODE

0466                          SAVE_SET:
0466 8A A5 0090 R                     MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
046A 8A FC                            MOV     BH,AH                   ; TO BH FOR LATER
046C 80 E4 C0                         AND     AH,RATE_MSK             ; KEEP ONLY RATE
046F 80 FC 00                         CMP     AH,RATE_500             ; RATE 500 ?
0472 74 10                            JZ      CHK_144                 ; YES, 1.2/1.2 OR 1.44/1.44
0474 B0 01                            MOV     AL,M3D1U                ; AL = 360 IN 1.2 UNESTABLISHED
0476 80 FC 40                         CMP     AH,RATE_300             ; RATE 300 ?
0479 75 16                            JNZ     CHK_250                 ; NO, 360/360 ,720/720 OR 720/1.44
047B F6 C7 20                         TEST    BH,DBL_STEP             ; YES, DOUBLE STEP ?
047E 75 1D                            JNZ     TST_DET                 ; YES, MUST BE 360 IN 1.2

0480                          UNKNO:
0480 B0 07                            MOV     AL,MED_UNK              ; 'NONE OF THE ABOVE'
0482 EB 20                            JMP     SHORT AL_SET            ; PROCESS COMPLETE

0484                          CHK_144:
0484 E8 08EC R                        CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
0487 72 F7                            JC      UNKNO                   ; ERROR, SET 'NONE OF THE ABOVE'
0489 3C 02                            CMP     AL,02                   ; 1.2MB DRIVE ?
048B 75 F3                            JNE     UNKNO                   ; NO, GO SET 'NONE OF THE ABOVE'
048D B0 02                            MOV     AL,M1D1U                ; AL = 1.2 IN 1.2 UNESTABLISHED
048F EB 0C                            JMP     SHORT TST_DET

0491                          CHK_250:
0491 B0 00                            MOV     AL,M3D3U                ; AL = 360 IN 360 UNESTABLISHED
0493 80 FC 80                         CMP     AH,RATE_250             ; RATE 250 ?
0496 75 E8                            JNZ     UNKNO                   ; IF SO FALL THRU
0498 F6 C7 01                         TEST    BH,TRK_CAPA             ; 80 TRACK CAPABILITY ?
049B 75 E3                            JNZ     UNKNO                   ; IF SO JUMP, FALL THRU TEST DET

049D                          TST_DET:
049D F6 C7 10                         TEST    BH,MED_DET              ; DETERMINED ?
04A0 74 02                            JZ      AL_SET                  ; IF NOT THEN SET
04A2 04 03                            ADD     AL,3                    ; MAKE DETERMINED/ESTABLISHED

04A4                          AL_SET:
04A4 80 A5 0090 R F8                  AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA  ; CLEAR DRIVE
04A9 08 85 0090 R                     OR      @DSK_STATE[DI],AL       ; REPLACE WITH COMPATIBLE MODE
04AD                          XO_OUT:
04AD C3                               RET
04AE                          XLAT_OLD        ENDP
```

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                                   PAGE
                                   ;--------------------------------------------------------------
                                   ; RD_WR_VF                                                    :
                                   ;       COMMON READ, WRITE AND VERIFY;                        :
                                   ;       MAIN LOOP FOR STATE RETRIES.                          :
                                   ;                                                             :
                                   ; ON ENTRY:     AH : READ/WRITE/VERIFY NEC PARAMETER          :
                                   ;               AL : READ/WRITE/VERIFY DMA PARAMETER          :
                                   ;                                                             :
                                   ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                                   ;--------------------------------------------------------------
04AE                               RD_WR_VF        PROC    NEAR
04AE 50                                    PUSH    AX                      ; SAVE DMA, NEC PARAMETERS
04AF E8 040F R                             CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
04B2 E8 056A R                             CALL    SETUP_STATE             ; INITIALIZE START AND END RATE
04B5 58                                    POP     AX                      ; RESTORE READ/WRITE/VERIFY

04B6                               DO_AGAIN:
04B6 50                                    PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
04B7 E8 05E9 R                             CALL    MED_CHANGE              ; MEDIA CHANGE AND RESET IF CHANGED
04BA 58                                    POP     AX                      ; RESTORE READ/WRITE/VERIFY
                                   ;       JC      RWV_END                 ; MEDIA CHANGE ERROR OR TIME-OUT
04BB 73 03                                 JNC     RWV
04BD E9 055B R                             JMP     RWV_END
04C0                               RWV:
04C0 50                                    PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER

04C1 8A B5 0090 R                          MOV     DH,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
04C5 80 E6 C0                              AND     DH,RATE_MSK             ; KEEP ONLY RATE
04C8 E8 08EC R                             CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
04CB 72 46                                 JC      RWV_ASSUME              ; ERROR IN CMOS
04CD 3C 01                                 CMP     AL,1                    ; 40 TRACK DRIVE?
04CF 75 0B                                 JNE     RWV_1                   ; NO, BYPASS CMOS VALIDITY CHECK
04D1 F6 85 0090 R 01                       TEST    @DSK_STATE[DI],TRK_CAPA ; CHECK FOR 40 TRACK DRIVE
04D6 74 0F                                 JZ      RWV_2                   ; YES, CMOS IS CORRECT
04D8 B0 02                                 MOV     AL,2                    ; CHANGE TO 1.2 M
04DA EB 0B                                 JMP     SHORT RWV_2             ; CONTINUE
04DC                               RWV_1:
04DC 72 09                                 JB      RWV_2                   ; NO DRIVE SPECIFIED, CONTINUE
04DE F6 85 0090 R 01                       TEST    @DSK_STATE[DI],TRK_CAPA ; IS IT REALLY 40 TRACK?
04E3 75 02                                 JNZ     RWV_2                   ; NO, 80 TRACK
04E5 B0 01                                 MOV     AL,1                    ; IT'S 40 TRACK, FIX CMOS VALUE
04E7                               RWV_2:

04E7 0A C0                                 OR      AL,AL                   ; TEST FOR NO DRIVE
04E9 74 28                                 JZ      RWV_ASSUME              ; ASSUME TYPE, USE MAX TRACK
04EB E8 03B8 R                             CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
04EE 72 23                                 JC      RWV_ASSUME              ; TYPE NOT IN TABLE (BAD CMOS)

                                   ;--- SEARCH FOR MEDIA/DRIVE PARAMETER TABLE

04F0 57                                    PUSH    DI                      ; SAVE DRIVE #
04F1 33 DB                                 XOR     BX,BX                   ; BX = INDEX TO DR_TYPE TABLE
04F3 B9 0006                               MOV     CX,DR_CNT               ; CX = LOOP COUNT
04F6                               RWV_DR_SEARCH:
04F6 2E: 8A A7 0000 R                      MOV     AH,CS:DR_TYPE[BX]       ; GET DRIVE TYPE
04FB 80 E4 7F                              AND     AH,BIT7OFF              ; MASK OUT MSB
04FE 3A C4                                 CMP     AL,AH                   ; DRIVE TYPE MATCH ?
0500 75 0B                                 JNE     RWV_NXT_MD              ; NO, CHECK NEXT DRIVE TYPE
0502                               RWV_DR_FND:
0502 2E: 8B BF 0001 R                      MOV     DI,WORD PTR CS:DR_TYPE[BX+1]  ; DI = MEDIA/DRIVE PARAMETER TABLE
0507                               RWV_MD_SEARCH:
0507 2E: 3A 75 0C                          CMP     DH,CS:[DI].MD_RATE      ; MATCH ?
050B 74 16                                 JE      RWV_MD_FND              ; YES, GO GET 1ST SPECIFY BYTE
050D                               RWV_NXT_MD:
050D 83 C3 03                              ADD     BX,3                    ; CHECK NEXT DRIVE TYPE
0510 E2 E4                                 LOOP    RWV_DR_SEARCH
0512 5F                                    POP     DI                      ; RESTORE DRIVE #

                                   ;--- ASSUME PRIMARY DRIVE IS INSTALLED AS SHIPPED

0513                               RWV_ASSUME:
0513 BB 0012 R                             MOV     BX,OFFSET MD_TBL1       ; POINT TO 40 TK 250 KBS
0516 F6 85 0090 R 01                       TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACK
051B 74 09                                 JZ      RWV_MD_FND1             ; MUST BE 40 TRACK
051D BB 002C R                             MOV     BX,OFFSET MD_TBL3       ; POINT TO 80 TK 500 KBS
0520 EB 04 90                              JMP     RWV_MD_FND1             ; GO SET SPECIFY PARAMETERS

                                   ;--- CS:BX POINTS TO MEDIA/DRIVE PARAMETER TABLE

0523                               RWV_MD_FND:

0523 8B DF                                 MOV     BX,DI                   ; BX = MEDIA/DRIVE PARAMETER TABLE
0525 5F                                    POP     DI                      ; RESTORE DRIVE #
0526                               RWV_MD_FND1:

                                   ;--- SEND THE SPECIFY COMMAND TO THE CONTROLLER

0526 E8 03F5 R                             CALL    SEND_SPEC_MD
0529 E8 063D R                             CALL    CHK_LASTRATE            ; ZF=1 ATTEMPT RATE IS SAME AS LAST RATE
052C 74 03                                 JZ      RWV_DBL                 ; YES, SKIP SEND RATE COMMAND
052E E8 0624 R                             CALL    SEND_RATE               ; SEND DATA RATE TO NEC


0531                               RWV_DBL:
0531 53                                    PUSH    BX                      ; SAVE MEDIA/DRIVE PARAM ADDRESS
0532 E8 086E R                             CALL    SETUP_DBL               ; CHECK FOR DOUBLE STEP
0535 5B                                    POP     BX                      ; RESTORE ADDRESS
0536 72 1A                                 JC      CHK_RET                 ; ERROR FROM READ ID, POSSIBLE RETRY
0538 58                                    POP     AX                      ; RESTORE NEC,DMA COMMAND
0539 50                                    PUSH    AX                      ; SAVE NEC COMMAND
053A 53                                    PUSH    BX                      ; SAVE MEDIA/DRIVE PARAM ADDRESS
053B E8 064D R                             CALL    DMA_SETUP               ; SET UP THE DMA
053E 5B                                    POP     BX                      ; RESTORE ADDRESS
053F 58                                    POP     AX                      ; RESTORE NEC COMMAND
0540 72 1F                                 JC      RWV_BAC                 ; CHECK FOR DMA BOUNDARY ERROR
0542 50                                    PUSH    AX                      ; SAVE NEC COMMAND
0543 53                                    PUSH    BX                      ; SAVE MEDIA/DRIVE PARAM ADDRESS
0544 E8 0700 R                             CALL    NEC_INIT                ; INITIALIZE NEC
0547 5B                                    POP     BX                      ; RESTORE ADDRESS
0548 72 08                                 JC      CHK_RET                 ; ERROR - EXIT
054A E8 0725 R                             CALL    RWV_COM                 ; OP CODE COMMON TO READ/WRITE/VERIFY
054D 72 03                                 JC      CHK_RET                 ; ERROR - EXIT
054F E8 075B R                             CALL    NEC_TERM                ; TERMINATE, GET STATUS, ETC.
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0552                        CHK_RET:
0552 E8 07E5 R                      CALL    RETRY                   ; CHECK FOR, SETUP RETRY
0555 58                             POP     AX                      ; RESTORE READ/WRITE/VERIFY PARAMETER
0556 73 03                          JNC     RWV_END                 ; CY = 0 NO RETRY
0558 E9 04B6 R                      JMP     DO_AGAIN                ; CY = 1 MEANS RETRY

055B                        RWV_END:
055B E8 07AD R                      CALL    DSTATE                  ; ESTABLISH STATE IF SUCCESSFUL
055E E8 0827 R                      CALL    NUM_TRANS               ; AL = NUMBER TRANSFERRED

0561                        RWV_BAC:                                ; BAD DMA ERROR ENTRY
0561 50                             PUSH    AX                      ; SAVE NUMBER TRANSFERRED
0562 E8 0435 R                      CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0565 58                             POP     AX                      ; RESTORE NUMBER TRANSFERRED
0566 E8 0854 R                      CALL    SETUP_END               ; VARIOUS CLEANUPS
0569 C3                             RET
056A                        RD_WR_VF        ENDP

                            ;----------------------------------------------------------------
                            ; SETUP_STATE:  INITIALIZES START AND END RATES.               :
                            ;----------------------------------------------------------------
056A                        SETUP_STATE     PROC    NEAR
056A F6 85 0090 R 10                TEST    @DSK_STATE[DI],MED_DET  ; MEDIA DETERMINED ?
056F 75 29                          JNZ     J1C                     ; NO STATES IF DETERMINED
0571 B8 0040                        MOV     AX,RATE_500*H+RATE_300  ; AH = START RATE,  AL = END RATE
0574 F6 85 0090 R 04                TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE ?
0579 74 0A                          JZ      AX_SET                  ; DO NOT KNOW DRIVE
057B F6 85 0090 R 02                TEST    @DSK_STATE[DI],FMT_CAPA ; MULTI-RATE ?
0580 75 03                          JNZ     AX_SET                  ; JUMP IF YES
0582 B8 8080                        MOV     AX,RATE_250*X           ; START & END RATE = 250 FOR 360 DRIVE

0585                        AX_SET:
0585 80 A5 0090 R 1F                AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP ; TURN OFF THE RATE
058A 08 A5 0090 R                   OR      @DSK_STATE[DI],AH       ; RATE FIRST TO TRY
058E 80 26 008B R F3                AND     @LASTRATE,NOT STRT_MSK  ; ERASE LAST TO TRY RATE BITS
0593 C0 C8 04                       ROR     AL,4                    ; TO OPERATION LAST RATE LOCATION
0596 08 06 008B R                   OR      @LASTRATE,AL            ; LAST RATE
059A                        J1C:
059A C3                             RET
059B                        SETUP_STATE     ENDP

                            ;----------------------------------------------------------------
                            ;  FMT_INIT: ESTABLISH STATE IF UNESTABLISHED AT FORMAT TIME.   :
                            ;----------------------------------------------------------------
059B                        FMT_INIT        PROC    NEAR
059B F6 85 0090 R 10                TEST    @DSK_STATE[DI],MED_DET  ; IS MEDIA ESTABLISHED
05A0 75 42                          JNZ     FI_OUT                  ; IF SO RETURN
05A2 E8 08EC R                      CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
05A5 72 3E                          JC      CL_DRV                  ; ERROR IN CMOS ASSUME NO DRIVE
05A7 FE C8                          DEC     AL                      ; MAKE ZERO ORIGIN
05A9 78 3A                          JS      CL_DRV                  ; NO DRIVE IF AL 0
05AB 8A A5 0090 R                   MOV     AH,@DSK_STATE[DI]       ; AH = CURRENT STATE
05AF 80 E4 0F                       AND     AH,NOT MED_DET+DBL_STEP+RATE_MSK       ; CLEAR
05B2 0A C0                          OR      AL,AL                   ; CHECK FOR 360
05B4 75 05                          JNZ     N_360                   ; IF 360 WILL BE 0
05B6 80 CC 90                       OR      AH,MED_DET+RATE_250     ; ESTABLISH MEDIA
05B9 EB 25                          JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

05BB                        N_360:
05BB FE C8                          DEC     AL                      ; 1.2 M DRIVE
05BD 75 05                          JNZ     N_12                    ; JUMP IF NOT
05BF 80 CC 10               FI_RATE:OR      AH,MED_DET+RATE_500     ; SET FORMAT RATE
05C2 EB 1C                          JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

05C4                        N_12:
05C4 FE C8                          DEC     AL                      ; CHECK FOR TYPE 3
05C6 75 0F                          JNZ     N_720                   ; JUMP IF NOT
05C8 F6 C4 04                       TEST    AH,DRV_DET              ; IS DRIVE DETERMINED
05CB 74 10                          JZ      ISNT_12                 ; TREAT AS NON 1.2 DRIVE
05CD F6 C4 02                       TEST    AH,FMT_CAPA             ; IS 1.2M
05D0 74 0B                          JZ      ISNT_12                 ; JUMP IF NOT
05D2 80 CC 50                       OR      AH,MED_DET+RATE_300     ; RATE 300
05D5 EB 09                          JMP     SHORT SKP_STATE         ; CONTINUE

05D7                        N_720:
05D7 FE C8                          DEC     AL                      ; CHECK FOR TYPE 4
05D9 75 0A                          JNZ     CL_DRV                  ; NO DRIVE, CMOS BAD
05DB EB E2                          JMP     SHORT FI_RATE

05DD                        ISNT_12:
05DD 80 CC 90                       OR      AH,MED_DET+RATE_250     ; MUST BE RATE 250

05E0                        SKP_STATE:
05E0 88 A5 0090 R                   MOV     @DSK_STATE[DI],AH       ; STORE AWAY

05E4                        FI_OUT:
05E4 C3                             RET

05E5                        CL_DRV:
05E5 32 E4                          XOR     AH,AH                   ; CLEAR STATE
05E7 EB F7                          JMP     SHORT SKP_STATE         ; SAVE IT
05E9                        FMT_INIT        ENDP
                            ;----------------------------------------------------------------
                            ; MED_CHANGE                                                   :
                            ;       CHECKS FOR MEDIA CHANGE, RESETS MEDIA CHANGE,          :
                            ;       CHECKS MEDIA CHANGE AGAIN.                             :
                            ;                                                              :
                            ; ON EXIT:      CY = 1 MEANS MEDIA CHANGE OR TIMEOUT           :
                            ;               @DSKETTE_STATUS = ERROR CODE                   :
                            ;----------------------------------------------------------------
05E9                        MED_CHANGE      PROC    NEAR
05E9 E8 0B28 R                      CALL    READ_DSKCHNG            ; READ DISK CHANGE LINE STATE
05EC 74 34                          JZ      MC_OUT                  ; BYPASS HANDLING DISK CHANGE LINE
05EE 80 A5 0090 R EF                AND     @DSK_STATE[DI],NOT MED_DET      ; CLEAR STATE FOR THIS DRIVE

                            ;       THIS SEQUENCE ENSURES WHENEVER A DISKETTE IS CHANGED THAT
                            ;       ON THE NEXT OPERATION THE REQUIRED MOTOR START UP TIME WILL
                            ;       BE WAITED. (DRIVE MOTOR MAY GO OFF UPON DOOR OPENING).

05F3 8B CF                          MOV     CX,DI                   ; CL = DRIVE #
05F5 B0 01                          MOV     AL,1                    ; MOTOR ON BIT MASK
05F7 D2 E0                          SHL     AL,CL                   ; TO APPROPRIATE POSITION
05F9 F6 D0                          NOT     AL                      ; KEEP ALL BUT MOTOR ON
05FB FA                             CLI                             ; NO INTERRUPTS
05FC 20 06 003F R                   AND     @MOTOR_STATUS,AL        ; TURN MOTOR OFF INDICATOR
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0600 FB                         STI                              ; INTERRUPTS ENABLED
0601 E8 091A R                  CALL     MOTOR_ON                ; TURN MOTOR ON

                        ;-----  THIS SEQUENCE OF SEEKS IS USED TO RESET DISKETTE CHANGE SIGNAL

0604 E8 00E7 R                  CALL     DISK_RESET              ; RESET NEC
0607 B5 01                      MOV      CH,01H                  ; MOVE TO CYLINDER 1
0609 E8 0A24 R                  CALL     SEEK                    ; ISSUE SEEK
060C 32 ED                      XOR      CH,CH                   ; MOVE TO CYLINDER 0
060E E8 0A24 R                  CALL     SEEK                    ; ISSUE SEEK
0611 C6 06 0041 R 06            MOV      @DSKETTE_STATUS,MEDIA_CHANGE    ; STORE IN STATUS

0616 E8 0B28 R          OK1:    CALL     READ_DSKCHNG            ; CHECK MEDIA CHANGED AGAIN
0619 74 05                      JZ       OK2                     ; IF ACTIVE, NO DISKETTE, TIMEOUT

061B C6 06 0041 R 80    OK4:    MOV      @DSKETTE_STATUS,TIME_OUT; TIMEOUT IF DRIVE EMPTY

0620 F9                 OK2:    STC                              ; MEDIA CHANGED, SET CY
0621 C3                         RET
0622                    MC_OUT:
0622 F8                         CLC                              ; NO MEDIA CHANGED, CLEAR CY
0623 C3                         RET
0624                    MED_CHANGE     ENDP
                        ;----------------------------------------------------------------
                        ; SEND_RATE                                                      :
                        ;       SENDS DATA RATE COMMAND TO NEC                           :
                        ; ON ENTRY:     DI = DRIVE #                                     :
                        ; ON EXIT:      NONE                                             :
                        ; REGISTERS ALTERED: DX                                          :
                        ;----------------------------------------------------------------
0624                    SEND_RATE       PROC     NEAR            ;

0624 50                         PUSH     AX                      ; SAVE REG.
0625 80 26 008B R 3F            AND      @LASTRATE,NOT SEND_MSK  ; ELSE CLEAR LAST RATE ATTEMPTED
062A 8A 85 0090 R               MOV      AL,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
062E 24 C0                      AND      AL,SEND_MSK             ; KEEP ONLY RATE BITS
0630 08 06 008B R               OR       @LASTRATE,AL            ; SAVE NEW RATE FOR NEXT CHECK
0634 C0 C0 02                   ROL      AL,2                    ; MOVE TO BIT OUTPUT POSITIONS
0637 BA 03F7                    MOV      DX,03F7H                ; OUTPUT NEW DATA RATE
063A EE                         OUT      DX,AL

063B 58                         POP      AX                      ; RESTORE REG.
063C C3                         RET
063D                    SEND_RATE       ENDP

                        ;----------------------------------------------------------------
                        ; CHK_LASTRATE                                                   :
                        ;       CHECK PREVIOUS DATA RATE SENT TO THE CONTROLLER.         :
                        ; ON ENTRY:                                                      :
                        ;       DI = DRIVE #                                             :
                        ; ON EXIT:                                                       :
                        ;       ZF = 1   DATA RATE IS THE SAME AS LAST RATE SENT TO NEC  :
                        ;       ZF = 0   DATA RATE IS DIFFERENT FROM LAST RATE           :
                        ; REGISTERS ALTERED: NONE                                        :
                        ;----------------------------------------------------------------
063D                    CHK_LASTRATE    PROC     NEAR
063D 50                         PUSH     AX                      ; SAVE REG
063E 8A 26 008B R               MOV      AH,@LASTRATE            ; GET LAST DATA RATE SELECTED
0642 8A 85 0090 R               MOV      AL,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
0646 25 C0C0                    AND      AX,SEND_MSK*X           ; KEEP ONLY RATE BITS OF BOTH
0649 3A C4                      CMP      AL,AH                   ; COMPARE TO PREVIOUSLY TRIED
                                                                 ; ZF = 1  RATE IS THE SAME
064B 58                         POP      AX                      ; RESTORE REG.
064C C3                         RET
064D                    CHK_LASTRATE    ENDP

                        SUBTTL (DSK3.ASM)
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SECTION 5

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                              PAGE
                              ;---------------------------------------------------------------
                              ; DMA_SETUP                                                     :
                              ;       THIS ROUTINE SETS UP THE DMA FOR READ/WRITE/VERIFY      :
                              ;       OPERATIONS.                                             :
                              ;                                                               :
                              ; ON ENTRY:     AL = DMA COMMAND                                :
                              ;                                                               :
                              ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                              ;---------------------------------------------------------------
 064D                         DMA_SETUP       PROC    NEAR
 064D FA                              CLI                             ; DISABLE INTERRUPTS DURING DMA SET-UP
 064E E6 0C                           OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
 0650 EB 00                           JMP     $+2                     ; WAIT FOR I/O
 0652 E6 0B                           OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
 0654 3C 42                           CMP     AL,42H                  ; DMA VERIFY COMMAND
 0656 75 04                           JNE     NOT_VERF                ; NO
 0658 33 C0                           XOR     AX,AX                   ; START ADDRESS
 065A EB 10                           JMP     SHORT J33
 065C                         NOT_VERF:
 065C 8C C0                           MOV     AX,ES                   ; GET THE ES VALUE
 065E C1 C0 04                        ROL     AX,4                    ; ROTATE LEFT
 0661 8A E8                           MOV     CH,AL                   ; GET HIGHEST NIBBLE OF ES TO CH
 0663 24 F0                           AND     AL,11110000B            ; ZERO THE LOW NIBBLE FROM SEGMENT
 0665 03 46 02                        ADD     AX,[BP+2]               ; TEST FOR CARRY FROM ADDITION
 0668 73 02                           JNC     J33
 066A FE C5                           INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
 066C                         J33:
 066C 50                              PUSH    AX                      ; SAVE START ADDRESS
 066D E6 04                           OUT     DMA+4,AL                ; OUTPUT LOW ADDRESS
 066F EB 00                           JMP     $+2                     ; WAIT FOR I/O
 0671 8A C4                           MOV     AL,AH
 0673 E6 04                           OUT     DMA+4,AL                ; OUTPUT HIGH ADDRESS
 0675 8A C5                           MOV     AL,CH                   ; GET HIGH 4 BITS
 0677 EB 00                           JMP     $+2                     ; I/O WAIT STATE
 0679 24 0F                           AND     AL,00001111B
 067B E6 81                           OUT     081H,AL                 ; OUTPUT HIGH 4 BITS TO PAGE REGISTER

                              ;-----  DETERMINE COUNT

 067D 8B C6                           MOV     AX,SI                   ; AL = # OF SECTORS
 067F 86 C4                           XCHG    AL,AH                   ; AH = # OF SECTORS
 0681 2A C0                           SUB     AL,AL                   ; AL = 0, AX = # OF SECTORS * 256
 0683 D1 E8                           SHR     AX,1                    ; AX = # SECTORS * 128
 0685 50                              PUSH    AX                      ; SAVE # OF SECTORS * 128
 0686 B2 03                           MOV     DL,3                    ; GET BYTES/SECTOR PARAMETER
 0688 E8 0905 R                       CALL    GET_PARM                ; "
 068B 8A CC                           MOV     CL,AH                   ; SHIFT COUNT (0=128, 1=256 ETC)
 068D 58                              POP     AX                      ; AX = # OF SECTORS * 128
 068E D3 E0                           SHL     AX,CL                   ; SHIFT BY PARAMETER VALUE
 0690 48                              DEC     AX                      ;-1 FOR DMA VALUE
 0691 50                              PUSH    AX                      ; SAVE COUNT VALUE
 0692 E6 05                           OUT     DMA+5,AL                ; LOW BYTE OF COUNT
 0694 EB 00                           JMP     $+2                     ; WAIT FOR I/O
 0696 8A C4                           MOV     AL,AH
 0698 E6 05                           OUT     DMA+5,AL                ; HIGH BYTE OF COUNT
 069A FB                              STI                             ; RE-ENABLE INTERRUPTS
 069B 59                              POP     CX                      ; RECOVER COUNT VALUE
 069C 58                              POP     AX                      ; RECOVER ADDRESS VALUE
 069D 03 C1                           ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
 069F B0 02                           MOV     AL,2                    ; MODE FOR 8237
 06A1 EB 00                           JMP     $+2                     ; WAIT FOR I/O
 06A3 E6 0A                           OUT     DMA+10,AL               ; INITIALIZE THE DISKETTE CHANNEL

 06A5 73 05                           JNC     NO_BAD                  ; CHECK FOR ERROR
 06A7 C6 06 0041 R 09                 MOV     @DSKETTE_STATUS,DMA_BOUNDARY    ; SET ERROR

 06AC                         NO_BAD:
 06AC C3                              RET                             ; CY SET BY ABOVE IF ERROR
 06AD                         DMA_SETUP       ENDP
```

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                                PAGE
                                ;-----------------------------------------------------------------
                                ; FMTDMA_SET                                                      :
                                ;       THIS ROUTINE SETS UP THE DMA CONTROLLER FOR A FORMAT      :
                                ;       OPERATION.                                                :
                                ;                                                                 :
                                ; ON ENTRY:     NOTHING REQUIRED                                  :
                                ;                                                                 :
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION   :
                                ;-----------------------------------------------------------------
06AD                            FMTDMA_SET      PROC    NEAR
06AD B0 4A                              MOV     AL,04AH                 ; WILL WRITE TO THE DISKETTE
06AF FA                                 CLI                             ; DISABLE INTERRUPTS DURING DMA SET-UP
06B0 E6 0C                              OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
06B2 EB 00                              JMP     $+2                     ; WAIT FOR I/O
06B4 E6 0B                              OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE

06B6 8C C0                              MOV     AX,ES                   ; GET THE ES VALUE
06B8 C1 C0 04                           ROL     AX,4                    ; ROTATE LEFT
06BB 8A E8                              MOV     CH,AL                   ; GET HIGHEST NIBBLE OF ES TO CH
06BD 24 F0                              AND     AL,11110000B            ; ZERO THE LOW NIBBLE FROM SEGMENT
06BF 03 46 02                           ADD     AX,[BP+2]               ; TEST FOR CARRY FROM ADDITION
06C2 73 02                              JNC     J33A
06C4 FE C5                              INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
06C6                            J33A:
06C6 50                                 PUSH    AX                      ; SAVE START ADDRESS
06C7 E6 04                              OUT     DMA+4,AL                ; OUTPUT LOW ADDRESS
06C9 EB 00                              JMP     $+2                     ; WAIT FOR I/O
06CB 8A C4                              MOV     AL,AH
06CD E6 04                              OUT     DMA+4,AL                ; OUTPUT HIGH ADDRESS
06CF 8A C5                              MOV     AL,CH                   ; GET HIGH 4 BITS
06D1 EB 00                              JMP     $+2                     ; I/O WAIT STATE
06D3 24 0F                              AND     AL,00001111B
06D5 E6 81                              OUT     081H,AL                 ; OUTPUT HIGH 4 BITS TO PAGE REGISTER

                                ;-----  DETERMINE COUNT

06D7 B2 04                              MOV     DL,4                    ; SECTORS/TRACK VALUE IN PARM TABLE
06D9 E8 0905 R                          CALL    GET_PARM                ; "
06DC 86 C4                              XCHG    AL,AH                   ; AL = SECTORS/TRACK VALUE
06DE 2A E4                              SUB     AH,AH                   ; AX = SECTORS/TRACK VALUE
06E0 C1 E0 02                           SHL     AX,2                    ; AX = SEC/TRK * 4 (OFFSET FOR C,H,R,N)
06E3 48                                 DEC     AX                      ;-1 FOR DMA VALUE
06E4 50                                 PUSH    AX                      ; SAVE # OF BYTES TO BE TRANSFERED
06E5 E6 05                              OUT     DMA+5,AL                ; LOW BYTE OF COUNT
06E7 EB 00                              JMP     $+2                     ; WAIT FOR I/O
06E9 8A C4                              MOV     AL,AH
06EB E6 05                              OUT     DMA+5,AL                ; HIGH BYTE OF COUNT
06ED FB                                 STI                             ; RE-ENABLE INTERRUPTS
06EE 59                                 POP     CX                      ; RECOVER COUNT VALUE
06EF 58                                 POP     AX                      ; RECOVER ADDRESS VALUE
06F0 03 C1                              ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
06F2 B0 02                              MOV     AL,2                    ; MODE FOR 8237
06F4 EB 00                              JMP     $+2                     ; WAIT FOR I/O
06F6 E6 0A                              OUT     DMA+10,AL               ; INITIALIZE THE DISKETTE CHANNEL

06F8 73 05                              JNC     FMTDMA_OK               ; CHECK FOR ERROR
06FA C6 06 0041 R 09                    MOV     @DSKETTE_STATUS,DMA_BOUNDARY    ; SET ERROR

06FF                            FMTDMA_OK:
06FF C3                                 RET                             ; CY SET BY ABOVE IF ERROR
0700                            FMTDMA_SET      ENDP
                                ;-----------------------------------------------------------------
                                ; NEC_INIT                                                        :
                                ;       THIS ROUTINE SEEKS TO THE REQUESTED TRACK AND             :
                                ;       INITIALIZES THE NEC FOR THE READ/WRITE/VERIFY/FORMAT      :
                                ;       OPERATION.                                                :
                                ;                                                                 :
                                ; ON ENTRY:     AH : NEC COMMAND TO BE PERFORMED                  :
                                ;                                                                 :
                                ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION   :
                                ;-----------------------------------------------------------------
0700                            NEC_INIT        PROC    NEAR
0700 50                                 PUSH    AX                      ; SAVE NEC COMMAND
0701 E8 091A R                          CALL    MOTOR_ON                ; TURN MOTOR ON FOR SPECIFIC DRIVE

                                ;-----  DO THE SEEK OPERATION

0704 8A 6E 01                           MOV     CH,[BP+1]               ; CH = TRACK #
0707 E8 0A24 R                          CALL    SEEK                    ; MOVE TO CORRECT TRACK
070A 58                                 POP     AX                      ; RECOVER COMMAND
070B 72 17                              JC      ER_1                    ; ERROR ON SEEK
070D BB 0724 R                          MOV     BX,OFFSET ER_1          ; LOAD ERROR ADDRESS
0710 53                                 PUSH    BX                      ; PUSH NEC_OUT ERROR RETURN

                                ;-----  SEND OUT THE PARAMETERS TO THE CONTROLLER

0711 E8 09F8 R                          CALL    NEC_OUTPUT              ; OUTPUT THE OPERATION COMMAND
0714 8B C6                              MOV     AX,SI                   ; AH = HEAD #
0716 8B DF                              MOV     BX,DI                   ; BL = DRIVE #
0718 C0 E4 02                           SAL     AH,2                    ; MOVE IT TO BIT 2
071B 80 E4 04                           AND     AH,00000100B            ; ISOLATE THAT BIT
071E 0A E3                              OR      AH,BL                   ; OR IN THE DRIVE NUMBER
0720 E8 09F8 R                          CALL    NEC_OUTPUT              ; FALL THRU CY SET IF ERROR
0723 5B                                 POP     BX                      ; THROW AWAY ERROR RETURN
0724                            ER_1:
0724 C3                                 RET
0725                            NEC_INIT        ENDP
                                ;-----------------------------------------------------------------
                                ; RWV_COM                                                         :
                                ;       THIS ROUTINE SENDS PARAMETERS TO THE NEC SPECIFIC         :
                                ;       TO THE READ/WRITE/VERIFY OPERATIONS.                      :
                                ;                                                                 :
                                ; ON ENTRY:     CS:BX = ADDRESS OF MEDIA/DRIVE PARAMETER TABLE    :
                                ; ON EXIT :     @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION   :
                                ;-----------------------------------------------------------------
0725                            RWV_COM PROC    NEAR
0725 B8 075A R                          MOV     AX,OFFSET ER_2          ; LOAD ERROR ADDRESS
0728 50                                 PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
0729 8A 66 01                           MOV     AH,[BP+1]               ; OUTPUT TRACK #
072C E8 09F8 R                          CALL    NEC_OUTPUT
072F 8B C6                              MOV     AX,SI                   ; OUTPUT HEAD #
0731 E8 09F8 R                          CALL    NEC_OUTPUT
0734 8A 66 00                           MOV     AH,[BP]                 ; OUTPUT SECTOR #
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SECTION 5

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0737 E8 09F8 R                      CALL    NEC_OUTPUT
073A B2 03                          MOV     DL,3                    ; BYTES/SECTOR PARAMETER FROM BLOCK
073C E8 0905 R                      CALL    GET_PARM                ; . TO THE NEC
073F E8 09F8 R                      CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
0742 B2 04                          MOV     DL,4                    ; EOT PARAMETER FROM BLOCK
0744 E8 0905 R                      CALL    GET_PARM                ; . TO THE NEC
0747 E8 09F8 R                      CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER

074A 2E: 8A 67 05                   MOV     AH,CS:[BX].MD_GAP        ; GET GAP LENGTH
074E E8 09F8 R              R15:    CALL    NEC_OUTPUT
0751 B2 06                          MOV     DL,6                    ; DTL PARAMETER FROM BLOCK
0753 E8 0905 R                      CALL    GET_PARM                ;  TO THE NEC
0756 E8 09F8 R                      CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
0759 58                             POP     AX                      ; THROW AWAY ERROR EXIT
075A                        ER_2:
075A C3                             RET
075B                        RWV_COM ENDP

                            ;-------------------------------------------------------------
                            ; NEC_TERM
                            ;       THIS ROUTINE WAITS FOR THE OPERATION THEN ACCEPTS       :
                            ;       THE STATUS FROM THE NEC FOR THE READ/WRITE/VERIFY/      :
                            ;       FORMAT OPERATION.                                       :
                            ;                                                               :
                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                            ;-------------------------------------------------------------
075B                        NEC_TERM        PROC    NEAR

                            ;----- LET THE OPERATION HAPPEN

075B 56                             PUSH    SI                      ; SAVE HEAD #, # OF SECTORS
075C E8 0AC1 R                      CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
075F 9C                             PUSHF
0760 E8 0AE9 R                      CALL    RESULTS                 ; GET THE NEC STATUS
0763 72 45                          JC      SET_END_POP
0765 9D                             POPF
0766 72 3A                          JC      SET_END                 ; LOOK FOR ERROR

                            ;----- CHECK THE RESULTS RETURNED BY THE CONTROLLER

0768 FC                             CLD                             ; SET THE CORRECT DIRECTION
0769 BE 0042 R                      MOV     SI,OFFSET @NEC_STATUS   ; POINT TO STATUS FIELD
076C AC                             LODS    @NEC_STATUS             ; GET ST0
076D 24 C0                          AND     AL,11000000B            ; TEST FOR NORMAL TERMINATION
076F 74 31                          JZ      SET_END                 ;
0771 3C 40                          CMP     AL,01000000B            ; TEST FOR ABNORMAL TERMINATION
0773 75 27                          JNZ     J18                     ; NOT ABNORMAL, BAD NEC

                            ;----- ABNORMAL TERMINATION, FIND OUT WHY

0775 AC                             LODS    @NEC_STATUS             ; GET ST1
0776 D0 E0                          SAL     AL,1                    ; TEST FOR EOT FOUND
0778 B4 04                          MOV     AH,RECORD_NOT_FND
077A 72 22                          JC      J19
077C C0 E0 02                       SAL     AL,2
077F B4 10                          MOV     AH,BAD_CRC
0781 72 1B                          JC      J19
0783 D0 E0                          SAL     AL,1                    ; TEST FOR DMA OVERRUN
0785 B4 08                          MOV     AH,BAD_DMA
0787 72 15                          JC      J19
0789 C0 E0 02                       SAL     AL,2                    ; TEST FOR RECORD NOT FOUND
078C B4 04                          MOV     AH,RECORD_NOT_FND
078E 72 0E                          JC      J19
0790 D0 E0                          SAL     AL,1
0792 B4 03                          MOV     AH,WRITE_PROTECT        ; TEST FOR WRITE_PROTECT
0794 72 08                          JC      J19
0796 D0 E0                          SAL     AL,1                    ; TEST MISSING ADDRESS MARK
0798 B4 02                          MOV     AH,BAD_ADDR_MARK
079A 72 02                          JC      J19

                            ;----- NEC MUST HAVE FAILED
079C                        J18:
079C B4 20                          MOV     AH,BAD_NEC
079E                        J19:
079E 08 26 0041 R                   OR      @DSKETTE_STATUS,AH
07A2                        SET_END:
07A2 80 3E 0041 R 01                CMP     @DSKETTE_STATUS,1       ; SET ERROR CONDITION
07A7 F5                             CMC                             ;
07A8 5E                             POP     SI                      ; RESTORE HEAD #, # OF SECTORS
07A9 C3                             RET

07AA                        SET_END_POP:
07AA 9D                             POPF
07AB EB F5                          JMP     SHORT SET_END
07AD                        NEC_TERM        ENDP
                            ;-------------------------------------------------------------
                            ; DSTATE:       ESTABLISH STATE UPON SUCCESSFUL OPERATION.     :
                            ;-------------------------------------------------------------
07AD                        DSTATE  PROC    NEAR
07AD 80 3E 0041 R 00                CMP     @DSKETTE_STATUS,0       ; CHECK FOR ERROR
07B2 75 30                          JNZ     SETBAC                  ; IF ERROR JUMP
07B4 80 8D 0090 R 10                OR      @DSK_STATE[DI],MED_DET  ; NO ERROR, MARK MEDIA AS DETERMINED
07B9 F6 85 0090 R 04                TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
07BE 75 24                          JNZ     SETBAC                  ; IF DETERMINED NO TRY TO DETERMINE
07C0 8A 85 0090 R                   MOV     AL,@DSK_STATE[DI]       ; LOAD STATE
07C4 24 C0                          AND     AL,RATE_MSK             ; KEEP ONLY RATE
07C6 3C 80                          CMP     AL,RATE_250             ; RATE 250 ?
07C8 75 15                          JNE     M_12                    ; NO, MUST BE 1.2M OR 1.44M DRV

                            ;--- CHECK IF IT IS 1.44M

07CA E8 08EC R                      CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
07CD 72 10                          JC      M_12                    ; CMOS BAD
07CF 3C 04                          CMP     AL,04                   ; 1.44MB DRIVE ?
07D1 74 0C                          JE      M_12                    ; YES
07D3                        M_720:
07D3 80 A5 0090 R FD                AND     @DSK_STATE[DI],NOT FMT_CAPA ; TURN OFF FORMAT CAPA
07D8 80 8D 0090 R 04                OR      @DSK_STATE[DI],DRV_DET  ; MARK DRIVE DETERMINED
07DD EB 05                          JMP     SHORT SETBAC            ; BACK

07DF 80 8D 0090 R 06        M_12:   OR      @DSK_STATE[DI],DRV_DET+FMT_CAPA   ; TURN ON DETERMINED & FMT CAPA

07E4                        SETBAC:
07E4 C3                             RET
07E5                        DSTATE  ENDP
```

```
                                ;-------------------------------------------------------------
                                ; RETRY                                                        :
                                ;       DETERMINES WHETHER A RETRY IS NECESSARY. IF RETRY IS   :
                                ;       REQUIRED THEN STATE INFORMATION IS UPDATED FOR RETRY.  :
                                ;                                                              :
                                ; ON EXIT:      CY = 1 FOR RETRY, CY = 0 FOR NO RETRY          :
                                ;-------------------------------------------------------------
07E5                            RETRY   PROC    NEAR
07E5 80 3E 0041 R 00                    CMP     @DSKETTE_STATUS,0       ; GET STATUS OF OPERATION
07EA 74 39                              JZ      NO_RETRY                ; SUCCESSFUL OPERATION
07EC 80 3E 0041 R 80                    CMP     @DSKETTE_STATUS,TIME_OUT        ; IF TIME OUT NO RETRY
07F1 74 32                              JZ      NO_RETRY                ;
07F3 8A A5 0090 R                       MOV     AH,@DSK_STATE[DI]       ; GET MEDIA STATE OF DRIVE
07F7 F6 C4 10                           TEST    AH,MED_DET              ; ESTABLISHED/DETERMINED ?
07FA 75 29                              JNZ     NO_RETRY                ; IF ESTABLISHED STATE THEN TRUE ERROR
07FC 80 E4 C0                           AND     AH,RATE_MSK             ; ISOLATE RATE
07FF 8A 2E 008B R                       MOV     CH,@LASTRATE            ; GET START OPERATION STATE
0803 C0 C5 04                           ROL     CH,4                    ; TO CORRESPONDING BITS
0806 80 E5 C0                           AND     CH,RATE_MSK             ; ISOLATE RATE BITS
0809 3A EC                              CMP     CH,AH                   ; ALL RATES TRIED
080B 74 18                              JE      NO_RETRY                ; IF YES, THEN TRUE ERROR

                                ;       SETUP STATE INDICATOR FOR RETRY ATTEMPT TO NEXT RATE
                                ;         00000000B (500) -> 10000000B (250)
                                ;         10000000B (250) -> 01000000B (300)
                                ;         01000000B (300) -> 00000000B (500)

080D 80 FC 01                           CMP     AH,RATE_500+1           ; SET CY FOR RATE 500
0810 D0 DC                              RCR     AH,1                    ; TO NEXT STATE
0812 80 E4 C0                           AND     AH,RATE_MSK             ; KEEP ONLY RATE BITS
0815 80 A5 0090 R 1F                    AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP    ; RATE, DBL STEP OFF
081A 08 A5 0090 R                       OR      @DSK_STATE[DI],AH       ; TURN ON NEW RATE
081E C6 06 0041 R 00                    MOV     @DSKETTE_STATUS,0       ; RESET STATUS FOR RETRY
0823 F9                                 STC                             ; SET CARRY FOR RETRY
0824 C3                                 RET                             ; RETRY RETURN

0825                            NO_RETRY:
0825 F8                                 CLC                             ; CLEAR CARRY NO RETRY
0826 C3                                 RET                             ; NO RETRY RETURN
0827                            RETRY   ENDP
                                ;-------------------------------------------------------------
                                ; NUM_TRANS                                                    :
                                ;       THIS ROUTINE CALCULATES THE NUMBER OF SECTORS THAT     :
                                ;       WERE ACTUALLY TRANSFERRED TO/FROM THE DISKETTE.        :
                                ;                                                              :
                                ; ON ENTRY:     [BP+1] = TRACK                                 :
                                ;               SI-HI  = HEAD                                  :
                                ;               [BP]   = START SECTOR                          :
                                ;                                                              :
                                ; ON EXIT:      AL = NUMBER ACTUALLY TRANSFERRED               :
                                ;-------------------------------------------------------------
0827                            NUM_TRANS       PROC    NEAR
0827 32 C0                              XOR     AL,AL                   ; CLEAR FOR ERROR
0829 80 3E 0041 R 00                    CMP     @DSKETTE_STATUS,0       ; CHECK FOR ERROR
082E 75 23                              JNZ     NT_OUT                  ; IF ERROR 0 TRANSFERRED
0830 B2 04                              MOV     DL,4                    ; SECTORS/TRACK OFFSET TO DL
0832 E8 0905 R                          CALL    GET_PARM                ; AH = SECTORS/TRACK
0835 8A 1E 0047 R                       MOV     BL,@NEC_STATUS+5        ; GET ENDING SECTOR
0839 8B CE                              MOV     CX,SI                   ; CH = HEAD # STARTED
083B 3A 2E 0046 R                       CMP     CH,@NEC_STATUS+4        ; GET HEAD ENDED UP ON
083F 75 0B                              JNZ     DIF_HD                  ; IF ON SAME HEAD, THEN NO ADJUST

0841 8A 2E 0045 R                       MOV     CH,@NEC_STATUS+3        ; GET TRACK ENDED UP ON
0845 3A 6E 01                           CMP     CH,[BP+1]               ; IS IT ASKED FOR TRACK
0848 74 04                              JZ      SAME_TRK                ; IF SAME TRACK NO INCREASE

084A 02 DC                              ADD     BL,AH                   ; ADD SECTORS/TRACK
084C                            DIF_HD:
084C 02 DC                              ADD     BL,AH                   ; ADD SECTORS/TRACK
084E                            SAME_TRK:
084E 2A 5E 00                           SUB     BL,[BP]                 ; SUBTRACT START FROM END
0851 8A C3                              MOV     AL,BL                   ; TO AL

0853                            NT_OUT:
0853 C3                                 RET
0854                            NUM_TRANS       ENDP
                                ;-------------------------------------------------------------
                                ; SETUP_END                                                    :
                                ;       RESTORES @MOTOR_COUNT TO PARAMETER PROVIDED IN TABLE   :
                                ;       AND LOADS @DSKETTE_STATUS TO AH, AND SETS CY.          :
                                ; ON EXIT:                                                     :
                                ;       AH, @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION    :
                                ;-------------------------------------------------------------
0854                            SETUP_END       PROC    NEAR
0854 B2 02                              MOV     DL,2                    ; GET THE MOTOR WAIT PARAMETER
0856 50                                 PUSH    AX                      ; SAVE NUMBER TRANSFERRED
0857 E8 0905 R                          CALL    GET_PARM
085A 88 26 0040 R                       MOV     @MOTOR_COUNT,AH         ; STORE UPON RETURN
085E 58                                 POP     AX                      ; RESTORE NUMBER TRANSFERRED
085F 8A 26 0041 R                       MOV     AH,@DSKETTE_STATUS      ; GET STATUS OF OPERATION
0863 0A E4                              OR      AH,AH                   ; CHECK FOR ERROR
0865 74 02                              JZ      NUN_ERR                 ; NO ERROR
0867 32 C0                              XOR     AL,AL                   ; CLEAR NUMBER RETURNED

0869                            NUN_ERR:
0869 80 FC 01                           CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
086C F5                                 CMC                             ; SUCCESS OR FAILURE
086D C3                                 RET
086E                            SETUP_END       ENDP
```

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                                PAGE
                                ;--------------------------------------------------------------
                                ; SETUP_DBL                                                   :
                                ;       CHECK DOUBLE STEP.                                    :
                                ; ON ENTRY:                                                   :
                                ;               DI = DRIVE                                    :
                                ; ON EXIT :     CY = 1 MEANS ERROR                            :
                                ;--------------------------------------------------------------
 086E                           SETUP_DBL       PROC    NEAR
 086E 8A A5 0090 R                      MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
 0872 F6 C4 10                          TEST    AH,MED_DET              ; ESTABLISHED STATE ?
 0875 75 5E                             JNZ     NO_DBL                  ; IF ESTABLISHED THEN DOUBLE DONE

                                ;-----  CHECK FOR TRACK 0 TO SPEED UP ACKNOWLEDGE OF UNFORMATTED DISKETTE

 0877 C6 06 003E R 00                   MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
 087C E8 091A R                         CALL    MOTOR_ON                ; ENSURE MOTOR STAY ON
 087F B5 00                             MOV     CH,0                    ; LOAD TRACK 0
 0881 E8 0A24 R                         CALL    SEEK                    ; SEEK TO TRACK 0
 0884 E8 08D7 R                         CALL    READ_ID                 ; READ ID FUNCTION
 0887 72 37                             JC      SD_ERR                  ; IF ERROR NO TRACK 0

                                ;-----  INITIALIZE START AND MAX TRACKS (TIMES 2 FOR BOTH HEADS)

 0889 B9 0450                           MOV     CX,0450H                ; START, MAX TRACKS
 088C F6 85 0090 R 01                   TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACK CAPABILITY
 0891 74 02                             JZ      CNT_OK                  ; IF NOT COUNT IS SETUP
 0893 B1 A0                             MOV     CL,0A0H                 ; MAXIMUM TRACK 1.2 MB

                                ;       ATTEMPT READ ID OF ALL TRACKS, ALL HEADS UNTIL SUCCESS; UPON SUCCESS,
                                ;       MUST SEE IF ASKED FOR TRACK IN SINGLE STEP MODE = TRACK ID READ; IF NOT
                                ;       THEN SET DOUBLE STEP ON.

 0895 C6 06 0040 R FF           CNT_OK: MOV     @MOTOR_COUNT,0FFH       ; ENSURE MOTOR STAYS ON FOR OPERATION
 089A 51                                PUSH    CX                      ; SAVE TRACK, COUNT
 089B C6 06 0041 R 00                   MOV     @DSKETTE_STATUS,0       ; CLEAR STATUS, EXPECT ERRORS
 08A0 33 C0                             XOR     AX,AX                   ; CLEAR AX
 08A2 D0 ED                             SHR     CH,1                    ; HALVE TRACK, CY = HEAD
 08A4 C0 D0 03                          RCL     AL,3                    ; AX = HEAD IN CORRECT BIT
 08A7 50                                PUSH    AX                      ; SAVE HEAD
 08A8 E8 0A24 R                         CALL    SEEK                    ; SEEK TO TRACK
 08AB 58                                POP     AX                      ; RESTORE HEAD
 08AC 0B F8                             OR      DI,AX                   ; DI = HEAD OR'ED DRIVE
 08AE E8 08D7 R                         CALL    READ_ID                 ; READ ID HEAD 0
 08B1 9C                                PUSHF                           ; SAVE RETURN FROM READ_ID
 08B2 81 E7 00FB                        AND     DI,11111011B            ; TURN OFF HEAD 1 BIT
 08B6 9D                                POPF                            ; RESTORE ERROR RETURN
 08B7 59                                POP     CX                      ; RESTORE COUNT
 08B8 73 08                             JNC     DO_CHK                  ; IF OK, ASKED = RETURNED TRACK ?
 08BA FE C5                             INC     CH                      ; INC FOR NEXT TRACK
 08BC 3A E9                             CMP     CH,CL                   ; REACHED MAXIMUM YET
 08BE 75 D5                             JNZ     CNT_OK                  ; CONTINUE TILL ALL TRIED

                                ;-----  FALL THRU, READ ID FAILED FOR ALL TRACKS

 08C0 F9                        SD_ERR: STC                             ; SET CARRY FOR ERROR
 08C1 C3                                RET                             ; SETUP_DBL ERROR EXIT

 08C2 8A 0E 0045 R              DO_CHK: MOV     CL,@NEC_STATUS+3        ; LOAD RETURNED TRACK
 08C6 88 8D 0094 R                      MOV     @DSK_TRK[DI],CL         ; STORE TRACK NUMBER
 08CA D0 ED                             SHR     CH,1                    ; HALVE TRACK
 08CC 3A E9                             CMP     CH,CL                   ; IS IT THE SAME AS ASKED FOR TRACK
 08CE 74 05                             JZ      NO_DBL                  ; IF SAME THEN NO DOUBLE STEP
 08D0 80 8D 0090 R 20                   OR      @DSK_STATE[DI],DBL_STEP ; TURN ON DOUBLE STEP REQUIRED

 08D5 F8                        NO_DBL: CLC                             ; CLEAR ERROR FLAG
 08D6 C3                                RET
 08D7                           SETUP_DBL       ENDP
                                ;--------------------------------------------------------------
                                ; READ_ID                                                     :
                                ;       READ ID FUNCTION.                                     :
                                ; ON ENTRY:     DI = BIT 2 = HEAD; BITS 1,0 = DRIVE           :
                                ;                                                             :
                                ; ON EXIT:      DI = BIT 2 IS RESET, BITS 1,0 = DRIVE         :
                                ;               @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                                ;--------------------------------------------------------------
 08D7                           READ_ID PROC    NEAR
 08D7 B8 08EB R                         MOV     AX,OFFSET ER_3          ; MOVE NEC OUTPUT ERROR ADDRESS
 08DA 50                                PUSH    AX
 08DB B4 4A                             MOV     AH,4AH                  ; READ ID COMMAND
 08DD E8 09F8 R                         CALL    NEC_OUTPUT              ; TO CONTROLLER
 08E0 8B C7                             MOV     AX,DI                   ; DRIVE # TO AH, HEAD 0
 08E2 8A E0                             MOV     AH,AL
 08E4 E8 09F8 R                         CALL    NEC_OUTPUT              ; TO CONTROLLER
 08E7 E8 075B R                         CALL    NEC_TERM                ; WAIT FOR OPERATION, GET STATUS
 08EA 58                                POP     AX                      ; THROW AWAY ERROR ADDRESS
 08EB                           ER_3:
 08EB C3                                RET
 08EC                           READ_ID ENDP
                                ;--------------------------------------------------------------
                                ; CMOS_TYPE                                                   :
                                ;       RETURNS DISKETTE TYPE FROM CMOS                       :
                                ;                                                             :
                                ; ON ENTRY:     DI = DRIVE #                                  :
                                ;                                                             :
                                ; ON EXIT:      AL = TYPE; CY REFLECTS STATUS                 :
                                ;--------------------------------------------------------------
 08EC                           CMOS_TYPE       PROC    NEAR
 08EC B0 0E                             MOV     AL,CMOS_DIAG            ; CMOS DIAGNOSTIC STATUS BYTE ADDRESS
 08EE E8 0000 E                         CALL    CMOS_READ               ; GET CMOS STATUS
 08F1 A8 C0                             TEST    AL,BAD_BAT+BAD_CKSUM    ; BATTERY GOOD AND CHECKSUM VALID ?
 08F3 F9                                STC                             ; SET CY = 1 INDICATING ERROR FOR RETURN
 08F4 75 0E                             JNZ     BAD_CM                  ; ERROR IF EITHER BIT ON

 08F6 B0 10                             MOV     AL,CMOS_DISKETTE        ; ADDRESS OF DISKETTE BYTE IN CMOS
 08F8 E8 0000 E                         CALL    CMOS_READ               ; GET DISKETTE BYTE
 08FB 0B FF                             OR      DI,DI                   ; SEE WHICH DRIVE IN QUESTION
 08FD 75 03                             JNZ     TB                      ; IF DRIVE 1, DATA IN LOW NIBBLE
 08FF C0 C8 04                          ROR     AL,4                    ; EXCHANGE NIBBLES IF SECOND DRIVE
 0902                           TB:
 0902 24 0F                             AND     AL,00FH                 ; KEEP ONLY DRIVE DATA, RESET CY = 0
 0904                           BAD_CM:
 0904 C3                                RET
 0905                           CMOS_TYPE       ENDP
```

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                          ;-------------------------------------------------------------------------
                          ; GET_PARM                                                                :
                          ;       THIS ROUTINE FETCHES THE INDEXED POINTER FROM THE                 :
                          ;       DISK_BASE BLOCK POINTED TO BY THE DATA VARIABLE                   :
                          ;       @DISK_POINTER. A BYTE FROM THAT TABLE IS THEN MOVED               :
                          ;       INTO AH, THE INDEX OF THAT BYTE BEING THE PARAMETER               :
                          ;       IN DL.                                                            :
                          ;                                                                         :
                          ; ON ENTRY:     DL = INDEX OF BYTE TO BE FETCHED                          :
                          ;                                                                         :
                          ; ON EXIT:      AH = THAT BYTE FROM BLOCK                                 :
                          ;               AL,DH DESTROYED                                           :
                          ;-------------------------------------------------------------------------
0905                      GET_PARM        PROC    NEAR
0905  1E                          PUSH    DS
0906  56                          PUSH    SI
0907  2B C0                       SUB     AX,AX                   ; DS = 0 , BIOS DATA AREA
0909  8E D8                       MOV     DS,AX
090B  87 D3                       XCHG    DX,BX                   ; BL = INDEX
090D  2A FF                       SUB     BH,BH                   ; BX = INDEX
                                  ASSUME  DS:ABS0
090F  C5 36 0078 R                LDS     SI,@DISK_POINTER        ; POINT TO BLOCK
0913  8A 20                       MOV     AH,[SI+BX]              ; GET THE WORD
0915  87 D3                       XCHG    DX,BX                   ; RESTORE BX
0917  5E                          POP     SI
0918  1F                          POP     DS
0919  C3                          RET
                                  ASSUME  DS:DATA
091A                      GET_PARM        ENDP
                          ;-------------------------------------------------------------------------
                          ; MOTOR_ON                                                                :
                          ;       TURN MOTOR ON AND WAIT FOR MOTOR START UP TIME. THE @MOTOR_COUNT:
                          ;       IS REPLACED WITH A SUFFICIENTLY HIGH NUMBER (0FFH) TO ENSURE      :
                          ;       THAT THE MOTOR DOES NOT GO OFF DURING THE OPERATION. IF THE       :
                          ;       MOTOR NEEDED TO BE TURNED ON, THE MULTITASKING HOOK FUNCTION      :
                          ;       (AX=90FDH, INT 15H) IS CALLED TELLING THE OPERATING SYSTEM        :
                          ;       THAT THE BIOS IS ABOUT TO WAIT FOR MOTOR START UP. IF THIS        :
                          ;       FUNCTION RETURNS WITH CY = 1, IT MEANS THAT THE MINIMUM WAIT      :
                          ;       HAS BEEN COMPLETED. AT THIS POINT A CHECK IS MADE TO ENSURE       :
                          ;       THAT THE MOTOR WASN'T TURNED OFF BY THE TIMER. IF THE HOOK DID    :
                          ;       NOT WAIT, THE WAIT FUNCTION (AH=086H) IS CALLED TO WAIT THE       :
                          ;       PRESCRIBED AMOUNT OF TIME. IF THE CARRY FLAG IS SET ON RETURN,    :
                          ;       IT MEANS THAT THE FUNCTION IS IN USE AND DID NOT PERFORM THE      :
                          ;       WAIT. A TIMER 1 WAIT LOOP WILL THEN DO THE WAIT.                  :
                          ;                                                                         :
                          ; ON ENTRY:     DI = DRIVE #                                              :
                          ;                                                                         :
                          ; ON EXIT:      AX,CX,DX DESTROYED                                        :
                          ;-------------------------------------------------------------------------
091A                      MOTOR_ON        PROC    NEAR
091A  53                          PUSH    BX                      ; SAVE REG.
091B  E8 0965 R                   CALL    TURN_ON                 ; TURN ON MOTOR
091E  72 43                       JC      MOT_IS_ON               ; IF CY=1 NO WAIT
0920  E8 0435 R                   CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0923  B8 90FD                     MOV     AX,090FDH               ; LOAD WAIT CODE & TYPE
0926  CD 15                       INT     15H                     ; TELL OPERATING SYSTEM ABOUT TO DO WAIT
0928  9C                          PUSHF                           ; SAVE CY FOR TEST
0929  E8 040F R                   CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
092C  9D                          POPF                            ; RESTORE CY FOR TEST
092D  73 05                       JNC     M_WAIT                  ; BYPASS LOOP IF OP SYSTEM HANDLED WAIT
092F  E8 0965 R                   CALL    TURN_ON                 ; CHECK AGAIN IF MOTOR ON
0932  72 2F                       JC      MOT_IS_ON               ; IF NO WAIT MEANS IT IS ON

0934                      M_WAIT:
0934  B2 0A                       MOV     DL,10                   ; GET THE MOTOR WAIT PARAMETER
0936  E8 0905 R                   CALL    GET_PARM
0939  8A C4                       MOV     AL,AH                   ; AL = MOTOR WAIT PARAMETER
093B  32 E4                       XOR     AH,AH                   ; AX = MOTOR WAIT PARAMETER
093D  3C 08                       CMP     AL,8                    ; SEE IF AT LEAST A SECOND IS SPECIFIED
093F  73 02                       JAE     GP2                     ; IF YES, CONTINUE
0941  B0 08                       MOV     AL,8                    ; ONE SECOND WAIT FOR MOTOR START UP

                          ;-----  AX CONTAINS NUMBER OF 1/8 SECONDS (125000 MICROSECONDS) TO WAIT

0943  50                  GP2:    PUSH    AX                      ; SAVE WAIT PARAMETER
0944  BA F424                     MOV     DX,62500                ; LOAD LARGEST POSSIBLE MULTIPLIER
0947  F7 E2                       MUL     DX                      ; MULTIPLY BY HALF OF WHAT'S NECESSARY
0949  8B CA                       MOV     CX,DX                   ; CX = HIGH WORD
094B  8B D0                       MOV     DX,AX                   ; CX,DX = 1/2 * (# OF MICROSECONDS)
094D  F8                          CLC                             ; CLEAR CARRY FOR ROTATE
094E  D1 D2                       RCL     DX,1                    ; DOUBLE LOW WORD, CY CONTAINS OVERFLOW
0950  D1 D1                       RCL     CX,1                    ; DOUBLE HI, INCLUDING LOW WORD OVERFLOW
0952  B4 86                       MOV     AH,86H                  ; LOAD WAIT CODE
0954  CD 15                       INT     15H                     ; PERFORM WAIT
0956  58                          POP     AX                      ; RESTORE WAIT PARAMETER
0957  73 0A                       JNC     MOT_IS_ON               ; CY MEANS WAIT COULD NOT BE DONE

                          ;-----  FOLLOWING LOOPS REQUIRED WHEN RTC WAIT FUNCTION IS ALREADY IN USE

0959                      J13:                                    ;       WAIT FOR 1/8 SECOND PER (AL)
0959  B9 205E                     MOV     CX,8286                 ; COUNT FOR 1/8 SECOND AT 15.085737 US
095C  E8 0000 E                   CALL    WAITF                   ; GO TO FIXED WAIT ROUTINE
095F  FE C8                       DEC     AL                      ; DECREMENT TIME VALUE
0961  75 F6                       JNZ     J13                     ; ARE WE DONE YET

0963                      MOT_IS_ON:
0963  5B                          POP     BX                      ; RESTORE REG.
0964  C3                          RET
0965                      MOTOR_ON        ENDP
                          ;-------------------------------------------------------------------------
                          ; TURN_ON                                                                 :
                          ;       TURN MOTOR ON AND RETURN WAIT STATE.                              :
                          ;                                                                         :
                          ; ON ENTRY:     DI = DRIVE #                                              :
                          ;                                                                         :
                          ; ON EXIT:      CY = 0 MEANS WAIT REQUIRED                                :
                          ;               CY = 1 MEANS NO WAIT REQUIRED                             :
                          ;               AX,BX,CX,DX DESTROYED                                     :
                          ;-------------------------------------------------------------------------
0965                      TURN_ON PROC    NEAR
0965  8B DF                       MOV     BX,DI                   ; BX = DRIVE #
0967  8A CB                       MOV     CL,BL                   ; CL = DRIVE #
0969  C0 C3 04                    ROL     BL,4                    ; BL = DRIVE SELECT
096C  FA                          CLI                             ; NO INTERRUPTS WHILE DETERMINING STATUS
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096D C6 06 0040 R FF               MOV    @MOTOR_COUNT,0FFH       ; ENSURE MOTOR STAYS ON FOR OPERATION
0972 A0 003F R                     MOV    AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
0975 24 30                         AND    AL,00110000B            ; KEEP ONLY DRIVE SELECT BITS
0977 B4 01                         MOV    AH,1                    ; MASK FOR DETERMINING MOTOR BIT
0979 D2 E4                         SHL    AH,CL                   ; AH = MOTOR ON, A=00000001, B=00000010

                    ;  AL = DRIVE SELECT FROM @MOTOR_STATUS
                    ;  BL = DRIVE SELECT DESIRED
                    ;  AH = MOTOR ON MASK DESIRED

097B 3A C3                         CMP    AL,BL                   ; REQUESTED DRIVE ALREADY SELECTED ?
097D 75 06                         JNZ    TURN_IT_ON              ; IF NOT SELECTED JUMP
097F 84 26 003F R                  TEST   AH,@MOTOR_STATUS        ; TEST MOTOR ON BIT
0983 75 2C                         JNZ    NO_MOT_WAIT             ; JUMP IF MOTOR ON AND SELECTED

0985                TURN_IT_ON:
0985 0A E3                         OR     AH,BL                   ; AH = DRIVE SELECT AND MOTOR ON
0987 8A 3E 003F R                  MOV    BH,@MOTOR_STATUS        ; SAVE COPY OF @MOTOR_STATUS BEFORE
098B 80 E7 0F                      AND    BH,00001111B            ; KEEP ONLY MOTOR BITS
098E 80 26 003F R CF               AND    @MOTOR_STATUS,11001111B ; CLEAR OUT DRIVE SELECT
0993 08 26 003F R                  OR     @MOTOR_STATUS,AH        ; OR IN DRIVE SELECTED AND MOTOR ON
0997 A0 003F R                     MOV    AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
099A 8A D8                         MOV    BL,AL                   ; BL=@MOTOR_STATUS AFTER, BH=BEFORE
099C 80 E3 0F                      AND    BL,00001111B            ; KEEP ONLY MOTOR BITS
099F FB                            STI                            ; ENABLE INTERRUPTS AGAIN
09A0 24 3F                         AND    AL,00111111B            ; STRIP AWAY UNWANTED BITS
09A2 C0 C0 04                      ROL    AL,4                    ; PUT BITS IN DESIRED POSITIONS
09A5 0C 0C                         OR     AL,00001100B            ; NO RESET, ENABLE DMA/INTERRUPT
09A7 BA 03F2                       MOV    DX,03F2H                ; SELECT DRIVE AND TURN ON MOTOR
09AA EE                            OUT    DX,AL                   ; "
09AB 3A DF                         CMP    BL,BH                   ; NEW MOTOR TURNED ON ?
09AD 74 02                         JZ     NO_MOT_WAIT             ; NO WAIT REQUIRED IF JUST SELECT
09AF F8                            CLC                            ; SET CARRY MEANING WAIT
09B0 C3                            RET

09B1                NO_MOT_WAIT:
09B1 F9                            STC                            ; SET NO WAIT REQUIRED
09B2 FB                            STI                            ; INTERRUPTS BACK ON
09B3 C3                            RET
09B4                TURN_ON ENDP
                    ;-------------------------------------------------------------
                    ; HD_WAIT                                                    :
                    ;       WAIT FOR HEAD SETTLE TIME.                           :
                    ;                                                            :
                    ; ON ENTRY:     DI : DRIVE #                                 :
                    ;                                                            :
                    ; ON EXIT:      AX,BX,CX,DX DESTROYED                        :
                    ;-------------------------------------------------------------
09B4                HD_WAIT        PROC    NEAR
09B4 B2 09                         MOV    DL,9                    ; GET HEAD SETTLE PARAMETER
09B6 E8 0905 R                     CALL   GET_PARM                ; "
09B9 F6 06 003F R 80               TEST   @MOTOR_STATUS,10000000B ; SEE IF A WRITE OPERATION
09BE 74 14                         JZ     ISNT_WRITE              ; IF NOT, DO NOT ENFORCE ANY VALUES
09C0 0A E4                         OR     AH,AH                   ; CHECK FOR ANY WAIT?
09C2 75 14                         JNZ    DO_WAT                  ; IF THERE DO NOT ENFORCE
09C4 B4 0F                         MOV    AH,HD12_SETTLE          ; LOAD 1.2M HEAD SETTLE MINIMUM
09C6 8A 85 0090 R                  MOV    AL,@DSK_STATE[DI]       ; LOAD STATE
09CA 24 C0                         AND    AL,RATE_MSK             ; KEEP ONLY RATE
09CC 3C 80                         CMP    AL,RATE_250             ; 1.2 M DRIVE ?
09CE 75 08                         JNZ    DO_WAT                  ; DEFAULT HEAD SETTLE LOADED

09D0 B4 14          GP3:           MOV    AH,HD320_SETTLE         ; USE 320/360 HEAD SETTLE
09D2 EB 04                         JMP    SHORT DO_WAT            ; "

09D4                ISNT_WRITE:
09D4 0A E4                         OR     AH,AH                   ; CHECK FOR NO WAIT
09D6 74 1F                         JZ     HW_DONE                 ; IF NOT WRITE AND 0 ITS OK

                    ;-----  AH CONTAINS NUMBER OF MILLISECONDS TO WAIT

09D8 8A C4          DO_WAT:        MOV    AL,AH                   ; AL = # MILLISECONDS
09DA 32 E4                         XOR    AH,AH                   ; AX = # MILLISECONDS
09DC 50                            PUSH   AX                      ; SAVE HEAD SETTLE PARAMETER
09DD BA 03E8                       MOV    DX,1000                 ; SET UP FOR MULTIPLY TO MICROSECONDS
09E0 F7 E2                         MUL    DX                      ; DX,AX = # MICROSECONDS
09E2 8B CA                         MOV    CX,DX                   ; CX,AX = # MICROSECONDS
09E4 8B D0                         MOV    DX,AX                   ; CX,DX = # MICROSECONDS
09E6 B4 86                         MOV    AH,86H                  ; LOAD WAIT CODE
09E8 CD 15                         INT    15H                     ; PERFORM WAIT
09EA 58                            POP    AX                      ; RESTORE HEAD SETTLE PARAMETER
09EB 73 0A                         JNC    HW_DONE                 ; CHECK FOR EVENT WAIT ACTIVE

09ED                J29:                                          ;       1 MILLISECOND LOOP
09ED B9 0042                       MOV    CX,66                   ; COUNT AT 15.085737 US PER COUNT
09F0 E8 0000 E                     CALL   WAITF                   ; DELAY FOR 1 MILLISECOND
09F3 FE C8                         DEC    AL                      ; DECREMENT THE COUNT
09F5 75 F6                         JNZ    J29                     ; DO AL MILLISECOND # OF TIMES
09F7                HW_DONE:
09F7 C3                            RET
09F8                HD_WAIT        ENDP
                    ;-------------------------------------------------------------
                    ; NEC_OUTPUT                                                 :
                    ;       THIS ROUTINE SENDS A BYTE TO THE NEC CONTROLLER AFTER :
                    ;       TESTING FOR CORRECT DIRECTION AND CONTROLLER READY THIS :
                    ;       ROUTINE WILL TIME OUT IF THE BYTE IS NOT ACCEPTED WITHIN:
                    ;       A REASONABLE AMOUNT OF TIME, SETTING THE DISKETTE STATUS:
                    ;       ON COMPLETION.                                       :
                    ;                                                            :
                    ; ON ENTRY:                                                  :
                    ;       AH = BYTE TO BE OUTPUT                               :
                    ; ON EXIT:                                                   :
                    ;       CY = 0  SUCCESS                                      :
                    ;       CY = 1  FAILURE -- DISKETTE STATUS UPDATED           :
                    ;               IF A FAILURE HAS OCCURRED, THE RETURN IS MADE :
                    ;               ONE LEVEL HIGHER THAN THE CALLER OF NEC_OUTPUT. :
                    ;               THIS REMOVES THE REQUIREMENT OF TESTING AFTER :
                    ;               EVERY CALL OF NEC_OUTPUT.                    :
                    ;       AX,CX,DX DESTROYED                                   :
                    ;-------------------------------------------------------------
09F8                NEC_OUTPUT     PROC    NEAR
09F8 53                            PUSH   BX                      ; SAVE REG.
09F9 BA 03F4                       MOV    DX,03F4H                ; STATUS PORT
09FC B3 02                         MOV    BL,2                    ; HIGH ORDER COUNTER
09FE 33 C9                         XOR    CX,CX                   ; COUNT FOR TIME OUT
```

```

0A00 EC                       J23:    IN      AL,DX                   ; GET STATUS
0A01 24 C0                            AND     AL,11000000B            ; KEEP STATUS AND DIRECTION
0A03 3C 80                            CMP     AL,10000000B            ; STATUS 1 AND DIRECTION 0 ?
0A05 74 0F                            JZ      J27                     ; STATUS AND DIRECTION OK
0A07 E2 F7                            LOOP    J23                     ; CONTINUE TILL CX EXHAUSTED

0A09 FE CB                            DEC     BL                      ; DECREMENT COUNTER
0A0B 75 F3                            JNZ     J23                     ; REPEAT TILL DELAY FINISHED, CX = 0

                              ;-----  FALL THRU TO ERROR RETURN

0A0D 80 0E 0041 R 80                  OR      @DSKETTE_STATUS,TIME_OUT
0A12 5B                               POP     BX                      ; RESTORE REG.
0A13 58                               POP     AX                      ; DISCARD THE RETURN ADDRESS
0A14 F9                               STC                             ; INDICATE ERROR TO CALLER
0A15 C3                               RET

                              ;-----  DIRECTION AND STATUS OK; OUTPUT BYTE

0A16                          J27:
0A16 8A C4                            MOV     AL,AH                   ; GET BYTE TO OUTPUT
0A18 42                               INC     DX                      ; DATA PORT = STATUS PORT + 1
0A19 EE                               OUT     DX,AL                   ; OUTPUT THE BYTE

0A1A 9C                               PUSHF                           ; SAVE FLAGS
0A1B B9 0003                          MOV     CX,3                    ; 30 TO 45 MICROSECOND WAIT FOR
0A1E E8 0000 E                        CALL    WAITF                   ; NEC FLAGS UPDATE CYCLE
0A21 9D                               POPF                            ; RESTORE FLAGS FOR EXIT
0A22 5B                               POP     BX                      ; RESTORE REG.
0A23 C3                               RET                             ; CY = 0 FROM TEST INSTRUCTION
0A24                          NEC_OUTPUT      ENDP
                              ;---------------------------------------------------------------
                              ; SEEK
                              ;       THIS ROUTINE WILL MOVE THE HEAD ON THE NAMED DRIVE      :
                              ;       TO THE NAMED TRACK.  IF THE DRIVE HAS NOT BEEN ACCESSED :
                              ;       SINCE THE DRIVE RESET COMMAND WAS ISSUED, THE DRIVE     :
                              ;       WILL BE RECALIBRATED.                                   :
                              ;                                                               :
                              ; ON ENTRY:     DI = DRIVE #                                    :
                              ;               CH = TRACK #                                    :
                              ;                                                               :
                              ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                              ;               AX,BX,CX,DX DESTROYED                           :
                              ;---------------------------------------------------------------
0A24                          SEEK    PROC    NEAR
0A24 8B DF                            MOV     BX,DI                   ; BX = DRIVE #
0A26 B0 01                            MOV     AL,1                    ; ESTABLISH MASK FOR RECALIBRATE TEST
0A28 86 CB                            XCHG    CL,BL                   ; GET DRIVE VALUE INTO CL
0A2A D2 C0                            ROL     AL,CL                   ; SHIFT MASK BY THE DRIVE VALUE
0A2C 86 CB                            XCHG    CL,BL                   ; RECOVER TRACK VALUE
0A2E 84 06 003E R                     TEST    AL,@SEEK_STATUS         ; TEST FOR RECALIBRATE REQUIRED
0A32 75 1C                            JNZ     J28A                    ; JUMP IF RECALIBRATE NOT REQUIRED

0A34 08 06 003E R                     OR      @SEEK_STATUS,AL         ; TURN ON THE NO RECALIBRATE BIT IN FLAG
0A38 E8 0A83 R                        CALL    RECAL                   ; RECALIBRATE DRIVE
0A3B 73 0A                            JNC     AFT_RECAL               ; RECALIBRATE DONE

                              ;-----  ISSUE RECALIBRATE FOR 80 TRACK DISKETTES

0A3D C6 06 0041 R 00                  MOV     @DSKETTE_STATUS,0       ; CLEAR OUT INVALID STATUS
0A42 E8 0A83 R                        CALL    RECAL                   ; RECALIBRATE DRIVE
0A45 72 3B                            JC      RB                      ; IF RECALIBRATE FAILS TWICE THEN ERROR

0A47                          AFT_RECAL:
0A47 C6 85 0094 R 00                  MOV     @DSK_TRK[DI],0          ; SAVE NEW CYLINDER AS PRESENT POSITION
0A4C 0A ED                            OR      CH,CH                   ; CHECK FOR SEEK TO TRACK 0
0A4E 74 2D                            JZ      DO_WAIT                 ; HEAD SETTLE, CY = 0 IF JUMP

                              ;-----  DRIVE IS IN SYNCHRONIZATION WITH CONTROLLER, SEEK TO TRACK

0A50 F6 85 0090 R 20          J28A:   TEST    @DSK_STATE[DI],DBL_STEP ; CHECK FOR DOUBLE STEP REQUIRED
0A55 74 02                            JZ      R7                      ; SINGLE STEP REQUIRED BYPASS DOUBLE
0A57 D0 E5                            SHL     CH,1                    ; DOUBLE NUMBER OF STEP TO TAKE

0A59 3A AD 0094 R             R7:     CMP     CH,@DSK_TRK[DI]         ; SEE IF ALREADY AT THE DESIRED TRACK
0A5D 74 23                            JE      RB                      ; IF YES, DO NOT NEED TO SEEK

0A5F BA 0A82 R                        MOV     DX,OFFSET NEC_ERR       ; LOAD RETURN ADDRESS
0A62 52                               PUSH    DX                      ; ON STACK FOR NEC_OUTPUT ERROR
0A63 88 AD 0094 R                     MOV     @DSK_TRK[DI],CH         ; SAVE NEW CYLINDER AS PRESENT POSITION
0A67 B4 0F                            MOV     AH,0FH                  ; SEEK COMMAND TO NEC
0A69 E8 09F8 R                        CALL    NEC_OUTPUT
0A6C 8B DF                            MOV     BX,DI                   ; BX = DRIVE #
0A6E 8A E3                            MOV     AH,BL                   ; OUTPUT DRIVE NUMBER
0A70 E8 09F8 R                        CALL    NEC_OUTPUT
0A73 8A A5 0094 R                     MOV     AH,@DSK_TRK[DI]         ; GET CYLINDER NUMBER
0A77 E8 09F8 R                        CALL    NEC_OUTPUT
0A7A E8 0A9A R                        CALL    CHK_STAT_2              ; ENDING INTERRUPT AND SENSE STATUS

                              ;-----  WAIT FOR HEAD SETTLE

0A7D                          DO_WAIT:
0A7D 9C                               PUSHF                           ; SAVE STATUS
0A7E E8 09B4 R                        CALL    HD_WAIT                 ; WAIT FOR HEAD SETTLE TIME
0A81 9D                               POPF                            ; RESTORE STATUS
0A82                          RB:
0A82                          NEC_ERR:
0A82 C3                               RET                             ; RETURN TO CALLER
0A83                          SEEK    ENDP
                              ;---------------------------------------------------------------
                              ; RECAL                                                         :
                              ;       RECALIBRATE DRIVE                                       :
                              ;                                                               :
                              ; ON ENTRY      DI = DRIVE #                                    :
                              ;                                                               :
                              ; ON EXIT:      CY  REFLECTS STATUS OF OPERATION.               :
                              ;---------------------------------------------------------------
0A83                          RECAL   PROC    NEAR
0A83 51                               PUSH    CX
0A84 B8 0A98 R                        MOV     AX,OFFSET RC_BACK       ; LOAD NEC_OUTPUT ERROR
0A87 50                               PUSH    AX
0A88 B4 07                            MOV     AH,07H                  ; RECALIBRATE COMMAND
0A8A E8 09F8 R                        CALL    NEC_OUTPUT
```

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0A8D 8B DF                          MOV     BX,DI                   ; BX = DRIVE #
0A8F 8A E3                          MOV     AH,BL
0A91 E8 09F8 R                      CALL    NEC_OUTPUT              ; OUTPUT THE DRIVE NUMBER
0A94 E8 0A9A R                      CALL    CHK_STAT_2              ; GET THE INTERRUPT AND SENSE INT STATUS
0A97 58                             POP     AX                      ; THROW AWAY ERROR
0A98                        RC_BACK:
0A98 59                             POP     CX
0A99 C3                             RET
0A9A                        RECAL   ENDP
                            ;-------------------------------------------------------------
                            ; CHK_STAT_2                                                  :
                            ;       THIS ROUTINE HANDLES THE INTERRUPT RECEIVED AFTER     :
                            ;       RECALIBRATE OR SEEK TO THE ADAPTER. THE               :
                            ;       INTERRUPT IS WAITED FOR, THE INTERRUPT STATUS SENSED, :
                            ;       AND THE RESULT RETURNED TO THE CALLER.                :
                            ;                                                             :
                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                            ;-------------------------------------------------------------
0A9A                        CHK_STAT_2      PROC    NEAR
0A9A B8 0AB8 R                      MOV     AX,OFFSET CS_BACK       ; LOAD NEC_OUTPUT ERROR ADDRESS
0A9D 50                             PUSH    AX
0A9E E8 0AC1 R                      CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
0AA1 72 14                          JC      J34                     ; IF ERROR, RETURN IT
0AA3 B4 08                          MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
0AA5 E8 09F8 R                      CALL    NEC_OUTPUT
0AA8 E8 0AE9 R                      CALL    RESULTS                 ; READ IN THE RESULTS
0AAB 72 0A                          JC      J34
0AAD A0 0042 R                      MOV     AL,@NEC_STATUS          ; GET THE FIRST STATUS BYTE
0AB0 24 60                          AND     AL,01100000B            ; ISOLATE THE BITS
0AB2 3C 60                          CMP     AL,01100000B            ; TEST FOR CORRECT VALUE
0AB4 74 03                          JZ      J35                     ; IF ERROR, GO MARK IT
0AB6 F8                             CLC                             ; GOOD RETURN
0AB7                        J34:
0AB7 58                             POP     AX                      ; THROW AWAY ERROR RETURN
0AB8                        CS_BACK:
0AB8 C3                             RET

0AB9                        J35:
0AB9 80 0E 0041 R 40                OR      @DSKETTE_STATUS,BAD_SEEK
0ABE F9                             STC                             ; ERROR RETURN CODE
0ABF EB F6                          JMP     SHORT J34
0AC1                        CHK_STAT_2      ENDP
                            ;-------------------------------------------------------------
                            ; WAIT_INT                                                    :
                            ;       THIS ROUTINE WAITS FOR AN INTERRUPT TO OCCUR A TIME OUT :
                            ;       ROUTINE TAKES PLACE DURING THE WAIT, SO THAT AN ERROR :
                            ;       MAY BE RETURNED IF THE DRIVE IS NOT READY.            :
                            ;                                                             :
                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                            ;-------------------------------------------------------------
0AC1                        WAIT_INT        PROC    NEAR
0AC1 FB                             STI                             ; TURN ON INTERRUPTS, JUST IN CASE
0AC2 F8                             CLC                             ; CLEAR TIMEOUT INDICATOR
0AC3 B8 9001                        MOV     AX,09001H               ; LOAD WAIT CODE AND TYPE
0AC6 CD 15                          INT     15H                     ; PERFORM OTHER FUNCTION
0AC8 72 11                          JC      J36A                    ; BYPASS TIMING LOOP IF TIMEOUT DONE
0ACA B3 0A                          MOV     BL,10                   ; CLEAR THE COUNTERS
0ACC 33 C9                          XOR     CX,CX                   ; FOR 2 SECOND WAIT
0ACE                        J36:
0ACE F6 06 003E R 80                TEST    @SEEK_STATUS,INT_FLAG   ; TEST FOR INTERRUPT OCCURRING
0AD3 75 0C                          JNZ     J37
0AD5 E2 F7                          LOOP    J36                     ; COUNT DOWN WHILE WAITING
0AD7 FE CB                          DEC     BL                      ; SECOND LEVEL COUNTER
0AD9 75 F3                          JNZ     J36

0ADB 80 0E 0041 R 80        J36A:   OR      @DSKETTE_STATUS,TIME_OUT        ; NOTHING HAPPENED
0AE0 F9                             STC                             ; ERROR RETURN
0AE1                        J37:
0AE1 9C                             PUSHF                           ; SAVE CURRENT CARRY
0AE2 80 26 003E R 7F                AND     @SEEK_STATUS,NOT INT_FLAG       ; TURN OFF INTERRUPT FLAG
0AE7 9D                             POPF                            ; RECOVER CARRY
0AE8 C3                             RET                             ; GOOD RETURN CODE
0AE9                        WAIT_INT        ENDP
                            ;-------------------------------------------------------------
                            ; RESULTS                                                     :
                            ;       THIS ROUTINE WILL READ ANYTHING THAT THE NEC CONTROLLER :
                            ;       RETURNS FOLLOWING AN INTERRUPT.                       :
                            ;                                                             :
                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                            ;               AX,BX,CX,DX DESTROYED                         :
                            ;-------------------------------------------------------------
0AE9                        RESULTS PROC    NEAR
0AE9 57                             PUSH    DI
0AEA BF 0042 R                      MOV     DI,OFFSET @NEC_STATUS   ; POINTER TO DATA AREA
0AED B3 07                          MOV     BL,7                    ; MAX STATUS BYTES
0AEF BA 03F4                        MOV     DX,03F4H                ; STATUS PORT

                            ;-----  WAIT FOR REQUEST FOR MASTER

0AF2 B7 02                  R10:    MOV     BH,2                    ; HIGH ORDER COUNTER
0AF4 33 C9                          XOR     CX,CX                   ; COUNTER
0AF6                        J39:                                    ; WAIT FOR MASTER
0AF6 EC                             IN      AL,DX                   ; GET STATUS
0AF7 24 C0                          AND     AL,11000000B            ; KEEP ONLY STATUS AND DIRECTION
0AF9 3C C0                          CMP     AL,11000000B            ; STATUS 1 AND DIRECTION 1 ?
0AFB 74 0E                          JZ      J42                     ; STATUS AND DIRECTION OK
0AFD E2 F7                          LOOP    J39                     ; LOOP TILL TIMEOUT

0AFF FE CF                          DEC     BH                      ; DECREMENT HIGH ORDER COUNTER
0B01 75 F3                          JNZ     J39                     ; REPEAT TILL DELAY DONE

0B03 80 0E 0041 R 80                OR      @DSKETTE_STATUS,TIME_OUT
0B08 F9                             STC                             ; SET ERROR RETURN
0B09 EB 1B                          JMP     SHORT POPRES            ; POP REGISTERS AND RETURN

                            ;-----  READ IN THE STATUS

0B0B                        J42:
                            ;       JMP     $+2                     ; I/O DELAY
0B0B 42                             INC     DX                      ; POINT AT DATA PORT
0B0C EC                             IN      AL,DX                   ; GET THE DATA
0B0D 88 05                          MOV     [DI],AL                 ; STORE THE BYTE
0B0F 47                             INC     DI                      ; INCREMENT THE POINTER
```

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0B10 B9 0003                     MOV     CX,3                    ; MINIMUM 24 MICROSECONDS FOR NEC
0B13 E8 0000 E                   CALL    WAITF                   ; WAIT 30 TO 45 MICROSECONDS
0B16 4A                          DEC     DX                      ; POINT AT STATUS PORT
0B17 EC                          IN      AL,DX                   ; GET STATUS
0B18 A8 10                       TEST    AL,00010000B            ; TEST FOR NEC STILL BUSY
0B1A 74 0A                       JZ      POPRES                  ; RESULTS DONE ?

0B1C FE CB                       DEC     BL                      ; DECREMENT THE STATUS COUNTER
0B1E 75 D2                       JNZ     R10                     ; GO BACK FOR MORE
0B20 80 0E 0041 R 20             OR      @DSKETTE_STATUS,BAD_NEC ; TOO MANY STATUS BYTES
0B25 F9                          STC                             ; SET ERROR FLAG

                        ;-----  RESULT OPERATION IS DONE

0B26                    POPRES:
0B26 5F                          POP     DI
0B27 C3                          RET                             ; RETURN WITH CARRY SET
0B28                    RESULTS ENDP
                        ;-------------------------------------------------------------------
                        ; READ_DSKCHNG                                                      :
                        ;         READS THE STATE OF THE DISK CHANGE LINE.                  :
                        ;                                                                   :
                        ; ON ENTRY:      DI = DRIVE #                                       :
                        ;                                                                   :
                        ; ON EXIT:       DI = DRIVE #                                       :
                        ;                ZF = 0 : DISK CHANGE LINE INACTIVE                 :
                        ;                ZF = 1 : DISK CHANGE LINE ACTIVE                   :
                        ;                AX,CX,DX DESTROYED                                 :
                        ;-------------------------------------------------------------------
0B28                    READ_DSKCHNG     PROC    NEAR
0B28 E8 091A R                   CALL    MOTOR_ON                ; TURN ON THE MOTOR IF OFF
0B2B BA 03F7                     MOV     DX,03F7H                ; ADDRESS DIGITAL INPUT REGISTER
0B2E EC                          IN      AL,DX                   ; INPUT DIGITAL INPUT REGISTER
0B2F A8 80                       TEST    AL,DSK_CHG              ; CHECK FOR DISK CHANGE LINE ACTIVE
0B31 C3                          RET                             ; RETURN TO CALLER WITH ZERO FLAG SET
0B32                    READ_DSKCHNG     ENDP
                        ;-------------------------------------------------------------------
                        ; DRIVE_DET                                                         :
                        ;        DETERMINES WHETHER DRIVE IS 80 OR 40 TRACKS AND            :
                        ;        UPDATES STATE INFORMATION ACCORDINGLY.                     :
                        ;                                                                   :
                        ; ON ENTRY:      DI = DRIVE #                                       :
                        ;-------------------------------------------------------------------
0B32                    DRIVE_DET        PROC    NEAR
0B32 E8 091A R                   CALL    MOTOR_ON                ; TURN ON MOTOR IF NOT ALREADY ON
0B35 E8 0A83 R                   CALL    RECAL                   ; RECALIBRATE DRIVE
0B38 72 3C                       JC      DD_BAC                  ; ASSUME NO DRIVE PRESENT
0B3A B5 30                       MOV     CH,TRK_SLAP             ; SEEK TO TRACK 48
0B3C E8 0A24 R                   CALL    SEEK                    ; "
0B3F 72 35                       JC      DD_BAC                  ; ERROR NO DRIVE
0B41 B5 0B                       MOV     CH,QUIET_SEEK+1         ; SEEK TO TRACK 10
0B43                    SK_GIN:
0B43 FE CD                       DEC     CH                      ; DECREMENT TO NEXT TRACK
0B45 51                          PUSH    CX                      ; SAVE TRACK
0B46 E8 0A24 R                   CALL    SEEK                    ; "
0B49 72 2C                       JC      POP_BAC                 ; POP AND RETURN
0B4B B8 0B77 R                   MOV     AX,OFFSET POP_BAC       ; LOAD NEC OUTPUT ERROR ADDRESS
0B4E 50                          PUSH    AX                      ; "
0B4F B4 04                       MOV     AH,SENSE_DRV_ST         ; SENSE DRIVE STATUS COMMAND BYTE
0B51 E8 09F8 R                   CALL    NEC_OUTPUT              ; OUTPUT TO NEC
0B54 8B C7                       MOV     AX,DI                   ; AL = DRIVE
0B56 8A E0                       MOV     AH,AL                   ; AH = DRIVE
0B58 E8 09F8 R                   CALL    NEC_OUTPUT              ; OUTPUT TO NEC
0B5B E8 0AE9 R                   CALL    RESULTS                 ; GO GET STATUS
0B5E 58                          POP     AX                      ; THROW AWAY ERROR ADDRESS
0B5F 59                          POP     CX                      ; RESTORE TRACK
0B60 F6 06 0042 R 10             TEST    @NEC_STATUS,HOME        ; TRACK 0 ?
0B65 74 DC                       JZ      SK_GIN                  ; GO TILL TRACK 0
0B67 0A ED                       OR      CH,CH                   ; IS HOME AT TRACK 0 ?
0B69 74 06                       JZ      IS_80                   ; MUST BE 80 TRACK DRIVE

                        ;        DRIVE IS A 360; SET DRIVE TO DETERMINED;
                        ;        SET MEDIA TO DETERMINED AT RATE 250.

0B6B 80 8D 0090 R 94             OR      @DSK_STATE[DI],DRV_DET+MED_DET+RATE_250
0B70 C3                          RET                             ; ALL INFORMATION SET

0B71                    IS_80:
0B71 80 8D 0090 R 01             OR      @DSK_STATE[DI],TRK_CAPA ; SETUP 80 TRACK CAPABILITY
0B76                    DD_BAC:
0B76 C3                          RET

0B77                    POP_BAC:
0B77 59                          POP     CX                      ; THROW AWAY
0B78 C3                          RET

0B79                    DRIVE_DET        ENDP
                        ;-------------------------------------------------------------------
                        ; DISK_INT                                                          :
                        ;         THIS ROUTINE HANDLES THE DISKETTE INTERRUPT.              :
                        ;                                                                   :
                        ; ON EXIT:       THE INTERRUPT FLAG IS SET IN @SEEK_STATUS.         :
                        ;-------------------------------------------------------------------
0B79                    DISK_INT_1       PROC    FAR             ; ENTRY POINT FOR ORG 0EF57H
0B79 50                          PUSH    AX                      ; SAVE WORK REGISTER
0B7A 1E                          PUSH    DS                      ; SAVE REGISTERS
0B7B E8 0000 E                   CALL    DDS                     ; SETUP DATA ADDRESSING
0B7E 80 0E 003E R 80             OR      @SEEK_STATUS,INT_FLAG   ; TURN ON INTERRUPT OCCURRED
0B83 1F                          POP     DS                      ; RESTORE USER (DS)
0B84 B0 20                       MOV     AL,EOI                  ; END OF INTERRUPT MARKER
0B86 E6 20                       OUT     INTA00,AL               ; INTERRUPT CONTROL PORT
0B88 FB                          STI                             ; RE-ENABLE INTERRUPTS
0B89 B8 9101                     MOV     AX,09101H               ; INTERRUPT POST CODE AND TYPE
0B8C CD 15                       INT     15H                     ; GO PERFORM OTHER TASK
0B8E 58                          POP     AX                      ; RECOVER REGISTER
0B8F CF                          IRET                            ; RETURN FROM INTERRUPT
0B90                    DISK_INT_1       ENDP
```

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                              PAGE
                              ;-----------------------------------------------------------------
                              ; DSKETTE_SETUP                                                   :
                              ;        THIS ROUTINE DOES A PRELIMINARY CHECK TO SEE WHAT TYPE   :
                              ;        OF DISKETTE DRIVES ARE ATTACH TO THE SYSTEM.             :
                              ;-----------------------------------------------------------------
0B90                          DSKETTE_SETUP PROC        NEAR
0B90 50                               PUSH    AX                          ; SAVE REGISTERS
0B91 53                               PUSH    BX
0B92 51                               PUSH    CX
0B93 52                               PUSH    DX
0B94 57                               PUSH    DI
0B95 1E                               PUSH    DS
0B96 E8 0000 E                        CALL    DDS                         ; POINT DATA SEGMENT TO BIOS DATA AREA
0B99 80 0E 00A0 R 01                  OR      @RTC_WAIT_FLAG,01           ; NO RTC WAIT, FORCE USE OF LOOP
0B9E 33 FF                            XOR     DI,DI                       ; INITIALIZE DRIVE POINTER
0BA0 C7 06 0090 R 0000                MOV     WORD PTR @DSK_STATE,0       ; INITIALIZE STATES
0BA6 80 26 008B R 33                  AND     @LASTRATE,NOT STRT_MSK+SEND_MSK  ; CLEAR START & SEND
0BAB 80 0E 008B R C0                  OR      @LASTRATE,SEND_MSK          ; INITIALIZE SENT TO IMPOSSIBLE
0BB0 C6 06 003E R 00                  MOV     @SEEK_STATUS,0              ; INDICATE RECALIBRATE NEEDED
0BB5 C6 06 0040 R 00                  MOV     @MOTOR_COUNT,0              ; INITIALIZE MOTOR COUNT
0BBA C6 06 003F R 00                  MOV     @MOTOR_STATUS,0             ; INITIALIZE DRIVES TO OFF STATE
0BBF C6 06 0041 R 00                  MOV     @DSKETTE_STATUS,0           ; NO ERRORS

0BC4                          SUP0:
0BC4 E8 0B32 R                        CALL    DRIVE_DET                   ; DETERMINE DRIVE
0BC7 E8 0435 R                        CALL    XLAT_OLD                    ; TRANSLATE STATE TO COMPATIBLE MODE
0BCA 47                               INC     DI                          ; POINT TO NEXT DRIVE
0BCB 83 FF 02                         CMP     DI,MAX_DRV                  ; SEE IF DONE
0BCE 75 F4                            JNZ     SUP0                        ; REPEAT FOR EACH DRIVE
0BD0 C6 06 003E R 00                  MOV     @SEEK_STATUS,0              ; FORCE RECALIBRATE
0BD5 80 26 00A0 R FE                  AND     @RTC_WAIT_FLAG,0FEH         ; ALLOW FOR RTC WAIT
0BDA E8 0854 R                        CALL    SETUP_END                   ; VARIOUS CLEANUPS
0BDD 1F                               POP     DS                          ; RESTORE CALLERS RESISTERS
0BDE 5F                               POP     DI
0BDF 5A                               POP     DX
0BE0 59                               POP     CX
0BE1 5B                               POP     BX
0BE2 58                               POP     AX
0BE3 C3                               RET
0BE4                          DSKETTE_SETUP ENDP
0BE4                          CODE    ENDS
                                      END
```

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                          PAGE 118,121
                          TITLE DISK ----- 09/25/85  FIXED DISK BIOS
                          .286C
                          .LIST
0000                      CODE    SEGMENT BYTE PUBLIC

                                  PUBLIC  DISK_IO
                                  PUBLIC  DISK_SETUP
                                  PUBLIC  HD_INT

                                  EXTRN   CMOS_READ:NEAR
                                  EXTRN   CMOS_WRITE:NEAR
                                  EXTRN   DDS:NEAR
                                  EXTRN   E_MSG:NEAR
                                  EXTRN   F1780:NEAR
                                  EXTRN   F1781:NEAR
                                  EXTRN   F1782:NEAR
                                  EXTRN   F1790:NEAR
                                  EXTRN   F1791:NEAR
                                  EXTRN   FD_TBL:NEAR

                          ;--- INT 13H -----------------------------------------------------------------
                          ;                                                                          :
                          ; FIXED DISK I/O INTERFACE                                                 :
                          ;                                                                          :
                          ;       THIS INTERFACE PROVIDES ACCESS TO 5 1/4" FIXED DISKS THROUGH       :
                          ;       THE IBM FIXED DISK CONTROLLER.                                     :
                          ;                                                                          :
                          ;       THE  BIOS  ROUTINES  ARE  MEANT  TO  BE  ACCESSED  THROUGH         :
                          ;       SOFTWARE  INTERRUPTS  ONLY.    ANY  ADDRESSES  PRESENT  IN         :
                          ;       THESE  LISTINGS  ARE  INCLUDED  ONLY  FOR  COMPLETENESS,           :
                          ;       NOT  FOR  REFERENCE.   APPLICATIONS  WHICH  REFERENCE  ANY         :
                          ;       ABSOLUTE  ADDRESSES  WITHIN  THE  CODE  SEGMENTS  OF  BIOS         :
                          ;       VIOLATE  THE  STRUCTURE  AND  DESIGN  OF  BIOS.                    :
                          ;                                                                          :
                          ;---------------------------------------------------------------------------
                          ;                                                                          :
                          ; INPUT  (AH)= HEX COMMAND VALUE                                           :
                          ;                                                                          :
                          ;       (AH)= 00H  RESET DISK (DL = 80H,81H) / DISKETTE                    :
                          ;       (AH)= 01H  READ THE STATUS OF THE LAST DISK OPERATION INTO (AL)    :
                          ;                    NOTE: DL < 80H - DISKETTE                             :
                          ;                          DL > 80H - DISK                                 :
                          ;       (AH)= 02H  READ THE DESIRED SECTORS INTO MEMORY                    :
                          ;       (AH)= 03H  WRITE THE DESIRED SECTORS FROM MEMORY                   :
                          ;       (AH)= 04H  VERIFY THE DESIRED SECTORS                              :
                          ;       (AH)= 05H  FORMAT THE DESIRED TRACK                                :
                          ;       (AH)= 06H  UNUSED                                                  :
                          ;       (AH)= 07H  UNUSED                                                  :
                          ;       (AH)= 08H  RETURN THE CURRENT DRIVE PARAMETERS                     :
                          ;       (AH)= 09H  INITIALIZE DRIVE CHARACTERISTICS                        :
                          ;                   INTERRUPT 41 POINTS TO DATA BLOCK FOR DRIVE 0          :
                          ;                   INTERRUPT 46 POINTS TO DATA BLOCK FOR DRIVE 1          :
                          ;       (AH)= 0AH  READ LONG                                               :
                          ;       (AH)= 0BH  WRITE LONG  (READ & WRITE LONG ENCOMPASS 512 + 4 BYTES ECC) :
                          ;       (AH)= 0CH  SEEK                                                    :
                          ;       (AH)= 0DH  ALTERNATE DISK RESET (SEE DL)                           :
                          ;       (AH)= 0EH  UNUSED                                                  :
                          ;       (AH)= 0FH  UNUSED                                                  :
                          ;       (AH)= 10H  TEST DRIVE READY                                        :
                          ;       (AH)= 11H  RECALIBRATE                                             :
                          ;       (AH)= 12H  UNUSED                                                  :
                          ;       (AH)= 13H  UNUSED                                                  :
                          ;       (AH)= 14H  CONTROLLER INTERNAL DIAGNOSTIC                          :
                          ;       (AH)= 15H  READ DASD TYPE                                          :
                          ;                                                                          :
                          ;--------------------------------------------------------------------------:
                          ;                                                                          :
                          ;       REGISTERS USED FOR FIXED DISK OPERATIONS                           :
                          ;                                                                          :
                          ;               (DL)    -  DRIVE NUMBER     (80H-81H FOR DISK, VALUE CHECKED)  :
                          ;               (DH)    -  HEAD NUMBER      (0-15 ALLOWED, NOT VALUE CHECKED)  :
                          ;               (CH)    -  CYLINDER NUMBER  (0-1023, NOT VALUE CHECKED)(SEE CL):
                          ;               (CL)    -  SECTOR NUMBER    (1-17, NOT VALUE CHECKED)          :
                          ;                                                                          :
                          ;                          NOTE: HIGH 2 BITS OF CYLINDER NUMBER ARE PLACED :
                          ;                                IN THE HIGH 2 BITS OF THE CL REGISTER     :
                          ;                                (10 BITS TOTAL)                           :
                          ;                                                                          :
                          ;               (AL)    -  NUMBER OF SECTORS (MAXIMUM POSSIBLE RANGE 1-80H,  :
                          ;                                             FOR READ/WRITE LONG 1-79H)   :
                          ;                                                                          :
                          ;               (ES:BX) -  ADDRESS OF BUFFER FOR READS AND WRITES,         :
                          ;                          (NOT REQUIRED FOR VERIFY)                       :
                          ;                                                                          :
                          ;               FORMAT (AH=5) ES:BX POINTS TO A 512 BYTE BUFFER.  THE FIRST  :
                          ;                          2*(SECTORS/TRACK) BYTES CONTAIN F,N FOR EACH SECTOR.:
                          ;                          F = 00H FOR A GOOD SECTOR                       :
                          ;                              80H FOR A BAD SECTOR                        :
                          ;                          N = SECTOR NUMBER                               :
                          ;                          FOR AN INTERLEAVE OF 2 AND 17 SECTORS/TRACK     :
                          ;                          THE TABLE SHOULD BE:                            :
                          ;                                                                          :
                          ;                   DB     00H,01H,00H,0AH,00H,02H,00H,0BH,00H,03H,00H,0CH :
                          ;                   DB     00H,04H,00H,0DH,00H,05H,00H,0EH,00H,06H,00H,0FH :
                          ;                   DB     00H,07H,00H,10H,00H,08H,00H,11H,00H,09H         :
                          ;                                                                          :
                          ;--------------------------------------------------------------------------:
                              PAGE
                              ;-----------------------------------------------------------------------------
                              ; OUTPUT                                                                      :
                              ;       AH = STATUS OF CURRENT OPERATION                                      :
                              ;            STATUS BITS ARE DEFINED IN THE EQUATES BELOW                     :
                              ;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN)                         :
                              ;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)                        :
                              ;                                                                             :
                              ;       NOTE:   ERROR 11H  INDICATES THAT THE DATA READ HAD A RECOVERABLE     :
                              ;               ERROR WHICH WAS CORRECTED BY THE ECC ALGORITHM.  THE DATA     :
                              ;               IS PROBABLY GOOD,   HOWEVER THE BIOS ROUTINE INDICATES AN     :
                              ;               ERROR TO ALLOW THE CONTROLLING PROGRAM A CHANCE TO DECIDE     :
                              ;               FOR  ITSELF.  THE  ERROR  MAY  NOT  RECUR  IF THE DATA IS     :
                              ;               REWRITTEN.                                                    :
                              ;                                                                             :
                              ;       IF DRIVE PARAMETERS WERE REQUESTED (DL >= 80H),                       :
                              ;          INPUT:                                                             :
                              ;            (DL) = DRIVE NUMBER                                              :
                              ;          OUTPUT:                                                            :
                              ;            (DL) = NUMBER OF CONSECUTIVE ACKNOWLEDGING DRIVES ATTACHED (1-2) :
                              ;                   (CONTROLLER CARD ZERO TALLY ONLY)                         :
                              ;            (DH) = MAXIMUM USEABLE VALUE FOR HEAD NUMBER                     :
                              ;            (CH) = MAXIMUM USEABLE VALUE FOR CYLINDER NUMBER                 :
                              ;            (CL) = MAXIMUM USEABLE VALUE FOR SECTOR NUMBER                   :
                              ;                   AND CYLINDER NUMBER HIGH BITS                             :
                              ;                                                                             :
                              ;       IF READ DASD TYPE WAS REQUESTED,                                      :
                              ;                                                                             :
                              ;       AH = 0 - NOT PRESENT                                                  :
                              ;            1 - DISKETTE - NO CHANGE LINE AVAILABLE                          :
                              ;            2 - DISKETTE - CHANGE LINE AVAILABLE                             :
                              ;            3 - FIXED DISK                                                   :
                              ;       CX,DX = NUMBER OF 512 BYTE BLOCKS WHEN AH = 3                         :
                              ;                                                                             :
                              ;       REGISTERS WILL BE PRESERVED EXCEPT WHEN THEY ARE USED TO RETURN       :
                              ;       INFORMATION.                                                          :
                              ;                                                                             :
                              ;       NOTE: IF AN ERROR IS REPORTED BY THE DISK CODE, THE APPROPRIATE       :
                              ;               ACTION IS TO RESET THE DISK, THEN RETRY THE OPERATION.        :
                              ;                                                                             :
                              ;-----------------------------------------------------------------------------


 = 00FF                       SENSE_FAIL      EQU     0FFH            ; NOT IMPLEMENTED
 = 00E0                       NO_ERR          EQU     0E0H            ; STATUS ERROR/ERROR REGISTER=0
 = 00CC                       WRITE_FAULT     EQU     0CCH            ; WRITE FAULT ON SELECTED DRIVE
 = 00BB                       UNDEF_ERR       EQU     0BBH            ; UNDEFINED ERROR OCCURRED
 = 00AA                       NOT_RDY         EQU     0AAH            ; DRIVE NOT READY
 = 0080                       TIME_OUT        EQU     80H             ; ATTACHMENT FAILED TO RESPOND
 = 0040                       BAD_SEEK        EQU     40H             ; SEEK OPERATION FAILED
 = 0020                       BAD_CNTLR       EQU     20H             ; CONTROLLER HAS FAILED
 = 0011                       DATA_CORRECTED  EQU     11H             ; ECC CORRECTED DATA ERROR
 = 0010                       BAD_ECC         EQU     10H             ; BAD ECC ON DISK READ
 = 000B                       BAD_TRACK       EQU     0BH             ; NOT IMPLEMENTED
 = 000A                       BAD_SECTOR      EQU     0AH             ; BAD SECTOR FLAG DETECTED
 = 0009                       DMA_BOUNDARY    EQU     09H             ; DATA EXTENDS TOO FAR
 = 0007                       INIT_FAIL       EQU     07H             ; DRIVE PARAMETER ACTIVITY FAILED
 = 0005                       BAD_RESET       EQU     05H             ; RESET FAILED
 = 0004                       RECORD_NOT_FND  EQU     04H             ; REQUESTED SECTOR NOT FOUND
 = 0002                       BAD_ADDR_MARK   EQU     02H             ; ADDRESS MARK NOT FOUND
 = 0001                       BAD_CMD         EQU     01H             ; BAD COMMAND PASSED TO DISK I/O


                              ;------------------------------------------------------
                              ;                                                      :
                              ; FIXED DISK PARAMETER TABLE                           :
                              ;                                                      :
                              ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:     :
                              ;                                                      :
                              ;  +0    (1 WORD) - MAXIMUM NUMBER OF CYLINDERS        :
                              ;  +2    (1 BYTE) - MAXIMUM NUMBER OF HEADS            :
                              ;  +3    (1 WORD) - NOT USED/SEE PC-XT                 :
                              ;  +5    (1 WORD) - STARTING WRITE PRECOMPENSATION CYL :
                              ;  +7    (1 BYTE) - MAXIMUM ECC DATA BURST LENGTH      :
                              ;  +8    (1 BYTE) - CONTROL BYTE                       :
                              ;                   BIT    7 DISABLE RETRIES -OR-      :
                              ;                   BIT    6 DISABLE RETRIES           :
                              ;                   BIT    3 MORE THAN 8 HEADS         :
                              ;  +9    (3 BYTES)- NOT USED/SEE PC-XT                 :
                              ; +12    (1 WORD) - LANDING ZONE                       :
                              ; +14    (1 BYTE) - NUMBER OF SECTORS/TRACK            :
                              ; +15    (1 BYTE) - RESERVED FOR FUTURE USE            :
                              ;                                                      :
                              ;        - TO DYNAMICALLY DEFINE A SET OF PARAMETERS   :
                              ;          BUILD A TABLE FOR UP TO 15 TYPES AND PLACE  :
                              ;          THE CORRESPONDING VECTOR INTO INTERRUPT 41  :
                              ;          FOR DRIVE 0 AND INTERRUPT 46 FOR DRIVE 1.   :
                              ;                                                      :
                              ;------------------------------------------------------
```

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                        PAGE
                        ;-----------------------------------------------------
                        ;                                                     ;
                        ; HARDWARE SPECIFIC VALUES                            ;
                        ;                                                     ;
                        ;  -  CONTROLLER I/O PORT                             ;
                        ;                                                     ;
                        ;     > WHEN READ FROM:                               ;
                        ;       HF_PORT+0 - READ DATA (FROM CONTROLLER TO CPU) ;
                        ;       HF_PORT+1 - GET ERROR REGISTER                ;
                        ;       HF_PORT+2 - GET SECTOR COUNT                  ;
                        ;       HF_PORT+3 - GET SECTOR NUMBER                 ;
                        ;       HF_PORT+4 - GET CYLINDER LOW                  ;
                        ;       HF_PORT+5 - GET CYLINDER HIGH (2 BITS)        ;
                        ;       HF_PORT+6 - GET SIZE/DRIVE/HEAD               ;
                        ;       HF_PORT+7 - GET STATUS REGISTER               ;
                        ;                                                     ;
                        ;     > WHEN WRITTEN TO:                              ;
                        ;       HF_PORT+0 - WRITE DATA (FROM CPU TO CONTROLLER) ;
                        ;       HF_PORT+1 - SET PRECOMPENSATION CYLINDER      ;
                        ;       HF_PORT+2 - SET SECTOR COUNT                  ;
                        ;       HF_PORT+3 - SET SECTOR NUMBER                 ;
                        ;       HF_PORT+4 - SET CYLINDER LOW                  ;
                        ;       HF_PORT+5 - SET CYLINDER HIGH (2 BITS)        ;
                        ;       HF_PORT+6 - SET SIZE/DRIVE/HEAD               ;
                        ;       HF_PORT+7 - SET COMMAND REGISTER              ;
                        ;                                                     ;
                        ;-----------------------------------------------------

 = 01F0                 HF_PORT         EQU     01F0H           ; DISK PORT
 = 03F6                 HF_REG_PORT     EQU     03F6H

                        ;-----          STATUS REGISTER

 = 0001                 ST_ERROR        EQU     00000001B       ;
 = 0002                 ST_INDEX        EQU     00000010B       ;
 = 0004                 ST_CORRCTD      EQU     00000100B       ; ECC CORRECTION SUCCESSFUL
 = 0008                 ST_DRQ          EQU     00001000B       ;
 = 0010                 ST_SEEK_COMPL   EQU     00010000B       ; SEEK COMPLETE
 = 0020                 ST_WRT_FLT      EQU     00100000B       ; WRITE FAULT
 = 0040                 ST_READY        EQU     01000000B       ;
 = 0080                 ST_BUSY         EQU     10000000B       ;

                        ;-----          ERROR REGISTER

 = 0001                 ERR_DAM         EQU     00000001B       ; DATA ADDRESS MARK NOT FOUND
 = 0002                 ERR_TRK_0       EQU     00000010B       ; TRACK 0 NOT FOUND ON RECAL
 = 0004                 ERR_ABORT       EQU     00000100B       ; ABORTED COMMAND
                        ;               EQU     00001000B       ; NOT USED
 = 0010                 ERR_ID          EQU     00010000B       ; ID NOT FOUND
                        ;               EQU     00100000B       ; NOT USED
 = 0040                 ERR_DATA_ECC    EQU     01000000B
 = 0080                 ERR_BAD_BLOCK   EQU     10000000B


 = 0010                 RECAL_CMD       EQU     00010000B       ; DRIVE RECAL    (10H)
 = 0020                 READ_CMD        EQU     00100000B       ;       READ     (20H)
 = 0030                 WRITE_CMD       EQU     00110000B       ;       WRITE    (30H)
 = 0040                 VERIFY_CMD      EQU     01000000B       ;       VERIFY   (40H)
 = 0050                 FMTTRK_CMD      EQU     01010000B       ; FORMAT TRACK   (50H)
 = 0060                 INIT_CMD        EQU     01100000B       ;   INITIALIZE   (60H)
 = 0070                 SEEK_CMD        EQU     01110000B       ;       SEEK     (70H)
 = 0090                 DIAG_CMD        EQU     10010000B       ; DIAGNOSTIC     (90H)
 = 0091                 SET_PARM_CMD    EQU     10010001B       ; DRIVE PARMS    (91H)
 = 0001                 NO_RETRIES      EQU     00000001B       ; CMD MODIFIER   (01H)
 = 0002                 ECC_MODE        EQU     00000010B       ; CMD MODIFIER   (02H)
 = 0008                 BUFFER_MODE     EQU     00001000B       ; CMD MODIFIER   (08H)

 = 0002                 MAX_FILE        EQU     2
 = 0002                 S_MAX_FILE      EQU     2

 = 0025                 DELAY_1         EQU     25H             ; DELAY FOR OPERATION COMPLETE
 = 0600                 DELAY_2         EQU     0600H           ; DELAY FOR READY
 = 0100                 DELAY_3         EQU     0100H           ; DELAY FOR DATA REQUEST

 = 0008                 HF_FAIL         EQU     08H             ; CMOS FLAG IN BYTE 0EH

                        ;-----          COMMAND BLOCK REFERENCE

 =                      @CMD_BLOCK      EQU     BYTE PTR [BP]-8 ; @CMD_BLOCK REFERENCES BLOCK HEAD IN SS
                                                                ;  (BP) POINTS TO COMMAND BLOCK TAIL
                                                                ;       AS DEFINED BY THE "ENTER" PARMS
```

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                             PAGE
                             ;----------------------------------------------------------------
                             ; FIXED DISK I/O SETUP                                           :
                             ;                                                                :
                             ;  -  ESTABLISH TRANSFER VECTORS FOR THE FIXED DISK              :
                             ;  -  PERFORM POWER ON DIAGNOSTICS                               :
                             ;     SHOULD AN ERROR OCCUR A "1701" MESSAGE IS DISPLAYED        :
                             ;                                                                :
                             ;----------------------------------------------------------------
                                     ASSUME  CS:CODE,DS:ABS0                          ; WORK OFF DS REGISTER

0000                         DISK_SETUP      PROC    NEAR
0000 FA                              CLI
0001 B8 ---- R                       MOV     AX,ABS0                                  ; GET ABSOLUTE SEGMENT
0004 8E D8                           MOV     DS,AX                                    ; SET SEGMENT REGISTER
0006 A1 004C R                       MOV     AX,WORD PTR @ORG_VECTOR                  ; GET DISKETTE VECTOR
0009 A3 0100 R                       MOV     WORD PTR @DISK_VECTOR,AX                 ;  INTO INT 40H
000C A1 004E R                       MOV     AX,WORD PTR @ORG_VECTOR+2
000F A3 0102 R                       MOV     WORD PTR @DISK_VECTOR+2,AX
0012 C7 06 004C R 01A9 R             MOV     WORD PTR @ORG_VECTOR,OFFSET DISK_IO      ; FIXED DISK HANDLER
0018 8C 0E 004E R                    MOV     WORD PTR @ORG_VECTOR+2,CS
001C C7 06 01D8 R 06DA R             MOV     WORD PTR @HDISK_INT,OFFSET HD_INT        ; FIXED DISK INTERRUPT
0022 8C 0E 01DA R                    MOV     WORD PTR @HDISK_INT+2,CS
0026 C7 06 0104 R 0000 E             MOV     WORD PTR @HF_TBL_VEC,OFFSET FD_TBL       ; PARM TABLE DRIVE 80
002C 8C 0E 0106 R                    MOV     WORD PTR @HF_TBL_VEC+2,CS
0030 C7 06 0118 R 0000 E             MOV     WORD PTR @HF1_TBL_VEC,OFFSET FD_TBL      ; PARM TABLE DRIVE 81
0036 8C 0E 011A R                    MOV     WORD PTR @HF1_TBL_VEC+2,CS
003A E4 A1                           IN      AL,INTB01                           ; TURN ON SECOND INTERRUPT CHIP
003C 24 BF                           AND     AL,0BFH
003E EB 00                           JMP     $+2
0040 E6 A1                           OUT     INTB01,AL
0042 E4 21                           IN      AL,INTA01                 ; LET INTERRUPTS PASS THRU TO
0044 24 FB                           AND     AL,0FBH                   ;  SECOND CHIP
0046 EB 00                           JMP     $+2
0048 E6 21                           OUT     INTA01,AL

004A FB                              STI
                                     ASSUME  DS:DATA,ES:ABS0
004B 1E                              PUSH    DS                        ; MOVE ABS0 POINTER TO
004C 07                              POP     ES                        ; EXTRA SEGMENT POINTER
004D E8 0000 E                       CALL    DDS                       ; ESTABLISH DATA SEGMENT
0050 C6 06 0074 R 00                 MOV     @DISK_STATUS1,0           ; RESET THE STATUS INDICATOR
0055 C6 06 0075 R 00                 MOV     @HF_NUM,0                 ; ZERO NUMBER OF FIXED DISKS
005A C6 06 0076 R 00                 MOV     @CONTROL_BYTE,0
005F B0 8E                           MOV     AL,CMOS_DIAG+NMI
0061 E8 0000 E                       CALL    CMOS_READ                 ; CHECK CMOS VALIDITY
0064 8A E0                           MOV     AH,AL                     ; SAVE CMOS FLAG
0066 24 C0                           AND     AL,BAD_BAT+BAD_CKSUM      ; CHECK FOR VALID CMOS
0068 74 03                           JZ      L1
006A E9 00F8 R                       JMP     POD_DONE                  ; CMOS NOT VALID -- NO FIXED DISKS
006D                         L1:
006D 80 E4 F7                        AND     AH,NOT HF_FAIL            ; ALLOW FIXED DISK IPL
0070 B0 8E                           MOV     AL,CMOS_DIAG+NMI          ; WRITE IT BACK
0072 E8 0000 E                       CALL    CMOS_WRITE
0075 B0 92                           MOV     AL,CMOS_DISK+NMI
0077 E8 0000 E                       CALL    CMOS_READ
007A C6 06 0077 R 00                 MOV     @PORT_OFF,0               ; ZERO CARD OFFSET
007F 8A D8                           MOV     BL,AL                     ; SAVE FIXED DISK BYTE
0081 25 00F0                         AND     AX,000F0H                 ; GET FIRST DRIVE TYPE AS OFFSET
0084 74 72                           JZ      POD_DONE                  ; NO FIXED DISKS

0086 3C F0                           CMP     AL,0F0H                   ; CHECK FOR EXTENDED DRIVE TYPE BYTE USE
0088 75 10                           JNE     L2                        ; USE DRIVE TYPE 1 --> 14 IF NOT IN USE

008A B0 99                           MOV     AL,CMOS_DISK_1+NMI        ; GET EXTENDED TYPE FOR DRIVE C:
008C E8 0000 E                       CALL    CMOS_READ                 ; FROM CMOS
008F 3C 00                           CMP     AL,0                      ; IS TYPE SET TO ZERO
0091 74 65                           JE      POD_DONE                  ; EXIT IF NOT VALID AND NO FIXED DISKS
0093 3C 2F                           CMP     AL,47                     ; IS TYPE WITHIN VALID RANGE
0095 77 61                           JA      POD_DONE                  ; EXIT WITH NO FIXED DISKS IF NOT VALID
0097 C1 E0 04                        SHL     AX,4                      ; ADJUST TYPE TO HIGH NIBBLE
009A                         L2:
009A 05 FFF0 E                       ADD     AX,OFFSET FD_TBL-16D      ; COMPUTE OFFSET OF FIRST DRIVE TABLE
009D 26: A3 0104 R                   MOV     WORD PTR @HF_TBL_VEC,AX   ; SAVE IN VECTOR POINTER
00A1 C6 06 0075 R 01                 MOV     @HF_NUM,1                 ; AT LEAST ONE DRIVE
00A6 8A C3                           MOV     AL,BL
00A8 C0 E0 04                        SHL     AL,4                      ; GET SECOND DRIVE TYPE
00AB 74 2A                           JZ      SHORT L4                  ; ONLY ONE DRIVE
00AD B4 00                           MOV     AH,0

00AF 3C F0                           CMP     AL,0F0H                   ; CHECK FOR EXTENDED DRIVE TYPE BYTE USE
00B1 75 10                           JNE     L3                        ; USE DRIVE TYPE 1 --> 14 IF NOT IN USE

00B3 B0 9A                           MOV     AL,CMOS_DISK_2+NMI        ; GET EXTENDED TYPE FOR DRIVE D:
00B5 E8 0000 E                       CALL    CMOS_READ                 ; FROM CMOS
00B8 3C 00                           CMP     AL,0                      ; IS TYPE SET TO ZERO
00BA 74 1B                           JE      L4                        ; SKIP IF SECOND FIXED DISK NOT VALID
00BC 3C 2F                           CMP     AL,47                     ; IS TYPE WITHIN VALID RANGE
00BE 77 17                           JA      L4                        ; SKIP IF NOT VALID
00C0 C1 E0 04                        SHL     AX,4                      ; ADJUST TYPE TO HIGH NIBBLE
00C3                         L3:
00C3 05 FFF0 E                       ADD     AX,OFFSET FD_TBL-16D      ; COMPUTE OFFSET FOR SECOND FIXED DISK
00C6 8B D8                           MOV     BX,AX
00C8 2E: 83 3F 00                    CMP     WORD PTR CS:[BX],0        ; CHECK FOR ZERO CYLINDERS IN TABLE
00CC 74 09                           JE      L4                        ; SKIP DRIVE IF NOT A VALID TABLE ENTRY
00CE 26: A3 0118 R                   MOV     WORD PTR @HF1_TBL_VEC,AX
00D2 C6 06 0075 R 02                 MOV     @HF_NUM,2                 ; TWO DRIVES
00D7                         L4:
00D7 B2 80                           MOV     DL,80H                    ; CHECK THE CONTROLLER
00D9 B4 14                           MOV     AH,14H                    ; USE CONTROLLER DIAGNOSTIC COMMAND
00DB CD 13                           INT     13H                       ; CALL BIOS WITH DIAGNOSTIC COMMAND
00DD 72 1A                           JC      CTL_ERRX                  ;  DISPLAY ERROR MESSAGE IF BAD RETURN
00DF A1 006C R                       MOV     AX,@TIMER_LOW             ; GET START TIMER COUNTS
00E2 8B D8                           MOV     BX,AX
00E4 05 0444                         ADD     AX,6*182                  ; 60 SECONDS* 18.2
00E7 8B C8                           MOV     CX,AX
00E9 E8 0104 R                       CALL    HD_RESET_1                ; SET UP DRIVE 0
00EC 80 3E 0075 R 01                 CMP     @HF_NUM,1                 ; WERE THERE TWO DRIVES?
00F1 76 05                           JBE     POD_DONE                  ; NO-ALL DONE
00F3 B2 81                           MOV     DL,81H                    ; SET UP DRIVE 1
00F5 E8 0104 R                       CALL    HD_RESET_1
00F8                         POD_DONE:
00F8 C3                              RET

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                       ;----- POD ERROR

00F9                   CTL_ERRX:
00F9 BE 0000 E                   MOV     SI,OFFSET F1782          ; CONTROLLER ERROR
00FC E8 017C R                   CALL    SET_FAIL                 ; DO NOT IPL FROM DISK
00FF E8 0000 E                   CALL    E_MSG                    ; DISPLAY ERROR AND SET (BP) ERROR FLAG
0102 EB F4                       JMP     POD_DONE


0104                   HD_RESET_1        PROC    NEAR
0104 53                          PUSH    BX                       ; SAVE TIMER LIMITS
0105 51                          PUSH    CX
0106 B4 09             RES_1:    MOV     AH,09H                   ; SET DRIVE PARAMETERS
0108 CD 13                       INT     13H
010A 72 06                       JC      RES_2
010C B4 11                       MOV     AH,11H                   ; RECALIBRATE DRIVE
010E CD 13                       INT     13H
0110 73 19                       JNC     RES_CK                   ; DRIVE OK
0112 E8 018A R         RES_2:    CALL    POD_TCHK                 ; CHECK TIME OUT
0115 73 EF                       JNC     RES_1
0117 BE 0000 E         RES_FL:   MOV     SI,OFFSET F1781          ; INDICATE DISK 1 FAILURE
011A F6 C2 01                    TEST    DL,1
011D 75 57                       JNZ     RES_E1
011F BE 0000 E                   MOV     SI,OFFSET F1780          ; INDICATE DISK 0 FAILURE
0122 E8 017C R                   CALL    SET_FAIL                 ; DO NOT TRY TO IPL DISK 0
0125 EB 4F                       JMP     SHORT RES_E1
0127 B4 00             RES_RS:   MOV     AH,00H                   ; RESET THE DRIVE
0129 CD 13                       INT     13H
012B B4 08             RES_CK:   MOV     AH,08H                   ; GET MAX CYLINDER,HEAD,SECTOR
012D 8A DA                       MOV     BL,DL                    ; SAVE DRIVE CODE
012F CD 13                       INT     13H
0131 72 38                       JC      RES_ER
0133 89 0E 0042 R                MOV     WORD PTR @NEC_STATUS,CX  ; SAVE MAX CYLINDER, SECTOR
0137 8A D3                       MOV     DL,BL                    ; RESTORE DRIVE CODE
0139 B8 0401           RES_3:    MOV     AX,0401H                 ; VERIFY THE LAST SECTOR
013C CD 13                       INT     13H
013E 73 39                       JNC     RES_OK                   ; VERIFY OK
0140 80 FC 0A                    CMP     AH,BAD_SECTOR            ; OK ALSO IF JUST ID READ
0143 74 34                       JE      RES_OK
0145 80 FC 11                    CMP     AH,DATA_CORRECTED
0148 74 2F                       JE      RES_OK
014A 80 FC 10                    CMP     AH,BAD_ECC
014D 74 2A                       JE      RES_OK
014F E8 018A R                   CALL    POD_TCHK                 ; CHECK FOR TIME OUT
0152 72 17                       JC      RES_ER                   ; FAILED
0154 8B 0E 0042 R                MOV     CX,WORD PTR @NEC_STATUS  ; GET SECTOR ADDRESS, AND CYLINDER
0158 8A C1                       MOV     AL,CL                    ; SEPARATE OUT SECTOR NUMBER
015A 24 3F                       AND     AL,3FH
015C FE C8                       DEC     AL                       ; TRY PREVIOUS ONE
015E 74 C7                       JZ      RES_RS                   ; WE'VE TRIED ALL SECTORS ON TRACK
0160 80 E1 C0                    AND     CL,0C0H                  ; KEEP CYLINDER BITS
0163 0A C8                       OR      CL,AL                    ; MERGE SECTOR WITH CYLINDER BITS
0165 89 0E 0042 R                MOV     WORD PTR @NEC_STATUS,CX  ; SAVE CYLINDER, NEW SECTOR NUMBER
0169 EB CE                       JMP     RES_3                    ; TRY AGAIN
016B BE 0000 E         RES_ER:   MOV     SI,OFFSET F1791          ; INDICATE DISK 1 ERROR
016E F6 C2 01                    TEST    DL,1
0171 75 03                       JNZ     RES_E1
0173 BE 0000 E                   MOV     SI,OFFSET F1790          ; INDICATE DISK 0 ERROR
0176                   RES_E1:
0176 E8 0000 E                   CALL    E_MSG                    ; DISPLAY ERROR AND SET (BP) ERROR FLAG
0179                   RES_OK:
0179 59                          POP     CX                       ; RESTORE TIMER LIMITS
017A 5B                          POP     BX
017B C3                          RET
017C                   HD_RESET_1        ENDP

017C                   SET_FAIL          PROC    NEAR
017C B8 8E8E                     MOV     AX,X*(CMOS_DIAG+NMI)     ; GET CMOS ERROR BYTE
017F E8 0000 E                   CALL    CMOS_READ
0182 0C 08                       OR      AL,HF_FAIL               ; SET DO NOT IPL FROM DISK FLAG
0184 86 E0                       XCHG    AH,AL                    ; SAVE IT
0186 E8 0000 E                   CALL    CMOS_WRITE               ; PUT IT OUT
0189 C3                          RET
018A                   SET_FAIL          ENDP

018A                   POD_TCHK          PROC NEAR                ; CHECK FOR 30 SECOND TIME OUT
018A 58                          POP     AX                       ; SAVE RETURN
018B 59                          POP     CX                       ; GET TIME OUT LIMITS
018C 5B                          POP     BX
018D 53                          PUSH    BX                       ; AND SAVE THEM AGAIN
018E 51                          PUSH    CX
018F 50                          PUSH    AX                       ; RESTORE RETURN
0190 A1 006C R                   MOV     AX,@TIMER_LOW            ; AX = CURRENT TIME
                                                                  ; BX = START TIME
                                                                  ; CX = END TIME
0193 3B D9                       CMP     BX,CX
0195 72 06                       JB      TCHK1                    ; START < END
0197 3B D8                       CMP     BX,AX
0199 72 0C                       JB      TCHKG                    ; END < START < CURRENT
019B EB 04                       JMP     SHORT TCHK2              ; END, CURRENT < START
019D 3B C3             TCHK1:    CMP     AX,BX
019F 72 04                       JB      TCHKNG                   ; CURRENT < START < END
01A1 3B C1             TCHK2:    CMP     AX,CX
01A3 72 02                       JB      TCHKG                    ; START < CURRENT < END
                                                                  ; OR CURRENT < END < START
01A5 F9                TCHKNG:   STC                              ; CARRY SET INDICATES TIME OUT
01A6 C3                          RET
01A7 F8                TCHKG:    CLC                              ; INDICATE STILL TIME
01A8 C3                          RET
01A9                   POD_TCHK          ENDP

01A9                   DISK_SETUP        ENDP
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                                  PAGE
                                  ;--------------------------------------
                                  ;       FIXED DISK BIOS ENTRY POINT    ;
                                  ;--------------------------------------

01A9                              DISK_IO PROC     FAR
                                          ASSUME   DS:DATA,ES:NOTHING
01A9 80 FA 80                             CMP      DL,80H              ; TEST FOR FIXED DISK DRIVE
01AC 73 05                                JAE      A1                  ; YES, HANDLE HERE
01AE CD 40                                INT      40H                 ; DISKETTE HANDLER
01B0                              RET_2:
01B0 CA 0002                              RET      2                   ; BACK TO CALLER

01B3                              A1:
01B3 FB                                   STI                          ; ENABLE INTERRUPTS
01B4 0A E4                                OR       AH,AH
01B6 75 09                                JNZ      A2
01B8 CD 40                                INT      40H                 ; RESET NEC WHEN AH=0
01BA 2A E4                                SUB      AH,AH
01BC 80 FA 81                             CMP      DL,(80H + S_MAX_FILE - 1)
01BF 77 EF                                JA       RET_2
01C1                              A2:
01C1 80 FC 08                             CMP      AH,08H              ; GET PARAMETERS IS A SPECIAL CASE
01C4 75 03                                JNZ      A3
01C6 E9 0393 R                            JMP      GET_PARM_N
01C9 80 FC 15                     A3:     CMP      AH,15H              ; READ DASD TYPE IS ALSO
01CC 75 03                                JNZ      A4
01CE E9 0353 R                            JMP      READ_DASD_TYPE

01D1                              A4:                                  ;       SAVE REGISTERS DURING OPERATION
01D1 C8 0008 00                           ENTER    8,0                 ; SAVE (BP) AND MAKE ROOM FOR @CMD_BLOCK
01D5 53                                   PUSH     BX                  ;  IN THE STACK. THE COMMAND BLOCK IS:
01D6 51                                   PUSH     CX                  ;   @CMD_BLOCK == BYTE PTR [BP]-8
01D7 52                                   PUSH     DX
01D8 1E                                   PUSH     DS
01D9 06                                   PUSH     ES
01DA 56                                   PUSH     SI
01DB 57                                   PUSH     DI
01DC 0A E4                                OR       AH,AH               ; CHECK FOR RESET
01DE 75 02                                JNZ      A5
01E0 B2 80                                MOV      DL,80H              ; FORCE DRIVE 80 FOR RESET
01E2 E8 0225 R                    A5:     CALL     DISK_IO_CONT        ; PERFORM THE OPERATION
01E5 E8 0000 E                            CALL     DDS                 ; ESTABLISH SEGMENT
01E8 8A 26 0074 R                         MOV      AH,@DISK_STATUS1    ; GET STATUS FROM OPERATION
01EC 80 FC 01                             CMP      AH,1                ; SET THE CARRY FLAG TO INDICATE
01EF F5                                   CMC                          ;  SUCCESS OR FAILURE
01F0 5F                                   POP      DI                  ; RESTORE REGISTERS
01F1 5E                                   POP      SI
01F2 07                                   POP      ES
01F3 1F                                   POP      DS
01F4 5A                                   POP      DX
01F5 59                                   POP      CX
01F6 5B                                   POP      BX
01F7 C9                                   LEAVE                        ; ADJUST (SP) AND RESTORE (BP)
01F8 CA 0002                              RET      2                   ; THROW AWAY SAVED FLAGS
01FB                              DISK_IO ENDP

01FB                              M1      LABEL    WORD                ; FUNCTION TRANSFER TABLE
01FB 02C1 R                               DW       DISK_RESET          ; 000H
01FD 0315 R                               DW       RETURN_STATUS       ; 001H
01FF 031E R                               DW       DISK_READ           ; 002H
0201 0325 R                               DW       DISK_WRITE          ; 003H
0203 032C R                               DW       DISK_VERF           ; 004H
0205 033E R                               DW       FMT_TRK             ; 005H
0207 02B9 R                               DW       BAD_COMMAND         ; 006H  FORMAT BAD SECTORS
0209 02B9 R                               DW       BAD_COMMAND         ; 007H  FORMAT DRIVE
020B 02B9 R                               DW       BAD_COMMAND         ; 008H  RETURN PARAMETERS
020D 03F1 R                               DW       INIT_DRV            ; 009H
020F 0423 R                               DW       RD_LONG             ; 00AH
0211 042A R                               DW       WR_LONG             ; 00BH
0213 0431 R                               DW       DISK_SEEK           ; 00CH
0215 02C1 R                               DW       DISK_RESET          ; 00DH
0217 02B9 R                               DW       BAD_COMMAND         ; 00EH  READ BUFFER
0219 02B9 R                               DW       BAD_COMMAND         ; 00FH  WRITE BUFFER
021B 044F R                               DW       TST_RDY             ; 010H
021D 0466 R                               DW       HDISK_RECAL         ; 011H
021F 02B9 R                               DW       BAD_COMMAND         ; 012H  MEMORY DIAGNOSTIC
0221 02B9 R                               DW       BAD_COMMAND         ; 013H  DRIVE DIAGNOSTIC
0223 048E R                               DW       CTLR_DIAGNOSTIC     ; 014H  CONTROLLER DIAGNOSTIC
= 002A                            M1L     EQU      $-M1

0225                              DISK_IO_CONT     PROC    NEAR
0225 E8 0000 E                            CALL     DDS                 ; ESTABLISH SEGMENT
0228 80 FC 01                             CMP      AH,01H              ; RETURN STATUS
022B 75 03                                JNZ      SU0
022D E9 0315 R                            JMP      RETURN_STATUS
0230                              SU0:
0230 C6 06 0074 R 00                      MOV      @DISK_STATUS1,0     ; RESET THE STATUS INDICATOR
0235 53                                   PUSH     BX                  ; SAVE DATA ADDRESS
0236 8A 1E 0075 R                         MOV      BL,@HF_NUM          ; GET NUMBER OF DRIVES
023A 50                                   PUSH     AX
023B 80 E2 7F                             AND      DL,7FH              ; GET DRIVE AS 0 OR 1
023E 3A DA                                CMP      BL,DL
0240 76 75                                JBE      BAD_COMMAND_POP     ; INVALID DRIVE
0242 06                                   PUSH     ES
0243 E8 06C4 R                            CALL     GET_VEC             ; GET DISK PARAMETERS
0246 26: 8B 47 05                         MOV      AX,WORD PTR ES:[BX][5]  ; GET WRITE PRE-COMPENSATION CYLINDER
024A C1 E8 02                             SHR      AX,2
024D 88 46 F8                             MOV      @CMD_BLOCK,AL
0250 26: 8A 47 08                         MOV      AL,BYTE PTR ES:[BX][8]  ; GET CONTROL BYTE MODIFIER
0254 52                                   PUSH     DX
0255 BA 03F6                              MOV      DX,HF_REG_PORT
0258 EE                                   OUT      DX,AL               ; SET EXTRA HEAD OPTION
0259 5A                                   POP      DX
025A 07                                   POP      ES
025B 8A 26 0076 R                         MOV      AH,@CONTROL_BYTE    ; SET EXTRA HEAD OPTION IN
025F 80 E4 C0                             AND      AH,0C0H             ; CONTROL BYTE
0262 0A E0                                OR       AH,AL
0264 88 26 0076 R                         MOV      @CONTROL_BYTE,AH
0268 58                                   POP      AX
0269 88 46 F9                             MOV      @CMD_BLOCK+1,AL     ; SECTOR COUNT
026C 50                                   PUSH     AX
026D 8A C1                                MOV      AL,CL               ; GET SECTOR NUMBER
026F 24 3F                                AND      AL,3FH
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0271 88 46 FA                   MOV     @CMD_BLOCK+2,AL
0274 88 6E FB                   MOV     @CMD_BLOCK+3,CH         ; GET CYLINDER NUMBER
0277 8A C1                      MOV     AL,CL
0279 C0 E8 06                   SHR     AL,6
027C 88 46 FC                   MOV     @CMD_BLOCK+4,AL         ; CYLINDER HIGH ORDER 2 BITS
027F 8A C2                      MOV     AL,DL                   ; DRIVE NUMBER
0281 C0 E0 04                   SHL     AL,4
0284 80 E6 0F                   AND     DH,0FH                  ; HEAD NUMBER
0287 0A C6                      OR      AL,DH
0289 0C A0                      OR      AL,80H OR 20H           ; ECC AND 512 BYTE SECTORS
028B 88 46 FD                   MOV     @CMD_BLOCK+5,AL         ; ECC/SIZE/DRIVE/HEAD
028E 58                         POP     AX
028F 50                         PUSH    AX
0290 8A C4                      MOV     AL,AH                   ; GET INTO LOW BYTE
0292 32 E4                      XOR     AH,AH                   ; ZERO HIGH BYTE
0294 D1 E0                      SAL     AX,1                    ; *2 FOR TABLE LOOKUP
0296 8B F0                      MOV     SI,AX                   ; PUT INTO SI FOR BRANCH
0298 3D 002A                    CMP     AX,M1L                  ; TEST WITHIN RANGE
029B 73 1A                      JNB     BAD_COMMAND_POP
029D 58                         POP     AX                      ; RESTORE AX
029E 5B                         POP     BX                      ; AND DATA ADDRESS
029F 51                         PUSH    CX
02A0 50                         PUSH    AX                      ; ADJUST ES:BX
02A1 8B CB                      MOV     CX,BX                   ; GET 3 HIGH ORDER NIBBLES OF BX
02A3 C1 E9 04                   SHR     CX,4
02A6 8C C0                      MOV     AX,ES
02A8 03 C1                      ADD     AX,CX
02AA 8E C0                      MOV     ES,AX
02AC 81 E3 000F                 AND     BX,000FH                ; ES:BX CHANGED TO ES:000X
02B0 58                         POP     AX
02B1 59                         POP     CX
02B2 2E: FF A4 01FB R           JMP     WORD PTR CS:[SI + OFFSET M1]
02B7                    BAD_COMMAND_POP:
02B7 58                         POP     AX
02B8 5B                         POP     BX
02B9                    BAD_COMMAND:
02B9 C6 06 0074 R 01            MOV     @DISK_STATUS1,BAD_CMD   ; COMMAND ERROR
02BE B0 00                      MOV     AL,0
02C0 C3                         RET
02C1                    DISK_IO_CONT    ENDP

                        ;----------------------------------------
                        ;       RESET THE DISK SYSTEM  (AH=00H) :
                        ;----------------------------------------

02C1                    DISK_RESET      PROC    NEAR
02C1 FA                         CLI
02C2 E4 A1                      IN      AL,INTB01               ; GET THE MASK REGISTER
02C4 EB 00                      JMP     $+2
02C6 24 BF                      AND     AL,0BFH                 ; ENABLE FIXED DISK INTERRUPT
02C8 E6 A1                      OUT     INTB01,AL
02CA FB                         STI                             ; START INTERRUPTS
02CB B0 04                      MOV     AL,04H
02CD BA 03F6                    MOV     DX,HF_REG_PORT
02D0 EE                         OUT     DX,AL                   ; RESET
02D1 B9 000A                    MOV     CX,10                   ; DELAY COUNT
02D4 49                 DRD:    DEC     CX
02D5 75 FD                      JNZ     DRD                     ; WAIT 4.8 MICRO-SEC
02D7 A0 0076 R                  MOV     AL,@CONTROL_BYTE
02DA 24 0F                      AND     AL,0FH                  ; SET HEAD OPTION
02DC EE                         OUT     DX,AL                   ; TURN RESET OFF
02DD E8 05F3 R                  CALL    NOT_BUSY
02E0 75 2D                      JNZ     DRERR                   ; TIME OUT ON RESET
02E2 BA 01F1                    MOV     DX,HF_PORT+1
02E5 EC                         IN      AL,DX                   ; GET RESET STATUS
02E6 3C 01                      CMP     AL,1
02E8 75 25                      JNZ     DRERR                   ; BAD RESET STATUS
02EA 80 66 FD EF                AND     @CMD_BLOCK+5,0EFH       ; SET TO DRIVE 0
02EE 2A D2                      SUB     DL,DL
02F0 E8 03F1 R                  CALL    INIT_DRV                ; SET MAX HEADS
02F3 E8 0466 R                  CALL    HDISK_RECAL             ; RECAL TO RESET SEEK SPEED
02F6 80 3E 0075 R 01            CMP     @HF_NUM,1               ; CHECK FOR DRIVE 1
02FB 76 0C                      JBE     DRE
02FD 80 4E FD 10                OR      @CMD_BLOCK+5,010H       ; SET TO DRIVE 1
0301 B2 01                      MOV     DL,1
0303 E8 03F1 R                  CALL    INIT_DRV                ; SET MAX HEADS
0306 E8 0466 R                  CALL    HDISK_RECAL             ; RECAL TO RESET SEEK SPEED
0309 C6 06 0074 R 00    DRE:    MOV     @DISK_STATUS1,0         ; IGNORE ANY SET UP ERRORS
030E C3                         RET
030F C6 06 0074 R 05    DRERR:  MOV     @DISK_STATUS1,BAD_RESET ; CARD FAILED
0314 C3                         RET
0315                    DISK_RESET      ENDP

                        ;----------------------------------------
                        ;       DISK STATUS ROUTINE  (AH = 01H) :
                        ;----------------------------------------

0315                    RETURN_STATUS   PROC    NEAR
0315 A0 0074 R                  MOV     AL,@DISK_STATUS1        ; OBTAIN PREVIOUS STATUS
0318 C6 06 0074 R 00            MOV     @DISK_STATUS1,0         ; RESET STATUS
031D C3                         RET
031E                    RETURN_STATUS   ENDP
```

SECTION 5

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                                PAGE
                                ;----------------------------------------
                                ;       DISK READ ROUTINE     (AH = 02H) :
                                ;----------------------------------------

 031E                           DISK_READ       PROC    NEAR
 031E C6 46 FE 20                       MOV     @CMD_BLOCK+6,READ_CMD
 0322 E9 04C6 R                         JMP     COMMANDI
 0325                           DISK_READ       ENDP

                                ;----------------------------------------
                                ;       DISK WRITE ROUTINE    (AH = 03H) :
                                ;----------------------------------------

 0325                           DISK_WRITE      PROC    NEAR
 0325 C6 46 FE 30                       MOV     @CMD_BLOCK+6,WRITE_CMD
 0329 E9 0505 R                         JMP     COMMANDO
 032C                           DISK_WRITE      ENDP

                                ;----------------------------------------
                                ;       DISK VERIFY           (AH = 04H) :
                                ;----------------------------------------

 032C                           DISK_VERF       PROC    NEAR
 032C C6 46 FE 40                       MOV     @CMD_BLOCK+6,VERIFY_CMD
 0330 E8 055C R                         CALL    COMMAND
 0333 75 08                             JNZ     VERF_EXIT               ; CONTROLLER STILL BUSY
 0335 E8 05C2 R                         CALL    WAIT
 0338 75 03                             JNZ     VERF_EXIT               ; TIME OUT
 033A E8 0630 R                         CALL    CHECK_STATUS
 033D                           VERF_EXIT:
 033D C3                                RET
 033E                           DISK_VERF       ENDP

                                ;----------------------------------------
                                ;       FORMATTING            (AH = 05H) :
                                ;----------------------------------------

 033E                           FMT_TRK PROC    NEAR                    ; FORMAT TRACK  (AH = 005H)
 033E C6 46 FE 50                       MOV     @CMD_BLOCK+6,FMTTRK_CMD
 0342 06                                PUSH    ES
 0343 53                                PUSH    BX
 0344 E8 06C4 R                         CALL    GET_VEC                 ; GET DISK PARAMETERS ADDRESS
 0347 26: 8A 47 0E                      MOV     AL,ES:[BX][14]          ; GET SECTORS/TRACK
 034B 88 46 F9                          MOV     @CMD_BLOCK+1,AL         ; SET SECTOR COUNT IN COMMAND
 034E 5B                                POP     BX
 034F 07                                POP     ES
 0350 E9 050A R                         JMP     CMD_OF                  ; GO EXECUTE THE COMMAND
 0353                           FMT_TRK ENDP


                                ;----------------------------------------
                                ;       READ DASD TYPE        (AH = 15H) :
                                ;----------------------------------------

 0353                           READ_DASD_TYPE  LABEL   NEAR
 0353                           READ_D_T        PROC    FAR             ; GET DRIVE PARAMETERS
 0353 1E                                PUSH    DS                      ; SAVE REGISTERS
 0354 06                                PUSH    ES
 0355 53                                PUSH    BX
                                        ASSUME  DS:DATA
 0356 E8 0000 E                         CALL    DDS                     ; ESTABLISH ADDRESSING
 0359 C6 06 0074 R 00                   MOV     @DISK_STATUS1,0
 035E 8A 1E 0075 R                      MOV     BL,@HF_NUM              ; GET NUMBER OF DRIVES
 0362 80 E2 7F                          AND     DL,7FH                  ; GET DRIVE NUMBER
 0365 3A DA                             CMP     BL,DL
 0367 76 22                             JBE     RDT_NOT_PRESENT         ; RETURN DRIVE NOT PRESENT
 0369 E8 06C4 R                         CALL    GET_VEC                 ; GET DISK PARAMETER ADDRESS
 036C 26: 8A 47 02                      MOV     AL,ES:[BX][2]           ; HEADS
 0370 26: 8A 4F 0E                      MOV     CL,ES:[BX][14]
 0374 F6 E9                             IMUL    CL                      ; * NUMBER OF SECTORS
 0376 26: 8B 0F                         MOV     CX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
 0379 49                                DEC     CX                      ; LEAVE ONE FOR DIAGNOSTICS
 037A F7 E9                             IMUL    CX                      ; NUMBER OF SECTORS
 037C 8B CA                             MOV     CX,DX                   ; HIGH ORDER HALF
 037E 8B D0                             MOV     DX,AX                   ; LOW ORDER HALF
 0380 2B C0                             SUB     AX,AX
 0382 B4 03                             MOV     AH,03H                  ; INDICATE FIXED DISK
 0384 5B                        RDT2:   POP     BX                      ; RESTORE REGISTERS
 0385 07                                POP     ES
 0386 1F                                POP     DS
 0387 F8                                CLC                             ; CLEAR CARRY
 0388 CA 0002                           RET     2
 038B                           RDT_NOT_PRESENT:
 038B 2B C0                             SUB     AX,AX                   ; DRIVE NOT PRESENT RETURN
 038D 8B C8                             MOV     CX,AX                   ; ZERO BLOCK COUNT
 038F 8B D0                             MOV     DX,AX
 0391 EB F1                             JMP     RDT2
 0393                           READ_D_T        ENDP
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                         PAGE
                         ;---------------------------------------
                         ;       GET PARAMETERS       (AH = 08H) :
                         ;---------------------------------------

0393                     GET_PARM_N      LABEL   NEAR
0393                     GET_PARM        PROC    FAR             ; GET DRIVE PARAMETERS
0393 1E                          PUSH    DS                      ; SAVE REGISTERS
0394 06                          PUSH    ES
0395 53                          PUSH    BX
                                 ASSUME  DS:ABS0
0396 B8 ---- R                   MOV     AX,ABS0                 ; ESTABLISH ADDRESSING
0399 8E D8                       MOV     DS,AX
039B F6 C2 01                    TEST    DL,1                    ; CHECK FOR DRIVE 1
039E 74 06                       JZ      G0
03A0 C4 1E 0118 R                LES     BX,@HF1_TBL_VEC
03A4 EB 04                       JMP     SHORT G1
03A6 C4 1E 0104 R        G0:     LES     BX,@HF_TBL_VEC
                                 ASSUME  DS:DATA
03AA                     G1:
03AA E8 0000 E                   CALL    DDS                     ; ESTABLISH SEGMENT
03AD 80 EA 80                    SUB     DL,80H
03B0 80 FA 02                    CMP     DL,MAX_FILE             ; TEST WITHIN RANGE
03B3 73 2C                       JAE     G4
03B5 C6 06 0074 R 00             MOV     @DISK_STATUS1,0
03BA 26: 8B 07                   MOV     AX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
03BD 2D 0002                     SUB     AX,2                    ; ADJUST FOR 0-N
03C0 8A E8                       MOV     CH,AL
03C2 25 0300                     AND     AX,0300H                ; HIGH TWO BITS OF CYLINDER
03C5 D1 E8                       SHR     AX,1
03C7 D1 E8                       SHR     AX,1
03C9 26: 0A 47 0E                OR      AL,ES:[BX][14]          ; SECTORS
03CD 8A C8                       MOV     CL,AL
03CF 26: 8A 77 02                MOV     DH,ES:[BX][2]           ; HEADS
03D3 FE CE                       DEC     DH                      ; 0-N RANGE
03D5 8A 16 0075 R                MOV     DL,@HF_NUM              ; DRIVE COUNT
03D9 2B C0                       SUB     AX,AX
03DB                     G5:
03DB 5B                          POP     BX                      ; RESTORE REGISTERS
03DC 07                          POP     ES
03DD 1F                          POP     DS
03DE CA 0002                     RET     2
03E1                     G4:
03E1 C6 06 0074 R 07             MOV     @DISK_STATUS1,INIT_FAIL ; OPERATION FAILED
03E6 B4 07                       MOV     AH,INIT_FAIL
03E8 2A C0                       SUB     AL,AL
03EA 2B D2                       SUB     DX,DX
03EC 2B C9                       SUB     CX,CX
03EE F9                          STC                             ; SET ERROR FLAG
03EF EB EA                       JMP     G5
03F1                     GET_PARM        ENDP


                         ;---------------------------------------
                         ;       INITIALIZE DRIVE     (AH = 09H) :
                         ;---------------------------------------
03F1                     INIT_DRV        PROC    NEAR
03F1 C6 46 FE 91                 MOV     @CMD_BLOCK+6,SET_PARM_CMD
03F5 E8 06C4 R                   CALL    GET_VEC                 ; ES:BX -> PARAMETER BLOCK
03F8 26: 8A 47 02                MOV     AL,ES:[BX][2]           ; GET NUMBER OF HEADS
03FC FE C8                       DEC     AL                      ; CONVERT TO 0-INDEX
03FE 8A 66 FD                    MOV     AH,@CMD_BLOCK+5         ; GET SDH REGISTER
0401 80 E4 F0                    AND     AH,0F0H                 ; CHANGE HEAD NUMBER
0404 0A E0                       OR      AH,AL                   ;  TO MAX HEAD
0406 88 66 FD                    MOV     @CMD_BLOCK+5,AH
0409 26: 8A 47 0E                MOV     AL,ES:[BX][14]          ; MAX SECTOR NUMBER
040D 88 46 F9                    MOV     @CMD_BLOCK+1,AL
0410 2B C0                       SUB     AX,AX
0412 88 46 FB                    MOV     @CMD_BLOCK+3,AL         ; ZERO FLAGS
0415 E8 055C R                   CALL    COMMAND                 ; TELL CONTROLLER
0418 75 08                       JNZ     INIT_EXIT               ; CONTROLLER BUSY ERROR
041A E8 05F3 R                   CALL    NOT_BUSY                ; WAIT FOR IT TO BE DONE
041D 75 03                       JNZ     INIT_EXIT               ; TIME OUT
041F E8 0630 R                   CALL    CHECK_STATUS
0422                     INIT_EXIT:
0422 C3                          RET
0423                     INIT_DRV        ENDP


                         ;---------------------------------------
                         ;       READ LONG            (AH = 0AH) :
                         ;---------------------------------------

0423                     RD_LONG         PROC    NEAR
0423 C6 46 FE 22                 MOV     @CMD_BLOCK+6,READ_CMD OR ECC_MODE
0427 E9 04C6 R                   JMP     COMMANDI
042A                     RD_LONG         ENDP

                         ;---------------------------------------
                         ;       WRITE LONG           (AH = 0BH) :
                         ;---------------------------------------

042A                     WR_LONG         PROC    NEAR
042A C6 46 FE 32                 MOV     @CMD_BLOCK+6,WRITE_CMD OR ECC_MODE
042E E9 0505 R                   JMP     COMMANDO
0431                     WR_LONG         ENDP

                         ;---------------------------------------
                         ;       SEEK                 (AH = 0CH) :
                         ;---------------------------------------

0431                     DISK_SEEK       PROC    NEAR
0431 C6 46 FE 70                 MOV     @CMD_BLOCK+6,SEEK_CMD
0435 E8 055C R                   CALL    COMMAND
0438 75 14                       JNZ     DS_EXIT                 ; CONTROLLER BUSY ERROR
043A E8 05C2 R                   CALL    WAIT
043D 75 0F                       JNZ     DS_EXIT                 ; TIME OUT ON SEEK
043F E8 0630 R                   CALL    CHECK_STATUS
0442 80 3E 0074 R 40             CMP     @DISK_STATUS1,BAD_SEEK
0447 75 05                       JNE     DS_EXIT
0449 C6 06 0074 R 00             MOV     @DISK_STATUS1,0
044E                     DS_EXIT:
044E C3                          RET

044F                     DISK_SEEK       ENDP
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                                PAGE
                                ;---------------------------------------
                                ;       TEST DISK READY       (AH = 10H) ;
                                ;---------------------------------------

044F                            TST_RDY PROC    NEAR
044F E8 05F3 R                          CALL    NOT_BUSY                ; WAIT FOR CONTROLLER
0452 75 11                              JNZ     TR_EX
0454 8A 46 FD                           MOV     AL,@CMD_BLOCK+5         ; SELECT DRIVE
0457 BA 01F6                            MOV     DX,HF_PORT+6
045A EE                                 OUT     DX,AL
045B E8 0642 R                          CALL    CHECK_ST                ; CHECK STATUS ONLY
045E 75 05                              JNZ     TR_EX
0460 C6 06 0074 R 00                    MOV     @DISK_STATUS1,0         ; WIPE OUT DATA CORRECTED ERROR
0465 C3                         TR_EX:  RET
0466                            TST_RDY ENDP

                                ;---------------------------------------
                                ;       RECALIBRATE           (AH = 11H) ;
                                ;---------------------------------------

0466                            HDISK_RECAL     PROC    NEAR
0466 C6 46 FE 10                        MOV     @CMD_BLOCK+6,RECAL_CMD
046A E8 055C R                          CALL    COMMAND                 ; START THE OPERATION
046D 75 19                              JNZ     RECAL_EXIT              ; ERROR
046F E8 05C2 R                          CALL    WAIT                    ; WAIT FOR COMPLETION
0472 74 05                              JZ      RECAL_X                 ; TIME OUT ONE OK ?
0474 E8 05C2 R                          CALL    WAIT                    ; WAIT FOR COMPLETION LONGER
0477 75 0F                              JNZ     RECAL_EXIT              ; TIME OUT TWO TIMES IS ERROR
0479                            RECAL_X:
0479 E8 0630 R                          CALL    CHECK_STATUS
047C 80 3E 0074 R 40                    CMP     @DISK_STATUS1,BAD_SEEK  ; SEEK NOT COMPLETE
0481 75 05                              JNE     RECAL_EXIT              ; IS OK
0483 C6 06 0074 R 00                    MOV     @DISK_STATUS1,0
0488                            RECAL_EXIT:
0488 80 3E 0074 R 00                    CMP     @DISK_STATUS1,0
048D C3                                 RET
048E                            HDISK_RECAL     ENDP

                                ;---------------------------------------
                                ;     CONTROLLER DIAGNOSTIC (AH = 14H) ;
                                ;---------------------------------------

048E                            CTLR_DIAGNOSTIC PROC    NEAR
048E FA                                 CLI                             ; DISABLE INTERRUPTS WHILE CHANGING MASK
048F E4 A1                              IN      AL,INTB01               ; TURN ON SECOND INTERRUPT CHIP
0491 24 BF                              AND     AL,0BFH
0493 EB 00                              JMP     $+2
0495 E6 A1                              OUT     INTB01,AL
0497 E4 21                              IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
0499 24 FB                              AND     AL,0FBH                 ;  SECOND CHIP
049B EB 00                              JMP     $+2
049D E6 21                              OUT     INTA01,AL
049F FB                                 STI
04A0 E8 05F3 R                          CALL    NOT_BUSY                ; WAIT FOR CARD
04A3 75 1A                              JNZ     CD_ERR                  ; BAD CARD
04A5 BA 01F7                            MOV     DX,HF_PORT+7
04A8 B0 90                              MOV     AL,DIAG_CMD             ; START DIAGNOSE
04AA EE                                 OUT     DX,AL
04AB E8 05F3 R                          CALL    NOT_BUSY                ; WAIT FOR IT TO COMPLETE
04AE B4 80                              MOV     AH,TIME_OUT
04B0 75 0F                              JNZ     CD_EXIT                 ; TIME OUT ON DIAGNOSTIC
04B2 BA 01F1                            MOV     DX,HF_PORT+1            ; GET ERROR REGISTER
04B5 EC                                 IN      AL,DX
04B6 A2 008D R                          MOV     @HF_ERROR,AL            ; SAVE IT
04B9 B4 00                              MOV     AH,0
04BB 3C 01                              CMP     AL,1                    ; CHECK FOR ALL OK
04BD 74 02                              JE      SHORT CD_EXIT
04BF B4 20                      CD_ERR: MOV     AH,BAD_CNTLR
04C1                            CD_EXIT:
04C1 88 26 0074 R                       MOV     @DISK_STATUS1,AH
04C5 C3                                 RET
04C6                            CTLR_DIAGNOSTIC ENDP

                                ;---------------------------------------
                                ; COMMANDI                              ;
                                ;       REPEATEDLY INPUTS DATA TILL     ;
                                ;       NSECTOR RETURNS ZERO            ;
                                ;---------------------------------------
04C6                            COMMANDI:
04C6 E8 06A1 R                          CALL    CHECK_DMA               ; CHECK 64K BOUNDARY ERROR
04C9 72 39                              JC      CMD_ABORT
04CB 8B FB                              MOV     DI,BX
04CD E8 055C R                          CALL    COMMAND                 ; OUTPUT COMMAND
04D0 75 32                              JNZ     CMD_ABORT
04D2                            CMD_I1:
04D2 E8 05C2 R                          CALL    WAIT                    ; WAIT FOR DATA REQUEST INTERRUPT
04D5 75 2D                              JNZ     TM_OUT                  ; TIME OUT
04D7 B9 0100                            MOV     CX,256D                 ; SECTOR SIZE IN WORDS
04DA BA 01F0                            MOV     DX,HF_PORT
04DD FA                                 CLI
04DE FC                                 CLD
04DF F3/ 6D                             REP     INSW                    ; GET THE SECTOR
04E1 FB                                 STI
04E2 F6 46 FE 02                        TEST    @CMD_BLOCK+6,ECC_MODE   ; CHECK FOR NORMAL INPUT
04E6 74 12                              JZ      CMD_I3
04E8 E8 061A R                          CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
04EB 72 17                              JC      TM_OUT
04ED BA 01F0                            MOV     DX,HF_PORT
04F0 B9 0004                            MOV     CX,4                    ; GET ECC BYTES
04F3 EC                         CMD_I2: IN      AL,DX
04F4 26: 88 05                          MOV     ES:BYTE PTR [DI],AL     ; GO SLOW FOR BOARD
04F7 47                                 INC     DI
04F8 E2 F9                              LOOP    CMD_I2
04FA E8 0630 R                  CMD_I3: CALL    CHECK_STATUS
04FD 75 05                              JNZ     CMD_ABORT               ; ERROR RETURNED
04FF FE 4E F9                           DEC     @CMD_BLOCK+1            ; CHECK FOR MORE
0502 75 CE                              JNZ     SHORT CMD_I1
0504                            CMD_ABORT:
0504                            TM_OUT:
0504 C3                                 RET
```

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                                PAGE
                                ;----------------------------------------
                                ; COMMANDO                              :
                                ;       REPEATEDLY OUTPUTS DATA TILL    :
                                ;       NSECTOR RETURNS ZERO            :
                                ;----------------------------------------
0505                            COMMANDO:
0505  E8 06A1 R                         CALL    CHECK_DMA               ; CHECK 64K BOUNDARY ERROR
0508  72 FA                             JC      CMD_ABORT
050A  8B F3                     CMD_OF: MOV     SI,BX
050C  E8 055C R                         CALL    COMMAND                 ; OUTPUT COMMAND
050F  75 F3                             JNZ     CMD_ABORT
0511  E8 061A R                         CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
0514  72 EE                             JC      TM_OUT                  ; TOO LONG
0516  1E                        CMD_01: PUSH    DS
0517  06                                PUSH    ES                      ; MOVE ES TO DS
0518  1F                                POP     DS
0519  B9 0100                           MOV     CX,256D                 ; PUT THE DATA OUT TO THE CARD
051C  BA 01F0                           MOV     DX,HF_PORT
051F  FA                                CLI
0520  FC                                CLD
0521  F3/ 6F                            REP     OUTSW
0523  FB                                STI
0524  1F                                POP     DS                      ; RESTORE DS
0525  F6 46 FE 02                       TEST    @CMD_BLOCK+6,ECC_MODE   ; CHECK FOR NORMAL OUTPUT
0529  74 12                             JZ      CMD_03
052B  E8 061A R                         CALL    WAIT_DRQ                ; WAIT FOR DATA REQUEST
052E  72 D4                             JC      TM_OUT
0530  BA 01F0                           MOV     DX,HF_PORT
0533  B9 0004                           MOV     CX,4                    ; OUTPUT THE ECC BYTES
0536  26: 8A 04                 CMD_02: MOV     AL,ES:BYTE PTR [SI]
0539  EE                                OUT     DX,AL
053A  46                                INC     SI
053B  E2 F9                             LOOP    CMD_02
053D                            CMD_03:
053D  E8 05C2 R                         CALL    WAIT                    ; WAIT FOR SECTOR COMPLETE INTERRUPT
0540  75 C2                             JNZ     TM_OUT                  ; ERROR RETURNED
0542  E8 0630 R                         CALL    CHECK_STATUS
0545  75 BD                             JNZ     CMD_ABORT
0547  F6 06 008C R 08                   TEST    @HF_STATUS,ST_DRQ       ; CHECK FOR MORE
054C  75 C8                             JNZ     SHORT CMD_01
054E  BA 01F2                           MOV     DX,HF_PORT+2            ; CHECK RESIDUAL SECTOR COUNT
0551  EC                                IN      AL,DX                   ;
0552  A8 FF                             TEST    AL,0FFH                 ;
0554  74 05                             JZ      CMD_04                  ; COUNT = 0  OK
0556  C6 06 0074 R BB                   MOV     @DISK_STATUS1,UNDEF_ERR ; OPERATION ABORTED - PARTIAL TRANSFER
055B                            CMD_04:
055B  C3                                RET

                                ;-------------------------------------------------------
                                ; COMMAND                                              :
                                ;       THIS ROUTINE OUTPUTS THE COMMAND BLOCK         :
                                ; OUTPUT                                               :
                                ;       BL = STATUS                                    :
                                ;       BH = ERROR REGISTER                            :
                                ;-------------------------------------------------------

055C                            COMMAND PROC    NEAR
055C  53                                PUSH    BX                      ; WAIT FOR SEEK COMPLETE AND READY
055D  B9 0600                           MOV     CX,DELAY_2              ; SET INITIAL DELAY BEFORE TEST
0560                            COMMAND1:
0560  51                                PUSH    CX                      ; SAVE LOOP COUNT
0561  E8 044F R                         CALL    TST_RDY                 ; CHECK DRIVE READY
0564  59                                POP     CX
0565  74 0B                             JZ      COMMAND2                ; DRIVE IS READY
0567  80 3E 0074 R 80                   CMP     @DISK_STATUS1,TIME_OUT  ; TST_RDY TIMED OUT--GIVE UP
056C  74 48                             JZ      CMD_TIMEOUT
056E  E2 F0                             LOOP    COMMAND1                ; KEEP TRYING FOR A WHILE
0570  EB 49                             JMP     SHORT COMMAND4          ; ITS NOT GOING TO GET READY
0572                            COMMAND2:
0572  5B                                POP     BX
0573  57                                PUSH    DI
0574  C6 06 008E R 00                   MOV     @HF_INT_FLAG,0          ; RESET INTERRUPT FLAG
0579  FA                                CLI                             ; INHIBIT INTERRUPTS WHILE CHANGING MASK
057A  E4 A1                             IN      AL,INTB01               ; TURN ON SECOND INTERRUPT CHIP
057C  24 BF                             AND     AL,0BFH
057E  EB 00                             JMP     $+2
0580  E6 A1                             OUT     INTB01,AL
0582  E4 21                             IN      AL,INTA01               ; LET INTERRUPTS PASS THRU TO
0584  24 FB                             AND     AL,0FBH                 ;  SECOND CHIP
0586  EB 00                             JMP     $+2
0588  E6 21                             OUT     INTA01,AL
058A  FB                                STI
058B  33 FF                             XOR     DI,DI                   ; INDEX THE COMMAND TABLE
058D  BA 01F1                           MOV     DX,HF_PORT+1            ; DISK ADDRESS
0590  F6 06 0076 R C0                   TEST    @CONTROL_BYTE,0C0H      ; CHECK FOR RETRY SUPPRESSION
0595  74 11                             JZ      COMMAND3
0597  8A 46 FE                          MOV     AL,@CMD_BLOCK+6         ; YES-GET OPERATION CODE
059A  24 F0                             AND     AL,0F0H                 ; GET RID OF MODIFIERS
059C  3C 20                             CMP     AL,20H                  ; 20H-40H IS READ, WRITE, VERIFY
059E  72 08                             JB      COMMAND3
05A0  3C 40                             CMP     AL,40H
05A2  77 04                             JA      COMMAND3
05A4  80 4E FE 01                       OR      @CMD_BLOCK+6,NO_RETRIES ; VALID OPERATION FOR RETRY SUPPRESS
05A8                            COMMAND3:
05A8  8A 43 F8                          MOV     AL,[@CMD_BLOCK+DI]      ; GET THE COMMAND STRING BYTE
05AB  EE                                OUT     DX,AL                   ; GIVE IT TO CONTROLLER
05AC  47                                INC     DI                      ; NEXT BYTE IN COMMAND BLOCK
05AD  42                                INC     DX                      ; NEXT DISK ADAPTER REGISTER
05AE  81 FA 01F8                        CMP     DX,HF_PORT+8            ; ALL DONE?
05B2  75 F4                             JNZ     COMMAND3                ; NO--GO DO NEXT ONE
05B4  5F                                POP     DI
05B5  C3                                RET                             ; ZERO FLAG IS SET
05B6                            CMD_TIMEOUT:
05B6  C6 06 0074 R 20                   MOV     @DISK_STATUS1,BAD_CNTLR
05BB                            COMMAND4:
05BB  5B                                POP     BX
05BC  80 3E 0074 R 00                   CMP     @DISK_STATUS1,0         ; SET CONDITION CODE FOR CALLER
05C1  C3                                RET
05C2                            COMMAND ENDP
```

SECTION 5

```
                                  PAGE
                                  ;----------------------------------------
                                  ;       WAIT FOR INTERRUPT             :
                                  ;----------------------------------------
 05C2                             WAIT    PROC    NEAR
 05C2  FB                                 STI                           ; MAKE SURE INTERRUPTS ARE ON
 05C3  2B C9                              SUB     CX,CX                 ; SET INITIAL DELAY BEFORE TEST
 05C5  F8                                 CLC
 05C6  B8 9000                            MOV     AX,9000H              ; DEVICE WAIT INTERRUPT
 05C9  CD 15                              INT     15H
 05CB  72 0F                              JC      WT2                   ; DEVICE TIMED OUT

 05CD  B3 25                              MOV     BL,DELAY_1            ; SET DELAY COUNT

                                  ;-----  WAIT LOOP

 05CF  F6 06 008E R 80            WT1:    TEST    @HF_INT_FLAG,80H      ; TEST FOR INTERRUPT
 05D4  E1 F9                              LOOPZ   WT1
 05D6  75 0B                              JNZ     WT3                   ; INTERRUPT--LETS GO
 05D8  FE CB                              DEC     BL
 05DA  75 F3                              JNZ     WT1                   ; KEEP TRYING FOR A WHILE

 05DC  C6 06 0074 R 80            WT2:    MOV     @DISK_STATUS1,TIME_OUT ; REPORT TIME OUT ERROR
 05E1  EB 0A                              JMP     SHORT WT4
 05E3  C6 06 0074 R 00            WT3:    MOV     @DISK_STATUS1,0
 05E8  C6 06 008E R 00                    MOV     @HF_INT_FLAG,0
 05ED  80 3E 0074 R 00            WT4:    CMP     @DISK_STATUS1,0       ; SET CONDITION CODE FOR CALLER
 05F2  C3                                 RET
 05F3                             WAIT    ENDP


                                  ;----------------------------------------
                                  ;       WAIT FOR CONTROLLER NOT BUSY   :
                                  ;----------------------------------------
 05F3                             NOT_BUSY        PROC    NEAR
 05F3  FB                                 STI                           ; MAKE SURE INTERRUPTS ARE ON
 05F4  53                                 PUSH    BX
 05F5  2B C9                              SUB     CX,CX                 ; SET INITIAL DELAY BEFORE TEST
 05F7  BA 01F7                            MOV     DX,HF_PORT+7
 05FA  B3 25                              MOV     BL,DELAY_1
 05FC  EC                         NB1:    IN      AL,DX                 ; CHECK STATUS
 05FD  A8 80                              TEST    AL,ST_BUSY
 05FF  E0 FB                              LOOPNZ  NB1
 0601  74 0B                              JZ      NB2                   ; NOT BUSY--LETS GO
 0603  FE CB                              DEC     BL
 0605  75 F5                              JNZ     NB1                   ; KEEP TRYING FOR A WHILE
 0607  C6 06 0074 R 80                    MOV     @DISK_STATUS1,TIME_OUT ; REPORT TIME OUT ERROR
 060C  EB 05                              JMP     SHORT NB3
 060E  C6 06 0074 R 00            NB2:    MOV     @DISK_STATUS1,0
 0613  5B                         NB3:    POP     BX
 0614  80 3E 0074 R 00                    CMP     @DISK_STATUS1,0       ; SET CONDITION CODE FOR CALLER
 0619  C3                                 RET
 061A                             NOT_BUSY        ENDP


                                  ;----------------------------------------
                                  ;       WAIT FOR DATA REQUEST          :
                                  ;----------------------------------------
 061A                             WAIT_DRQ        PROC    NEAR
 061A  B9 0100                            MOV     CX,DELAY_3
 061D  BA 01F7                            MOV     DX,HF_PORT+7
 0620  EC                         WQ_1:   IN      AL,DX                 ; GET STATUS
 0621  A8 08                              TEST    AL,ST_DRQ             ; WAIT FOR DRQ
 0623  75 09                              JNZ     WQ_OK
 0625  E2 F9                              LOOP    WQ_1                  ; KEEP TRYING FOR A SHORT WHILE
 0627  C6 06 0074 R 80                    MOV     @DISK_STATUS1,TIME_OUT ; ERROR
 062C  F9                                 STC
 062D  C3                                 RET
 062E  F8                         WQ_OK:  CLC
 062F  C3                                 RET
 0630                             WAIT_DRQ        ENDP
                                  ;----------------------------------------
                                  ;       CHECK FIXED DISK STATUS        :
                                  ;----------------------------------------
 0630                             CHECK_STATUS    PROC    NEAR
 0630  E8 0642 R                          CALL    CHECK_ST              ; CHECK THE STATUS BYTE
 0633  75 07                              JNZ     CHECK_S1              ; AN ERROR WAS FOUND
 0635  A8 01                              TEST    AL,ST_ERROR           ; WERE THERE ANY OTHER ERRORS
 0637  74 03                              JZ      CHECK_S1              ; NO ERROR REPORTED
 0639  E8 0676 R                          CALL    CHECK_ER              ; ERROR REPORTED
 063C                             CHECK_S1:
 063C  80 3E 0074 R 00                    CMP     @DISK_STATUS1,0       ; SET STATUS FOR CALLER
 0641  C3                                 RET
 0642                             CHECK_STATUS    ENDP
                                  ;----------------------------------------
                                  ;       CHECK FIXED DISK STATUS BYTE   :
                                  ;----------------------------------------
 0642                             CHECK_ST        PROC    NEAR
 0642  BA 01F7                            MOV     DX,HF_PORT+7          ; GET THE STATUS
 0645  EC                                 IN      AL,DX
 0646  A2 008C R                          MOV     @HF_STATUS,AL
 0649  B4 00                              MOV     AH,0
 064B  A8 80                              TEST    AL,ST_BUSY            ; IF STILL BUSY
 064D  75 1A                              JNZ     CKST_EXIT             ;  REPORT OK
 064F  B4 CC                              MOV     AH,WRITE_FAULT
 0651  A8 20                              TEST    AL,ST_WRT_FLT         ; CHECK FOR WRITE FAULT
 0653  75 14                              JNZ     CKST_EXIT
 0655  B4 AA                              MOV     AH,NOT_RDY
 0657  A8 40                              TEST    AL,ST_READY           ; CHECK FOR NOT READY
 0659  74 0E                              JZ      CKST_EXIT
 065B  B4 40                              MOV     AH,BAD_SEEK
 065D  A8 10                              TEST    AL,ST_SEEK_COMPL      ; CHECK FOR SEEK NOT COMPLETE
 065F  74 08                              JZ      CKST_EXIT
 0661  B4 11                              MOV     AH,DATA_CORRECTED
 0663  A8 04                              TEST    AL,ST_CORRCTD         ; CHECK FOR CORRECTED ECC
 0665  75 02                              JNZ     CKST_EXIT
 0667  B4 00                              MOV     AH,0
 0669                             CKST_EXIT:
 0669  88 26 0074 R                       MOV     @DISK_STATUS1,AH      ; SET ERROR FLAG
 066D  80 FC 11                           CMP     AH,DATA_CORRECTED     ; KEEP GOING WITH DATA CORRECTED
 0670  74 03                              JZ      CKST_EXT
 0672  80 FC 00                           CMP     AH,0
 0675                             CKST_EXT:
 0675  C3                                 RET
 0676                             CHECK_ST        ENDP
```

```
                                PAGE
                                ;---------------------------------------
                                ;       CHECK FIXED DISK ERROR REGISTER :
                                ;---------------------------------------
0676                            CHECK_ER        PROC    NEAR
0676  BA 01F1                           MOV     DX,HF_PORT+1            ; GET THE ERROR REGISTER
0679  EC                                IN      AL,DX
067A  A2 008D R                         MOV     @HF_ERROR,AL
067D  53                                PUSH    BX
067E  B9 0008                           MOV     CX,8                    ; TEST ALL 8 BITS
0681  D0 E0                     CK1:    SHL     AL,1                    ; MOVE NEXT ERROR BIT TO CARRY
0683  72 02                             JC      CK2                     ; FOUND THE ERROR
0685  E2 FA                             LOOP    CK1                     ; KEEP TRYING
0687  BB 0698 R                 CK2:    MOV     BX,OFFSET ERR_TBL       ; COMPUTE ADDRESS OF
068A  03 D9                             ADD     BX,CX                   ; ERROR CODE'
068C  2E: 8A 27                         MOV     AH,BYTE PTR CS:[BX]     ; GET ERROR CODE
068F  88 26 0074 R              CKEX:   MOV     @DISK_STATUS1,AH        ; SAVE ERROR CODE
0693  5B                                POP     BX
0694  80 FC 00                          CMP     AH,0
0697  C3                                RET
0698  E0                        ERR_TBL DB      NO_ERR
0699  02 40 01 BB                       DB      BAD_ADDR_MARK,BAD_SEEK,BAD_CMD,UNDEF_ERR
069D  04 BB 10 0A                       DB      RECORD_NOT_FND,UNDEF_ERR,BAD_ECC,BAD_SECTOR
06A1                            CHECK_ER        ENDP

                                ;-----------------------------------------------------------
                                ; CHECK_DMA                                                 :
                                ;  -CHECK ES:BX AND # SECTORS TO MAKE SURE THAT IT WILL     :
                                ;   FIT WITHOUT SEGMENT OVERFLOW.                           :
                                ;  -ES:BX HAS BEEN REVISED TO THE FORMAT SSSS:000X          :
                                ;  -OK IF # SECTORS < 80H (7FH IF LONG READ OR WRITE)       :
                                ;  -OK IF # SECTORS = 80H (7FH) AND BX <= 00H (04H)         :
                                ;  -ERROR OTHERWISE                                         :
                                ;-----------------------------------------------------------
06A1                            CHECK_DMA       PROC    NEAR
06A1  50                                PUSH    AX                      ; SAVE REGISTERS
06A2  B8 8000                           MOV     AX,8000H                ; AH = MAX # SECTORS    AL = MAX OFFSET
06A5  F6 46 FE 02                       TEST    @CMD_BLOCK+6,ECC_MODE
06A9  74 03                             JZ      CKD1
06AB  B8 7F04                           MOV     AX,7F04H                ; ECC IS 4 MORE BYTES
06AE  3A 66 F9                  CKD1:   CMP     AH,@CMD_BLOCK+1         ; NUMBER OF SECTORS
06B1  77 06                             JA      CKDOK                   ; IT WILL FIT
06B3  72 07                             JB      CKDERR                  ; TOO MANY
06B5  3A C3                             CMP     AL,BL                   ; CHECK OFFSET ON MAX SECTORS
06B7  72 03                             JB      CKDERR                  ; ERROR
06B9  F8                        CKDOK:  CLC                             ; CLEAR CARRY
06BA  58                                POP     AX
06BB  C3                                RET                             ; NORMAL RETURN
06BC  F9                        CKDERR: STC                             ; INDICATE ERROR
06BD  C6 06 0074 R 09                   MOV     @DISK_STATUS1,DMA_BOUNDARY
06C2  58                                POP     AX
06C3  C3                                RET
06C4                            CHECK_DMA       ENDP

                                ;---------------------------------------
                                ;       SET UP  ES:BX-> DISK PARMS      :
                                ;---------------------------------------
06C4                            GET_VEC PROC    NEAR
06C4  2B C0                             SUB     AX,AX                   ; GET DISK PARAMETER ADDRESS
06C6  8E C0                             MOV     ES,AX
                                        ASSUME  ES:ABS0
06C8  F6 C2 01                          TEST    DL,1
06CB  74 07                             JZ      GV_0
06CD  26: C4 1E 0118 R                  LES     BX,@HF1_TBL_VEC         ; ES:BX -> DRIVE PARAMETERS
06D2  EB 05                             JMP     SHORT GV_EXIT
06D4                            GV_0:
06D4  26: C4 1E 0104 R                  LES     BX,@HF_TBL_VEC          ; ES:BX -> DRIVE PARAMETERS
06D9                            GV_EXIT:
06D9  C3                                RET
06DA                            GET_VEC ENDP

                                ;--- HARDWARE INT  76H -- ( IRQ LEVEL  14 ) ------------------------------------
                                ;                                                                              :
                                ;       FIXED DISK INTERRUPT ROUTINE                                           :
                                ;                                                                              :
                                ;-------------------------------------------------------------------------------

06DA                            HD_INT  PROC    NEAR
06DA  50                                PUSH    AX
06DB  1E                                PUSH    DS
06DC  E8 0000 E                         CALL    DDS
06DF  C6 06 008E R FF                   MOV     @HF_INT_FLAG,0FFH       ; ALL DONE
06E4  B0 20                             MOV     AL,EOI                  ; NON-SPECIFIC END OF INTERRUPT
06E6  E6 A0                             OUT     INTB00,AL               ; FOR CONTROLLER #2
06E8  EB 00                             JMP     $+2                     ; WAIT
06EA  E6 20                             OUT     INTA00,AL               ; FOR CONTROLLER #1
06EC  1F                                POP     DS
06ED  FB                                STI                             ; RE-ENABLE INTERRUPTS
06EE  B8 9100                           MOV     AX,9100H                ; DEVICE POST
06F1  CD 15                             INT     15H                     ;  INTERRUPT
06F3  58                                POP     AX
06F4  CF                                IRET                            ; RETURN FROM INTERRUPT
06F5                            HD_INT  ENDP

06F5  31 31 2F 31 35 2F                 DB      '11/15/85'              ; RELEASE MARKER
      38 35
06FD                            CODE    ENDS
                                        END
```

SECTION 5

```
                        PAGE 118,121
                        TITLE KYBD ----- 03/06/86  KEYBOARD BIOS
                        .LIST
 0000                   CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  K16
                                PUBLIC  KEYBOARD_IO_1
                                PUBLIC  KB_INT_1
                                PUBLIC  SND_DATA

                                EXTRN   BEEP:NEAR
                                EXTRN   DDS:NEAR
                                EXTRN   START_1:NEAR
                                EXTRN   K6:BYTE
                                EXTRN   K6L:ABS
                                EXTRN   K7:BYTE
                                EXTRN   K8:BYTE
                                EXTRN   K10:BYTE
                                EXTRN   K11:BYTE
                                EXTRN   K12:BYTE
                                EXTRN   K14:BYTE
                                EXTRN   K15:BYTE

                        ;--- INT 16 H -----------------------------------------------------------------
                        ; KEYBOARD I/O                                                               :
                        ;       THESE ROUTINES PROVIDE READ KEYBOARD SUPPORT                         :
                        ; INPUT                                                                      :
                        ;       (AH)= 00H  READ THE NEXT ASCII CHARACTER ENTERED FROM THE KEYBOARD,  :
                        ;                  RETURN THE RESULT IN (AL), SCAN CODE IN (AH).             :
                        ;                  THIS IS THE COMPATIBLE READ INTERFACE, EQUIVALENT TO THE  :
                        ;                  STANDARD PC OR PCAT KEYBOARD                              :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 01H  SET THE Z FLAG TO INDICATE IF AN ASCII CHARACTER IS       :
                        ;                  AVAILABLE TO BE READ.                                     :
                        ;                  (ZF)= 1 -- NO CODE AVAILABLE                              :
                        ;                  (ZF)= 0 -- CODE IS AVAILABLE  (AX)= CHARACTER             :
                        ;                  IF (ZF)= 0, THE NEXT CHARACTER IN THE BUFFER TO BE READ IS :
                        ;                  IN (AX), AND THE ENTRY REMAINS IN THE BUFFER.             :
                        ;                  THIS WILL RETURN ONLY PC/PCAT KEYBOARD COMPATIBLE CODES   :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 02H  RETURN THE CURRENT SHIFT STATUS IN AL REGISTER            :
                        ;                  THE BIT SETTINGS FOR THIS CODE ARE INDICATED IN THE       :
                        ;                  THE EQUATES FOR @KB_FLAG                                  :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 03H  SET TYPAMATIC RATE AND DELAY                              :
                        ;             (AL) = 05H                                                     :
                        ;             (BL) = TYPAMATIC RATE  (BITS 5 - 7 MUST BE RESET TO 0)         :
                        ;                                                                            :
                        ;                    REGISTER     RATE      REGISTER     RATE                :
                        ;                     VALUE     SELECTED     VALUE     SELECTED              :
                        ;                    ---------------------------------------------           :
                        ;                      00H        30.0        10H        7.5                 :
                        ;                      01H        26.7        11H        6.7                 :
                        ;                      02H        24.0        12H        6.0                 :
                        ;                      03H        21.8        13H        5.5                 :
                        ;                      04H        20.0        14H        5.0                 :
                        ;                      05H        18.5        15H        4.6                 :
                        ;                      06H        17.1        16H        4.3                 :
                        ;                      07H        16.0        17H        4.0                 :
                        ;                      08H        15.0        18H        3.7                 :
                        ;                      09H        13.3        19H        3.3                 :
                        ;                      0AH        12.0        1AH        3.0                 :
                        ;                      0BH        10.9        1BH        2.7                 :
                        ;                      0CH        10.0        1CH        2.5                 :
                        ;                      0DH         9.2        1DH        2.3                 :
                        ;                      0EH         8.6        1EH        2.1                 :
                        ;                      0FH         8.0        1FH        2.0                 :
                        ;                                                                            :
                        ;             (BH) = TYPAMATIC DELAY (BITS 2 - 7 MUST BE RESET TO 0)         :
                        ;                                                                            :
                        ;                   REGISTER    DELAY                                        :
                        ;                    VALUE      VALUE                                        :
                        ;                   ------------------                                       :
                        ;                      00H       250 ms                                      :
                        ;                      01H       500 ms                                      :
                        ;                      02H       750 ms                                      :
                        ;                      03H      1000 ms                                      :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 05H  PLACE ASCII CHARACTER/SCAN CODE COMBINATION IN KEYBOARD   :
                        ;                  BUFFER AS IF STRUCK FROM KEYBOARD                         :
                        ;                  ENTRY:  (CL) = ASCII CHARACTER                            :
                        ;                          (CH) = SCAN CODE                                  :
                        ;                  EXIT:   (AL) = 00H = SUCCESSFUL OPERATION                 :
                        ;                          (AL) = 01H = UNSUCCESSFUL - BUFFER FULL           :
                        ;                  FLAGS:  CARRY IF ERROR                                    :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 10H  EXTENDED READ INTERFACE FOR THE ENHANCED KEYBOARD,        :
                        ;                  OTHERWISE SAME AS FUNCTION AH=0                           :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 11H  EXTENDED ASCII STATUS FOR THE ENHANCED KEYBOARD,          :
                        ;                  OTHERWISE SAME AS FUNCTION AH=1                           :
                        ;----------------------------------------------------------------------------:
                        ;       (AH)= 12H  RETURN THE EXTENDED SHIFT STATUS IN AX REGISTER           :
                        ;                  AL = BITS FROM KB_FLAG, AH = BITS FOR LEFT AND RIGHT      :
                        ;                  CTL AND ALT KEYS FROM KB_FLAG_1 AND KB_FLAG_3             :
                        ;                                                                            :
                        ; OUTPUT                                                                     :
                        ;       AS NOTED ABOVE, ONLY (AX) AND FLAGS CHANGED                          :
                        ;       ALL REGISTERS RETAINED                                               :
                        ;-----------------------------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA

 0000                   KEYBOARD_IO_1   PROC    FAR             ; >>> ENTRY POINT FOR ORG 0E82EH
 0000  FB                       STI                             ; INTERRUPTS BACK ON
 0001  1E                       PUSH    DS                      ; SAVE CURRENT DS
 0002  53                       PUSH    BX                      ; SAVE BX TEMPORARILY
 0003  51                       PUSH    CX                      ; SAVE CX TEMPORARILY
 0004  E8 0000 E                CALL    DDS                     ; ESTABLISH POINTER TO DATA REGION
 0007  0A E4                    OR      AH,AH                   ; CHECK FOR (AH)= 00H
 0009  74 2D                    JZ      K1                      ; ASCII_READ
 000B  FE CC                    DEC     AH                      ; CHECK FOR (AH)= 01H
 000D  74 3E                    JZ      K2                      ; ASCII_STATUS
 000F  FE CC                    DEC     AH                      ; CHECK FOR (AH)= 02H
 0011  74 6B                    JZ      K3                      ; SHIFT_STATUS
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0013 FE CC                       DEC     AH                      ; CHECK FOR (AH)= 03H
0015 74 6C                       JZ      K300                    ; SET TYPAMATIC RATE/DELAY
0017 80 EC 02                    SUB     AH,2                    ; CHECK FOR (AH)= 05H
001A 75 03                       JNZ     KIO1                    ;
001C E9 00A4 R                   JMP     K500                    ; KEYBOARD WRITE
001F 80 EC 0B           KIO1:    SUB     AH,11                   ; AH = 10
0022 74 0C                       JZ      K1E                     ; EXTENDED_ASCII_READ
0024 FE CC                       DEC     AH                      ; CHECK FOR (AH)= 11H
0026 74 1A                       JZ      K2E                     ; EXTENDED_ASCII_STATUS
0028 FE CC                       DEC     AH                      ; CHECK FOR (AH)= 12H
002A 74 39                       JZ      K3E                     ; EXTENDED_SHIFT_STATUS
002C                    KIO_EXIT:
002C 59                          POP     CX                      ; RECOVER REGISTER
002D 5B                          POP     BX                      ; RECOVER REGISTER
002E 1F                          POP     DS                      ; RECOVER SEGMENT
002F CF                          IRET                            ; INVALID COMMAND

                        ;------ ASCII CHARACTER

0030 E8 00C7 R          K1E:     CALL    K1S             ; GET A CHARACTER FROM THE BUFFER (EXTENDED)
0033 E8 0125 R                   CALL    KIO_E_XLAT      ; ROUTINE TO XLATE FOR EXTENDED CALLS
0036 EB F4                       JMP     KIO_EXIT        ; GIVE IT TO THE CALLER

0038 E8 00C7 R          K1:      CALL    K1S             ; GET A CHARACTER FROM THE BUFFER
003B E8 0130 R                   CALL    KIO_S_XLAT      ; ROUTINE TO XLATE FOR STANDARD CALLS
003E 72 F8                       JC      K1              ; CARRY SET MEANS THROW CODE AWAY
0040 EB EA              K1A:     JMP     KIO_EXIT        ; RETURN TO CALLER

                        ;------ ASCII STATUS

0042 E8 0103 R          K2E:     CALL    K2S             ; TEST FOR CHARACTER IN BUFFER (EXTENDED)
0045 74 18                       JZ      K2B             ; RETURN IF BUFFER EMPTY
0047 9C                          PUSHF                   ; SAVE ZF FROM TEST
0048 E8 0125 R                   CALL    KIO_E_XLAT      ; ROUTINE TO XLATE FOR EXTENDED CALLS
004B EB 11                       JMP     SHORT K2A       ; GIVE IT TO THE CALLER

004D E8 0103 R          K2:      CALL    K2S             ; TEST FOR CHARACTER IN BUFFER
0050 74 0D                       JZ      K2B             ; RETURN IF BUFFER EMPTY
0052 9C                          PUSHF                   ; SAVE ZF FROM TEST
0053 E8 0130 R                   CALL    KIO_S_XLAT      ; ROUTINE TO XLATE FOR STANDARD CALLS
0056 73 06                       JNC     K2A             ; CARRY CLEAR MEANS PASS VALID CODE
0058 9D                          POPF                    ;  INVALID CODE FOR THIS TYPE OF CALL
0059 E8 00C7 R                   CALL    K1S             ;  THROW THE CHARACTER AWAY
005C EB EF                       JMP     K2              ; GO LOOK FOR NEXT CHAR, IF ANY

005E 9D                 K2A:     POPF                    ; RESTORE ZF FROM TEST
005F 59                 K2B:     POP     CX              ; RECOVER REGISTER
0060 5B                          POP     BX              ; RECOVER REGISTER
0061 1F                          POP     DS              ; RECOVER SEGMENT
0062 CA 0002                     RET     2               ; THROW AWAY FLAGS

                        ;------ SHIFT STATUS

0065                    K3E:                             ; GET THE EXTENDED SHIFT STATUS FLAGS
0065 8A 26 0018 R                MOV     AH,•KB_FLAG_1   ; GET SYSTEM SHIFT KEY STATUS
0069 80 E4 04                    AND     AH,SYS_SHIFT    ; MASK ALL BUT SYS KEY BIT
006C B1 05                       MOV     CL,5            ; SHIFT THE SYSTEM KEY BIT OVER TO
006E D2 E4                       SHL     AH,CL           ;  BIT 7 POSITION
0070 A0 0018 R                   MOV     AL,•KB_FLAG_1   ; GET SHIFT STATES BACK
0073 24 73                       AND     AL,01110011B    ; ELIMINATE SYS_SHIFT, HOLD_STATE, AND INS_SHIFT
0075 0A E0                       OR      AH,AL           ; MERGE THE REMAINING BITS INTO AH
0077 A0 0096 R                   MOV     AL,•KB_FLAG_3   ; GET RIGHT CTL AND ALT
007A 24 0C                       AND     AL,00001100B    ; ELIMINATE LC_E0 AND LC_E1
007C 0A E0                       OR      AH,AL           ; OR THE SHIFT FLAGS TOGETHER
007E A0 0017 R          K3:      MOV     AL,•KB_FLAG     ; GET THE SHIFT STATUS FLAGS
0081 EB A9                       JMP     KIO_EXIT        ; RETURN TO CALLER

                        ;------ SET TYPAMATIC RATE AND DELAY

0083 3C 05              K300:    CMP     AL,5            ; CORRECT FUNCTION CALL?
0085 75 A5                       JNE     KIO_EXIT        ;  NO, RETURN
0087 F6 C3 E0                    TEST    BL,0E0h         ; TEST FOR OUT-OF-RANGE RATE
008A 75 A0                       JNZ     KIO_EXIT        ; RETURN IF SO
008C F6 C7 FC                    TEST    BH,0FCh         ; TEST FOR OUT-OF-RANGE DELAY
008F 75 9B                       JNZ     KIO_EXIT        ; RETURN IF SO
0091 B0 F3                       MOV     AL,KB_TYPA_RD   ; COMMAND FOR TYPAMATIC RATE/DELAY
0093 E8 064B R                   CALL    SND_DATA        ; SEND TO KEYBOARD
0096 B9 0005                     MOV     CX,5            ; SHIFT COUNT
0099 D2 E7                       SHL     BH,CL           ; SHIFT DELAY OVER
009B 8A C3                       MOV     AL,BL           ; PUT IN RATE
009D 0A C7                       OR      AL,BH           ; AND DELAY
009F E8 064B R                   CALL    SND_DATA        ; SEND TO KEYBOARD
00A2 EB 88                       JMP     KIO_EXIT        ; RETURN TO CALLER

                        ;------ WRITE TO KEYBOARD BUFFER

00A4 56                 K500:    PUSH    SI              ; SAVE SI
00A5 FA                          CLI
00A6 8B 1E 001C R                MOV     BX,•BUFFER_TAIL ; GET THE "IN TO" POINTER TO THE BUFFER
00AA 8B F3                       MOV     SI,BX           ; SAVE A COPY IN CASE BUFFER NOT FULL
00AC E8 0168 R                   CALL    K4              ; BUMP THE POINTER TO SEE IF BUFFER IS FULL
00AF 3B 1E 001A R                CMP     BX,•BUFFER_HEAD ; WILL THE BUFFER OVERRUN IF WE STORE THIS?
00B3 74 0B                       JE      K502            ;  YES - INFORM CALLER OF ERROR
00B5 89 0C                       MOV     [SI],CX         ;  NO  - PUT THE ASCII/SCAN CODE INTO BUFFER
00B7 89 1E 001C R                MOV     •BUFFER_TAIL,BX ; ADJUST "IN TO" POINTER TO REFLECT CHANGE
00BB 2A C0                       SUB     AL,AL           ; TELL CALLER THAT OPERATION WAS SUCCESSFUL
00BD EB 03 90                    JMP     K504            ; SUB INSTRUCTION ALSO RESETS CARRY FLAG
00C0                    K502:
00C0 B0 01                       MOV     AL,01H          ; BUFFER FULL INDICATION
00C2                    K504:
00C2 FB                          STI
00C3 5E                          POP     SI              ; RECOVER SI
00C4 E9 002C R                   JMP     KIO_EXIT        ; RETURN TO CALLER WITH STATUS IN AL

00C7                    KEYBOARD_IO_1    ENDP
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                             PAGE
                             ;------ READ THE KEY TO FIGURE OUT WHAT TO DO -----------------------

00C7                         K1S     PROC    NEAR
00C7 8B 1E 001A R                    MOV     BX,@BUFFER_HEAD   ; GET POINTER TO HEAD OF BUFFER
00CB 3B 1E 001C R                    CMP     BX,@BUFFER_TAIL   ; TEST END OF BUFFER
00CF 75 07                           JNE     K1U               ; IF ANYTHING IN BUFFER DONT DO INTERRUPT

00D1 B8 9002                         MOV     AX,09002H         ; MOVE IN WAIT CODE & TYPE
00D4 CD 15                           INT     15H               ; PERFORM OTHER FUNCTION
00D6                         K1T:                              ; ASCII READ
00D6 FB                              STI                       ; INTERRUPTS BACK ON DURING LOOP
00D7 90                              NOP                       ; ALLOW AN INTERRUPT TO OCCUR
00D8 FA                      K1U:    CLI                       ; INTERRUPTS BACK OFF
00D9 8B 1E 001A R                    MOV     BX,@BUFFER_HEAD   ; GET POINTER TO HEAD OF BUFFER
00DD 3B 1E 001C R                    CMP     BX,@BUFFER_TAIL   ; TEST END OF BUFFER
00E1 53                              PUSH    BX                ; SAVE ADDRESS
00E2 9C                              PUSHF                     ; SAVE FLAG
00E3 E8 06D8 R                       CALL    MAKE_LED          ; GO GET MODE INDICATOR DATA BYTE
00E6 8A 1E 0097 R                    MOV     BL,@KB_FLAG_2     ; GET PREVIOUS BITS
00EA 32 D8                           XOR     BL,AL             ; SEE IF ANY DIFFERENT
00EC 80 E3 07                        AND     BL,07H            ; ISOLATE INDICATOR BITS
00EF 74 04                           JZ      K1V               ; IF NO CHANGE BYPASS UPDATE

00F1 E8 069A R                       CALL    SND_LED1          ; GO TURN ON MODE INDICATORS
00F4 FA                              CLI                       ; DISABLE INTERRUPTS
00F5 9D                      K1V:    POPF                      ; RESTORE FLAGS
00F6 5B                              POP     BX                ; RESTORE ADDRESS
00F7 74 DD                           JZ      K1T               ; LOOP UNTIL SOMETHING IN BUFFER

00F9 8B 07                           MOV     AX,[BX]           ; GET SCAN CODE AND ASCII CODE
00FB E8 0168 R                       CALL    K4                ; MOVE POINTER TO NEXT POSITION
00FE 89 1E 001A R                    MOV     @BUFFER_HEAD,BX   ; STORE VALUE IN VARIABLE
0102 C3                              RET                       ; RETURN
0103                         K1S     ENDP


                             ;------ READ THE KEY TO SEE IF ONE IS PRESENT -----------------------

0103                         K2S     PROC    NEAR
0103 FA                              CLI                       ; INTERRUPTS OFF
0104 8B 1E 001A R                    MOV     BX,@BUFFER_HEAD   ; GET HEAD POINTER
0108 3B 1E 001C R                    CMP     BX,@BUFFER_TAIL   ; IF EQUAL (Z=1) THEN NOTHING THERE
010C 8B 07                           MOV     AX,[BX]
010E 9C                              PUSHF                     ; SAVE FLAGS

010F 50                              PUSH    AX                ; SAVE CODE
0110 E8 06D8 R                       CALL    MAKE_LED          ; GO GET MODE INDICATOR DATA BYTE
0113 8A 1E 0097 R                    MOV     BL,@KB_FLAG_2     ; GET PREVIOUS BITS
0117 32 D8                           XOR     BL,AL             ; SEE IF ANY DIFFERENT
0119 80 E3 07                        AND     BL,07H            ; ISOLATE INDICATOR BITS
011C 74 03                           JZ      K2T               ; IF NO CHANGE BYPASS UPDATE

011E E8 0687 R                       CALL    SND_LED           ; GO TURN ON MODE INDICATORS
0121 58                      K2T:    POP     AX                ; RESTORE CODE
0122 9D                              POPF                      ; RESTORE FLAGS
0123 FB                              STI                       ; INTERRUPTS BACK ON
0124 C3                              RET                       ; RETURN
0125                         K2S     ENDP


                             ;------ ROUTINE TO TRANSLATE SCAN CODE PAIRS FOR EXTENDED CALLS

0125                         KIO_E_XLAT:
0125 3C F0                           CMP     AL,0F0h           ; IS IT ONE OF THE FILL-INs?
0127 75 06                           JNE     KIO_E_RET         ;  NO, PASS IT ON
0129 0A E4                           OR      AH,AH             ; AH = 0 IS SPECIAL CASE
012B 74 02                           JZ      KIO_E_RET         ;  PASS THIS ON UNCHANGED
012D 32 C0                           XOR     AL,AL             ;  OTHERWISE SET AL = 0
012F                         KIO_E_RET:
012F C3                              RET                       ; GO BACK


                             ;------ ROUTINE TO TRANSLATE SCAN CODE PAIRS FOR STANDARD CALLS

0130                         KIO_S_XLAT:
0130 80 FC E0                        CMP     AH,0E0h           ; IS IT KEYPAD ENTER OR / ?
0133 75 12                           JNE     KIO_S2            ;  NO, CONTINUE
0135 3C 0D                           CMP     AL,0Dh            ; KEYPAD ENTER CODE?
0137 74 09                           JE      KIO_S1            ;  YES, MASSAGE A BIT
0139 3C 0A                           CMP     AL,0Ah            ; CTRL KEYPAD ENTER CODE?
013B 74 05                           JE      KIO_S1            ;  YES, MASSAGE THE SAME
013D B4 35                           MOV     AH,35h            ;  NO, MUST BE KEYPAD /
013F EB 23 90                        JMP     KIO_USE           ; GIVE TO CALLER
0142 B4 1C                   KIO_S1: MOV     AH,1Ch            ; CONVERT TO COMPATIBLE OUTPUT
0144 EB 1E 90                        JMP     KIO_USE           ; GIVE TO CALLER

0147 80 FC 84                KIO_S2: CMP     AH,84h            ; IS IT ONE OF THE EXTENDED ONES?
014A 77 1A                           JA      KIO_DIS           ;  YES, THROW AWAY AND GET ANOTHER CHAR

014C 3C F0                           CMP     AL,0F0h           ; IS IT ONE OF THE FILL-INs?
014E 75 07                           JNE     KIO_S3            ;  NO, TRY LAST TEST
0150 0A E4                           OR      AH,AH             ; AH = 0 IS SPECIAL CASE
0152 74 10                           JZ      KIO_USE           ;  PASS THIS ON UNCHANGED
0154 EB 10 90                        JMP     KIO_DIS           ;  THROW AWAY THE REST

0157 3C E0                   KIO_S3: CMP     AL,0E0h           ; IS IT AN EXTENSION OF A PREVIOUS ONE?
0159 75 09                           JNE     KIO_USE           ;  NO, MUST BE A STANDARD CODE
015B 0A E4                           OR      AH,AH             ; AH = 0 IS SPECIAL CASE
015D 74 05                           JZ      KIO_USE           ; JUMP IF AH = 0
015F 32 C0                           XOR     AL,AL             ; CONVERT TO COMPATIBLE OUTPUT
0161 EB 01 90                        JMP     KIO_USE           ; PASS IT ON TO CALLER

0164                         KIO_USE:
0164 F8                              CLC                       ; CLEAR CARRY TO INDICATE GOOD CODE
0165 C3                              RET                       ; RETURN
0166                         KIO_DIS:
0166 F9                              STC                       ; SET CARRY TO INDICATE DISCARD CODE
0167 C3                              RET                       ; RETURN
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                                 PAGE
                                 ;-----------------------------------------------------------------
                                 ;       INCREMENT BUFFER POINTER ROUTINE                         -
                                 ;-----------------------------------------------------------------

 0168                            K4      PROC    NEAR
 0168 43                                 INC     BX                      ; MOVE TO NEXT WORD IN LIST
 0169 43                                 INC     BX

 016A 3B 1E 0082 R                       CMP     BX,@BUFFER_END          ; AT END OF BUFFER?
 016E 75 04                              JNE     K5                      ; NO, CONTINUE
 0170 8B 1E 0080 R                       MOV     BX,@BUFFER_START        ; YES, RESET TO BUFFER BEGINNING
 0174 C3                         K5:     RET
 0175                            K4      ENDP

                                 ;--- HARDWARE INT  09 H -- ( IRQ LEVEL  1 ) ----------------------------------
                                 ;                                                                           :
                                 ;       KEYBOARD INTERRUPT ROUTINE                                          :
                                 ;                                                                           :
                                 ;----------------------------------------------------------------------------

 0175                            KB_INT_1 PROC   FAR
 0175 FB                                 STI                             ; ENABLE INTERRUPTS
 0176 55                                 PUSH    BP
 0177 50                                 PUSH    AX
 0178 53                                 PUSH    BX
 0179 51                                 PUSH    CX
 017A 52                                 PUSH    DX
 017B 56                                 PUSH    SI
 017C 57                                 PUSH    DI
 017D 1E                                 PUSH    DS
 017E 06                                 PUSH    ES
 017F FC                                 CLD                             ; FORWARD DIRECTION
 0180 E8 0000 E                          CALL    DDS                     ; SET UP ADDRESSING

                                 ;-----  WAIT FOR KEYBOARD DISABLE COMMAND TO BE ACCEPTED

 0183 B0 AD                              MOV     AL,DIS_KBD              ; DISABLE THE KEYBOARD COMMAND
 0185 E8 063C R                          CALL    SHIP_IT                 ; EXECUTE DISABLE
 0188 FA                                 CLI                             ; DISABLE INTERRUPTS
 0189 2B C9                              SUB     CX,CX                   ; SET MAXIMUM TIMEOUT
 018B                            KB_INT_01:
 018B E4 64                              IN      AL,STATUS_PORT          ; READ ADAPTER STATUS
 018D A8 02                              TEST    AL,INPT_BUF_FULL        ; CHECK INPUT BUFFER FULL STATUS BIT
 018F E0 FA                              LOOPNZ  KB_INT_01               ; WAIT FOR COMMAND TO BE ACCEPTED

                                 ;-----  READ CHARACTER FROM KEYBOARD INTERFACE

 0191 E4 60                              IN      AL,PORT_A               ; READ IN THE CHARACTER

                                 ;-----  SYSTEM HOOK  INT 15H - FUNCTION 4FH  (ON HARDWARE INTERRUPT LEVEL 9H)

 0193 B4 4F                              MOV     AH,04FH                 ; SYSTEM INTERCEPT - KEY CODE FUNCTION
 0195 F9                                 STC                             ; SET CY= 1 (IN CASE OF IRET)
 0196 CD 15                              INT     15H                     ; CASSETTE CALL   (AL)= KEY SCAN CODE
                                                                         ;  RETURNS CY= 1 FOR INVALID FUNCTION
 0198 72 03                              JC      KB_INT_02               ; CONTINUE IF CARRY FLAG SET ((AL)=CODE)
 019A E9 03A0 R                          JMP     K26                     ; EXIT IF SYSTEM HANDLED SCAN CODE
                                                                         ;  EXIT HANDLES HARDWARE EOI AND ENABLE

                                 ;------ CHECK FOR A RESEND COMMAND TO KEYBOARD

 019D                            KB_INT_02:                              ;        (AL)= SCAN CODE
 019D FB                                 STI                             ; ENABLE INTERRUPTS AGAIN
 019E 3C FE                              CMP     AL,KB_RESEND            ; IS THE INPUT A RESEND
 01A0 74 0D                              JE      KB_INT_4                ; GO IF RESEND

                                 ;------ CHECK FOR RESPONSE TO A COMMAND TO KEYBOARD

 01A2 3C FA                              CMP     AL,KB_ACK               ; IS THE INPUT AN ACKNOWLEDGE
 01A4 75 12                              JNZ     KB_INT_2                ; GO IF NOT

                                 ;------ A COMMAND TO THE KEYBOARD WAS ISSUED

 01A6 FA                                 CLI                             ; DISABLE INTERRUPTS
 01A7 80 0E 0097 R 10                    OR      @KB_FLAG_2,KB_FA        ; INDICATE ACK RECEIVED
 01AC E9 03A0 R                          JMP     K26                     ; RETURN IF NOT (ACK RETURNED FOR DATA)

                                 ;------ RESEND THE LAST BYTE

 01AF                            KB_INT_4:
 01AF FA                                 CLI                             ; DISABLE INTERRUPTS
 01B0 80 0E 0097 R 20                    OR      @KB_FLAG_2,KB_FE        ; INDICATE RESEND RECEIVED
 01B5 E9 03A0 R                          JMP     K26                     ; RETURN IF NOT (ACK RETURNED FOR DATA)


                                 ;------ UPDATE MODE INDICATORS IF CHANGE IN STATE

 01B8                            KB_INT_2:
 01B8 50                                 PUSH    AX                      ; SAVE DATA IN
 01B9 E8 06D8 R                          CALL    MAKE_LED                ; GO GET MODE INDICATOR DATA BYTE
 01BC 8A 1E 0097 R                       MOV     BL,@KB_FLAG_2           ; GET PREVIOUS BITS
 01C0 32 D8                              XOR     BL,AL                   ; SEE IF ANY DIFFERENT
 01C2 80 E3 07                           AND     BL,KB_LEDS              ; ISOLATE INDICATOR BITS
 01C5 74 03                              JZ      UP0                     ; IF NO CHANGE BYPASS UPDATE
 01C7 E8 0687 R                          CALL    SND_LED                 ; GO TURN ON MODE INDICATORS
 01CA 58                         UP0:    POP     AX                      ; RESTORE DATA IN
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                              PAGE
                              ;----------------------------------------------------------------
                              ;              START OF KEY PROCESSING                          -
                              ;----------------------------------------------------------------

01CB 8A E0                            MOV     AH,AL                   ; SAVE SCAN CODE IN AH ALSO

                              ;------ TEST FOR OVERRUN SCAN CODE FROM KEYBOARD

01CD 3C FF                            CMP     AL,KB_OVER_RUN          ; IS THIS AN OVERRUN CHAR?
01CF 75 03                            JNZ     K16                     ; NO, TEST FOR SHIFT KEY
01D1 E9 062D R                        JMP     K62                     ; BUFFER_FULL_BEEP

01D4 0E                       K16:    PUSH    CS
01D5 07                               POP     ES                      ; ESTABLISH ADDRESS OF TABLES
01D6 8A 3E 0096 R                     MOV     BH,@KB_FLAG_3           ; LOAD FLAGS FOR TESTING

                              ;------ TEST TO SEE IF A READ_ID IS IN PROGRESS

01DA F6 C7 C0                         TEST    BH,RD_ID+LC_AB          ; ARE WE DOING A READ ID?
01DD 74 34                            JZ      NOT_ID                  ; CONTINUE IF NOT
01DF 79 10                            JNS     TST_ID_2                ; IS THE RD_ID FLAG ON?
01E1 3C AB                            CMP     AL,ID_1                 ; IS THIS THE 1ST ID CHARACTER?
01E3 75 05                            JNE     RST_RD_ID
01E5 80 0E 0096 R 40                  OR      @KB_FLAG_3,LC_AB        ; INDICATE 1ST ID WAS OK
01EA                          RST_RD_ID:
01EA 80 26 0096 R 7F                  AND     @KB_FLAG_3,NOT RD_ID    ; RESET THE READ ID FLAG
01EF EB 1F                            JMP     SHORT ID_EX             ; AND EXIT

01F1                          TST_ID_2:
01F1 80 26 0096 R BF                  AND     @KB_FLAG_3,NOT LC_AB    ; RESET FLAG
01F6 3C 54                            CMP     AL,ID_2A                ; IS THIS THE 2ND ID CHARACTER?
01F8 74 11                            JE      KX_BIT                  ;  JUMP IF SO
01FA 3C 41                            CMP     AL,ID_2                 ; IS THIS THE 2ND ID CHARACTER?
01FC 75 12                            JNE     ID_EX                   ;  LEAVE IF NOT

                              ;------ A READ ID SAID THAT IT WAS ENHANCED KEYBOARD

01FE F6 C7 20                         TEST    BH,SET_NUM_LK           ; SHOULD WE SET NUM LOCK?
0201 74 08                            JZ      KX_BIT                  ; EXIT IF NOT
0203 80 0E 0017 R 20                  OR      @KB_FLAG,NUM_STATE      ; FORCE NUM LOCK ON
0208 E8 0687 R                        CALL    SND_LED                 ; GO SET THE NUM LOCK INDICATOR
020B 80 0E 0096 R 10          KX_BIT: OR      @KB_FLAG_3,KBX          ; INDICATE ENHANCED KEYBOARD WAS FOUND
0210 E9 03A0 R                ID_EX:  JMP     K26                     ; EXIT


0213                          NOT_ID:
0213 3C E0                            CMP     AL,MC_E0                ; IS THIS THE GENERAL MARKER CODE?
0215 75 07                            JNE     TEST_E1                 ;
0217 80 0E 0096 R 12                  OR      @KB_FLAG_3,LC_E0+KBX    ; SET FLAG BIT, SET KBX, AND
021C EB 09                            JMP     SHORT EXIT              ; THROW AWAY THIS CODE

021E                          TEST_E1:
021E 3C E1                            CMP     AL,MC_E1                ; IS THIS THE PAUSE KEY?
0220 75 08                            JNE     NOT_HC                  ;
0222 80 0E 0096 R 11                  OR      @KB_FLAG_3,LC_E1+KBX    ; SET FLAG, PAUSE KEY MARKER CODE
0227 E9 03A5 R                EXIT:   JMP     K26A                    ; THROW AWAY THIS CODE

022A                          NOT_HC:
022A 24 7F                            AND     AL,07FH                 ; TURN OFF THE BREAK BIT
022C F6 C7 02                         TEST    BH,LC_E0                ; LAST CODE THE E0 MARKER CODE?
022F 74 0C                            JZ      NOT_LC_E0               ; JUMP IF NOT

0231 B9 0002                          MOV     CX,2                    ; LENGTH OF SEARCH
0234 BF 0006 E                        MOV     DI,OFFSET K6+6          ; IS THIS A SHIFT KEY?
0237 F2/ AE                           REPNE   SCASB                   ; CHECK IT
0239 75 65                            JNE     K16A                    ; NO, CONTINUE KEY PROCESSING
023B EB 49                            JMP     SHORT K16B              ; YES, THROW AWAY & RESET FLAG

023D                          NOT_LC_E0:
023D F6 C7 01                         TEST    BH,LC_E1                ; LAST CODE THE E1 MARKER CODE?
0240 74 1D                            JZ      T_SYS_KEY               ; JUMP IF NOT

0242 B9 0004                          MOV     CX,4                    ; LENGTH OF SEARCH
0245 BF 0004 E                        MOV     DI,OFFSET K6+4          ; IS THIS AN ALT, CTL, OR SHIFT?
0248 F2/ AE                           REPNE   SCASB                   ; CHECK IT
024A 74 DB                            JE      EXIT                    ; THROW AWAY IF SO

024C 3C 45                            CMP     AL,NUM_KEY              ; IS IT THE PAUSE KEY?
024E 75 36                            JNE     K16B                    ; NO, THROW AWAY & RESET FLAG
0250 F6 C4 80                         TEST    AH,80H                  ; YES, IS IT THE BREAK OF THE KEY?
0253 75 31                            JNZ     K16B                    ;  YES, THROW THIS AWAY, TOO
0255 F6 06 0018 R 08                  TEST    @KB_FLAG_1,HOLD_STATE   ;  NO, ARE WE PAUSED ALREADY?
025A 75 2A                            JNZ     K16B                    ;   YES, THROW AWAY
025C E9 04DB R                        JMP     K39P                    ;  NO, THIS IS THE REAL PAUSE STATE

                              ;------ TEST FOR SYSTEM KEY

025F                          T_SYS_KEY:
025F 3C 54                            CMP     AL,SYS_KEY              ; IS IT THE SYSTEM KEY?
0261 75 3D                            JNE     K16A                    ; CONTINUE IF NOT

0263 F6 C4 80                         TEST    AH,080H                 ; CHECK IF THIS A BREAK CODE
0266 75 21                            JNZ     K16C                    ; DON'T TOUCH SYSTEM INDICATOR IF TRUE

0268 F6 06 0018 R 04                  TEST    @KB_FLAG_1,SYS_SHIFT    ; SEE IF IN SYSTEM KEY HELD DOWN
026D 75 17                            JNZ     K16B                    ; IF YES, DON'T PROCESS SYSTEM INDICATOR

026F 80 0E 0018 R 04                  OR      @KB_FLAG_1,SYS_SHIFT    ; INDICATE SYSTEM KEY DEPRESSED
0274 B0 20                            MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
0276 E6 20                            OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                      ; INTERRUPT-RETURN-NO-EOI
0278 B0 AE                            MOV     AL,ENA_KBD              ; INSURE KEYBOARD IS ENABLED
027A E8 063C R                        CALL    SHIP_IT                 ; EXECUTE ENABLE
027D B8 8500                          MOV     AX,08500H               ; FUNCTION VALUE FOR MAKE OF SYSTEM KEY
0280 FB                               STI                             ; MAKE SURE INTERRUPTS ENABLED
0281 CD 15                            INT     15H                     ; USER INTERRUPT
0283 E9 03AF R                        JMP     K27A                    ; END PROCESSING

0286 E9 03A0 R                K16B:   JMP     K26                     ; IGNORE SYSTEM KEY

0289 80 26 0018 R FB          K16C:   AND     @KB_FLAG_1,NOT SYS_SHIFT ;TURN OFF SHIFT KEY HELD DOWN
028E B0 20                            MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
0290 E6 20                            OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT
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                                                                  ; INTERRUPT-RETURN-NO-EOI
 0292 B0 AE                            MOV    AL,ENA_KBD          ; INSURE KEYBOARD IS ENABLED
 0294 E8 063C R                        CALL   SHIP_IT             ; EXECUTE ENABLE
 0297 B8 8501                          MOV    AX,08501H           ; FUNCTION VALUE FOR BREAK OF SYSTEM KEY
 029A FB                               STI                        ; MAKE SURE INTERRUPTS ENABLED
 029B CD 15                            INT    15H                 ; USER INTERRUPT
 029D E9 03AF R                        JMP    K27A                ; IGNORE SYSTEM KEY

                               ;------ TEST FOR SHIFT KEYS

 02A0 8A 1E 0017 R             K16A:   MOV    BL,@KB_FLAG         ; PUT STATE FLAGS IN BL
 02A4 BF 0000 E                        MOV    DI,OFFSET K6        ; SHIFT KEY TABLE
 02A7 B9 0000 E                        MOV    CX,OFFSET K6L       ; LENGTH
 02AA F2/ AE                           REPNE  SCASB               ; LOOK THROUGH THE TABLE FOR A MATCH
 02AC 8A C4                            MOV    AL,AH               ; RECOVER SCAN CODE
 02AE 74 03                            JE     K17                 ; JUMP IF MATCH FOUND
 02B0 E9 038C R                        JMP    K25                 ; IF NO MATCH, THEN SHIFT NOT FOUND

                               ;------ SHIFT KEY FOUND

 02B3 81 EF 0001 E             K17:    SUB    DI,OFFSET K6+1      ; ADJUST PTR TO SCAN CODE MTCH
 02B7 2E: 8A A5 0000 E                 MOV    AH,CS:K7[DI]        ; GET MASK INTO AH
 02BC B1 02                            MOV    CL,2                ; SET UP COUNT FOR FLAG SHIFTS
 02BE A8 80                            TEST   AL,80H              ; TEST FOR BREAK KEY
 02C0 74 03                            JZ     K17C
 02C2 EB 78 90                         JMP    K23                 ; JUMP IF BREAK

                               ;------ SHIFT MAKE FOUND, DETERMINE SET OR TOGGLE

 02C5 80 FC 10                 K17C:   CMP    AH,SCROLL_SHIFT
 02C8 73 21                            JAE    K18                 ; IF SCROLL SHIFT OR ABOVE, TOGGLE KEY

                               ;------ PLAIN SHIFT KEY, SET SHIFT ON

 02CA 08 26 0017 R                     OR     @KB_FLAG,AH         ; TURN ON SHIFT BIT
 02CE F6 C4 0C                         TEST   AH,CTL_SHIFT+ALT_SHIFT  ; IS IT ALT OR CTRL?
 02D1 75 03                            JNZ    K17D                ;  YES, MORE FLAGS TO SET
 02D3 E9 03A0 R                        JMP    K26                 ;  NO, INTERRUPT_RETURN
 02D6 F6 C7 02                 K17D:   TEST   BH,LC_E0            ; IS THIS ONE OF THE NEW KEYS?
 02D9 74 07                            JZ     K17E                ;  NO, JUMP
 02DB 08 26 0096 R                     OR     @KB_FLAG_3,AH       ; SET BITS FOR RIGHT CTRL, ALT
 02DF E9 03A0 R                        JMP    K26                 ; INTERRUPT_RETURN
 02E2 D2 EC                    K17E:   SHR    AH,CL               ; MOVE FLAG BITS TWO POSITIONS
 02E4 08 26 0018 R                     OR     @KB_FLAG_1,AH       ; SET BITS FOR LEFT CTRL, ALT
 02E8 E9 03A0 R                        JMP    K26                 ; INTERRUPT_RETURN

                               ;------ TOGGLED SHIFT KEY, TEST FOR 1ST MAKE OR NOT

 02EB                          K18:                               ; SHIFT-TOGGLE
 02EB F6 C3 04                         TEST   BL,CTL_SHIFT        ; CHECK CTL SHIFT STATE
 02EE 74 03                            JZ     K18A                ; JUMP IF NOT CTL STATE
 02F0 E9 038C R                        JMP    K25                 ; JUMP IF CTL STATE
 02F3 3C 52                    K18A:   CMP    AL,INS_KEY          ; CHECK FOR INSERT KEY
 02F5 75 21                            JNE    K22                 ; JUMP IF NOT INSERT KEY
 02F7 F6 C3 08                         TEST   BL,ALT_SHIFT        ; CHECK FOR ALTERNATE SHIFT
 02FA 74 03                            JZ     K18B                ; JUMP IF NOT ALTERNATE SHIFT
 02FC E9 038C R                        JMP    K25                 ; JUMP IF ALTERNATE SHIFT
 02FF F6 C7 02                 K18B:   TEST   BH,LC_E0            ; IS THIS THE NEW INSERT KEY?
 0302 75 14                            JNZ    K22                 ; YES, THIS ONE'S NEVER A "0"
 0304 F6 C3 20                 K19:    TEST   BL,NUM_STATE        ; CHECK FOR BASE STATE
 0307 75 0A                            JNZ    K21                 ; JUMP IF NUM LOCK IS ON
 0309 F6 C3 03                         TEST   BL,LEFT_SHIFT+RIGHT_SHIFT  ; TEST FOR SHIFT STATE
 030C 74 0A                            JZ     K22                 ; JUMP IF BASE STATE
 030E 8A E0                    K20:    MOV    AH,AL               ; PUT SCAN CODE BACK IN AH
 0310 EB 7A 90                         JMP    K25                 ; NUMERAL "0", STNDRD. PROCESSING

 0313 F6 C3 03                 K21:    TEST   BL,LEFT_SHIFT+RIGHT_SHIFT  ; MIGHT BE NUMERIC
 0316 74 F6                            JZ     K20                 ; IS NUMERIC, STD. PROC.

 0318                          K22:                               ; SHIFT TOGGLE KEY HIT; PROCESS IT
 0318 84 26 0018 R                     TEST   AH,@KB_FLAG_1       ; IS KEY ALREADY DEPRESSED?
 031C 74 03                            JZ     K22A
 031E E9 03A0 R                        JMP    K26                 ; JUMP IF KEY ALREADY DEPRESSED
 0321 08 26 0018 R             K22A:   OR     @KB_FLAG_1,AH       ; INDICATE THAT THE KEY IS DEPRESSED
 0325 30 26 0017 R                     XOR    @KB_FLAG,AH         ; TOGGLE THE SHIFT STATE

                               ;------ TOGGLE LED IF CAPS, NUM, OR SCROLL KEY DEPRESSED

 0329 F6 C4 70                         TEST   AH,CAPS_SHIFT+NUM_SHIFT+SCROLL_SHIFT ; SHIFT TOGGLE?
 032C 74 05                            JZ     K22B                ; GO IF NOT
 032E 50                               PUSH   AX                  ; SAVE SCAN CODE AND SHIFT MASK
 032F E8 0687 R                        CALL   SND_LED             ; GO TURN MODE INDICATORS ON
 0332 58                               POP    AX                  ; RESTORE SCAN CODE

 0333 3C 52                    K22B:   CMP    AL,INS_KEY          ; TEST FOR 1ST MAKE OF INSERT KEY
 0335 75 69                            JNE    K26                 ; JUMP IF NOT INSERT KEY
 0337 8A E0                            MOV    AH,AL               ; SCAN CODE IN BOTH HALVES OF AX
 0339 EB 7F 90                         JMP    K28                 ; FLAGS UPDATED, PROC. FOR BUFFER

                               ;------ BREAK SHIFT FOUND

 033C                          K23:                               ; BREAK-SHIFT-FOUND
 033C 80 FC 10                         CMP    AH,SCROLL_SHIFT     ; IS THIS A TOGGLE KEY?
 033F F6 D4                            NOT    AH                  ; INVERT MASK
 0341 73 43                            JAE    K24                 ; YES, HANDLE BREAK TOGGLE
 0343 20 26 0017 R                     AND    @KB_FLAG,AH         ; TURN OFF SHIFT BIT
 0347 80 FC FB                         CMP    AH,NOT CTL_SHIFT    ; IS THIS ALT OR CTL?
 034A 77 26                            JA     K23D                ;  NO, ALL DONE

 034C F6 C7 02                         TEST   BH,LC_E0            ; 2ND ALT OR CTL?
 034F 74 06                            JZ     K23A                ; NO, HANDLE NORMALLY
 0351 20 26 0096 R                     AND    @KB_FLAG_3,AH       ; RESET BIT FOR RIGHT ALT OR CTL
 0355 EB 06                            JMP    SHORT K23B          ; CONTINUE
 0357 D2 FC                    K23A:   SAR    AH,CL               ; MOVE THE MASK BIT TWO POSITIONS
 0359 20 26 0018 R                     AND    @KB_FLAG_1,AH       ; RESET BIT FOR LEFT ALT OR CTL
 035D 8A E0                    K23B:   MOV    AH,AL               ; SAVE SCAN CODE
 035F A0 0096 R                        MOV    AL,@KB_FLAG_3       ; GET RIGHT ALT & CTRL FLAGS
 0362 D2 E8                            SHR    AL,CL               ; MOVE TO BITS 1 & 0
 0364 0A 06 0018 R                     OR     AL,@KB_FLAG_1       ; PUT IN LEFT ALT & CTL FLAGS
 0368 D2 E0                            SHL    AL,CL               ; MOVE BACK TO BITS 3 & 2
 036A 24 0C                            AND    AL,ALT_SHIFT+CTL_SHIFT  ; FILTER OUT OTHER GARBAGE
 036C 08 06 0017 R                     OR     @KB_FLAG,AL         ; PUT RESULT IN THE REAL FLAGS
 0370 8A C4                            MOV    AL,AH               ; RECOVER SAVED SCAN CODE
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0372 3C B8                  K23D:   CMP     AL,ALT_KEY+80H           ; IS THIS ALTERNATE SHIFT RELEASE
0374 75 2A                          JNE     K26                      ; INTERRUPT_RETURN

                            ;------ ALTERNATE SHIFT KEY RELEASED, GET THE VALUE INTO BUFFER

0376 A0 0019 R                      MOV     AL,@ALT_INPUT
0379 B4 00                          MOV     AH,0                     ; SCAN CODE OF 0
037B 88 26 0019 R                   MOV     @ALT_INPUT,AH            ; ZERO OUT THE FIELD
037F 3C 00                          CMP     AL,0                     ; WAS THE INPUT = 0?
0381 74 1D                          JE      K26                      ; INTERRUPT_RETURN
0383 E9 0601 R                      JMP     K61                      ; IT WASN'T, SO PUT IN BUFFER

0386                        K24:                                     ; BREAK-TOGGLE
0386 20 26 0018 R                   AND     @KB_FLAG_1,AH            ; INDICATE NO LONGER DEPRESSED
038A EB 14                          JMP     SHORT K26                ; INTERRUPT_RETURN

                            ;------ TEST FOR HOLD STATE
                                                                     ; AL, AH = SCAN CODE
038C                        K25:                                     ; NO-SHIFT-FOUND
038C 3C 80                          CMP     AL,80H                   ; TEST FOR BREAK KEY
038E 73 10                          JAE     K26                      ; NOTHING FOR BREAK CHARS FROM HERE ON
0390 F6 06 0018 R 08                TEST    @KB_FLAG_1,HOLD_STATE    ; ARE WE IN HOLD STATE
0395 74 23                          JZ      K28                      ; BRANCH AROUND TEST IF NOT
0397 3C 45                          CMP     AL,NUM_KEY
0399 74 05                          JE      K26                      ; CAN'T END HOLD ON NUM_LOCK
039B 80 26 0018 R F7                AND     @KB_FLAG_1,NOT HOLD_STATE  ; TURN OFF THE HOLD STATE BIT

03A0                        K26:
03A0 80 26 0096 R FC                AND     @KB_FLAG_3,NOT LC_E0+LC_E1 ; RESET LAST CHAR H.C. FLAG

03A5                        K26A:                                    ; INTERRUPT-RETURN
03A5 FA                             CLI                              ; TURN OFF INTERRUPTS
03A6 B0 20                          MOV     AL,EOI                   ; END OF INTERRUPT COMMAND
03A8 E6 20                          OUT     020H,AL                  ; SEND COMMAND TO INTERRUPT CONTROL PORT

03AA                        K27:                                     ; INTERRUPT-RETURN-NO-EOI
03AA B0 AE                          MOV     AL,ENA_KBD               ; INSURE KEYBOARD IS ENABLED
03AC E8 063C R                      CALL    SHIP_IT                  ; EXECUTE ENABLE

03AF FA                     K27A:   CLI                              ; DISABLE INTERRUPTS
03B0 07                             POP     ES                       ; RESTORE REGISTERS
03B1 1F                             POP     DS
03B2 5F                             POP     DI
03B3 5E                             POP     SI
03B4 5A                             POP     DX
03B5 59                             POP     CX
03B6 5B                             POP     BX
03B7 58                             POP     AX
03B8 5D                             POP     BP
03B9 CF                             IRET                             ; RETURN
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                               PAGE
                               ;------ NOT IN HOLD STATE
                                                                  ; AL, AH = SCAN CODE (ALL MAKES)
03BA                           K28:                               ; NO-HOLD-STATE
03BA 3C 58                            CMP     AL,88               ; TEST FOR OUT-OF-RANGE SCAN CODES
03BC 77 E2                            JA      K26                 ; IGNORE IF OUT-OF-RANGE

03BE F6 C3 08                         TEST    BL,ALT_SHIFT        ; ARE WE IN ALTERNATE SHIFT?
03C1 74 0C                            JZ      K28A                ; JUMP IF NOT ALTERNATE

03C3 F6 C7 10                         TEST    BH,KBX              ; IS THIS THE ENHANCED KEYBOARD?
03C6 74 0A                            JZ      K29                 ; NO, ALT STATE IS REAL

03C8 F6 06 0018 R 04                  TEST    @KB_FLAG_1,SYS_SHIFT ; YES, IS SYSREQ KEY DOWN?
03CD 74 03                            JZ      K29                 ;  NO, ALT STATE IS REAL
03CF E9 04A3 R                 K28A:  JMP     K38                 ;  YES, THIS IS PHONY ALT STATE
                                                                  ;      DUE TO PRESSING SYSREQ

                               ;------ TEST FOR RESET KEY SEQUENCE (CTL ALT DEL)

03D2                           K29:                               ; TEST-RESET
03D2 F6 C3 04                         TEST    BL,CTL_SHIFT        ; ARE WE IN CONTROL SHIFT ALSO?
03D5 74 31                            JZ      K31                 ; NO_RESET
03D7 3C 53                            CMP     AL,DEL_KEY          ; SHIFT STATE IS THERE, TEST KEY
03D9 75 2D                            JNE     K31                 ; NO_RESET, IGNORE

                               ;------ CTL-ALT-DEL HAS BEEN FOUND, DO I/O CLEANUP

03DB C7 06 0072 R 1234                MOV     @RESET_FLAG,1234H   ; SET FLAG FOR RESET FUNCTION
03E1 E9 0000 E                        JMP     START_T             ; JUMP TO POWER ON DIAGNOSTICS

                               ;----------------------- TABLES FOR ALT CASE ------------------------
                               ;------ ALT-INPUT-TABLE
03E4                           K30    LABEL   BYTE
03E4 52 4F 50 51 4B                   DB      82,79,80,81,75
03E9 4C 4D 47 48 49                   DB      76,77,71,72,73      ; 10 NUMBERS ON KEYPAD
                               ;------ SUPER-SHIFT-TABLE
03EE 10 11 12 13 14 15                DB      16,17,18,19,20,21   ; A-Z TYPEWRITER CHARS
03F4 16 17 18 19 1E 1F                DB      22,23,24,25,30,31
03FA 20 21 22 23 24 25                DB      32,33,34,35,36,37
0400 26 2C 2D 2E 2F 30                DB      38,44,45,46,47,48
0406 31 32                            DB      49,50

                               ;------ IN ALTERNATE SHIFT, RESET NOT FOUND

0408                           K31:                               ; NO-RESET
0408 3C 39                            CMP     AL,57               ; TEST FOR SPACE KEY
040A 75 05                            JNE     K311                ; NOT THERE
040C B0 20                            MOV     AL,' '              ; SET SPACE CHAR
040E E9 05F5 R                        JMP     K57                 ; BUFFER_FILL
0411                           K311:
0411 3C 0F                            CMP     AL,15               ; TEST FOR TAB KEY
0413 75 06                            JNE     K312                ; NOT THERE
0415 B8 A500                          MOV     AX,0A500h           ; SET SPECIAL CODE FOR ALT-TAB
0418 E9 05F5 R                        JMP     K57                 ; BUFFER_FILL
041B                           K312:
041B 3C 4A                            CMP     AL,74               ; TEST FOR KEYPAD -
041D 74 79                            JE      K37B                ; GO PROCESS
041F 3C 4E                            CMP     AL,78               ; TEST FOR KEYPAD +
0421 74 75                            JE      K37B                ; GO PROCESS

                               ;------ LOOK FOR KEY PAD ENTRY

0423                           K32:                               ; ALT-KEY-PAD
0423 BF 03E4 R                        MOV     DI,OFFSET K30       ; ALT-INPUT-TABLE
0426 B9 000A                          MOV     CX,10               ; LOOK FOR ENTRY USING KEYPAD
0429 F2/ AE                           REPNE   SCASB               ; LOOK FOR MATCH
042B 75 18                            JNE     K33                 ; NO_ALT_KEYPAD
042D F6 C7 02                         TEST    BH,LC_E0            ; IS THIS ONE OF THE NEW KEYS?
0430 75 6B                            JNZ     K37C                ;  YES, JUMP, NOT NUMPAD KEY
0432 81 EF 03E5 R                     SUB     DI,OFFSET K30+1     ; DI NOW HAS ENTRY VALUE
0436 A0 0019 R                        MOV     AL,@ALT_INPUT       ; GET THE CURRENT BYTE
0439 B4 0A                            MOV     AH,10               ; MULTIPLY BY 10
043B F6 E4                            MUL     AH
043D 03 C7                            ADD     AX,DI               ; ADD IN THE LATEST ENTRY
043F A2 0019 R                        MOV     @ALT_INPUT,AL       ; STORE IT AWAY
0442 E9 03A0 R                 K32A:  JMP     K26                 ; THROW AWAY THAT KEYSTROKE

                               ;------ LOOK FOR SUPERSHIFT ENTRY

0445                           K33:                               ; NO-ALT-KEYPAD
0445 C6 06 0019 R 00                  MOV     @ALT_INPUT,0        ; ZERO ANY PREVIOUS ENTRY INTO INPUT
044A B9 001A                          MOV     CX,26               ; DI,ES ALREADY POINTING
044D F2/ AE                           REPNE   SCASB               ; LOOK FOR MATCH IN ALPHABET
044F 74 42                            JE      K37A                ; MATCH FOUND, GO FILL THE BUFFER

                               ;------ LOOK FOR TOP ROW OF ALTERNATE SHIFT

0451                           K34:                               ; ALT-TOP-ROW
0451 3C 02                            CMP     AL,2                ; KEY WITH '1' ON IT
0453 72 43                            JB      K37B                ; MUST BE ESCAPE
0455 3C 0D                            CMP     AL,13               ; IS IT IN THE REGION
0457 77 05                            JA      K35                 ;  NO, ALT-SOMETHING ELSE
0459 80 C4 76                         ADD     AH,118              ; CONVERT PSEUDO SCAN CODE TO RANGE
045C EB 35                            JMP     SHORT K37A          ; GO FILL THE BUFFER

                               ;------ TRANSLATE ALTERNATE SHIFT PSEUDO SCAN CODES

045E                           K35:                               ; ALT-FUNCTION
045E 3C 57                            CMP     AL,F11_M            ; IS IT F11?
0460 72 09                            JB      K35A                ;  NO, BRANCH
0462 3C 58                            CMP     AL,F12_M            ; IS IT F12?
0464 77 05                            JA      K35A                ;  NO, BRANCH
0466 80 C4 34                         ADD     AH,52               ; CONVERT TO PSEUDO SCAN CODE
0469 EB 28                            JMP     SHORT K37A          ; GO FILL THE BUFFER

046B F6 C7 02                  K35A:  TEST    BH,LC_E0            ; DO WE HAVE ONE OF THE NEW KEYS?
046E 74 18                            JZ      K37                 ;  NO, JUMP
0470 3C 1C                            CMP     AL,28               ; TEST FOR KEYPAD ENTER
0472 75 06                            JNE     K35B                ; NOT THERE
0474 B8 A600                          MOV     AX,0A600h           ; SPECIAL CODE
0477 E9 05F5 R                        JMP     K57                 ; BUFFER FILL
047A 3C 53                     K35B:  CMP     AL,83               ; TEST FOR DELETE KEY
047C 74 1F                            JE      K37C                ; HANDLE WITH OTHER EDIT KEYS
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047E 3C 35                           CMP    AL,53                    ; TEST FOR KEYPAD /
0480 75 C0                           JNE    K32A                     ; NOT THERE, NO OTHER E0 SPECIALS
0482 B8 A400                         MOV    AX,0A400h                ; SPECIAL CODE
0485 E9 05F5 R                       JMP    K57                      ; BUFFER FILL

0488 3C 3B                   K37:    CMP    AL,59                    ; TEST FOR FUNCTION KEYS (F1)
048A 72 0C                           JB     K37B                     ;  NO FN, HANDLE W/OTHER EXTENDED
048C 3C 44                           CMP    AL,68                    ; IN KEYPAD REGION?
                                                                     ; OR NUMLOCK, SCROLLOCK?
048E 77 B2                           JA     K32A                     ; IF SO, IGNORE
0490 80 C4 2D                        ADD    AH,45                    ; CONVERT TO PSEUDO SCAN CODE

0493 B0 00                   K37A:   MOV    AL,0                     ; ASCII CODE OF ZERO
0495 E9 05F5 R                       JMP    K57                      ; PUT IT IN THE BUFFER

0498 B0 F0                   K37B:   MOV    AL,0F0h                  ; USE SPECIAL ASCII CODE
049A E9 05F5 R                       JMP    K57                      ; PUT IT IN THE BUFFER

049D 04 50                   K37C:   ADD    AL,80                    ; CONVERT SCAN CODE (EDIT KEYS)
049F 8A E0                           MOV    AH,AL                    ; (SCAN CODE NOT IN AH FOR INSERT)
04A1 EB F0                           JMP    K37A                     ; PUT IT IN THE BUFFER

                             ;------ NOT IN ALTERNATE SHIFT

04A3                         K38:                                    ; NOT-ALT-SHIFT
                                                                     ; BL STILL HAS SHIFT FLAGS
04A3 F6 C3 04                        TEST   BL,CTL_SHIFT             ; ARE WE IN CONTROL SHIFT?
04A6 75 03                           JNZ    K38A                     ;  YES, START PROCESSING
04A8 E9 0535 R                       JMP    K44                      ; NOT-CTL-SHIFT

                             ;------ CONTROL SHIFT, TEST SPECIAL CHARACTERS

                             ;------ TEST FOR BREAK

04AB 3C 46                   K38A:   CMP    AL,SCROLL_KEY            ; TEST FOR BREAK
04AD 75 23                           JNE    K39                      ; JUMP, NO-BREAK
04AF F6 C7 10                        TEST   BH,KBX                   ; IS THIS THE ENHANCED KEYBOARD?
04B2 74 05                           JZ     K38B                     ;  NO, BREAK IS VALID
04B4 F6 C7 02                        TEST   BH,LC_E0                 ;  YES, WAS LAST CODE AN E0?
04B7 74 19                           JZ     K39                      ;   NO-BREAK, TEST FOR PAUSE

04B9 8B 1E 001A R            K38B:   MOV    BX,@BUFFER_HEAD          ; RESET BUFFER TO EMPTY
04BD 89 1E 001C R                    MOV    @BUFFER_TAIL,BX          ;
04C1 C6 06 0071 R 80                 MOV    @BIOS_BREAK,80H          ; TURN ON BIOS_BREAK BIT

                             ;-------- ENABLE KEYBOARD

04C6 B0 AE                           MOV    AL,ENA_KBD               ; ENABLE KEYBOARD
04C8 E8 063C R                       CALL   SHIP_IT                  ; EXECUTE ENABLE
04CB CD 1B                           INT    1BH                      ; BREAK INTERRUPT VECTOR
04CD 2B C0                           SUB    AX,AX                    ; PUT OUT DUMMY CHARACTER
04CF E9 05F5 R                       JMP    K57                      ; BUFFER_FILL

                             ;-------- TEST FOR PAUSE

04D2                         K39:                                    ; NO-BREAK
04D2 F6 C7 10                        TEST   BH,KBX                   ; IS THIS THE ENHANCED KEYBOARD?
04D5 75 2A                           JNZ    K41                      ; YES, THEN THIS CAN'T BE PAUSE
04D7 3C 45                           CMP    AL,NUM_KEY               ; LOOK FOR PAUSE KEY
04D9 75 26                           JNE    K41                      ; NO-PAUSE
04DB 80 0E 0018 R 08         K39P:   OR     @KB_FLAG_1,HOLD_STATE    ; TURN ON THE HOLD FLAG

                             ;-------- ENABLE KEYBOARD

04E0 B0 AE                           MOV    AL,ENA_KBD               ; ENABLE KEYBOARD
04E2 E8 063C R                       CALL   SHIP_IT                  ; EXECUTE ENABLE
04E5 B0 20                   K39A:   MOV    AL,EOI                   ; END OF INTERRUPT TO CONTROL PORT
04E7 E6 20                           OUT    020H,AL                  ; ALLOW FURTHER KEYSTROKE INTS

                             ;------ DURING PAUSE INTERVAL, TURN CRT BACK ON

04E9 80 3E 0049 R 07                 CMP    @CRT_MODE,7              ; IS THIS BLACK AND WHITE CARD
04EE 74 07                           JE     K40                      ; YES, NOTHING TO DO
04F0 BA 03D8                         MOV    DX,03D8H                 ; PORT FOR COLOR CARD
04F3 A0 0065 R                       MOV    AL,@CRT_MODE_SET         ; GET THE VALUE OF THE CURRENT MODE
04F6 EE                              OUT    DX,AL                    ; SET THE CRT MODE, SO THAT CRT IS ON
04F7                         K40:                                    ; PAUSE-LOOP
04F7 F6 06 0018 R 08                 TEST   @KB_FLAG_1,HOLD_STATE
04FC 75 F9                           JNZ    K40                      ; LOOP UNTIL FLAG TURNED OFF
04FE E9 03AA R                       JMP    K27                      ; INTERRUPT_RETURN_NO_EOI

                             ;------ TEST SPECIAL CASE KEY 55

0501                         K41:                                    ; NO-PAUSE
0501 3C 37                           CMP    AL,55                    ; TEST FOR */PRTSC KEY
0503 75 10                           JNE    K42                      ; NOT-KEY-55
0505 F6 C7 10                        TEST   BH,KBX                   ; IS THIS THE ENHANCED KEYBOARD?
0508 74 05                           JZ     K41A                     ;  NO, CTL-PRTSC IS VALID
050A F6 C7 02                        TEST   BH,LC_E0                 ;  YES, WAS LAST CODE AN E0?
050D 74 20                           JZ     K42B                     ;   NO, TRANSLATE TO A FUNCTION
050F B8 7200                 K41A:   MOV    AX,114*256               ; START/STOP PRINTING SWITCH
0512 E9 05F5 R                       JMP    K57                      ; BUFFER_FILL

                             ;------ SET UP TO TRANSLATE CONTROL SHIFT

0515                         K42:                                    ; NOT-KEY-55
0515 3C 0F                           CMP    AL,15                    ; IS IT THE TAB KEY?
0517 74 16                           JE     K42B                     ;  YES, XLATE TO FUNCTION CODE
0519 3C 35                           CMP    AL,53                    ; IS IT THE / KEY?
051B 75 0B                           JNE    K42A                     ;  NO, NO MORE SPECIAL CASES
051D F6 C7 02                        TEST   BH,LC_E0                 ;  YES, IS IT FROM THE KEYPAD?
0520 74 06                           JZ     K42A                     ;   NO, JUST TRANSLATE
0522 B8 9500                         MOV    AX,9500h                 ;   YES, SPECIAL CODE FOR THIS ONE
0525 E9 05F5 R                       JMP    K57                      ;   BUFFER FILL

0528 BB 0000 E               K42A:   MOV    BX,OFFSET K8             ; SET UP TO TRANSLATE CTL
052B 3C 3B                           CMP    AL,59                    ; IS IT IN CHARACTER TABLE?
052D 72 5E                           JB     K45F                     ;  YES, GO TRANSLATE CHAR
052F BB 0000 E               K42B:   MOV    BX,OFFSET K8             ; SET UP TO TRANSLATE CTL
0532 E9 05E4 R                       JMP    K64                      ;  NO, GO TRANSLATE_SCAN

                             ;------ NOT IN CONTROL SHIFT

0535 3C 37                   K44:    CMP    AL,55                    ; PRINT SCREEN KEY?
```

```
0537 75 26                       JNE     K45                      ; NOT-PRINT-SCREEN
0539 F6 C7 10                    TEST    BH,KBX                   ; IS THIS ENHANCED KEYBOARD?
053C 74 07                       JZ      K44A                     ; NO, TEST FOR SHIFT STATE
053E F6 C7 02                    TEST    BH,LC_E0                 ; YES, LAST CODE A MARKER?
0541 75 07                       JNZ     K44B                     ;  YES, IS PRINT SCREEN
0543 EB 3B                       JMP     SHORT K45C               ;  NO, XLATE TO "*" CHARACTER
0545 F6 C3 03            K44A:   TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ;NOT 101 KBD, SHIFT KEY DOWN?
0548 74 36                       JZ      K45C                     ; NO, XLATE TO "*" CHARACTER

                         ;------ ISSUE INTERRUPT TO PERFORM PRINT SCREEN FUNCTION
054A B0 AE               K44B:   MOV     AL,ENA_KBD               ; INSURE KEYBOARD IS ENABLED
054C E8 063C R                   CALL    SHIP_IT                  ; EXECUTE ENABLE
054F B0 20                       MOV     AL,EOI                   ; END OF CURRENT INTERRUPT
0551 E6 20                       OUT     020H,AL                  ;  SO FURTHER THINGS CAN HAPPEN
0553 55                          PUSH    BP                       ; SAVE POINTER
0554 CD 05                       INT     5H                       ; ISSUE PRINT SCREEN INTERRUPT
0556 5D                          POP     BP                       ; RESTORE POINTER
0557 80 26 0096 R FC             AND     @KB_FLAG_3,NOT LC_E0+LC_E1 ;ZERO OUT THESE FLAGS
055C E9 03AA R                   JMP     K27                      ; GO BACK WITHOUT EOI OCCURRING


                         ;------ HANDLE THE IN-CORE KEYS
055F                     K45:                                     ; NOT-PRINT-SCREEN
055F 3C 3A                       CMP     AL,58                    ; TEST FOR IN-CORE AREA
0561 77 2C                       JA      K46                      ; JUMP IF NOT

0563 3C 35                       CMP     AL,53                    ; IS THIS THE "/" KEY?
0565 75 05                       JNE     K45A                     ;  NO, JUMP
0567 F6 C7 02                    TEST    BH,LC_E0                 ; WAS LAST CODE THE MARKER?
056A 75 14                       JNZ     K45C                     ;  YES, TRANSLATE TO CHARACTER

056C B9 001A             K45A:   MOV     CX,26                    ; LENGTH OF SEARCH
056F BF 03EE R                   MOV     DI,OFFSET K30+10         ; POINT TO TABLE OF A-Z CHARS
0572 F2/ AE                      REPNE   SCASB                    ; IS THIS A LETTER KEY?
0574 75 05                       JNE     K45B                     ;  NO, SYMBOL KEY

0576 F6 C3 40                    TEST    BL,CAPS_STATE            ; ARE WE IN CAPS_LOCK?
0579 75 0A                       JNZ     K45D                     ; TEST FOR SURE
057B F6 C3 03            K45B:   TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ; ARE WE IN SHIFT STATE?
057E 75 0A                       JNZ     K45E                       ; YES, UPPERCASE
                                                                    ; NO, LOWERCASE
0580 BB 0000 E           K45C:   MOV     BX,OFFSET K10            ; TRANSLATE TO LOWERCASE LETTERS
0583 EB 50                       JMP     SHORT K56
0585                     K45D:                                    ; ALMOST-CAPS-STATE
0585 F6 C3 03                    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ; CL ON. IS SHIFT ON, TOO?
0588 75 F6                       JNZ     K45C                     ; SHIFTED TEMP OUT OF CAPS STATE
058A BB 0000 E           K45E:   MOV     BX,OFFSET K11            ; TRANSLATE TO UPPERCASE LETTERS
058D EB 46               K45F:   JMP     SHORT K56


                         ;------ TEST FOR KEYS F1 - F10
058F                     K46:                                     ; NOT IN-CORE AREA
058F 3C 44                       CMP     AL,68                    ; TEST FOR F1 - F10
0591 77 02                       JA      K47                      ; JUMP IF NOT
0593 EB 36                       JMP     SHORT K53                ; YES, GO DO FN KEY PROCESS


                         ;------ HANDLE THE NUMERIC PAD KEYS
0595                     K47:                                     ; NOT F1 - F10
0595 3C 53                       CMP     AL,83                    ; TEST FOR NUMPAD KEYS
0597 77 2C                       JA      K52                      ; JUMP IF NOT

                         ;------ KEYPAD KEYS, MUST TEST NUM LOCK FOR DETERMINATION
0599 3C 4A               K48:    CMP     AL,74                    ; SPECIAL CASE FOR MINUS
059B 74 ED                       JE      K45E                     ; GO TRANSLATE
059D 3C 4E                       CMP     AL,78                    ; SPECIAL CASE FOR PLUS
059F 74 E9                       JE      K45E                     ; GO TRANSLATE
05A1 F6 C7 02                    TEST    BH,LC_E0                 ; IS THIS ONE OF THE NEW KEYS?
05A4 75 0A                       JNZ     K49                      ;  YES, TRANSLATE TO BASE STATE

05A6 F6 C3 20                    TEST    BL,NUM_STATE             ; ARE WE IN NUM_LOCK?
05A9 75 13                       JNZ     K50                      ; TEST FOR SURE
05AB F6 C3 03                    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT  ; ARE WE IN SHIFT STATE?
05AE 75 13                       JNZ     K51                        ; IF SHIFTED, REALLY NUM STATE

                         ;------ BASE CASE FOR KEYPAD
05B0 3C 4C               K49:    CMP     AL,76                    ; SPECIAL CASE FOR BASE STATE 5
05B2 75 05                       JNE     K49A                     ; CONTINUE IF NOT KEYPAD 5
05B4 B0 F0                       MOV     AL,0F0h                  ; SPECIAL ASCII CODE
05B6 EB 3D 90                    JMP     K57                      ; BUFFER FILL
05B9 BB 0000 E           K49A:   MOV     BX,OFFSET K10            ; BASE CASE TABLE
05BC EB 26                       JMP     SHORT K64                ; CONVERT TO PSEUDO SCAN

                         ;------ MIGHT BE NUM LOCK, TEST SHIFT STATUS
05BE F6 C3 03            K50:    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT        ;ALMOST-NUM-STATE
05C1 75 ED                       JNZ     K49                      ; SHIFTED TEMP OUT OF NUM STATE
05C3 EB C5               K51:    JMP     SHORT K45E               ; REALLY_NUM_STATE


                         ;------ TEST FOR THE NEW KEY ON WT KEYBOARDS

05C5                     K52:                                     ; NOT A NUMPAD KEY
05C5 3C 56                       CMP     AL,86                    ; IS IT THE NEW WT KEY?
05C7 75 02                       JNE     K53                      ; JUMP IF NOT
05C9 EB B0                       JMP     SHORT K45B               ; HANDLE WITH REST OF LETTER KEYS


                         ;------ MUST BE F11 OR F12
                                                                  ; F1 - F10 COME HERE, TOO
05CB F6 C3 03            K53:    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ;TEST SHIFT STATE
05CE 74 E0                       JZ      K49                      ; JUMP, LOWERCASE PSEUDO SC'S

05D0 BB 0000 E                   MOV     BX,OFFSET K11            ; UPPER CASE PSEUDO SCAN CODES
05D3 EB 0F                       JMP     SHORT K64                ; TRANSLATE_SCAN

                         ;------ TRANSLATE THE CHARACTER

05D5                     K56:                                     ; TRANSLATE-CHAR
05D5 FE C8                       DEC     AL                       ; CONVERT ORIGIN
05D7 2E: D7                      XLAT    CS:K11                   ; CONVERT THE SCAN CODE TO ASCII
05D9 F6 06 0096 R 02             TEST    @KB_FLAG_3,LC_E0         ; IS THIS A NEW KEY?
05DE 74 15                       JZ      K57                      ;  NO, GO FILL BUFFER
05E0 B4 E0                       MOV     AH,MC_E0                 ;  YES, PUT SPECIAL MARKER IN AH
05E2 EB 11                       JMP     SHORT K57                ; PUT IT INTO THE BUFFER
```

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                                ;------ TRANSLATE SCAN FOR PSEUDO SCAN CODES

05E4                            K64:                                        ; TRANSLATE-SCAN-ORGD
05E4 FE C8                              DEC     AL                          ; CONVERT ORIGIN
05E6 2E: D7                             XLAT    CS:K8                       ; CTL TABLE SCAN
05E8 8A E0                              MOV     AH,AL                       ; PUT VALUE INTO AH
05EA B0 00                              MOV     AL,0                        ; ZERO ASCII CODE
05EC F6 06 0096 R 02                    TEST    @KB_FLAG_3,LC_E0            ; IS THIS A NEW KEY?
05F1 74 02                              JZ      K57                         ;  NO, GO FILL BUFFER
05F3 B0 E0                              MOV     AL,MC_E0                    ;  YES, PUT SPECIAL MARKER IN AL

                                ;------ PUT CHARACTER INTO BUFFER

05F5                            K57:                                        ; BUFFER-FILL
05F5 3C FF                              CMP     AL,-1                       ; IS THIS AN IGNORE CHAR
05F7 74 05                              JE      K59                         ; YES, DO NOTHING WITH IT
05F9 80 FC FF                           CMP     AH,-1                       ; LOOK FOR -1 PSEUDO SCAN
05FC 75 03                              JNE     K61                         ; NEAR_INTERRUPT_RETURN

05FE                            K59:                                        ; NEAR-INTERRUPT-RETURN
05FE E9 03A0 R                          JMP     K26                         ; INTERRUPT_RETURN

0601                            K61:
0601 8B 1E 001C R                       MOV     BX,@BUFFER_TAIL             ; GET THE END POINTER TO THE BUFFER
0605 8B F3                              MOV     SI,BX                       ; SAVE THE VALUE
0607 E8 0168 R                          CALL    K4                          ; ADVANCE THE TAIL
060A 3B 1E 001A R                       CMP     BX,@BUFFER_HEAD             ; HAS THE BUFFER WRAPPED AROUND
060E 74 1D                              JE      K62                         ; BUFFER_FULL_BEEP
0610 89 04                              MOV     [SI],AX                     ; STORE THE VALUE
0612 89 1E 001C R                       MOV     @BUFFER_TAIL,BX             ; MOVE THE POINTER UP
0616 FA                                 CLI                                 ; TURN OFF INTERRUPTS
0617 B0 20                              MOV     AL,EOI                      ; END OF INTERRUPT COMMAND
0619 E6 20                              OUT     INTA00,AL                   ; SEND COMMAND TO INTERRUPT CONTROL PORT
061B B0 AE                              MOV     AL,ENA_KBD                  ; INSURE KEYBOARD IS ENABLED
061D E8 063C R                          CALL    SHIP_IT                     ; EXECUTE ENABLE
0620 B8 9102                            MOV     AX,09102H                   ; MOVE IN POST CODE & TYPE
0623 CD 15                              INT     15H                         ; PERFORM OTHER FUNCTION
0625 80 26 0096 R FC                    AND     @KB_FLAG_3,NOT LC_E0+LC_E1  ; RESET LAST CHAR H.C. FLAG
062A E9 03AF R                          JMP     K27A                        ; INTERRUPT_RETURN

                                ;------ BUFFER IS FULL SOUND THE BEEPER

062D                            K62:
062D B0 20                              MOV     AL,EOI                      ; ENABLE INTERRUPT CONTROLLER CHIP
062F E6 20                              OUT     INTA00,AL                   ;
0631 B9 02A6                            MOV     CX,678                      ; DIVISOR FOR 1760 HZ
0634 B3 04                              MOV     BL,4                        ; SHORT BEEP COUNT (1/16 + 1/64 DELAY)
0636 E8 0000 E                          CALL    BEEP                        ; GO TO COMMON BEEP HANDLER
0639 E9 03AA R                          JMP     K27                         ; EXIT

063C                            KB_INT_1        ENDP
```

```
                                PAGE
                                ;-----------------------------------------------------------------------
                                ;                                                                      -
                                ;       SHIP_IT                                                        -
                                ;                                                                      -
                                ;       THIS ROUTINE HANDLES TRANSMISSION OF COMMAND AND DATA BYTES    -
                                ;       TO THE KEYBOARD CONTROLLER.                                    -
                                ;                                                                      -
                                ;-----------------------------------------------------------------------
063C                            SHIP_IT PROC    NEAR
063C 50                                 PUSH    AX                      ; SAVE DATA TO SEND

                                ;------- WAIT FOR COMMAND TO BE ACCEPTED
063D FA                                 CLI                             ; DISABLE INTERRUPTS TILL DATA SENT
063E 2B C9                              SUB     CX,CX                   ; CLEAR TIMEOUT COUNTER
0640                            S10:
0640 E4 64                              IN      AL,STATUS_PORT          ; READ KEYBOARD CONTROLLER STATUS
0642 A8 02                              TEST    AL,INPT_BUF_FULL        ; CHECK FOR ITS INPUT BUFFER BUSY
0644 E0 FA                              LOOPNZ  S10                     ; WAIT FOR COMMAND TO BE ACCEPTED

0646 58                                 POP     AX                      ; GET DATA TO SEND
0647 E6 64                              OUT     STATUS_PORT,AL          ; SEND TO KEYBOARD CONTROLLER
0649 FB                                 STI                             ; ENABLE INTERRUPTS AGAIN
064A C3                                 RET                             ; RETURN TO CALLER
064B                            SHIP_IT ENDP

                                ;-----------------------------------------------------------------------
                                ;                                                                      -
                                ;       SND_DATA                                                       -
                                ;                                                                      -
                                ;       THIS ROUTINE HANDLES TRANSMISSION OF COMMAND AND DATA BYTES    -
                                ;       TO THE KEYBOARD AND RECEIPT OF ACKNOWLEDGEMENTS.  IT ALSO      -
                                ;       HANDLES ANY RETRIES IF REQUIRED                                -
                                ;                                                                      -
                                ;-----------------------------------------------------------------------

064B                            SND_DATA PROC   NEAR
064B 50                                 PUSH    AX                      ; SAVE REGISTERS
064C 53                                 PUSH    BX                      ; *
064D 51                                 PUSH    CX
064E 8A F8                              MOV     BH,AL                   ; SAVE TRANSMITTED BYTE FOR RETRIES
0650 B3 03                              MOV     BL,3                    ; LOAD RETRY COUNT
0652 FA                         SD0:    CLI                             ; DISABLE INTERRUPTS
0653 80 26 0097 R CF                    AND     @KB_FLAG_2,NOT (KB_FE+KB_FA) ; CLEAR ACK AND RESEND FLAGS

                                ;------- WAIT FOR COMMAND TO BE ACCEPTED

0658 2B C9                              SUB     CX,CX
065A E4 64                      SD5:    IN      AL,STATUS_PORT
065C A8 02                              TEST    AL,INPT_BUF_FULL
065E E0 FA                              LOOPNZ  SD5                     ; WAIT FOR COMMAND TO BE ACCEPTED

0660 8A C7                              MOV     AL,BH                   ; REESTABLISH BYTE TO TRANSMIT
0662 E6 60                              OUT     PORT_A,AL               ; SEND BYTE
0664 FB                                 STI                             ; ENABLE INTERRUPTS
0665 B9 1A00                            MOV     CX,01A00H               ; LOAD COUNT FOR 10mS+
0668 F6 06 0097 R 30            SD1:    TEST    @KB_FLAG_2,KB_FE+KB_FA  ; SEE IF EITHER BIT SET
066D 75 0D                              JNZ     SD3                     ; IF SET, SOMETHING RECEIVED GO PROCESS
066F E2 F7                              LOOP    SD1                     ; OTHERWISE WAIT

0671 FE CB                      SD2:    DEC     BL                      ; DECREMENT RETRY COUNT
0673 75 DD                              JNZ     SD0                     ; RETRY TRANSMISSION
0675 80 0E 0097 R 80                    OR      @KB_FLAG_2,KB_ERR       ; TURN ON TRANSMIT ERROR FLAG
067A EB 07                              JMP     SHORT SD4               ; RETRIES EXHAUSTED FORGET TRANSMISSION

067C F6 06 0097 R 10            SD3:    TEST    @KB_FLAG_2,KB_FA        ; SEE IF THIS IS AN ACKNOWLEDGE
0681 74 EE                              JZ      SD2                     ; IF NOT, GO RESEND

0683 59                         SD4:    POP     CX                      ; RESTORE REGISTERS
0684 5B                                 POP     BX                      ;
0685 58                                 POP     AX                      ; *
0686 C3                                 RET                             ; RETURN, GOOD TRANSMISSION
0687                            SND_DATA ENDP
```

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                                PAGE
                                ;-----------------------------------------------------------------
                                ;                                                                -
                                ;       SND_LED                                                  -
                                ;                                                                -
                                ;       THIS ROUTINE TURNS ON THE MODE INDICATORS.               -
                                ;                                                                -
                                ;-----------------------------------------------------------------
 0687                           SND_LED PROC    NEAR
 0687  FA                               CLI                             ; TURN OFF INTERRUPTS
 0688  F6 06 0097 R 40                  TEST    @KB_FLAG_2,KB_PR_LED    ; CHECK FOR MODE INDICATOR UPDATE
 068D  75 47                            JNZ     SL1                     ; DONT UPDATE AGAIN IF UPDATE UNDERWAY
                                ;
 068F  80 0E 0097 R 40                  OR      @KB_FLAG_2,KB_PR_LED    ; TURN ON UPDATE IN PROCESS
 0694  B0 20                            MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
 0696  E6 20                            OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT
 0698  EB 0D                            JMP     SHORT SL0               ; GO SEND MODE INDICATOR COMMAND
                                ;
 069A                           SND_LED1:
 069A  FA                               CLI                             ; TURN OFF INTERRUPTS
 069B  F6 06 0097 R 40                  TEST    @KB_FLAG_2,KB_PR_LED    ; CHECK FOR MODE INDICATOR UPDATE
 06A0  75 34                            JNZ     SL1                     ; DONT UPDATE AGAIN IF UPDATE UNDERWAY
                                ;
 06A2  80 0E 0097 R 40                  OR      @KB_FLAG_2,KB_PR_LED    ; TURN ON UPDATE IN PROCESS
 06A7  B0 ED                    SL0:    MOV     AL,LED_CMD              ; LED CMD BYTE
 06A9  E8 064B R                        CALL    SND_DATA                ; SEND DATA TO KEYBOARD
 06AC  FA                               CLI                             ;
 06AD  E8 06D8 R                        CALL    MAKE_LED                ; GO FORM INDICATOR DATA BYTE
 06B0  80 26 0097 R F8                  AND     @KB_FLAG_2,0F8H         ; CLEAR MODE INDICATOR BITS
 06B5  08 06 0097 R                     OR      @KB_FLAG_2,AL           ; SAVE PRESENT INDICATORS FOR NEXT TIME
 06B9  F6 06 0097 R 80                  TEST    @KB_FLAG_2,KB_ERR       ; TRANSMIT ERROR DETECTED
 06BE  75 0B                            JNZ     SL2                     ;  YES, BYPASS SECOND BYTE TRANSMISSION
                                ;
 06C0  E8 064B R                        CALL    SND_DATA                ; SEND DATA TO KEYBOARD
 06C3  FA                               CLI                             ; TURN OFF INTERRUPTS
 06C4  F6 06 0097 R 80                  TEST    @KB_FLAG_2,KB_ERR       ; TRANSMIT ERROR DETECTED
 06C9  74 06                            JZ      SL3                     ; IF NOT, DONT SEND AN ENABLE COMMAND
                                ;
 06CB  B0 F4                    SL2:    MOV     AL,KB_ENABLE            ; GET KEYBOARD CSA ENABLE COMMAND
 06CD  E8 064B R                        CALL    SND_DATA                ; SEND DATA TO KEYBOARD
 06D0  FA                               CLI                             ; TURN OFF INTERRUPTS
 06D1  80 26 0097 R 3F          SL3:    AND     @KB_FLAG_2,NOT(KB_PR_LED+KB_ERR) ; TURN OFF MODE INDICATOR
                                                                        ; UPDATE AND TRANSMIT ERROR FLAG
 06D6  FB                       SL1:    STI                             ; ENABLE INTERRUPTS
 06D7  C3                               RET                             ; RETURN TO CALLER
 06D8                           SND_LED ENDP

                                ;-----------------------------------------------------------------
                                ;                                                                -
                                ;       MAKE_LED                                                 -
                                ;                                                                -
                                ;       THIS ROUTINE FORMS THE DATA BYTE NECESSARY TO TURN ON/OFF -
                                ;         THE MODE INDICATORS                                    -
                                ;                                                                -
                                ;-----------------------------------------------------------------
 06D8                           MAKE_LED PROC   NEAR
 06D8  51                               PUSH    CX                      ; SAVE CX
 06D9  A0 0017 R                        MOV     AL,@KB_FLAG             ; GET CAPS & NUM LOCK INDICATORS
 06DC  24 70                            AND     AL,CAPS_STATE+NUM_STATE+SCROLL_STATE ; ISOLATE INDICATORS
 06DE  B1 04                            MOV     CL,4                    ; SHIFT COUNT
 06E0  D2 C0                            ROL     AL,CL                   ; SHIFT BITS OVER TO TURN ON INDICATORS
 06E2  24 07                            AND     AL,07H                  ; MAKE SURE ONLY MODE BITS ON
 06E4  59                               POP     CX
 06E5  C3                               RET                             ; RETURN TO CALLER
 06E6                           MAKE_LED ENDP

 06E6                           CODE    ENDS
                                        END
```

```
                              PAGE 118,121
                              TITLE PRT ------ 06/10/85  PRINTER ADAPTER BIOS
                              .286C
                              .LIST
 0000                         CODE    SEGMENT BYTE PUBLIC

                                      PUBLIC  PRINTER_IO_1
                                      EXTRN   DDS:NEAR

                              ;--- INT  17 H ---------------------------------------------------------------
                              ; PRINTER_IO                                                                  :
                              ;       THIS ROUTINE PROVIDES COMMUNICATION WITH THE PRINTER                  :
                              ; INPUT                                                                       :
                              ;       (AH)= 00H  PRINT THE CHARACTER IN (AL)                                :
                              ;                   ON RETURN, (AH)= 1 IF CHARACTER NOT BE PRINTED (TIME OUT) :
                              ;                   OTHER BITS SET AS ON NORMAL STATUS CALL                   :
                              ;       (AH)= 01H  INITIALIZE THE PRINTER PORT                                :
                              ;                   RETURNS WITH (AH) SET WITH PRINTER STATUS                 :
                              ;       (AH)= 02H  READ THE PRINTER STATUS INTO (AH)                          :
                              ;                  7       6       5       4       3       2-1     0          :
                              ;                  |       |       |       |       |       |       |_ TIME OUT :
                              ;                  |       |       |       |       |       |                  :
                              ;                  |       |       |       |       |       |_ UNUSED          :
                              ;                  |       |       |       |       |                          :
                              ;                  |       |       |       |       |_ 1 = I/O ERROR           :
                              ;                  |       |       |       |                                  :
                              ;                  |       |       |       |_ 1 = SELECTED                    :
                              ;                  |       |       |                                          :
                              ;                  |       |       |_ 1 = OUT OF PAPER                        :
                              ;                  |       |                                                  :
                              ;                  |       |_ 1 = ACKNOWLEDGE                                 :
                              ;                  |                                                          :
                              ;                  |_ 1 = NOT BUSY                                            :
                              ;                                                                             :
                              ;       (DX) = PRINTER TO BE USED (0,1,2) CORRESPONDING TO ACTUAL VALUES      :
                              ;               IN @PRINTER_BASE AREA                                         :
                              ; DATA AREA @PRINTER_BASE CONTAINS THE BASE ADDRESS OF THE PRINTER CARD(S)    :
                              ; AVAILABLE (LOCATED AT BEGINNING OF DATA SEGMENT, 408H ABSOLUTE, 3 WORDS)    :
                              ;                                                                             :
                              ; DATA AREA @PRINT_TIM_OUT (BYTE) MAY BE CHANGE TO CAUSE DIFFERENT            :
                              ; TIME OUT WAITS. DEFAULT=20 * 4                                              :
                              ;                                                                             :
                              ; REGISTERS      (AH) IS MODIFIED WITH STATUS INFORMATION                     :
                              ;                ALL OTHERS UNCHANGED                                         :
                              ;-----------------------------------------------------------------------------
                                      ASSUME  CS:CODE,DS:DATA

 0000                         PRINTER_IO_1    PROC    FAR             ; ENTRY POINT FOR ORG 0EFD2H
 0000 FB                              STI                             ; INTERRUPTS BACK ON
 0001 1E                              PUSH    DS                      ; SAVE SEGMENT
 0002 56                              PUSH    SI
 0003 52                              PUSH    DX
 0004 51                              PUSH    CX
 0005 53                              PUSH    BX
 0006 E8 0000 E                       CALL    DDS                     ; ADDRESS DATA SEGMENT
 0009 8B F2                           MOV     SI,DX                   ; GET PRINTER PARAMETER
 000B C1 EA 02                        SHR     DX,2                    ; tEST PARAMETER
 000E 75 1A                           JNZ     B10                     ; rETURN IF NOT IN RANGE
 0010 8A 9C 0078 R                    MOV     BL,@PRINT_TIM_OUT[SI]   ; LOAD TIMEOUT VALUE
 0014 D1 E6                           SHL     SI,1                    ; WORD OFFSET INTO TABLE INTO (SI)
 0016 8B 94 0008 R                    MOV     DX,@PRINTER_BASE[SI]    ; GET BASE ADDRESS FOR PRINTER CARD
 001A 0B D2                           OR      DX,DX                   ; TEST DX = ZERO, INDICATING NO PRINTER
 001C 74 0C                           JZ      B10                     ; EXIT,  NO PRINTER ADAPTER AT OFFSET
 001E 0A E4                           OR      AH,AH                   ; TEST FOR (AH)= 00H
 0020 74 0E                           JZ      B20                     ;  PRINT CHARACTER IN (AL)
 0022 FE CC                           DEC     AH                      ; TEST FOR (AH)= 01H
 0024 74 58                           JZ      B80                     ;  INITIALIZE PRINTER
 0026 FE CC                           DEC     AH                      ; TEST FOR (AH)= 02H
 0028 74 3F                           JZ      B50                     ;  GET PRINTER STATUS
 002A                         B10:
 002A 5B                              POP     BX                      ; RETURN
 002B 59                              POP     CX
 002C 5A                              POP     DX
 002D 5E                              POP     SI                      ; RECOVER REGISTERS
 002E 1F                              POP     DS
 002F CF                              IRET                            ; RETURN TO CALLING PROGRAM

                              ;-----  PRINT THE CHARACTER IN (AL)

 0030 50                      B20:    PUSH    AX                      ; SAVE VALUE TO PRINT
 0031 EE                              OUT     DX,AL                   ; OUTPUT CHARACTER TO DATA PORT
 0032 42                              INC     DX                      ; POINT TO STATUS PORT

                              ;-----  CHECK FOR PRINTER BUSY

 0033 53                              PUSH    BX                      ; SAVE TIMEOUT BASE COUNT
 0034 EC                              IN      AL,DX                   ; GET STATUS PORT VALUE
 0035 A8 80                           TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
 0037 75 05                           JNZ     B25                     ; SKIP SYSTEM DEVICE BUSY CALL IF NOT

                              ;-----  INT 15 H -- DEVICE BUSY

 0039 B8 90FE                         MOV     AX,90FEH                ; FUNCTION 90 PRINTER ID
 003C CD 15                           INT     15H                     ; SYSTEM CALL

                              ;-----  WAIT BUSY
                                                                      ; ADJUST OUTER LOOP COUNT
 003E 2A FF                   B25:    SUB     BH,BH                   ; CLEAR (BH)
 0040 C1 D3 02                        RCL     BX,2                    ; MULTIPLY BY 4
 0043                         B30:
 0043 2B C9                           SUB     CX,CX                   ; INNER LOOP (64K)
 0045                         B35:
 0045 EC                              IN      AL,DX                   ; GET STATUS
 0046 8A E0                           MOV     AH,AL                   ; STATUS TO (AH) ALSO
 0048 A8 80                           TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
 004A 75 0E                           JNZ     B40                     ; GO TO OUTPUT STROBE
 004C E2 F7                           LOOP    B35                     ; LOOP IF NOT
 004E 4B                              DEC     BX                      ; DECREMENT OUTER LOOP COUNT
 004F 75 F2                           JNZ     B30                     ; MAKE ANOTHER PASS IF NOT ZERO

 0051 5B                              POP     BX                      ; CLEAR (BX) FROM STACK
 0052 80 CC 01                        OR      AH,1                    ; SET ERROR FLAG
 0055 80 E4 F9                        AND     AH,0F9H                 ; TURN OFF THE UNUSED BITS
 0058 EB 1C                           JMP     SHORT B70               ; RETURN WITH ERROR FLAG SET
 005A                         B40:                                          ;       SEND STROBE PULSE
 005A 5B                                 POP     BX                          ; RESTORE (BX) WITH TIMEOUT COUNT
 005B B0 0D                              MOV     AL,0DH                      ; SET THE STROBE LOW (BIT ON)
 005D 42                                 INC     DX                          ; OUTPUT STROBE TO CONTROL PORT
 005E FA                                 CLI                                 ; PREVENT INTERRUPT PULSE STRETCHING
 005F EE                                 OUT     DX,AL                       ; OUTPUT STROBE BIT   > 1us  < 5us
 0060 EB 00                              JMP     $+2                         ; I/O DELAY TO ALLOW FOR LINE LOADING
 0062 EB 00                              JMP     $+2                         ;  AND FOR CORRECT PULSE WIDTH
 0064 B0 0C                              MOV     AL,0CH                      ; SET THE -STROBE HIGH
 0066 EE                                 OUT     DX,AL
 0067 FB                                 STI                                 ; INTERRUPTS BACK ON
 0068 58                                 POP     AX                          ; RECOVER THE OUTPUT CHAR

                              ;-----  PRINTER STATUS

 0069                         B50:
 0069 50                                 PUSH    AX                          ; SAVE (AL) REGISTER
 006A                         B60:
 006A 8B 94 0008 R                       MOV     DX,@PRINTER_BASE[SI]        ; GET PRINTER ATTACHMENT BASE ADDRESS
 006E 42                                 INC     DX                          ; POINT TO CONTROL PORT
 006F EC                                 IN      AL,DX                       ; PRE-CHARGE +BUSY LINE IF FLOATING
 0070 EC                                 IN      AL,DX                       ; GET PRINTER STATUS HARDWARE BITS
 0071 8A E0                              MOV     AH,AL                       ; SAVE
 0073 80 E4 F8                           AND     AH,0F8H                     ; TURN OFF UNUSED BITS
 0076                         B70:
 0076 5A                                 POP     DX                          ; RECOVER (AL) REGISTER
 0077 8A C2                              MOV     AL,DL                       ; MOVE CHARACTER INTO (AL)
 0079 80 F4 48                           XOR     AH,48H                      ; FLIP A COUPLE OF BITS
 007C EB AC                              JMP     B10                         ; RETURN FROM ROUTINE WITH STATUS IN AH

                              ;-----  INITIALIZE THE PRINTER PORT

 007E                         B80:
 007E 50                                 PUSH    AX                          ; SAVE (AL)
 007F 42                                 INC     DX                          ; POINT TO OUTPUT PORT
 0080 42                                 INC     DX
 0081 B0 08                              MOV     AL,8                        ; SET INIT LINE LOW
 0083 EE                                 OUT     DX,AL
 0084 B8 0FA0                            MOV     AX,1000*4                   ; ADJUST FOR INITIALIZATION DELAY LOOP
 0087                         B90:                                          ; INIT_LOOP
 0087 48                                 DEC     AX                          ; LOOP FOR RESET TO TAKE
 0088 75 FD                              JNZ     B90                         ; INIT_LOOP
 008A B0 0C                              MOV     AL,0CH                      ; NO INTERRUPTS, NON AUTO LF, INIT HIGH
 008C EE                                 OUT     DX,AL
 008D EB DB                              JMP     B60                         ; EXIT THROUGH STATUS ROUTINE

 008F                         PRINTER_IO_1       ENDP

 008F                                    CODE    ENDS
                                         END
```

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                                  PAGE 118,121
                                  TITLE RS232 ---- 06/10/85  COMMUNICATIONS BIOS (RS232)
                                  .286C
                                  .LIST
 0000                             CODE     SEGMENT BYTE PUBLIC
                                           PUBLIC  RS232_IO_1
                                           EXTRN   A1:NEAR
                                           EXTRN   DDS:NEAR

                                  ;--- INT 14 H ---------------------------------------------------------------
                                  ;RS232_IO                                                                   :
                                  ;        THIS ROUTINE PROVIDES BYTE STREAM I/O TO THE COMMUNICATIONS         :
                                  ;        PORT ACCORDING TO THE PARAMETERS:                                   :
                                  ;                                                                            :
                                  ;        (AH)= 00H  INITIALIZE THE COMMUNICATIONS PORT                       :
                                  ;                   (AL) HAS PARAMETERS FOR INITIALIZATION                   :
                                  ;                                                                            :
                                  ;               7      6      5       4      3       2        1       0      :
                                  ;               ----- BAUD RATE --     -PARITY--     STOPBIT   --WORD LENGTH--:
                                  ;                                                                            :
                                  ;               000 - 110              X0 - NONE      0 - 1     10 - 7 BITS  :
                                  ;               001 - 150              01 - ODD       1 - 2     11 - 8 BITS  :
                                  ;               010 - 300              11 - EVEN                             :
                                  ;               011 - 600                                                    :
                                  ;               100 - 1200                                                   :
                                  ;               101 - 2400                                                   :
                                  ;               110 - 4800                                                   :
                                  ;               111 - 9600                                                   :
                                  ;               ON RETURN, CONDITIONS SET AS IN CALL TO COMMO STATUS (AH=03H) :
                                  ;                                                                            :
                                  ;        (AH)= 01H  SEND THE CHARACTER IN (AL) OVER THE COMMO LINE           :
                                  ;                   (AL) REGISTER IS PRESERVED                               :
                                  ;                   ON EXIT, BIT 7 OF AH IS SET IF THE ROUTINE WAS UNABLE TO :
                                  ;                        TO TRANSMIT THE BYTE OF DATA OVER THE LINE.         :
                                  ;                        IF BIT 7 OF AH IS NOT SET, THE                      :
                                  ;                        REMAINDER OF (AH) IS SET AS IN A STATUS REQUEST,    :
                                  ;                        REFLECTING THE CURRENT STATUS OF THE LINE.          :
                                  ;        (AH)= 02H  RECEIVE A CHARACTER IN (AL) FROM COMMO LINE BEFORE       :
                                  ;                        RETURNING TO CALLER                                 :
                                  ;                   ON EXIT, (AH) HAS THE CURRENT LINE STATUS, AS SET BY THE :
                                  ;                        THE STATUS ROUTINE, EXCEPT THAT THE ONLY BITS       :
                                  ;                        LEFT ON ARE THE ERROR BITS (7,4,3,2,1)              :
                                  ;                        IF (AH) HAS BIT 7 ON (TIME OUT) THE REMAINING       :
                                  ;                        BITS ARE NOT PREDICTABLE.                           :
                                  ;                        THUS, (AH) IS NON ZERO ONLY WHEN AN ERROR OCCURRED. :
                                  ;        (AH)= 03H  RETURN THE COMMO PORT STATUS IN (AX)                     :
                                  ;                    (AH) CONTAINS THE LINE CONTROL STATUS                   :
                                  ;                         BIT 7 = TIME OUT                                   :
                                  ;                         BIT 6 = TRANSMIT SHIFT REGISTER EMPTY              :
                                  ;                         BIT 5 = TRANSMIT HOLDING REGISTER EMPTY            :
                                  ;                         BIT 4 = BREAK DETECT                               :
                                  ;                         BIT 3 = FRAMING ERROR                              :
                                  ;                         BIT 2 = PARITY ERROR                               :
                                  ;                         BIT 1 = OVERRUN ERROR                              :
                                  ;                         BIT 0 = DATA READY                                 :
                                  ;                    (AL) CONTAINS THE MODEM STATUS                          :
                                  ;                         BIT 7 = RECEIVE LINE SIGNAL DETECT                 :
                                  ;                         BIT 6 = RING INDICATOR                             :
                                  ;                         BIT 5 = DATA SET READY                             :
                                  ;                         BIT 4 = CLEAR TO SEND                              :
                                  ;                         BIT 3 = DELTA RECEIVE LINE SIGNAL DETECT           :
                                  ;                         BIT 2 = TRAILING EDGE RING DETECTOR                :
                                  ;                         BIT 1 = DELTA DATA SET READY                       :
                                  ;                         BIT 0 = DELTA CLEAR TO SEND                        :
                                  ;                                                                            :
                                  ;        (DX) = PARAMETER INDICATING WHICH RS232 CARD (0 - 3 ALLOWED)        :
                                  ;                                                                            :
                                  ; DATA AREA @RS232_BASE CONTAINS THE BASE ADDRESS OF THE 8250 ON THE CARD    :
                                  ;        LOCATION 400H CONTAINS UP TO 4 RS232 ADDRESSES POSSIBLE             :
                                  ;        DATA AREA LABEL @RS232_TIM_OUT (BYTE) CONTAINS OUTER LOOP COUNT     :
                                  ;        VALUE FOR TIMEOUT (DEFAULT=1)                                       :
                                  ;OUTPUT                                                                     :
                                  ;               AX MODIFIED ACCORDING TO PARAMETERS OF CALL                  :
                                  ;               ALL OTHERS UNCHANGED                                         :
                                  ;----------------------------------------------------------------------------

                                           ASSUME  CS:CODE,DS:DATA
 0000                             RS232_IO_1       PROC    FAR

                                  ;-----   VECTOR TO APPROPRIATE ROUTINE

 0000  FB                                  STI                              ; INTERRUPTS BACK ON
 0001  1E                                  PUSH    DS                       ; SAVE SEGMENT
 0002  52                                  PUSH    DX
 0003  56                                  PUSH    SI
 0004  57                                  PUSH    DI
 0005  51                                  PUSH    CX
 0006  53                                  PUSH    BX
 0007  8B F2                               MOV     SI,DX                    ; RS232 VALUE TO (SI)
 0009  8B FA                               MOV     DI,DX                    ; AND TO (DI) (FOR TIMEOUTS)
 000B  C1 EA 02                            SHR     DX,2                     ; TEST PARAMETER
 000E  75 20                               JNZ     A3                       ; RETURN IF NOT IN RANGE
 0010  D1 E6                               SHL     SI,1                     ; WORD OFFSET
 0012  E8 0000 E                           CALL    DDS
 0015  8B 94 0000 R                        MOV     DX,@RS232_BASE[SI]       ; GET BASE ADDRESS
 0019  0B D2                               OR      DX,DX                    ; TEST FOR 0 BASE ADDRESS
 001B  74 13                               JZ      A3                       ; RETURN
 001D  0A E4                               OR      AH,AH                    ; TEST FOR (AH)= 00H
 001F  74 16                               JZ      A4                       ; COMMO INITIALIZATION
 0021  FE CC                               DEC     AH                       ; TEST FOR (AH)= 01H
 0023  74 4B                               JZ      A5                       ; SEND (AL)
 0025  FE CC                               DEC     AH                       ; TEST FOR (AH)= 02H
 0027  74 70                               JZ      A12                      ; RECEIVE INTO (AL)
 0029                             A2:
 0029  FE CC                               DEC     AH                       ; TEST FOR (AH)= 03H
 002B  75 03                               JNZ     A3
 002D  E9 00BB R                           JMP     A18                      ; COMMUNICATION STATUS
 0030                             A3:                                       ; RETURN FROM RS232
 0030  5B                                  POP     BX
 0031  59                                  POP     CX
 0032  5F                                  POP     DI
 0033  5E                                  POP     SI
 0034  5A                                  POP     DX
 0035  1F                                  POP     DS
 0036  CF                                  IRET                             ; RETURN TO CALLER, NO ACTION
```

```
                                PAGE
                                ;-----  INITIALIZE THE COMMUNICATIONS PORT

0037                            A4:
0037 8A E0                              MOV     AH,AL                   ; SAVE INITIALIZATION PARAMETERS IN (AH)
0039 83 C2 03                           ADD     DX,3                    ; POINT TO 8250 CONTROL REGISTER
003C B0 80                              MOV     AL,80H
003E EE                                 OUT     DX,AL                   ; SET DLAB=1

                                ;-----  DETERMINE BAUD RATE DIVISOR

003F 8A D4                              MOV     DL,AH                   ; GET PARAMETERS TO (DL)
0041 B1 04                              MOV     CL,4
0043 D2 C2                              ROL     DL,CL
0045 81 E2 000E                         AND     DX,0EH                  ; ISOLATE THEM
0049 BF 0000 E                          MOV     DI,OFFSET A1            ; BASE OF TABLE
004C 03 FA                              ADD     DI,DX                   ; PUT INTO INDEX REGISTER
004E 8B 94 0000 R                       MOV     DX,@RS232_BASE[SI]      ; POINT TO HIGH ORDER OF DIVISOR
0052 42                                 INC     DX
0053 2E: 8A 45 01                       MOV     AL,CS:[DI]+1            ; GET HIGH ORDER OF DIVISOR
0057 EE                                 OUT     DX,AL                   ; SET ms OF DIVISOR TO 0
0058 4A                                 DEC     DX
0059 EB 00                              JMP     $+2                     ; I/O DELAY
005B 2E: 8A 05                          MOV     AL,CS:[DI]              ; GET LOW ORDER OF DIVISOR
005E EE                                 OUT     DX,AL                   ; SET LOW OF DIVISOR
005F 83 C2 03                           ADD     DX,3
0062 8A C4                              MOV     AL,AH                   ; GET PARAMETERS BACK
0064 24 1F                              AND     AL,01FH                 ; STRIP OFF THE BAUD BITS
0066 EE                                 OUT     DX,AL                   ; LINE CONTROL TO 8 BITS
0067 4A                                 DEC     DX
0068 4A                                 DEC     DX
0069 EB 00                              JMP     $+2                     ; I/O DELAY
006B B0 00                              MOV     AL,0
006D EE                                 OUT     DX,AL                   ; INTERRUPT ENABLES ALL OFF
006E EB 4B                              JMP     SHORT A18               ; COM_STATUS

                                ;-----  SEND CHARACTER IN (AL) OVER COMMO LINE

0070                            A5:
0070 50                                 PUSH    AX                      ; SAVE CHAR TO SEND
0071 83 C2 04                           ADD     DX,4                    ; MODEM CONTROL REGISTER
0074 B0 03                              MOV     AL,3                    ; DTR AND RTS
0076 EE                                 OUT     DX,AL                   ; DATA TERMINAL READY, REQUEST TO SEND
0077 42                                 INC     DX                      ; MODEM STATUS REGISTER
0078 42                                 INC     DX
0079 B7 30                              MOV     BH,30H                  ; DATA SET READY & CLEAR TO SEND
007B E8 00CA R                          CALL    WAIT_FOR_STATUS         ; ARE BOTH TRUE
007E 74 08                              JE      A9                      ; YES, READY TO TRANSMIT CHAR
0080                            A7:
0080 59                                 POP     CX
0081 8A C1                              MOV     AL,CL                   ; RELOAD DATA BYTE
0083                            A8:
0083 80 CC 80                           OR      AH,80H                  ; INDICATE TIME OUT
0086 EB A8                              JMP     A3                      ; RETURN

0088                            A9:                                     ; CLEAR_TO_SEND
0088 4A                                 DEC     DX                      ; LINE STATUS REGISTER
0089                            A10:                                    ; WAIT_SEND
0089 B7 20                              MOV     BH,20H                  ; IS TRANSMITTER READY
008B E8 00CA R                          CALL    WAIT_FOR_STATUS         ; TEST FOR TRANSMITTER READY
008E 75 F0                              JNZ     A7                      ; RETURN WITH TIME OUT SET
0090                            A11:                                    ; OUT_CHAR
0090 83 EA 05                           SUB     DX,5                    ; DATA PORT
0093 59                                 POP     CX                      ; RECOVER IN CX TEMPORARILY
0094 8A C1                              MOV     AL,CL                   ; MOVE CHAR TO AL FOR OUT, STATUS IN AH
0096 EE                                 OUT     DX,AL                   ; OUTPUT CHARACTER
0097 EB 97                              JMP     A3                      ; RETURN

                                ;-----  RECEIVE CHARACTER FROM COMMO LINE

0099                            A12:
0099 83 C2 04                           ADD     DX,4                    ; MODEM CONTROL REGISTER
009C B0 01                              MOV     AL,1                    ; DATA TERMINAL READY
009E EE                                 OUT     DX,AL
009F 42                                 INC     DX                      ; MODEM STATUS REGISTER
00A0 42                                 INC     DX
00A1                            A13:                                    ; WAIT_DSR
00A1 B7 20                              MOV     BH,20H                  ; DATA_SET READY
00A3 E8 00CA R                          CALL    WAIT_FOR_STATUS         ; TEST FOR DSR
00A6 75 DB                              JNZ     A8                      ; RETURN WITH ERROR
00A8                            A15:                                    ; WAIT_DSR_END
00A8 4A                                 DEC     DX                      ; LINE_STATUS REGISTER
00A9                            A16:                                    ; WAIT_RECV
00A9 B7 01                              MOV     BH,1                    ; RECEIVE BUFFER FULL
00AB E8 00CA R                          CALL    WAIT_FOR_STATUS         ; TEST FOR RECEIVE BUFFER FULL
00AE 75 D3                              JNZ     A8                      ; SET TIME OUT ERROR
00B0                            A17:                                    ; GET_CHAR
00B0 80 E4 1E                           AND     AH,00011110B            ; TEST FOR ERROR CONDITIONS ON RECEIVE

00B3 8B 94 0000 R                       MOV     DX,@RS232_BASE[SI]      ; DATA PORT
00B7 EC                                 IN      AL,DX                   ; GET CHARACTER FROM LINE
00B8 E9 0030 R                          JMP     A3                      ; RETURN

                                ;-----  COMMO PORT STATUS ROUTINE

00BB                            A18:
00BB 8B 94 0000 R                       MOV     DX,@RS232_BASE[SI]
00BF 83 C2 05                           ADD     DX,5                    ; CONTROL PORT
00C2 EC                                 IN      AL,DX                   ; GET LINE CONTROL STATUS
00C3 8A E0                              MOV     AH,AL                   ; PUT IN (AH) FOR RETURN
00C5 42                                 INC     DX                      ; POINT TO MODEM STATUS REGISTER
00C6 EC                                 IN      AL,DX                   ; GET MODEM CONTROL STATUS
00C7 E9 0030 R                          JMP     A3                      ; RETURN
```

```
                                PAGE
                                ;----------------------------------------
                                ;       WAIT FOR STATUS ROUTINE         :
                                ;ENTRY:  (BH)= STATUS BIT(S) TO LOOK FOR :
                                ;        (DX)= ADDRESS OF STATUS REG    :
                                ;EXIT:   ZERO FLAG ON = STATUS FOUND    :
                                ;        ZERO FLAG OFF = TIMEOUT.       :
                                ;        (AH)= LAST STATUS READ         :
                                ;----------------------------------------

 00CA                           WAIT_FOR_STATUS PROC     NEAR
 00CA 8A 9D 007C R                      MOV     BL,@RS232_TIM_OUT[DI]     ; LOAD OUTER LOOP COUNT

                                ;-----  ADJUST OUTER LOOP COUNT

 00CE 55                                PUSH    BP                        ; SAVE (BP)
 00CF 53                                PUSH    BX                        ; SAVE (BX)
 00D0 5D                                POP     BP                        ; USE BP FOR OUTER LOOP COUNT
 00D1 81 E5 00FF                        AND     BP,00FFH                  ; STRIP HIGH BITS
 00D5 D1 D5                             RCL     BP,1                      ; MULTIPLY OUTER COUNT BY 4
 00D7 D1 D5                             RCL     BP,1
 00D9                           WFS0:
 00D9 2B C9                             SUB     CX,CX
 00DB                           WFS1:
 00DB EC                                IN      AL,DX                     ; GET STATUS
 00DC 8A E0                             MOV     AH,AL                     ; MOVE TO (AH)
 00DE 22 C7                             AND     AL,BH                     ; ISOLATE BITS TO TEST
 00E0 3A C7                             CMP     AL,BH                     ; EXACTLY = TO MASK
 00E2 74 07                             JE      WFS_END                   ; RETURN WITH ZERO FLAG ON

 00E4 E2 F5                             LOOP    WFS1                      ; TRY AGAIN

 00E6 4D                                DEC     BP
 00E7 75 F0                             JNZ     WFS0

 00E9 0A FF                             OR      BH,BH                     ; SET ZERO FLAG OFF
 00EB                           WFS_END:
 00EB 5D                                POP     BP                        ; RESTORE (BP)
 00EC C3                                RET

 00ED                           WAIT_FOR_STATUS ENDP

 00ED                           RS232_IO_1      ENDP

 00ED                           CODE    ENDS
                                        END
```

SECTION 5

```
                         PAGE 118,121
                         TITLE VIDEO1 --- 03/24/86  VIDEO DISPLAY BIOS
                         .LIST
 0000                    CODE    SEGMENT BYTE PUBLIC

                                 PUBLIC  ACT_DISP_PAGE
                                 PUBLIC  READ_AC_CURRENT
                                 PUBLIC  READ_CURSOR
                                 PUBLIC  READ_DOT
                                 PUBLIC  READ_LPEN
                                 PUBLIC  SCROLL_DOWN
                                 PUBLIC  SCROLL_UP
                                 PUBLIC  SET_COLOR
                                 PUBLIC  SET_CPOS
                                 PUBLIC  SET_CTYPE
                                 PUBLIC  SET_MODE
                                 PUBLIC  WRITE_AC_CURRENT
                                 PUBLIC  WRITE_C_CURRENT
                                 PUBLIC  WRITE_DOT
                                 PUBLIC  WRITE_TTY
                                 PUBLIC  VIDEO_IO_1
                                 PUBLIC  VIDEO_STATE

                                 EXTRN   BEEP:NEAR               ; SPEAKER BEEP ROUTINE
                                 EXTRN   CRT_CHAR_GEN:NEAR       ; CHARACTER GENERATOR GRAPHICS TABLE
                                 EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                 EXTRN   M5:WORD                 ; REGEN BUFFER LENGTH TABLE
                                 EXTRN   M6:BYTE                 ; COLUMNS PER MODE TABLE
                                 EXTRN   M7:BYTE                 ; MODE SET VALUE PER MODE TABLE

                         ;--- INT 10 H -------------------------------------------------------------------------
                         ;                                                                                    :
                         ; VIDEO_IO                                                                           :
                         ;       THESE ROUTINES PROVIDE THE CRT DISPLAY INTERFACE                             :
                         ;       THE FOLLOWING FUNCTIONS ARE PROVIDED:                                        :
                         ;                                                                                    :
                         ;    (AH)= 00H  SET MODE (AL) CONTAINS MODE VALUE                                    :
                         ;               (AL) = 00H  40X25 BW MODE (POWER ON DEFAULT)                         :
                         ;               (AL) = 01H  40X25 COLOR                                              :
                         ;               (AL) = 02H  80X25 BW                                                 :
                         ;               (AL) = 03H  80X25 COLOR                                              :
                         ;                            GRAPHICS MODES                                          :
                         ;               (AL) = 04H  320X200 COLOR                                            :
                         ;               (AL) = 05H  320X200 BW MODE                                          :
                         ;               (AL) = 06H  640X200 BW MODE                                          :
                         ;               (AL) = 07H   80X25 MONOCHROME (USED INTERNAL TO VIDEO ONLY)          :
                         ;               *** NOTES -BW MODES OPERATE SAME AS COLOR MODES, BUT COLOR           :
                         ;                          BURST IS NOT ENABLED                                      :
                         ;                         -CURSOR IS NOT DISPLAYED IN GRAPHICS MODE                  :
                         ;    (AH)= 01H  SET CURSOR TYPE                                                      :
                         ;               (CH) =  BITS 4-0 = START LINE FOR CURSOR                             :
                         ;                       ** HARDWARE WILL ALWAYS CAUSE BLINK                          :
                         ;                       ** SETTING BIT 5 OR 6 WILL CAUSE ERRATIC BLINKING            :
                         ;                          OR NO CURSOR AT ALL                                       :
                         ;               (CL) =  BITS 4-0 = END LINE FOR CURSOR                               :
                         ;    (AH)= 02H  SET CURSOR POSITION                                                  :
                         ;               (DH,DL) = ROW,COLUMN  (00H,00H) IS UPPER LEFT                        :
                         ;               (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)                  :
                         ;    (AH)= 03H  READ CURSOR POSITION                                                 :
                         ;               (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)                  :
                         ;               ON EXIT (DH,DL) = ROW,COLUMN OF CURRENT CURSOR                       :
                         ;                       (CH,CL) = CURSOR MODE CURRENTLY SET                          :
                         ;    (AH)= 04H  READ LIGHT PEN POSITION                                              :
                         ;               ON EXIT:                                                             :
                         ;               (AH) = 00H -- LIGHT PEN SWITCH NOT DOWN/NOT TRIGGERED                :
                         ;               (AH) = 01H -- VALID LIGHT PEN VALUE IN REGISTERS                     :
                         ;                       (DH,DL) = ROW,COLUMN OF CHARACTER LP POSITION                :
                         ;                       (CH) = RASTER LINE (0-199)                                   :
                         ;                       (BX) = PIXEL COLUMN (0-319,639)                              :
                         ;    (AH)= 05H  SELECT ACTIVE DISPLAY PAGE (VALID ONLY FOR ALPHA MODES)              :
                         ;               (AL) = NEW PAGE VALUE (0-7 FOR MODES 0&1, 0-3 FOR MODES 2&3)         :
                         ;    (AH)= 06H  SCROLL ACTIVE PAGE UP                                                :
                         ;               (AL) = NUMBER OF LINES, ( LINES BLANKED AT BOTTOM OF WINDOW )        :
                         ;                       (AL) = 00H MEANS BLANK ENTIRE WINDOW                         :
                         ;               (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL                  :
                         ;               (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL                 :
                         ;               (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                            :
                         ;    (AH)= 07H  SCROLL ACTIVE PAGE DOWN                                              :
                         ;               (AL) = NUMBER OF LINES, INPUT LINES BLANKED AT TOP OF WINDOW         :
                         ;                       (AL) = 00H MEANS BLANK ENTIRE WINDOW                         :
                         ;               (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL                  :
                         ;               (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL                 :
                         ;               (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                            :
                         ;                                                                                    :
                         ;   CHARACTER HANDLING ROUTINES                                                      :
                         ;                                                                                    :
                         ;    (AH)= 08H  READ ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION                  :
                         ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)                     :
                         ;               ON EXIT:                                                             :
                         ;               (AL) = CHAR READ                                                     :
                         ;               (AH) = ATTRIBUTE OF CHARACTER READ (ALPHA MODES ONLY)                :
                         ;    (AH)= 09H  WRITE ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION                 :
                         ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)                     :
                         ;               (CX) = COUNT OF CHARACTERS TO WRITE                                  :
                         ;               (AL) = CHAR TO WRITE                                                 :
                         ;               (BL) = ATTRIBUTE OF CHARACTER (ALPHA)/COLOR OF CHAR (GRAPHICS)       :
                         ;                       SEE NOTE ON WRITE DOT FOR BIT 7 OF BL = 1.                   :
                         ;    (AH)= 0AH  WRITE CHARACTER ONLY AT CURRENT CURSOR POSITION                      :
                         ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)                     :
                         ;               (CX) = COUNT OF CHARACTERS TO WRITE                                  :
                         ;               (AL) = CHAR TO WRITE                                                 :
                         ;                       NOTE: USE FUNCTION (AH)= 09H IN GRAPHICS MODES               :
                         ;       FOR READ/WRITE CHARACTER INTERFACE WHILE IN GRAPHICS MODE, THE               :
                         ;               CHARACTERS ARE FORMED FROM A CHARACTER GENERATOR IMAGE               :
                         ;               MAINTAINED IN THE SYSTEM ROM.  ONLY THE 1ST 128 CHARS                :
                         ;               ARE CONTAINED THERE.  TO READ/WRITE THE SECOND 128 CHARS,            :
                         ;               THE USER MUST INITIALIZE THE POINTER AT INTERRUPT 1FH                :
                         ;               (LOCATION 0007CH) TO POINT TO THE 1K BYTE TABLE CONTAINING           :
                         ;               THE CODE POINTS FOR THE SECOND 128 CHARS (128-255).                  :
                         ;       FOR WRITE CHARACTER INTERFACE IN GRAPHICS MODE, THE REPLICATION FACTOR       :
                         ;               CONTAINED IN (CX) ON ENTRY WILL PRODUCE VALID RESULTS ONLY           :
                         ;               FOR CHARACTERS CONTAINED ON THE SAME ROW.  CONTINUATION TO           :
                         ;               SUCCEEDING LINES WILL NOT PRODUCE CORRECTLY.                         :
                         ;                                                                                    :
```

```
                         ;    GRAPHICS INTERFACE                                                        ;
                         ;                                                                              ;
                         ;    (AH)= 0BH  SET COLOR PALETTE                                              ;
                         ;                (BH) = PALETTE COLOR ID BEING SET (0-127)                     ;
                         ;                (BL) = COLOR VALUE TO BE USED WITH THAT COLOR ID              ;
                         ;                       NOTE: FOR THE CURRENT COLOR CARD, THIS ENTRY POINT HAS ;
                         ;                             MEANING ONLY FOR 320X200 GRAPHICS.               ;
                         ;                       COLOR ID = 0 SELECTS THE BACKGROUND COLOR (0-15)       ;
                         ;                       COLOR ID = 1 SELECTS THE PALETTE TO BE USED:           ;
                         ;                               0 = GREEN(1)/RED(2)/YELLOW(3)                  ;
                         ;                               1 = CYAN(1)/MAGENTA(2)/WHITE(3)                ;
                         ;                       IN 40X25 OR 80X25 ALPHA MODES, THE VALUE SET FOR       ;
                         ;                               PALETTE COLOR 0 INDICATES THE BORDER COLOR     ;
                         ;                               TO BE USED (VALUES 0-31, WHERE 16-31 SELECT    ;
                         ;                               THE HIGH INTENSITY BACKGROUND SET.             ;
                         ;    (AH)= 0CH  WRITE DOT                                                      ;
                         ;                (DX) = ROW NUMBER                                             ;
                         ;                (CX) = COLUMN NUMBER                                          ;
                         ;                (AL) = COLOR VALUE                                            ;
                         ;                        IF BIT 7 OF AL = 1, THEN THE COLOR VALUE IS EXCLUSIVE ;
                         ;                        ORed WITH THE CURRENT CONTENTS OF THE DOT             ;
                         ;    (AH)= 0DH  READ DOT                                                       ;
                         ;                (DX) = ROW NUMBER                                             ;
                         ;                (CX) = COLUMN NUMBER                                          ;
                         ;                (AL) RETURNS THE DOT READ                                     ;
                         ;                                                                              ;
                         ;    ASCII TELETYPE ROUTINE FOR OUTPUT                                         ;
                         ;                                                                              ;
                         ;    (AH)= 0EH  WRITE TELETYPE TO ACTIVE PAGE                                  ;
                         ;                (AL) = CHAR TO WRITE                                          ;
                         ;                (BL) = FOREGROUND COLOR IN GRAPHICS MODE                      ;
                         ;                NOTE -- SCREEN WIDTH IS CONTROLLED BY PREVIOUS MODE SET       ;
                         ;    (AH)= 0FH  CURRENT VIDEO STATE                                            ;
                         ;                RETURNS THE CURRENT VIDEO STATE                               ;
                         ;                (AL) = MODE CURRENTLY SET ( SEE (AH)= 00H FOR EXPLANATION)    ;
                         ;                (AH) = NUMBER OF CHARACTER COLUMNS ON SCREEN                  ;
                         ;                (BH) = CURRENT ACTIVE DISPLAY PAGE                            ;
                         ;    (AH)= 10H  RESERVED                                                       ;
                         ;    (AH)= 11H  RESERVED                                                       ;
                         ;    (AH)= 12H  RESERVED                                                       ;
                         ;    (AH)= 13H  WRITE STRING                                                   ;
                         ;                          ES:BP   -  POINTER TO STRING TO BE WRITTEN          ;
                         ;                          CX      -  LENGTH OF CHARACTER STRING TO WRITTEN    ;
                         ;                          DX      -  CURSOR POSITION FOR STRING TO BE WRITTEN ;
                         ;                          BH      -  PAGE NUMBER                              ;
                         ;              (AL)= 00H  WRITE CHARACTER STRING                               ;
                         ;                          BL      -  ATTRIBUTE                                ;
                         ;                          STRING IS  <CHAR,CHAR, ... ,CHAR>                   ;
                         ;                          CURSOR NOT MOVED                                    ;
                         ;              (AL)= 01H  WRITE CHARACTER STRING AND MOVE CURSOR               ;
                         ;                          BL      -  ATTRIBUTE                                ;
                         ;                          STRING IS  <CHAR,CHAR, ... ,CHAR>                   ;
                         ;                          CURSOR IS MOVED                                     ;
                         ;              (AL)= 02H  WRITE CHARACTER AND ATTRIBUTE STRING                 ;
                         ;                                (VALID FOR ALPHA MODES ONLY)                  ;
                         ;                          STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR>     ;
                         ;                          CURSOR IS NOT MOVED                                 ;
                         ;              (AL)= 03H  WRITE CHARACTER AND ATTRIBUTE STRING AND MOVE CURSOR ;
                         ;                                (VALID FOR ALPHA MODES ONLY)                  ;
                         ;                          STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR>     ;
                         ;                          CURSOR IS MOVED                                     ;
                         ;                 NOTE:  CARRIAGE RETURN, LINE FEED, BACKSPACE, AND BELL ARE   ;
                         ;                        TREATED AS COMMANDS RATHER THAN PRINTABLE CHARACTERS. ;
                         ;                                                                              ;
                         ;       BX,CX,DX,SI,DI,BP,SP,DS,ES,SS PRESERVED DURING CALLS EXCEPT FOR        ;
                         ;       BX,CX,DX RETURN VALUES ON FUNCTIONS 03H,04H,0DH AND 0DH. ON ALL CALLS   ;
                         ;       AX IS MODIFIED.                                                        ;
                         ;-------------------------------------------------------------------------------

                                 ASSUME  CS:CODE,DS:DATA,ES:NOTHING

0000 005F R              M1      DW      OFFSET  SET_MODE         ; TABLE OF ROUTINES WITHIN VIDEO I/O
0002 0146 R                      DW      OFFSET  SET_CTYPE
0004 016B R                      DW      OFFSET  SET_CPOS
0006 0193 R                      DW      OFFSET  READ_CURSOR
0008 0789 R                      DW      OFFSET  READ_LPEN
000A 01AA R                      DW      OFFSET  ACT_DISP_PAGE
000C 0213 R                      DW      OFFSET  SCROLL_UP
000E 02B1 R                      DW      OFFSET  SCROLL_DOWN
0010 0303 R                      DW      OFFSET  READ_AC_CURRENT
0012 0360 R                      DW      OFFSET  WRITE_AC_CURRENT
0014 0392 R                      DW      OFFSET  WRITE_C_CURRENT
0016 01CC R                      DW      OFFSET  SET_COLOR
0018 0454 R                      DW      OFFSET  WRITE_DOT
001A 0443 R                      DW      OFFSET  READ_DOT
001C 0702 R                      DW      OFFSET  WRITE_TTY
001E 01F2 R                      DW      OFFSET  VIDEO_STATE
0020 013D R                      DW      OFFSET  VIDEO_RETURN     ; RESERVED
0022 013D R                      DW      OFFSET  VIDEO_RETURN     ; RESERVED
0024 013D R                      DW      OFFSET  VIDEO_RETURN     ; RESERVED
0026 03BF R                      DW      OFFSET  WRITE_STRING     ; CASE 13H, WRITE STRING
= 0028                   M1L     EQU     $-M1

0028                     VIDEO_IO_1      PROC    NEAR             ;      ENTRY POINT FOR ORG 0F065H
0028 FB                          STI                              ; INTERRUPTS BACK ON
0029 FC                          CLD                              ; SET DIRECTION FORWARD
002A 80 FC 14                    CMP     AH,M1L/2                 ; TEST FOR WITHIN TABLE RANGE
002D 73 2F                       JNB     M4                       ; BRANCH TO EXIT IF NOT A VALID COMMAND

002F 06                          PUSH    ES
0030 1E                          PUSH    DS                       ; SAVE WORK AND PARAMETER REGISTERS
0031 52                          PUSH    DX
0032 51                          PUSH    CX
0033 53                          PUSH    BX
0034 56                          PUSH    SI
0035 57                          PUSH    DI
0036 55                          PUSH    BP
0037 BE ---- R                   MOV     SI,DATA                  ; POINT DS: TO DATA SEGMENT
003A 8E DE                       MOV     DS,SI
003C 8B F0                       MOV     SI,AX                    ; SAVE COMMAND/DATA INTO (SI) REGISTER
003E A0 0010 R                   MOV     AL,BYTE PTR @EQUIP_FLAG  ; GET THE EQUIPMENT FLAG VIDEO BITS
0041 24 30                       AND     AL,30H                   ; ISOLATE CRT SWITCHES
0043 3C 30                       CMP     AL,30H                   ; IS SETTING FOR MONOCHROME CARD?
0045 BF B800                     MOV     DI,0B800H                ; GET SEGMENT FOR COLOR CARD
```

```
0048 75 03                      JNE     M2                      ; SKIP IF NOT MONOCHROME CARD
004A BF B000                    MOV     DI,0B000H               ; ELSE GET SEGMENT FOR MONOCHROME CARD
004D                    M2:
004D 8E C7                      MOV     ES,DI                   ; SET UP TO POINT AT VIDEO MEMORY AREAS
004F 8A C4                      MOV     AL,AH                   ; PLACE COMMAND IN LOW BYTE OF (AX)
0051 98                         CBW                             ; AND FORM BYTE OFFSET WITH COMMAND
0052 D1 E0                      SAL     AX,1                    ; TIMES 2 FOR WORD TABLE LOOKUP
0054 96                         XCHG    SI,AX                   ; MOVE OFFSET INTO LOOK UP REGISTER (SI)
                                                                ;  AND RESTORE COMMAND/DATA INTO (AX)
0055 8A 26 0049 R               MOV     AH,@CRT_MODE            ; MOVE CURRENT MODE INTO (AH) REGISTER

0059 2E: FF A4 0000 R           JMP     WORD PTR CS:[SI+OFFSET M1]      ; GO TO SELECTED FUNCTION

005E                    M4:                                     ;       COMMAND NOT VALID
005E CF                         IRET                            ; DO NOTHING IF NOT IN VALID RANGE
005F                    VIDEO_IO_1      ENDP
                        ;----------------------------------------------------
                        ; SET_MODE                                          :
                        ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO  :
                        ;       THE SELECTED MODE.  THE SCREEN IS BLANKED.  :
                        ; INPUT                                             :
                        ;       @EQUIP_FLAG BITS 5-4 = MODE/WIDTH           :
                        ;          11 = MONOCHROME (FORCES MODE 7)          :
                        ;          01 = COLOR ADAPTER 40x25 (MODE 0 DEFAULT) :
                        ;          10 = COLOR ADAPTER 80x25 (MODE 2 DEFAULT) :
                        ;        (AL) = COLOR MODE REQUESTED ( RANGE  0 - 6 ) :
                        ; OUTPUT                                            :
                        ;       NONE                                        :
                        ;----------------------------------------------------
005F                    SET_MODE        PROC    NEAR
005F BA 03D4                    MOV     DX,03D4H                ; ADDRESS OF COLOR CARD
0062 8B 3E 0010 R               MOV     DI,@EQUIP_FLAG          ; GET EQUIPMENT FLAGS SETTING
0066 81 E7 0030                 AND     DI,30H                  ; ISOLATE CRT SWITCHES
006A 83 FF 30                   CMP     DI,30H                  ; IS BW CARD INSTALLED AS PRIMARY
006D 75 06                      JNE     M8C                     ; SKIP AND CHECK IF COLOR
006F B0 07                      MOV     AL,7                    ; ELSE INDICATE INTERNAL BW CARD MODE
0071 B2 B4                      MOV     DL,0B4H                 ; SET ADDRESS OF BW (MONOCHROME) CARD
0073 EB 0D                      JMP     SHORT M8                ; CONTINUE WITH FORCED MODE 7
0075                    M8C:
0075 3C 07                      CMP     AL,7                    ; CHECK FOR VALID COLOR MODES 0-6
0077 72 09                      JB      M8                      ; CONTINUE IF BELOW MODE 7
0079 B0 00                      MOV     AL,0                    ; FORCE DEFAULT 40x25 BW MODE
007B 83 FF 10                   CMP     DI,10H                  ; CHECK FOR @EQUIP_FLAG AT 40x25 COLOR
007E 74 02                      JE      M8                      ; CONTINUE WITH MODE 0 IF NOT
0080 B0 02                      MOV     AL,2                    ; ELSE FORCE MODE 2
0082                    M8:
0082 A2 0049 R                  MOV     @CRT_MODE,AL            ; SAVE MODE IN GLOBAL VARIABLE
0085 89 16 0063 R               MOV     @ADDR_6845,DX           ; SAVE ADDRESS OF BASE
0089 C6 06 0084 R 18            MOV     @ROWS,25-1              ; INITIALIZE DEFAULT ROW COUNT OF 25
008E 1E                         PUSH    DS                      ; SAVE POINTER TO DATA SEGMENT
008F 50                         PUSH    AX                      ; SAVE MODE NUMBER (AL)
0090 98                         CBW                             ; CLEAR HIGH BYTE OF MODE
0091 8B F0                      MOV     SI,AX                   ; SET TABLE POINTER, INDEXED BY MODE
0093 2E: 8A 84 0000 E           MOV     AL,CS:[SI + OFFSET M7]  ; GET THE MODE SET VALUE FROM TABLE
0098 A2 0065 R                  MOV     @CRT_MODE_SET,AL        ; SAVE THE MODE SET VALUE
009B 24 37                      AND     AL,037H                 ; VIDEO OFF, SAVE HIGH RESOLUTION BIT
009D 52                         PUSH    DX                      ; SAVE OUTPUT PORT VALUE
009E 83 C2 04                   ADD     DX,4                    ; POINT TO CONTROL REGISTER
00A1 EE                         OUT     DX,AL                   ; RESET VIDEO TO OFF TO SUPPRESS ROLLING
00A2 5A                         POP     DX                      ; BACK TO BASE REGISTER
                                ASSUME  DS:ABS0
00A3 2B DB                      SUB     BX,BX                   ; SET UP FOR ABS0 SEGMENT
00A5 8E DB                      MOV     DS,BX                   ; ESTABLISH VECTOR TABLE ADDRESSING
00A7 C5 1E 0074 R               LDS     BX,@PARM_PTR            ; GET POINTER TO VIDEO PARMS
                                ASSUME  DS:CODE
00AB 58                         POP     AX                      ; RECOVER MODE NUMBER IN (AL)
00AC B9 0010                    MOV     CX,16                   ; LENGTH OF EACH ROW OF TABLE
00AF 3C 02                      CMP     AL,2                    ; DETERMINE WHICH ONE TO USE
00B1 72 0E                      JC      M9                      ; MODE IS 0 OR 1
00B3 03 D9                      ADD     BX,CX                   ; NEXT ROW OF INITIALIZATION TABLE
00B5 3C 04                      CMP     AL,4
00B7 72 08                      JC      M9                      ; MODE IS 2 OR 3
00B9 03 D9                      ADD     BX,CX                   ; MOVE TO GRAPHICS ROW OF INIT_TABLE
00BB 3C 07                      CMP     AL,7
00BD 72 02                      JC      M9                      ; MODE IS 4,5, OR 6
00BF 03 D9                      ADD     BX,CX                   ; MOVE TO BW CARD ROW OF INIT_TABLE

                        ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

00C1                    M9:                                     ; OUT_INIT
00C1 50                         PUSH    AX                      ; SAVE MODE IN (AL)
00C2 8B 47 0A                   MOV     AX,[BX+10]              ; GET THE CURSOR MODE FROM THE TABLE
00C5 86 E0                      XCHG    AH,AL                   ; PUT CURSOR MODE IN CORRECT POSITION
00C7 1E                         PUSH    DS                      ; SAVE TABLE SEGMENT POINTER
                                ASSUME  DS:DATA
00C8 E8 0000 E                  CALL    DDS                     ; POINT DS TO DATA SEGMENT
00CB A3 0060 R                  MOV     @CURSOR_MODE,AX         ; PLACE INTO BIOS DATA SAVE AREA
                                ASSUME  DS:CODE
00CE 1F                         POP     DS                      ; RESTORE THE TABLE SEGMENT POINTER
00CF 32 E4                      XOR     AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                        ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE

00D1                    M10:                                    ;  INITIALIZATION LOOP
00D1 8A C4                      MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
00D3 EE                         OUT     DX,AL
00D4 42                         INC     DX                      ; POINT TO DATA PORT
00D5 FE C4                      INC     AH                      ; NEXT REGISTER VALUE
00D7 8A 07                      MOV     AL,[BX]                 ; GET TABLE VALUE
00D9 EE                         OUT     DX,AL                   ; OUT TO CHIP
00DA 43                         INC     BX                      ; NEXT IN TABLE
00DB 4A                         DEC     DX                      ; BACK TO POINTER REGISTER
00DC E2 F3                      LOOP    M10                     ; DO THE WHOLE TABLE
00DE 58                         POP     AX                      ; GET MODE BACK INTO (AL)
00DF 1F                         POP     DS                      ; RECOVER SEGMENT VALUE
                                ASSUME  DS:DATA

                        ;-----  FILL REGEN AREA WITH BLANK

00E0 33 FF                      XOR     DI,DI                   ; SET UP POINTER FOR REGEN
00E2 89 3E 004E R               MOV     @CRT_START,DI           ; START ADDRESS SAVED IN GLOBAL
00E6 C6 06 0062 R 00            MOV     @ACTIVE_PAGE,0          ; SET PAGE VALUE
00EB B9 2000                    MOV     CX,8192                 ; NUMBER OF WORDS IN COLOR CARD
00EE 3C 04                      CMP     AL,4                    ; TEST FOR GRAPHICS
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00F0 72 0A                         JC      M12                     ; NO_GRAPHICS_INIT
00F2 3C 07                         CMP     AL,7                    ; TEST FOR BW_CARD
00F4 74 04                         JE      M11                     ; BW_CARD_INIT
00F6 33 C0                         XOR     AX,AX                   ; FILL FOR GRAPHICS MODE
00F8 EB 05                         JMP     SHORT M13               ; CLEAR_BUFFER
00FA                       M11:                                    ; BW_CARD_INIT
00FA B5 08                         MOV     CH,08H                  ; BUFFER SIZE ON BW CARD (2048)
00FC                       M12:                                    ; NO_GRAPHICS_INIT
00FC B8 0720                       MOV     AX,' '+7*H              ; FILL CHAR FOR ALPHA + ATTRIBUTE
00FF                       M13:                                    ; CLEAR_BUFFER
00FF F3/ AB                        REP     STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS

                           ;-----  ENABLE VIDEO AND CORRECT PORT SETTING

0101 8B 16 0063 R                  MOV     DX,@ADDR_6845           ; PREPARE TO OUTPUT TO VIDEO ENABLE PORT
0105 83 C2 04                      ADD     DX,4                    ; POINT TO THE MODE CONTROL REGISTER
0108 A0 0065 R                     MOV     AL,@CRT_MODE_SET        ; GET THE MODE SET VALUE
010B EE                            OUT     DX,AL                   ; SET VIDEO ENABLE PORT

                           ;-----  DETERMINE NUMBER OF COLUMNS, BOTH FOR ENTIRE DISPLAY
                           ;-----  AND THE NUMBER TO BE USED FOR TTY INTERFACE

010C 2E: 8A 84 0000 E              MOV     AL,CS:[SI + OFFSET M6]  ; GET NUMBER OF COLUMNS ON THIS SCREEN
0111 98                            CBW                             ; CLEAR HIGH BYTE
0112 A3 004A R                     MOV     @CRT_COLS,AX            ; INITIALIZE NUMBER OF COLUMNS COUNT

                           ;-----  SET CURSOR POSITIONS

0115 81 E6 000E                    AND     SI,000EH                ; WORD OFFSET INTO CLEAR LENGTH TABLE
0119 2E: 8B 84 0000 E              MOV     AX,CS:[SI + OFFSET M5]  ; LENGTH TO CLEAR
011E A3 004C R                     MOV     @CRT_LEN,AX             ; SAVE LENGTH OF CRT -- NOT USED FOR BW
0121 B9 0008                       MOV     CX,8                    ; CLEAR ALL CURSOR POSITIONS
0124 BF 0050 R                     MOV     DI,OFFSET @CURSOR_POSN
0127 1E                            PUSH    DS                      ; ESTABLISH SEGMENT
0128 07                            POP     ES                      ;   ADDRESSING
0129 33 C0                         XOR     AX,AX
012B F3/ AB                        REP     STOSW                   ; FILL WITH ZEROES

                           ;-----  SET UP OVERSCAN REGISTER

012D 42                            INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
012E B0 30                         MOV     AL,30H                  ; 30H VALUE FOR ALL MODES EXCEPT 640X200
0130 80 3E 0049 R 06               CMP     @CRT_MODE,6             ; SEE IF THE MODE IS 640X200 BW
0135 75 02                         JNZ     M14                     ; IF NOT 640X200, THEN GO TO REGULAR
0137 B0 3F                         MOV     AL,3FH                  ; IF IT IS 640X200, THEN PUT IN 3FH
0139                       M14:
0139 EE                            OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
013A A2 0066 R                     MOV     @CRT_PALETTE,AL         ; SAVE THE VALUE FOR FUTURE USE

                           ;-----  NORMAL RETURN FROM ALL VIDEO RETURNS

013D                       VIDEO_RETURN:
013D 5D                            POP     BP
013E 5F                            POP     DI
013F 5E                            POP     SI
0140 5B                            POP     BX
0141                       M15:                                    ; VIDEO_RETURN_C
0141 59                            POP     CX
0142 5A                            POP     DX
0143 1F                            POP     DS
0144 07                            POP     ES                      ; RECOVER SEGMENTS
0145 CF                            IRET                            ; ALL DONE
0146                       SET_MODE        ENDP
                           ;--------------------------------------------------
                           ; SET_CTYPE
                           ;       THIS ROUTINE SETS THE CURSOR VALUE
                           ; INPUT
                           ;       (CX) HAS CURSOR VALUE CH-START LINE, CL-STOP LINE
                           ; OUTPUT
                           ;       NONE
                           ;--------------------------------------------------
0146                       SET_CTYPE       PROC    NEAR
0146 B4 0A                         MOV     AH,10                   ; 6845 REGISTER FOR CURSOR SET
0148 89 0E 0060 R                  MOV     @CURSOR_MODE,CX         ; SAVE IN DATA AREA
014C E8 0151 R                     CALL    M16                     ; OUTPUT CX REGISTER
014F EB EC                         JMP     VIDEO_RETURN

                           ;-----  THIS ROUTINE OUTPUTS THE CX REGISTER TO THE 6845 REGISTERS NAMED IN (AH)


0151                       M16:
0151 8B 16 0063 R                  MOV     DX,@ADDR_6845           ; ADDRESS REGISTER
0155 8A C4                         MOV     AL,AH                   ; GET VALUE
0157 EE                            OUT     DX,AL                   ; REGISTER SET
0158 42                            INC     DX                      ; DATA REGISTER
0159 EB 00                         JMP     $+2                     ; I/O DELAY
015B 8A C5                         MOV     AL,CH                   ; DATA
015D EE                            OUT     DX,AL
015E 4A                            DEC     DX
015F 8A C4                         MOV     AL,AH
0161 FE C0                         INC     AL                      ; POINT TO OTHER DATA REGISTER
0163 EE                            OUT     DX,AL                   ; SET FOR SECOND REGISTER
0164 42                            INC     DX
0165 EB 00                         JMP     $+2                     ; I/O DELAY
0167 8A C1                         MOV     AL,CL                   ; SECOND DATA VALUE
0169 EE                            OUT     DX,AL
016A C3                            RET                             ; ALL DONE
016B                       SET_CTYPE       ENDP

                           ;------------------------------------------
                           ; SET_CPOS
                           ;       THIS ROUTINE SETS THE CURRENT CURSOR POSITION TO THE
                           ;       NEW X-Y VALUES PASSED
                           ; INPUT
                           ;       DX - ROW,COLUMN OF NEW CURSOR
                           ;       BH - DISPLAY PAGE OF CURSOR
                           ; OUTPUT
                           ;       CURSOR IS SET AT 6845 IF DISPLAY PAGE IS CURRENT DISPLAY
                           ;------------------------------------------
016B                       SET_CPOS        PROC    NEAR
016B 8A C7                         MOV     AL,BH                   ; MOVE PAGE NUMBER TO WORK REGISTER
016D 98                            CBW                             ; CONVERT PAGE TO WORD VALUE
016E D1 E0                         SAL     AX,1                    ; WORD OFFSET
0170 96                            XCHG    AX,SI                   ; USE INDEX REGISTER
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0171 89 94 0050 R              MOV     [SI+OFFSET @CURSOR_POSN],DX      ; SAVE THE POINTER
0175 38 3E 0062 R              CMP     @ACTIVE_PAGE,BH
0179 75 05                     JNZ     M17                      ; SET_CPOS_RETURN
017B 8B C2                     MOV     AX,DX                    ; GET ROW/COLUMN TO AX
017D E8 0182 R                 CALL    M18                      ; CURSOR_SET
0180                    M17:                                    ; SET_CPOS_RETURN
0180 EB BB                     JMP     VIDEO_RETURN
0182                    SET_CPOS       ENDP

                        ;-----  SET CURSOR POSITION, AX HAS ROW/COLUMN FOR CURSOR

0182                    M18    PROC    NEAR
0182 E8 0204 R                 CALL    POSITION                 ; DETERMINE LOCATION IN REGEN BUFFER
0185 8B C8                     MOV     CX,AX
0187 03 0E 004E R              ADD     CX,@CRT_START            ; ADD IN THE START ADDRESS FOR THIS PAGE
018B D1 F9                     SAR     CX,1                     ; DIVIDE BY 2 FOR CHAR ONLY COUNT
018D B4 0E                     MOV     AH,14                    ; REGISTER NUMBER FOR CURSOR
018F E8 0151 R                 CALL    M16                      ; OUTPUT THE VALUE TO THE 6845
0192 C3                        RET
0193                    M18    ENDP
                        ;------------------------------------------------
                        ; READ_CURSOR
                        ;       THIS ROUTINE READS THE CURRENT CURSOR VALUE FROM THE
                        ;       6845, FORMATS IT, AND SENDS IT BACK TO THE CALLER
                        ; INPUT
                        ;       BH - PAGE OF CURSOR
                        ; OUTPUT
                        ;       DX - ROW, COLUMN OF THE CURRENT CURSOR POSITION
                        ;       CX - CURRENT CURSOR MODE
                        ;----------------------------------------
0193                    READ_CURSOR    PROC    NEAR
0193 8A DF                     MOV     BL,BH
0195 32 FF                     XOR     BH,BH
0197 D1 E3                     SAL     BX,1                     ; WORD OFFSET
0199 8B 97 0050 R              MOV     DX,[BX+OFFSET @CURSOR_POSN]
019D 8B 0E 0060 R              MOV     CX,@CURSOR_MODE
01A1 5D                        POP     BP
01A2 5F                        POP     DI
01A3 5E                        POP     SI
01A4 5B                        POP     BX
01A5 58                        POP     AX                       ; DISCARD SAVED CX AND DX
01A6 58                        POP     AX
01A7 1F                        POP     DS
01A8 07                        POP     ES
01A9 CF                        IRET
01AA                    READ_CURSOR    ENDP
                        ;----------------------------------------------
                        ; ACT_DISP_PAGE
                        ;       THIS ROUTINE SETS THE ACTIVE DISPLAY PAGE, ALLOWING
                        ;       THE FULL USE OF THE MEMORY SET ASIDE FOR THE VIDEO ATTACHMENT
                        ; INPUT
                        ;       AL HAS THE NEW ACTIVE DISPLAY PAGE
                        ; OUTPUT
                        ;       THE 6845 IS RESET TO DISPLAY THAT PAGE
                        ;----------------------------------------------
01AA                    ACT_DISP_PAGE  PROC    NEAR
01AA A2 0062 R                 MOV     @ACTIVE_PAGE,AL          ; SAVE ACTIVE PAGE VALUE
01AD 98                        CBW                              ; CONVERT (AL) TO WORD
01AE 50                        PUSH    AX                       ; SAVE PAGE VALUE
01AF F7 26 004C R              MUL     WORD PTR @CRT_LEN        ; DISPLAY PAGE TIMES REGEN LENGTH
01B3 A3 004E R                 MOV     @CRT_START,AX            ; SAVE START ADDRESS FOR LATER
01B6 8B C8                     MOV     CX,AX                    ; START ADDRESS TO CX
01B8 D1 F9                     SAR     CX,1                     ; DIVIDE BY 2 FOR 6845 HANDLING
01BA B4 0C                     MOV     AH,12                    ; 6845 REGISTER FOR START ADDRESS
01BC E8 0151 R                 CALL    M16
01BF 5B                        POP     BX                       ; RECOVER PAGE VALUE
01C0 D1 E3                     SAL     BX,1                     ; *2 FOR WORD OFFSET
01C2 8B 87 0050 R              MOV     AX,[BX + OFFSET @CURSOR_POSN]    ; GET CURSOR FOR THIS PAGE
01C6 E8 0182 R                 CALL    M18                      ; SET THE CURSOR POSITION
01C9 E9 013D R                 JMP     VIDEO_RETURN
01CC                    ACT_DISP_PAGE  ENDP
                        ;------------------------------------------
                        ; SET_COLOR
                        ;       THIS ROUTINE WILL ESTABLISH THE BACKGROUND COLOR, THE OVERSCAN COLOR,
                        ;       AND THE FOREGROUND COLOR SET FOR MEDIUM RESOLUTION GRAPHICS
                        ; INPUT
                        ;       (BH) HAS COLOR ID
                        ;               IF BH=0, THE BACKGROUND COLOR VALUE IS SET
                        ;                       FROM THE LOW BITS OF BL (0-31)
                        ;               IF BH=1, THE PALETTE SELECTION IS MADE
                        ;                       BASED ON THE LOW BIT OF BL:
                        ;                               0 = GREEN, RED, YELLOW FOR COLORS 1,2,3
                        ;                               1 = BLUE, CYAN, MAGENTA FOR COLORS 1,2,3
                        ;       (BL) HAS THE COLOR VALUE TO BE USED
                        ; OUTPUT
                        ;       THE COLOR SELECTION IS UPDATED
                        ;------------------------------------------
01CC                    SET_COLOR      PROC    NEAR
01CC 8B 16 0063 R              MOV     DX,@ADDR_6845            ; I/O PORT FOR PALETTE
01D0 83 C2 05                  ADD     DX,5                     ; OVERSCAN PORT
01D3 A0 0066 R                 MOV     AL,@CRT_PALETTE          ; GET THE CURRENT PALETTE VALUE
01D6 0A FF                     OR      BH,BH                    ; IS THIS COLOR 0?
01D8 75 0E                     JNZ     M20                      ; OUTPUT COLOR 1

                        ;-----  HANDLE COLOR 0 BY SETTING THE BACKGROUND COLOR

01DA 24 E0                     AND     AL,0E0H                  ; TURN OFF LOW 5 BITS OF CURRENT
01DC 80 E3 1F                  AND     BL,01FH                  ; TURN OFF HIGH 3 BITS OF INPUT VALUE
01DF 0A C3                     OR      AL,BL                    ; PUT VALUE INTO REGISTER
01E1                    M19:                                    ; OUTPUT THE PALETTE
01E1 EE                        OUT     DX,AL                    ; OUTPUT COLOR SELECTION TO 3D9 PORT
01E2 A2 0066 R                 MOV     @CRT_PALETTE,AL          ; SAVE THE COLOR VALUE
01E5 E9 013D R                 JMP     VIDEO_RETURN

                        ;-----  HANDLE COLOR 1 BY SELECTING THE PALETTE TO BE USED

01E8                    M20:
01E8 24 DF                     AND     AL,0DFH                  ; TURN OFF PALETTE SELECT BIT
01EA D0 EB                     SHR     BL,1                     ; TEST THE LOW ORDER BIT OF BL
01EC 73 F3                     JNC     M19                      ; ALREADY DONE
01EE 0C 20                     OR      AL,20H                   ; TURN ON PALETTE SELECT BIT
01F0 EB EF                     JMP     M19                      ; GO DO IT
01F2                    SET_COLOR      ENDP
```

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                        ;----------------------------------------------
                        ; VIDEO STATE
                        ;  RETURNS THE CURRENT VIDEO STATE IN AX
                        ;  AH = NUMBER OF COLUMNS ON THE SCREEN
                        ;  AL = CURRENT VIDEO MODE
                        ;  BH = CURRENT ACTIVE PAGE
                        ;----------------------------------------------
01F2                    VIDEO_STATE     PROC    NEAR
01F2 8A 26 004A R               MOV     AH,BYTE PTR @CRT_COLS   ; GET NUMBER OF COLUMNS
01F6 A0 0049 R                  MOV     AL,@CRT_MODE            ; CURRENT MODE
01F9 8A 3E 0062 R               MOV     BH,@ACTIVE_PAGE         ; GET CURRENT ACTIVE PAGE
01FD 5D                         POP     BP                      ; RECOVER REGISTERS
01FE 5F                         POP     DI
01FF 5E                         POP     SI
0200 59                         POP     CX                      ; DISCARD SAVED BX
0201 E9 0141 R                  JMP     M15                     ; RETURN TO CALLER
0204                    VIDEO_STATE     ENDP
                        ;---------------------------------------
                        ; POSITION
                        ;       THIS SERVICE ROUTINE CALCULATES THE REGEN BUFFER ADDRESS
                        ;       OF A CHARACTER IN THE ALPHA MODE
                        ; INPUT
                        ;       AX = ROW, COLUMN POSITION
                        ; OUTPUT
                        ;       AX = OFFSET OF CHAR POSITION IN REGEN BUFFER
                        ;---------------------------------------
0204                    POSITION        PROC    NEAR
0204 53                         PUSH    BX                      ; SAVE REGISTER
0205 93                         XCHG    BX,AX                   ; SAVE ROW/COLUMN POSITION IN (BX)
0206 A0 004A R                  MOV     AL,BYTE PTR @CRT_COLS   ; GET COLUMNS PER ROW COUNT
0209 F6 E7                      MUL     BH                      ; DETERMINE BYTES TO ROW
020B 32 FF                      XOR     BH,BH
020D 03 C3                      ADD     AX,BX                   ; ADD IN COLUMN VALUE
020F D1 E0                      SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
0211 5B                         POP     BX
0212 C3                         RET
0213                    POSITION        ENDP
                        ;-----------------------------------------
                        ; SCROLL UP
                        ;       THIS ROUTINE MOVES A BLOCK OF CHARACTERS UP
                        ;       ON THE SCREEN
                        ; INPUT
                        ;       (AH) = CURRENT CRT MODE
                        ;       (AL) = NUMBER OF ROWS TO SCROLL
                        ;       (CX) = ROW/COLUMN OF UPPER LEFT CORNER
                        ;       (DX) = ROW/COLUMN OF LOWER RIGHT CORNER
                        ;       (BH) = ATTRIBUTE TO BE USED ON BLANKED LINE
                        ;       (DS) = DATA SEGMENT
                        ;       (ES) = REGEN BUFFER SEGMENT
                        ; OUTPUT
                        ;       NONE -- THE REGEN BUFFER IS MODIFIED
                        ;-----------------------------------------
                                ASSUME  DS:DATA,ES:DATA
0213                    SCROLL_UP       PROC    NEAR

0213 E8 02EE R                  CALL    TEST_LINE_COUNT
0216 80 FC 04                   CMP     AH,4                    ; TEST FOR GRAPHICS MODE
0219 72 08                      JC      N1                      ; HANDLE SEPARATELY
021B 80 FC 07                   CMP     AH,7                    ; TEST FOR BW CARD
021E 74 03                      JE      N1
0220 E9 04B0 R                  JMP     GRAPHICS_UP
0223                    N1:                                     ; UP_CONTINUE
0223 53                         PUSH    BX                      ; SAVE FILL ATTRIBUTE IN BH
0224 8B C1                      MOV     AX,CX                   ; UPPER LEFT POSITION
0226 E8 0260 R                  CALL    SCROLL_POSITION         ; DO SETUP FOR SCROLL
0229 74 31                      JZ      N7                      ; BLANK_FIELD
022B 03 F0                      ADD     SI,AX                   ; FROM ADDRESS
022D 8A E6                      MOV     AH,DH                   ; # ROWS IN BLOCK
022F 2A E3                      SUB     AH,BL                   ; # ROWS TO BE MOVED
0231                    N2:                                     ; ROW_LOOP
0231 E8 02A1 R                  CALL    N10                     ; MOVE ONE ROW
0234 03 F5                      ADD     SI,BP
0236 03 FD                      ADD     DI,BP                   ; POINT TO NEXT LINE IN BLOCK
0238 FE CC                      DEC     AH                      ; COUNT OF LINES TO MOVE
023A 75 F5                      JNZ     N2                      ; ROW_LOOP
023C                    N3:                                     ; CLEAR_ENTRY
023C 58                         POP     AX                      ; RECOVER ATTRIBUTE IN AH
023D B0 20                      MOV     AL,' '                  ; FILL WITH BLANKS
023F                    N4:                                     ; CLEAR_LOOP
023F E8 02AA R                  CALL    N11                     ; CLEAR THE ROW
0242 03 FD                      ADD     DI,BP                   ; POINT TO NEXT LINE
0244 FE CB                      DEC     BL                      ; COUNTER OF LINES TO SCROLL
0246 75 F7                      JNZ     N4                      ; CLEAR_LOOP
0248                    N5:                                     ; SCROLL_END
0248 E8 0000 E                  CALL    DDS
024B 80 3E 0049 R 07            CMP     @CRT_MODE,7             ; IS THIS THE BLACK AND WHITE CARD
0250 74 07                      JE      N6                      ; IF SO, SKIP THE MODE RESET
0252 A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE MODE SET
0255 BA 03D8                    MOV     DX,03D8H                ; ALWAYS SET COLOR CARD PORT
0258 EE                         OUT     DX,AL
0259                    N6:                                     ; VIDEO_RET_HERE
0259 E9 013D R                  JMP     VIDEO_RETURN
025C                    N7:                                     ; BLANK_FIELD
025C 8A DE                      MOV     BL,DH                   ; GET ROW COUNT
025E EB DC                      JMP     N3                      ; GO CLEAR THAT AREA
0260                    SCROLL_UP       ENDP

                        ;-----  HANDLE COMMON SCROLL SET UP HERE

0260                    SCROLL_POSITION PROC    NEAR
0260 E8 0204 R                  CALL    POSITION                ; CONVERT TO REGEN POINTER
0263 03 06 004E R               ADD     AX,@CRT_START           ; OFFSET OF ACTIVE PAGE
0267 8B F8                      MOV     DI,AX                   ; TO ADDRESS FOR SCROLL
0269 8B F0                      MOV     SI,AX                   ; FROM ADDRESS FOR SCROLL
026B 2B D1                      SUB     DX,CX                   ; DX = #ROWS, #COLS IN BLOCK
026D FE C6                      INC     DH
026F FE C2                      INC     DL                      ; INCREMENT FOR 0 ORIGIN
0271 32 ED                      XOR     CH,CH                   ; SET HIGH BYTE OF COUNT TO ZERO
0273 8B 2E 004A R               MOV     BP,@CRT_COLS            ; GET NUMBER OF COLUMNS IN DISPLAY
0277 03 ED                      ADD     BP,BP                   ; TIMES 2 FOR ATTRIBUTE BYTE
0279 A0 004A R                  MOV     AL,BYTE PTR @CRT_COLS   ; GET CHARACTERS PER LINE COUNT
027C F6 E3                      MUL     BL                      ; DETERMINE OFFSET TO FROM ADDRESS
027E 03 C0                      ADD     AX,AX                   ; *2 FOR ATTRIBUTE BYTE
0280 50                         PUSH    AX                      ; SAVE LINE COUNT
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0281 A0 0049 R                  MOV     AL,@CRT_MODE            ; GET CURRENT MODE
0284 06                         PUSH    ES                      ; ESTABLISH ADDRESSING TO REGEN BUFFER
0285 1F                         POP     DS                      ;  FOR BOTH POINTERS
0286 3C 02                      CMP     AL,2                    ; TEST FOR COLOR CARD SPECIAL CASES HERE
0288 72 13                      JB      N9                      ; HAVE TO HANDLE 80X25 SEPARATELY
028A 3C 03                      CMP     AL,3
028C 77 0F                      JA      N9

                        ;-----                                  ; 80X25 COLOR CARD SCROLL
028E 52                         PUSH    DX
028F BA 03DA                    MOV     DX,3DAH                 ; GUARANTEED TO BE COLOR CARD HERE
0292                    N8:                                     ; WAIT_DISP_ENABLE
0292 EC                         IN      AL,DX                   ; GET PORT
0293 A8 08                      TEST    AL,RVRT                 ; WAIT FOR VERTICAL RETRACE
0295 74 FB                      JZ      N8                      ; WAIT_DISP_ENABLE
0297 B0 25                      MOV     AL,25H
0299 B2 D8                      MOV     DL,0D8H                 ; ADDRESS CONTROL PORT
029B EE                         OUT     DX,AL                   ; TURN OFF VIDEO DURING VERTICAL RETRACE
029C 5A                         POP     DX
029D                    N9:
029D 58                         POP     AX                      ; RESTORE LINE COUNT
029E 0A DB                      OR      BL,BL                   ; 0 SCROLL MEANS BLANK FIELD
02A0 C3                         RET                             ; RETURN WITH FLAGS SET
02A1                    SCROLL_POSITION ENDP

                        ;-----  MOVE_ROW
02A1                    N10     PROC    NEAR
02A1 8A CA                      MOV     CL,DL                   ; GET # OF COLS TO MOVE
02A3 56                         PUSH    SI
02A4 57                         PUSH    DI                      ; SAVE START ADDRESS
02A5 F3/ A5                     REP     MOVSW                   ; MOVE THAT LINE ON SCREEN
02A7 5F                         POP     DI
02A8 5E                         POP     SI                      ; RECOVER ADDRESSES
02A9 C3                         RET
02AA                    N10     ENDP

                        ;-----  CLEAR_ROW
02AA                    N11     PROC    NEAR
02AA 8A CA                      MOV     CL,DL                   ; GET # COLUMNS TO CLEAR
02AC 57                         PUSH    DI
02AD F3/ AB                     REP     STOSW                   ; STORE THE FILL CHARACTER
02AF 5F                         POP     DI
02B0 C3                         RET
02B1                    N11     ENDP
                        ;----------------------------------------
                        ; SCROLL_DOWN
                        ;       THIS ROUTINE MOVES THE CHARACTERS WITHIN A DEFINED
                        ;       BLOCK DOWN ON THE SCREEN, FILLING THE TOP LINES
                        ;       WITH A DEFINED CHARACTER
                        ; INPUT
                        ;       (AH) = CURRENT CRT MODE
                        ;       (AL) = NUMBER OF LINES TO SCROLL
                        ;       (CX) = UPPER LEFT CORNER OF REGION
                        ;       (DX) = LOWER RIGHT CORNER OF REGION
                        ;       (BH) = FILL CHARACTER
                        ;       (DS) = DATA SEGMENT
                        ;       (ES) = REGEN SEGMENT
                        ; OUTPUT
                        ;       NONE -- SCREEN IS SCROLLED
                        ;----------------------------------------
02B1                    SCROLL_DOWN     PROC    NEAR
02B1 FD                         STD                             ; DIRECTION FOR SCROLL DOWN
02B2 E8 02EE R                  CALL    TEST_LINE_COUNT         ;
02B5 80 FC 04                   CMP     AH,4                    ; TEST FOR GRAPHICS
02B8 72 08                      JC      N12
02BA 80 FC 07                   CMP     AH,7                    ; TEST FOR BW CARD
02BD 74 03                      JE      N12
02BF E9 0507 R                  JMP     GRAPHICS_DOWN
02C2                    N12:                                    ; CONTINUE_DOWN
02C2 53                         PUSH    BX                      ; SAVE ATTRIBUTE IN BH
02C3 8B C2                      MOV     AX,DX                   ; LOWER RIGHT CORNER
02C5 E8 0260 R                  CALL    SCROLL_POSITION         ; GET REGEN LOCATION
02C8 74 20                      JZ      N16
02CA 2B F0                      SUB     SI,AX                   ; SI IS FROM ADDRESS
02CC 8A E6                      MOV     AH,DH                   ; GET TOTAL # ROWS
02CE 2A E3                      SUB     AH,BL                   ; COUNT TO MOVE IN SCROLL
02D0                    N13:
02D0 E8 02A1 R                  CALL    N10                     ; MOVE ONE ROW
02D3 2B F5                      SUB     SI,BP
02D5 2B FD                      SUB     DI,BP
02D7 FE CC                      DEC     AH
02D9 75 F5                      JNZ     N13
02DB                    N14:
02DB 58                         POP     AX                      ; RECOVER ATTRIBUTE IN AH
02DC B0 20                      MOV     AL,' '
02DE                    N15:
02DE E8 02AA R                  CALL    N11                     ; CLEAR ONE ROW
02E1 2B FD                      SUB     DI,BP                   ; GO TO NEXT ROW
02E3 FE CB                      DEC     BL
02E5 75 F7                      JNZ     N15
02E7 E9 0248 R                  JMP     N5                      ; SCROLL_END
02EA                    N16:
02EA 8A DE                      MOV     BL,DH
02EC EB ED                      JMP     N14
02EE                    SCROLL_DOWN     ENDP

                        ;-----  IF  AMOUNT OF LINES TO BE SCROLLED = AMOUNT OF LINES IN WINDOW
                        ;-----   THEN  ADJUST AL; ELSE  RETURN;

02EE                    TEST_LINE_COUNT PROC    NEAR

02EE 8A D8                      MOV     BL,AL                   ; SAVE LINE COUNT IN BL
02F0 0A C0                      OR      AL,AL                   ; TEST IF AL IS ALREADY ZERO
02F2 74 0E                      JZ      BL_SET                  ; IF IT IS THEN RETURN...
02F4 50                         PUSH    AX                      ; SAVE AX
02F5 8A C6                      MOV     AL,DH                   ; SUBTRACT LOWER ROW FROM UPPER ROW
02F7 2A C5                      SUB     AL,CH
02F9 FE C0                      INC     AL                      ; ADJUST DIFFERENCE BY 1
02FB 3A C3                      CMP     AL,BL                   ; LINE COUNT = AMOUNT OF ROWS IN WINDOW?
02FD 58                         POP     AX                      ; RESTORE AX
02FE 75 02                      JNE     BL_SET                  ; IF NOT THEN WE'RE ALL SET
0300 2A DB                      SUB     BL,BL                   ; OTHERWISE SET BL TO ZERO
0302                    BL_SET:
0302 C3                         RET                             ; RETURN
0303                    TEST_LINE_COUNT ENDP
```

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                                PAGE
                                ;--------------------------------------------------------------------------------
                                ; READ_AC_CURRENT                                                              :
                                ;       THIS ROUTINE READS THE ATTRIBUTE AND CHARACTER AT THE CURRENT          :
                                ;       CURSOR POSITION AND RETURNS THEM TO THE CALLER                         :
                                ; INPUT                                                                        :
                                ;       (AH) = CURRENT CRT MODE                                                :
                                ;       (BH) = DISPLAY PAGE ( ALPHA MODES ONLY )                               :
                                ;       (DS) = DATA SEGMENT                                                    :
                                ;       (ES) = REGEN SEGMENT                                                   :
                                ; OUTPUT                                                                       :
                                ;       (AL) = CHARACTER READ                                                  :
                                ;       (AH) = ATTRIBUTE READ                                                  :
                                ;--------------------------------------------------------------------------------
                                        ASSUME  DS:DATA,ES:DATA

 0303                           READ_AC_CURRENT PROC    NEAR
 0303  80 FC 04                         CMP     AH,4                    ; IS THIS GRAPHICS
 0306  72 08                            JC      P10

 0308  80 FC 07                         CMP     AH,7                    ; IS THIS BW CARD
 030B  74 03                            JE      P10

 030D  E9 0642 R                        JMP     GRAPHICS_READ
 0310                           P10:                                    ;  READ_AC_CONTINUE
 0310  E8 032C R                        CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
 0313  8B F7                            MOV     SI,DI                   ; ESTABLISH ADDRESSING IN SI
 0315  06                               PUSH    ES                      ; GET REGEN SEGMENT FOR QUICK ACCESS
 0316  1F                               POP     DS

                                ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 0317  0A DB                            OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
 0319  75 0D                            JNZ     P13                     ; ELSE SKIP RETRACE WAIT - DO FAST READ
 031B                           P11:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 031B  FB                               STI                             ; ENABLE INTERRUPTS FIRST
 031C  90                               NOP                             ; ALLOW FOR SMALL INTERRUPT WINDOW
 031D  FA                               CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 031E  EC                               IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 031F  A8 01                            TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW
 0321  75 F8                            JNZ     P11                     ; WAIT UNTIL IT IS
 0323                           P12:                                    ;  NOW WAIT FOR EITHER RETRACE HIGH
 0323  EC                               IN      AL,DX                   ; GET STATUS
 0324  A8 09                            TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 0326  74 FB                            JZ      P12                     ; WAIT UNTIL EITHER IS ACTIVE
 0328                           P13:
 0328  AD                               LODSW                           ; GET THE CHARACTER AND ATTRIBUTE
 0329  E9 013D R                        JMP     VIDEO_RETURN            ;  EXIT WITH (AX)

 032C                           READ_AC_CURRENT ENDP



 032C                           FIND_POSITION   PROC    NEAR            ;       SETUP FOR BUFFER READ OR WRITE
 032C  86 E3                            XCHG    AH,BL                   ; SWAP MODE TYPE WITH ATTRIBUTE
 032E  8B E8                            MOV     BP,AX                   ; SAVE CHARACTER/ATTR IN (BP) REGISTER
 0330  80 EB 02                         SUB     BL,2                    ; CONVERT DISPLAY MODE TYPE TO A
 0333  D0 EB                            SHR     BL,1                    ;  ZERO VALUE FOR COLOR IN 80 COLUMN
 0335  8A C7                            MOV     AL,BH                   ; MOVE DISPLAY PAGE TO LOW BYTE
 0337  98                               CBW                             ; CLEAR HIGH BYTE FOR BYTE OFFSET
 0338  8B F8                            MOV     DI,AX                   ; MOVE DISPLAY PAGE (COUNT) TO WORK REG
 033A  D1 E7                            SAL     DI,1                    ; TIMES 2 FOR WORD OFFSET
 033C  8B 95 0050 R                     MOV     DX,[DI+OFFSET @CURSOR_POSN]     ; GET ROW/COLUMN OF THAT PAGE
 0340  74 09                            JZ      P21                     ; SKIP BUFFER ADJUSTMENT IF PAGE ZERO

 0342  33 FF                            XOR     DI,DI                   ; ELSE SET BUFFER START ADDRESS TO ZERO
 0344                           P20:
 0344  03 3E 004C R                     ADD     DI,@CRT_LEN             ; ADD LENGTH OF BUFFER FOR ONE PAGE
 0348  48                               DEC     AX                      ; DECREMENT PAGE COUNT
 0349  75 F9                            JNZ     P20                     ; LOOP TILL PAGE COUNT EXHAUSTED

 034B                           P21:                                    ; DETERMINE LOCATION IN REGEN IN PAGE
 034B  A0 004A R                        MOV     AL,BYTE PTR @CRT_COLS   ; GET COLUMNS PER ROW COUNT
 034E  F6 E6                            MUL     DH                      ; DETERMINE BYTES TO ROW
 0350  32 F6                            XOR     DH,DH
 0352  03 C2                            ADD     AX,DX                   ; ADD IN COLUMN VALUE
 0354  D1 E0                            SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
 0356  03 F8                            ADD     DI,AX                   ; ADD LOCATION TO START OF REGEN PAGE
 0358  8B 16 0063 R                     MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF ACTIVE DISPLAY
 035C  83 C2 06                         ADD     DX,6                    ;  DX= STATUS PORT ADDRESS OF ADAPTER
 035F  C3                               RET                             ;  BP= ATTRIBUTE/CHARACTER (FROM BL/AL)
                                                                        ;  DI= POSITION (OFFSET IN REGEN BUFFER)
 0360                           FIND_POSITION   ENDP                    ;  BL= MODE FLAG (ZERO FOR 80X25 COLOR)
```

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                             PAGE
                             ;--------------------------------------------------------------------------
                             ; WRITE_AC_CURRENT                                                        :
                             ;       THIS ROUTINE WRITES THE ATTRIBUTE AND CHARACTER                   :
                             ;       AT THE CURRENT CURSOR POSITION                                    :
                             ; INPUT                                                                   :
                             ;       (AH) = CURRENT CRT MODE                                           :
                             ;       (BH) = DISPLAY PAGE                                               :
                             ;       (CX) = COUNT OF CHARACTERS TO WRITE                               :
                             ;       (AL) = CHAR TO WRITE                                              :
                             ;       (BL) = ATTRIBUTE OF CHAR TO WRITE                                 :
                             ;       (DS) = DATA SEGMENT                                               :
                             ;       (ES) = REGEN SEGMENT                                              :
                             ; OUTPUT                                                                  :
                             ;       DISPLAY REGEN BUFFER UPDATED                                      :
                             ;--------------------------------------------------------------------------

 0360                        WRITE_AC_CURRENT       PROC    NEAR
 0360 80 FC 04                      CMP     AH,4                    ; IS THIS GRAPHICS
 0363 72 08                         JC      P30
 0365 80 FC 07                      CMP     AH,7                    ; IS THIS BW CARD
 0368 74 03                         JE      P30
 036A E9 058E R                     JMP     GRAPHICS_WRITE
 036D                        P30:                                   ;  WRITE_AC_CONTINUE
 036D E8 032C R                     CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                    ; ADDRESS IN (DI) REGISTER
 0370 0A DB                         OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD AT 80
 0372 74 06                         JZ      P32                     ; SKIP TO RETRACE WAIT IF COLOR AT 80

 0374 95                            XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED FOR FAST WRITE
 0375 F3/ AB                        REP     STOSW                   ; STRING WRITE THE ATTRIBUTE & CHARACTER
 0377 EB 16                         JMP     SHORT  P35              ; EXIT FAST WRITE ROUTINE

                             ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 0379                        P31:                                   ;  LOOP FOR EACH ATTR/CHAR WRITE
 0379 95                            XCHG    BP,AX                   ; PLACE ATTR/CHAR BACK IN SAVE REGISTER
 037A                        P32:                                   ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 037A FB                            STI                             ; ENABLE INTERRUPTS FIRST
 037B 90                            NOP                             ; ALLOW FOR INTERRUPT WINDOW
 037C FA                            CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 037D EC                            IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 037E A8 08                         TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 0380 75 09                         JNZ     P34                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 0382 A8 01                         TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 0384 75 F4                         JNZ     P32                     ; WAIT UNTIL IT IS
 0386                        P33:                                   ;  WAIT FOR EITHER RETRACE HIGH
 0386 EC                            IN      AL,DX                   ; GET STATUS AGAIN
 0387 A8 09                         TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 0389 74 FB                         JZ      P33                     ; WAIT UNTIL EITHER IS ACTIVE
 038B                        P34:
 038B 95                            XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED IN (BP)
 038C AB                            STOSW                           ; WRITE THE ATTRIBUTE AND CHARACTER
 038D E2 EA                         LOOP    P31                     ; AS MANY TIMES AS REQUESTED - TILL CX=0
 038F                        P35:
 038F E9 013D R                     JMP     VIDEO_RETURN            ; EXIT

 0392                        WRITE_AC_CURRENT       ENDP

                             ;--------------------------------------------------------------------------
                             ; WRITE_C_CURRENT                                                         :
                             ;       THIS ROUTINE WRITES THE CHARACTER AT                              :
                             ;       THE CURRENT CURSOR POSITION, ATTRIBUTE UNCHANGED                  :
                             ; INPUT                                                                   :
                             ;       (AH) = CURRENT CRT MODE                                           :
                             ;       (BH) = DISPLAY PAGE                                               :
                             ;       (CX) = COUNT OF CHARACTERS TO WRITE                               :
                             ;       (AL) = CHAR TO WRITE                                              :
                             ;       (DS) = DATA SEGMENT                                               :
                             ;       (ES) = REGEN SEGMENT                                              :
                             ; OUTPUT                                                                  :
                             ;       DISPLAY REGEN BUFFER UPDATED                                      :
                             ;--------------------------------------------------------------------------

 0392                        WRITE_C_CURRENT PROC    NEAR
 0392 80 FC 04                      CMP     AH,4                    ; IS THIS GRAPHICS
 0395 72 08                         JC      P40
 0397 80 FC 07                      CMP     AH,7                    ; IS THIS BW CARD
 039A 74 03                         JE      P40
 039C E9 058E R                     JMP     GRAPHICS_WRITE
 039F                        P40:
 039F E8 032C R                     CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                    ; ADDRESS OF LOCATION IN (DI)

                             ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 03A2                        P41:                                   ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 03A2 FB                            STI                             ; ENABLE INTERRUPTS FIRST
 03A3 0A DB                         OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
 03A5 75 0F                         JNZ     P43                     ; ELSE SKIP RETRACE WAIT - DO FAST WRITE
 03A7 FA                            CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 03A8 EC                            IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 03A9 A8 08                         TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 03AB 75 09                         JNZ     P43                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 03AD A8 01                         TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 03AF 75 F1                         JNZ     P41                     ; WAIT UNTIL IT IS
 03B1                        P42:                                   ;  WAIT FOR EITHER RETRACE HIGH
 03B1 EC                            IN      AL,DX                   ; GET STATUS AGAIN
 03B2 A8 09                         TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 03B4 74 FB                         JZ      P42                     ; WAIT UNTIL EITHER RETRACE ACTIVE
 03B6                        P43:
 03B6 8B C5                         MOV     AX,BP                   ; GET THE CHARACTER SAVE IN (BP)
 03B8 AA                            STOSB                           ; PUT THE CHARACTER INTO REGEN BUFFER
 03B9 47                            INC     DI                      ; BUMP POINTER PAST ATTRIBUTE
 03BA E2 E6                         LOOP    P41                     ;  AS MANY TIMES AS REQUESTED

 03BC E9 013D R                     JMP     VIDEO_RETURN

 03BF                        WRITE_C_CURRENT ENDP
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                            PAGE
                            ;--------------------------------------------------------------------------
                            ; WRITE_STRING                                                            :
                            ;        THIS ROUTINE WRITES A STRING OF CHARACTERS TO THE CRT.           :
                            ; INPUT                                                                   :
                            ;        (AL) = WRITE STRING COMMAND  0 - 3                               :
                            ;        (BH) = DISPLAY PAGE (ACTIVE PAGE)                                :
                            ;        (CX) = COUNT OF CHARACTERS TO WRITE, IF (CX) = 0 THEN RETURN     :
                            ;        (DX) = CURSOR POSITION FOR START OF STRING WRITE                 :
                            ;        (BL) = ATTRIBUTE OF CHARACTER TO WRITE IF (AL) = 0  OR  (AL) = 1 :
                            ;        (BP) = SOURCE STRING OFFSET                                      :
                            ;        [0E] = SOURCE STRING SEGMENT (FOR USE IN (ES) IN STACK +14)      :
                            ; OUTPUT                                                                  :
                            ;        NONE                                                             :
                            ;--------------------------------------------------------------------------
03BF                        WRITE_STRING    PROC    NEAR
03BF  55                            PUSH    BP                      ; SAVE BUFFER OFFSET (BP) IN STACK
03C0  8B EC                         MOV     BP,SP                   ; GET POINTER TO STACKED REGISTERS
03C2  8E 46 10                      MOV     ES,[BP]+14+2            ; RECOVER ENTRY (ES) SEGMENT REGISTER
03C5  5D                            POP     BP                      ; RESTORE BUFFER OFFSET
03C6  98                            CBW                             ; CLEAR (AH) REGISTER
03C7  8B F8                         MOV     DI,AX                   ; SAVE (AL) COMMAND IN (DI) REGISTER
03C9  3C 04                         CMP     AL,04                   ; TEST FOR INVALID WRITE STRING OPTION
03CB  73 73                         JNB     P59                     ; IF OPTION INVALID THEN RETURN

03CD  E3 71                         JCXZ    P59                     ; IF ZERO LENGTH STRING THEN RETURN

03CF  8B F3                         MOV     SI,BX                   ; SAVE CURRENT CURSOR PAGE
03D1  8A DF                         MOV     BL,BH                   ; MOVE PAGE TO LOW BYTE
03D3  32 FF                         XOR     BH,BH                   ; CLEAR HIGH BYTE
03D5  87 F3                         XCHG    SI,BX                   ; MOVE OFFSET AND RESTORE PAGE REGISTER
03D7  D1 E6                         SAL     SI,1                    ; CONVERT TO PAGE OFFSET  (SI= PAGE)
03D9  FF B4 0050 R                  PUSH    [SI+OFFSET @CURSOR_POSN]; SAVE CURRENT CURSOR POSITION IN STACK
03DD  B8 0200                       MOV     AX,0200H                ; SET NEW CURSOR POSITION
03E0  CD 10                         INT     10H
03E2                        P50:
03E2  26: 8A 46 00                  MOV     AL,ES:[BP]              ; GET CHARACTER FROM INPUT STRING
03E6  45                            INC     BP                      ; BUMP POINTER TO CHARACTER

                            ;-----  TEST FOR SPECIAL CHARACTER'S

03E7  3C 08                         CMP     AL,08H                  ; IS IT A BACKSPACE
03E9  74 0C                         JE      P51                     ; BACK_SPACE
03EB  3C 0D                         CMP     AL,CR                   ; IS IT CARRIAGE RETURN
03ED  74 08                         JE      P51                     ; CAR_RET
03EF  3C 0A                         CMP     AL,LF                   ; IS IT A LINE FEED
03F1  74 04                         JE      P51                     ; LINE_FEED
03F3  3C 07                         CMP     AL,07H                  ; IS IT A BELL
03F5  75 0A                         JNE     P52                     ; IF NOT THEN DO WRITE CHARACTER
03F7                        P51:
03F7  B4 0E                         MOV     AH,0EH                  ; TTY_CHARACTER WRITE
03F9  CD 10                         INT     10H                       ; WRITE TTY CHARACTER TO THE CRT
03FB  8B 94 0050 R                  MOV     DX,[SI+OFFSET @CURSOR_POSN] ; GET CURRENT CURSOR POSITION
03FF  EB 2D                         JMP     SHORT P54                 ; SET CURSOR POSITION AND CONTINUE

0401                        P52:
0401  51                            PUSH    CX
0402  53                            PUSH    BX
0403  B9 0001                       MOV     CX,1                    ; SET CHARACTER WRITE AMOUNT TO ONE
0406  83 FF 02                      CMP     DI,2                    ; IS THE ATTRIBUTE IN THE STRING
0409  72 05                         JB      P53                     ; IF NOT THEN SKIP
040B  26: 8A 5E 00                  MOV     BL,ES:[BP]              ; ELSE GET NEW ATTRIBUTE
040F  45                            INC     BP                      ; BUMP STRING POINTER
0410                        P53:
0410  B4 09                         MOV     AH,09H                  ;  GOT_CHARACTER
0412  CD 10                         INT     10H                     ; WRITE CHARACTER TO THE CRT
0414  5B                            POP     BX                      ; RESTORE REGISTERS
0415  59                            POP     CX
0416  FE C2                         INC     DL                      ; INCREMENT COLUMN COUNTER
0418  3A 16 004A R                  CMP     DL,BYTE PTR @CRT_COLS   ; IF COLS ARE WITHIN RANGE FOR THIS MODE
041C  72 10                         JB      P54                     ;     THEN GO TO COLUMNS SET
041E  FE C6                         INC     DH                      ; BUMP ROW COUNTER BY ONE
0420  2A D2                         SUB     DL,DL                   ; SET COLUMN COUNTER TO ZERO
0422  80 FE 19                      CMP     DH,25                   ; IF ROWS ARE LESS THAN 25 THEN
0425  72 07                         JB      P54                     ;     GO TO ROWS_COLUMNS_SET

0427  B8 0E0A                       MOV     AX,0E0AH                ; ELSE SCROLL SCREEN ONE LINE
042A  CD 10                         INT     10H                     ; RESET ROW COUNTER TO 24
042C  FE CE                         DEC     DH
042E                        P54:                                    ;  ROW_COLUMNS_SET
042E  B8 0200                       MOV     AX,0200H                ; SET NEW CURSOR POSITION COMMAND
0431  CD 10                         INT     10H                     ; ESTABLISH NEW CURSOR POSITION
0433  E2 AD                         LOOP    P50                     ; DO IT ONCE MORE UNTIL (CX) = ZERO

0435  5A                            POP     DX                      ; RESTORE OLD CURSOR COORDINATES
0436  97                            XCHG    AX,DI                   ; RECOVER WRITE STRING COMMAND
0437  A8 01                         TEST    AL,01H                  ; IF CURSOR WAS NOT TO BE MOVED THEN
0439  75 05                         JNZ     P59                     ;  THEN EXIT WITHOUT RESETTING OLD VALUE
043B  B8 0200                       MOV     AX,0200H                ; ELSE RESTORE OLD CURSOR POSITION
043E  CD 10                         INT     10H
0440                        P59:                                    ;  DONE - EXIT WRITE STRING
0440  E9 013D R                     JMP     VIDEO_RETURN            ; RETURN TO CALLER

0443                        WRITE_STRING    ENDP
```

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                                PAGE
                                ;---------------------------------------------
                                ; READ DOT  -- WRITE DOT
                                ; THESE ROUTINES WILL WRITE A DOT, OR READ THE
                                ;  DOT AT THE INDICATED LOCATION
                                ; ENTRY --
                                ;   DX = ROW (0-199)     (THE ACTUAL VALUE DEPENDS ON THE MODE)
                                ;   CX = COLUMN ( 0-639) ( THE VALUES ARE NOT RANGE CHECKED )
                                ;   AL = DOT VALUE TO WRITE (1,2 OR 4 BITS DEPENDING ON MODE,
                                ;        REQUIRED FOR WRITE DOT ONLY, RIGHT JUSTIFIED)
                                ;        BIT 7 OF AL = 1 INDICATES XOR THE VALUE INTO THE LOCATION
                                ;   DS = DATA SEGMENT
                                ;   ES = REGEN SEGMENT
                                ;
                                ; EXIT
                                ;        AL = DOT VALUE READ, RIGHT JUSTIFIED, READ ONLY
                                ;---------------------------------------------
                                        ASSUME  DS:DATA,ES:DATA
 0443                           READ_DOT        PROC    NEAR
 0443  E8 0477 R                        CALL    R3                      ; DETERMINE BYTE POSITION OF DOT
 0446  26: 8A 04                        MOV     AL,ES:[SI]              ; GET THE BYTE
 0449  22 C4                            AND     AL,AH                   ; MASK OFF THE OTHER BITS IN THE BYTE
 044B  D2 E0                            SHL     AL,CL                   ; LEFT JUSTIFY THE VALUE
 044D  8A CE                            MOV     CL,DH                   ; GET NUMBER OF BITS IN RESULT
 044F  D2 C0                            ROL     AL,CL                   ; RIGHT JUSTIFY THE RESULT
 0451  E9 013D R                        JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
 0454                           READ_DOT        ENDP

 0454                           WRITE_DOT       PROC    NEAR
 0454  50                               PUSH    AX                      ; SAVE DOT VALUE
 0455  50                               PUSH    AX                      ;  TWICE
 0456  E8 0477 R                        CALL    R3                      ; DETERMINE BYTE POSITION OF THE DOT
 0459  D2 E8                            SHR     AL,CL                   ; SHIFT TO SET UP THE BITS FOR OUTPUT
 045B  22 C4                            AND     AL,AH                   ; STRIP OFF THE OTHER BITS
 045D  26: 8A 0C                        MOV     CL,ES:[SI]              ; GET THE CURRENT BYTE
 0460  5B                               POP     BX                      ; RECOVER XOR FLAG
 0461  F6 C3 80                         TEST    BL,80H                  ; IS IT ON
 0464  75 0D                            JNZ     R2                      ; YES, XOR THE DOT
 0466  F6 D4                            NOT     AH                      ; SET MASK TO REMOVE THE INDICATED BITS
 0468  22 CC                            AND     CL,AH
 046A  0A C1                            OR      AL,CL                   ; OR IN THE NEW VALUE OF THOSE BITS
 046C                           R1:                                     ; FINISH_DOT
 046C  26: 88 04                        MOV     ES:[SI],AL              ; RESTORE THE BYTE IN MEMORY
 046F  58                               POP     AX
 0470  E9 013D R                        JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
 0473                           R2:                                     ; XOR_DOT
 0473  32 C1                            XOR     AL,CL                   ; EXCLUSIVE OR THE DOTS
 0475  EB F5                            JMP     R1                      ; FINISH UP THE WRITING
 0477                           WRITE_DOT       ENDP
                                ;---------------------------------------------
                                ; THIS SUBROUTINE DETERMINES THE REGEN BYTE LOCATION OF THE
                                ; INDICATED ROW COLUMN VALUE IN GRAPHICS MODE.
                                ; ENTRY --
                                ;  DX = ROW VALUE (0-199)
                                ;  CX = COLUMN VALUE (0-639)
                                ; EXIT --
                                ;  SI = OFFSET INTO REGEN BUFFER FOR BYTE OF INTEREST
                                ;  AH = MASK TO STRIP OFF THE BITS OF INTEREST
                                ;  CL = BITS TO SHIFT TO RIGHT JUSTIFY THE MASK IN AH
                                ;  DH = # BITS IN RESULT
                                ;  BX = MODIFIED
                                ;---------------------------------------------
 0477                           R3      PROC    NEAR

                                ;-----  DETERMINE 1ST BYTE IN INDICATED ROW BY MULTIPLYING ROW VALUE BY 40
                                ;-----   ( LOW BIT OF ROW DETERMINES EVEN/ODD, 80 BYTES/ROW )

 0477  96                               XCHG    SI,AX                   ; WILL SAVE AL AND AH DURING OPERATION
 0478  B0 28                            MOV     AL,40
 047A  F6 E2                            MUL     DL                      ; AX= ADDRESS OF START OF INDICATED ROW
 047C  A8 08                            TEST    AL,008H                 ; TEST FOR EVEN/ODD ROW CALCULATED
 047E  74 03                            JZ      R4                      ; JUMP IF EVEN ROW
 0480  05 1FD8                          ADD     AX,2000H-40             ; OFFSET TO LOCATION OF ODD ROWS ADJUST
 0483                           R4:                                     ; EVEN_ROW
 0483  96                               XCHG    SI,AX                   ; MOVE POINTER TO (SI) AND RECOVER (AX)
 0484  8B D1                            MOV     DX,CX                   ; COLUMN VALUE TO DX

                                ;-----  DETERMINE GRAPHICS MODE CURRENTLY IN EFFECT

                                ; SET UP THE REGISTERS ACCORDING TO THE MODE
                                ; CH = MASK FOR LOW OF COLUMN ADDRESS ( 7/3 FOR HIGH/MED RES )
                                ; CL = # OF ADDRESS BITS IN COLUMN VALUE ( 3/2 FOR H/M )
                                ; BL = MASK TO SELECT BITS FROM POINTED BYTE ( 80H/C0H FOR H/M )
                                ; BH = NUMBER OF VALID BITS IN POINTED BYTE ( 1/2 FOR H/M )

 0486  BB 02C0                          MOV     BX,2C0H
 0489  B9 0302                          MOV     CX,302H                 ; SET PARMS FOR MED RES
 048C  80 3E 0049 R 06                  CMP     @CRT_MODE,6
 0491  72 06                            JC      R5                      ; HANDLE IF MED RES
 0493  BB 0180                          MOV     BX,180H
 0496  B9 0703                          MOV     CX,703H                 ; SET PARMS FOR HIGH RES

                                ;-----  DETERMINE BIT OFFSET IN BYTE FROM COLUMN MASK
 0499                           R5:
 0499  22 EA                            AND     CH,DL                   ; ADDRESS OF PEL WITHIN BYTE TO CH

                                ;-----  DETERMINE BYTE OFFSET FOR THIS LOCATION IN COLUMN

 049B  D3 EA                            SHR     DX,CL                   ; SHIFT BY CORRECT AMOUNT
 049D  03 F2                            ADD     SI,DX                   ; INCREMENT THE POINTER
 049F  8A F7                            MOV     DH,BH                   ; GET THE # OF BITS IN RESULT TO DH

                                ;-----  MULTIPLY BH (VALID BITS IN BYTE) BY CH (BIT OFFSET)

 04A1  2A C9                            SUB     CL,CL                   ; ZERO INTO STORAGE LOCATION
 04A3                           R6:
 04A3  D0 C8                            ROR     AL,1                    ; LEFT JUSTIFY VALUE IN AL (FOR WRITE)
 04A5  02 CD                            ADD     CL,CH                   ; ADD IN THE BIT OFFSET VALUE
 04A7  FE CF                            DEC     BH                      ; LOOP CONTROL
 04A9  75 F8                            JNZ     R6                      ; ON EXIT, CL HAS COUNT TO RESTORE BITS
 04AB  8A E3                            MOV     AH,BL                   ;  GET MASK TO AH
 04AD  D2 EC                            SHR     AH,CL                   ;  MOVE THE MASK TO CORRECT LOCATION
 04AF  C3                               RET                             ;  RETURN WITH EVERYTHING SET UP
 04B0                           R3      ENDP
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                             ;--------------------------------------------------
                             ;  SCROLL UP
                             ;   THIS ROUTINE SCROLLS UP THE INFORMATION ON THE CRT
                             ; ENTRY --
                             ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                             ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                             ;   BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                             ;  BH = FILL VALUE FOR BLANKED LINES
                             ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                             ;  DS = DATA SEGMENT
                             ;  ES = REGEN SEGMENT
                             ; EXIT --
                             ;  NOTHING, THE SCREEN IS SCROLLED
                             ;-----------------------------------------------------
04B0                         GRAPHICS_UP     PROC    NEAR
04B0  8A D8                          MOV     BL,AL                   ; SAVE LINE COUNT IN BL
04B2  8B C1                          MOV     AX,CX                   ; GET UPPER LEFT POSITION INTO AX REG

                             ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
                             ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE

04B4  E8 06F0 R                      CALL    GRAPH_POSN
04B7  8B F8                          MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS

                             ;-----  DETERMINE SIZE OF WINDOW

04B9  2B D1                          SUB     DX,CX
04BB  81 C2 0101                     ADD     DX,101H                 ; ADJUST VALUES
04BF  D0 E6                          SAL     DH,1                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
04C1  D0 E6                          SAL     DH,1                    ;  AND EVEN/ODD ROWS

                             ;-----  DETERMINE CRT MODE

04C3  80 3E 0049 R 06                CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
04C8  73 04                          JNC     R7                      ; FIND_SOURCE

                             ;-----  MEDIUM RES UP
04CA  D0 E2                          SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
04CC  D1 E7                          SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR

                             ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
04CE                         R7:                                     ; FIND_SOURCE
04CE  06                             PUSH    ES                      ; GET SEGMENTS BOTH POINTING TO REGEN
04CF  1F                             POP     DS
04D0  2A ED                          SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
04D2  D0 E3                          SAL     BL,1                    ; MULTIPLY NUMBER OF LINES BY 4
04D4  D0 E3                          SAL     BL,1
04D6  74 2B                          JZ      R11                     ; IF ZERO, THEN BLANK ENTIRE FIELD
04D8  B0 50                          MOV     AL,80                   ; 80 BYTES/ROW
04DA  F6 E3                          MUL     BL                      ; DETERMINE OFFSET TO SOURCE
04DC  8B F7                          MOV     SI,DI                   ; SET UP SOURCE
04DE  03 F0                          ADD     SI,AX                   ;  ADD IN OFFSET TO IT
04E0  8A E6                          MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
04E2  2A E3                          SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE

                             ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
04E4                         R8:                                     ; ROW_LOOP
04E4  E8 0564 R                      CALL    R17                     ; MOVE ONE ROW
04E7  81 EE 1FB0                     SUB     SI,2000H-80             ; MOVE TO NEXT ROW
04EB  81 EF 1FB0                     SUB     DI,2000H-80
04EF  FE CC                          DEC     AH                      ; NUMBER OF ROWS TO MOVE
04F1  75 F1                          JNZ     R8                      ; CONTINUE TILL ALL MOVED

                             ;-----  FILL IN THE VACATED LINE(S)
04F3                         R9:                                     ; CLEAR_ENTRY
04F3  8A C7                          MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
04F5                         R10:
04F5  E8 057D R                      CALL    R18                     ; CLEAR THAT ROW
04F8  81 EF 1FB0                     SUB     DI,2000H-80             ; POINT TO NEXT LINE
04FC  FE CB                          DEC     BL                      ; NUMBER OF LINES TO FILL
04FE  75 F5                          JNZ     R10                     ; CLEAR_LOOP
0500  E9 013D R                      JMP     VIDEO_RETURN            ; EVERYTHING DONE

0503                         R11:                                    ; BLANK_FIELD
0503  8A DE                          MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
0505  EB EC                          JMP     R9                      ; CLEAR THE FIELD
0507                         GRAPHICS_UP     ENDP
                             ;--------------------------------------------------
                             ; SCROLL DOWN
                             ;  THIS ROUTINE SCROLLS DOWN THE INFORMATION ON THE CRT
                             ; ENTRY --
                             ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                             ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                             ;   BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                             ;  BH = FILL VALUE FOR BLANKED LINES
                             ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                             ;  DS = DATA SEGMENT
                             ;  ES = REGEN SEGMENT
                             ; EXIT --
                             ;  NOTHING, THE SCREEN IS SCROLLED
                             ;-----------------------------------------------------

0507                         GRAPHICS_DOWN   PROC    NEAR
0507  FD                             STD                             ; SET DIRECTION
0508  8A D8                          MOV     BL,AL                   ; SAVE LINE COUNT IN BL
050A  8B C2                          MOV     AX,DX                   ; GET LOWER RIGHT POSITION INTO AX REG

                             ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
                             ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE

050C  E8 06F0 R                      CALL    GRAPH_POSN
050F  8B F8                          MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS

                             ;-----  DETERMINE SIZE OF WINDOW

0511  2B D1                          SUB     DX,CX
0513  81 C2 0101                     ADD     DX,101H                 ; ADJUST VALUES
0517  D0 E6                          SAL     DH,1                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
0519  D0 E6                          SAL     DH,1                    ;  AND EVEN/ODD ROWS

                             ;-----  DETERMINE CRT MODE

051B  80 3E 0049 R 06                CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
0520  73 05                          JNC     R12                     ; FIND_SOURCE_DOWN
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SECTION 5

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                                  ;-----  MEDIUM RES DOWN
0522 D0 E2                                SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
0524 D1 E7                                SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
0526 47                                   INC     DI                      ; POINT TO LAST BYTE

                                  ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER

0527                              R12:                                    ; FIND_SOURCE_DOWN
0527 06                                   PUSH    ES                      ; BOTH SEGMENTS TO REGEN
0528 1F                                   POP     DS
0529 2A ED                                SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
052B 81 C7 00F0                           ADD     DI,240                  ; POINT TO LAST ROW OF PIXELS
052F D0 E3                                SAL     BL,1                    ; MULTIPLY NUMBER OF LINES BY 4
0531 D0 E3                                SAL     BL,1
0533 74 2B                                JZ      R16                     ; IF ZERO, THEN BLANK ENTIRE FIELD
0535 B0 50                                MOV     AL,80                   ; 80 BYTES/ROW
0537 F6 E3                                MUL     BL                      ; DETERMINE OFFSET TO SOURCE
0539 8B F7                                MOV     SI,DI                   ; SET UP SOURCE
053B 2B F0                                SUB     SI,AX                   ;  SUBTRACT THE OFFSET
053D 8A E6                                MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
053F 2A E3                                SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE

                                  ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS

0541                              R13:                                    ; ROW_LOOP_DOWN
0541 E8 0564 R                            CALL    R17                     ; MOVE ONE ROW
0544 81 EE 2050                           SUB     SI,2000H+80             ; MOVE TO NEXT ROW
0548 81 EF 2050                           SUB     DI,2000H+80
054C FE CC                                DEC     AH                      ; NUMBER OF ROWS TO MOVE
054E 75 F1                                JNZ     R13                     ; CONTINUE TILL ALL MOVED

                                  ;-----  FILL IN THE VACATED LINE(S)
0550                              R14:                                    ; CLEAR_ENTRY_DOWN
0550 8A C7                                MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
0552                              R15:                                    ; CLEAR_LOOP_DOWN
0552 E8 057D R                            CALL    R18                     ; CLEAR A ROW
0555 81 EF 2050                           SUB     DI,2000H+80             ; POINT TO NEXT LINE
0559 FE CB                                DEC     BL                      ; NUMBER OF LINES TO FILL
055B 75 F5                                JNZ     R15                     ; CLEAR_LOOP_DOWN

055D E9 013D R                            JMP     VIDEO_RETURN            ; EVERYTHING DONE

0560                              R16:                                    ; BLANK_FIELD_DOWN
0560 8A DE                                MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
0562 EB EC                                JMP     R14                     ; CLEAR THE FIELD
0564                              GRAPHICS_DOWN   ENDP

                                  ;-----  ROUTINE TO MOVE ONE ROW OF INFORMATION

0564                              R17     PROC    NEAR
0564 8A CA                                MOV     CL,DL                   ; NUMBER OF BYTES IN THE ROW
0566 56                                   PUSH    SI
0567 57                                   PUSH    DI                      ; SAVE POINTERS
0568 F3/ A4                               REP     MOVSB                   ; MOVE THE EVEN FIELD
056A 5F                                   POP     DI
056B 5E                                   POP     SI
056C 81 C6 2000                           ADD     SI,2000H
0570 81 C7 2000                           ADD     DI,2000H                ; POINT TO THE ODD FIELD
0574 56                                   PUSH    SI
0575 57                                   PUSH    DI                      ; SAVE THE POINTERS
0576 8A CA                                MOV     CL,DL                   ; COUNT BACK
0578 F3/ A4                               REP     MOVSB                   ; MOVE THE ODD FIELD
057A 5F                                   POP     DI
057B 5E                                   POP     SI                      ; POINTERS BACK
057C C3                                   RET                             ; RETURN TO CALLER
057D                              R17     ENDP

                                  ;-----  CLEAR A SINGLE ROW

057D                              R18     PROC    NEAR
057D 8A CA                                MOV     CL,DL                   ; NUMBER OF BYTES IN FIELD
057F 57                                   PUSH    DI                      ; SAVE POINTER
0580 F3/ AA                               REP     STOSB                   ; STORE THE NEW VALUE
0582 5F                                   POP     DI                      ; POINTER BACK
0583 81 C7 2000                           ADD     DI,2000H                ; POINT TO ODD FIELD
0587 57                                   PUSH    DI
0588 8A CA                                MOV     CL,DL
058A F3/ AA                               REP     STOSB                   ; FILL THE ODD FIELD
058C 5F                                   POP     DI
058D C3                                   RET                             ; RETURN TO CALLER
058E                              R18     ENDP

                                  ;-------------------------------------------------
                                  ; GRAPHICS WRITE
                                  ;  THIS ROUTINE WRITES THE ASCII CHARACTER TO THE CURRENT
                                  ;  POSITION ON THE SCREEN.
                                  ; ENTRY --
                                  ;  AL = CHARACTER TO WRITE
                                  ;  BL = COLOR ATTRIBUTE TO BE USED FOR FOREGROUND COLOR
                                  ;       IF BIT 7 IS SET, THE CHAR IS XOR'D INTO THE REGEN BUFFER
                                  ;       (0 IS USED FOR THE BACKGROUND COLOR)
                                  ;  CX = NUMBER OF CHARS TO WRITE
                                  ;  DS = DATA SEGMENT
                                  ;  ES = REGEN SEGMENT
                                  ; EXIT --
                                  ;  NOTHING IS RETURNED
                                  ;
                                  ; GRAPHICS READ
                                  ;   THIS ROUTINE READS THE ASCII CHARACTER AT THE CURRENT CURSOR
                                  ;   POSITION ON THE SCREEN BY MATCHING THE DOTS ON THE SCREEN TO THE
                                  ;   CHARACTER GENERATOR CODE POINTS
                                  ; ENTRY --
                                  ;  NONE  (0 IS ASSUMED AS THE BACKGROUND COLOR)
                                  ; EXIT --
                                  ;  AL = CHARACTER READ AT THAT POSITION (0 RETURNED IF NONE FOUND)
                                  ;
                                  ; FOR BOTH ROUTINES, THE IMAGES USED TO FORM CHARS ARE CONTAINED IN ROM
                                  ;  FOR THE 1ST 128 CHARS.  TO ACCESS CHARS IN THE SECOND HALF, THE USER
                                  ;  MUST INITIALIZE THE VECTOR AT INTERRUPT 1FH (LOCATION 0007CH) TO
                                  ;  POINT TO THE USER SUPPLIED TABLE OF GRAPHIC IMAGES (8X8 BOXES).
                                  ;  FAILURE TO DO SO WILL CAUSE IN STRANGE RESULTS
                                  ;-------------------------------------------------

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                                        ASSUME  DS:DATA,ES:DATA
058E                            GRAPHICS_WRITE  PROC    NEAR
058E B4 00                              MOV     AH,0                    ; ZERO TO HIGH OF CODE POINT
0590 50                                 PUSH    AX                      ; SAVE CODE POINT VALUE

                                ;-----  DETERMINE POSITION IN REGEN BUFFER TO PUT CODE POINTS

0591 E8 06ED R                          CALL    S26                     ; FIND LOCATION IN REGEN BUFFER
0594 8B F8                              MOV     DI,AX                   ; REGEN POINTER IN DI

                                ;-----  DETERMINE REGION TO GET CODE POINTS FROM

0596 58                                 POP     AX                      ; RECOVER CODE POINT
0597 3C 80                              CMP     AL,80H                  ; IS IT IN SECOND HALF
0599 73 06                              JAE     S1                      ; YES

                                ;-----  IMAGE IS IN FIRST HALF, CONTAINED IN ROM

059B BE 0000 E                          MOV     SI,OFFSET CRT_CHAR_GEN  ; OFFSET OF IMAGES
059E 0E                                 PUSH    CS                      ; SAVE SEGMENT ON STACK
059F EB 18                              JMP     SHORT S2                ; DETERMINE_MODE

                                ;-----  IMAGE IS IN SECOND HALF, IN USER MEMORY

05A1                            S1:                                     ; EXTEND_CHAR
05A1 2C 80                              SUB     AL,80H                  ; ZERO ORIGIN FOR SECOND HALF
05A3 1E                                 PUSH    DS                      ; SAVE DATA POINTER
05A4 2B F6                              SUB     SI,SI
05A6 8E DE                              MOV     DS,SI                   ; ESTABLISH VECTOR ADDRESSING
                                        ASSUME  DS:ABS0
05A8 C5 36 007C R                       LDS     SI,@EXT_PTR             ; GET THE OFFSET OF THE TABLE
05AC 8C DA                              MOV     DX,DS                   ; GET THE SEGMENT OF THE TABLE
                                        ASSUME  DS:DATA
05AE 1F                                 POP     DS                      ; RECOVER DATA SEGMENT
05AF 52                                 PUSH    DX                      ; SAVE TABLE SEGMENT ON STACK
05B0 0B D6                              OR      DX,SI                   ; CHECK FOR VALID TABLE DEFINED
05B2 75 05                              JNZ     S2                      ; CONTINUE IF DS:SI NOT 0000:0000

05B4 58                                 POP     AX                      ; ELSE SET (AX)= 0000 FOR "NULL"
05B5 BE 0000 E                          MOV     SI,OFFSET CRT_CHAR_GEN  ; POINT TO DEFAULT TABLE OFFSET
05B8 0E                                 PUSH    CS                      ;  IN THE CODE SEGMENT

                                ;-----  DETERMINE GRAPHICS MODE IN OPERATION

05B9                            S2:                                     ;         DETERMINE_MODE
05B9 D1 E0                              SAL     AX,1                    ; MULTIPLY CODE POINT VALUE BY 8
05BB D1 E0                              SAL     AX,1
05BD D1 E0                              SAL     AX,1
05BF 03 F0                              ADD     SI,AX                   ; SI HAS OFFSET OF DESIRED CODES
05C1 80 3E 0049 R 06                    CMP     @CRT_MODE,6
05C6 1F                                 POP     DS                      ; RECOVER TABLE POINTER SEGMENT
05C7 72 2C                              JC      S7                      ; TEST FOR MEDIUM RESOLUTION MODE

                                ;-----  HIGH RESOLUTION MODE

05C9                            S3:                                     ; HIGH_CHAR
05C9 57                                 PUSH    DI                      ; SAVE REGEN POINTER
05CA 56                                 PUSH    SI                      ; SAVE CODE POINTER
05CB B6 04                              MOV     DH,4                    ; NUMBER OF TIMES THROUGH LOOP
05CD                            S4:
05CD AC                                 LODSB                           ; GET BYTE FROM CODE POINTS
05CE F6 C3 80                           TEST    BL,80H                  ; SHOULD WE USE THE FUNCTION
05D1 75 16                              JNZ     S6                      ;  TO PUT CHAR IN
05D3 AA                                 STOSB                           ; STORE IN REGEN BUFFER
05D4 AC                                 LODSB
05D5                            S5:
05D5 26: 88 85 1FFF                     MOV     ES:[DI+2000H-1],AL      ; STORE IN SECOND HALF
05DA 83 C7 4F                           ADD     DI,79                   ; MOVE TO NEXT ROW IN REGEN
05DD FE CE                              DEC     DH                      ; DONE WITH LOOP
05DF 75 EC                              JNZ     S4
05E1 5E                                 POP     SI
05E2 5F                                 POP     DI                      ; RECOVER REGEN POINTER
05E3 47                                 INC     DI                      ; POINT TO NEXT CHAR POSITION
05E4 E2 E3                              LOOP    S3                      ; MORE CHARS TO WRITE
05E6 E9 013D R                          JMP     VIDEO_RETURN

05E9                            S6:
05E9 26: 32 05                          XOR     AL,ES:[DI]              ; EXCLUSIVE OR WITH CURRENT
05EC AA                                 STOSB                           ; STORE THE CODE POINT
05ED AC                                 LODSB                           ; AGAIN FOR ODD FIELD
05EE 26: 32 85 1FFF                     XOR     AL,ES:[DI+2000H-1]
05F3 EB E0                              JMP     S5                      ; BACK TO MAINSTREAM

                                ;-----  MEDIUM RESOLUTION WRITE
05F5                            S7:                                     ;  MED_RES_WRITE
05F5 8A D3                              MOV     DL,BL                   ; SAVE HIGH COLOR BIT
05F7 D1 E7                              SAL     DI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
                                                                        ; EXPAND BL TO FULL WORD OF COLOR
05F9 80 E3 03                           AND     BL,3                    ; ISOLATE THE COLOR BITS ( LOW 2 BITS )
05FC B0 55                              MOV     AL,055H                 ; GET BIT CONVERSION MULTIPLIER
05FE F6 E3                              MUL     BL                      ; EXPAND 2 COLOR BITS TO 4 REPLICATIONS
0600 8A D8                              MOV     BL,AL                   ; PLACE BACK IN WORK REGISTER
0602 8A F8                              MOV     BH,AL                   ; EXPAND TO 8 REPLICATIONS OF COLOR BITS
0604                            S8:                                     ;  MED_CHAR
0604 57                                 PUSH    DI                      ; SAVE REGEN POINTER
0605 56                                 PUSH    SI                      ; SAVE THE CODE POINTER
0606 B6 04                              MOV     DH,4                    ; NUMBER OF LOOPS
0608                            S9:
0608 AC                                 LODSB                           ; GET CODE POINT
0609 E8 06C4 R                          CALL    S21                     ; DOUBLE UP ALL THE BITS
060C 23 C3                              AND     AX,BX                   ; CONVERT TO FOREGROUND COLOR ( 0 BACK )
060E 86 E0                              XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
0610 F6 C2 80                           TEST    DL,80H                  ; IS THIS XOR FUNCTION
0613 74 03                              JZ      S10                     ; NO, STORE IT IN AS IT IS
0615 26: 33 05                          XOR     AX,ES:[DI]              ; DO FUNCTION WITH LOW/HIGH
0618                            S10:
0618 26: 89 05                          MOV     ES:[DI],AX              ; STORE FIRST BYTE HIGH, SECOND LOW
061B AC                                 LODSB                           ; GET CODE POINT
061C E8 06C4 R                          CALL    S21
061F 23 C3                              AND     AX,BX                   ; CONVERT TO COLOR
0621 86 E0                              XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
0623 F6 C2 80                           TEST    DL,80H                  ; AGAIN, IS THIS XOR FUNCTION
0626 74 05                              JZ      S11                     ; NO, JUST STORE THE VALUES
0628 26: 33 85 2000                     XOR     AX,ES:[DI+2000H]        ; FUNCTION WITH FIRST HALF LOW
```

SECTION 5

```
062D                          S11:
062D 26: 89 85 2000                   MOV     ES:[DI+2000H],AX        ; STORE SECOND PORTION HIGH
0632 83 C7 50                         ADD     DI,80                   ; POINT TO NEXT LOCATION
0635 FE CE                            DEC     DH
0637 75 CF                            JNZ     S9                      ; KEEP GOING
0639 5E                               POP     SI                      ; RECOVER CODE POINTER
063A 5F                               POP     DI                      ; RECOVER REGEN POINTER
063B 47                               INC     DI                      ; POINT TO NEXT CHAR POSITION
063C 47                               INC     DI
063D E2 C5                            LOOP    S8                      ; MORE TO WRITE
063F E9 013D R                        JMP     VIDEO_RETURN
0642                          GRAPHICS_WRITE  ENDP
                              ;------------------------------------------
                              ; GRAPHICS READ
                              ;------------------------------------------
0642                          GRAPHICS_READ   PROC    NEAR
0642 E8 06ED R                        CALL    S26                     ; CONVERTED TO OFFSET IN REGEN
0645 8B F0                            MOV     SI,AX                   ; SAVE IN SI
0647 83 EC 08                         SUB     SP,8                    ; ALLOCATE SPACE FOR THE READ CODE POINT
064A 8B EC                            MOV     BP,SP                   ; POINTER TO SAVE AREA

                              ;-----  DETERMINE GRAPHICS MODES
064C 80 3E 0049 R 06                  CMP     @CRT_MODE,6
0651 06                               PUSH    ES
0652 1F                               POP     DS                      ; POINT TO REGEN SEGMENT
0653 72 19                            JC      S13                     ; MEDIUM RESOLUTION

                              ;-----  HIGH RESOLUTION READ
                              ;-----  GET VALUES FROM REGEN BUFFER AND CONVERT TO CODE POINT
0655 B6 04                            MOV     DH,4                    ; NUMBER OF PASSES
0657                          S12:
0657 8A 04                            MOV     AL,[SI]                 ; GET FIRST BYTE
0659 88 46 00                         MOV     [BP],AL                 ; SAVE IN STORAGE AREA
065C 45                               INC     BP                      ; NEXT LOCATION
065D 8A 84 2000                       MOV     AL,[SI+2000H]           ; GET LOWER REGION BYTE
0661 88 46 00                         MOV     [BP],AL                 ; ADJUST AND STORE
0664 45                               INC     BP
0665 83 C6 50                         ADD     SI,80                   ; POINTER INTO REGEN
0668 FE CE                            DEC     DH                      ; LOOP CONTROL
066A 75 EB                            JNZ     S12                     ; DO IT SOME MORE
066C EB 16                            JMP     SHORT S15               ; GO MATCH THE SAVED CODE POINTS

                              ;-----  MEDIUM RESOLUTION READ
066E D1 E6                    S13:    SAL     SI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
0670 B6 04                            MOV     DH,4                    ; NUMBER OF PASSES
0672                          S14:
0672 E8 06D3 R                        CALL    S23                     ; GET BYTES FROM REGEN INTO SINGLE SAVE
0675 81 C6 1FFE                       ADD     SI,2000H-2              ; GO TO LOWER REGION
0679 E8 06D3 R                        CALL    S23                     ; GET THIS PAIR INTO SAVE
067C 81 EE 1FB2                       SUB     SI,2000H-80+2           ; ADJUST POINTER BACK INTO UPPER
0680 FE CE                            DEC     DH
0682 75 EE                            JNZ     S14                     ; KEEP GOING UNTIL ALL 8 DONE

                              ;-----  SAVE AREA HAS CHARACTER IN IT, MATCH IT
0684                          S15:                                    ; FIND_CHAR
0684 BF 0000 E                        MOV     DI,OFFSET CRT_CHAR_GEN  ; ESTABLISH ADDRESSING
0687 0E                               PUSH    CS
0688 07                               POP     ES                      ; CODE POINTS IN CS
0689 83 ED 08                         SUB     BP,8                    ; ADJUST POINTER TO START OF SAVE AREA
068C 8B F5                            MOV     SI,BP
068E B0 00                            MOV     AL,0                    ; CURRENT CODE POINT BEING MATCHED
0690                          S16:
0690 16                               PUSH    SS                      ; ESTABLISH ADDRESSING TO STACK
0691 1F                               POP     DS                      ; FOR THE STRING COMPARE
0692 BA 0080                          MOV     DX,128                  ; NUMBER TO TEST AGAINST
0695                          S17:
0695 56                               PUSH    SI                      ; SAVE SAVE AREA POINTER
0696 57                               PUSH    DI                      ; SAVE CODE POINTER
0697 B9 0004                          MOV     CX,4                    ; NUMBER OF WORDS TO MATCH
069A F3/ A7                           REPE    CMPSW                   ; COMPARE THE 8 BYTES AS WORDS
069C 5F                               POP     DI                      ; RECOVER THE POINTERS
069D 5E                               POP     SI
069E 74 1E                            JZ      S18                     ; IF ZERO FLAG SET, THEN MATCH OCCURRED
06A0 FE C0                            INC     AL                      ; NO MATCH, MOVE ON TO NEXT
06A2 83 C7 08                         ADD     DI,8                    ; NEXT CODE POINT
06A5 4A                               DEC     DX                      ; LOOP CONTROL
06A6 75 ED                            JNZ     S17                     ; DO ALL OF THEM

                              ;-----  CHAR NOT MATCHED, MIGHT BE IN USER SUPPLIED SECOND HALF
06A8 3C 00                            CMP     AL,0                    ;  AL<> 0 IF ONLY 1ST HALF SCANNED
06AA 74 12                            JE      S18                     ;  IF = 0, THEN ALL HAS BEEN SCANNED
06AC 2B C0                            SUB     AX,AX
06AE 8E D8                            MOV     DS,AX                   ;  ESTABLISH ADDRESSING TO VECTOR
                                      ASSUME  DS:ABS0
06B0 C4 3E 007C R                     LES     DI,@EXT_PTR             ;  GET POINTER
06B4 8C C0                            MOV     AX,ES                   ;  SEE IF THE POINTER REALLY EXISTS
06B6 0B C7                            OR      AX,DI                   ; IF ALL 0, THEN DOESN'T EXIST
06B8 74 04                            JZ      S18                     ; NO SENSE LOOKING
06BA B0 80                            MOV     AL,128                  ; ORIGIN FOR SECOND HALF
06BC EB D2                            JMP     S16                     ; GO BACK AND TRY FOR IT
                                      ASSUME  DS:DATA

                              ;-----  CHARACTER IS FOUND ( AL=0 IF NOT FOUND )
06BE 83 C4 08                 S18:    ADD     SP,8                    ; READJUST THE STACK, THROW AWAY SAVE
06C1 E9 013D R                        JMP     VIDEO_RETURN            ; ALL DONE
06C4                          GRAPHICS_READ   ENDP
                              ;------------------------------------------
                              ; EXPAND_BYTE
                              ;  THIS ROUTINE TAKES THE BYTE IN AL AND DOUBLES ALL
                              ;  OF THE BITS, TURNING THE 8 BITS INTO 16 BITS.
                              ;  THE RESULT IS LEFT IN AX
                              ;------------------------------------------
06C4                          S21     PROC    NEAR
06C4 51                               PUSH    CX                      ; SAVE REGISTER
06C5 B9 0008                          MOV     CX,8                    ; SHIFT COUNT REGISTER FOR ONE BYTE
06C8                          S22:
06C8 D0 C8                            ROR     AL,1                    ; SHIFT BITS, LOW BIT INTO CARRY FLAG
06CA D1 DD                            RCR     BP,1                    ; MOVE CARRY FLAG (LOW BIT) INTO RESULTS
06CC D1 FD                            SAR     BP,1                    ; SIGN EXTEND HIGH BIT (DOUBLE IT)
06CE E2 F8                            LOOP    S22                     ; REPEAT FOR ALL 8 BITS
06D0 95                               XCHG    AX,BP                   ; MOVE RESULTS TO PARAMETER REGISTER
06D1 59                               POP     CX                      ; RECOVER REGISTER
06D2 C3                               RET                             ; ALL DONE
06D3                          S21     ENDP
```

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                                ;--------------------------------------------------
                                ; MED_READ_BYTE
                                ; THIS ROUTINE WILL TAKE 2 BYTES FROM THE REGEN BUFFER,
                                ;  COMPARE AGAINST THE CURRENT FOREGROUND COLOR, AND PLACE
                                ;  THE CORRESPONDING ON/OFF BIT PATTERN INTO THE CURRENT
                                ;  POSITION IN THE SAVE AREA
                                ; ENTRY --
                                ;  SI,DS = POINTER TO REGEN AREA OF INTEREST
                                ;  BX = EXPANDED FOREGROUND COLOR
                                ;  BP = POINTER TO SAVE AREA
                                ; EXIT --
                                ;  SI AND BP ARE INCREMENTED
                                ;-----------------------------------------------------
06D3                            S23     PROC    NEAR
06D3 AD                                 LODSW                           ; GET FIRST BYTE AND SECOND BYTES
06D4 86 C4                              XCHG    AL,AH                   ; SWAP FOR COMPARE
06D6 B9 C000                            MOV     CX,0C000H               ; 2 BIT MASK TO TEST THE ENTRIES
06D9 B2 00                              MOV     DL,0                    ; RESULT REGISTER
06DB                            S24:
06DB 85 C1                              TEST    AX,CX                   ; IS THIS SECTION BACKGROUND?
06DD 74 01                              JZ      S25                     ; IF ZERO, IT IS BACKGROUND (CARRY=0)
06DF F9                                 STC                             ; WASN'T, SO SET CARRY
06E0                            S25:
06E0 D0 D2                              RCL     DL,1                    ; MOVE THAT BIT INTO THE RESULT
06E2 D1 E9                              SHR     CX,1
06E4 D1 E9                              SHR     CX,1                    ; MOVE THE MASK TO THE RIGHT BY 2 BITS
06E6 73 F3                              JNC     S24                     ; DO IT AGAIN IF MASK DIDN'T FALL OUT
06E8 88 56 00                           MOV     [BP],DL                 ; STORE RESULT IN SAVE AREA
06EB 45                                 INC     BP                      ; ADJUST POINTER
06EC C3                                 RET                             ; ALL DONE
06ED                            S23     ENDP
                                ;----------------------------------------
                                ; V4_POSITION
                                ;  THIS ROUTINE TAKES THE CURSOR POSITION CONTAINED IN
                                ;  THE MEMORY LOCATION, AND CONVERTS IT INTO AN OFFSET
                                ;  INTO THE REGEN BUFFER, ASSUMING ONE BYTE/CHAR.
                                ;  FOR MEDIUM RESOLUTION GRAPHICS, THE NUMBER MUST
                                ;  BE DOUBLED.
                                ; ENTRY -- NO REGISTERS,MEMORY LOCATION @CURSOR_POSN IS USED
                                ; EXIT--
                                ;  AX CONTAINS OFFSET INTO REGEN BUFFER
                                ;----------------------------------------
06ED                            S26     PROC    NEAR
06ED A1 0050 R                          MOV     AX,@CURSOR_POSN         ; GET CURRENT CURSOR
06F0                            GRAPH_POSN      LABEL   NEAR
06F0 53                                 PUSH    BX                      ; SAVE REGISTER
06F1 8B D8                              MOV     BX,AX                   ; SAVE A COPY OF CURRENT CURSOR
06F3 A0 004A R                          MOV     AL,BYTE PTR @CRT_COLS   ; GET BYTES PER COLUMN
06F6 F6 E4                              MUL     AH                      ; MULTIPLY BY ROWS
06F8 D1 E0                              SHL     AX,1
06FA D1 E0                              SHL     AX,1                    ; MULTIPLY * 4 SINCE 4 ROWS/BYTE
06FC 2A FF                              SUB     BH,BH                   ; ISOLATE COLUMN VALUE
06FE 03 C3                              ADD     AX,BX                   ; DETERMINE OFFSET
0700 5B                                 POP     BX                      ; RECOVER POINTER
0701 C3                                 RET                             ; ALL DONE
0702                            S26     ENDP
                                ;--- WRITE_TTY -----------------------------------------------------------
                                ;                                                                        :
                                ;   THIS INTERFACE PROVIDES A TELETYPE LIKE INTERFACE TO THE             :
                                ;     VIDEO CARDS.  THE INPUT CHARACTER IS WRITTEN TO THE CURRENT        :
                                ;     CURSOR POSITION, AND THE CURSOR IS MOVED TO THE NEXT POSITION.     :
                                ;     IF THE CURSOR LEAVES THE LAST COLUMN OF THE FIELD, THE COLUMN      :
                                ;     IS SET TO ZERO, AND THE ROW VALUE IS INCREMENTED.  IF THE ROW      :
                                ;     ROW VALUE LEAVES THE FIELD, THE CURSOR IS PLACED ON THE LAST ROW,  :
                                ;     FIRST COLUMN, AND THE ENTIRE SCREEN IS SCROLLED UP ONE LINE.       :
                                ;     WHEN THE SCREEN IS SCROLLED UP, THE ATTRIBUTE FOR FILLING THE      :
                                ;     NEWLY BLANKED LINE IS READ FROM THE CURSOR POSITION ON THE PREVIOUS :
                                ;     LINE BEFORE THE SCROLL, IN CHARACTER MODE.  IN GRAPHICS MODE,      :
                                ;     THE 0 COLOR IS USED.                                               :
                                ;   ENTRY --                                                             :
                                ;     (AH) = CURRENT CRT MODE                                            :
                                ;     (AL) = CHARACTER TO BE WRITTEN                                     :
                                ;            NOTE THAT BACK SPACE, CARRIAGE RETURN, BELL AND LINE FEED ARE :
                                ;            HANDLED AS COMMANDS RATHER THAN AS DISPLAY GRAPHICS CHARACTERS :
                                ;     (BL) = FOREGROUND COLOR FOR CHAR WRITE IF CURRENTLY IN A GRAPHICS MODE :
                                ;   EXIT --                                                              :
                                ;     ALL REGISTERS SAVED THROUGH VIDEO_EXIT (INCLUDING (AX))            :
                                ;------------------------------------------------------------------------
                                        ASSUME  DS:DATA
0702                            WRITE_TTY       PROC    NEAR
0702 97                                 XCHG    DI,AX                   ; SAVE (AX) REGISTER IN (DI) FOR EXIT
0703 B4 03                              MOV     AH,03H                  ; READ CURSOR POSITION
0705 8A 3E 0062 R                       MOV     BH,@ACTIVE_PAGE         ; GET CURRENT PAGE SETTING
0709 CD 10                              INT     10H                     ; READ THE CURRENT CURSOR POSITION
070B 8B C7                              MOV     AX,DI                   ; RECOVER CHARACTER FROM (DI) REGISTER

                                ;-----  DX NOW HAS THE CURRENT CURSOR POSITION

070D 3C 0D                              CMP     AL,CR                   ; IS IT CARRIAGE RETURN OR CONTROL
070F 76 46                              JBE     U8                      ; GO TO CONTROL CHECKS IF IT IS

                                ;-----  WRITE THE CHAR TO THE SCREEN
0711 B4 0A                      U0:     MOV     AH,0AH                  ; WRITE CHARACTER ONLY COMMAND
0713 B9 0001                            MOV     CX,1                    ; ONLY ONE CHARACTER
0716 CD 10                              INT     10H                     ; WRITE THE CHARACTER

                                ;-----  POSITION THE CURSOR FOR NEXT CHAR

0718 FE C2                              INC     DL
071A 3A 16 004A R                       CMP     DL,BYTE PTR @CRT_COLS   ; TEST FOR COLUMN OVERFLOW
071E 75 33                              JNZ     U7                      ;  SET_CURSOR
0720 B2 00                              MOV     DL,0                    ; COLUMN FOR CURSOR
0722 80 FE 18                           CMP     DH,25-1                 ; CHECK FOR LAST ROW
0725 75 2A                              JNZ     U6                      ;  SET_CURSOR_INC

                                ;-----  SCROLL REQUIRED
0727 B4 02                      U1:     MOV     AH,02H
0729 CD 10                              INT     10H                     ; SET THE CURSOR

                                ;-----  DETERMINE VALUE TO FILL WITH DURING SCROLL

072B A0 0049 R                          MOV     AL,@CRT_MODE            ; GET THE CURRENT MODE
072E 3C 04                              CMP     AL,4
0730 72 06                              JC      U2                      ; READ-CURSOR
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SECTION 5

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0732 3C 07                         CMP     AL,7
0734 B7 00                         MOV     BH,0                    ; FILL WITH BACKGROUND
0736 75 06                         JNE     U3                      ; SCROLL-UP
0738                       U2:                                     ; READ-CURSOR
0738 B4 08                         MOV     AH,08H                  ; GET READ CURSOR COMMAND
073A CD 10                         INT     10H                     ; READ CHAR/ATTR AT CURRENT CURSOR
073C 8A FC                         MOV     BH,AH                   ; STORE IN BH
073E                       U3:                                     ; SCROLL-UP
073E B8 0601                       MOV     AX,0601H                ; SCROLL ONE LINE
0741 2B C9                         SUB     CX,CX                   ; UPPER LEFT CORNER
0743 B6 18                         MOV     DH,25-1                 ; LOWER RIGHT ROW
0745 8A 16 004A R                  MOV     DL,BYTE PTR @CRT_COLS   ; LOWER RIGHT COLUMN
0749 FE CA                         DEC     DL
074B                       U4:                                     ; VIDEO-CALL-RETURN
074B CD 10                         INT     10H                     ; SCROLL UP THE SCREEN
074D                       U5:                                     ; TTY-RETURN
074D 97                            XCHG    AX,DI                   ; RESTORE THE ENTRY CHARACTER FROM (DI)
074E E9 013D R                     JMP     VIDEO_RETURN            ; RETURN TO CALLER

0751                       U6:                                     ; SET-CURSOR-INC
0751 FE C6                         INC     DH                      ; NEXT ROW
0753                       U7:                                     ; SET-CURSOR
0753 B4 02                         MOV     AH,02H
0755 EB F4                         JMP     U4                      ; ESTABLISH THE NEW CURSOR

                           ;-----  CHECK FOR CONTROL CHARACTERS
0757                       U8:
0757 74 13                         JE      U9                      ; WAS IT A CARRIAGE RETURN
0759 3C 0A                         CMP     AL,LF                   ; IS IT A LINE FEED
075B 74 13                         JE      U10                     ; GO TO LINE FEED
075D 3C 07                         CMP     AL,07H                  ; IS IT A BELL
075F 74 16                         JE      U11                     ; GO TO BELL
0761 3C 08                         CMP     AL,08H                  ; IS IT A BACKSPACE
0763 75 AC                         JNE     U0                      ; IF NOT A CONTROL, DISPLAY IT

                           ;-----  BACK SPACE FOUND

0765 0A D2                         OR      DL,DL                   ; IS IT ALREADY AT START OF LINE
0767 74 EA                         JE      U7                      ; SET_CURSOR
0769 4A                            DEC     DX                      ; NO -- JUST MOVE IT BACK
076A EB E7                         JMP     U7                      ; SET_CURSOR

                           ;-----  CARRIAGE RETURN FOUND
076C B2 00                 U9:     MOV     DL,0                    ; MOVE TO FIRST COLUMN
076E EB E3                         JMP     U7                      ; SET_CURSOR

                           ;-----  LINE FEED FOUND
0770 80 FE 18              U10:    CMP     DH,25-1                 ; BOTTOM OF SCREEN
0773 75 DC                         JNE     U6                      ; YES, SCROLL THE SCREEN
0775 EB B0                         JMP     U1                      ; NO, JUST SET THE CURSOR

                           ;-----  BELL FOUND
0777 B9 0533               U11:    MOV     CX,1331                 ; DIVISOR FOR 896 HZ TONE
077A B3 1F                         MOV     BL,31                   ; SET COUNT FOR 31/64 SECOND FOR BEEP
077C E8 0000 E                     CALL    BEEP                    ; SOUND THE POD BELL
077F EB CC                         JMP     U5                      ; TTY_RETURN
0781                       WRITE_TTY       ENDP
                           ;--------------------------------------------------------------------
                           ; LIGHT PEN                                                         :
                           ;       THIS ROUTINE TESTS THE LIGHT PEN SWITCH AND THE LIGHT       :
                           ;       PEN TRIGGER. IF BOTH ARE SET, THE LOCATION OF THE LIGHT     :
                           ;       PEN IS DETERMINED. OTHERWISE, A RETURN WITH NO INFORMATION  :
                           ;       IS MADE.                                                    :
                           ; ON EXIT:                                                          :
                           ;       (AH) = 0 IF NO LIGHT PEN INFORMATION IS AVAILABLE           :
                           ;               BX,CX,DX ARE DESTROYED                              :
                           ;       (AH) = 1 IF LIGHT PEN IS AVAILABLE                          :
                           ;               (DH,DL) = ROW,COLUMN OF CURRENT LIGHT PEN POSITION  :
                           ;               (CH) = RASTER POSITION                              :
                           ;               (BX) = BEST GUESS AT PIXEL HORIZONTAL POSITION      :
                           ;--------------------------------------------------------------------
                                   ASSUME  DS:DATA
0781 03 03 05 05 03 03     V1      DB      3,3,5,5,3,3,3,4         ; SUBTRACT_TABLE
     03 04
                           ;-----  WAIT FOR LIGHT PEN TO BE DEPRESSED

0789                       READ_LPEN       PROC    NEAR
0789 B4 00                         MOV     AH,0                    ; SET NO LIGHT PEN RETURN CODE
078B 8B 16 0063 R                  MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF 6845
078F 83 C2 06                      ADD     DX,6                    ; POINT TO STATUS REGISTER
0792 EC                            IN      AL,DX                   ; GET STATUS REGISTER
0793 A8 04                         TEST    AL,004H                 ; TEST LIGHT PEN SWITCH
0795 74 03                         JZ      V6_A                    ; GO IF YES
0797 E9 081C R                     JMP     V6                      ; NOT SET, RETURN

                           ;-----  NOW TEST FOR LIGHT PEN TRIGGER

079A A8 02                 V6_A:   TEST    AL,2                    ; TEST LIGHT PEN TRIGGER
079C 75 03                         JNZ     V7A                     ; RETURN WITHOUT RESETTING TRIGGER
079E E9 0826 R                     JMP     V7

                           ;-----  TRIGGER HAS BEEN SET, READ THE VALUE IN

07A1 B4 10                 V7A:    MOV     AH,16                   ; LIGHT PEN REGISTERS ON 6845

                           ;-----  INPUT REGISTERS POINTED TO BY AH, AND CONVERT TO ROW COLUMN IN (DX)

07A3 8B 16 0063 R                  MOV     DX,@ADDR_6845           ; ADDRESS REGISTER FOR 6845
07A7 8A C4                         MOV     AL,AH                   ; REGISTER TO READ
07A9 EE                            OUT     DX,AL                   ; SET IT UP
07AA EB 00                         JMP     $+2                     ; I/O DELAY
07AC 42                            INC     DX                      ; DATA REGISTER
07AD EC                            IN      AL,DX                   ; GET THE VALUE
07AE 8A E8                         MOV     CH,AL                   ; SAVE IN CX
07B0 4A                            DEC     DX                      ; ADDRESS REGISTER
07B1 FE C4                         INC     AH
07B3 8A C4                         MOV     AL,AH                   ; SECOND DATA REGISTER
07B5 EE                            OUT     DX,AL
07B6 42                            INC     DX                      ; POINT TO DATA REGISTER
07B7 EB 00                         JMP     $+2                     ; I/O DELAY
07B9 EC                            IN      AL,DX                   ; GET SECOND DATA VALUE
07BA 8A E5                         MOV     AH,CH                   ; AX HAS INPUT VALUE
```

```
                           PAGE
                           ;-----  AX HAS THE VALUE READ IN FROM THE 6845

07BC 8A 1E 0049 R                  MOV     BL,@CRT_MODE
07C0 2A FF                         SUB     BH,BH                   ; MODE VALUE TO BX
07C2 2E: 8A 9F 0781 R              MOV     BL,CS:V1[BX]            ; DETERMINE AMOUNT TO SUBTRACT
07C7 2B C3                         SUB     AX,BX                   ; TAKE IT AWAY
07C9 8B 1E 004E R                  MOV     BX,@CRT_START
07CD D1 EB                         SHR     BX,1
07CF 2B C3                         SUB     AX,BX                   ; CONVERT TO CORRECT PAGE ORIGIN
07D1 79 02                         JNS     V2                      ; IF POSITIVE, DETERMINE MODE
07D3 2B C0                         SUB     AX,AX                   ; <0 PLAYS AS 0

                           ;-----  DETERMINE MODE OF OPERATION

07D5                       V2:                                     ; DETERMINE_MODE
07D5 B1 03                         MOV     CL,3                    ; SET *8 SHIFT COUNT
07D7 80 3E 0049 R 04               CMP     @CRT_MODE,4             ; DETERMINE IF GRAPHICS OR ALPHA
07DC 72 2A                         JB      V4                      ; ALPHA_PEN
07DE 80 3E 0049 R 07               CMP     @CRT_MODE,7
07E3 74 23                         JE      V4                      ; ALPHA_PEN

                           ;-----  GRAPHICS MODE

07E5 B2 28                         MOV     DL,40                   ; DIVISOR FOR GRAPHICS
07E7 F6 F2                         DIV     DL                      ; DETERMINE ROW(AL) AND COLUMN(AH)
                                                                   ;  AL RANGE 0-99, AH RANGE 0-39
                           ;-----  DETERMINE GRAPHIC ROW POSITION

07E9 8A E8                         MOV     CH,AL                   ; SAVE ROW VALUE IN CH
07EB 02 ED                         ADD     CH,CH                   ; *2 FOR EVEN/ODD FIELD
07ED 8A DC                         MOV     BL,AH                   ; COLUMN VALUE TO BX
07EF 2A FF                         SUB     BH,BH                   ; MULTIPLY BY 8 FOR MEDIUM RES
07F1 80 3E 0049 R 06               CMP     @CRT_MODE,6             ; DETERMINE MEDIUM OR HIGH RES
07F6 75 04                         JNE     V3                      ; NOT_HIGH_RES
07F8 B1 04                         MOV     CL,4                    ; SHIFT VALUE FOR HIGH RES
07FA D0 E4                         SAL     AH,1                    ; COLUMN VALUE TIMES 2 FOR HIGH RES
07FC                       V3:                                     ; NOT_HIGH_RES
07FC D3 E3                         SHL     BX,CL                   ; MULTIPLY *16 FOR HIGH RES

                           ;-----  DETERMINE ALPHA CHAR POSITION

07FE 8A D4                         MOV     DL,AH                   ; COLUMN VALUE FOR RETURN
0800 8A F0                         MOV     DH,AL                   ; ROW VALUE
0802 D0 EE                         SHR     DH,1                    ; DIVIDE BY 4
0804 D0 EE                         SHR     DH,1                    ;    FOR VALUE IN 0-24 RANGE
0806 EB 12                         JMP     SHORT V5                ; LIGHT_PEN_RETURN_SET

                           ;-----  ALPHA MODE ON LIGHT PEN

0808                       V4:                                     ; ALPHA_PEN
0808 F6 36 004A R                  DIV     BYTE PTR @CRT_COLS      ; DETERMINE ROW,COLUMN VALUE
080C 8A F0                         MOV     DH,AL                   ; ROWS TO DH
080E 8A D4                         MOV     DL,AH                   ; COLS TO DL
0810 D2 E0                         SAL     AL,CL                   ; MULTIPLY ROWS * 8
0812 8A E8                         MOV     CH,AL                   ; GET RASTER VALUE TO RETURN REGISTER
0814 8A DC                         MOV     BL,AH                   ; COLUMN VALUE
0816 32 FF                         XOR     BH,BH                   ;  TO BX
0818 D3 E3                         SAL     BX,CL
081A                       V5:                                     ; LIGHT_PEN_RETURN_SET
081A B4 01                         MOV     AH,1                    ; INDICATE EVERY THING SET
081C                       V6:                                     ; LIGHT_PEN_RETURN
081C 52                            PUSH    DX                      ; SAVE RETURN VALUE (IN CASE)
081D 8B 16 0063 R                  MOV     DX,@ADDR_6845           ; GET BASE ADDRESS
0821 83 C2 07                      ADD     DX,7                    ; POINT TO RESET PARM
0824 EE                            OUT     DX,AL                   ; ADDRESS, NOT DATA, IS IMPORTANT
0825 5A                            POP     DX                      ; RECOVER VALUE
0826                       V7:                                     ; RETURN_NO_RESET
0826 5D                            POP     BP
0827 5F                            POP     DI
0828 5E                            POP     SI
0829 1F                            POP     DS                      ; DISCARD SAVED BX,CX,DX
082A 1F                            POP     DS
082B 1F                            POP     DS
082C 1F                            POP     DS
082D 07                            POP     ES
082E CF                            IRET
082F                       READ_LPEN       ENDP
082F                       CODE    ENDS
                                   END
```

SECTION 5

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                        PAGE 118,121
                        TITLE BIOS ----- 06/10/85  BIOS ROUTINES
                        .286C
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  EQUIPMENT_1
                                PUBLIC  MEMORY_SIZE_DET_1
                                PUBLIC  NMI_INT_1

                                EXTRN   C8042:NEAR              ; POST SEND 8042 COMMAND ROUTINE
                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   D1:NEAR                 ; "PARITY CHECK 1" MESSAGE
                                EXTRN   D2:NEAR                 ; "PARITY CHECK 2" MESSAGE
                                EXTRN   D2A:NEAR                ; "?????" UNKNOWN ADDRESS MESSAGE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   OBF_42:NEAR             ; POST WAIT 8042 RESPONSE ROUTINE
                                EXTRN   PRT_HEX:NEAR            ; DISPLAY CHARACTER ROUTINE
                                EXTRN   PRT_SEG:NEAR            ; DISPLAY FIVE CHARACTER ADDRESS ROUTINE
                                EXTRN   P_MSG:NEAR              ; DISPLAY MESSAGE STRING ROUTINE

                        ;--- INT  12 H --------------------------------------------------------------
                        ; MEMORY_SIZE_DETERMINE                                                     :
                        ;       THIS ROUTINE RETURNS THE AMOUNT OF MEMORY IN THE SYSTEM AS          :
                        ;       DETERMINED BY THE POST ROUTINES.  (UP TO 640K)                      :
                        ;       NOTE THAT THE SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS       :
                        ;       THERE IS A FULL COMPLEMENT OF 512K BYTES ON THE PLANAR.             :
                        ; INPUT                                                                     :
                        ;       NO REGISTERS                                                        :
                        ;       THE @MEMORY_SIZE VARIABLE IS SET DURING POWER ON DIAGNOSTICS        :
                        ;       ACCORDING TO THE FOLLOWING ASSUMPTIONS:                             :
                        ;                                                                           :
                        ;       1. CONFIGURATION RECORD IN NON-VOLATILE MEMORY EQUALS THE ACTUAL    :
                        ;          MEMORY SIZE INSTALLED.                                           :
                        ;                                                                           :
                        ;       2. ALL INSTALLED MEMORY IS FUNCTIONAL.  IF THE MEMORY TEST DURING   :
                        ;          POST INDICATES LESS, THEN THIS VALUE BECOMES THE DEFAULT.        :
                        ;          IF NON-VOLATILE MEMORY IS NOT VALID (NOT INITIALIZED OR BATTERY  :
                        ;          FAILURE) THEN ACTUAL MEMORY DETERMINED BECOMES THE DEFAULT.      :
                        ;                                                                           :
                        ;       3. ALL MEMORY FROM 0 TO 640K MUST BE CONTIGUOUS.                    :
                        ;                                                                           :
                        ; OUTPUT                                                                    :
                        ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY                     :
                        ;----------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    MEMORY_SIZE_DET_1  PROC FAR
0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS                      ; SAVE SEGMENT
0002 E8 0000 E                  CALL    DDS                     ; ESTABLISH ADDRESSING
0005 A1 0013 R                  MOV     AX,@MEMORY_SIZE         ; GET VALUE
0008 1F                         POP     DS                      ; RECOVER SEGMENT
0009 CF                         IRET                            ; RETURN TO CALLER
000A                    MEMORY_SIZE_DET_1 ENDP

                        ;--- INT  11 H --------------------------------------------------------------
                        ; EQUIPMENT DETERMINATION                                                   :
                        ;       THIS ROUTINE ATTEMPTS TO DETERMINE WHAT OPTIONAL                    :
                        ;       DEVICES ARE ATTACHED TO THE SYSTEM.                                 :
                        ; INPUT                                                                     :
                        ;       NO REGISTERS                                                        :
                        ;       THE @EQUIP_FLAG VARIABLE IS SET DURING THE POWER ON                 :
                        ;       DIAGNOSTICS USING THE FOLLOWING HARDWARE ASSUMPTIONS:               :
                        ;       PORT 03FA = INTERRUPT ID REGISTER OF 8250 (PRIMARY)                 :
                        ;            02FA = INTERRUPT ID REGISTER OF 8250 (SECONDARY)               :
                        ;                 BITS 7-3 ARE ALWAYS 0                                     :
                        ;       PORT 0378 = OUTPUT PORT OF PRINTER (PRIMARY)                        :
                        ;            0278 = OUTPUT PORT OF PRINTER (SECONDARY)                      :
                        ;            03BC = OUTPUT PORT OF PRINTER (MONOCHROME-PRINTER)             :
                        ;  OUTPUT                                                                   :
                        ;       (AX) IS SET, BIT SIGNIFICANT, TO INDICATE ATTACHED I/O              :
                        ;       BIT 15,14 = NUMBER OF PRINTERS ATTACHED                             :
                        ;       BIT 13 = INTERNAL MODEM INSTALLED                                   :
                        ;       BIT 12 NOT USED                                                     :
                        ;       BIT 11,10,9 = NUMBER OF RS232 CARDS ATTACHED                        :
                        ;       BIT 8 = NOT USED                                                    :
                        ;       BIT 7,6 = NUMBER OF DISKETTE DRIVES                                 :
                        ;               00=1, 01=2 ONLY IF BIT 0 = 1                                :
                        ;       BIT 5,4 = INITIAL VIDEO MODE                                        :
                        ;                       00 - UNUSED                                         :
                        ;                       01 - 40X25 BW USING COLOR CARD                      :
                        ;                       10 - 80X25 BW USING COLOR CARD                      :
                        ;                       11 - 80X25 BW USING BW CARD                         :
                        ;                                                                           :
                        ;       BIT 3 = NOT USED                                                    :
                        ;       BIT 2 = NOT USED                                                    :
                        ;       BIT 1 = MATH COPROCESSOR                                            :
                        ;       BIT 0 = 1 (IPL DISKETTE INSTALLED)                                  :
                        ;       NO OTHER REGISTERS AFFECTED                                         :
                        ;----------------------------------------------------------------------------

000A                    EQUIPMENT_1  PROC  FAR                  ; ENTRY POINT FOR ORG 0F84DH
000A FB                         STI                             ; INTERRUPTS BACK ON
000B 1E                         PUSH    DS                      ; SAVE SEGMENT REGISTER
000C E8 0000 E                  CALL    DDS                     ; ESTABLISH ADDRESSING
000F A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; GET THE CURRENT SETTINGS
0012 1F                         POP     DS                      ; RECOVER SEGMENT
0013 CF                         IRET                            ; RETURN TO CALLER
0014                    EQUIPMENT_1     ENDP
```

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                        PAGE
                        ;-- HARDWARE INT  02 H -- ( NMI LEVEL ) ----------------------------------------
                        ; NON-MASKABLE INTERRUPT ROUTINE (REAL MODE)                                  :
                        ;         THIS ROUTINE WILL PRINT A "PARITY CHECK 1 OR 2" MESSAGE AND ATTEMPT :
                        ;         TO FIND THE STORAGE LOCATION IN BASE 640K CONTAINING THE BAD PARITY.:
                        ;         IF FOUND, THE SEGMENT ADDRESS WILL BE PRINTED.  IF NO PARITY ERROR  :
                        ;         CAN BE FOUND (INTERMITTENT READ PROBLEM)  ?????  WILL BE DISPLAYED  :
                        ;         WHERE THE ADDRESS WOULD NORMALLY GO.                                :
                        ;                                                                             :
                        ;         PARITY CHECK 1 = PLANAR BOARD MEMORY FAILURE.                       :
                        ;         PARITY CHECK 2 = OFF PLANAR BOARD MEMORY FAILURE.                   :
                        ;------------------------------------------------------------------------------

 0014                   NMI_INT_1 PROC    NEAR
 0014 50                          PUSH    AX                      ; SAVE ORIGINAL CONTENTS OF (AX)

 0015 E4 61                       IN      AL,PORT_B               ; READ STATUS PORT
 0017 A8 C0                       TEST    AL,PARITY_ERR           ; PARITY CHECK OR I/O CHECK ?
 0019 75 07                       JNZ     NMI_1                   ; GO TO ERROR HALTS IF HARDWARE ERROR

 001B B0 0F                       MOV     AL,CMOS_SHUT_DOWN       ; ELSE ?? - LEAVE NMI ON
 001D E8 0000 E                   CALL    CMOS_READ               ; TOGGLE NMI USING COMMON READ ROUTINE
 0020 58                          POP     AX                      ; RESTORE ORIGINAL CONTENTS OF (AX)
 0021 CF                          IRET                            ; EXIT NMI HANDLER BACK TO PROGRAM


 0022                   NMI_1:                                    ;          HARDWARE ERROR
 0022 50                          PUSH    AX                      ; SAVE INITIAL CHECK MASK IN (AL)
 0023 B0 8F                       MOV     AL,CMOS_SHUT_DOWN+NMI   ; MASK TRAP (NMI) INTERRUPTS OFF
 0025 E8 0000 E                   CALL    CMOS_READ               ; OPEN STANDBY LATCH BEFORE POWER DOWN
 0028 B0 AD                       MOV     AL,DIS_KBD              ; DISABLE THE KEYBOARD
 002A E8 0000 E                   CALL    C8042                   ; SEND COMMAND TO ADAPTER
 002D E8 0000 E                   CALL    DDS                     ; ADDRESS DATA SEGMENT
 0030 B4 00                       MOV     AH,0                    ; INITIALIZE AND SET MODE FOR VIDEO
 0032 A0 0049 R                   MOV     AL,@CRT_MODE            ; GET CURRENT MODE
 0035 CD 10                       INT     10H                     ; CALL VIDEO_IO TO CLEAR SCREEN

                        ;-----    DISPLAY "PARITY CHECK ?" ERROR MESSAGES

 0037 58                          POP     AX                      ; RECOVER INITIAL CHECK STATUS
 0038 BE 0000 E                   MOV     SI,OFFSET D1            ; PLANAR ERROR, ADDRESS "PARITY CHECK 1"
 003B A8 80                       TEST    AL,PARITY_CHECK         ; CHECK FOR PLANAR ERROR
 003D 74 05                       JZ      NMI_2                   ; SKIP IF NOT

 003F 50                          PUSH    AX                      ; SAVE STATUS
 0040 E8 0000 E                   CALL    P_MSG                   ; DISPLAY "PARITY CHECK 1" MESSAGE
 0043 58                          POP     AX                      ; AND RECOVER STATUS
 0044                   NMI_2:
 0044 BE 0000 E                   MOV     SI,OFFSET D2            ; ADDRESS OF "PARITY CHECK 2" MESSAGE
 0047 A8 40                       TEST    AL,IO_CHECK             ; I/O PARITY CHECK ?
 0049 74 03                       JZ      NMI_3                   ; SKIP IF CORRECT ERROR DISPLAYED
 004B E8 0000 E                   CALL    P_MSG                   ; DISPLAY "PARITY CHECK 2" ERROR

                        ;-----    TEST FOR HOT NMI ON PLANAR PARITY LINE

 004E                   NMI_3:
 004E E4 61                       IN      AL,PORT_B
 0050 0C 0C                       OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK ENABLES
 0052 E6 61                       OUT     PORT_B,AL
 0054 24 F3                       AND     AL,RAM_PAR_ON           ; TO CLEAR THE PENDING CHECK
 0056 E6 61                       OUT     PORT_B,AL

 0058 FC                          CLD                             ; SET DIRECTION FLAG TO INCREMENT
 0059 2B D2                       SUB     DX,DX                   ; POINT (DX) AT START OF REAL MEMORY
 005B 2B F6                       SUB     SI,SI                   ; SET (SI) TO START OF (DS:)
 005D E4 61                       IN      AL,PORT_B               ; READ CURRENT PARITY CHECK LATCH
 005F A8 C0                       TEST    AL,PARITY_ERR           ; CHECK FOR HOT NMI SOURCE
 0061 75 19                       JNZ     NMI_5                   ; SKIP IF ERROR NOT RESET (DISPLAY ???)

                        ;-----    SEE IF LOCATION THAT CAUSED PARITY CHECK CAN BE FOUND IN BASE MEMORY

 0063 8B 1E 0013 R                MOV     BX,@MEMORY_SIZE         ; GET BASE MEMORY SIZE WORD
 0067                   NMI_4:
 0067 8E DA                       MOV     DS,DX                   ; POINT TO 64K SEGMENT
 0069 B9 8000                     MOV     CX,4000H*2              ; SET WORD COUNT FOR 64 KB SCAN
 006C F3/ AD                      REP     LODSW                   ; READ 64 KB OF MEMORY
 006E E4 61                       IN      AL,PORT_B               ; READ PARITY CHECK LATCHES
 0070 A8 C0                       TEST    AL,PARITY_ERR           ; CHECK FOR ANY PARITY ERROR PENDING
 0072 75 10                       JNZ     NMI_6                   ; GO PRINT SEGMENT ADDRESS IF ERROR

 0074 80 C6 10                    ADD     DH,010H                 ; POINT TO NEXT 64K BLOCK
 0077 83 EB 40                    SUB     BX,16D*4                ; DECREMENT COUNT OF 1024 BYTE SEGMENTS
 007A 77 EB                       JA      NMI_4                   ; LOOP TILL ALL 64K SEGMENTS DONE
 007C                   NMI_5:
 007C BE 0000 E                   MOV     SI,OFFSET D2A           ; PRINT ROW OF ????? IF PARITY
 007F E8 0000 E                   CALL    P_MSG                   ; CHECK COULD NOT BE RE-CREATED
 0082 FA                          CLI
 0083 F4                          HLT                             ; HALT SYSTEM

 0084                   NMI_6:
 0084 E8 0000 E                   CALL    PRT_SEG                 ; PRINT SEGMENT VALUE (IN DX)
 0087 B0 28                       MOV     AL,'('                  ; PRINT (S)
 0089 E8 0000 E                   CALL    PRT_HEX
 008C B0 53                       MOV     AL,'S'
 008E E8 0000 E                   CALL    PRT_HEX
 0091 B0 29                       MOV     AL,')'
 0093 E8 0000 E                   CALL    PRT_HEX
 0096 FA                          CLI                             ; HALT SYSTEM
 0097 F4                          HLT

 0098                   NMI_INT_1 ENDP

 0098                   CODE      ENDS
                                  END
                        PAGE 118,121
                        TITLE BIOS1 ---- 06/10/85  INTERRUPT 15H BIOS ROUTINES
                        .286C
                        .LIST
 0000                   CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  CASSETTE_IO_1
                                PUBLIC  GATE_A20
                                PUBLIC  SHUT9

                                EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                EXTRN   CMOS_WRITE:NEAR         ; WRITE CMOS LOCATION ROUTINE
                                EXTRN   CONF_TBL:NEAR           ; SYSTEM/BIOS CONFIGURATION TABLE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   PROC_SHUTDOWN:NEAR      ; 80286 HARDWARE RESET ROUTINE

                        ;--- INT 15 H -----------------------------------------------------------------
                        ;     INPUT - CASSETTE I/O FUNCTIONS                                         :
                        ;                                                                            :
                        ;           (AH) = 00H                                                       :
                        ;           (AH) = 01H                                                       :
                        ;           (AH) = 02H                                                       :
                        ;           (AH) = 03H                                                       :
                        ;        RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)              :
                        ;        IF CASSETTE PORT NOT PRESENT                                        :
                        ;----------------------------------------------------------------------------:
                        ;     INPUT - UNUSED FUNCTIONS                                               :
                        ;           (AH) = 04H THROUGH 7FH                                           :
                        ;        RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)              :
                        ;                 (UNLESS INTERCEPTED BY SYSTEM HANDLERS)                    :
                        ;                 NOTE: THE KEYBOARD INTERRUPT HANDLER INTERRUPTS WITH AH=4FH  :
                        ;----------------------------------------------------------------------------:
                        ; EXTENSIONS                                                                 :
                        ;           (AH) = 80H   DEVICE OPEN                                         :
                        ;                           (BX) = DEVICE ID                                 :
                        ;                           (CX) = PROCESS ID                                :
                        ;                                                                            :
                        ;           (AH) = 81H   DEVICE CLOSE                                        :
                        ;                           (BX) = DEVICE ID                                 :
                        ;                           (CX) = PROCESS ID                                :
                        ;                                                                            :
                        ;           (AH) = 82H   PROGRAM TERMINATION                                 :
                        ;                           (BX) = DEVICE ID                                 :
                        ;                                                                            :
                        ;           (AH) = 83H   EVENT WAIT                                          :
                        ;                                                                            :
                        ;                          (AL) = 00H SET INTERVAL                           :
                        ;                           (ES:BX) POINTER TO A BYTE IN CALLERS MEMORY      :
                        ;                                   THAT WILL HAVE THE HIGH ORDER BIT SET    :
                        ;                                   AS SOON AS POSSIBLE AFTER THE INTERVAL   :
                        ;                                   EXPIRES.                                 :
                        ;                           (CX,DX) NUMBER OF MICROSECONDS TO ELAPSE BEFORE  :
                        ;                                   POSTING.                                 :
                        ;                          (AL) = 01H CANCEL                                 :
                        ;                                                                            :
                        ;                  RETURNS: CARRY IF AL NOT = 00H OR 01H                     :
                        ;                           OR IF FUNCTION AL=0 ALREADY BUSY                 :
                        ;                                                                            :
                        ;           (AH) = 84H   JOYSTICK SUPPORT                                    :
                        ;                          (DX) = 00H - READ THE CURRENT SWITCH SETTINGS     :
                        ;                                   RETURNS AL = SWITCH SETTINGS (BITS 7-4)  :
                        ;                          (DX) = 01H - READ THE RESISTIVE INPUTS            :
                        ;                                   RETURNS AX = A(x) VALUE                  :
                        ;                                           BX = A(y) VALUE                  :
                        ;                                           CX = B(x) VALUE                  :
                        ;                                           DX = B(y) VALUE                  :
                        ;                                                                            :
                        ;           (AH) = 85H   SYSTEM REQUEST KEY PRESSED                          :
                        ;                          (AL) = 00H MAKE OF KEY                            :
                        ;                          (AL) = 01H BREAK OF KEY                           :
                        ;                                                                            :
                        ;           (AH) = 86H   WAIT                                                :
                        ;                          (CX,DX) NUMBER OF MICROSECONDS TO ELAPSE BEFORE   :
                        ;                                  RETURN TO CALLER                          :
                        ;                                                                            :
                        ;           (AH) = 87H   MOVE BLOCK                                          :
                        ;                          (CX)     NUMBER OF WORDS TO MOVE                  :
                        ;                          (ES:SI)  POINTER TO DESCRIPTOR TABLE              :
                        ;                                                                            :
                        ;           (AH) = 88H   EXTENDED MEMORY SIZE DETERMINE                      :
                        ;                                                                            :
                        ;           (AH) = 89H   PROCESSOR TO VIRTUAL MODE                           :
                        ;                                                                            :
                        ;           (AH) = 90H    DEVICE BUSY LOOP                                   :
                        ;                          (AL)   SEE TYPE CODE                              :
                        ;                                                                            :
                        ;           (AH) = 91H    INTERRUPT COMPLETE FLAG SET                        :
                        ;                          (AL)   TYPE CODE                                  :
                        ;                          00H -> 7FH                                        :
                        ;                                 SERIALLY REUSABLE DEVICES                  :
                        ;                                 OPERATING SYSTEM MUST SERIALIZE ACCESS     :
                        ;                          80H -> BFH                                        :
                        ;                                 REENTRANT DEVICES; ES:BX IS USED TO        :
                        ;                                 DISTINGUISH DIFFERENT CALLS (MULTIPLE I/O  :
                        ;                                 CALLS ARE ALLOWED SIMULTANEOUSLY)          :
                        ;                          C0H -> FFH                                        :
                        ;                                 WAIT ONLY CALLS -- THERE IS NO             :
                        ;                                 COMPLEMENTARY 'POST' FOR THESE WAITS.      :
                        ;                                 THESE ARE TIMEOUT ONLY.  TIMES ARE         :
                        ;                                 FUNCTION NUMBER DEPENDENT.                 :
                        ;                                                                            :
                        ;                          TYPE  DESCRIPTION              TIMEOUT            :
                        ;                                                                            :
                        ;                          00H = DISK                     YES                :
                        ;                          01H = DISKETTE                 YES                :
                        ;                          02H = KEYBOARD                 NO                 :
                        ;                          80H = NETWORK                  NO                 :
                        ;                                ES:BX --> NCB                               :
                        ;                          FDH = DISKETTE MOTOR START     YES                :
                        ;                          FEH = PRINTER                  YES                :
                        ;                                                                            :
                                PAGE
                                ;         (AH) = C0H   RETURN CONFIGURATION PARAMETERS POINTER              ;
                                ;                        RETURNS                                            ;
                                ;                          (AH) = 00H AND CY= 0 (IF PRESENT ELSE 86 AND CY= 1)  ;
                                ;                          (ES:BX) = PARAMETER TABLE ADDRESS POINTER        ;
                                ;                                    WHERE:                                 ;
                                ;                                                                           ;
                                ;                   DW    8             LENGTH OF FOLLOWING TABLE           ;
                                ;                   DB    MODEL_BYTE    SYSTEM MODEL BYTE                   ;
                                ;                   DB    TYPE_BYTE     SYSTEM MODEL TYPE BYTE              ;
                                ;                   DB    BIOS_LEVEL    BIOS REVISION LEVEL                 ;
                                ;                   DB    ?             10000000 = DMA CHANNEL 3 USE BY BIOS ;
                                ;                                       01000000 = CASCADED INTERRUPT LEVEL 2 ;
                                ;                                       00100000 = REAL TIME CLOCK AVAILABLE ;
                                ;                                       00010000 = KEYBOARD SCAN CODE HOOK 1AH ;
                                ;                   DB    0             RESERVED                            ;
                                ;                   DB    0             RESERVED                            ;
                                ;                   DB    0             RESERVED                            ;
                                ;                   DB    0             RESERVED                            ;
                                ;                                                                           ;
                                ;----------------------------------------------------------------------------

                                        ASSUME  CS:CODE

 0000                           CASSETTE_IO_1   PROC    FAR
 0000 FB                                STI                     ; ENABLE INTERRUPTS
 0001 80 FC 80                          CMP     AH,080H         ; CHECK FOR RANGE
 0004 72 4C                             JB      C1              ; RETURN IF 00-7FH
 0006 80 FC C0                          CMP     AH,0C0H         ; CHECK FOR CONFIGURATION PARAMETERS
 0009 74 4F                             JE      CONF_PARMS
 000B 80 EC 80                          SUB     AH,080H         ; BASE ON 0
 000E 74 48                             JZ      DEV_OPEN        ; DEVICE OPEN
 0010 FE CC                             DEC     AH
 0012 74 44                             JZ      DEV_CLOSE       ; DEVICE CLOSE
 0014 FE CC                             DEC     AH
 0016 74 40                             JZ      PROG_TERM       ; PROGRAM TERMINATION
 0018 FE CC                             DEC     AH
 001A 74 47                             JZ      EVENT_WAIT      ; EVENT WAIT
 001C FE CC                             DEC     AH
 001E 75 03                             JNZ     NOT_JOYSTICK
 0020 E9 00DB R                         JMP     JOY_STICK       ; JOYSTICK BIOS
 0023                           NOT_JOYSTICK:
 0023 FE CC                             DEC     AH
 0025 74 31                             JZ      SYS_REQ         ; SYSTEM REQUEST KEY
 0027 FE CC                             DEC     AH
 0029 74 07                             JZ      C1_A            ; WAIT
 002B FE CC                             DEC     AH
 002D 75 06                             JNZ     C1_B
 002F E9 01D6 R                         JMP     BLOCKMOVE       ; MOVE BLOCK

 0032 E9 0175 R                 C1_A:   JMP     WAIT            ; WAIT

 0035 FE CC                     C1_B:   DEC     AH

 0037 75 03                             JNZ     C1_C
 0039 E9 03FC R                         JMP     EXT_MEMORY      ; GO GET THE EXTENDED MEMORY

 003C FE CC                     C1_C:   DEC     AH
 003E 75 03                             JNZ     C1_D            ; CHECK FOR FUNCTION 89H
 0040 E9 0408 R                         JMP     SET_VMODE       ; SWAP TO VIRTUAL MODE

 0043 80 EC 07                  C1_D:   SUB     AH,7            ; CHECK FOR FUNCTION 90H
 0046 75 03                             JNZ     C1_E            ; GO IF NOT
 0048 E9 0491 R                         JMP     DEVICE_BUSY

 004B FE CC                     C1_E:   DEC     AH              ; CHECK FOR FUNCTION 91H
 004D 75 03                             JNZ     C1              ; GO IF NOT
 004F E9 0495 R                         JMP     INT_COMPLETE

 0052 B4 86                     C1:     MOV     AH,86H          ; SET BAD COMMAND
 0054 F9                                STC                     ; SET CARRY FLAG ON
 0055                           C1_F:
 0055 CA 0002                           RET     2               ; FAR RETURN EXIT FROM ROUTINES


 0058                           DEV_OPEN:                       ; NULL HANDLERS

 0058                           DEV_CLOSE:

 0058                           PROG_TERM:

 0058                           SYS_REQ:
 0058 EB FB                             JMP     C1_F            ; RETURN
 005A                           CASSETTE_IO_1   ENDP

 005A                           CONF_PARMS      PROC    NEAR
 005A 0E                                PUSH    CS              ; GET CODE SEGMENT
 005B 07                                POP     ES              ; PLACE IN SELECTOR POINTER
 005C BB 0000 E                         MOV     BX,OFFSET CONF_TBL ; GET OFFSET OF PARAMETER TABLE
 005F 32 E4                             XOR     AH,AH           ; CLEAR AH AND SET CARRY OFF
 0061 EB F2                             JMP     C1_F            ; EXIT THROUGH COMMON RETURN
 0063                           CONF_PARMS      ENDP

 0063                           EVENT_WAIT      PROC    NEAR
                                        ASSUME  DS:DATA
 0063 1E                                PUSH    DS              ; SAVE
 0064 E8 0000 E                         CALL    DDS
 0067 0A C0                             OR      AL,AL
 0069 74 08                             JZ      EVENT_WAIT_2    ; GO IF ZERO
 006B FE C8                             DEC     AL              ; CHECK IF 1
 006D 74 45                             JZ      EVENT_WAIT_3
 006F 1F                                POP     DS              ; RESTORE DATA SEGMENT
 0070 F9                                STC                     ; SET CARRY
 0071 EB E2                             JMP     C1_F            ; EXIT

 0073                           EVENT_WAIT_2:
 0073 FA                                CLI                     ; NO INTERRUPTS ALLOWED
 0074 F6 06 00A0 R 01                   TEST    @RTC_WAIT_FLAG,01 ; CHECK FOR FUNCTION ACTIVE
 0079 74 05                             JZ      EVENT_WAIT_1
 007B FB                                STI                     ; ENABLE INTERRUPTS
 007C 1F                                POP     DS
 007D F9                                STC                     ; SET ERROR
 007E EB D5                             JMP     C1_F            ; RETURN
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SECTION 5

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 0080                         EVENT_WAIT_1:
 0080 E4 A1                         IN      AL,INTB01               ; ENSURE INTERRUPT UNMASKED
 0082 EB 00                         JMP     $+2
 0084 24 FE                         AND     AL,0FEH
 0086 E6 A1                         OUT     INTB01,AL
 0088 8C 06 009A R                  MOV     @USER_FLAG_SEG,ES       ; SET UP TRANSFER TABLE
 008C 89 1E 0098 R                  MOV     @USER_FLAG,BX
 0090 89 0E 009E R                  MOV     @RTC_HIGH,CX
 0094 89 16 009C R                  MOV     @RTC_LOW,DX
 0098 C6 06 00A0 R 01               MOV     @RTC_WAIT_FLAG,01       ; SET ON FUNCTION ACTIVE SWITCH
 009D B0 0B                         MOV     AL,CMOS_REG_B           ; ENABLE PIE
 009F E8 0000 E                     CALL    CMOS_READ               ; READ CMOS LOCATION
 00A2 24 7F                         AND     AL,07FH                 ; CLEAR SET
 00A4 0C 40                         OR      AL,040H                 ; ENABLE PIE
 00A6 50                            PUSH    AX                      ; SAVE AH
 00A7 8A E0                         MOV     AH,AL                   ; PLACE DATA INTO DATA REGISTER
 00A9 B0 0B                         MOV     AL,CMOS_REG_B           ; ADDRESS ALARM REGISTER
 00AB E8 0000 E                     CALL    CMOS_WRITE              ; PLACE DATA IN AH INTO ALARM REGISTER
 00AE 58                            POP     AX                      ; RESTORE AH
 00AF 1F                            POP     DS
 00B0 FB                            STI                             ; ENABLE INTERRUPTS
 00B1 F8                            CLC                             ; CLEAR CARRY
 00B2 EB A1                         JMP     C1_F

                              ;----- CANCEL

 00B4                         EVENT_WAIT_3:
 00B4 FA                            CLI                             ; DISABLE INTERRUPTS
 00B5 F6 06 00A0 R 02               TEST    @RTC_WAIT_FLAG,02H      ; CHECK FOR "WAIT" IN PROGRESS
 00BA 74 05                         JZ      EVENT_WAIT_4            ; SKIP TO CANCEL CURRENT "EVENT_WAIT"

 00BC FB                            STI                             ; ENABLE INTERRUPTS
 00BD 1F                            POP     DS                      ; CLEAR STACK
 00BE F9                            STC                             ; AND SET CARRY FLAG FOR ERROR REQUEST
 00BF EB 94                         JMP     C1_F                    ; EXIT

 00C1                         EVENT_WAIT_4:
 00C1 50                            PUSH    AX                      ; SAVE (WITH INTERRUPTS DISABLED)
 00C2 B8 0B0B                       MOV     AX,X*CMOS_REG_B         ; TURN OFF PIE
 00C5 E8 0000 E                     CALL    CMOS_READ               ; GET ALARM REGISTER
 00C8 24 BF                         AND     AL,0BFH                 ; CLEAR PIE
 00CA 86 E0                         XCHG    AH,AL                   ; PLACE INTO WRITE REGISTER
 00CC E8 0000 E                     CALL    CMOS_WRITE              ; WRITE BACK TO ALARM REGISTER
 00CF 58                            POP     AX                      ; RESTORE AH
 00D0 C6 06 00A0 R 00               MOV     @RTC_WAIT_FLAG,0        ; SET FUNCTION ACTIVE FLAG OFF
 00D5 FB                            STI                             ; ENABLE INTERRUPTS
 00D6 1F                            POP     DS                      ; RESTORE DATA SEGMENT
 00D7 F8                            CLC                             ; SET CARRY OFF
 00D8 E9 0055 R                     JMP     C1_F                    ; RETURN

 00DB                         EVENT_WAIT        ENDP
                              ;--- JOY_STICK ------------------------------------------------
                              ;           THIS ROUTINE WILL READ THE JOYSTICK PORT            :
                              ;                                                               :
                              ;           INPUT                                               :
                              ;           (DX)=0 READ THE CURRENT SWITCHES                    :
                              ;                  RETURNS (AL)= SWITCH SETTINGS IN BITS 7-4    :
                              ;                                                               :
                              ;           (DX)=1  READ THE RESISTIVE INPUTS                   :
                              ;                   RETURNS (AX)=A(x) VALUE                     :
                              ;                           (BX)=A(y) VALUE                     :
                              ;                           (CX)=B(x) VALUE                     :
                              ;                           (DX)=B(y) VALUE                     :
                              ;                                                               :
                              ;           CY FLAG ON IF NO ADAPTER CARD OR INVALID CALL       :
                              ;---------------------------------------------------------------

 00DB                         JOY_STICK         PROC    NEAR
 00DB FB                            STI                             ; INTERRUPTS BACK ON
 00DC 8B C2                         MOV     AX,DX                   ; GET SUB FUNCTION CODE
 00DE BA 0201                       MOV     DX,201H                 ; ADDRESS OF PORT
 00E1 0A C0                         OR      AL,AL
 00E3 74 0B                         JZ      JOY_2                   ; READ SWITCHES
 00E5 FE C8                         DEC     AL
 00E7 74 0C                         JZ      JOY_3                   ; READ RESISTIVE INPUTS
 00E9 E9 0052 R                     JMP     C1                      ; GO TO ERROR RETURN
 00EC                         JOY_1:
 00EC FB                            STI
 00ED E9 0055 R                     JMP     C1_F                    ; GO TO COMMON RETURN

 00F0                         JOY_2:
 00F0 EC                            IN      AL,DX
 00F1 24 F0                         AND     AL,0F0H                 ; STRIP UNWANTED BITS OFF
 00F3 EB F7                         JMP     JOY_1                   ; FINISHED

 00F5                         JOY_3:
 00F5 B3 01                         MOV     BL,1
 00F7 E8 0113 R                     CALL    TEST_CORD
 00FA 51                            PUSH    CX                      ; SAVE A(X) VALUE
 00FB B3 02                         MOV     BL,2
 00FD E8 0113 R                     CALL    TEST_CORD
 0100 51                            PUSH    CX                      ; SAVE A(Y) VALUE
 0101 B3 04                         MOV     BL,4
 0103 E8 0113 R                     CALL    TEST_CORD
 0106 51                            PUSH    CX                      ; SAVE B(X) VALUE
 0107 B3 08                         MOV     BL,8
 0109 E8 0113 R                     CALL    TEST_CORD
 010C 8B D1                         MOV     DX,CX                   ; SAVE B(Y) VALUE
 010E 59                            POP     CX                      ; GET B(X) VALUE
 010F 5B                            POP     BX                      ; GET A(Y) VALUE
 0110 58                            POP     AX                      ; GET A(X) VALUE
 0111 EB D9                         JMP     JOY_1                   ; FINISHED - RETURN

 0113                         TEST_CORD         PROC  NEAR
 0113 52                            PUSH    DX                      ; SAVE
 0114 FA                            CLI                             ; BLOCK INTERRUPTS WHILE READING
 0115 B0 00                         MOV     AL,0                    ; SET UP TO LATCH TIMER 0
 0117 E6 43                         OUT     TIMER+3,AL
 0119 EB 00                         JMP     $+2
 011B E4 40                         IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
 011D EB 00                         JMP     $+2
 011F 8A E0                         MOV     AH,AL
 0121 E4 40                         IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
 0123 86 E0                         XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW
```

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0125 50                                   PUSH    AX                       ; SAVE
0126 B9 04FF                              MOV     CX,4FFH                  ; SET COUNT
0129 EE                                   OUT     DX,AL                    ; FIRE TIMER
012A EB 00                                JMP     $+2
012C                            TEST_CORD_1:
012C EC                                   IN      AL,DX                    ; READ VALUES
012D 84 C3                                TEST    AL,BL                    ; HAS PULSE ENDED?
012F E0 FB                                LOOPNZ  TEST_CORD_1
0131 83 F9 00                             CMP     CX,0
0134 59                                   POP     CX                       ; ORIGINAL COUNT
0135 75 04                                JNZ     SHORT TEST_CORD_2
0137 2B C9                                SUB     CX,CX                    ; SET 0 COUNT FOR RETURN
0139 EB 28                                JMP     SHORT TEST_CORD_3        ; EXIT WITH COUNT = 0
013B                            TEST_CORD_2:
013B B0 00                                MOV     AL,0                     ; SET UP TO LATCH TIMER 0
013D E6 43                                OUT     TIMER+3,AL
013F EB 00                                JMP     $+2
0141 E4 40                                IN      AL,TIMER                 ; READ LOW BYTE OF TIMER 0
0143 8A E0                                MOV     AH,AL
0145 EB 00                                JMP     $+2
0147 E4 40                                IN      AL,TIMER                 ; READ HIGH BYTE OF TIMER 0
0149 86 E0                                XCHG    AH,AL                    ; REARRANGE TO HIGH,LOW

014B 3B C8                                CMP     CX,AX                    ; CHECK FOR COUNTER WRAP
014D 73 0B                                JAE     TEST_CORD_4              ; GO IF NO
014F 52                                   PUSH    DX
0150 BA FFFF                              MOV     DX,-1

0153 2B D0                                SUB     DX,AX                    ; ADJUST FOR WRAP
0155 03 CA                                ADD     CX,DX
0157 5A                                   POP     DX
0158 EB 02                                JMP     SHORT TEST_CORD_5

015A                            TEST_CORD_4:
015A 2B C8                                SUB     CX,AX
015C                            TEST_CORD_5:
015C 81 E1 1FF0                           AND     CX,1FF0H                 ; ADJUST
0160 C1 E9 04                             SHR     CX,4

0163                            TEST_CORD_3:
0163 FB                                   STI                              ; INTERRUPTS BACK ON
0164 BA 0201                              MOV     DX,201H                  ; FLUSH OTHER INPUTS
0167 51                                   PUSH    CX
0168 50                                   PUSH    AX
0169 B9 04FF                              MOV     CX,4FFH                  ; COUNT
016C                            TEST_CORD_6:
016C EC                                   IN      AL,DX
016D A8 0F                                TEST    AL,0FH
016F E0 FB                                LOOPNZ  TEST_CORD_6

0171 58                                   POP     AX
0172 59                                   POP     CX
0173 5A                                   POP     DX                       ; SET COUNT

0174 C3                                   RET                              ; RETURN

0175                            TEST_CORD         ENDP
0175                            JOY_STICK         ENDP

0175                            WAIT      PROC    NEAR
0175 1E                                   PUSH    DS                       ; SAVE
0176 E8 0000 E                            CALL    DDS
0179 FA                                   CLI                              ; NO INTERRUPTS ALLOWED
017A F6 06 00A0 R 01                      TEST    @RTC_WAIT_FLAG,01        ; TEST FOR FUNCTION ACTIVE
017F 74 06                                JZ      WAIT_1
0181 FB                                   STI                              ; ENABLE INTERRUPTS PRIOR TO RETURN
0182 1F                                   POP     DS
0183 F9                                   STC                              ; SET ERROR
0184 E9 0055 R                            JMP     C1_F                     ; RETURN
0187                            WAIT_1:
0187 E4 A1                                IN      AL,INTB01                ; ENSURE INTERRUPT UNMASKED
0189 EB 00                                JMP     $+2
018B 24 FE                                AND     AL,0FEH
018D E6 A1                                OUT     INTB01,AL
018F 8C 1E 009A R                         MOV     @USER_FLAG_SEG,DS        ; SET UP TRANSFER TABLE
0193 C7 06 0098 R 00A0 R                  MOV     @USER_FLAG,OFFSET @RTC_WAIT_FLAG
0199 89 0E 009E R                         MOV     @RTC_HIGH,CX
019D 89 16 009C R                         MOV     @RTC_LOW,DX
01A1 C6 06 00A0 R 03                      MOV     @RTC_WAIT_FLAG,03        ; SET ON "WAIT" FUNCTION ACTIVE SWITCHES
01A6 50                                   PUSH    AX                       ; SAVE (AH)
01A7 B8 0B0B                              MOV     AX,X*CMOS_REG_B          ; ENABLE PIE
01AA E8 0000 E                            CALL    CMOS_READ                ; READ ALARM BYTE
01AD 24 7F                                AND     AL,07FH                  ; CLEAR SIT BIT
01AF 0C 40                                OR      AL,040H                  ; ENABLE PIE BIT
01B1 86 E0                                XCHG    AH,AL                    ; DATA TO WORK REGISTER
01B3 E8 0000 E                            CALL    CMOS_WRITE               ; WRITE NEW ALARM BYTE
01B6 58                                   POP     AX                       ; RESTORE (AH)

                                ;-----  WAIT TILL RTC TIMEOUT POSTED     (WITH ERROR TIMEOUT)

01B7 FB                                   STI                              ; ENABLE INTERRUPTS
01B8 51                                   PUSH    CX
01B9 52                                   PUSH    DX                       ; SAVE CALLERS PARAMETERS
01BA 87 D1                                XCHG    DX,CX                    ; SWAP COUNT WORK REGISTERS
01BC                            WAIT_2:
01BC F6 06 00A0 R 80                      TEST    @RTC_WAIT_FLAG,080H      ; CHECK FOR END OF WAIT - CLEAR CARRY
01C1 E1 F9                                LOOPZ   WAIT_2                   ; DECREMENT TIMEOUT DELAY TILL WAIT END
01C3 75 05                                JNZ     WAIT_9                   ; EXIT IF RTC TIMER WAIT ENDED FLAG SET
01C5 83 EA 01                             SUB     DX,1                     ; DECREMENT ERROR TIMEOUT COUNTER
01C8 73 F2                                JNC     WAIT_2                   ; LOOP TILL COUNTERS TIMEOUT
01CA                            WAIT_9:
01CA C6 06 00A0 R 00                      MOV     @RTC_WAIT_FLAG,0         ; SET FUNCTION INACTIVE
01CF 5A                                   POP     DX
01D0 59                                   POP     CX                       ; RESTORE CALLERS PARAMETERS
01D1 1F                                   POP     DS
01D2 F8                                   CLC                              ; CLEAR CARRY FLAG
01D3 E9 0055 R                            JMP     C1_F

01D6                            WAIT      ENDP
```

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                                PAGE
                                ;--- INT  15 H -- ( FUNCTION 87 H - BLOCK MOVE ) ------------------------------
                                ;                                                                             :
                                ;       THIS BIOS FUNCTION PROVIDES A MEANS FOR A REAL MODE PROGRAM OR SYSTEM :
                                ;       TO TRANSFER A BLOCK OF STORAGE TO AND FROM STORAGE ABOVE THE 1 MEG    :
                                ;       ADDRESS RANGE IN PROTECTED MODE SPACE BY SWITCHING TO PROTECTED MODE. :
                                ;                                                                             :
                                ; ENTRY:                                                                      :
                                ;       (AH) =  87H (FUNCTION CALL) - BLOCK MOVE.                            :
                                ;       (CX) =  WORD COUNT OF STORAGE BLOCK TO BE MOVED.                     :
                                ;               NOTE: MAX COUNT = 8000H FOR 32K WORDS (65K BYTES)            :
                                ;       ES:SI = LOCATION OF A GDT TABLE BUILT BY ROUTINE USING THIS FUNCTION. :
                                ;                                                                             :
                                ;       (ES:SI) POINTS TO A DESCRIPTOR TABLE (GDT) BUILT BEFORE INTERRUPTING  :
                                ;       TO THIS FUNCTION.  THE DESCRIPTORS ARE USE TO PERFORM THE BLOCK       :
                                ;       MOVE IN THE PROTECTED MODE.  THE SOURCE AND TARGET DESCRIPTORS        :
                                ;       BUILT BY THE USER MUST HAVE A SEGMENT LENGTH = 2 * CX-1 OR GREATER.   :
                                ;       THE DATA ACCESS RIGHTS BYTE MUST BE SET TO CPL0-R/W (93H).  THE       :
                                ;       24 BIT ADDRESS (BYTE HI, WORD LOW) MUST BE SET TO THE TARGET/SOURCE.  :
                                ;                                                                             :
                                ;       ***  NO INTERRUPTS ARE ALLOWED DURING TRANSFER.  LARGE BLOCK MOVES    :
                                ;            MAY CAUSE LOST INTERRUPTS.                                       :
                                ;                                                                             :
                                ; EXIT:                                                                       :
                                ;       (AH) = 00H  IF SUCCESSFUL                                             :
                                ;       (AH) = 01H  IF MEMORY PARITY (PARITY ERROR REGISTERS ARE CLEARED)     :
                                ;       (AH) = 02H  IF ANY OTHER EXCEPTION INTERRUPT ERROR OCCURRED           :
                                ;       (AH) = 03H  IF GATE ADDRESS LINE 20 FAILED                            :
                                ;                 ALL REGISTERS ARE RESTORED EXCEPT (AH).                     :
                                ;                                                                             :
                                ;       IF SUCCESSFUL - CARRY FLAG = 0                                        :
                                ;       IF ERROR ------ CARRY FLAG = 1                                        :
                                ;                                                                             :
                                ; DESCRIPTION:                                                                :
                                ;                                                                             :
                                ;        1.  SAVE ENTRY REGISTERS AND SETUP FOR SHUTDOWN EXIT.                :
                                ;        2.  THE REQUIRED ENTRIES ARE BUILT IN THE GDT AT (ES:SI).            :
                                ;        3.  GATE ADDRESS LINE 20 ACTIVE, CLI AND SET SHUTDOWN CODES.         :
                                ;        4.  THE IDTR IS LOADED AND POINTS TO A ROM RESIDENT TABLE.           :
                                ;        5.  THE GDTR IS LOADED FROM THE OFFSET POINTER (ES:SI).              :
                                ;        6.  THE PROCESSOR IS PUT INTO PROTECTED MODE.                        :
                                ;        7.  LOAD (DS) AND (ES) WITH SELECTORS FOR THE SOURCE AND TARGET.     :
                                ;        8.  DS:SI (SOURCE) (ES:DI) (TARGET) REP MOVSW IS EXECUTED.           :
                                ;        9.  CHECK MADE FOR PARITY ERRORS.                                    :
                                ;       10.  REAL MODE RESTORED WHEN SHUTDOWN 09H IS EXECUTED.                :
                                ;       11.  ERRORS ARE CHECKED FOR AND RETURN CODES ARE SET FOR (AH).        :
                                ;       12.  ADDRESS LINE 20 GATE IS DISABLED.                                :
                                ;       13.  RETURN WITH REGISTERS RESTORED AND STATUS RETURN CODE.           :
                                ;             (FOR PC-AT COMPATIBILITY ZF=1 IF SUCCESSFUL, ZF=0 IF ERROR.)    :
                                ;------------------------------------------------------------------------------
                                ;
                                ;       THE FOLLOWING DIAGRAM DEPICTS THE ORGANIZATION OF A BLOCK MOVE GDT.
                                ;------------------------------------------------------------------------------
                                ;                 G D T                                                       :
                                ; (ES:SI)                                                                     :
                                ;    |             .-----------.                                              :
                                ;    |             v           |                                              :
                                ;   +00 .----------------.     |                                              :
                                ;       |                |     |                                              :
                                ;       |     DUMMY      |     |   1. THE FIRST DESCRIPTOR IS THE REQUIRED DUMMY. :
                                ;       |                |     |       (USER INITIALIZED TO 0)                :
                                ;   +08 |----------------|     |                                              :
                                ;       |    GDT LOC     |   --'   2. THE SECOND DESCRIPTOR POINTS TO THE GDT :
                                ;       |                |          TABLE AS A DATA SEGMENT.                  :
                                ;   +10 |----------------|           (USER INITIALIZED TO 0 - MODIFIED BY BIOS) :
                                ;       |     SOURCE     |       3. THE THIRD DESCRIPTOR POINTS TO THE SOURCE :
                                ;       |      GDT       |          TO BE MOVED. (FROM)                       :
                                ;   +18 |----------------|           (USER INITIALIZED)                       :
                                ;       |     TARGET     |       4. THE FOURTH DESCRIPTOR POINTS TO THE       :
                                ;       |      GDT       |          DESTINATION SEGMENT. (TO)                 :
                                ;   +20 |----------------|           (USER INITIALIZED)                       :
                                ;       |      BIOS      |       5. THE FIFTH IS A DESCRIPTOR THAT BIOS USES  :
                                ;       |      (CS)      |          TO CREATE THE PROTECTED MODE CODE SEGMENT. :
                                ;   +28 |----------------|           (USER INITIALIZED TO 0 - MODIFIED BY BIOS) :
                                ;       |      (SS)      |       6. THE SIXTH DESCRIPTOR IS USED BY BIOS TO   :
                                ;       |                |          CREATE A PROTECTED MODE STACK SEGMENT.    :
                                ;       '----------------'           (USER INITIALIZED TO 0 - MODIFIED BY BIOS) :
                                ;                                   (POINTS TO USERS STACK)                   :
                                ;                                                                             :
                                ;                                                                             :
                                ;          SAMPLE  OF  SOURCE  OR  TARGET  DESCRIPTOR                         :
                                ;                                                                             :
                                ;       SOURCE_TARGET_DEF      STRUC                                          :
                                ;                                                                             :
                                ;         SEG_LIMIT        DW      ?   ; SEGMENT LIMIT (1-65536 BYTES)        :
                                ;         LO_WORD          DW      ?   ; 24 BIT SEGMENT PHYSICAL              :
                                ;         HI_BYTE          DB      ?   ;    ADDRESS (0 TO (16M-1))            :
                                ;         DATA_ACC_RIGHTS  DB      93H ; ACCESS RIGHTS BYTE (CPL0-R/W)        :
                                ;         RESERVED         DW      0   ; RESERVED WORD (MUST BE ZERO)         :
                                ;                                                                             :
                                ;       SOURCE_TARGET_DEF      ENDS                                           :
                                ;                                                                             :
                                ;------------------------------------------------------------------------------
                                ;
                                ;     THE GLOBAL DESCRIPTOR TABLE (ACTUAL LOCATION POINTED TO BY ES:SI)

                                BLOCKMOVE_GDT_DEF       STRUC
 0000 ????????????????                          DQ      ?               ; FIRST DESCRIPTOR NOT ACCESSIBLE
 0008 ????????????????          CGDT_LOC        DQ      ?               ; LOCATION OF CALLING ROUTINE GDT
 0010 ????????????????          SOURCE          DQ      ?               ; SOURCE DESCRIPTOR
 0018 ????????????????          TARGET          DQ      ?               ; TARGET DESCRIPTOR
 0020 ????????????????          BIOS_CS         DQ      ?               ; BIOS CODE DESCRIPTOR
 0028 ????????????????          TEMP_SS         DQ      ?               ; STACK DESCRIPTOR
 0030                           BLOCKMOVE_GDT_DEF       ENDS

 01D6                           BLOCKMOVE       PROC    NEAR

 01D6  FC                               CLD                             ; SET DIRECTION FORWARD
 01D7  60                               PUSHA                           ; SAVE GENERAL PURPOSE REGISTERS
 01D8  06                               PUSH    ES                      ; SAVE USERS EXTRA SEGMENT
 01D9  1E                               PUSH    DS                      ; SAVE USERS DATA SEGMENT

                                ;-----  SAVE THE CALLING ROUTINE'S STACK

 01DA  E8 0000 E                        CALL    DDS                     ; SET DS TO DATA AREA
 01DD 8C 16 0069 R                MOV     @IO_ROM_SEG,SS          ; SAVE USERS STACK SEGMENT
 01E1 89 26 0067 R                MOV     @IO_ROM_INIT,SP         ; SAVE USERS STACK POINTER

                          ;=====  SET UP THE PROTECTED MODE DEFINITIONS  =====

                          ;-----  MAKE A 24 BIT ADDRESS OUT OF THE ES:SI FOR THE GDT POINTER

                                  ASSUME  DS:NOTHING              ; POINT (DS) TO USERS CONTROL BLOCK
 01E5 8C C0                       MOV     AX,ES                   ; GET THE GDT DATA SEGMENT
 01E7 8E D8                       MOV     DS,AX                   ; MOVE THE GDT SEGMENT POINTER TO (DS)
 01E9 8A F4                       MOV     DH,AH                   ; BUILD HIGH BYTE OF THE 24 BIT ADDRESS
 01EB C0 EE 04                    SHR     DH,4                    ; USE ONLY HIGH NIBBLE SHIFT - RIGHT 4
 01EE C1 E0 04                    SHL     AX,4                    ; STRIP HIGH NIBBLE FROM (AX)
 01F1 03 C6                       ADD     AX,SI                   ; ADD THE GDT OFFSET TO DEVELOP LOW WORD
 01F3 80 D6 00                    ADC     DH,0                    ; ADJUST HIGH BYTE IF CARRY FROM LOW

                          ;-----  SET THE GDT_LOC

 01F6 C7 44 08 FFFF               MOV     [SI].CGDT_LOC.SEG_LIMIT,MAX_SEG_LEN
 01FB 89 44 0A                    MOV     [SI].CGDT_LOC.BASE_LO_WORD,AX   ; SET THE LOW WORD
 01FE 88 74 0C                    MOV     [SI].CGDT_LOC.BASE_HI_BYTE,DH   ; SET THE HIGH BYTE
 0201 C7 44 0E 0000               MOV     [SI].CGDT_LOC.DATA_RESERVED,0   ; RESERVED

                          ;-----  SET UP THE CODE SEGMENT DESCRIPTOR

 0206 C7 44 20 FFFF               MOV     [SI].BIOS_CS.SEG_LIMIT,MAX_SEG_LEN
 020B C7 44 22 0000               MOV     [SI].BIOS_CS.BASE_LO_WORD,CSEG@_LO      ; LOW WORD OF (CS)= 0
 0210 C6 44 24 0F                 MOV     [SI].BIOS_CS.BASE_HI_BYTE,CSEG@_HI      ; HIGH BYTE OF (CS)= 0FH
 0214 C6 44 25 9B                 MOV     [SI].BIOS_CS.DATA_ACC_RIGHTS,CPL0_CODE_ACCESS
 0218 C7 44 26 0000               MOV     [SI].BIOS_CS.DATA_RESERVED,0            ; RESERVED

                          ;-----  MAKE A 24 BIT ADDRESS OUT OF THE (SS) - ( (SP) REMAINS USER (SP) )

 021D 8C D0                       MOV     AX,SS                   ; GET THE CURRENT STACK SEGMENT
 021F 8A F4                       MOV     DH,AH                   ; FORM HIGH BYTE OF 24 BIT ADDRESS
 0221 C0 EE 04                    SHR     DH,4                    ; FORM HIGH BYTE - SHIFT RIGHT 4
 0224 C1 E0 04                    SHL     AX,4                    ; STRIP HIGH NIBBLE FROM (AX)

                          ;-----  SS IS NOW IN POSITION FOR A 24 BIT ADDRESS --> SETUP THE (SS) DESCRIPTOR

 0227 C7 44 28 FFFF               MOV     [SI].TEMP_SS.SEG_LIMIT,MAX_SEG_LEN    ; SET THE SS SEGMENT LIMIT
 022C 89 44 2A                    MOV     [SI].TEMP_SS.BASE_LO_WORD,AX          ; SET THE LOW WORD
 022F 88 74 2C                    MOV     [SI].TEMP_SS.BASE_HI_BYTE,DH          ; SET THE HIGH BYTE
 0232 C6 44 2D 93                 MOV     [SI].TEMP_SS.DATA_ACC_RIGHTS,CPL0_DATA_ACCESS   ; SET CPL 0

                          ;-----  GATE ADDRESS BIT 20 ON  (DISABLE INTERRUPTS)

 0236 B4 DF                       MOV     AH,ENABLE_BIT20         ; GET ENABLE MASK
 0238 E8 03DA R                   CALL    GATE_A20                ; ENABLE A20 AND CLEAR INTERRUPTS
 023B 3C 00                       CMP     AL,0                    ; WAS THE COMMAND ACCEPTED?
 023D 74 06                       JZ      BL4                     ; GO IF YES

 023F B0 03                       MOV     AL,03H                  ; SET THE ERROR FLAG IF NOT
 0241 E6 80                       OUT     MFG_PORT,AL
 0243 EB 51                       JMP     SHORT SHUT9             ; EARLY ERROR EXIT

                          ;-----  SET SHUTDOWN RETURN ADDRESS AND DISABLE NMI

 0245                     BL4:
 0245 B8 098F                     MOV     AX,9*H+CMOS_SHUT_DOWN+NMI       ; SET THE SHUTDOWN BYTE LOCATION
 0248 E8 0000 E                   CALL    CMOS_WRITE                      ; TO SHUT DOWN 9 AND DISABLE NMI

                          ;-----  CLEAR EXCEPTION ERROR FLAG

 024B 2A C0                       SUB     AL,AL
 024D E6 80                       OUT     MFG_PORT,AL             ; SET ERROR FLAG LOCATION TO 0

                          ;-----  LOAD THE IDT AND GDT

 024F BD 02D4 R                   MOV     BP,OFFSET ROM_IDT_LOC
                                  SEGOV   CS                      ; LOAD THE IDT
 0252 2E                  +       DB      02EH
                                  LIDT    [BP]                    ;   REGISTER FROM THIS AREA
 0253 0F                  +       DB      00FH
 0254                     + ??0001 LABEL  BYTE
 0254 8B 5E 00            +       MOV     BX,WORD PTR [BP]
 0257                     + ??0002 LABEL  BYTE
 0254                     +       ORG     OFFSET CS:??0001
 0254 01                  +       DB      001H
 0257                     +       ORG     OFFSET CS:??0002

                                  LGDT    [SI].CGDT_LOC           ; LOAD GLOBAL DESCRIPTOR TABLE REGISTER
 0257 0F                  +       DB      00FH
 0258                     + ??0003 LABEL  BYTE
 0258 8B 54 08            +       MOV     DX,WORD PTR [SI].CGDT_LOC
 025B                     + ??0004 LABEL  BYTE
 0258                     +       ORG     OFFSET CS:??0003
 0258 01                  +       DB      001H
 025B                     +       ORG     OFFSET CS:??0004


                          ;-----  SWITCH TO VIRTUAL MODE

 025B B8 0001                     MOV     AX,VIRTUAL_ENABLE       ; MACHINE STATUS WORD NEEDED TO
                                  LMSW    AX                      ;  SWITCH TO VIRTUAL MODE
 025E 0F 01 F0            +       DB      00FH,001H,0F0H
 0261 EA                           DB     0EAH                    ; PURGE PRE-FETCH QUEUE WITH FAR JUMP
 0262 0266 R                       DW     OFFSET VIRT             ;  - TO OFFSET
 0264 0020                         DW     BIOS_CS                 ;  - IN SEGMENT -PROTECTED MODE SELECTOR
 0266                     VIRT:

                          ;-----  IN PROTECTED MODE - SETUP STACK SELECTOR AND SOURCE/TARGET SELECTORS

 0266 B8 0028                     MOV     AX,TEMP_SS              ; USER'S SS+SP IS NOT A DESCRIPTOR
 0269 8E D0                       MOV     SS,AX                   ; LOAD STACK SELECTOR
 026B B8 0010                     MOV     AX,SOURCE               ; GET THE SOURCE ENTRY
 026E 8E D8                       MOV     DS,AX                   ; LOAD SOURCE SELECTOR
 0270 B8 0018                     MOV     AX,TARGET               ; GET THE TARGET ENTRY
 0273 8E C0                       MOV     ES,AX                   ; LOAD TARGET SELECTOR
 0275 2B F6                       SUB     SI,SI                   ; SET SOURCE INDEX REGISTER TO ZERO
 0277 2B FF                       SUB     DI,DI                   ; SET TARGET INDEX REGISTER TO ZERO

 0279 F3/ A5                      REP     MOVSW                   ; MOVE THE BLOCK COUNT PASSED IN (CX)

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                                ;-----  CHECK FOR MEMORY PARITY BEFORE SHUTDOWN

 027B E4 61                             IN      AL,PORT_B               ; GET THE PARITY LATCHES
 027D 24 C0                             AND     AL,PARITY_ERR           ; STRIP UNWANTED BITS
 027F 74 12                             JZ      DONE1                   ; GO IF NO PARITY ERROR

                                ;-----  CLEAR PARITY BEFORE SHUTDOWN

 0281 8B 05                             MOV     AX,DS:[DI]              ; FETCH CURRENT SOURCE DATA
 0283 89 05                             MOV     DS:[DI],AX              ; WRITE IT BACK
 0285 B0 01                             MOV     AL,01                   ; SET PARITY CHECK ERROR = 01
 0287 E6 80                             OUT     MFG_PORT,AL
 0289 E4 61                             IN      AL,PORT_B
 028B 0C 0C                             OR      AL,RAM_PAR_OFF          ; TOGGLE PARITY CHECK LATCHES
 028D E6 61                             OUT     PORT_B,AL               ;  TO CLEAR THE PENDING ERROR
 028F 24 F3                             AND     AL,RAM_PAR_ON           ;  AND ENABLE CHECKING
 0291 E6 61                             OUT     PORT_B,AL

                                ;-----  CAUSE A SHUTDOWN

 0293                           DONE1:
 0293 E9 0000 E                         JMP     PROC_SHUTDOWN           ; GO RESET PROCESSOR AND SHUTDOWN

                                        ;=====================
                                ;------   RETURN FROM SHUTDOWN
                                        ;=====================

 0296                           SHUT9:                                  ;       RESTORE USERS STACK
                                        ASSUME  DS:DATA
 0296 B8 ---- R                         MOV     AX,DATA                 ; SET DS TO DATA AREA
 0299 8E D8                             MOV     DS,AX
 029B 8E 16 0069 R                      MOV     SS,@IO_ROM_SEG          ; GET USER STACK SEGMENT
 029F 8B 26 0067 R                      MOV     SP,@IO_ROM_INIT         ; GET USER STACK POINTER

                                ;-----  GATE ADDRESS BIT 20 OFF

 02A3 B4 DD                             MOV     AH,DISABLE_BIT20        ; DISABLE MASK
 02A5 E8 03DA R                         CALL    GATE_A20                ; GATE ADDRESS 20 LINE OFF
 02A8 3C 00                             CMP     AL,0                    ; COMMAND ACCEPTED?
 02AA 74 0A                             JZ      DONE3                   ; GO IF YES

 02AC E4 80                             IN      AL,MFG_PORT             ; CHECK FOR ANY OTHER ERROR FIRST
 02AE 3C 00                             CMP     AL,0                    ; WAS THERE AN ERROR?
 02B0 75 04                             JNZ     DONE3                   ; REPORT FIRST ERROR IF YES
 02B2 B0 03                             MOV     AL,03H                  ; ELSE SET GATE A20 ERROR FLAG
 02B4 E6 80                             OUT     MFG_PORT,AL

                                ;-----  RESTORE THE USERS REGISTERS AND SET RETURN CODES

 02B6                           DONE3:
 02B6 B8 000F                           MOV     AX,CMOS_SHUT_DOWN       ; CLEAR (AH) TO ZERO AND (AL) TO DEFAULT
 02B9 E6 70                             OUT     CMOS_PORT,AL            ; ENABLE NMI INTERRUPTS
 02BB 1F                                POP     DS                      ; RESTORE USER DATA SEGMENT
 02BC 07                                POP     ES                      ; RESTORE USER EXTRA SEGMENT
 02BD E4 71                             IN      AL,CMOS_DATA            ; OPEN CMOS STANDBY LATCH

 02BF E4 80                             IN      AL,MFG_PORT             ; GET THE ENDING STATUS RETURN CODE
 02C1 8B EC                             MOV     BP,SP                   ; POINT TO REGISTERS IN THE STACK
 02C3 88 46 0F                          MOV     [BP+15],AL              ; PLACE ERROR CODE INTO STACK AT (AH)
 02C6 3A E0                             CMP     AH,AL                   ; SET THE ZF & CY FLAGS WITH RETURN CODE
 02C8 61                                POPA                            ; RESTORE THE GENERAL PURPOSE REGISTERS
 02C9 FB                                STI                             ; TURN INTERRUPTS ON
 02CA                           DONE4   PROC    FAR
 02CA CA 0002                           RET     2                       ; RETURN WITH FLAGS SET --  (AH)= CODE
 02CD                           DONE4   ENDP                            ;  (CY=0,ZF=1)= OK   (CY=1,ZF=0)= ERROR

                                ;-----  BLOCK MOVE EXCEPTION INTERRUPT HANDLER

 02CD                           EX_INT:
 02CD B0 02                             MOV     AL,02H                  ; GET EXCEPTION ERROR CODE
 02CF E6 80                             OUT     MFG_PORT,AL             ; SET EXCEPTION INTERRUPT OCCURRED FLAG
 02D1 E9 0000 E                         JMP     PROC_SHUTDOWN           ; CAUSE A EARLY SHUTDOWN

                                ;-----  ROM IDT LOCATION

 02D4                           ROM_IDT_LOC:
 02D4 0100                              DW      ROM_IDT_END-ROM_IDT     ; LENGTH OF ROM IDT TABLE
 02D6 02DA R                            DW      ROM_IDT                 ; LOW WORD OF BASE ADDRESS
 02D8 0F                                DB      CSEG@_HI                ; HIGH BYTE OF BASE ADDRESS
 02D9 00                                DB      0                       ; RESERVED

                                ;-----  THE ROM EXCEPTION INTERRUPT VECTOR GATES FOR BLOCK MOVE

 02DA                           ROM_IDT:                                ;       EXCEPTION 00
 02DA 02CD R                            DW      EX_INT                  ; DESTINATION OFFSET
 02DC 0020                              DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
 02DE 00                                DB      0                       ; WORD COPY COUNT
 02DF 87                                DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
 02E0 0000                              DW      0                       ; RESERVED
                                                                        ;       EXCEPTION 01
 02E2 02CD R                            DW      EX_INT                  ; DESTINATION OFFSET
 02E4 0020                              DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
 02E6 00                                DB      0                       ; WORD COPY COUNT
 02E7 87                                DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
 02E8 0000                              DW      0                       ; RESERVED
                                                                        ;       EXCEPTION 02
 02EA 02CD R                            DW      EX_INT                  ; DESTINATION OFFSET
 02EC 0020                              DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
 02EE 00                                DB      0                       ; WORD COPY COUNT
 02EF 87                                DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
 02F0 0000                              DW      0                       ; RESERVED
                                                                        ;       EXCEPTION 03
 02F2 02CD R                            DW      EX_INT                  ; DESTINATION OFFSET
 02F4 0020                              DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
 02F6 00                                DB      0                       ; WORD COPY COUNT
 02F7 87                                DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
 02F8 0000                              DW      0                       ; RESERVED
                                                                        ;       EXCEPTION 04
 02FA 02CD R                            DW      EX_INT                  ; DESTINATION OFFSET
 02FC 0020                              DW      BIOS_CS                 ; DESTINATION SEGMENT SELECTOR
 02FE 00                                DB      0                       ; WORD COPY COUNT
 02FF 87                                DB      TRAP_GATE               ; GATE TYPE - ACCESS RIGHTS BYTE
 0300 0000                              DW      0                       ; RESERVED
                                                                        ;       EXCEPTION 05
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0302 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0304 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0306 00                      DB      0                            ; WORD COPY COUNT
0307 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0308 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 06
030A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
030C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
030E 00                      DB      0                            ; WORD COPY COUNT
030F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0310 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 07
0312 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0314 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0316 00                      DB      0                            ; WORD COPY COUNT
0317 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0318 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 08
031A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
031C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
031E 00                      DB      0                            ; WORD COPY COUNT
031F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0320 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 09
0322 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0324 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0326 00                      DB      0                            ; WORD COPY COUNT
0327 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0328 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 10
032A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
032C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
032E 00                      DB      0                            ; WORD COPY COUNT
032F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0330 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 11
0332 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0334 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0336 00                      DB      0                            ; WORD COPY COUNT
0337 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0338 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 12
033A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
033C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
033E 00                      DB      0                            ; WORD COPY COUNT
033F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0340 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 13
0342 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0344 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0346 00                      DB      0                            ; WORD COPY COUNT
0347 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0348 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 14
034A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
034C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
034E 00                      DB      0                            ; WORD COPY COUNT
034F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0350 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 15
0352 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0354 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0356 00                      DB      0                            ; WORD COPY COUNT
0357 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0358 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 16
035A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
035C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
035E 00                      DB      0                            ; WORD COPY COUNT
035F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0360 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 17
0362 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0364 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0366 00                      DB      0                            ; WORD COPY COUNT
0367 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0368 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 18
036A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
036C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
036E 00                      DB      0                            ; WORD COPY COUNT
036F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0370 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 19
0372 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0374 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0376 00                      DB      0                            ; WORD COPY COUNT
0377 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0378 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 20
037A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
037C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
037E 00                      DB      0                            ; WORD COPY COUNT
037F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0380 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 21
0382 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0384 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0386 00                      DB      0                            ; WORD COPY COUNT
0387 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0388 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 22
038A 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
038C 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
038E 00                      DB      0                            ; WORD COPY COUNT
038F 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0390 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 23
0392 02CD R                  DW      EX_INT                       ; DESTINATION OFFSET
0394 0020                    DW      BIOS_CS                      ; DESTINATION SEGMENT SELECTOR
0396 00                      DB      0                            ; WORD COPY COUNT
0397 87                      DB      TRAP_GATE                    ; GATE TYPE - ACCESS RIGHTS BYTE
0398 0000                    DW      0                            ; RESERVED
                                                                  ;       EXCEPTION 24
```

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039A 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
039C 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
039E 00                       DB      0                      ; WORD COPY COUNT
039F 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03A0 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 25
03A2 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03A4 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03A6 00                       DB      0                      ; WORD COPY COUNT
03A7 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03A8 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 26
03AA 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03AC 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03AE 00                       DB      0                      ; WORD COPY COUNT
03AF 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03B0 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 27
03B2 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03B4 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03B6 00                       DB      0                      ; WORD COPY COUNT
03B7 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03B8 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 28
03BA 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03BC 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03BE 00                       DB      0                      ; WORD COPY COUNT
03BF 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03C0 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 29
03C2 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03C4 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03C6 00                       DB      0                      ; WORD COPY COUNT
03C7 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03C8 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 30
03CA 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03CC 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03CE 00                       DB      0                      ; WORD COPY COUNT
03CF 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03D0 0000                     DW      0                      ; RESERVED
                                                             ;         EXCEPTION 31
03D2 02CD R                   DW      EX_INT                 ; DESTINATION OFFSET
03D4 0020                     DW      BIOS_CS                ; DESTINATION SEGMENT SELECTOR
03D6 00                       DB      0                      ; WORD COPY COUNT
03D7 87                       DB      TRAP_GATE              ; GATE TYPE - ACCESS RIGHTS BYTE
03D8 0000                     DW      0                      ; RESERVED
03DA                    ROM_IDT_END:

03DA                    BLOCKMOVE   ENDP
```

```
                    PAGE
                    ;---------------------------------------------------------------------
                    ; GATE_A20                                                            :
                    ;       THIS ROUTINE CONTROLS A SIGNAL WHICH GATES ADDRESS BIT 20.    :
                    ;       THE GATE A20 SIGNAL IS AN OUTPUT OF THE 8042 SLAVE PROCESSOR. :
                    ;       ADDRESS BIT 20 SHOULD BE GATED ON BEFORE ENTERING PROTECTED MODE. :
                    ;       IT SHOULD BE GATED OFF AFTER ENTERING REAL MODE FROM PROTECTED :
                    ;       MODE.  INTERRUPTS ARE LEFT DISABLED ON EXIT.                  :
                    ; INPUT                                                               :
                    ;       (AH)= DDH  ADDRESS BIT 20 GATE OFF. (A20 ALWAYS ZERO)         :
                    ;       (AH)= DFH  ADDRESS BIT 20 GATE ON. (A20 CONTROLLED BY 80286)  :
                    ; OUTPUT                                                              :
                    ;       (AL)= 00H  OPERATION SUCCESSFUL. 8042 HAS ACCEPTED COMMAND.   :
                    ;       (AL)= 02H  FAILURE--8042 UNABLE TO ACCEPT COMMAND.            :
                    ;---------------------------------------------------------------------
03DA                GATE_A20        PROC
03DA 51                     PUSH    CX                      ; SAVE USERS (CX)
03DB FA                     CLI                             ; DISABLE INTERRUPTS WHILE USING 8042
03DC E8 03F3 R              CALL    EMPTY_8042              ; INSURE 8042 INPUT BUFFER EMPTY
03DF 75 10                  JNZ     GATE_A20_RETURN         ; EXIT IF 8042 UNABLE TO ACCEPT COMMAND
03E1 B0 D1                  MOV     AL,0D1H                 ; 8042 COMMAND TO WRITE OUTPUT PORT
03E3 E6 64                  OUT     STATUS_PORT,AL          ; OUTPUT COMMAND TO 8042
03E5 E8 03F3 R              CALL    EMPTY_8042              ; WAIT FOR 8042 TO ACCEPT COMMAND
03E8 75 07                  JNZ     GATE_A20_RETURN         ; EXIT IF 8042 UNABLE TO ACCEPT COMMAND
03EA 8A C4                  MOV     AL,AH                   ; 8042 PORT DATA
03EC E6 60                  OUT     PORT_A,AL               ; OUTPUT PORT DATA TO 8042
03EE E8 03F3 R              CALL    EMPTY_8042              ; WAIT FOR 8042 TO ACCEPT PORT DATA

                    ;-----  8042 OUTPUT WILL SWITCH WITHIN 20 MICRO SECONDS OF ACCEPTING PORT DATA

03F1                GATE_A20_RETURN:
03F1 59                     POP     CX                      ; RESTORE USERS (CX)
03F2 C3                     RET
                    ;---------------------------------------------------------------------
                    ; EMPTY_8042                                                          :
                    ;       THIS ROUTINE WAITS FOR THE 8042 INPUT BUFFER TO EMPTY.        :
                    ; INPUT                                                               :
                    ;       NONE                                                          :
                    ; OUTPUT                                                              :
                    ;       (AL)= 00H  8042 INPUT BUFFER EMPTY (ZERO FLAG SET)            :
                    ;       (AL)= 02H  TIME OUT, 8042 INPUT BUFFER FULL (NON-ZERO FLAG SET) :
                    ;       (CX)       - MODIFIED                                         :
                    ;---------------------------------------------------------------------
03F3                EMPTY_8042:
03F3 2B C9                  SUB     CX,CX                   ; (CX)=0, WILL BE USED AS TIME OUT VALUE
03F5                EMPTY_L:
03F5 E4 64                  IN      AL,STATUS_PORT          ; READ 8042 STATUS PORT
03F7 24 02                  AND     AL,INPT_BUF_FULL        ; TEST INPUT BUFFER FULL FLAG (BIT 1)
03F9 E0 FA                  LOOPNZ  EMPTY_L                 ; LOOP UNTIL BUFFER EMPTY OR TIME OUT
03FB C3                     RET
03FC                GATE_A20        ENDP


                    ;--- INT 15 H -- ( FUNCTION 88 H - I/O MEMORY SIZE DETERMINE ) ----------
                    ; EXT_MEMORY                                                          :
                    ;       THIS ROUTINE RETURNS  THE AMOUNT OF MEMORY IN THE SYSTEM THAT IS :
                    ;       LOCATED STARTING AT THE 1024K ADDRESSING RANGE, AS DETERMINED BY :
                    ;       THE POST ROUTINES.                                            :
                    ;       NOTE THAT THE SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS THERE :
                    ;       IS A FULL COMPLEMENT OF 512K OR 640 BYTES ON THE PLANAR.  THIS SIZE :
                    ;       SIZE IS STORED IN CMOS AT ADDRESS LOCATIONS 30H AND 31H.      :
                    ; INPUT                                                               :
                    ;       AH = 88H                                                      :
                    ;                                                                     :
                    ;       THE I/O MEMORY SIZE VARIABLE IS SET DURING POWER ON           :
                    ;       DIAGNOSTICS ACCORDING TO THE FOLLOWING ASSUMPTIONS:           :
                    ;                                                                     :
                    ;       1. ALL INSTALLED MEMORY IS FUNCTIONAL.                        :
                    ;       2. ALL MEMORY FROM 0 TO 640K MUST BE CONTIGUOUS.              :
                    ;                                                                     :
                    ; OUTPUT                                                              :
                    ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY A             :
                    ;              AVAILABLE STARTING AT ADDRESS 1024K.                   :
                    ;                                                                     :
                    ;---------------------------------------------------------------------

03FC                EXT_MEMORY      PROC

03FC B8 3031                MOV     AX,CMOS_U_M_S_LO*H+CMOS_U_M_S_HI ; ADDRESS HIGH/LOW BYTES
03FF E8 0000 E              CALL    CMOS_READ               ; GET THE HIGH BYTE OF I/O MEMORY
0402 86 C4                  XCHG    AL,AH                   ; PUT HIGH BYTE IN POSITION (AH)
0404 E8 0000 E              CALL    CMOS_READ               ; GET THE LOW BYTE OF I/O MEMORY
0407 CF                     IRET                            ; RETURN TO USER

0408                EXT_MEMORY      ENDP
```

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PAGE
;--- INT 15 H ( FUNCTION 89 H ) ---------------------------------------------------
; PURPOSE:                                                                         :
;       THIS BIOS FUNCTION PROVIDES A MEANS TO THE USER TO SWITCH INTO             :
;       VIRTUAL (PROTECTED) MODE.  UPON COMPLETION OF THIS FUNCTION THE            :
;       PROCESSOR WILL BE IN  VIRTUAL (PROTECTED) MODE AND CONTROL WILL            :
;       BE TRANSFERRED TO THE CODE SEGMENT THAT WAS SPECIFIED BY THE USER.         :
;                                                                                  :
; ENTRY REQUIREMENTS:                                                              :
;                                                                                  :
;       (ES:SI) POINTS TO A DESCRIPTOR TABLE (GDT) BUILT BEFORE INTERRUPTING       :
;       TO THIS FUNCTION.  THESE DESCRIPTORS ARE USED BY THIS FUNCTION TO          :
;       INITIALIZE THE IDTR, THE GDTR AND THE STACK SEGMENT SELECTOR.  THE         :
;       DATA SEGMENT (DS) SELECTOR AND THE EXTRA SEGMENT (ES) SELECTOR WILL        :
;       BE INITIALIZE TO DESCRIPTORS BUILT BY THE ROUTINE USING THIS FUNCTION.     :
;       BH - OFFSET INTO THE INTERRUPT DESCRIPTOR TABLE STATING WHERE THE          :
;            FIRST EIGHT HARDWARE INTERRUPTS WILL BEGIN. ( INTERRUPT LEVEL 1 )     :
;       BL - OFFSET INTO THE INTERRUPT DESCRIPTOR TABLE STATING WHERE THE          :
;            SECOND EIGHT HARDWARE INTERRUPTS BEGIN. ( INTERRUPT LEVEL 2 )         :
;                                                                                  :
; THE DESCRIPTORS ARE DEFINED AS FOLLOWS:                                          :
;                                                                                  :
;       1.  THE FIRST DESCRIPTOR IS THE REQUIRED DUMMY.                            :
;           (USER INITIALIZED TO 0)                                                :
;       2.  THE SECOND DESCRIPTOR POINTS TO THE GDT TABLE AS                       :
;           A DATA SEGMENT.                                                        :
;           (USER INITIALIZED)                                                     :
;       3.  THE THIRD DESCRIPTOR POINTS TO THE USER DEFINED                        :
;           INTERRUPT DESCRIPTOR TABLE (IDT).                                      :
;           (USER INITIALIZED)                                                     :
;       4.  THE FORTH DESCRIPTOR POINTS TO THE USER'S DATA                         :
;           SEGMENT (DS).                                                          :
;           (USER INITIALIZED)                                                     :
;       5.  THE FIFTH DESCRIPTOR POINTS TO THE USER'S EXTRA                        :
;           SEGMENT (ES).                                                          :
;           (USER INITIALIZED)                                                     :
;       6.  THE SIXTH DESCRIPTOR POINTS TO THE USER'S STACK                        :
;           SEGMENT (SS).                                                          :
;           (USER INITIALIZED)                                                     :
;       7.  THE SEVENTH DESCRIPTOR POINTS TO THE CODE SEGMENT                      :
;           THAT THIS FUNCTION WILL RETURN TO.                                     :
;           (USER INITIALIZED TO THE USER'S CODE SEGMENT.)                         :
;       8.  THE EIGHTH DESCRIPTOR IS USED BY THIS FUNCTION TO                      :
;           ESTABLISH A CODE SEGMENT FOR ITSELF. THIS IS                           :
;           NEEDED SO THAT THIS FUNCTION CAN COMPLETE IT'S                         :
;           EXECUTION WHILE IN PROTECTED MODE.  WHEN CONTROL                       :
;           GETS PASSED TO THE USER'S CODE THIS DESCRIPTOR CAN                     :
;           BE USED BY HIM IN ANY WAY HE CHOOSES.                                  :
;                                                                                  :
;    NOTE -  EACH DESCRIPTOR MUST CONTAIN ALL THE NECESSARY DATA                   :
;            I.E. THE LIMIT,  BASE ADDRESS AND THE ACCESS RIGHTS BYTE.             :
;                                                                                  :
;       AH= 89H  (FUNCTION CALL)                                                   :
;       ES:SI = LOCATION OF THE GDT TABLE BUILD BY ROUTINE                         :
;       USING THIS FUNCTION.                                                       :
;                                                                                  :
; EXIT PARAMETERS:                                                                 :
;                                                                                  :
;       AH = 0  IF SUCCESSFUL                                                      :
;       ALL SEGMENT REGISTERS ARE CHANGED, (AX) AND (BP) DESTROYED                 :
;                                                                                  :
; CONSIDERATIONS:                                                                  :
;                                                                                  :
;       1.  NO BIOS AVAILABLE TO USER.  USER MUST HANDLE ALL                       :
;           I/O COMMANDS.                                                          :
;       2.  INTERRUPTS - INTERRUPT VECTOR LOCATIONS MUST BE                        :
;           MOVED,  DUE TO THE 286 RESERVED AREAS.  THE                            :
;           HARDWARE INTERRUPT CONTROLLERS MUST BE REINITIALIZED                   :
;           TO DEFINE LOCATIONS THAT DO NOT RESIDE IN THE 286                      :
;           RESERVED AREAS.                                                        :
;       3.  EXCEPTION INTERRUPT TABLE AND HANDLER MUST BE                          :
;           INITIALIZED BY THE USER.                                               :
;       4.  THE INTERRUPT DESCRIPTOR TABLE MUST NOT OVERLAP                        :
;           THE REAL MODE BIOS INTERRUPT DESCRIPTOR TABLE.                         :
;       5.  THE FOLLOWING GIVES AN IDEA OF WHAT THE USER CODE                      :
;           SHOULD LOOK LIKE WHEN INVOKING THIS FUNCTION.                          :
;                                                                                  :
;       REAL MODE --->      "USER CODE"                                            :
;                     "     MOV    AX,GDT SEGMENT                                  :
;                     "     MOV    ES,AX                                           :
;                     "     MOV    SI,GDT OFFSET                                   :
;                     "     MOV    BH,HARDWARE INT LEVEL 1 OFFSET                  :
;                     "     MOV    BL,HARDWARE INT LEVEL 2 OFFSET                  :
;                     "     MOV    AH,89H                                          :
;                     "     INT    15H                                             :
;    VIRTUAL MODE --->      "USER CODE"                                            :
;                                                                                  :
; DESCRIPTION:                                                                     :
;                                                                                  :
;       1.  CLI (NO INTERRUPTS ALLOWED) WHILE THIS FUNCTION IS EXECUTING.          :
;       2.  ADDRESS LINE 20 IS GATED ACTIVE.                                       :
;       3.  THE CURRENT USER STACK SEGMENT DESCRIPTOR IS INITIALIZED.              :
;       4.  THE GDTR IS LOADED WITH THE GDT BASE ADDRESS.                          :
;       5.  THE IDTR IS LOADED WITH THE IDT BASE ADDRESS.                          :
;       6.  THE 8259 IS REINITIALIZED WITH THE NEW INTERRUPT OFFSETS.              :
;       7.  THE PROCESSOR IS PUT IN VIRTUAL MODE WITH THE CODE                     :
;           SEGMENT DESIGNATED FOR THIS FUNCTION.                                  :
;       8.  DATA SEGMENT IS LOADED WITH THE USER DEFINED                           :
;           SELECTOR FOR THE DS REGISTER.                                          :
;       9.  EXTRA SEGMENT IS LOADED WITH THE USER DEFINED                          :
;           SELECTOR FOR THE ES REGISTER.                                          :
;      10.  STACK SEGMENT IS LOADED WITH THE USER DEFINED                          :
;           SELECTOR FOR THE SS REGISTER.                                          :
;      11.  CODE SEGMENT DESCRIPTOR SELECTOR VALUE IS                              :
;           SUBSTITUTED ON THE STACK FOR RETURN TO USER.                           :
;      12.  WE TRANSFER CONTROL TO THE USER WITH INTERRUPTS DISABLED.              :
;-----------------------------------------------------------------------------------
```

```
                                PAGE
                                ;
                                ;       THE FOLLOWING DIAGRAM DEPICTS THE ORGANIZATION
                                ;       OF GDT.
                                ;----------------------------------------------------------------------
                                ;                               G D T                                  :
                                ;                                                                      :
                                ;                             .-------------.                          :
                                ;                               v           |                          :
                                ;      (ES:SI)-->>  +00 .---------------.   |                          :
                                ;                       |     DUMMY     |   |                          :
                                ;                       |               |   |                          :
                                ;                   +08 |---------------|   |                          :
                                ;                       |      GDT      |---'                          :
                                ;                       |               |                              :
                                ;                   +10 |---------------|                              :
                                ;                       |      IDT      |                              :
                                ;                       |               |                              :
                                ;                   +18 |---------------|                              :
                                ;                       |      DS       |                              :
                                ;                       |               |                              :
                                ;                   +20 |---------------|                              :
                                ;                       |      ES       |                              :
                                ;                       |               |                              :
                                ;                   +28 |---------------|                              :
                                ;                       |      SS       |                              :
                                ;                       |               |                              :
                                ;                   +30 |---------------|                              :
                                ;                       |      CS       |                              :
                                ;                       |               |                              :
                                ;                   +38 |---------------|                              :
                                ;                       |   TEMP BIOS   |                              :
                                ;                       |      CS       |                              :
                                ;                       |---------------|                              :
                                ;                                                                      :
                                ;----------------------------------------------------------------------

                                ;----------------------------------------------------------------------
                                ;     THE GLOBAL DESCRIPTOR TABLE (ACTUAL LOCATION POINTED TO BY ES:SI)  :
                                ;----------------------------------------------------------------------

                                VIRTUAL_ENABLE_GDT_DEF  STRUC
 0000  ????????????????                         DQ      ?               ; FIRST DESCRIPTOR NOT ACCESSIBLE
 0008  ????????????????         GDTPTR          DQ      ?               ; GDT DESCRIPTOR
 0010  ????????????????         IDTPTR          DQ      ?               ; IDT DESCRIPTOR
 0018  ????????????????         USER_DS         DQ      ?               ; USER DATA SEGMENT DESCRIPTOR
 0020  ????????????????         USER_ES         DQ      ?               ; USER EXTRA SEGMENT DESCRIPTOR
 0028  ????????????????         USER_SS         DQ      ?               ; USER STACK SEGMENT DESCRIPTOR
 0030  ????????????????         USER_CS         DQ      ?               ; USER CODE SEGMENT DESCRIPTOR
 0038  ????????????????         BIO_CS          DQ      ?               ; TEMPORARY BIOS DESCRIPTOR
 0040                           VIRTUAL_ENABLE_GDT_DEF  ENDS

                                        ASSUME  DS:DATA

 0408                           X_VIRTUAL       PROC    FAR
 0408                           SET_VMODE:

                                ;-----  ENABLE ADDRESS LATCH BIT 20

 0408  FA                               CLI                             ; NO INTERRUPTS ALLOWED
 0409  B4 DF                            MOV     AH,ENABLE_BIT20         ; ENABLE BIT 20 FOR ADDRESS GATE
 040B  E8 03DA R                        CALL    GATE_A20
 040E  3C 00                            CMP     AL,0                    ; WAS THE COMMAND ACCEPTED?
 0410  74 04                            JZ      BIT20_ON                ; GO IF YES
 0412  B4 FF                            MOV     AH,0FFH                 ; SET THE ERROR FLAG
 0414  F9                               STC                             ; SET CARRY
 0415  CF                               IRET                            ; EARLY EXIT


 0416                           BIT20_ON:
 0416  06                               PUSH    ES                      ; MOVE SEGMENT POINTER
 0417  1F                               POP     DS                      ; TO THE DATA SEGMENT

                                ;----------------------------------------------------------------------
                                ; REINITIALIZE THE 8259 INTERRUPT CONTROLLER #1 TO THE USER SPECIFIED OFFSET  :
                                ;----------------------------------------------------------------------

 0418  B0 11                            MOV     AL,11H                  ; START INITIALIZATION SEQUENCE-ICW1
 041A  E6 20                            OUT     INTA00,AL               ; EDGE,INTERVAL-8,MASTER,ICW4 NEEDED
 041C  EB 00                            JMP     $+2
 041E  8A C7                            MOV     AL,BH                   ; HARDWARE INT'S START AT INT # (BH)
 0420  E6 21                            OUT     INTA01,AL               ; SEND ICW2
 0422  EB 00                            JMP     $+2
 0424  B0 04                            MOV     AL,04H                  ; SEND ICW3 - MASTER LEVEL 2
 0426  E6 21                            OUT     INTA01,AL
 0428  EB 00                            JMP     $+2
 042A  B0 01                            MOV     AL,01H                  ; SEND ICW4 - MASTER,8086 MODE
 042C  E6 21                            OUT     INTA01,AL
 042E  EB 00                            JMP     $+2
 0430  B0 FF                            MOV     AL,0FFH                 ; MASK OFF ALL INTERRUPTS
 0432  E6 21                            OUT     INTA01,AL

                                ;----------------------------------------------------------------------
                                ; REINITIALIZE THE 8259 INTERRUPT CONTROLLER #2 TO THE USER SPECIFIED OFFSET  :
                                ;----------------------------------------------------------------------

 0434  B0 11                            MOV     AL,11H                  ; INITIALIZE SEQUENCE-ICW1 FOR SLAVE
 0436  E6 A0                            OUT     INTB00,AL               ; EDGE,INTERVAL-8,MASTER,ICW4 NEEDED
 0438  EB 00                            JMP     $+2
 043A  8A C3                            MOV     AL,BL                   ; HARDWARE INT'S START AT INT # (BL)
 043C  E6 A1                            OUT     INTB01,AL               ; SEND ICW2
 043E  B0 02                            MOV     AL,02H
 0440  EB 00                            JMP     $+2
 0442  E6 A1                            OUT     INTB01,AL               ; SEND ICW3 - SLAVE LEVEL 2
 0444  EB 00                            JMP     $+2
 0446  B0 01                            MOV     AL,01H
 0448  E6 A1                            OUT     INTB01,AL               ; SEND ICW4 - SLAVE,8086 MODE
 044A  EB 00                            JMP     $+2
 044C  B0 FF                            MOV     AL,0FFH
 044E  E6 A1                            OUT     INTB01,AL               ; MASK OFF ALL INTERRUPTS
```

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                              PAGE
                              ;----------------------------------------
                              ; SETUP BIOS CODE SEGMENT DESCRIPTOR     :
                              ;----------------------------------------

0450 C7 44 38 FFFF                    MOV     [SI].BIO_CS.SEG_LIMIT,MAX_SEG_LEN        ; SET LENGTH
0455 C6 44 3C 0F                      MOV     [SI].BIO_CS.BASE_HI_BYTE,CSEG@_HI        ; SET HIGH BYTE OF CS=0F
0459 C7 44 3A 0000                    MOV     [SI].BIO_CS.BASE_LO_WORD,CSEG@_LO        ; SET LOW WORD OF CS=0
045E C6 44 3D 9B                      MOV     [SI].BIO_CS.DATA_ACC_RIGHTS,CPL0_CODE_ACCESS
0462 C7 44 3E 0000                    MOV     [SI].BIO_CS.DATA_RESERVED,0              ; ZERO RESERVED AREA

                              ;----------------------------------------
                              ;       ENABLE PROTECTED MODE            :
                              ;----------------------------------------
                                      LGDT    [SI].GDTPTR              ; LOAD GLOBAL DESCRIPTOR TABLE REGISTER
0467 0F                     +         DB      00FH
0468                        + ??0005  LABEL   BYTE
0468 8B 54 08               +         MOV     DX,WORD PTR [SI].GDTPTR
046B                        + ??0006  LABEL   BYTE
0468                        +         ORG     OFFSET CS:??0005
0468 01                     +         DB      001H
046B                        +         ORG     OFFSET CS:??0006
                                      LIDT    [SI].IDTPTR              ; INTERRUPT DESCRIPTOR TABLE REGISTER
046B 0F                     +         DB      00FH
046C                        + ??0007  LABEL   BYTE
046C 8B 5C 10               +         MOV     BX,WORD PTR [SI].IDTPTR
046F                        + ??0008  LABEL   BYTE
046C                        +         ORG     OFFSET CS:??0007
046C 01                     +         DB      001H
046F                        +         ORG     OFFSET CS:??0008

046F B8 0001                          MOV     AX,VIRTUAL_ENABLE        ; MACHINE STATUS WORD NEEDED TO
                                      LMSW    AX                       ;  SWITCH TO VIRTUAL MODE
0472 0F 01 F0               +         DB      00FH,001H,0F0H
0475 EA                                DB     0EAH                     ; PURGE PRE-FETCH QUEUE WITH FAR JUMP
0476 047A R                            DW     OFFSET VMODE             ;  - TO OFFSET
0478 0038                              DW     BIO_CS                   ;  - IN SEGMENT -PROTECTED MODE SELECTOR

047A                          VMODE:
                              ;----------------------------------------
                              ;       SETUP USER SEGMENT REGISTERS     :
                              ;----------------------------------------
047A B8 0018                          MOV     AX,USER_DS               ; SETUP USER'S DATA SEGMENT
047D 8E D8                            MOV     DS,AX                    ; TO PROTECTED MODE SELECTORS
047F B8 0020                          MOV     AX,USER_ES               ; SETUP USER'S EXTRA SEGMENT
0482 8E C0                            MOV     ES,AX
0484 B8 0028                          MOV     AX,USER_SS               ; SETUP USER'S STACK SEGMENT
0487 8E D0                            MOV     SS,AX
                              ;----------------------------------------
                              ;       PUT TRANSFER ADDRESS ON STACK    :
                              ;       AND RETURN TO THE USER           :
                              ;----------------------------------------
0489 5B                               POP     BX                       ; GET RETURN IP FROM THE STACK
048A 83 C4 04                         ADD     SP,4                     ; NORMALIZE STACK POINTER
048D 6A 30                            PUSH    USER_CS                  ; SET STACK FOR A RETURN FAR
048F 53                               PUSH    BX
0490 CB                               RET                              ; RETURN TO USER IN VIRTUAL MODE

0491                          X_VIRTUAL       ENDP

                              ;--- DEVICE BUSY AND INTERRUPT COMPLETE -------------------------
                              ;                                                              :
                              ;       THIS ROUTINE IS A TEMPORARY HANDLER FOR DEVICE BUSY    :
                              ;       AND INTERRUPT COMPLETE                                 :
                              ;                                                              :
                              ;       INPUT   - SEE PROLOGUE                                 :
                              ;---------------------------------------------------------------

0491                          DEVICE_BUSY     PROC    NEAR
0491 F8                                 CLC                            ; TURN CARRY OFF
0492 E9 0055 R                          JMP   C1_F                     ; RETURN WITH CARRY FLAG
0495                          DEVICE_BUSY     ENDP

0495                          INT_COMPLETE    PROC    NEAR
0495 CF                                 IRET                           ; RETURN
0496                          INT_COMPLETE    ENDP

0496                          CODE    ENDS
                                      END
                              PAGE 118,121
                              TITLE BIOS2 ---- 06/10/85  BIOS INTERRUPT ROUTINES
                              .286C
                              .LIST
 0000                         CODE    SEGMENT BYTE PUBLIC

                                      PUBLIC  PRINT_SCREEN_1
                                      PUBLIC  RTC_INT
                                      PUBLIC  TIME_OF_DAY_1
                                      PUBLIC  TIMER_INT_1

                                      EXTRN   CMOS_READ:NEAR          ; READ CMOS LOCATION ROUTINE
                                      EXTRN   CMOS_WRITE:NEAR         ; WRITE CMOS LOCATION ROUTINE
                                      EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR

                              ;--- INT  1A H -- (TIME_OF_DAY) ------------------------------------------------
                              ;       THIS BIOS ROUTINE ALLOWS THE CLOCKS TO BE SET OR READ                  :
                              ;                                                                              :
                              ; PARAMETERS:                                                                  :
                              ;     (AH) = 00H  READ THE CURRENT CLOCK SETTING AND RETURN WITH,              :
                              ;                      (CX) = HIGH PORTION OF COUNT                            :
                              ;                      (DX) = LOW PORTION OF COUNT                             :
                              ;                      (AL) = 0 TIMER HAS NOT PASSED 24 HOURS SINCE LAST READ  :
                              ;                             1 IF ON ANOTHER DAY. (RESET TO ZERO AFTER READ)  :
                              ;                                                                              :
                              ;     (AH) = 01H  SET THE CURRENT CLOCK USING,                                 :
                              ;                      (CX) = HIGH PORTION OF COUNT                            :
                              ;                      (DX) = LOW PORTION OF COUNT.                            :
                              ;                                                                              :
                              ;               NOTE: COUNTS OCCUR AT THE RATE OF 1193180/65536 COUNTS/SECOND  :
                              ;                             (OR ABOUT 18.2 PER SECOND -- SEE EQUATES)        :
                              ;                                                                              :
                              ;     (AH) = 02H  READ THE REAL TIME CLOCK AND RETURN WITH,                    :
                              ;                      (CH) = HOURS IN BCD (00-23)                             :
                              ;                      (CL) = MINUTES IN BCD (00-59)                           :
                              ;                      (DH) = SECONDS IN BCD (00-59)                           :
                              ;                      (DL) = DAYLIGHT SAVINGS ENABLE (00-01).                 :
                              ;                                                                              :
                              ;     (AH) = 03H  SET THE REAL TIME CLOCK USING,                               :
                              ;                      (CH) = HOURS IN BCD (00-23)                             :
                              ;                      (CL) = MINUTES IN BCD (00-59)                           :
                              ;                      (DH) = SECONDS IN BCD (00-59)                           :
                              ;                      (DL) = 01 IF DAYLIGHT SAVINGS ENABLE OPTION, ELSE 00.   :
                              ;                                                                              :
                              ;               NOTE: (DL)= 00 IF DAYLIGHT SAVINGS TIME ENABLE IS NOT ENABLED. :
                              ;                     (DL)= 01 ENABLES TWO SPECIAL UPDATES THE LAST SUNDAY IN  :
                              ;                     APRIL   (1:59:59 --> 3:00:00 AM) AND THE LAST SUNDAY IN  :
                              ;                     OCTOBER (1:59:59 --> 1:00:00 AM) THE FIRST TIME.         :
                              ;                                                                              :
                              ;     (AH) = 04H  READ THE DATE FROM THE REAL TIME CLOCK AND RETURN WITH,      :
                              ;                      (CH) = CENTURY IN BCD (19 OR 20)                        :
                              ;                      (CL) = YEAR IN BCD (00-99)                              :
                              ;                      (DH) = MONTH IN BCD (01-12)                             :
                              ;                      (DL) = DAY IN BCD (01-31).                              :
                              ;                                                                              :
                              ;     (AH) = 05H  SET THE DATE INTO THE REAL TIME CLOCK USING,                 :
                              ;                      (CH) = CENTURY IN BCD (19 OR 20)                        :
                              ;                      (CL) = YEAR IN BCD (00 - 99)                            :
                              ;                      (DH) = MONTH IN BCD (01 - 12)                           :
                              ;                      (DL) = DAY IN BCD (01-31).                              :
                              ;                                                                              :
                              ;     (AH) = 06H  SET THE ALARM TO INTERRUPT AT SPECIFIED TIME,                :
                              ;                      (CH) = HOURS IN BCD (00-23 (OR FFH))                    :
                              ;                      (CL) = MINUTES IN BCD (00-59 (OR FFH))                  :
                              ;                      (DH) = SECONDS IN BCD (00-59 (OR FFH)).                 :
                              ;                                                                              :
                              ;     (AH) = 07H  RESET THE ALARM INTERRUPT FUNCTION.                          :
                              ;                                                                              :
                              ; NOTES: FOR ALL RETURNS CY= 0 FOR SUCCESSFUL OPERATION.                       :
                              ;        FOR (AH)= 2, 4, 6 - CARRY FLAG SET IF REAL TIME CLOCK NOT OPERATING.  :
                              ;        FOR (AH)= 6 - CARRY FLAG SET IF ALARM ALREADY ENABLED.                :
                              ;        FOR THE ALARM FUNCTION (AH = 6) THE USER MUST SUPPLY A ROUTINE AND    :
                              ;         INTERCEPT THE CORRECT ADDRESS IN THE VECTOR TABLE FOR INTERRUPT 4AH. :
                              ;         USE 0FFH FOR ANY "DO NOT CARE" POSITION FOR INTERVAL INTERRUPTS.     :
                              ;        INTERRUPTS ARE DISABLED DURING DATA MODIFICATION.                     :
                              ;        AH & AL ARE RETURNED MODIFIED AND NOT DEFINED EXCEPT WHERE INDICATED. :
                              ;-------------------------------------------------------------------------------

                                      ASSUME  CS:CODE,DS:DATA

 0000                         TIME_OF_DAY_1   PROC    FAR
 0000 FB                              STI                             ; INTERRUPTS BACK ON
 0001 80 FC 08                        CMP     AH,(RTC_TBE-RTC_TB)/2   ; CHECK IF COMMAND IN VALID RANGE (0-7)
 0004 F5                              CMC                             ; COMPLEMENT CARRY FOR ERROR EXIT
 0005 72 17                           JC      TIME_9                  ; EXIT WITH CARRY = 1 IF NOT VALID

 0007 1E                              PUSH    DS                      ; SAVE USERS (DS) SEGMENT
 0008 E8 0000 E                       CALL    DDS                     ; GET DATA SEGMENT SELECTOR
 000B 56                              PUSH    SI                      ; SAVE WORK REGISTER
 000C C1 E8 08                        SHR     AX,8                    ; CONVERT FUNCTION TO BYTE OFFSET
 000F 03 C0                           ADD     AX,AX                   ; CONVERT FUNCTION TO WORD OFFSET (CY=0)
 0011 8B F0                           MOV     SI,AX                   ; PLACE INTO ADDRESSING REGISTER
 0013 FA                              CLI                             ; NO INTERRUPTS DURING TIME FUNCTIONS
 0014 2E: FF 94 0021 R                CALL    CS:[SI]+OFFSET RTC_TB   ; VECTOR TO FUNCTION REQUESTED WITH CY=0
                                                                      ;  RETURN WITH CARRY FLAG SET FOR RESULT
 0019 FB                              STI                             ; INTERRUPTS BACK ON
 001A B4 00                           MOV     AH,0                    ; CLEAR (AH) TO ZERO
 001C 5E                              POP     SI                      ; RECOVER USERS REGISTER
 001D 1F                              POP     DS                      ; RECOVER USERS SEGMENT SELECTOR
 001E                         TIME_9:                                 ; RETURN WITH CY= 0 IF NO ERROR
 001E CA 0002                         RET     2

                                                                      ;       ROUTINE VECTOR TABLE (AH)=
 0021 0031 R                  RTC_TB  DW      RTC_00                  ; 0 = READ CURRENT CLOCK COUNT
 0023 0042 R                          DW      RTC_10                  ; 1 = SET CLOCK COUNT
 0025 0050 R                          DW      RTC_20                  ; 2 = READ THE REAL TIME CLOCK TIME
 0027 0075 R                          DW      RTC_30                  ; 3 = SET REAL TIME CLOCK TIME
 0029 00A8 R                          DW      RTC_40                  ; 4 = READ THE REAL TIME CLOCK DATE
 002B 00CB R                          DW      RTC_50                  ; 5 = SET REAL TIME CLOCK DATE
 002D 0104 R                          DW      RTC_60                  ; 6 = SET THE REAL TIME CLOCK ALARM
 002F 0145 R                          DW      RTC_70                  ; 7 = RESET ALARM
 = 0031                       RTC_TBE EQU     $

 0031                         TIME_OF_DAY_1   ENDP
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                                PAGE
0031                    RTC_00  PROC    NEAR                ;       READ TIME COUNT
0031 A0 0070 R                  MOV     AL,@TIMER_OFL       ; GET THE OVERFLOW FLAG
0034 C6 06 0070 R 00            MOV     @TIMER_OFL,0        ; AND THEN RESET THE OVERFLOW FLAG
0039 8B 0E 006E R               MOV     CX,@TIMER_HIGH      ; GET COUNT OF TIME HIGH WORD
003D 8B 16 006C R               MOV     DX,@TIMER_LOW       ; GET COUNT OF TIME LOW WORD
0041 C3                         RET                         ; RETURN WITH NO CARRY

0042                    RTC_10:                             ;       SET TIME COUNT
0042 89 16 006C R               MOV     @TIMER_LOW,DX       ; SET TIME COUNT LOW WORD
0046 89 0E 006E R               MOV     @TIMER_HIGH,CX      ; SET THE TIME COUNT HIGH WORD
004A C6 06 0070 R 00            MOV     @TIMER_OFL,0        ; RESET OVERFLOW FLAG
004F C3                         RET                         ; RETURN WITH NO CARRY

0050                    RTC_20:                             ;       GET RTC TIME
0050 E8 016B R                  CALL    UPD_IPR             ; CHECK FOR UPDATE IN PROCESS
0053 72 1F                      JC      RTC_29              ; EXIT IF ERROR (CY= 1)

0055 B0 00                      MOV     AL,CMOS_SECONDS     ; SET ADDRESS OF SECONDS
0057 E8 0000 E                  CALL    CMOS_READ           ; GET SECONDS
005A 8A F0                      MOV     DH,AL               ; SAVE
005C B0 0B                      MOV     AL,CMOS_REG_B       ; ADDRESS ALARM REGISTER
005E E8 0000 E                  CALL    CMOS_READ           ; READ CURRENT VALUE OF DSE BIT
0061 24 01                      AND     AL,00000001B        ; MASK FOR VALID DSE BIT
0063 8A D0                      MOV     DL,AL               ; SET (DL) TO ZERO FOR NO DSE BIT
0065 B0 02                      MOV     AL,CMOS_MINUTES     ; SET ADDRESS OF MINUTES
0067 E8 0000 E                  CALL    CMOS_READ           ; GET MINUTES
006A 8A C8                      MOV     CL,AL               ; SAVE
006C B0 04                      MOV     AL,CMOS_HOURS       ; SET ADDRESS OF HOURS
006E E8 0000 E                  CALL    CMOS_READ           ; GET HOURS
0071 8A E8                      MOV     CH,AL               ; SAVE
0073 F8                         CLC                         ; SET CY= 0
0074                    RTC_29:
0074 C3                         RET                         ; RETURN WITH RESULT IN CARRY FLAG

0075                    RTC_30:                             ;       SET RTC TIME
0075 E8 016B R                  CALL    UPD_IPR             ; CHECK FOR UPDATE IN PROCESS
0078 73 03                      JNC     RTC_35              ; GO AROUND IF CLOCK OPERATING
007A E8 0154 R                  CALL    RTC_STA             ; ELSE TRY INITIALIZING CLOCK
007D                    RTC_35:
007D 8A E6                      MOV     AH,DH               ; GET TIME BYTE - SECONDS
007F B0 00                      MOV     AL,CMOS_SECONDS     ; ADDRESS SECONDS
0081 E8 0000 E                  CALL    CMOS_WRITE          ; UPDATE SECONDS
0084 8A E1                      MOV     AH,CL               ; GET TIME BYTE - MINUTES
0086 B0 02                      MOV     AL,CMOS_MINUTES     ; ADDRESS MINUTES
0088 E8 0000 E                  CALL    CMOS_WRITE          ; UPDATE MINUTES
008B 8A E5                      MOV     AH,CH               ; GET TIME BYTE - HOURS
008D B0 04                      MOV     AL,CMOS_HOURS       ; ADDRESS HOURS
008F E8 0000 E                  CALL    CMOS_WRITE          ; UPDATE ADDRESS
0092 B8 0B0B                    MOV     AX,X*CMOS_REG_B     ; ADDRESS ALARM REGISTER
0095 E8 0000 E                  CALL    CMOS_READ           ; READ CURRENT VALUE
0098 24 62                      AND     AL,01100010B        ; MASK FOR VALID BIT POSITIONS
009A 0C 02                      OR      AL,00000010B        ; TURN ON 24 HOUR MODE
009C 80 E2 01                   AND     DL,00000001B        ; USE ONLY THE DSE BIT
009F 0A C2                      OR      AL,DL               ; GET DAY LIGHT SAVINGS TIME BIT (DSE)
00A1 86 E0                      XCHG    AH,AL               ; PLACE IN WORK REGISTER AND GET ADDRESS
00A3 E8 0000 E                  CALL    CMOS_WRITE          ; SET NEW ALARM BITS
00A6 F8                         CLC                         ; SET CY= 0
00A7 C3                         RET                         ; RETURN WITH CY= 0

00A8                    RTC_40:                             ;       GET RTC DATE
00A8 E8 016B R                  CALL    UPD_IPR             ; CHECK FOR UPDATE IN PROCESS
00AB 72 1D                      JC      RTC_49              ; EXIT IF ERROR (CY= 1)

00AD B0 07                      MOV     AL,CMOS_DAY_MONTH   ; ADDRESS DAY OF MONTH
00AF E8 0000 E                  CALL    CMOS_READ           ; READ DAY OF MONTH
00B2 8A D0                      MOV     DL,AL               ; SAVE
00B4 B0 08                      MOV     AL,CMOS_MONTH       ; ADDRESS MONTH
00B6 E8 0000 E                  CALL    CMOS_READ           ; READ MONTH
00B9 8A F0                      MOV     DH,AL               ; SAVE
00BB B0 09                      MOV     AL,CMOS_YEAR        ; ADDRESS YEAR
00BD E8 0000 E                  CALL    CMOS_READ           ; READ YEAR
00C0 8A C8                      MOV     CL,AL               ; SAVE
00C2 B0 32                      MOV     AL,CMOS_CENTURY     ; ADDRESS CENTURY LOCATION
00C4 E8 0000 E                  CALL    CMOS_READ           ; GET CENTURY BYTE
00C7 8A E8                      MOV     CH,AL               ; SAVE
00C9 F8                         CLC                         ; SET CY=0
00CA                    RTC_49:
00CA C3                         RET                         ; RETURN WITH RESULTS IN CARRY FLAG

00CB                    RTC_50:                             ;       SET RTC DATE
00CB E8 016B R                  CALL    UPD_IPR             ; CHECK FOR UPDATE IN PROCESS
00CE 73 03                      JNC     RTC_55              ; GO AROUND IF NO ERROR
00D0 E8 0154 R                  CALL    RTC_STA             ; ELSE INITIALIZE CLOCK
00D3                    RTC_55:
00D3 B8 0006                    MOV     AX,CMOS_DAY_WEEK    ; ADDRESS OF DAY OF WEEK BYTE
00D6 E8 0000 E                  CALL    CMOS_WRITE          ; LOAD ZEROS TO DAY OF WEEK
00D9 8A E2                      MOV     AH,DL               ; GET DAY OF MONTH BYTE
00DB B0 07                      MOV     AL,CMOS_DAY_MONTH   ; ADDRESS DAY OF MONTH BYTE
00DD E8 0000 E                  CALL    CMOS_WRITE          ; WRITE OF DAY OF MONTH REGISTER
00E0 8A E6                      MOV     AH,DH               ; GET MONTH
00E2 B0 08                      MOV     AL,CMOS_MONTH       ; ADDRESS MONTH BYTE
00E4 E8 0000 E                  CALL    CMOS_WRITE          ; WRITE MONTH REGISTER
00E7 8A E1                      MOV     AH,CL               ; GET YEAR BYTE
00E9 B0 09                      MOV     AL,CMOS_YEAR        ; ADDRESS YEAR REGISTER
00EB E8 0000 E                  CALL    CMOS_WRITE          ; WRITE YEAR REGISTER
00EE 8A E5                      MOV     AH,CH               ; GET CENTURY BYTE
00F0 B0 32                      MOV     AL,CMOS_CENTURY     ; ADDRESS CENTURY BYTE
00F2 E8 0000 E                  CALL    CMOS_WRITE          ; WRITE CENTURY LOCATION
00F5 B8 0B0B                    MOV     AX,X*CMOS_REG_B     ; ADDRESS ALARM REGISTER
00F8 E8 0000 E                  CALL    CMOS_READ           ; READ CURRENT SETTINGS
00FB 24 7F                      AND     AL,07FH             ; CLEAR 'SET BIT'
00FD 86 E0                      XCHG    AH,AL               ; MOVE TO WORK REGISTER
00FF E8 0000 E                  CALL    CMOS_WRITE          ;  AND START CLOCK UPDATING
0102 F8                         CLC                         ; SET CY= 0
0103 C3                         RET                         ; RETURN CY=0
```

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                                PAGE
 0104                           RTC_60:                                 ;       SET RTC ALARM
 0104 B0 0B                             MOV     AL,CMOS_REG_B           ; ADDRESS ALARM
 0106 E8 0000 E                         CALL    CMOS_READ               ; READ ALARM REGISTER
 0109 A8 20                             TEST    AL,20H                  ; CHECK FOR ALARM ALREADY ENABLED
 010B F9                                STC                             ; SET CARRY IN CASE OF ERROR
 010C 75 33                             JNZ     RTC_69                  ; ERROR EXIT IF ALARM SET

 010E E8 016B R                         CALL    UPD_IPR                 ; CHECK FOR UPDATE IN PROCESS
 0111 73 03                             JNC     RTC_65                  ; SKIP INITIALIZATION IF NO ERROR
 0113 E8 0154 R                         CALL    RTC_STA                 ; ELSE INITIALIZE CLOCK
 0116                           RTC_65:
 0116 8A E6                             MOV     AH,DH                   ; GET SECONDS BYTE
 0118 B0 01                             MOV     AL,CMOS_SEC_ALARM       ; ADDRESS THE SECONDS ALARM REGISTER
 011A E8 0000 E                         CALL    CMOS_WRITE              ; INSERT SECONDS
 011D 8A E1                             MOV     AH,CL                   ; GET MINUTES PARAMETER
 011F B0 03                             MOV     AL,CMOS_MIN_ALARM       ; ADDRESS MINUTES ALARM REGISTER
 0121 E8 0000 E                         CALL    CMOS_WRITE              ; INSERT MINUTES
 0124 8A E5                             MOV     AH,CH                   ; GET HOURS PARAMETER
 0126 B0 05                             MOV     AL,CMOS_HR_ALARM        ; ADDRESS HOUR ALARM REGISTER
 0128 E8 0000 E                         CALL    CMOS_WRITE              ; INSERT HOURS
 012B E4 A1                             IN      AL,INTB01               ; READ SECOND INTERRUPT MASK REGISTER
 012D 24 FE                             AND     AL,0FEH                 ; ENABLE ALARM TIMER BIT (CY= 0)
 012F E6 A1                             OUT     INTB01,AL               ; WRITE UPDATED MASK
 0131 B8 0B0B                           MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER
 0134 E8 0000 E                         CALL    CMOS_READ               ; READ CURRENT ALARM REGISTER
 0137 24 7F                             AND     AL,07FH                 ; ENSURE SET BIT TURNED OFF
 0139 0C 20                             OR      AL,20H                  ; TURN ON ALARM ENABLE
 013B 86 E0                             XCHG    AH,AL                   ; MOVE MASK TO OUTPUT REGISTER
 013D E8 0000 E                         CALL    CMOS_WRITE              ; WRITE NEW ALARM MASK
 0140 F8                                CLC                             ; SET CY= 0
 0141                           RTC_69:
 0141 B8 0000                           MOV     AX,0                    ; CLEAR AX REGISTER
 0144 C3                                RET                             ; RETURN WITH RESULTS IN CARRY FLAG

 0145                           RTC_70:                                 ;       RESET ALARM
 0145 B8 0B0B                           MOV     AX,X*CMOS_REG_B         ; ADDRESS ALARM REGISTER (TO BOTH AH,AL)
 0148 E8 0000 E                         CALL    CMOS_READ               ; READ ALARM REGISTER
 014B 24 57                             AND     AL,57H                  ; TURN OFF ALARM ENABLE
 014D 86 E0                             XCHG    AH,AL                   ; SAVE DATA AND RECOVER ADDRESS
 014F E8 0000 E                         CALL    CMOS_WRITE              ; RESTORE NEW VALUE
 0152 F8                                CLC                             ; SET CY= 0
 0153 C3                                RET                             ; RETURN WITH NO CARRY

 0154                           RTC_00  ENDP

 0154                           RTC_STA PROC    NEAR                    ;       INITIALIZE REAL TIME CLOCK
 0154 B8 260A                           MOV     AX,26H*H+CMOS_REG_A     ; ADDRESS REGISTER A AND LOAD DATA MASK
 0157 E8 0000 E                         CALL    CMOS_WRITE              ; INITIALIZE STATUS REGISTER A
 015A B8 820B                           MOV     AX,82H*H+CMOS_REG_B     ; SET "SET BIT" FOR CLOCK INITIALIZATION
 015D E8 0000 E                         CALL    CMOS_WRITE              ; AND 24 HOUR MODE TO REGISTER B
 0160 B0 0C                             MOV     AL,CMOS_REG_C           ; ADDRESS REGISTER C
 0162 E8 0000 E                         CALL    CMOS_READ               ; READ REGISTER C TO INITIALIZE
 0165 B0 0D                             MOV     AL,CMOS_REG_D           ; ADDRESS REGISTER D
 0167 E8 0000 E                         CALL    CMOS_READ               ; READ REGISTER D TO INITIALIZE
 016A C3                                RET

 016B                           RTC_STA ENDP

 016B                           UPD_IPR PROC    NEAR                    ;       WAIT TILL UPDATE NOT IN PROGRESS
 016B 51                                PUSH    CX                      ; SAVE CALLERS REGISTER
 016C B9 0320                           MOV     CX,800                  ; SET TIMEOUT LOOP COUNT
 016F                           UPD_10:
 016F B0 0A                             MOV     AL,CMOS_REG_A           ; ADDRESS STATUS REGISTER A
 0171 FA                                CLI                             ; NO TIMER INTERRUPTS DURING UPDATES
 0172 E8 0000 E                         CALL    CMOS_READ               ; READ UPDATE IN PROCESS FLAG
 0175 A8 80                             TEST    AL,80H                  ; IF UIP BIT IS ON ( CANNOT READ TIME )
 0177 74 06                             JZ      UPD_90                  ; EXIT WITH CY= 0 IF CAN READ CLOCK NOW
 0179 FB                                STI                             ; ALLOW INTERRUPTS WHILE WAITING
 017A E2 F3                             LOOP    UPD_10                  ; LOOP TILL READY OR TIMEOUT
 017C 33 C0                             XOR     AX,AX                   ; CLEAR RESULTS IF ERROR
 017E F9                                STC                             ; SET CARRY FOR ERROR
 017F                           UPD_90:
 017F 59                                POP     CX                      ; RESTORE CALLERS REGISTER
 0180 FA                                CLI                             ; INTERRUPTS OFF DURING SET
 0181 C3                                RET                             ; RETURN WITH CY FLAG SET

 0182                           UPD_IPR ENDP
```

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                                 PAGE
                                 ;--- HARDWARE INT  70 H -- ( IRQ LEVEL  8 ) ----------------------------------
                                 ; ALARM INTERRUPT HANDLER (RTC)                                              :
                                 ;       THIS ROUTINE HANDLES THE PERIODIC AND ALARM INTERRUPTS FROM THE CMOS  :
                                 ;       TIMER.  INPUT FREQUENCY IS 1.024 KHZ OR APPROXIMATELY 1024 INTERRUPTS :
                                 ;       EVERY SECOND FOR THE PERIODIC INTERRUPT.  FOR THE ALARM FUNCTION,     :
                                 ;       THE INTERRUPT WILL OCCUR AT THE DESIGNATED TIME.                      :
                                 ;                                                                             :
                                 ;       INTERRUPTS ARE ENABLED WHEN THE EVENT OR ALARM FUNCTION IS ACTIVATED. :
                                 ;       FOR THE EVENT INTERRUPT, THE HANDLER WILL DECREMENT THE WAIT COUNTER  :
                                 ;       AND WHEN IT EXPIRES WILL SET THE DESIGNATED LOCATION TO 80H.  FOR     :
                                 ;       THE ALARM INTERRUPT, THE USER MUST PROVIDE A ROUTINE TO INTERCEPT     :
                                 ;       THE CORRECT ADDRESS FROM THE VECTOR TABLE INVOKED BY INTERRUPT 4AH    :
                                 ;       PRIOR TO SETTING THE REAL TIME CLOCK ALARM (INT 1AH, AH= 06H).        :
                                 ;-----------------------------------------------------------------------------

0182                             RTC_INT PROC    FAR                       ;       ALARM INTERRUPT
0182 1E                                  PUSH    DS                        ; LEAVE INTERRUPTS DISABLED
0183 50                                  PUSH    AX                        ; SAVE REGISTERS
0184 57                                  PUSH    DI

0185                             RTC_I_1:                                  ;       CHECK FOR SECOND INTERRUPT
0185 B8 8B8C                             MOV     AX,(CMOS_REG_B+NMI)*H+CMOS_REG_C+NMI ; ALARM AND STATUS
0188 E6 70                               OUT     CMOS_PORT,AL              ; WRITE ALARM FLAG MASK ADDRESS
018A 90                                  NOP                               ; I/O DELAY
018B E4 71                               IN      AL,CMOS_DATA              ; READ AND RESET INTERRUPT REQUEST FLAGS
018D A8 60                               TEST    AL,01100000B              ; CHECK FOR EITHER INTERRUPT PENDING
018F 74 5C                               JZ      RTC_I_9                   ; EXIT IF NOT A VALID RTC INTERRUPT

0191 86 E0                               XCHG    AH,AL                     ; SAVE FLAGS AND GET ENABLE ADDRESS
0193 E6 70                               OUT     CMOS_PORT,AL              ; WRITE ALARM ENABLE MASK ADDRESS
0195 90                                  NOP                               ; I/O DELAY
0196 E4 71                               IN      AL,CMOS_DATA              ; READ CURRENT ALARM ENABLE MASK
0198 22 C4                               AND     AL,AH                     ; ALLOW ONLY SOURCES THAT ARE ENABLED
019A A8 40                               TEST    AL,01000000B              ; CHECK FOR PERIODIC INTERRUPT
019C 74 3F                               JZ      RTC_I_5                   ; SKIP IF NOT A PERIODIC INTERRUPT

                                 ;-----  DECREMENT WAIT COUNT BY INTERRUPT INTERVAL

019E E8 0000 E                           CALL    DDS                       ; ESTABLISH DATA SEGMENT ADDRESSABILITY
01A1 81 2E 009C R 03D0                   SUB     @RTC_LOW,0976             ; DECREMENT COUNT LOW BY 1/1024
01A7 83 1E 009E R 00                     SBB     @RTC_HIGH,0               ; ADJUST HIGH WORD FOR LOW WORD BORROW
01AC 73 2F                               JNC     RTC_I_5                   ; SKIP TILL 32 BIT WORD LESS THAN ZERO

                                 ;-----  TURN OFF PERIODIC INTERRUPT ENABLE

01AE 50                                  PUSH    AX                        ; SAVE INTERRUPT FLAG MASK
01AF B8 8B8B                             MOV     AX,X*(CMOS_REG_B+NMI)     ; INTERRUPT ENABLE REGISTER
01B2 E6 70                               OUT     CMOS_PORT,AL              ; WRITE ADDRESS TO CMOS CLOCK
01B4 90                                  NOP                               ; I/O DELAY
01B5 E4 71                               IN      AL,CMOS_DATA              ; READ CURRENT ENABLES
01B7 24 BF                               AND     AL,0BFH                   ; TURN OFF PIE
01B9 86 C4                               XCHG    AL,AH                     ; GET CMOS ADDRESS AND SAVE VALUE
01BB E6 70                               OUT     CMOS_PORT,AL              ; ADDRESS REGISTER B
01BD 86 C4                               XCHG    AL,AH                     ; GET NEW INTERRUPT ENABLE MASK
01BF E6 71                               OUT     CMOS_DATA,AL              ; SET MASK IN INTERRUPT ENABLE REGISTER
01C1 58                                  POP     AX                        ; GET INTERRUPT SOURCE BACK
01C2 F6 06 00A0 R 02                     TEST    @RTC_WAIT_FLAG,02H        ; CHECK FOR "WAIT" FUNCTION ACTIVE
01C7 C6 06 00A0 R 00                     MOV     @RTC_WAIT_FLAG,0          ;  SET FUNCTION ACTIVE FLAGS OFF
01CC C5 3E 0098 R                        LDS     DI,DWORD PTR @USER_FLAG   ;  SET UP (DS:DI) TO POINT TO USER FLAG
01D0 C6 05 80                            MOV     BYTE PTR [DI],80H         ;  TURN ON USERS POSTED FLAG
01D3 74 08                               JZ      RTC_I_5                   ;  SKIP IF "EVENT_WAIT" FUNCTION

01D5 E8 0000 E                           CALL    DDS                       ; ESTABLISH DATA SEGMENT ADDRESSABILITY
01D8 C6 06 00A0 R 83                     MOV     @RTC_WAIT_FLAG,083H       ; AND SET "WAIT" BACK TO BUSY & POSTED
01DD                             RTC_I_5:
01DD A8 20                               TEST    AL,00100000B              ; TEST FOR ALARM INTERRUPT
01DF 74 0A                               JZ      RTC_I_7                   ; SKIP USER INTERRUPT CALL IF NOT ALARM

01E1 B0 0F                               MOV     AL,CMOS_SHUT_DOWN         ; POINT TO DEFAULT READ ONLY REGISTER
01E3 E6 70                               OUT     CMOS_PORT,AL              ; ENABLE NMI AND CMOS ADDRESS TO DEFAULT
01E5 FB                                  STI                               ; INTERRUPTS BACK ON NOW
01E6 52                                  PUSH    DX
01E7 CD 4A                               INT     4AH                       ; TRANSFER TO USER ROUTINE
01E9 5A                                  POP     DX
01EA FA                                  CLI                               ; BLOCK INTERRUPT FOR RETRY
01EB                             RTC_I_7:                                  ; RESTART ROUTINE TO HANDLE DELAYED
01EB EB 98                               JMP     RTC_I_1                   ;  ENTRY AND SECOND EVENT BEFORE DONE


01ED                             RTC_I_9:                                  ;       EXIT - NO PENDING INTERRUPTS
01ED B0 0F                               MOV     AL,CMOS_SHUT_DOWN         ; POINT TO DEFAULT READ ONLY REGISTER
01EF E6 70                               OUT     CMOS_PORT,AL              ; ENABLE NMI AND CMOS ADDRESS TO DEFAULT
01F1 90                                  NOP                               ; I/O DELAY
01F2 E4 71                               IN      AL,CMOS_DATA              ; OPEN STANDBY LATCH
01F4 B0 20                               MOV     AL,EOI                    ; END OF INTERRUPT MASK TO 8259 - 2
01F6 E6 A0                               OUT     INTB00,AL                 ;  TO 8259 - 2
01F8 E6 20                               OUT     INTA00,AL                 ;  TO 8259 - 1
01FA 5F                                  POP     DI                        ; RESTORE REGISTERS
01FB 58                                  POP     AX
01FC 1F                                  POP     DS
01FD CF                                  IRET                              ; END OF INTERRUPT

01FE                             RTC_INT ENDP
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                              PAGE
                              ;--- INT  05 H -------------------------------------------------------------
                              ; PRINT_SCREEN                                                              :
                              ;       THIS LOGIC WILL BE INVOKED BY INTERRUPT 05H TO PRINT THE SCREEN.    :
                              ;       THE CURSOR POSITION AT THE TIME THIS ROUTINE IS INVOKED WILL BE     :
                              ;       SAVED AND RESTORED UPON COMPLETION.  THE ROUTINE IS INTENDED TO     :
                              ;       RUN WITH INTERRUPTS ENABLED.   IF A SUBSEQUENT PRINT SCREEN KEY     :
                              ;       IS DEPRESSED WHILE THIS ROUTINE IS PRINTING IT WILL BE IGNORED.     :
                              ;       THE BASE PRINTERS STATUS IS CHECKED FOR NOT BUSY AND NOT OUT OF     :
                              ;       PAPER.  AN INITIAL STATUS ERROR WILL ABEND THE PRINT REQUEST.       :
                              ;       ADDRESS  0050:0000  CONTAINS THE STATUS OF THE PRINT SCREEN:        :
                              ;                                                                           :
                              ;       50:0    = 0     PRINT SCREEN HAS NOT BEEN CALLED OR UPON RETURN     :
                              ;                        FROM A CALL THIS INDICATES A SUCCESSFUL OPERATION. :
                              ;               = 1     PRINT SCREEN IS IN PROGRESS - IGNORE THIS REQUEST.  :
                              ;               = 255   ERROR ENCOUNTERED DURING PRINTING.                  :
                              ;---------------------------------------------------------------------------

 01FE                         PRINT_SCREEN_1  PROC    FAR
                                                              ; DELAY INTERRUPT ENABLE TILL FLAG SET
 01FE 1E                              PUSH    DS
 01FF 50                              PUSH    AX              ; SAVE WORK REGISTERS
 0200 53                              PUSH    BX
 0201 51                              PUSH    CX
 0202 52                              PUSH    DX              ; USE 0040:0100 FOR STATUS AREA STORAGE
 0203 E8 0000 E                       CALL    DDS             ; GET STATUS_BYTE DATA SEGMENT
 0206 80 3E 0100 R 01                 CMP     @STATUS_BYTE,1  ; SEE IF PRINT ALREADY IN PROGRESS
 020B 74 74                           JE      PR190           ; EXIT IF PRINT ALREADY IN PROGRESS
 020D C6 06 0100 R 01                 MOV     @STATUS_BYTE,1  ; INDICATE PRINT NOW IN PROGRESS
 0212 FB                              STI                     ; MUST RUN WITH INTERRUPTS ENABLED
 0213 B4 0F                           MOV     AH,0FH          ; WILL REQUEST THE CURRENT SCREEN MODE
 0215 CD 10                           INT     10H             ;       (AL)= MODE
                                                              ;       (AH)= NUMBER COLUMNS/LINE
                                                              ;       (BH)= VISUAL PAGE
 0217 8A CC                           MOV     CL,AH           ; WILL MAKE USE OF (CX) REGISTER TO
 0219 8A 2E 0084 R                    MOV     CH,@ROWS        ;  CONTROL ROWS ON SCREEN & COLUMNS
 021D FE C5                           INC     CH              ; ADJUST ROWS ON DISPLAY COUNT
                                                              ;       (CL)= NUMBER COLUMNS/LINE
                                                              ;       (CH)= NUMBER OF ROWS ON DISPLAY
                                      ;-------------------------------------------------------------
                                      ;       AT THIS POINT WE KNOW THE COLUMNS/LINE COUNT IS IN (CL) :
                                      ;       AND THE NUMBER OF ROWS ON THE DISPLAY IS IN (CH).       :
                                      ;       THE PAGE IF APPLICABLE IS IN (BH).  THE STACK HAS       :
                                      ;       (DS),(AX),(BX),(CX),(DX)  PUSHED.                       :
                                      ;-------------------------------------------------------------
 021F 33 D2                           XOR     DX,DX           ; FIRST PRINTER
 0221 B4 02                           MOV     AH,02H          ; SET PRINTER STATUS REQUEST COMMAND
 0223 CD 17                           INT     17H             ; REQUEST CURRENT PRINTER STATUS
 0225 80 F4 80                        XOR     AH,080H         ; CHECK FOR PRINTER BUSY (NOT CONNECTED)
 0228 F6 C4 A0                        TEST    AH,0A0H         ;  OR  OUT OF PAPER
 022B 75 4E                           JNZ     PR180           ; ERROR EXIT IF PRINTER STATUS ERROR

 022D E8 0287 R                       CALL    CRLF            ; CARRIAGE RETURN LINE FEED TO PRINTER

 0230 51                              PUSH    CX              ; SAVE SCREEN BOUNDS
 0231 B4 03                           MOV     AH,03H          ; NOW READ THE CURRENT CURSOR POSITION
 0233 CD 10                           INT     10H             ; AND RESTORE AT END OF ROUTINE
 0235 59                              POP     CX              ; RECALL SCREEN BOUNDS
 0236 52                              PUSH    DX              ; PRESERVE THE ORIGINAL POSITION
 0237 33 D2                           XOR     DX,DX           ; INITIAL CURSOR (0,0) AND FIRST PRINTER
                                      ;-------------------------------------------------------------
                                      ;       THIS LOOP IS TO READ EACH CURSOR POSITION FROM THE      :
                                      ;       SCREEN AND PRINT IT.  (BH)= VISUAL PAGE  (CH)= ROWS     :
                                      ;-------------------------------------------------------------
 0239                         PR110:
 0239 B4 02                           MOV     AH,02H          ; INDICATE CURSOR SET REQUEST
 023B CD 10                           INT     10H             ; NEW CURSOR POSITION ESTABLISHED
 023D B4 08                           MOV     AH,08H          ; INDICATE READ CHARACTER FROM DISPLAY
 023F CD 10                           INT     10H             ; CHARACTER NOW IN (AL)
 0241 0A C0                           OR      AL,AL           ; SEE IF VALID CHAR
 0243 75 02                           JNZ     PR120           ; JUMP IF VALID CHAR
 0245 B0 20                           MOV     AL,' '          ; ELSE MAKE IT A BLANK
 0247                         PR120:
 0247 52                              PUSH    DX              ; SAVE CURSOR POSITION
 0248 33 D2                           XOR     DX,DX           ; INDICATE FIRST PRINTER (DX= 0)
 024A 32 E4                           XOR     AH,AH           ; INDICATE PRINT CHARACTER IN (AL)
 024C CD 17                           INT     17H             ; PRINT THE CHARACTER
 024E 5A                              POP     DX              ; RECALL CURSOR POSITION
 024F F6 C4 29                        TEST    AH,29H          ; TEST FOR PRINTER ERROR
 0252 75 22                           JNZ     PR170           ; EXIT IF ERROR DETECTED
 0254 FE C2                           INC     DL              ; ADVANCE TO NEXT COLUMN
 0256 3A CA                           CMP     CL,DL           ; SEE IF AT END OF LINE
 0258 75 DF                           JNZ     PR110           ; IF NOT LOOP FOR NEXT COLUMN
 025A 32 D2                           XOR     DL,DL           ; BACK TO COLUMN 0
 025C 8A E2                           MOV     AH,DL           ; (AH)=0
 025E 52                              PUSH    DX              ; SAVE NEW CURSOR POSITION
 025F E8 0287 R                       CALL    CRLF            ; LINE FEED CARRIAGE RETURN
 0262 5A                              POP     DX              ; RECALL CURSOR POSITION
 0263 FE C6                           INC     DH              ; ADVANCE TO NEXT LINE
 0265 3A EE                           CMP     CH,DH           ; FINISHED?
 0267 75 D0                           JNZ     PR110           ; IF NOT LOOP FOR NEXT LINE

 0269 5A                              POP     DX              ; GET CURSOR POSITION
 026A B4 02                           MOV     AH,02H          ; INDICATE REQUEST CURSOR SET
 026C CD 10                           INT     10H             ; CURSOR POSITION RESTORED
 026E FA                              CLI                     ; BLOCK INTERRUPTS TILL STACK CLEARED
 026F C6 06 0100 R 00                 MOV     @STATUS_BYTE,0  ; MOVE OK RESULTS FLAG TO STATUS_BYTE
 0274 EB 0B                           JMP     SHORT PR190     ; EXIT PRINTER ROUTINE

 0276                         PR170:                          ;          ERROR EXIT
 0276 5A                              POP     DX              ; GET CURSOR POSITION
 0277 B4 02                           MOV     AH,02H          ; INDICATE REQUEST CURSOR SET
 0279 CD 10                           INT     10H             ; CURSOR POSITION RESTORED
 027B                         PR180:
 027B FA                              CLI                     ; BLOCK INTERRUPTS TILL STACK CLEARED
 027C C6 06 0100 R FF                 MOV     @STATUS_BYTE,0FFH ; SET ERROR FLAG
 0281                         PR190:
 0281 5A                              POP     DX              ;          EXIT ROUTINE
 0282 59                              POP     CX              ; RESTORE ALL THE REGISTERS USED
 0283 5B                              POP     BX
 0284 58                              POP     AX
 0285 1F                              POP     DS
 0286 CF                              IRET                    ; RETURN WITH INITIAL INTERRUPT MASK
 0287                         PRINT_SCREEN_1  ENDP
```

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                                ;-----  CARRIAGE RETURN, LINE FEED SUBROUTINE

0287                            CRLF    PROC    NEAR
                                                                ;       SEND CR,LF TO FIRST PRINTER
0287 33 D2                              XOR     DX,DX           ; ASSUME FIRST PRINTER (DX= 0)
0289 B8 000D                            MOV     AX,CR           ; GET THE PRINT CHARACTER COMMAND AND
028C CD 17                              INT     17H             ;   THE CARRIAGE RETURN CHARACTER
028E B8 000A                            MOV     AX,LF           ; NOW GET THE LINE FEED AND
0291 CD 17                              INT     17H             ;   SEND IT TO THE BIOS PRINTER ROUTINE
0293 C3                                 RET
0294                            CRLF    ENDP



                                ;-- HARDWARE INT  08 H -- ( IRQ LEVEL 0 ) ---------------------------------------
                                ;                                                                               :
                                ;       THIS ROUTINE HANDLES THE TIMER INTERRUPT FROM FROM CHANNEL 0 OF         :
                                ;       THE 8254 TIMER.  INPUT FREQUENCY IS 1.19318 MHZ AND THE DIVISOR         :
                                ;       IS 65536, RESULTING IN APPROXIMATELY 18.2 INTERRUPTS EVERY SECOND.      :
                                ;                                                                               :
                                ;       THE INTERRUPT HANDLER MAINTAINS A COUNT (40:6C) OF INTERRUPTS SINCE     :
                                ;       POWER ON TIME, WHICH MAY BE USED TO ESTABLISH TIME OF DAY.              :
                                ;       THE INTERRUPT HANDLER ALSO DECREMENTS THE MOTOR CONTROL COUNT (40:40)   :
                                ;       OF THE DISKETTE, AND WHEN IT EXPIRES, WILL TURN OFF THE                 :
                                ;       DISKETTE MOTOR(s), AND RESET THE MOTOR RUNNING FLAGS.                   :
                                ;       THE INTERRUPT HANDLER WILL ALSO INVOKE A USER ROUTINE THROUGH           :
                                ;       INTERRUPT 1CH AT EVERY TIME TICK.  THE USER MUST CODE A                 :
                                ;       ROUTINE AND PLACE THE CORRECT ADDRESS IN THE VECTOR TABLE.              :
                                ;--------------------------------------------------------------------------------

0294                            TIMER_INT_1     PROC    FAR
0294 FB                                 STI                     ; INTERRUPTS BACK ON
0295 1E                                 PUSH    DS
0296 50                                 PUSH    AX
0297 52                                 PUSH    DX              ; SAVE MACHINE STATE
0298 E8 0000 E                          CALL    DDS             ; ESTABLISH ADDRESSABILITY
029B FF 06 006C R                       INC     •TIMER_LOW      ; INCREMENT TIME
029F 75 04                              JNZ     T4              ; GO TO TEST_DAY
02A1 FF 06 006E R                       INC     •TIMER_HIGH     ; INCREMENT HIGH WORD OF TIME
02A5                            T4:                             ;       TEST_DAY
02A5 83 3E 006E R 18                    CMP     •TIMER_HIGH,018H ; TEST FOR COUNT EQUALING 24 HOURS
02AA 75 15                              JNZ     T5              ; GO TO DISKETTE_CTL
02AC 81 3E 006C R 00B0                  CMP     •TIMER_LOW,0B0H
02B2 75 0D                              JNZ     T5              ; GO TO DISKETTE_CTL

                                ;-----  TIMER HAS GONE 24 HOURS

02B4 2B C0                              SUB     AX,AX
02B6 A3 006E R                          MOV     •TIMER_HIGH,AX
02B9 A3 006C R                          MOV     •TIMER_LOW,AX
02BC C6 06 0070 R 01                    MOV     •TIMER_OFL,1

                                ;-----  TEST FOR DISKETTE TIME OUT

02C1                            T5:
02C1 FE 0E 0040 R                       DEC     •MOTOR_COUNT    ; DECREMENT DISKETTE MOTOR CONTROL
02C5 75 0B                              JNZ     T6              ; RETURN IF COUNT NOT OUT
02C7 80 26 003F R F0                    AND     •MOTOR_STATUS,0F0H ; TURN OFF MOTOR RUNNING BITS
02CC B0 0C                              MOV     AL,0CH
02CE BA 03F2                            MOV     DX,03F2H        ; FDC CTL PORT
02D1 EE                                 OUT     DX,AL           ; TURN OFF THE MOTOR

02D2                            T6:                             ;       TIMER TICK INTERRUPT
02D2 CD 1C                              INT     1CH             ; TRANSFER CONTROL TO A USER ROUTINE

02D4 5A                                 POP     DX              ; RESTORE (DX)
02D5 B0 20                              MOV     AL,EOI          ; GET END OF INTERRUPT MASK
02D7 FA                                 CLI                     ; DISABLE INTERRUPTS TILL STACK CLEARED
02D8 E6 20                              OUT     INTA00,AL       ; END OF INTERRUPT TO 8259 - 1
02DA 58                                 POP     AX
02DB 1F                                 POP     DS              ; RESET MACHINE STATE
02DC CF                                 IRET                    ; RETURN FROM INTERRUPT

02DD                            TIMER_INT_1     ENDP

02DD                            CODE    ENDS
                                        END
                                PAGE 118,121
                                TITLE ORGS ----- 04/21/86  COMPATIBILITY MODULE
                                .LIST
 0000                           CODE    SEGMENT BYTE PUBLIC

                                        PUBLIC  A1
                                        PUBLIC  CONF_TBL
                                        PUBLIC  CRT_CHAR_GEN
                                        PUBLIC  D1
                                        PUBLIC  D2
                                        PUBLIC  D2A
                                        PUBLIC  DISK_BASE
                                        PUBLIC  DUMMY_RETURN
                                        PUBLIC  E101
                                        PUBLIC  E102
                                        PUBLIC  E103
                                        PUBLIC  E104
                                        PUBLIC  E105
                                        PUBLIC  E106
                                        PUBLIC  E107
                                        PUBLIC  E108
                                        PUBLIC  E109
                                        PUBLIC  E161
                                        PUBLIC  E162
                                        PUBLIC  E163
                                        PUBLIC  E164
                                        PUBLIC  E201
                                        PUBLIC  E202
                                        PUBLIC  E203
                                        PUBLIC  E301
                                        PUBLIC  E302
                                        PUBLIC  E303
                                        PUBLIC  E304
                                        PUBLIC  E401
                                        PUBLIC  E501
                                        PUBLIC  E601
                                        PUBLIC  E602
                                        PUBLIC  F1780
                                        PUBLIC  F1781
                                        PUBLIC  F1782
                                        PUBLIC  F1790
                                        PUBLIC  F1791
                                        PUBLIC  F3A
                                        PUBLIC  F3D
                                        PUBLIC  F3D1
                                        PUBLIC  FD_TBL
                                        PUBLIC  FLOPPY
                                        PUBLIC  HRD
                                        PUBLIC  K6
                                        PUBLIC  K6L
                                        PUBLIC  K7
                                        PUBLIC  K8
                                        PUBLIC  K10
                                        PUBLIC  K11
                                        PUBLIC  K12
                                        PUBLIC  K14
                                        PUBLIC  K15
                                        PUBLIC  M4
                                        PUBLIC  M5
                                        PUBLIC  M6
                                        PUBLIC  M7
                                        PUBLIC  NMI_INT
                                        PUBLIC  PRINT_SCREEN
                                        PUBLIC  P_O_R
                                        PUBLIC  SEEKS_1
                                        PUBLIC  SLAVE_VECTOR_TABLE
                                        PUBLIC  TUTOR
                                        PUBLIC  VECTOR_TABLE
                                        PUBLIC  VIDEO_PARMS

                                        EXTRN   BOOT_STRAP_1:NEAR
                                        EXTRN   CASSETTE_IO_1:NEAR
                                        EXTRN   D11:NEAR
                                        EXTRN   DISK_INT_1:NEAR
                                        EXTRN   DISK_SETUP:NEAR
                                        EXTRN   DISKETTE_IO_1:NEAR
                                        EXTRN   DSKETTE_SETUP:NEAR
                                        EXTRN   EQUIPMENT_1:NEAR
                                        EXTRN   INT_287:NEAR
                                        EXTRN   K16:NEAR
                                        EXTRN   KEYBOARD_IO_1:NEAR
                                        EXTRN   KB_INT_1:NEAR
                                        EXTRN   MEMORY_SIZE_DET_1:NEAR
                                        EXTRN   NMI_INT_1:NEAR
                                        EXTRN   PRINT_SCREEN_1:NEAR
                                        EXTRN   PRINTER_IO_1:NEAR
                                        EXTRN   RE_DIRECT:NEAR
                                        EXTRN   RS232_IO_1:NEAR
                                        EXTRN   RTC_INT:NEAR
                                        EXTRN   SEEK:NEAR
                                        EXTRN   START_1:NEAR
                                        EXTRN   TIME_OF_DAY_1:NEAR
                                        EXTRN   TIMER_INT_1:NEAR
                                        EXTRN   VIDEO_IO_1:NEAR

                                        ASSUME  CS:CODE,DS:DATA

                                ;------------------------------------------------------------------------------
                                ;                                                                             :
                                ;   THIS MODULE HAS BEEN ADDED TO FACILITATE THE EXPANSION OF THIS PROGRAM.   :
                                ;   IT ALLOWS FOR THE FIXED ORG STATEMENT ENTRY POINTS THAT HAVE TO REMAIN    :
                                ;   AT THE SAME ADDRESSES.   THE USE OF ENTRY POINTS AND TABLES WITHIN THIS   :
                                ;   MODULE SHOULD BE AVOIDED AND ARE INCLUDED ONLY TO SUPPORT EXISTING CODE   :
                                ;   THAT VIOLATE THE STRUCTURE AND DESIGN OF BIOS.   ALL BIOS ACCESS SHOULD   :
                                ;   USE THE DOCUMENTED INTERRUPT VECTOR INTERFACE FOR COMPATIBILITY.          :
                                ;                                                                             :
                                ;------------------------------------------------------------------------------
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                                        PAGE
                                        ;---------------------------------
                                        ;       COPYRIGHT NOTICE         ;
                                        ;---------------------------------
                                        ;;-     ORG     0E000H
 0000                                           ORG     00000H

 0000 37 38 58 37 34 36                         DB       '78X7462 COPR. IBM 1981, 1986     '
      32 20 43 4F 50 52
      2E 20 49 42 4D 20
      31 39 38 31 2C 20
      31 39 38 36 20 20
      20 20

                                        ;----------------------------------------
                                        ;       PARITY ERROR MESSAGES           ;
                                        ;----------------------------------------

 0020 50 41 52 49 54 59                 D1      DB      'PARITY CHECK 1',CR,LF  ; PLANAR BOARD PARITY CHECK LATCH SET
      20 43 48 45 43 4B
      20 31 0D 0A
 0030 50 41 52 49 54 59                 D2      DB      'PARITY CHECK 2',CR,LF  ; I/O CHANNEL CHECK LATCH SET
      20 43 48 45 43 4B
      20 32 0D 0A
 0040 3F 3F 3F 3F 3F 0D                 D2A     DB      '?????',CR,LF
      0A
 = 0047                                 IP      =       $
                                        ;;-     ORG     0E05BH
 005B                                           ORG     0005BH
 005B                                   RESET:                                  ;         RESET START
 005B E9 0000 E                                 JMP     START_1                 ; VECTOR ON TO THE MOVED POST CODE

                                        ;---------------------------------
                                        ;       POST ERROR MESSAGES      ;
                                        ;---------------------------------

 005E 20 31 30 31 2D 53                 E101    DB      ' 101-System Board Error',CR,LF ; INTERRUPT FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 0077 20 31 30 32 2D 53                 E102    DB      ' 102-System Board Error',CR,LF ; TIMER FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 0090 20 31 30 33 2D 53                 E103    DB      ' 103-System Board Error',CR,LF ; TIMER INTERRUPT FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00A9 20 31 30 34 2D 53                 E104    DB      ' 104-System Board Error',CR,LF ; PROTECTED MODE FAILURE
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00C2 20 31 30 35 2D 53                 E105    DB      ' 105-System Board Error',CR,LF ; LAST 8042 COMMAND NOT ACCEPTED
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00DB 20 31 30 36 2D 53                 E106    DB      ' 106-System Board Error',CR,LF ; CONVERTING LOGIC TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 00F4 20 31 30 37 2D 53                 E107    DB      ' 107-System Board Error',CR,LF ; HOT NMI TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 010D 20 31 30 38 2D 53                 E108    DB      ' 108-System Board Error',CR,LF ; TIMER BUS TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 0126 20 31 30 39 2D 53                 E109    DB      ' 109-System Board Error',CR,LF ; LOW MEG CHIP SELECT TEST
      79 73 74 65 6D 20
      42 6F 61 72 64 20
      45 72 72 6F 72 0D
      0A
 013F 20 31 36 31 2D 53                 E161    DB      ' 161-System Options Not Set-(Run SETUP)',CR,LF ; DEAD BATTERY
      79 73 74 65 6D 20
      4F 70 74 69 6F 6E
      73 20 4E 6F 74 20
      53 65 74 2D 28 52
      75 6E 20 53 45 54
      55 50 29 0D 0A
 0168 20 31 36 32 2D 53                 E162    DB      ' 162-System Options Not Set-(Run SETUP)',CR,LF ;CHECKSUM/CONFIG
      79 73 74 65 6D 20
      4F 70 74 69 6F 6E
      73 20 4E 6F 74 20
      53 65 74 2D 28 52
      75 6E 20 53 45 54
      55 50 29 0D 0A
 0191 20 31 36 33 2D 54                 E163    DB      ' 163-Time & Date Not Set-(Run SETUP)',CR,LF ;CLOCK NOT UPDATING
      69 6D 65 20 26 20
      44 61 74 65 20 4E
      6F 74 20 53 65 74
      2D 28 52 75 6E 20
      53 45 54 55 50 29
      0D 0A
 01B7 20 31 36 34 2D 4D                 E164    DB      ' 164-Memory Size Error-(Run SETUP)',CR,LF ; CMOS DOES NOT MATCH
      65 6D 6F 72 79 20
      53 69 7A 65 20 45
      72 72 6F 72 2D 28
      52 75 6E 20 53 45
      54 55 50 29 0D 0A
 01DB 20 32 30 31 2D 4D                 E201    DB      ' 201-Memory Error',CR,LF
      65 6D 6F 72 79 20
      45 72 72 6F 72 0D
      0A
 01EE 20 32 30 32 2D 4D                 E202    DB      ' 202-Memory Address Error',CR,LF             ; LINE ERROR 00->15
      65 6D 6F 72 79 20
      41 64 64 72 65 73
      73 20 45 72 72 6F
      72 0D 0A
0209  20 32 30 33 2D 4D   E203    DB      ' 203-Memory Address Error',CR,LF            ; LINE ERROR 16->23
      65 6D 6F 72 79 20
      41 64 64 72 65 73
      73 20 45 72 72 6F
      72 0D 0A
0224  20 33 30 31 2D 4B   E301    DB      ' 301-Keyboard Error',CR,LF                  ; KEYBOARD ERROR
      65 79 62 6F 61 72
      64 20 45 72 72 6F
      72 0D 0A
0239  20 33 30 32 2D 53   E302    DB      ' 302-System Unit Keylock is Locked',CR,LF   ; KEYBOARD LOCK ON
      79 73 74 65 6D 20
      55 6E 69 74 20 4B
      65 79 6C 6F 63 6B
      20 69 73 20 4C 6F
      63 6B 65 64 0D 0A
025D  20 28 52 45 53 55   F3D     DB      ' (RESUME = "F1" KEY)',CR,LF
      4D 45 20 3D 20 22
      46 31 22 20 4B 45
      59 29 0D 0A

                          ;-----  NMI ENTRY

= 0273                    IP      =       $
                          ;;-     ORG     0E2C3H
02C3                              ORG     002C3H
= 02C3                    NMI_INT EQU     $
02C3 E9 0000 E                    JMP     NMI_INT_1            ; VECTOR ON TO MOVED NMI CODE

02C6  20 33 30 33 2D 4B   E303    DB      ' 303-Keyboard Or System Unit Error',CR,LF
      65 79 62 6F 61 72
      64 20 4F 72 20 53
      79 73 74 65 6D 20
      55 6E 69 74 20 45
      72 72 6F 72 0D 0A
                          ;-----  KEYBOARD/SYSTEM ERROR
02EA  20 33 30 34 2D 4B   E304    DB      ' 304-Keyboard Or System Unit Error',CR,LF ; KEYBOARD CLOCK HIGH
      65 79 62 6F 61 72
      64 20 4F 72 20 53
      79 73 74 65 6D 20
      55 6E 69 74 20 45
      72 72 6F 72 0D 0A
030E  20 34 30 31 2D 43   E401    DB      ' 401-CRT Error',CR,LF                          ; MONOCHROME
      52 54 20 45 72 72
      6F 72 0D 0A
031E  20 35 30 31 2D 43   E501    DB      ' 501-CRT Error',CR,LF                          ; COLOR
      52 54 20 45 72 72
      6F 72 0D 0A
032E  20 36 30 31 2D 44   E601    DB      ' 601-Diskette Error',CR,LF                     ; DISKETTE ERROR
      69 73 6B 65 74 74
      65 20 45 72 72 6F
      72 0D 0A
                          ;-----  DISKETTE BOOT RECORD IS NOT VALID
0343  20 36 30 32 2D 44   E602    DB      ' 602-Diskette Boot Record Error',CR,LF
      69 73 6B 65 74 74
      65 20 42 6F 6F 74
      20 52 65 63 6F 72
      64 20 45 72 72 6F
      72 0D 0A
                          ;-----  HARD FILE ERROR MESSAGE
0364  31 37 38 30 2D 44   F1780   DB      '1780-Disk 0 Failure',CR,LF
      69 73 6B 20 30 20
      46 61 69 6C 75 72
      65 0D 0A
0379  31 37 38 31 2D 44   F1781   DB      '1781-Disk 1 Failure',CR,LF
      69 73 6B 20 31 20
      46 61 69 6C 75 72
      65 0D 0A
038E  31 37 38 32 2D 44   F1782   DB      '1782-Disk Controller Failure',CR,LF
      69 73 6B 20 43 6F
      6E 74 72 6F 6C 6C
      65 72 20 46 61 69
      6C 75 72 65 0D 0A
03AC  31 37 39 30 2D 44   F1790   DB      '1790-Disk 0 Error',CR,LF
      69 73 6B 20 30 20
      45 72 72 6F 72 0D
      0A
03BF  31 37 39 31 2D 44   F1791   DB      '1791-Disk 1 Error',CR,LF
      69 73 6B 20 31 20
      45 72 72 6F 72 0D
      0A

03D2  52 4F 4D 20 20 45   F3A     DB      'ROM  Error ',CR,LF                    ; ROM CHECKSUM
      72 72 6F 72 20 0D
      0A
03DF  20 20 20 20 2D 55   F3D1    DB      '    -Unlock System Unit Keylock ',CR,LF
      6E 6C 6F 63 6B 20
      53 79 73 74 65 6D
      20 55 6E 69 74 20
      4B 65 79 6C 6F 63
      6B 20 0D 0A
```

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                                PAGE
                                ;----------------------------------------------------
                                ; INITIALIZE DRIVE CHARACTERISTICS                   ;
                                ;                                                    ;
                                ; FIXED DISK PARAMETER TABLE                         ;
                                ;                                                    ;
                                ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:   ;
                                ;                                                    ;
                                ;  +0   (1 WORD) - MAXIMUM NUMBER OF CYLINDERS       ;
                                ;  +2   (1 BYTE) - MAXIMUM NUMBER OF HEADS           ;
                                ;  +3   (1 WORD) - NOT USED/SEE PC-XT                ;
                                ;  +5   (1 WORD) - STARTING WRITE PRECOMPENSATION CYL ;
                                ;  +7   (1 BYTE) - NOT USED/SEE PC-XT                ;
                                ;  +8   (1 BYTE) - CONTROL BYTE                      ;
                                ;                  BIT    7 DISABLE RETRIES -OR-     ;
                                ;                  BIT    6 DISABLE RETRIES          ;
                                ;                  BIT    3 MORE THAN 8 HEADS        ;
                                ;  +9   (3 BYTES)- NOT USED/SEE PC-XT                ;
                                ; +12   (1 WORD) - LANDING ZONE                      ;
                                ; +14   (1 BYTE) - NUMBER OF SECTORS/TRACK           ;
                                ; +15   (1 BYTE) - RESERVED FOR FUTURE USE           ;
                                ;                                                    ;
                                ;        - TO DYNAMICALLY DEFINE A SET OF PARAMETERS ;
                                ;          BUILD A TABLE FOR UP TO 15 TYPES AND PLACE ;
                                ;          THE CORRESPONDING VECTOR INTO INTERRUPT 41 ;
                                ;          FOR DRIVE 0 AND INTERRUPT 46 FOR DRIVE 1. ;
                                ;                                                    ;
                                ;----------------------------------------------------

 0401                           FD_TBL:

                                ;-----  DRIVE TYPE 01

 0401  0132                             DW      0306D                   ; CYLINDERS
 0403  04                               DB      04D                     ; HEADS
 0404  0000                             DW      0
 0406  0080                             DW      0128D                   ; WRITE PRE-COMPENSATION CYLINDER
 0408  00                               DB      0
 0409  00                               DB      0                       ; CONTROL BYTE
 040A  00 00 00                         DB      0,0,0
 040D  0131                             DW      0305D                   ; LANDING ZONE
 040F  11                               DB      17D                     ; SECTORS/TRACK
 0410  00                               DB      0

                                ;-----  DRIVE TYPE 02

 0411  0267                             DW      0615D                   ; CYLINDERS
 0413  04                               DB      04D                     ; HEADS
 0414  0000                             DW      0
 0416  012C                             DW      0300D                   ; WRITE PRE-COMPENSATION CYLINDER
 0418  00                               DB      0
 0419  00                               DB      0                       ; CONTROL BYTE
 041A  00 00 00                         DB      0,0,0
 041D  0267                             DW      0615D                   ; LANDING ZONE
 041F  11                               DB      17D                     ; SECTORS/TRACK
 0420  00                               DB      0

                                ;-----  DRIVE TYPE 03

 0421  0267                             DW      0615D                   ; CYLINDERS
 0423  06                               DB      06D                     ; HEADS
 0424  0000                             DW      0
 0426  012C                             DW      0300D                   ; WRITE PRE-COMPENSATION CYLINDER
 0428  00                               DB      0
 0429  00                               DB      0                       ; CONTROL BYTE
 042A  00 00 00                         DB      0,0,0
 042D  0267                             DW      0615D                   ; LANDING ZONE
 042F  11                               DB      17D                     ; SECTORS/TRACK
 0430  00                               DB      0

                                ;-----  DRIVE TYPE 04

 0431  03AC                             DW      0940D                   ; CYLINDERS
 0433  08                               DB      08D                     ; HEADS
 0434  0000                             DW      0
 0436  0200                             DW      0512D                   ; WRITE PRE-COMPENSATION CYLINDER
 0438  00                               DB      0
 0439  00                               DB      0                       ; CONTROL BYTE
 043A  00 00 00                         DB      0,0,0
 043D  03AC                             DW      0940D                   ; LANDING ZONE
 043F  11                               DB      17D                     ; SECTORS/TRACK
 0440  00                               DB      0

                                ;-----  DRIVE TYPE 05

 0441  03AC                             DW      0940D                   ; CYLINDERS
 0443  06                               DB      06D                     ; HEADS
 0444  0000                             DW      0
 0446  0200                             DW      0512D                   ; WRITE PRE-COMPENSATION CYLINDER
 0448  00                               DB      0
 0449  00                               DB      0                       ; CONTROL BYTE
 044A  00 00 00                         DB      0,0,0
 044D  03AC                             DW      0940D                   ; LANDING ZONE
 044F  11                               DB      17D                     ; SECTORS/TRACK
 0450  00                               DB      0

                                ;-----  DRIVE TYPE 06

 0451  0267                             DW      0615D                   ; CYLINDERS
 0453  04                               DB      04D                     ; HEADS
 0454  0000                             DW      0
 0456  FFFF                             DW      0FFFFH                  ; NO WRITE PRE-COMPENSATION
 0458  00                               DB      0
 0459  00                               DB      0                       ; CONTROL BYTE
 045A  00 00 00                         DB      0,0,0
 045D  0267                             DW      0615D                   ; LANDING ZONE
 045F  11                               DB      17D                     ; SECTORS/TRACK
 0460  00                               DB      0
```

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                              PAGE
                              ;-----  DRIVE TYPE 07

      0461 01CE                       DW      0462D             ; CYLINDERS
      0463 08                         DB      08D               ; HEADS
      0464 0000                       DW      0
      0466 0100                       DW      0256D             ; WRITE PRE-COMPENSATION CYLINDER
      0468 00                         DB      0
      0469 00                         DB      0                 ; CONTROL BYTE
      046A 00 00 00                   DB      0,0,0
      046D 01FF                       DW      0511D             ; LANDING ZONE
      046F 11                         DB      17D               ; SECTORS/TRACK
      0470 00                         DB      0

                              ;-----  DRIVE TYPE 08

      0471 02DD                       DW      0733D             ; CYLINDERS
      0473 05                         DB      05D               ; HEADS
      0474 0000                       DW      0
      0476 FFFF                       DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
      0478 00                         DB      0
      0479 00                         DB      0                 ; CONTROL BYTE
      047A 00 00 00                   DB      0,0,0
      047D 02DD                       DW      0733D             ; LANDING ZONE
      047F 11                         DB      17D               ; SECTORS/TRACK
      0480 00                         DB      0

                              ;-----  DRIVE TYPE 09

      0481 0384                       DW      0900D             ; CYLINDERS
      0483 0F                         DB      15D               ; HEADS
      0484 0000                       DW      0
      0486 FFFF                       DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
      0488 00                         DB      0
      0489 08                         DB      008H              ; CONTROL BYTE
      048A 00 00 00                   DB      0,0,0
      048D 0385                       DW      0901D             ; LANDING ZONE
      048F 11                         DB      17D               ; SECTORS/TRACK
      0490 00                         DB      0

                              ;-----  DRIVE TYPE 10

      0491 0334                       DW      0820D             ; CYLINDERS
      0493 03                         DB      03D               ; HEADS
      0494 0000                       DW      0
      0496 FFFF                       DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
      0498 00                         DB      0
      0499 00                         DB      0                 ; CONTROL BYTE
      049A 00 00 00                   DB      0,0,0
      049D 0334                       DW      0820D             ; LANDING ZONE
      049F 11                         DB      17D               ; SECTORS/TRACK
      04A0 00                         DB      0

                              ;-----  DRIVE TYPE 11

      04A1 0357                       DW      0855D             ; CYLINDERS
      04A3 05                         DB      05D               ; HEADS
      04A4 0000                       DW      0
      04A6 FFFF                       DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
      04A8 00                         DB      0
      04A9 00                         DB      0                 ; CONTROL BYTE
      04AA 00 00 00                   DB      0,0,0
      04AD 0357                       DW      0855D             ; LANDING ZONE
      04AF 11                         DB      17D               ; SECTORS/TRACK
      04B0 00                         DB      0

                              ;-----  DRIVE TYPE 12

      04B1 0357                       DW      0855D             ; CYLINDERS
      04B3 07                         DB      07D               ; HEADS
      04B4 0000                       DW      0
      04B6 FFFF                       DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
      04B8 00                         DB      0
      04B9 00                         DB      0                 ; CONTROL BYTE
      04BA 00 00 00                   DB      0,0,0
      04BD 0357                       DW      0855D             ; LANDING ZONE
      04BF 11                         DB      17D               ; SECTORS/TRACK
      04C0 00                         DB      0

                              ;-----  DRIVE TYPE 13

      04C1 0132                       DW      0306D             ; CYLINDERS
      04C3 08                         DB      08D               ; HEADS
      04C4 0000                       DW      0
      04C6 0080                       DW      0128D             ; WRITE PRE-COMPENSATION CYLINDER
      04C8 00                         DB      0
      04C9 00                         DB      0                 ; CONTROL BYTE
      04CA 00 00 00                   DB      0,0,0
      04CD 013F                       DW      0319D             ; LANDING ZONE
      04CF 11                         DB      17D               ; SECTORS/TRACK
      04D0 00                         DB      0

                              ;-----  DRIVE TYPE 14

      04D1 02DD                       DW      0733D             ; CYLINDERS
      04D3 07                         DB      07D               ; HEADS
      04D4 0000                       DW      0
      04D6 FFFF                       DW      0FFFFH            ; NO WRITE PRE-COMPENSATION
      04D8 00                         DB      0
      04D9 00                         DB      0                 ; CONTROL BYTE
      04DA 00 00 00                   DB      0,0,0
      04DD 02DD                       DW      0733D             ; LANDING ZONE
      04DF 11                         DB      17D               ; SECTORS/TRACK
      04E0 00                         DB      0
```

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                                PAGE
                                ;-----  DRIVE TYPE 15     RESERVED      ****  DO NOT USE****

 04E1 0000                              DW      0000D                ; CYLINDERS
 04E3 00                                DB      00D                  ; HEADS
 04E4 0000                              DW      0
 04E6 0000                              DW      0000D                ; WRITE PRE-COMPENSATION CYLINDER
 04E8 00                                DB      0
 04E9 00                                DB      0                    ; CONTROL BYTE
 04EA 00 00 00                          DB      0,0,0
 04ED 0000                              DW      0000D                ; LANDING ZONE
 04EF 00                                DB      00D                  ; SECTORS/TRACK
 04F0 00                                DB      0

                                ;-----  DRIVE TYPE 16

 04F1 0264                              DW      0612D                ; CYLINDERS
 04F3 04                                DB      04D                  ; HEADS
 04F4 0000                              DW      0
 04F6 0000                              DW      0000D                ; WRITE PRE-COMPENSATION ALL CYLINDER
 04F8 00                                DB      0
 04F9 00                                DB      0                    ; CONTROL BYTE
 04FA 00 00 00                          DB      0,0,0
 04FD 0297                              DW      0663D                ; LANDING ZONE
 04FF 11                                DB      17D                  ; SECTORS/TRACK
 0500 00                                DB      0

                                ;-----  DRIVE TYPE 17

 0501 03D1                              DW      0977D                ; CYLINDERS
 0503 05                                DB      05D                  ; HEADS
 0504 0000                              DW      0
 0506 012C                              DW      0300D                ; WRITE PRE-COMPENSATION CYL
 0508 00                                DB      0
 0509 00                                DB      0                    ; CONTROL BYTE
 050A 00 00 00                          DB      0,0,0
 050D 03D1                              DW      0977D                ; LANDING ZONE
 050F 11                                DB      17D                  ; SECTORS/TRACK
 0510 00                                DB      0

                                ;-----  DRIVE TYPE 18

 0511 03D1                              DW      0977D                ; CYLINDERS
 0513 07                                DB      07D                  ; HEADS
 0514 0000                              DW      0
 0516 FFFF                              DW      0FFFFH               ; NO WRITE PRE-COMPENSATION
 0518 00                                DB      0
 0519 00                                DB      0                    ; CONTROL BYTE
 051A 00 00 00                          DB      0,0,0
 051D 03D1                              DW      0977D                ; LANDING ZONE
 051F 11                                DB      17D                  ; SECTORS/TRACK
 0520 00                                DB      0

                                ;-----  DRIVE TYPE 19

 0521 0400                              DW      1024D                ; CYLINDERS
 0523 07                                DB      07D                  ; HEADS
 0524 0000                              DW      0
 0526 0200                              DW      0512D                ; WRITE PRE-COMPENSATION CYLINDER
 0528 00                                DB      0
 0529 00                                DB      0                    ; CONTROL BYTE
 052A 00 00 00                          DB      0,0,0
 052D 03FF                              DW      1023D                ; LANDING ZONE
 052F 11                                DB      17D                  ; SECTORS/TRACK
 0530 00                                DB      0

                                ;-----  DRIVE TYPE 20

 0531 02DD                              DW      0733D                ; CYLINDERS
 0533 05                                DB      05D                  ; HEADS
 0534 0000                              DW      0
 0536 012C                              DW      0300D                ; WRITE PRE-COMPENSATION CYL
 0538 00                                DB      0
 0539 00                                DB      0                    ; CONTROL BYTE
 053A 00 00 00                          DB      0,0,0
 053D 02DC                              DW      0732D                ; LANDING ZONE
 053F 11                                DB      17D                  ; SECTORS/TRACK
 0540 00                                DB      0

                                ;-----  DRIVE TYPE 21

 0541 02DD                              DW      0733D                ; CYLINDERS
 0543 07                                DB      07D                  ; HEADS
 0544 0000                              DW      0
 0546 012C                              DW      0300D                ; WRITE PRE-COMPENSATION CYL
 0548 00                                DB      0
 0549 00                                DB      0                    ; CONTROL BYTE
 054A 00 00 00                          DB      0,0,0
 054D 02DC                              DW      0732D                ; LANDING ZONE
 054F 11                                DB      17D                  ; SECTORS/TRACK
 0550 00                                DB      0

                                ;-----  DRIVE TYPE 22

 0551 02DD                              DW      0733D                ; CYLINDERS
 0553 05                                DB      05D                  ; HEADS
 0554 0000                              DW      0
 0556 012C                              DW      0300D                ; WRITE PRE-COMPENSATION CYL
 0558 00                                DB      0
 0559 00                                DB      0                    ; CONTROL BYTE
 055A 00 00 00                          DB      0,0,0
 055D 02DD                              DW      0733D                ; LANDING ZONE
 055F 11                                DB      17D                  ; SECTORS/TRACK
 0560 00                                DB      0
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                        PAGE
                        ;-----  DRIVE TYPE 23

0561 0132                       DW      0306D                   ; CYLINDERS
0563 04                         DB      04D                     ; HEADS
0564 0000                       DW      0
0566 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION ALL CYL
0568 00                         DB      0
0569 00                         DB      0                       ; CONTROL BYTE
056A 00 00 00                   DB      0,0,0
056D 0150                       DW      0336D                   ; LANDING ZONE
056F 11                         DB      17D                     ; SECTORS/TRACK
0570 00                         DB      0

                        ;-----  DRIVE TYPE 24

0571 0264                       DW      0612D                   ; CYLINDERS
0573 04                         DB      04D                     ; HEADS
0574 0000                       DW      0
0576 0131                       DW      0305D                   ; WRITE PRE-COMPENSATION CYL
0578 00                         DB      0
0579 00                         DB      0                       ; CONTROL BYTE
057A 00 00 00                   DB      0,0,0
057D 0297                       DW      0663D                   ; LANDING ZONE
057F 11                         DB      17D                     ; SECTORS/TRACK
0580 00                         DB      0

                        ;-----  DRIVE TYPE 25    *** RESERVED***

0581 0000                       DW      0000D                   ; CYLINDERS
0583 00                         DB      00D                     ; HEADS
0584 0000                       DW      0
0586 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0588 00                         DB      0
0589 00                         DB      0                       ; CONTROL BYTE
058A 00 00 00                   DB      0,0,0
058D 0000                       DW      0000D                   ; LANDING ZONE
058F 00                         DB      00D                     ; SECTORS/TRACK
0590 00                         DB      0

                        ;-----  DRIVE TYPE 26    *** RESERVED***

0591 0000                       DW      0000D                   ; CYLINDERS
0593 00                         DB      00D                     ; HEADS
0594 0000                       DW      0
0596 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
0598 00                         DB      0
0599 00                         DB      0                       ; CONTROL BYTE
059A 00 00 00                   DB      0,0,0
059D 0000                       DW      0000D                   ; LANDING ZONE
059F 00                         DB      00D                     ; SECTORS/TRACK
05A0 00                         DB      0

                        ;-----  DRIVE TYPE 27    *** RESERVED***

05A1 0000                       DW      0000D                   ; CYLINDERS
05A3 00                         DB      00D                     ; HEADS
05A4 0000                       DW      0
05A6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05A8 00                         DB      0
05A9 00                         DB      0                       ; CONTROL BYTE
05AA 00 00 00                   DB      0,0,0
05AD 0000                       DW      0000D                   ; LANDING ZONE
05AF 00                         DB      00D                     ; SECTORS/TRACK
05B0 00                         DB      0

                        ;-----  DRIVE TYPE 28    *** RESERVED***

05B1 0000                       DW      0000D                   ; CYLINDERS
05B3 00                         DB      00D                     ; HEADS
05B4 0000                       DW      0
05B6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05B8 00                         DB      0
05B9 00                         DB      0                       ; CONTROL BYTE
05BA 00 00 00                   DB      0,0,0
05BD 0000                       DW      0000D                   ; LANDING ZONE
05BF 00                         DB      00D                     ; SECTORS/TRACK
05C0 00                         DB      0

                        ;-----  DRIVE TYPE 29    *** RESERVED***

05C1 0000                       DW      0000D                   ; CYLINDERS
05C3 00                         DB      00D                     ; HEADS
05C4 0000                       DW      0
05C6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05C8 00                         DB      0
05C9 00                         DB      0                       ; CONTROL BYTE
05CA 00 00 00                   DB      0,0,0
05CD 0000                       DW      0000D                   ; LANDING ZONE
05CF 00                         DB      00D                     ; SECTORS/TRACK
05D0 00                         DB      0

                        ;-----  DRIVE TYPE 30    *** RESERVED***

05D1 0000                       DW      0000D                   ; CYLINDERS
05D3 00                         DB      00D                     ; HEADS
05D4 0000                       DW      0
05D6 0000                       DW      0000D                   ; WRITE PRE-COMPENSATION CYL
05D8 00                         DB      0
05D9 00                         DB      0                       ; CONTROL BYTE
05DA 00 00 00                   DB      0,0,0
05DD 0000                       DW      0000D                   ; LANDING ZONE
05DF 00                         DB      00D                     ; SECTORS/TRACK
05E0 00                         DB      0
```

```
                         PAGE
                         ;-----  DRIVE TYPE 31     *** RESERVED***

05E1 0000                        DW      0000D              ; CYLINDERS
05E3 00                          DB      00D                ; HEADS
05E4 0000                        DW      0
05E6 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
05E8 00                          DB      0
05E9 00                          DB      0                  ; CONTROL BYTE
05EA 00 00 00                    DB      0,0,0
05ED 0000                        DW      0000D              ; LANDING ZONE
05EF 00                          DB      00D                ; SECTORS/TRACK
05F0 00                          DB      0

                         ;-----  DRIVE TYPE 32     *** RESERVED***

05F1 0000                        DW      0000D              ; CYLINDERS
05F3 00                          DB      00D                ; HEADS
05F4 0000                        DW      0
05F6 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
05F8 00                          DB      0
05F9 00                          DB      0                  ; CONTROL BYTE
05FA 00 00 00                    DB      0,0,0
05FD 0000                        DW      0000D              ; LANDING ZONE
05FF 00                          DB      00D                ; SECTORS/TRACK
0600 00                          DB      0

                         ;-----  DRIVE TYPE 33     *** RESERVED***

0601 0000                        DW      0000D              ; CYLINDERS
0603 00                          DB      00D                ; HEADS
0604 0000                        DW      0
0606 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
0608 00                          DB      0
0609 00                          DB      0                  ; CONTROL BYTE
060A 00 00 00                    DB      0,0,0
060D 0000                        DW      0000D              ; LANDING ZONE
060F 00                          DB      00D                ; SECTORS/TRACK
0610 00                          DB      0

                         ;-----  DRIVE TYPE 34     *** RESERVED***

0611 0000                        DW      0000D              ; CYLINDERS
0613 00                          DB      00D                ; HEADS
0614 0000                        DW      0
0616 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
0618 00                          DB      0
0619 00                          DB      0                  ; CONTROL BYTE
061A 00 00 00                    DB      0,0,0
061D 0000                        DW      0000D              ; LANDING ZONE
061F 00                          DB      00D                ; SECTORS/TRACK
0620 00                          DB      0

                         ;-----  DRIVE TYPE 35     *** RESERVED***

0621 0000                        DW      0000D              ; CYLINDERS
0623 00                          DB      00D                ; HEADS
0624 0000                        DW      0
0626 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
0628 00                          DB      0
0629 00                          DB      0                  ; CONTROL BYTE
062A 00 00 00                    DB      0,0,0
062D 0000                        DW      0000D              ; LANDING ZONE
062F 00                          DB      00D                ; SECTORS/TRACK
0630 00                          DB      0

                         ;-----  DRIVE TYPE 36     *** RESERVED***

0631 0000                        DW      0000D              ; CYLINDERS
0633 00                          DB      00D                ; HEADS
0634 0000                        DW      0
0636 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
0638 00                          DB      0
0639 00                          DB      0                  ; CONTROL BYTE
063A 00 00 00                    DB      0,0,0
063D 0000                        DW      0000D              ; LANDING ZONE
063F 00                          DB      00D                ; SECTORS/TRACK
0640 00                          DB      0

                         ;-----  DRIVE TYPE 37     *** RESERVED***

0641 0000                        DW      0000D              ; CYLINDERS
0643 00                          DB      00D                ; HEADS
0644 0000                        DW      0
0646 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
0648 00                          DB      0
0649 00                          DB      0                  ; CONTROL BYTE
064A 00 00 00                    DB      0,0,0
064D 0000                        DW      0000D              ; LANDING ZONE
064F 00                          DB      00D                ; SECTORS/TRACK
0650 00                          DB      0

                         ;-----  DRIVE TYPE 38     *** RESERVED***

0651 0000                        DW      0000D              ; CYLINDERS
0653 00                          DB      00D                ; HEADS
0654 0000                        DW      0
0656 0000                        DW      0000D              ; WRITE PRE-COMPENSATION CYL
0658 00                          DB      0
0659 00                          DB      0                  ; CONTROL BYTE
065A 00 00 00                    DB      0,0,0
065D 0000                        DW      0000D              ; LANDING ZONE
065F 00                          DB      00D                ; SECTORS/TRACK
0660 00                          DB      0
```

```
                             PAGE
                             ;-----  DRIVE TYPE 39     *** RESERVED***

0661 0000                            DW      0000D              ; CYLINDERS
0663 00                              DB      00D                ; HEADS
0664 0000                            DW      0
0666 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
0668 00                              DB      0
0669 00                              DB      0                  ; CONTROL BYTE
066A 00 00 00                        DB      0,0,0
066D 0000                            DW      0000D              ; LANDING ZONE
066F 00                              DB      00D                ; SECTORS/TRACK
0670 00                              DB      0

                             ;-----  DRIVE TYPE 40     *** RESERVED***

0671 0000                            DW      0000D              ; CYLINDERS
0673 00                              DB      00D                ; HEADS
0674 0000                            DW      0
0676 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
0678 00                              DB      0
0679 00                              DB      0                  ; CONTROL BYTE
067A 00 00 00                        DB      0,0,0
067D 0000                            DW      0000D              ; LANDING ZONE
067F 00                              DB      00D                ; SECTORS/TRACK
0680 00                              DB      0

                             ;-----  DRIVE TYPE 41     *** RESERVED***

0681 0000                            DW      0000D              ; CYLINDERS
0683 00                              DB      00D                ; HEADS
0684 0000                            DW      0
0686 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
0688 00                              DB      0
0689 00                              DB      0                  ; CONTROL BYTE
068A 00 00 00                        DB      0,0,0
068D 0000                            DW      0000D              ; LANDING ZONE
068F 00                              DB      00D                ; SECTORS/TRACK
0690 00                              DB      0

                             ;-----  DRIVE TYPE 42     *** RESERVED***

0691 0000                            DW      0000D              ; CYLINDERS
0693 00                              DB      00D                ; HEADS
0694 0000                            DW      0
0696 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
0698 00                              DB      0
0699 00                              DB      0                  ; CONTROL BYTE
069A 00 00 00                        DB      0,0,0
069D 0000                            DW      0000D              ; LANDING ZONE
069F 00                              DB      00D                ; SECTORS/TRACK
06A0 00                              DB      0

                             ;-----  DRIVE TYPE 43     *** RESERVED***

06A1 0000                            DW      0000D              ; CYLINDERS
06A3 00                              DB      00D                ; HEADS
06A4 0000                            DW      0
06A6 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
06A8 00                              DB      0
06A9 00                              DB      0                  ; CONTROL BYTE
06AA 00 00 00                        DB      0,0,0
06AD 0000                            DW      0000D              ; LANDING ZONE
06AF 00                              DB      00D                ; SECTORS/TRACK
06B0 00                              DB      0

                             ;-----  DRIVE TYPE 44     *** RESERVED***

06B1 0000                            DW      0000D              ; CYLINDERS
06B3 00                              DB      00D                ; HEADS
06B4 0000                            DW      0
06B6 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
06B8 00                              DB      0
06B9 00                              DB      0                  ; CONTROL BYTE
06BA 00 00 00                        DB      0,0,0
06BD 0000                            DW      0000D              ; LANDING ZONE
06BF 00                              DB      00D                ; SECTORS/TRACK
06C0 00                              DB      0

                             ;-----  DRIVE TYPE 45     *** RESERVED***

06C1 0000                            DW      0000D              ; CYLINDERS
06C3 00                              DB      00D                ; HEADS
06C4 0000                            DW      0
06C6 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
06C8 00                              DB      0
06C9 00                              DB      0                  ; CONTROL BYTE
06CA 00 00 00                        DB      0,0,0
06CD 0000                            DW      0000D              ; LANDING ZONE
06CF 00                              DB      00D                ; SECTORS/TRACK
06D0 00                              DB      0

                             ;-----  DRIVE TYPE 46     *** RESERVED***

06D1 0000                            DW      0000D              ; CYLINDERS
06D3 00                              DB      00D                ; HEADS
06D4 0000                            DW      0
06D6 0000                            DW      0000D              ; WRITE PRE-COMPENSATION CYL
06D8 00                              DB      0
06D9 00                              DB      0                  ; CONTROL BYTE
06DA 00 00 00                        DB      0,0,0
06DD 0000                            DW      0000D              ; LANDING ZONE
06DF 00                              DB      00D                ; SECTORS/TRACK
06E0 00                              DB      0
```

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                              PAGE
                              ;-----  DRIVE TYPE 47     *** RESERVED***

06E1 0000                             DW      0000D                   ; CYLINDERS
06E3 00                               DB      00D                     ; HEADS
06E4 0000                             DW      0
06E6 0000                             DW      0000D                   ; WRITE PRE-COMPENSATION CYL
06E8 00                               DB      0
06E9 00                               DB      0                       ; CONTROL BYTE
06EA 00 00 00                         DB      0,0,0
06ED 0000                             DW      0000D                   ; LANDING ZONE
06EF 00                               DB      00D                     ; SECTORS/TRACK
06F0 00                               DB      0


                              ;-----  BOOT LOADER INTERRUPT

= 06F1                        IP      =       $
                              ;;-     ORG     0E6F2H
06F2                                  ORG     006F2H
= 06F2                        BOOT_STRAP      EQU     $
06F2 E9 0000 E                        JMP     BOOT_STRAP_1            ; VECTOR ON TO MOVED BOOT CODE

                                                                      ;       USE INT 15 H  AH= 0C0H
06F5                          CONF_TBL:                               ; CONFIGURATION TABLE FOR THIS SYSTEM
06F5 0008                             DW      CONF_E-CONF_TBL-2       ; LENGTH OF FOLLOWING TABLE
06F7 FC                               DB      MODEL_BYTE              ; SYSTEM MODEL BYTE
06F8 02                               DB      SUB_MODEL_BYTE          ; SYSTEM SUB MODEL TYPE BYTE
06F9 00                               DB      BIOS_LEVEL              ; BIOS REVISION LEVEL
06FA 70                               DB      01110000B               ; 10000000 = DMA CHANNEL 3 USE BY BIOS
                                                                      ; 01000000 = CASCADED INTERRUPT LEVEL 2
                                                                      ; 00100000 = REAL TIME CLOCK AVAILABLE
                                                                      ; 00010000 = KEYBOARD SCAN CODE HOOK 1AH
06FB 00                               DB      0                       ; RESERVED
06FC 00                               DB      0                       ; RESERVED
06FD 00                               DB      0                       ; RESERVED
06FE 00                               DB      0                       ; RESERVED
= 06FF                        CONF_E  EQU     $                       ; RESERVED FOR EXPANSION

                              ;-----  BAUD RATE INITIALIZATION TABLE

= 06FF                        IP      =       $
                              ;;-     ORG     0E729H
0729                                  ORG     00729H
0729 0417                     A1      DW      1047                    ; 110 BAUD      ; TABLE OF VALUES
072B 0300                             DW      768                     ; 150           ; FOR INITIALIZATION
072D 0180                             DW      384                     ; 300
072F 00C0                             DW      192                     ; 600
0731 0060                             DW      96                      ; 1200
0733 0030                             DW      48                      ; 2400
0735 0018                             DW      24                      ; 4800
0737 000C                             DW      12                      ; 9600

                              ;-----  RS232

                              ;;-     ORG     0E739H
0739                                  ORG     00739H
= 0739                        RS232_IO        EQU     $
0739 E9 0000 E                        JMP     RS232_IO_1              ; VECTOR ON TO MOVED RS232 CODE

                              ;-----  KEYBOARD

                              ;;-     ORG     0E82EH
082E                                  ORG     0082EH
= 082E                        KEYBOARD_IO     EQU     $
082E E9 0000 E                        JMP     KEYBOARD_IO_1           ; VECTOR ON TO MOVED KEYBOARD CODE

                              ;-----------------------------------------------------------------
                              ;       KEY IDENTIFICATION SCAN TABLES                          -
                              ;-----------------------------------------------------------------
                              ;;-     ORG     0E87EH
087E                                  ORG     0087EH
                              ;--------------  TABLE OF SHIFT KEYS AND MASK VALUES  ---------------
                              ;------ KEY_TABLE
087E                          K6      LABEL   BYTE
087E 52                               DB      INS_KEY                 ; INSERT KEY
087F 3A 45 46 38 1D                   DB      CAPS_KEY,NUM_KEY,SCROLL_KEY,ALT_KEY,CTL_KEY
0884 2A 36                            DB      LEFT_KEY,RIGHT_KEY
= 0008                        K6L     EQU     $-K6

                              ;------ MASK_TABLE
0886                          K7      LABEL   BYTE
0886 80                               DB      INS_SHIFT               ; INSERT MODE SHIFT
0887 40 20 10 08 04                   DB      CAPS_SHIFT,NUM_SHIFT,SCROLL_SHIFT,ALT_SHIFT,CTL_SHIFT
088C 02 01                            DB      LEFT_SHIFT,RIGHT_SHIFT

                              ;----------------------  TABLES FOR CTRL CASE  ----------------------

088E                          K8      LABEL   BYTE                    ;-------- CHARACTERS ---------
088E 1B FF 00 FF FF FF                DB      27,-1,00,-1,-1,-1       ; Esc, 1, 2, 3, 4, 5
0894 1E FF FF FF FF 1F                DB      30,-1,-1,-1,-1,31       ; 6, 7, 8, 9, 0, -
089A FF 7F 94 11 17 05                DB      -1,127,148,17,23,5      ; =, Bksp, Tab, Q, W, E
08A0 12 14 19 15 09 0F                DB      18,20,25,21,09,15       ; R, T, Y, U, I, O
08A6 10 1B 1D 0A FF 01                DB      16,27,29,10,-1,01       ; P, [,], Enter, Ctrl, A
08AC 13 04 06 07 08 0A                DB      19,04,06,07,08,10       ; S, D, F, G, H, J
08B2 0B 0C FF FF FF FF                DB      11,12,-1,-1,-1,-1       ; K, L, ;, ', `, LShift
08B8 1C 1A 18 03 16 02                DB      28,26,24,03,22,02       ; Bkslash, Z, X, C, V, B
08BE 0E 0D FF FF FF FF                DB      14,13,-1,-1,-1,-1       ; N, M, ,, ., /, RShift
08C4 96 FF 20 FF                      DB      150,-1,' ',-1           ; *, Alt, Space, CL
                                                                      ;--------- FUNCTIONS ---------
08C8 5E 5F 60 61 62 63                DB      94,95,96,97,98,99       ; F1 - F6
08CE 64 65 66 67 FF FF                DB      100,101,102,103,-1,-1   ; F7 - F10, NL, SL
08D4 77 8D 84 8E 73 8F                DB      119,141,132,142,115,143 ; Home, Up, PgUp, -, Left, Pad5
08DA 74 90 75 91 76 92                DB      116,144,117,145,118,146 ; Right, +, End, Down, PgDn, Ins
08E0 93 FF FF FF 89 8A                DB      147,-1,-1,-1,137,138    ; Del, SysReq, Undef, WT, F11, F12
```

```
                        PAGE
                        ;----------------------  TABLES FOR LOWER CASE  ----------------------

08E6                    K10     LABEL   BYTE
08E6 1B 31 32 33 34 35          DB      27,'12345'
08EC 36 37 38 39 30 2D          DB      '67890-'
08F2 3D 08 09 71 77 65          DB      '=',08,09,'qwe'
08F8 72 74 79 75 69 6F          DB      'rtyuio'
08FE 70 5B 5D 0D FF 61          DB      'p[]',0DH,-1,'a'        ; LETTERS, Return, Ctrl
0904 73 64 66 67 68 6A          DB      'adfghj'
090A 6B 6C 3B 27 60 FF          DB      "kl;'`",-1              ; LETTERS, L Shift
0910 5C 7A 78 63 76 62          DB      92,'zxcvb'
0916 6E 6D 2C 2E 2F             DB      'nm,./'
091B FF 2A FF 20 FF             DB      -1,'*',-1,' ',-1        ; R Shift,*, Alt, Space, CL

                        ;------ LC TABLE SCAN
0920 3B 3C 3D 3E 3F             DB      59,60,61,62,63          ; BASE STATE OF F1 - F10
0925 40 41 42 43 44             DB      64,65,66,67,68
092A FF FF                      DB      -1,-1                   ; NL, SL

                        ;------ KEYPAD TABLE
092C                    K15     LABEL   BYTE
092C 47 48 49 FF 4B FF          DB      71,72,73,-1,75,-1       ; BASE STATE OF KEYPAD KEYS
0932 4D FF 4F 50 51 52          DB      77,-1,79,80,81,82
0938 53                         DB      83
0939 FF FF 5C 85 86             DB      -1,-1,92,133,134        ; SysRq, Undef, WT, F11, F12

                        ;-----  KEYBOARD INTERRUPT

                        ;;-     ORG     0E987H
0987                            ORG     00987H
= 0987                  KB_INT  EQU     $
0987 E9 0000 E                  JMP     KB_INT_1                ; VECTOR ON TO MOVED KEYBOARD HANDLER

                        ;----------------------  TABLES FOR UPPER CASE  ----------------------

098A                    K11     LABEL   BYTE
098A 1B 21 40 23 24 25          DB      27,'!@#$%'
0990 5E 26 2A 28 29 5F          DB      94,'&*()_'
0996 2B 08 00 51 57 45          DB      '+',08,00,'QWE'
099C 52 54 59 55 49 4F          DB      'RTYUIO'
09A2 50 7B 7D 0D FF 41          DB      'P{}',0DH,-1,'A'        ; LETTERS, Return, Ctrl
09A8 53 44 46 47 48 4A          DB      'SDFGHJ'
09AE 4B 4C 3A 22 7E FF          DB      'KL:"',126,-1           ; LETTERS, L Shift
09B4 7C 5A 58 43 56 42          DB      124,'ZXCVB'
09BA 4E 4D 3C 3E 3F             DB      'NM<>?'
09BF FF 2A FF 20 FF             DB      -1,'*',-1,' ',-1        ; R Shift,*, Alt, Space, CL

                        ;------ UC TABLE SCAN
09C4                    K12     LABEL   BYTE
09C4 54 55 56 57 58             DB      84,85,86,87,88          ; SHIFTED STATE OF F1 - F10
09C9 59 5A 5B 5C 5D             DB      89,90,91,92,93
09CE FF FF                      DB      -1,-1                   ; NL, SL

                        ;------ NUM STATE TABLE
09D0                    K14     LABEL   BYTE
09D0 37 38 39 2D 34 35          DB      '789-456+1230.'         ; NUMLOCK STATE OF KEYPAD KEYS
     36 2B 31 32 33 30
     2E
09DD FF FF 7C 87 88             DB      -1,-1,124,135,136       ; SysRq, Undef, WT, F11, F12
```

SECTION 5

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                            PAGE
                            ;-----  DISKETTE I/O

                            ;;-        ORG     0EC59H
0C59                                   ORG     00C59H
= 0C59                      DISKETTE_IO        EQU     $
0C59 E9 0000 E                         JMP     DISKETTE_IO_1           ; VECTOR ON TO MOVED DISKETTE CODE

                            ;-----  DISKETTE INTERRUPT

                            ;;-        ORG     0EF57H
0F57                                   ORG     00F57H
= 0F57                      DISK_INT           EQU     $
0F57 E9 0000 E                         JMP     DISK_INT_1              ; VECTOR ON TO MOVED DISKETTE HANDLER

                            ;-----  DISKETTE PARAMETERS

                            ;;-        ORG     0EFC7H
0FC7                                   ORG     00FC7H

                            ;----------------------------------------------------------------
                            ; DISK_BASE                                                       :
                            ;          THIS IS THE SET OF PARAMETERS REQUIRED FOR             :
                            ;          DISKETTE OPERATION.  THEY ARE POINTED AT BY THE        :
                            ;          DATA VARIABLE @DISK_POINTER.  TO MODIFY THE PARAMETERS, :
                            ;          BUILD ANOTHER PARAMETER BLOCK AND POINT AT IT          :
                            ;----------------------------------------------------------------

0FC7                        DISK_BASE          LABEL   BYTE

0FC7 DF                                DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FC8 02                                DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FC9 25                                DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0FCA 02                                DB      2               ; 512 BYTES/SECTOR
0FCB 0F                                DB      15              ; EOT ( LAST SECTOR ON TRACK)
0FCC 1B                                DB      01BH            ; GAP LENGTH
0FCD FF                                DB      0FFH            ; DTL
0FCE 54                                DB      054H            ; GAP LENGTH FOR FORMAT
0FCF F6                                DB      0F6H            ; FILL BYTE FOR FORMAT
0FD0 0F                                DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0FD1 08                                DB      8               ; MOTOR START TIME (1/8 SECONDS)

                            ;-----  PRINTER I/O

                            ;;-        ORG     0EFD2H
0FD2                                   ORG     00FD2H
= 0FD2                      PRINTER_IO         EQU     $
0FD2 E9 0000 E                         JMP     PRINTER_IO_1            ; VECTOR ON TO MOVED PRINTER CODE

                            ;-----  FOR POSSIBLE COMPATIBILITY ENTRY POINTS

                            ;;-        ORG     0F045H
1045                                   ORG     01045H
                                       ASSUME  CS:CODE,DS:DATA

                                       EXTRN   SET_MODE:NEAR
                                       EXTRN   SET_CTYPE:NEAR
                                       EXTRN   SET_CPOS:NEAR
                                       EXTRN   READ_CURSOR:NEAR
                                       EXTRN   READ_LPEN:NEAR
                                       EXTRN   ACT_DISP_PAGE:NEAR
                                       EXTRN   SCROLL_UP:NEAR
                                       EXTRN   SCROLL_DOWN:NEAR
                                       EXTRN   READ_AC_CURRENT:NEAR
                                       EXTRN   WRITE_AC_CURRENT:NEAR
                                       EXTRN   WRITE_C_CURRENT:NEAR
                                       EXTRN   SET_COLOR:NEAR
                                       EXTRN   WRITE_DOT:NEAR
                                       EXTRN   READ_DOT:NEAR
                                       EXTRN   WRITE_TTY:NEAR
                                       EXTRN   VIDEO_STATE:NEAR

1045 0000 E                 M1         DW      OFFSET  SET_MODE        ;  TABLE OF ROUTINES WITHIN VIDEO I/O
1047 0000 E                            DW      OFFSET  SET_CTYPE       ;       EXIT STACK VALUES MAY BE
1049 0000 E                            DW      OFFSET  SET_CPOS        ;       DIFFERENT DEPENDING ON THE
104B 0000 E                            DW      OFFSET  READ_CURSOR     ;       SYSTEM AND MODEL
104D 0000 E                            DW      OFFSET  READ_LPEN
104F 0000 E                            DW      OFFSET  ACT_DISP_PAGE
1051 0000 E                            DW      OFFSET  SCROLL_UP
1053 0000 E                            DW      OFFSET  SCROLL_DOWN
1055 0000 E                            DW      OFFSET  READ_AC_CURRENT
1057 0000 E                            DW      OFFSET  WRITE_AC_CURRENT
1059 0000 E                            DW      OFFSET  WRITE_C_CURRENT
105B 0000 E                            DW      OFFSET  SET_COLOR
105D 0000 E                            DW      OFFSET  WRITE_DOT
105F 0000 E                            DW      OFFSET  READ_DOT
1061 0000 E                            DW      OFFSET  WRITE_TTY
1063 0000 E                            DW      OFFSET  VIDEO_STATE
= 0020                      M1L        EQU     $-M1

                            ;;-        ORG     0F065H
1065                                   ORG     01065H
= 1065                      VIDEO_IO           EQU     $
1065 E9 0000 E                         JMP     VIDEO_IO_1              ; VECTOR ON TO MOVED VIDEO CODE

                            ;-----  VIDEO PARAMETERS --- INIT_TABLE

                            ;;-        ORG     0F0A4H
10A4                                   ORG     010A4H

10A4                        VIDEO_PARMS        LABEL   BYTE
10A4 38 28 2D 0A 1F 06                 DB      38H,28H,2DH,0AH,1FH,6,19H       ; SET UP FOR 40X25
     19
10AB 1C 02 07 06 07                    DB      1CH,2,7,6,7
10B0 00 00 00 00                       DB      0,0,0,0
= 0010                      M4         EQU     $-VIDEO_PARMS

10B4 71 50 5A 0A 1F 06                 DB      71H,50H,5AH,0AH,1FH,6,19H       ; SET UP FOR 80X25
     19
10BB 1C 02 07 06 07                    DB      1CH,2,7,6,7
10C0 00 00 00 00                       DB      0,0,0,0

10C4 38 28 2D 0A 7F 06                 DB      38H,28H,2DH,0AH,7FH,6,64H       ; SET UP FOR GRAPHICS
     64
```

```
10CB 70 02 01 06 07                    DB      70H,2,1,6,7
10D0 00 00 00 00                       DB      0,0,0,0

10D4 61 50 52 0F 19 06                 DB      61H,50H,52H,0FH,19H,6,19H        ; SET UP FOR 80X25 B&W CARD
     19
10DB 19 02 0D 0B 0C                    DB      19H,2,0DH,0BH,0CH
10E0 00 00 00 00                       DB      0,0,0,0
                                                                        ; TABLE OF REGEN LENGTHS
10E4 0800                      M5      DW      2048                     ; 40X25
10E6 1000                              DW      4096                     ; 80X25
10E8 4000                              DW      16384                    ; GRAPHICS
10EA 4000                              DW      16384

                               ;-----  COLUMNS

10EC 28 28 50 50 28 28         M6      DB      40,40,80,80,40,40,80,80
     50 50
                               ;-----  C_REG_TAB

10F4 2C 28 2D 29 2A 2E         M7      DB      2CH,28H,2DH,29H,2AH,2EH,1EH,29H ; TABLE OF MODE SETS
     1E 29
                               ;-----  MEMORY SIZE

                               ;;-     ORG     0F841H
1841                                   ORG     01841H
= 1841                         MEMORY_SIZE_DET EQU  $
1841 E9 0000 E                         JMP     MEMORY_SIZE_DET_1        ; VECTOR ON TO MOVED BIOS CODE

                               ;-----  EQUIPMENT DETERMINE

                               ;;-     ORG     0F84DH
184D                                   ORG     0184DH
= 184D                         EQUIPMENT       EQU     $
184D E9 0000 E                         JMP     EQUIPMENT_1              ; VECTOR ON TO MOVED BIOS CODE

                               ;-----  CASSETTE (NO BIOS SUPPORT)

                               ;;-     ORG     0F859H
1859                                   ORG     01859H
= 1859                         CASSETTE_IO     EQU     $
1859 E9 0000 E                         JMP     CASSETTE_IO_1            ; VECTOR ON TO MOVED BIOS CODE

                               ;----------------------------------------------------------------------
                               ; CHARACTER GENERATOR GRAPHICS FOR 320X200 AND 640X200 GRAPHICS       ;
                               ;----------------------------------------------------------------------
                               ;;-     ORG     0FA6EH
1A6E                                   ORG     01A6EH
1A6E                           CRT_CHAR_GEN    LABEL   BYTE
1A6E 00 00 00 00 00 00                 DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_00    BLANK
     00 00
1A76 7E 81 A5 81 BD 99                 DB      07EH,081H,0A5H,081H,0BDH,099H,081H,07EH ; D_01    SMILING FACE
     81 7E
1A7E 7E FF DB FF C3 E7                 DB      07EH,0FFH,0DBH,0FFH,0C3H,0E7H,0FFH,07EH ; D_02    SMILING FACE N
     FF 7E
1A86 6C FE FE FE 7C 38                 DB      06CH,0FEH,0FEH,0FEH,07CH,038H,010H,000H ; D_03    HEART
     10 00
1A8E 10 38 7C FE 7C 38                 DB      010H,038H,07CH,0FEH,07CH,038H,010H,000H ; D_04    DIAMOND
     10 00
1A96 38 7C 38 FE FE 7C                 DB      038H,07CH,038H,0FEH,0FEH,07CH,038H,07CH ; D_05    CLUB
     38 7C
1A9E 10 10 38 7C FE 7C                 DB      010H,010H,038H,07CH,0FEH,07CH,038H,07CH ; D_06    SPADE
     38 7C
1AA6 00 00 18 3C 3C 18                 DB      000H,000H,018H,03CH,03CH,018H,000H,000H ; D_07    BULLET
     00 00
1AAE FF FF E7 C3 C3 E7                 DB      0FFH,0FFH,0E7H,0C3H,0C3H,0E7H,0FFH,0FFH ; D_08    BULLET NEG
     FF FF
1AB6 00 3C 66 42 42 66                 DB      000H,03CH,066H,042H,042H,066H,03CH,000H ; D_09    CIRCLE
     3C 00
1ABE FF C3 99 BD BD 99                 DB      0FFH,0C3H,099H,0BDH,0BDH,099H,0C3H,0FFH ; D_0A    CIRCLE NEG
     C3 FF
1AC6 0F 07 0F 7D CC CC                 DB      00FH,007H,00FH,07DH,0CCH,0CCH,0CCH,078H ; D_0B    MALE
     CC 78
1ACE 3C 66 66 66 3C 18                 DB      03CH,066H,066H,066H,03CH,018H,07EH,018H ; D_0C    FEMALE
     7E 18
1AD6 3F 33 3F 30 30 70                 DB      03FH,033H,03FH,030H,030H,070H,0F0H,0E0H ; D_0D    EIGHTH NOTE
     F0 E0
1ADE 7F 63 7F 63 63 67                 DB      07FH,063H,07FH,063H,063H,067H,0E6H,0C0H ; D_0E    TWO 1/16 NOTE
     E6 C0
1AE6 99 5A 3C E7 E7 3C                 DB      099H,05AH,03CH,0E7H,0E7H,03CH,05AH,099H ; D_0F    SUN
     5A 99

1AEE 80 E0 F8 FE F8 E0                 DB      080H,0E0H,0F8H,0FEH,0F8H,0E0H,080H,000H ; D_10    R ARROWHEAD
     80 00
1AF6 02 0E 3E FE 3E 0E                 DB      002H,00EH,03EH,0FEH,03EH,00EH,002H,000H ; D_11    L ARROWHEAD
     02 00
1AFE 18 3C 7E 18 18 7E                 DB      018H,03CH,07EH,018H,018H,07EH,03CH,018H ; D_12    ARROW 2 VERT
     3C 18
1B06 66 66 66 66 66 00                 DB      066H,066H,066H,066H,066H,000H,066H,000H ; D_13    2 EXCLAMATIONS
     66 00
1B0E 7F DB DB 7B 1B 1B                 DB      07FH,0DBH,0DBH,07BH,01BH,01BH,01BH,000H ; D_14    PARAGRAPH
     1B 00
1B16 3E 63 38 6C 6C 38                 DB      03EH,063H,038H,06CH,06CH,038H,0CCH,078H ; D_15    SECTION
     CC 78
1B1E 00 00 00 00 7E 7E                 DB      000H,000H,000H,000H,07EH,07EH,07EH,000H ; D_16    RECTANGLE
     7E 00
1B26 18 3C 7E 18 7E 3C                 DB      018H,03CH,07EH,018H,07EH,03CH,018H,0FFH ; D_17    ARROW 2 VRT UP
     18 FF
1B2E 18 3C 7E 18 18 18                 DB      018H,03CH,07EH,018H,018H,018H,018H,000H ; D_18    ARROW VRT UP
     18 00
1B36 18 18 18 18 7E 3C                 DB      018H,018H,018H,018H,07EH,03CH,018H,000H ; D_19    ARROW VRT DOWN
     18 00
1B3E 00 18 0C FE 0C 18                 DB      000H,018H,00CH,0FEH,00CH,018H,000H,000H ; D_1A    ARROW RIGHT
     00 00
1B46 00 30 60 FE 60 30                 DB      000H,030H,060H,0FEH,060H,030H,000H,000H ; D_1B    ARROW LEFT
     00 00
1B4E 00 00 C0 C0 C0 FE                 DB      000H,000H,0C0H,0C0H,0C0H,0FEH,000H,000H ; D_1C    NOT INVERTED
     00 00
1B56 00 24 66 FF 66 24                 DB      000H,024H,066H,0FFH,066H,024H,000H,000H ; D_1D    ARROW 2 HORZ
     00 00
1B5E 00 18 3C 7E FF FF                 DB      000H,018H,03CH,07EH,0FFH,0FFH,000H,000H ; D_1E    ARROWHEAD UP
     00 00
1B66 00 FF FF 7E 3C 18                 DB      000H,0FFH,0FFH,07EH,03CH,018H,000H,000H ; D_1F    ARROWHEAD DOWN
     00 00

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1B6E 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_20    SPACE
     00 00
1B76 30 78 78 30 30 00          DB      030H,078H,078H,030H,030H,000H,030H,000H ; D_21 !  EXCLAMATION
     30 00
1B7E 6C 6C 6C 00 00 00          DB      06CH,06CH,06CH,000H,000H,000H,000H,000H ; D_22 "  QUOTATION
     00 00
1B86 6C 6C FE 6C FE 6C          DB      06CH,06CH,0FEH,06CH,0FEH,06CH,06CH,000H ; D_23 #  LB.
     6C 00
1B8E 30 7C C0 78 0C F8          DB      030H,07CH,0C0H,078H,00CH,0F8H,030H,000H ; D_24 $  DOLLAR SIGN
     30 00
1B96 00 C6 CC 18 30 66          DB      000H,0C6H,0CCH,018H,030H,066H,0C6H,000H ; D_25 %  PERCENT
     C6 00
1B9E 38 6C 38 76 DC CC          DB      038H,06CH,038H,076H,0DCH,0CCH,076H,000H ; D_26 &  AMPERSAND
     76 00
1BA6 60 60 C0 00 00 00          DB      060H,060H,0C0H,000H,000H,000H,000H,000H ; D_27 '  APOSTROPHE
     00 00
1BAE 18 30 60 60 60 30          DB      018H,030H,060H,060H,060H,030H,018H,000H ; D_28 (  L. PARENTHESIS
     18 00
1BB6 60 30 18 18 18 30          DB      060H,030H,018H,018H,018H,030H,060H,000H ; D_29 )  R. PARENTHESIS
     60 00
1BBE 00 66 3C FF 3C 66          DB      000H,066H,03CH,0FFH,03CH,066H,000H,000H ; D_2A *  ASTERISK
     00 00
1BC6 00 30 30 FC 30 30          DB      000H,030H,030H,0FCH,030H,030H,000H,000H ; D_2B +  PLUS
     00 00
1BCE 00 00 00 00 00 30          DB      000H,000H,000H,000H,000H,030H,030H,060H ; D_2C ,  COMMA
     30 60
1BD6 00 00 00 FC 00 00          DB      000H,000H,000H,0FCH,000H,000H,000H,000H ; D_2D -  DASH
     00 00
1BDE 00 00 00 00 00 30          DB      000H,000H,000H,000H,000H,030H,030H,000H ; D_2E .  PERIOD
     30 00
1BE6 06 0C 18 30 60 C0          DB      006H,00CH,018H,030H,060H,0C0H,080H,000H ; D_2F /  SLASH
     80 00

1BEE 7C C6 CE DE F6 E6          DB      07CH,0C6H,0CEH,0DEH,0F6H,0E6H,07CH,000H ; D_30 0
     7C 00
1BF6 30 70 30 30 30 30          DB      030H,070H,030H,030H,030H,030H,0FCH,000H ; D_31 1
     FC 00
1BFE 78 CC 0C 38 60 CC          DB      078H,0CCH,00CH,038H,060H,0CCH,0FCH,000H ; D_32 2
     FC 00
1C06 78 CC 0C 38 0C CC          DB      078H,0CCH,00CH,038H,00CH,0CCH,078H,000H ; D_33 3
     78 00
1C0E 1C 3C 6C CC FE 0C          DB      01CH,03CH,06CH,0CCH,0FEH,00CH,01EH,000H ; D_34 4
     1E 00
1C16 FC C0 F8 0C 0C CC          DB      0FCH,0C0H,0F8H,00CH,00CH,0CCH,078H,000H ; D_35 5
     78 00
1C1E 38 60 C0 F8 CC CC          DB      038H,060H,0C0H,0F8H,0CCH,0CCH,078H,000H ; D_36 6
     78 00
1C26 FC CC 0C 18 30 30          DB      0FCH,0CCH,00CH,018H,030H,030H,030H,000H ; D_37 7
     30 00
1C2E 78 CC CC 78 CC CC          DB      078H,0CCH,0CCH,078H,0CCH,0CCH,078H,000H ; D_38 8
     78 00
1C36 78 CC CC 7C 0C 18          DB      078H,0CCH,0CCH,07CH,00CH,018H,070H,000H ; D_39 9
     70 00
1C3E 00 30 30 00 00 30          DB      000H,030H,030H,000H,000H,030H,030H,000H ; D_3A :  COLON
     30 00
1C46 00 30 30 00 00 30          DB      000H,030H,030H,000H,000H,030H,030H,060H ; D_3B ;  SEMICOLON
     30 60
1C4E 18 30 60 C0 60 30          DB      018H,030H,060H,0C0H,060H,030H,018H,000H ; D_3C <  LESS THAN
     18 00
1C56 00 00 FC 00 00 FC          DB      000H,000H,0FCH,000H,000H,0FCH,000H,000H ; D_3D =  EQUAL
     00 00
1C5E 60 30 18 0C 18 30          DB      060H,030H,018H,00CH,018H,030H,060H,000H ; D_3E >  GREATER THAN
     60 00
1C66 78 CC 0C 18 30 00          DB      078H,0CCH,00CH,018H,030H,000H,030H,000H ; D_3F ?  QUESTION MARK
     30 00

1C6E 7C C6 DE DE DE C0          DB      07CH,0C6H,0DEH,0DEH,0DEH,0C0H,078H,000H ; D_40 @  AT
     78 00
1C76 30 78 CC CC FC CC          DB      030H,078H,0CCH,0CCH,0FCH,0CCH,0CCH,000H ; D_41 A
     CC 00
1C7E FC 66 66 7C 66 66          DB      0FCH,066H,066H,07CH,066H,066H,0FCH,000H ; D_42 B
     FC 00
1C86 3C 66 C0 C0 C0 66          DB      03CH,066H,0C0H,0C0H,0C0H,066H,03CH,000H ; D_43 C
     3C 00
1C8E F8 6C 66 66 66 6C          DB      0F8H,06CH,066H,066H,066H,06CH,0F8H,000H ; D_44 D
     F8 00
1C96 FE 62 68 78 68 62          DB      0FEH,062H,068H,078H,068H,062H,0FEH,000H ; D_45 E
     FE 00
1C9E FE 62 68 78 68 60          DB      0FEH,062H,068H,078H,068H,060H,0F0H,000H ; D_46 F
     F0 00
1CA6 3C 66 C0 C0 CE 66          DB      03CH,066H,0C0H,0C0H,0CEH,066H,03EH,000H ; D_47 G
     3E 00
1CAE CC CC CC FC CC CC          DB      0CCH,0CCH,0CCH,0FCH,0CCH,0CCH,0CCH,000H ; D_48 H
     CC 00
1CB6 78 30 30 30 30 30          DB      078H,030H,030H,030H,030H,030H,078H,000H ; D_49 I
     78 00
1CBE 1E 0C 0C 0C CC CC          DB      01EH,00CH,00CH,00CH,0CCH,0CCH,078H,000H ; D_4A J
     78 00
1CC6 E6 66 6C 78 6C 66          DB      0E6H,066H,06CH,078H,06CH,066H,0E6H,000H ; D_4B K
     E6 00
1CCE F0 60 60 60 62 66          DB      0F0H,060H,060H,060H,062H,066H,0FEH,000H ; D_4C L
     FE 00
1CD6 C6 EE FE FE D6 C6          DB      0C6H,0EEH,0FEH,0FEH,0D6H,0C6H,0C6H,000H ; D_4D M
     C6 00
1CDE C6 E6 F6 DE CE C6          DB      0C6H,0E6H,0F6H,0DEH,0CEH,0C6H,0C6H,000H ; D_4E N
     C6 00
1CE6 38 6C C6 C6 C6 6C          DB      038H,06CH,0C6H,0C6H,0C6H,06CH,038H,000H ; D_4F O
     38 00

1CEE FC 66 66 7C 60 60          DB      0FCH,066H,066H,07CH,060H,060H,0F0H,000H ; D_50 P
     F0 00
1CF6 78 CC CC CC DC 78          DB      078H,0CCH,0CCH,0CCH,0DCH,078H,01CH,000H ; D_51 Q
     1C 00
1CFE FC 66 66 7C 6C 66          DB      0FCH,066H,066H,07CH,06CH,066H,0E6H,000H ; D_52 R
     E6 00
1D06 78 CC E0 70 1C CC          DB      078H,0CCH,0E0H,070H,01CH,0CCH,078H,000H ; D_53 S
     78 00
1D0E FC B4 30 30 30 30          DB      0FCH,0B4H,030H,030H,030H,030H,078H,000H ; D_54 T
     78 00
1D16 CC CC CC CC CC CC          DB      0CCH,0CCH,0CCH,0CCH,0CCH,0CCH,0FCH,000H ; D_55 U
     FC 00
1D1E CC CC CC CC CC 78          DB      0CCH,0CCH,0CCH,0CCH,0CCH,078H,030H,000H ; D_56 V
     30 00
1D26 C6 C6 C6 D6 FE EE          DB      0C6H,0C6H,0C6H,0D6H,0FEH,0EEH,0C6H,000H ; D_57 W
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          C6 00
1D2E C6 C6 6C 38 38 6C              DB      0C6H,0C6H,06CH,038H,038H,06CH,0C6H,000H ; D_58 X
          C6 00
1D36 CC CC CC 78 30 30              DB      0CCH,0CCH,0CCH,078H,030H,030H,078H,000H ; D_59 Y
          78 00
1D3E FE C6 8C 18 32 66              DB      0FEH,0C6H,08CH,018H,032H,066H,0FEH,000H ; D_5A Z
          FE 00
1D46 78 60 60 60 60 60              DB      078H,060H,060H,060H,060H,060H,078H,000H ; D_5B [  LEFT BRACKET
          78 00
1D4E C0 60 30 18 0C 06              DB      0C0H,060H,030H,018H,00CH,006H,002H,000H ; D_5C ‡  BACKSLASH
          02 00
1D56 78 18 18 18 18 18              DB      078H,018H,018H,018H,018H,018H,078H,000H ; D_5D ]  RIGHT BRACKET
          78 00
1D5E 10 38 6C C6 00 00              DB      010H,038H,06CH,0C6H,000H,000H,000H,000H ; D_5E ‡  CIRCUMFLEX
          00 00
1D66 00 00 00 00 00 00              DB      000H,000H,000H,000H,000H,000H,000H,0FFH ; D_5F _  UNDERSCORE
          00 FF

1D6E 30 30 18 00 00 00              DB      030H,030H,018H,000H,000H,000H,000H,000H ; D_60 '  APOSTROPHE REV
          00 00
1D76 00 00 78 0C 7C CC              DB      000H,000H,078H,00CH,07CH,0CCH,076H,000H ; D_61 a
          76 00
1D7E E0 60 60 7C 66 66              DB      0E0H,060H,060H,07CH,066H,066H,0DCH,000H ; D_62 b
          DC 00
1D86 00 00 78 CC C0 CC              DB      000H,000H,078H,0CCH,0C0H,0CCH,078H,000H ; D_63 c
          78 00
1D8E 1C 0C 0C 7C CC CC              DB      01CH,00CH,00CH,07CH,0CCH,0CCH,076H,000H ; D_64 d
          76 00
1D96 00 00 78 CC FC C0              DB      000H,000H,078H,0CCH,0FCH,0C0H,078H,000H ; D_65 e
          78 00
1D9E 38 6C 60 F0 60 60              DB      038H,06CH,060H,0F0H,060H,060H,0F0H,000H ; D_66 f
          F0 00
1DA6 00 00 76 CC CC 7C              DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,0F8H ; D_67 g
          0C F8
1DAE E0 60 6C 76 66 66              DB      0E0H,060H,06CH,076H,066H,066H,0E6H,000H ; D_68 h
          E6 00
1DB6 30 00 70 30 30 30              DB      030H,000H,070H,030H,030H,030H,078H,000H ; D_69 i
          78 00
1DBE 0C 00 0C 0C 0C CC              DB      00CH,000H,00CH,00CH,00CH,0CCH,0CCH,078H ; D_6A j
          CC 78
1DC6 E0 60 66 6C 78 6C              DB      0E0H,060H,066H,06CH,078H,06CH,0E6H,000H ; D_6B k
          E6 00
1DCE 70 30 30 30 30 30              DB      070H,030H,030H,030H,030H,030H,078H,000H ; D_6C l
          78 00
1DD6 00 00 CC FE FE D6              DB      000H,000H,0CCH,0FEH,0FEH,0D6H,0C6H,000H ; D_6D m
          C6 00
1DDE 00 00 F8 CC CC CC              DB      000H,000H,0F8H,0CCH,0CCH,0CCH,0CCH,000H ; D_6E n
          CC 00
1DE6 00 00 78 CC CC CC              DB      000H,000H,078H,0CCH,0CCH,0CCH,078H,000H ; D_6F o
          78 00

1DEE 00 00 DC 66 66 7C              DB      000H,000H,0DCH,066H,066H,07CH,060H,0F0H ; D_70 p
          60 F0
1DF6 00 00 76 CC CC 7C              DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,01EH ; D_71 q
          0C 1E
1DFE 00 00 DC 76 66 60              DB      000H,000H,0DCH,076H,066H,060H,0F0H,000H ; D_72 r
          F0 00
1E06 00 00 7C C0 78 0C              DB      000H,000H,07CH,0C0H,078H,00CH,0F8H,000H ; D_73 s
          F8 00
1E0E 10 30 7C 30 30 34              DB      010H,030H,07CH,030H,030H,034H,018H,000H ; D_74 t
          18 00
1E16 00 00 CC CC CC CC              DB      000H,000H,0CCH,0CCH,0CCH,0CCH,076H,000H ; D_75 u
          76 00
1E1E 00 00 CC CC CC 78              DB      000H,000H,0CCH,0CCH,0CCH,078H,030H,000H ; D_76 v
          30 00
1E26 00 00 C6 D6 FE FE              DB      000H,000H,0C6H,0D6H,0FEH,0FEH,06CH,000H ; D_77 w
          6C 00
1E2E 00 00 C6 6C 38 6C              DB      000H,000H,0C6H,06CH,038H,06CH,0C6H,000H ; D_78 x
          C6 00
1E36 00 00 CC CC CC 7C              DB      000H,000H,0CCH,0CCH,0CCH,07CH,00CH,0F8H ; D_79 y
          0C F8
1E3E 00 00 FC 98 30 64              DB      000H,000H,0FCH,098H,030H,064H,0FCH,000H ; D_7A z
          FC 00
1E46 1C 30 30 E0 30 30              DB      01CH,030H,030H,0E0H,030H,030H,01CH,000H ; D_7B {  LEFT BRACE
          1C 00
1E4E 18 18 18 00 18 18              DB      018H,018H,018H,000H,018H,018H,018H,000H ; D_7C |  BROKEN STROKE
          18 00
1E56 E0 30 30 1C 30 30              DB      0E0H,030H,030H,01CH,030H,030H,0E0H,000H ; D_7D }  RIGHT BRACE
          E0 00
1E5E 76 DC 00 00 00 00              DB      076H,0DCH,000H,000H,000H,000H,000H,000H ; D_7E ‡  TILDE
          00 00
1E66 00 10 38 6C C6 C6              DB      000H,010H,038H,06CH,0C6H,0C6H,0FEH,000H ; D_7F    DELTA
          FE 00


                                ;-----  TIME OF DAY

                                ;;-     ORG     0FE6EH
1E6E                                    ORG     01E6EH
= 1E6E                          TIME_OF_DAY     EQU     $
1E6E E9 0000 E                          JMP     TIME_OF_DAY_1           ; VECTOR ON TO MOVED BIOS CODE

                                ;-----  TIMER INTERRUPT

                                ;;-     ORG     0FEA5H
1EA5                                    ORG     01EA5H
= 1EA5                          TIMER_INT       EQU     $
1EA5 E9 0000 E                          JMP     TIMER_INT_1             ; VECTOR ON TO MOVED BIOS CODE
```

```
                         PAGE
                         ;-----  VECTOR TABLE

                         ;;-     ORG     0FEF3H
1EF3                             ORG     01EF3H                  ;     AT LOCATION 0FEF3H
1EF3                     VECTOR_TABLE    LABEL   WORD            ; VECTOR TABLE VALUES FOR POST TESTS
1EF3 1EA5 R                      DW      OFFSET TIMER_INT        ; INT 08H - HARDWARE TIMER 0        IRQ  0
1EF5 0987 R                      DW      OFFSET KB_INT           ; INT 09H - KEYBOARD                IRQ  1
1EF7 0000 E                      DW      OFFSET  DT1             ; INT 0AH - SLAVE INTERRUPT INPUT
1EF9 0000 E                      DW      OFFSET  D11             ; INT 0BH -                         IRQ  3
1EFB 0000 E                      DW      OFFSET  D11             ; INT 0CH -                         IRQ  4
1EFD 0000 E                      DW      OFFSET  D11             ; INT 0DH -                         IRQ  5
1EFF 0F57 R                      DW      OFFSET DISK_INT         ; INT 0EH - DISKETTE                IRQ  6
1F01 0000 E                      DW      OFFSET  D11             ; INT 0FH -                         IRQ  7

                         ;-----  SOFTWARE INTERRUPTS  ( BIOS CALLS AND POINTERS )

1F03 1065 R                      DW      OFFSET VIDEO_IO         ; INT 10H -- VIDEO DISPLAY
1F05 184D R                      DW      OFFSET EQUIPMENT        ; INT 11H -- GET EQUIPMENT FLAG WORD
1F07 1841 R                      DW      OFFSET MEMORY_SIZE_DET  ; INT 12H -- GET REAL MODE MEMORY SIZE
1F09 0C59 R                      DW      OFFSET DISKETTE_IO      ; INT 13H -- DISKETTE
1F0B 0739 R                      DW      OFFSET RS232_IO         ; INT 14H -- COMMUNICATION ADAPTER
1F0D 1859 R                      DW      OFFSET CASSETTE_IO      ; INT 15H -- EXPANDED BIOS FUNCTION CALL
1F0F 082E R                      DW      OFFSET KEYBOARD_IO      ; INT 16H -- KEYBOARD INPUT
1F11 0FD2 R                      DW      OFFSET PRINTER_IO       ; INT 17H -- PRINTER OUTPUT
1F13 0000                        DW      00000H                  ; INT 18H -- 0F600H INSERTED FOR BASIC
1F15 06F2 R                      DW      OFFSET BOOT_STRAP       ; INT 19H -- BOOT FROM SYSTEM MEDIA
1F17 1E6E R                      DW      OFFSET TIME_OF_DAY      ; INT 1AH -- TIME OF DAY
1F19 1F53 R                      DW      OFFSET DUMMY_RETURN     ; INT 1BH -- KEYBOARD BREAK ADDRESS
1F1B 1F53 R                      DW      OFFSET DUMMY_RETURN     ; INT 1CH -- TIMER BREAK ADDRESS
1F1D 10A4 R                      DW      OFFSET VIDEO_PARMS      ; INT 1DH -- VIDEO PARAMETERS
1F1F 0FC7 R                      DW      OFFSET DISK_BASE        ; INT 1EH -- DISKETTE PARAMETERS
1F21 0000                        DW      00000H                  ; INT 1FH -- POINTER TO VIDEO EXTENSION

1F23                     SLAVE_VECTOR_TABLE      LABEL WORD      ; ( INTERRUPT 70H THRU 7FH )

1F23 0000 E                      DW      OFFSET RTC_INT          ; INT 70H - REAL TIME CLOCK         IRQ  8
1F25 0000 E                      DW      OFFSET RE_DIRECT        ; INT 71H - REDIRECT TO INT 0AH     IRQ  9
1F27 0000 E                      DW      OFFSET  DT1             ; INT 72H -                         IRQ 10
1F29 0000 E                      DW      OFFSET  D11             ; INT 73H -                         IRQ 11
1F2B 0000 E                      DW      OFFSET  D11             ; INT 74H -                         IRQ 12
1F2D 0000 E                      DW      OFFSET INT_287          ; INT 75H -  -MATH COPROCESSOR      IRQ 13
1F2F 0000 E                      DW      OFFSET  D1T             ; INT 76H -  -FIXED DISK            IRQ 14
1F31 0000 E                      DW      OFFSET  D11             ; INT 77H -                         IRQ 15

                         ;-----  DUMMY INTERRUPT HANDLER

                         ;;-     ORG     0FF53H
1F53                             ORG     01F53H

= 1F53                   DUMMY_RETURN    EQU     $               ; BIOS DUMMY (NULL) INTERRUPT RETURN

1F53 CF                          IRET

                         ;-----  PRINT SCREEN

                         ;;-     ORG     0FF54H
1F54                             ORG     01F54H
= 1F54                   PRINT_SCREEN    EQU     $
1F54 E9 0000 E                   JMP     PRINT_SCREEN_1          ; VECTOR ON TO MOVED BIOS CODE
                         .LIST                                   ; TUTOR
                         ;----------------------------------------
                         ;                                       ;
                         ;       POWER ON RESET VECTOR           ;
                         ;                                       ;
                         ;----------------------------------------
                         ;;-     ORG     0FFF0H
1FF0                             ORG     01FF0H

                         ;-----  POWER ON RESET

1FF0                     P_O_R   LABEL  FAR                      ; POWER ON RESTART EXECUTION LOCATION

1FF0 EA                          DB      0EAH                    ; HARD CODE FAR JUMP TO SET
1FF1 005B R                       DW      OFFSET  RESET          ;  OFFSET
1FF3 F000                         DW     0F000H                  ;   SEGMENT

1FF5 30 34 2F 32 31 2F           DB      '04/21/86'              ; RELEASE MARKER
     38 36

1FFE                             ORG     01FFEH
1FFE FC                          DB      MODEL_BYTE              ; THIS PC'S ID ( MODEL BYTE )

1FFF                     CODE    ENDS                            ; CHECKSUM AT LAST LOCATION
                                 END
```

SECTION 6. INSTRUCTION SET

80286 Instruction Set

Data Transfer

MOV = move

Register to Register/Memory

1000100w	mod reg r/w

Register/Memory to Register

1000101w	mod reg r/w

Immediate to Register/Memory

1100011w	mod 000 r/w	data	data if w = 1

Immediate to Register

1011wreg	data	data if w = 1

Memory to Accumulator

1010000w	addr-low	addr-high

Accumulator to Memory

1010001w	addr-low	addr-high

Register/Memory to Segment Register

10001110	mod0reg r/w reg ≠ 01

Segment Register to Register/Memory

10001100	mod0reg r/w

PUSH = Push

Memory

11111111	mod110 r/w

Register

01010reg

Segment Register

000reg110

Immediate

011010s0	data	data if s = 0

PUSHA = Push All

01100000

POP = Pop

Memory

10001111	mod000 r/m

Register

01011reg

Segment Register

000reg111   reg ≠ 01

POPA = Pop All

01100001

XCHG = Exchange

Register/Memory with Register

1000011w	mod reg r/m

Register with Accumulator

10010reg

IN = Input From

Fixed Port

1110010w	port

Variable Port

1110110w

OUT = Output To

Fixed Port

1110011w	port

Variable Port

1110111w

XLAT = Translate Byte to AL

11010111

LEA = Load EA to Register

10001101	mod reg r/m

LDS = Load Pointer to DS

11000101	mod reg r/m mod ≠ 11

LES = Load Pointer to ES

11000100	mod reg r/m mod ≠ 11

LAHF = Load AH with Flags

10011111

SAHF = Store AH with Flags

10011110

PUSHF = Push Flags

10011100

POPF = Pop Flags

10011101

Arithmetic

ADD = Add

Register/Memory with Register to Either

0000000w	mod reg r/m

Immediate to Register Memory

100000sw	mod000 r/m	data	data if sw = 01

Immediate to Accumulator

0000010w	data	data if w = 1

ADC = Add with Carry

Register/Memory with Register to Either

000100dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod000 r/m	data	data if sw = 01

Immediate to Accumulator

0001010w	data	data if w = 1

INC = Increment

Register/Memory

1111111w	mod000 r/m

Register

01000reg

SUB = Subtract

Register/Memory with Register to Either

001010dw	mod reg r/m

Immediate from Register/Memory

100000sw	mod101 r/m	data	data if sw = 01

Immediate from Accumulator

0010110w	data	data if w = 1

SBB = Subtract with Borrow

Register/Memory with Register to Either

000110dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod011 r/m	data	data if sw = 01

Immediate to Accumulator

0001110w	data	data if w = 1

DEC = Decrement

Register/Memory

1111111w	mod001 r/m

Register

01001reg

CMP = Compare

Register/Memory with Register

0011101w	mod reg r/m

Register with Register/Memory

0011100w	mod reg r/m

Immediate with Register/Memory

100000sw	mod111 r/m	data	data if sw = 01

Immediate with Accumulator

0001110w	data	data if w = 1

NEG = Change Sign

1111011w	mod011 r/m

AAA = ASCII Adjust for Add

00110111

DAA = Decimal Adjust for Add

00100111

AAS = ASCII Adjust for Subtract

00111111

DAS = Decimal Adjust for Subtract

00110111

MUL = Multiply (Unsigned)

1111011w	mod100 r/m

IMUL = Integer Multiply (Signed)

1111011w	mod101 r/m

IIMUL = Integer Immediate Multiply (Signed)

011010s1	mod reg r/m	Data	Data if s = 0

DIV = Divide (Unsigned)

1111011w	mod110 r/m

IDIV = Integer Divide (Signed)

1111011w	mod111 r/m

AAM = ASCII Adjust for Multiply

11010100	00001010

AAD = ASCII Adjust for Divide

11010101	00001010

CBW = Convert Byte to Word

10011000

CWD = Convert Word to Double Word

10011001

Logic

Shift/Rotate Instructions

Register/Memory by 1

1101000w	mod TTT r/m

Register/Memory by CL

1101001w	mod TTT r/m

Register/Memory by Count

1100000w	mod TTT r/m	count

T T T	Instruction
000	ROL
001	ROR
010	RCL
011	RCR
100	SHL/SAL
101	SHR
111	SAR

AND = And

Register/Memory and Register to Either

001000dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod000 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

TEST = AND Function to Flags; No Result

Register/Memory and Register

1000010w	mod reg r/m

Immediate Data and Register/Memory

1111011w	mod000 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

Or = Or

Register/Memory and Register to Either

000010dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod001 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

XOR = Exclusive OR

Register/Memory and Register to Either

001100dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod110 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

NOT = Invert Register/Memory

1111011w	mod010 r/m

String Manipulation

MOVS = Move Byte Word

1010010w

CMPS = Compare Byte Word

1010011w

SCAS = Scan Byte Word

1010111w

LODS = Load Byte Word to AL/AX

1010110w

STOS = Store Byte Word from AL/AX

1010101w

INS = Input Byte from DX Port

0110110w

OUTS = Output Byte Word to DX Port

0110111w

REP/REPNE, REPZ/REPNZ = Repeat String

Repeat Move String

11110011	1010010w

Repeat Compare String (z/Not z)

1111001z	1010011w

Repeat Scan String (z/Not z)

1111001z	1010111w

Repeat Load String

11110011	1010110w

Repeat Store String

11110011	1010101w

Repeat Input String

11110011	0110110w

Repeat Output String

11110011	1010011w

Control Transfer

CALL = Call

Direct Within Segment

11101000	disp-low	disp-high

Register/Memory Indirect Within Segment

11111111	mod010 r/m

Direct Intersegment

10011010	Segment Offset	Segment Selector

Indirect Intersegment

11111111	mod011 r/m (mod $\neq$ 11)

JMP = Unconditional Jump

Short/Long

11101011	disp-low

Direct within Segment

11101001	disp-low	disp-high

Register/Memory Indirect Within Segment

11111111	mod100 r/m

Direct Intersegment

11101010	Segment Offset	Segment Selector

Indirect Intersegment

11111111	mod101 r/m (mod $\neq$ 11)

RET = Return from Call

Within Segment

11000011

Within Segment Adding Immediate to SP

11000010	data-low	data-high

Intersegment

11001011

Intersegment Adding Immediate to SP

11001010	data-low	data-high

JE/JZ = Jump on Equal/Zero

01110100	disp

JL/JNGE = Jump on Less/Not Greater, or Equal

01111100	disp

JLE/JNG = Jump on Less, or Equal/Not Greater

01111110	disp

JB/JNAE = Jump on Below/Not Above, or Equal

01110010	disp

JBE/JNA = Jump on Below, or Equal/Not Above

01110110	disp

JP/JPE = Jump on Parity/Parity Even

01111010	disp

JO = Jump on Overflow

01110000	disp

JS = Jump on Sign

01111000	disp

JNE/JNZ = Jump on Not Equal/Not Zero

01110101	disp

JNL/JGE = Jump on Not Less/Greater, or Equal

01111101	disp

JNLE/JG = Jump on Not Less, or Equal/Greater

01111111	disp

JNB/JAE = Jump on Not Below/Above, or Equal

01110011	disp

JNBE/JA = Jump on Not Below, or Equal/Above

01110111	disp

JNP/JPO = Jump on Not Parity/Parity Odd

01111011	disp

JNO = Jump on Not Overflow

01110001	disp

JNS = Jump on Not Sign

01111011	disp

LOOP = Loop CX Times

11100010	disp

LOOPZ/LOOPE = Loop while Zero/Equal

11100001	disp

LOOPNZ/LOOPNE = Loop while Not Zero/Not Equal

11100000	disp

JCXZ = Jump on CX Zero

11100011	disp

ENTER = Enter Procedure

11001000	data-low	data-high

LEAVE = Leave Procedure

11001001

INT = Interrupt

Type Specified

11001101	Type

Type 3

11001100

INTO = Interrupt on Overflow

11001110

IRET = Interrupt Return

11001111

BOUND = Detect Value Out of Range

01100010	mod reg r/m

Processor Control

CLC = Clear Carry

```
11111000
```

CMC = Complement Carry

```
11110101
```

STC = Set Carry

```
11111001
```

CLD = Clear Direction

```
11111100
```

STD = Set Direction

```
11111101
```

CLI Clear Interrupt

```
11111010
```

STI = Set Interrupt

```
11111011
```

HLT = Halt

```
11110100
```

WAIT = Wait

```
10011011
```

LOCK = Bus Lock Prefix

```
11110000
```

CTS = Clear Task Switched Flag

00001111	00000110

ESC = Processor Extension Escape

11011TTT	modLLL r/m

Protection Control

LGDT = Load Global Descriptor Table Register

00001111	00000001	mod010 r/m

SGDT = Store Global Descriptor Table Register

00001111	00000001	mod000 r/m

LIDT = Load Interrupt Descriptor Table Register

00001111	00000001	mod011 r/m

SIDT = Store Interrupt Descriptor Table Register

00001111	00000001	mod001 r/m

LLDT = Load Local Descriptor Table Register from Register/Memory

00001111	00000000	mod010 r/m

SLDT = Store Local Descriptor Table Register from Register/Memory

00001111	00000000	mod000 r/m

LTR = Load Task Register from Register/Memory

00001111	00000000	mod011 r/m

STR = Store Task Register to Register/Memory

00001111	00000000	mod001 r/m

LMSW = Load Machine Status Word from Register/Memory

00001111	00000001	mod110 r/m

SMSW = Store Machine Status Word

00001111	00000001	mod100 r/m

LAR = Load Access Rights from Register/Memory

00001111	00000010	mod reg r/m

LSL = Load Segment Limit from Register/Memory

00001111	00000011	mod reg r/m

ARPL = Adjust Requested Privilege Level from Register/Memory

	01100011	mod reg r/m

VERR = Verify Read Access; Register/Memory

00001111	00000000	mod100 r/m

VERR = Verify Write Access

00001111	00000000	mod101 r/m

The effective address (EA) of the memory operand is computed according to the mod and r/m fields:

If mod = 11, then r/m is treated as a reg field.
If mod = 00, then disp = 0, disp-low and disp-high are absent.
If mod = 01, then disp = disp-low sign-extended to 16 bits, disp-high is absent.
If mod = 10, then disp = disp-high:disp-low.

If r/m = 000, then EA = (BX) + (SI) + DISP
If r/m = 001, then EA = (BX) + (SI) + DISP
If r/m = 010, then EA = (BP) + (SI) + DISP
If r/m = 011, then EA = (BP) + (DI) + DISP
If r/m = 100, then EA = (SI) + DISP
If r/m = 101, then EA = (DI) + DISP
If r/m = 110, then EA = (BP) + DISP
If r/m = 111, then EA = (BX) + DISP

DISP follows the second byte of the instruction (before data if required).

Note: An exception to the above statements occurs when mod=00 and r/m=110, in which case EA = disp-high; disp-low.

Segment Override Prefix

```
001reg001
```

The 2-bit and 3-bit reg fields are defined as follows:

2-Bit reg Field

reg	Segment Register	reg	Segment Register
00	ES	10	SS
01	CS	11	DS

3-Bit reg Field

16-bit (w = 1)	8-bit (w = 0)
000 AX	000 AL
001 CX	001 CL
010 DX	010 DL
011 BX	011 BL
100 SP	100 AH
101 BP	101 CH
110 SI	110 DH
111 DI	111 BH

The physical addresses of all operands addressed by the BP register are computed using the SS segment register. The physical addresses of the destination operands of the string primitive operations (those addressed by the DI register) are computed using the ES segment, which may not be overridden.

80287 Coprocessor Instruction Set

The following is an instruction set summary for the 80287 coprocessor. In the following, the bit pattern for escape is 11011.

Data Transfer

FLD = Load

Integer/Real Memory to ST(0)

escape MF 1	mod 000 r/m

Long Integer Memory to ST(0)

escape 111	mod 101 r/m

Temporary Real Memory to ST(0)

escape 011	mod 101 r/m

BCD Memory to ST(0)

escape 111	mod 100 r/m

ST(i) to ST(0)

escape 001	11000ST(i)

FST = Store

ST(0) to Integer/Real Memory

escape MF 1	mod 010 r/m

ST(0) to ST(i)

escape 101	11010 ST(i)

FSTP = Store and Pop

ST(0) to Integer/Real Memory

escape MF 1	mod 011 r/m

ST(0) to Long Integer Memory

escape 111	mod 111 r/m

ST(0) to Temporary Real Memory

escape 011	mod 111 r/m

ST(0) to BCD Memory

escape 111	mod 110 r/m

ST(0) to ST(i)

escape 101	11011 ST(i)

FXCH = Exchange ST(i) and ST(0)

escape 001	11001 ST(i)

Comparison

FCOM = Compare

Integer/Real Memory to ST(0)

escape MF 0	mod 010 r/m

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMP = Compare and Pop

Integer/Real Memory to ST(0)

escape MF 0	mod 011 r/m

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMPP = Compare ST(i) to ST(0) and Pop Twice

escape 110	11011001

FTST = Test ST(0)

escape 001	11100100

FXAM = Examine ST(0)

escape 001	11100101

Constants

FLDZ = Load + 0.0 into ST(0)

escape 000	11101110

FLD1 = Load + 1.0 into ST(0)

escape 001	11101000

FLDP1 = Load π into ST(0)

escape 001	11101011

FLDL2T = Load $\log_2 10$ into ST(0)

escape 001	11101001

FLDLG2 = Load $\log_{10} 2$ into ST(0)

escape 001	11101100

FLDLN2 = Load $\log_e 2$ into ST(0)

escape 001	11101101

Arithmetic

FADD = Addition

Integer/Real Memory with ST(0)

escape MF 0	mod 000 r/m

ST(i) and ST(0)

escape dP0	11000 ST(i)

FSUB = Subtraction

Integer/Real Memory with ST(0)

escape MF 0	mod 10R r/m

ST(i) and ST(0)

escape dP0	1110R r/m

FMUL = Multiplication

Integer/Real Memory with ST(0)

escape MF 0	mod 001 r/m

ST(i) and ST(0)

escape dP0	11001 r/m

FDIV = Division

Integer/Real Memory with ST(0)

escape MF 0	mod 11R r/m

ST(i) and ST(0)

escape dP0	1111R r/m

FSQRT = Square Root of ST(0)

escape 001	11111010

FSCALE = Scale ST(0) by ST(1)

escape 001	11111101

FPREM = Partial Remainder of ST(0) + ST(1)

escape 001	11111000

FRNDINT = Round ST(0) to Integer

escape 001	11111100

FXTRACT = Extract Components of ST(0)

escape 001	11110100

FABS = Absolute Value of ST(0)

escape 001	11100001

FCHS = Change Sign of ST(0)

escape 001	11100000

Transcendental

FPTAN = Partial Tangent of ST(0)

escape 001	11110010

FPATAN = Partial Arctangent of ST(0) ÷ ST(1)

escape 001	11110011

F2XM1 = $2^{ST(0)}$ -1

escape 001	11110000

FYL2X = ST(1) x Log_2 [ST(0)]

escape 001	11110001

FYL2XP1 = ST(1) x Log_2 [ST(0) + 1]

escape 001	11111001

FINIT = Initialize NPX

escape 011	11100011

FSETPM = Enter Protected Mode

escape 011	11100100

FSTSWAX = Store Control Word

escape 111	11100000

FLDCW = Load Control Word

escape 001	mod 101 r/m

FSTCW = Store Control Word

escape 001	mod 111 r/m

FSTSW = Store Status Word

escape 101	mod 101 r/m

FCLEX = Clear Exceptions

escape 011	11100010

FSTENV = Store Environment

escape 001	mod 110 r/m

FLDENV = Load Environment

escape 001	mod 100 r/m

FSAVE = Save State

escape 101	mod 110 r/m

FRSTOR = Restore State

escape 101	mod 100 r/m

FINCSTP = Increment Stack Pointer

escape 001	11110111

FDECSTP = Decrement Stack Pointer

escape 001	111100110

FFREE = Free ST(i)

escape 101	11000ST(i)

FNOP = No Operation

escape 101	11010000

MF is assigned as follows:

MF	**Memory Format**
00	32-bit Real
01	32-bit Integer
10	64-bit Real
11	16-bit Integer

The other abbreviations are as follows:

Term	Definition	Bit = 0	Bit ≠ 0
ST	Stack top	Stack top	(i)= ith register from the top
d	Destination	Dest. is ST(0)	Dest. is ST(i)
P	Pop	No pop	Pop
R	Reverse*	Dest. (op) source	Source (op) dest.
* When d=1, reverse the sense of R.			

Notes:

SECTION 7. CHARACTERS, KEYSTROKES, AND COLORS

Character Codes

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
00	0	Blank (Null)	Ctrl 2		Black	Black	Non-Display
01	1	☺	Ctrl A		Black	Blue	Underline
02	2	☻	Ctrl B		Black	Green	Normal
03	3	♥	Ctrl C		Black	Cyan	Normal
04	4	♦	Ctrl D		Black	Red	Normal
05	5	♣	Ctrl E		Black	Magenta	Normal
06	6	♠	Ctrl F		Black	Brown	Normal
07	7	•	Ctrl G		Black	Light Grey	Normal
08	8	◘	Ctrl H, Backspace, Shift Backspace		Black	Dark Grey	Non-Display
09	9	○	Ctrl I		Black	Light Blue	High Intensity Underline
0A	10	◙	Ctrl J, Ctrl ↵		Black	Light Green	High Intensity
0B	11	♂	Ctrl K		Black	Light Cyan	High Intensity
0C	12	♀	Ctrl L		Black	Light Red	High Intensity
0D	13	♪	Ctrl M, ↵, Shift ↵		Black	Light Magenta	High Intensity
0E	14	♫	Ctrl N		Black	Yellow	High Intensity
0F	15	☼	Ctrl O		Black	White	High Intensity
10	16	►	Ctrl P		Blue	Black	Normal
11	17	◄	Ctrl Q		Blue	Blue	Underline
12	18	↕	Ctrl R		Blue	Green	Normal
13	19	‼	Ctrl S		Blue	Cyan	Normal
14	20	¶	Ctrl T		Blue	Red	Normal
15	21	§	Ctrl U		Blue	Magenta	Normal
16	22	▬	Ctrl V		Blue	Brown	Normal
17	23	↨	Ctrl W		Blue	Light Grey	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
18	24	↑	Ctrl X		Blue	Dark Grey	High Intensity
19	25	↓	Ctrl Y		Blue	Light Blue	High Intensity Underline
1A	26	→	Ctrl Z		Blue	Light Green	High Intensity
1B	27	←	Ctrl [, Esc, Shift Esc, Crtl Esc		Blue	Light Cyan	High Intensity
1C	28	∟	Ctrl \		Blue	Light Red	High Intensity
1D	29	↔	Ctrl]		Blue	Light Magenta	High Intensity
1E	30	▲	Ctrl 6		Blue	Yellow	High Intensity
1F	31	▼	Ctrl —		Blue	White	High Intensity
20	32	Blank Space	Space Bar, Shift, Space, Ctrl Space, Alt Space		Green	Black	Normal
21	33	!	!	Shift	Green	Blue	Underline
22	34	"	"	Shift	Green	Green	Normal
23	35	#	#	Shift	Green	Cyan	Normal
24	36	$	$	Shift	Green	Red	Normal
25	37	%	%	Shift	Green	Magenta	Normal
26	38	&	&	Shift	Green	Brown	Normal
27	39	'	'		Green	Light Grey	Normal
28	40	(	(	Shift	Green	Dark Grey	High Intensity
29	41	)	)	Shift	Green	Light Blue	High Intensity Underline
2A	42	*	*	Note 1	Green	Light Green	High Intensity
2B	43	+	+	Shift	Green	Light Cyan	High Intensity
2C	44	,	,		Green	Light Red	High Intensity
2D	45	-	-		Green	Light Magenta	High Intensity
2E	46	.	.	Note 2	Green	Yellow	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
2F	47	/	/		Green	White	High Intensity
30	48	0	0	Note 3	Cyan	Black	Normal
31	49	1	1	Note 3	Cyan	Blue	Underline
32	50	2	2	Note 3	Cyan	Green	Normal
33	51	3	3	Note 3	Cyan	Cyan	Normal
34	52	4	4	Note 3	Cyan	Red	Normal
35	53	5	5	Note 3	Cyan	Magenta	Normal
36	54	6	6	Note 3	Cyan	Brown	Normal
37	55	7	7	Note 3	Cyan	Light Grey	Normal
38	56	8	8	Note 3	Cyan	Dark Grey	High Intensity
39	57	9	9	Note 3	Cyan	Light Blue	High Intensity Underline
3A	58	:	:	Shift	Cyan	Light Green	High Intensity
3B	59	;	;		Cyan	Light Cyan	High Intensity
3C	60	<	<	Shift	Cyan	Light Red	High Intensity
3D	61	=	=		Cyan	Light Magenta	High Intensity
3E	62	>	>	Shift	Cyan	Yellow	High Intensity
3F	63	?	?	Shift	Cyan	White	High Intensity
40	64	@	@	Shift	Red	Black	Normal
41	65	A	A	Note 4	Red	Blue	Underline
42	66	B	B	Note 4	Red	Green	Normal
43	67	C	C	Note 4	Red	Cyan	Normal
44	68	D	D	Note 4	Red	Red	Normal
45	69	E	E	Note 4	Red	Magenta	Normal
46	70	F	F	Note 4	Red	Brown	Normal
47	71	G	G	Note 4	Red	Light Grey	Normal
48	72	H	H	Note 4	Red	Dark Grey	High Intensity
49	73	I	I	Note 4	Red	Light Blue	High Intensity Underline
4A	74	J	J	Note 4	Red	Light Green	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
4B	75	K	K	Note 4	Red	Light Cyan	High Intensity
4C	76	L	L	Note 4	Red	Light Red	High Intensity
4D	77	M	M	Note 4	Red	Light Magenta	High Intensity
4E	78	N	N	Note 4	Red	Yellow	High Intensity
4F	79	O	O	Note 4	Red	White	High Intensity
50	80	P	P	Note 4	Magenta	Black	Normal
51	81	Q	Q	Note 4	Magenta	Blue	Underline
52	82	R	R	Note 4	Magenta	Green	Normal
53	83	S	S	Note 4	Magenta	Cyan	Normal
54	84	T	T	Note 4	Magenta	Red	Normal
55	85	U	U	Note 4	Magenta	Magenta	Normal
56	86	V	V	Note 4	Magenta	Brown	Normal
57	87	W	W	Note 4	Magenta	Light Grey	Normal
58	88	X	X	Note 4	Magenta	Dark Grey	High Intensity
59	89	Y	Y	Note 4	Magenta	Light Blue	High Intensity Underline
5A	90	Z	Z	Note 4	Magenta	Light Green	High Intensity
5B	91	[	[		Magenta	Light Cyan	High Intensity
5C	92	\	\		Magenta	Light Red	High Intensity
5D	93	]	]		Magenta	Light Magenta	High Intensity
5E	94	^	^	Shift	Magenta	Yellow	High Intensity
5F	95	—	—	Shift	Magenta	White	High Intensity
60	96	'	'		Brown	Black	Normal
61	97	a	a	Note 5	Brown	Blue	Underline
62	98	b	b	Note 5	Brown	Green	Normal
63	99	c	c	Note 5	Brown	Cyan	Normal
64	100	d	d	Note 5	Brown	Red	Normal
65	101	e	e	Note 5	Brown	Magenta	Normal
66	102	f	f	Note 5	Brown	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
67	103	g	g	Note 5	Brown	Light Grey	Normal
68	104	h	h	Note 5	Brown	Dark Grey	High Intensity
69	105	i	i	Note 5	Brown	Light Blue	High Intensity Underline
6A	106	j	j	Note 5	Brown	Light Green	High Intensity
6B	107	k	k	Note 5	Brown	Light Cyan	High Intensity
6C	108	l	l	Note 5	Brown	Light Red	High Intensity
6D	109	m	m	Note 5	Brown	Light Magenta	High Intensity
6E	110	n	n	Note 5	Brown	Yellow	High Intensity
6F	111	o	o	Note 5	Brown	White	High Intensity
70	112	p	p	Note 5	Light Grey	Black	Reverse Video
71	113	q	q	Note 5	Light Grey	Blue	Underline
72	114	r	r	Note 5	Light Grey	Green	Normal
73	115	s	s	Note 5	Light Grey	Cyan	Normal
74	116	t	t	Note 5	Light Grey	Red	Normal
75	117	u	u	Note 5	Light Grey	Magenta	Normal
76	118	v	v	Note 5	Light Grey	Brown	Normal
77	119	w	w	Note 5	Light Grey	Light Grey	Normal
78	120	x	x	Note 5	Light Grey	Dark Grey	Reverse Video
79	121	y	y	Note 5	Light Grey	Light Blue	High Intensity Underline
7A	122	z	z	Note 5	Light Grey	Light Green	High Intensity
7B	123	{	{	Shift	Light Grey	Light Cyan	High Intensity
7C	124	¦	¦	Shift	Light Grey	Light Red	High Intensity
7D	125	}	}	Shift	Light Grey	Light Magenta	High Intensity
7E	126	~	~	Shift	Light Grey	Yellow	High Intensity
7F	127	△	Ctrl ←		Light Grey	White	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
* * * * 80 to FF Hex are Flashing in both Color & IBM Monochrome * * * *							
80	128	Ç	Alt 128	Note 6	Black	Black	Non-Display
81	129	ü	Alt 129	Note 6	Black	Blue	Underline
82	130	é	Alt 130	Note 6	Black	Green	Normal
83	131	â	Alt 131	Note 6	Black	Cyan	Normal
84	132	ä	Alt 132	Note 6	Black	Red	Normal
85	133	à	Alt 133	Note 6	Black	Magenta	Normal
86	134	å	Alt 134	Note 6	Black	Brown	Normal
87	135	ç	Alt 135	Note 6	Black	Light Grey	Normal
88	136	ê	Alt 136	Note 6	Black	Dark Grey	Non-Display
89	137	ë	Alt 137	Note 6	Black	Light Blue	High Intensity Underline
8A	138	è	Alt 138	Note 6	Black	Light Green	High Intensity
8B	139	ï	Alt 139	Note 6	Black	Light Cyan	High Intensity
8C	140	î	Alt 140	Note 6	Black	Light Red	High Intensity
8D	141	ì	Alt 141	Note 6	Black	Light Magenta	High Intensity
8E	142	Ä	Alt 142	Note 6	Black	Yellow	High Intensity
8F	143	Å	Alt 143	Note 6	Black	White	High Intensity
90	144	É	Alt 144	Note 6	Blue	Black	Normal
91	145	æ	Alt 145	Note 6	Blue	Blue	Underline
92	146	Æ	Alt 146	Note 6	Blue	Green	Normal
93	147	ô	Alt 147	Note 6	Blue	Cyan	Normal
94	148	ö	Alt 148	Note 6	Blue	Red	Normal
95	149	ò	Alt 149	Note 6	Blue	Magenta	Normal
96	150	û	Alt 150	Note 6	Blue	Brown	Normal
97	151	ù	Alt 151	Note 6	Blue	Light Grey	Normal
98	152	ÿ	Alt 152	Note 6	Blue	Dark Grey	High Intensity
99	153	Ö	Alt 153	Note 6	Blue	Light Blue	High Intensity Underline
9A	154	Ü	Alt 154	Note 6	Blue	Light Green	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
9B	155	¢	Alt 155	Note 6	Blue	Light Cyan	High Intensity
9C	156	£	Alt 156	Note 6	Blue	Light Red	High Intensity
9D	157	¥	Alt 157	Note 6	Blue	Light Magenta	High Intensity
9E	158	Pt	Alt 158	Note 6	Blue	Yellow	High Intensity
9F	159	ƒ	Alt 159	Note 6	Blue	White	High Intensity
A0	160	á	Alt 160	Note 6	Green	Black	Normal
A1	161	í	Alt 161	Note 6	Green	Blue	Underline
A2	162	ó	Alt 162	Note 6	Green	Green	Normal
A3	163	ú	Alt 163	Note 6	Green	Cyan	Normal
A4	164	ñ	Alt 164	Note 6	Green	Red	Normal
A5	165	Ñ	Alt 165	Note 6	Green	Magenta	Normal
A6	166	ª	Alt 166	Note 6	Green	Brown	Normal
A7	167	º	Alt 167	Note 6	Green	Light Grey	Normal
A8	168	¿	Alt 168	Note 6	Green	Dark Grey	High Intensity
A9	169	⌐	Alt 169	Note 6	Green	Light Blue	High Intensity Underline
AA	170	¬	Alt 170	Note 6	Green	Light Green	High Intensity
AB	171	½	Alt 171	Note 6	Green	Light Cyan	High Intensity
AC	172	¼	Alt 172	Note 6	Green	Light Red	High Intensity
AD	173	i	Alt 173	Note 6	Green	Light Magenta	High Intensity
AE	174	<<	Alt 174	Note 6	Green	Yellow	High Intensity
AF	175	>>	Alt 175	Note 6	Green	White	High Intensity
B0	176	░	Alt 176	Note 6	Cyan	Black	Normal
B1	177	▒	Alt 177	Note 6	Cyan	Blue	Underline
B2	178	▓	Alt 178	Note 6	Cyan	Green	Normal
B3	179	│	Alt 179	Note 6	Cyan	Cyan	Normal
B4	180	┤	Alt 180	Note 6	Cyan	Red	Normal
B5	181	╡	Alt 181	Note 6	Cyan	Magenta	Normal
B6	182	╢	Alt 182	Note 6	Cyan	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
B7	183	╖	Alt 183	Note 6	Cyan	Light Grey	Normal
B8	184	╕	Alt 184	Note 6	Cyan	Dark Grey	High Intensity
B9	185	╣	Alt 185	Note 6	Cyan	Light Blue	High Intensity Underline
BA	186	║	Alt 186	Note 6	Cyan	Light Green	High Intensity
BB	187	╗	Alt 187	Note 6	Cyan	Light Cyan	High Intensity
BC	188	╝	Alt 188	Note 6	Cyan	Light Red	High Intensity
BD	189	╜	Alt 189	Note 6	Cyan	Light Magenta	High Intensity
BE	190	╛	Alt 190	Note 6	Cyan	Yellow	High Intensity
BF	191	┐	Alt 191	Note 6	Cyan	White	High Intensity
C0	192	└	Alt 192	Note 6	Red	Black	Normal
C1	193	┴	Alt 193	Note 6	Red	Blue	Underline
C2	194	┬	Alt 194	Note 6	Red	Green	Normal
C3	195	├	Alt 195	Note 6	Red	Cyan	Normal
C4	196	─	Alt 196	Note 6	Red	Red	Normal
C5	197	┼	Alt 197	Note 6	Red	Magenta	Normal
C6	198	╞	Alt 198	Note 6	Red	Brown	Normal
C7	199	╟	Alt 199	Note 6	Red	Light Grey	Normal
C8	200	╚	Alt 200	Note 6	Red	Dark Grey	High Intensity
C9	201	╔	Alt 201	Note 6	Red	Light Blue	High Intensity Underline
CA	202	╩	Alt 202	Note 6	Red	Light Green	High Intensity
CB	203	╦	Alt 203	Note 6	Red	Light Cyan	High Intensity
CC	204	╠	Alt 204	Note 6	Red	Light Red	High Intensity
CD	205	═	Alt 205	Note 6	Red	Light Magenta	High Intensity
CE	206	╬	Alt 206	Note 6	Red	Yellow	High Intensity
CF	207	╧	Alt 207	Note 6	Red	White	High Intensity
D0	208	╨	Alt 208	Note 6	Magenta	Black	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
D1	209	╤	Alt 209	Note 6	Magenta	Blue	Underline
D2	210	╥	Alt 210	Note 6	Magenta	Green	Normal
D3	211	╙	Alt 211	Note 6	Magenta	Cyan	Normal
D4	212	╘	Alt 212	Note 6	Magenta	Red	Normal
D5	213	╒	Alt 213	Note 6	Magenta	Magenta	Normal
D6	214	╓	Alt 214	Note 6	Magenta	Brown	Normal
D7	215	╫	Alt 215	Note 6	Magenta	Light Grey	Normal
D8	216	╪	Alt 216	Note 6	Magenta	Dark Grey	High Intensity
D9	217	┘	Alt 217	Note 6	Magenta	Light Blue	High Intensity Underline
DA	218	┌	Alt 218	Note 6	Magenta	Light Green	High Intensity
DB	219	█	Alt 219	Note 6	Magenta	Light Cyan	High Intensity
DC	220	▄	Alt 220	Note 6	Magenta	Light Red	High Intensity
DD	221	▌	Alt 221	Note 6	Magenta	Light Magenta	High Intensity
DE	222	▐	Alt 222	Note 6	Magenta	Yellow	High Intensity
DF	223	▀	Alt 223	Note 6	Magenta	White	High Intensity
E0	224	α	Alt 224	Note 6	Brown	Black	Normal
E1	225	β	Alt 225	Note 6	Brown	Blue	Underline
E2	226	Γ	Alt 226	Note 6	Brown	Green	Normal
E3	227	π	Alt 227	Note 6	Brown	Cyan	Normal
E4	228	Σ	Alt 228	Note 6	Brown	Red	Normal
E5	229	σ	Alt 229	Note 6	Brown	Magenta	Normal
E6	230	μ	Alt 230	Note 6	Brown	Brown	Normal
E7	231	τ	Alt 231	Note 6	Brown	Light Grey	Normal
E8	232	Φ	Alt 232	Note 6	Brown	Dark Grey	High Intensity
E9	233	θ	Alt 233	Note 6	Brown	Light Blue	High Intensity Underline
EA	234	Ω	Alt 234	Note 6	Brown	Light Green	High Intensity
EB	235	δ	Alt 235	Note 6	Brown	Light Cyan	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
EC	236	∞	Alt 236	Note 6	Brown	Light Red	High Intensity
ED	237	φ	Alt 237	Note 6	Brown	Light Magenta	High Intensity
EE	238	ϵ	Alt 238	Note 6	Brown	Yellow	High Intensity
EF	239	∩	Alt 239	Note 6	Brown	White	High Intensity
F0	240	≡	Alt 240	Note 6	Light Grey	Black	Reverse Video
F1	241	±	Alt 241	Note 6	Light Grey	Blue	Underline
F2	242	≥	Alt 242	Note 6	Light Grey	Green	Normal
F3	243	≤	Alt 243	Note 6	Light Grey	Cyan	Normal
F4	244	⌠	Alt 244	Note 6	Light Grey	Red	Normal
F5	245	⌡	Alt 245	Note 6	Light Grey	Magenta	Normal
F6	246	÷	Alt 246	Note 6	Light Grey	Brown	Normal
F7	247	≈	Alt 247	Note 6	Light Grey	Light Grey	Normal
F8	248	○	Alt 248	Note 6	Light Grey	Dark Grey	Reverse Video
F9	249	●	Alt 249	Note 6	Light Grey	Light Blue	High Intensity Underline
FA	250	•	Alt 250	Note 6	Light Grey	Light Green	High Intensity
FB	251	√	Alt 251	Note 6	Light Grey	Light Cyan	High Intensity
FC	252	^{n}	Alt 252	Note 6	Light Grey	Light Red	High Intensity
FD	253	^{2}	Alt 253	Note 6	Light Grey	Light Magenta	High Intensity
FE	254	■	Alt 254	Note 6	Light Grey	Yellow	High Intensity
FF	255	BLANK	Alt 255	Note 6	Light Grey	White	High Intensity

Notes

1. Asterisk (*) can be typed using two methods: press the (*) key or, in the shift mode, press the 8 key.

2. Period (.) can be typed using two methods: press the . key or, in the shift or Num Lock mode, press the Del key.

3. Numeric characters 0-9 can be typed using two methods: press the numeric keys on the top row of the keyboard or, in the shift or Num Lock mode, press the numeric keys in the keypad portion of the keyboard.

4. Uppercase alphabetic characters (A-Z) can be typed in two modes: the shift mode or the Caps Lock mode.

5. Lowercase alphabetic characters (a-z) can be typed in two modes: in the normal mode or in Caps Lock and shift mode combined.

6. The three digits after the Alt key must be typed from the numeric keypad. Character codes 1-255 may be entered in this fashion (with Caps Lock activated, character codes 97-122 will display uppercase).

Quick Reference

DECIMAL VALUE	➡	0	16	32	48	64	80	96	112
⬇	HEXA-DECIMAL VALUE	0	1	2	3	4	5	6	7
0	0	BLANK (NULL)	►	BLANK (SPACE)	0	@	P	‘	p
1	1	☺	◄	!	1	A	Q	a	q
2	2	☻	↕	"	2	B	R	b	r
3	3	♥	‼	#	3	C	S	c	s
4	4	♦	¶	$	4	D	T	d	t
5	5	♣	§	%	5	E	U	e	u
6	6	♠	▬	&	6	F	V	f	v
7	7	•	↨	'	7	G	W	g	w
8	8	◘	↑	(	8	H	X	h	x
9	9	○	↓	)	9	I	Y	i	y
10	A	◙	→	*	:	J	Z	j	z
11	B	♂	←	+	;	K	[	k	{
12	C	♀	∟	,	<	L	\	l	¦
13	D	♪	↔	—	=	M	]	m	}
14	E	♫	▲	.	>	N	^	n	~
15	F	☼	▼	/	?	O	_	o	△

DECIMAL VALUE	➡	128	144	160	176	192	208	224	240
⬇	HEXA-DECIMAL VALUE	8	9	A	B	C	D	E	F
0	0	Ç	É	á	░	└	╨	∝	≡
1	1	ü	æ	í	▒	┴	╤	β	±
2	2	é	Æ	ó	▓	┬	╥	Γ	≥
3	3	â	ô	ú	│	├	╙	π	≤
4	4	ä	ö	ñ	┤	─	╘	Σ	⌠
5	5	à	ò	Ñ	╡	┼	╒	σ	⌡
6	6	å	û	ª	╢	╞	╓	μ	÷
7	7	ç	ù	º	╖	╟	╫	ϒ	≈
8	8	ê	ÿ	¿	╕	╚	╪	Φ	°
9	9	ë	Ö	⌐	╣	╔	┘	Θ	•
10	A	è	Ü	¬	║	╩	┌	Ω	•
11	B	ï	¢	½	╗	╦	█	δ	√
12	C	î	£	¼	╝	╠	▄	∞	n
13	D	ì	¥	¡	╜	═	▌	ϕ	2
14	E	Ä	₧	«	╛	╬	▐	∈	▮
15	F	Å	ƒ	»	┐	╧	▀	∩	BLANK 'FF'

Notes:

SECTION 8. IBM PERSONAL COMPUTER COMPATIBILITY

This section describes the differences among the members of the IBM Personal Computer family. It also contains information necessary to design hardware and programs that will be compatible with all members of the IBM Personal Computer family.

Hardware Considerations

To design compatible hardware or programs, you must consider hardware differences among the IBM Personal Computers. The following are hardware features of the IBM Personal Computer XT Model 286 that are not supported by all of the IBM Personal Computer family.

System Board

The IBM Personal Computer XT Model 286 system board uses an Intel 80286-6 Microprocessor. This microprocessor uses the 80287 Math Coprocessor and is generally compatible with the Intel 8088 Microprocessor used in other IBM Personal Computers.

The following table identifies the microprocessor and describes the I/O channel used with each type of IBM Personal Computer.

System Name	System Unit Microprocessor	I/O Channel Description
Personal Computer	8088	5 62-Pin
PCjr	8088	Not Compatible
Personal Computer XT	8088	8 62-Pin
Portable Personal Computer	8088	8 62-Pin
Personal Computer XT Model 286	80286-6	3 62-pin 5 98-Pin (62 Pin + 36 Pin)
Personal Computer AT	80286(-6 or -8)	2 62-pin 6 98-Pin (62 Pin + 36 Pin)

System Hardware Identification Chart

The faster processing capability of the 80286, compared to the 8088, creates special programming considerations, which are discussed later in this section under "Application Guidelines."

Adapters designed to use all 98 pins on the 98-pin connectors are not compatible with all members of the IBM Personal Computer family. Some options not supported by the IBM Personal Computer XT Model 286 are:

Expansion Unit
AT 128KB Memory Expansion
AT 512KB Memory Expansion
AT 128/640KB Memory Expansion
AT Fixed Disk And Diskette Drive Adapter
256KB Memory Expansion
64/256KB Memory Expansion
64KB Memory Module Kit
Full-high diskette drives
AT 30MB Fixed Disk Drive
AT 20MB Fixed Disk Drive
10MB Fixed Disk Drive
AT Prototype Card
Diskette Drive Adapter
Fixed Disk Adapter
8087 Math Coprocessor
Professional Graphics Adapter and Display
Game Control Adapter
Color Printer
Other keyboards

On the I/O channel:

- The system clock signal should be used only for synchronization and not for applications requiring a fixed frequency.

- The 14.31818-MHz oscillator is not synchronous with the system clock.

- The ALE signal remains high during DMA cycles.

- Pin B04 supports IRQ 9.

Fixed Disk Drive

Reading from and writing to this drive is initiated in the same way as with other IBM Personal Computers; however, the Fixed Disk and Diskette Drive Adapter may be addressed from different BIOS locations.

Diskette Drive Compatibility

The following chart shows the read, write, and format capabilities for each of the diskette drives used by IBM Personal Computers.

Diskette Drive Name	160/180K Mode	320/360K Mode	1.2M Mode	720K Mode
5-1/4 In. Diskette Drive				
Type 1	R W F	---	---	---
Type 2	R W F	R W F	---	---
Type 3	R W F	R W F	---	---
Slimline Diskette Drive	R W F	R W F	---	---
Double Sided Diskette Drive	R W F	R W F	---	---
High Capacity Diskette Drive	R W*	R W*	R W F	---
3-1/2 In.- 720K Drive	---	---	---	R W F
R=Read W=Write F=Format W*= If a diskette is formatted in either 160/180K mode or 320/360K mode and written on by a High Capacity Drive, that diskette may be read by only a High Capacity Drive.				

Diskette Drive Compatibility Chart

Note: Diskettes designed for the 1.2M mode may not be used in either a 160/180K or a 320/360K diskette drive.

Copy Protection

The following methods of copy protection may not work on systems using the High Capacity Diskette Drive:

- Bypassing BIOS
- Diskette drive controls
- Write current control

Bypassing BIOS

Copy protection that tries to bypass the following BIOS routines will not work on the High Capacity Diskette Drive:

Track Density: The High Capacity Diskette Drive records tracks at a density of 96 tracks per inch (TPI). This drive has to double-step in the 48 TPI mode, which is performed by BIOS.

Data Transfer Rate: BIOS selects the proper data transfer rate for the media being used.

Disk__Base: Copy protection, which creates its own disk__base will not work on the High Capacity Diskette Drive.

Diskette Drive Controls

Copy protection that uses the following will not work on the High Capacity Diskette Drive:

Rotational Speed: The time between two events on a diskette is controlled by the Fixed Disk and Diskette Drive Adapter.

Access Time: Diskette BIOS routines must set the track-to-track access time for the different types of media used on the IBM Personal Computer XT Model 286.

Head Geometry: See "Diskette Drive Compatibility" on page 8-5.

Diskette Change Signal: Copy protection may not be able to reset this signal.

Write Current Control

Copy protection that uses write current control will not work because the Fixed Disk and Diskette Drive Adapter selects the proper write current for the media being used.

Application Guidelines

The following information should be used to develop application programs for the IBM Personal Computer family.

High-Level Language Considerations

The IBM-supported languages of BASIC, FORTRAN, COBOL, Pascal, and APL are the best choices for writing compatible programs.

If a program uses specific features of the hardware, that program may not be compatible with all IBM Personal Computers. Specifically, the use of assembler language subroutines or hardware-specific commands (In, Out, Peek, Poke, ...) must follow the assembler language rules (see "Assembler Language Programming Considerations" on page 8-8).

Any program that requires precise timing information should obtain it through a DOS or language interface; for example, TIME$ in BASIC. If greater precision is required, the assembler techniques in "Assembler Language Programming Considerations" are available. The use of programming loops may prevent a program from being compatible with other IBM Personal Computers.

Assembler Language Programming Considerations

The following OP codes work differently on systems using the 80286 microprocessor than they do on systems using the 8088 microprocessor.

- If the system microprocessor executes a POPF instruction in either the real or the virtual address mode with CPL≤IOPL, then a pending maskable interrupt (the INTR pin active) may be improperly recognized after executing the POPF instruction even if maskable interrupts were disabled before the POPF instruction and the value popped had IF=0. If the interrupt is improperly recognized, the interrupt is still correctly executed. This errata has no effect when interrupts are enabled in either real or virtual address mode. This errata has no effect in the virtual address mode when CPL>IOPL.

  The POPF instruction may be simulated with the following code macro:

```
POPFF      Macro      ; use POPFF instead of POPF
                      ; simulate popping flags
                      ; using IRET
EB 01      JMP $+3    ; jump around IRET
CF         IRET       ; POP CS, IP, flags
0E         PUSH CS
E8 FB FF   CALL $-2   ; CALL within segment
                      ; program will continue here
```

- PUSH SP

  80286 microprocessor pushes the current stack pointer.

  8088 microprocessor pushes the new stack pointer.

- Single step interrupt (when TF=1) on the interrupt instruction (OP code hex CC,CD):

  80286 microprocessor does **not** interrupt on the INT instruction.

8088 microprocessor does interrupt on the INT instruction.

- The divide error exception (interrupt 0):

  80286 microprocessor pushes the CS:IP of the instruction, causing the exception.

  8088 microprocessor pushes the CS:IP **following** the instruction, causing the exception.

- Shift counts are masked to five bits. Shift counts greater than 31 are treated mod 32. For example, a shift count of 36, shifts the operand four places.

The following describes anomalies which may occur in systems which contain 80286 processors with 1983 and 1984 date codes (S40172, S54036, S40093, S54012).

In protected mode, the contents of the CX register may be unexpectedly altered under the following conditions:

Note: The value in parenthesis indicates the type of error code pushed onto the exception handler's stack.

Exception #NP() = Exception #11 = Not-present Fault
Exception #SS() = Exception #12 = Stack Fault
Exception #GP() = Exception #13 = General Protection Fault

- Exception #GP(0) from attempted access to data segment or extra segment when the corresponding segment register holds a null selector.

- Exception #GP(0) from attempted data read from code segment when code segment has the "execute only" attribute.

- Exception #GP(0) from attempted write to code segment (code segments are not writable in protected mode), or to data segment of extra segment if the data or extra segment has the read only attribute.

- Exception #GP(0) from attempted load of a selector referencing the local descriptor table into CS, DS, ES or SS, when the LDT is not present.

- Exception #GP(0) from attempted input or output instruction when CPL > IOPL.

- Exception #GP(selector) from attempted access to a descriptor is GDT, LDT, or IDT, beyond the defined limit of the descriptor table.

- Exception #GP(0) from attempted read or write (except for "PUSH" onto stack) beyond the defined limit of segment.

- Exception #SS(0) from attempted "PUSH" below the defined limit of the stack segment.

Restarting applications which generate the above exceptions may result in errors.

In the protected mode, when any of the null selector values (0000H, 0001H, 0002H, 0003H) are loaded into the DS or ES registers via a MOV or POP instruction or a task switch, the 80286 always loads the null selector 0000H into the corresponding register.

If a coprocessor (80287) operand is read from an "executable and readable" and conforming (ERC) code segment, and the coprocessor operand is sufficiently near the segment's limit that the second or subsequent byte lies outside the limit, no protection exception #9 will be generated.

The following correctly describes the operation of all 80286 parts:

- Instructions longer than 10 bytes (instructions using multiple redundant prefixes) generate exception #13 (General Purpose Exception) in both the real and protected modes.

- If the second operand of an ARPL instruction is a null selector, the instruction generates an exception #13.

Assembler language programs should perform all I/O operations through ROM BIOS or DOS function calls.

- Program interrupts are used for access to these functions. This practice removes the absolute addressing from the program. Only the interrupt number is required.

- The coprocessor detects six different exception conditions that can occur during instruction execution. If the appropriate exception mask within the coprocessor is not set, the coprocessor sets its error signal. This error signal generates a hardware interrupt (interrupt 13) and causes the 'busy' signal to the coprocessor to be held in the busy state. The 'busy' signal may be cleared by an 8-bit I/O Write command to address hex F0 with D0 through D7 equal to 0.

  The power-on-self-test code in the system ROM enables hardware IRQ 13 and sets up its vector to point to a routine in ROM. The ROM routine clears the 'busy' signal latch and then transfers control to the address pointed to by the NMI interrupt vector. This allows code written for any IBM Personal Computer to work on an IBM Personal Computer XT Model 286. The NMI interrupt handler should read the coprocessor's status to determine if the NMI was caused by the coprocessor. If the interrupt was not generated by the coprocessor, control should be passed to the original NMI interrupt handler.

- Back to back I/O commands to the same I/O ports will not permit enough recovery time for I/O chips. To ensure enough time, a JMP SHORT $+2 must be inserted between IN/OUT instructions to the same I/O chip.

  Note: MOV AL,AH type instruction does not allow enough recovery time. An example of the correct procedure follows:

```
OUT  IO_ADD,AL
JMP  SHORT $+2
MOV  AL,AH
OUT  IO_ADD,AL
```

- In systems using the 80286 microprocessor, IRQ 9 is redirected to INT hex 0A (hardware IRQ 2). This insures that hardware designed to use IRQ 2 will operate in the IBM Personal Computer XT Model 286.

- The system can mask hardware sensitivity. New devices can change the ROM BIOS to accept the same programming interface on the new device.

- In cases where BIOS provides parameter tables, such as for video or diskette, a program may substitute new parameter values by building a new copy of the table and changing the vector to point to that table. However, the program should copy the current table, using the current vector, and then modify those locations in the table that need to be changed. In this way, the program will not inadvertently change any values that should be left the same.

- Disk__Base consists of 11 parameters required for diskette operation. They are pointed at by the data variable, Disk__Pointer, at absolute address 0:78. It is strongly recommended that the values supplied in ROM be used. If it becomes necessary to modify any of the parameters, build another parameter block and modify the address in Disk__Pointer to point to the new block.

  The parameters were established to operate both the High Capacity Diskette Drive and the Double Sided Diskette Drive. Three of the parameters in this table are under control of BIOS in the following situations.

    The Gap Length Parameter is no longer retrieved from the parameter block.

    The gap length used during diskette read, write, and verify operations is derived from within diskette BIOS.

    The gap length for format operations is still obtained from the parameter block.

  Special considerations are required for formatting operations. See the prolog of Diskette BIOS for the required details. If a parameter block contains a head settle time parameter value of 0 milliseconds, and a write operation is being performed, at least 15 milliseconds of head settle time will be enforced for a High Capacity Diskette Drive and 20 milliseconds will be enforced for a Double Sided Diskette Drive. If a parameter block contains a motor start wait parameter of less than 1 second for a write or format operation of 625 milliseconds for a read or verify operation, Diskette BIOS will enforce those times listed above.

- The following procedure is used to determine the type of media inserted in the High Capacity Diskette Drive:

  1. Read Track 0, Head 0, Sector 1 to allow diskette BIOS to establish the media/drive combination. If this is successful, continue with the next step.

  2. Read Track 0, Sector 15. If an error occurs, a double sided diskette is in the drive.

     Note: Refer to the *DOS Technical Reference* manual for the File Allocation Table (FAT) parameters for single- and double-sided diskettes.
     If a successful read occurs, a high capacity diskette is in the drive.

  3. If Step 1 fails, issue the reset function (AH=0) to diskette BIOS and retry. If a successful read cannot be done, the media needs to be formatted or is defective.

ROM BIOS and DOS do not provide for all functions. The following are the allowable I/O operations with which IBM will maintain compatibility in future systems.

- Control of the sound, using port hex 61, and the sound channel of the timer/counter. A program can control timer/counter channels 0 and 2, ports hex 40, 42, and 43. A program must not change the value in port hex 41, because this port controls the dynamic-memory refresh. Channel 0 provides the time-of-day interrupt, and can also be used for timing short intervals. Channel 2 of the timer/counter is the output for the speaker and cassette ports. This channel may also be used for timing short intervals, although it cannot interrupt at the end of the period.

  Note: Programs should use the timer for delay on the paddle input rather than a program loop.

- Interrupt Mask Register (IMR), port hex 21, can be used to selectively mask and unmask the hardware features.

The following information pertains to absolute memory locations.

- Interrupt Vectors Segment (hex 0)--A program may change these to point at different processing routines. When an interrupt vector is modified, the original value should be retained. If the interrupt, either hardware or program, is not directed toward this device handler, the request should be passed to the next item in the list.

- Video Display Buffers (hex B0000 and B8000)-- For each mode of operation defined in the video display BIOS, the memory map will remain the same. For example, the bit map for the 320 x 200 medium-resolution graphics mode of the Color/Graphics Monitor adapter will be retained on any future adapter that supports that mode. If the bit map is modified, a different mode number will be used.

- ROM BIOS Data Area (hex 40:0)--Any variables in this area will retain their current definition, whenever it is reasonable to do so. IBM may use these data areas for other purposes when the variable no longer has meaning in the system. In general, ROM BIOS data variables should be read or modified through BIOS calls whenever possible, and not with direct access to the variable.

A program that requires timing information should use either the time-of-day clock or the timing channels of the timer/counter. The input frequency to the timer will be maintained at 1.19 MHz, providing a constant time reference. Program loops should be avoided.

Programs that use copy protection schemes should use the ROM BIOS diskette calls to read and verify the diskette and should not be timer dependent. Any method can be used to create the diskette, although manufacturing capability should be considered. The verifying program can look at the diskette controller's status bytes in the ROM BIOS data area for additional information about embedded errors. More information about copy protection may be found on page 8-5 under "Copy Protection".

Any DOS program must be relocatable and insensitive to the size of DOS or its own load addresses. A program's memory requirement should be identified and contiguous with the load module. A program should not assume that all of memory is available to it.

There are several 80286 instructions that, when executed, lock out external bus signals. DMA requests are not honored during the execution of these instructions. Consecutive instructions of this type prevent DMA activity from the start of the first instruction to the end of the last instruction. To allow for necessary DMA cycles, as required by the diskette controller in a multitasking system, multiple lock-out instructions must be separated by JMP SHORT $+2.

Multitasking Provisions

The IBM Personal Computer XT Model 286 BIOS contains a feature to assist multitasking implementation. "Hooks" are provided for a multitasking dispatcher. Whenever a busy (wait) loop occurs in the BIOS, a hook is provided for the program to break out of the loop. Also, whenever BIOS services an interrupt, a corresponding wait loop is exited, and another hook is provided. Thus a program may be written that employs the bulk of the device driver code. The following is valid only in the microprocessor's real address mode and must be taken by the code to allow this support.

The program is responsible for the serialization of access to the device driver. The BIOS code is not reentrant.

The program is responsible for matching corresponding wait and post calls.

Interfaces

There are four interfaces to be used by the multitasking dispatcher:

Startup

First, the startup code hooks interrupt hex 15. The dispatcher is responsible to check for function codes of AH= hex 90 or 91. The "Wait" and "Post" sections describe these codes. The dispatcher must pass all other functions to the previous user of interrupt hex 15. This can be done by a JMP or a CALL. If the function code is hex 90 or 91, the dispatcher should do the appropriate processing and return by the IRET instruction.

Serialization

It is up to the multitasking system to ensure that the device driver code is used serially. Multiple entries into the code can result in serious errors.

Wait (Busy)

Whenever the BIOS is about to enter a busy loop, it first issues an interrupt hex 15 with a function code of hex 90 in AH. This signals a wait condition. At this point, the dispatcher should save the task status and dispatch another task. This allows overlapped execution of tasks when the hardware is busy. The following is an outline of the code that has been added to the BIOS to perform this function.

```
MOV AX, 90XXH        ; wait code in AH and
                     ; type code in AL
INT 15H              ; issue call
JC  TIMEOUT          ; optional: for time-out or
                     ; if carry is set, time-out
                     ; occurred
NORMAL TIMEOUT LOGIC ; normal time-out
```

Post (Interrupt)

Whenever the BIOS has set an interrupt flag for a corresponding busy loop, an interrupt 15 occurs with a function code of hex 91 in AH. This signals a post condition. At this point, the dispatcher should set the task status to "ready to run" and return to the interrupt routine. The following is an outline of the code added to BIOS that performs this function.

```
MOV AX, 91XXH          ; post code AH and
                       ; type code AL
INT 15H                ; issue call
```

Classes

The following types of wait loops are supported:

- The class for hex 0 to 7F is serially reusable. This means that for the devices that use these codes, access to the BIOS must be restricted to only one task at a time.
- The class for hex 80 to BF is reentrant. There is no restriction on the number of tasks that may access the device.
- The class for hex C0 to FF is non-interrupt. There is no corresponding interrupt for the wait loop. Therefore, it is the responsibility of the dispatcher to determine what satisfies this condition to exit the loop.

Function Code Classes

Type Code (AL)	Description
00H->7FH	Serially reusable devices; operating system must serialize access
80H->0BFH	Reentrant devices; ES:BX is used to distinguish different calls (multiple I/O calls are allowed simultaneously)

0C0H->0FH	Wait only calls; there is no complementary POST for these waits--these are time-out only. Times are function-number dependent.

Function Code Assignments

The following are specific assignments for the IBM Personal Computer XT Model 286 BIOS. Times are approximate. They are grouped according to the classes described under "Function Code Classes".

Type Code (AL)	Time-out	Description
00H	yes (6 second)	fixed disk
01H	yes (2 second)	diskette
02H	no (2 second)	keyboard
0FDH	yes (1 second-write)	diskette motor start
--	(625 ms-read)	--
0FEH	yes (18 second)	printer

The asynchronous support has been omitted. The Serial/Parallel Adapter will generate interrupts, but BIOS does not support it in the interrupt mode. Therefore, the support should be included in the multitasking system code if that device is to be supported.

Time-Outs

To support time-outs properly, the multitasking dispatcher must be aware of time. If a device enters a busy loop, it generally should remain there for a specific amount of time before indicating an error. The dispatcher should return to the BIOS wait loop with the carry bit set if a time-out occurs.

Machine-Sensitive Code

Programs may select machine specific features, but they must test for specific machine type. Location of the specific machine identification codes can be found through interrupt 15 function code AH (See 'Configuration Parameters' in BIOS Listing). The code is two bytes. The first byte shows the machine type and the second byte shows the series type. They are as follows:

First Byte	Second Byte	Machine Identification
FF	00	IBM Personal Computer
FE	00	IBM Personal Computer XT
FE	00	IBM Portable Personal Computer
FD	00	IBM PCjr
FC	00	IBM Personal Computer AT
FC	02	IBM Personal Computer XT Model 286
FB	00	IBM Personal Computer XT with 256/640 system board

Machine Identification Code

IBM will define methods for uniquely determining the specific machine type or I/O feature for any new device.

Notes:

Glossary

This glossary includes terms and definitions from the *IBM Vocabulary for Data Processing, Telecommunications, and Office Systems,* GC20-1699.

μ. Prefix micro; 0.000 001.

***μ*s.** Microsecond; 0.000 001 second.

A. Ampere.

ac. Alternating current.

accumulator. A register in which the result of an operation is formed.

active high. Designates a signal that has to go high to produce an effect. Synonymous with positive true.

active low. Designates a signal that has to go low to produce an effect. Synonymous with negative true.

adapter. An auxiliary device or unit used to extend the operation of another system.

address bus. One or more conductors used to carry the binary-coded address from the processor throughout the rest of the system.

algorithm. A finite set of well-defined rules for the solution of a problem in a finite number of steps.

all points addressable (APA). A mode in which all points of a displayable image can be controlled by the user.

alphameric. Synonym for alphanumeric.

alphanumeric (A/N). Pertaining to a character set that contains letters, digits, and usually other characters, such as punctuation marks. Synonymous with alphameric.

alternating current (ac). A current that periodically reverses its direction of flow.

American National Standard Code for Information Interchange (ASCII). The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity check), used for information exchange between data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

ampere (A). The basic unit of electric current.

A/N. Alphanumeric

analog. (1) Pertaining to data in the form of continuously variable physical quantities. (2) Contrast with digital.

AND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the AND of P, Q, R,...is true if all statements are true, false if any statement is false.

AND gate. A logic gate in which the output is 1 only if all inputs are 1.

AND operation. The boolean operation whose result has the boolean value 1, if and only if, each operand has the boolean value 1. Synonymous with conjunction.

APA. All points addressable.

ASCII. American National Standard Code for Information Interchange.

assemble. To translate a program expressed in an assembler language into a computer language.

assembler. A computer program used to assemble.

assembler language. A computer-oriented language whose instructions are usually in one-to-one correspondence with computer instructions.

asynchronous transmission. (1) Transmission in which the time of occurrence of the start of each character, or block of characters, is arbitrary; once started, the time of occurrence of each signal representing a bit within a character, or block, has the same relationship to significant instants of a fixed time frame. (2) Transmission in which each information character is individually transmitted (usually timed by the use of start elements and stop elements).

audio frequencies. Frequencies that can be heard by the human ear (approximately 15 hertz to 20,000 hertz).

auxiliary storage. (1) A storage device that is not main storage. (2) Data storage other than main storage; for example, storage on magnetic disk. (3) Contrast with main storage.

BASIC. Beginner's all-purpose symbolic instruction code.

basic input/output system (BIOS). The feature of the IBM Personal Computer that provides the level control of the major I/O devices, and relieves the programmer from concern about hardware device characteristics.

baud. (1) A unit of signaling speed equal to the number of discrete conditions or signal events per second. For example, one baud equals one bit per second in a train of binary signals, one-half dot cycle per second in Morse code, and one 3-bit value per second in a train of signals each of which can assume one of eight different states. (2) In asynchronous transmission, the unit of modulation rate corresponding to one unit of interval per second; that is, if the duration of the unit interval is 20 milliseconds, the modulation rate is 50 baud.

BCC. Block-check character.

beginner's all-purpose symbolic instruction code (BASIC). A programming language with a small repertoire of commands and a simple syntax, primarily designed for numeric applications.

binary. (1) Pertaining to a selection, choice, or condition that has two possible values or states. (2) Pertaining to a fixed radix numeration system having a radix of 2.

binary digit. (1) In binary notation, either of the characters 0 or 1. (2) Synonymous with bit.

binary notation. Any notation that uses two different characters, usually the binary digits 0 and 1.

binary synchronous communications (BSC). A uniform procedure, using a standardized set of control characters and control character sequences for synchronous transmission of binary–coded data between stations.

BIOS. Basic input/output system.

bit. Synonym for binary digit

bits per second (bps). A unit of measurement representing the number of discrete binary digits transmitted by a device in one second.

block. (1) A string of records, a string of words, or a character string formed for technical or logic reasons to be treated as an entity. (2) A set of things, such as words, characters, or digits, treated as a unit.

block-check character (BCC). In cyclic redundancy checking, a character that is transmitted by the sender after each message block and is compared with a block-check character computed by the receiver to determine if the transmission was successful.

boolean operation. (1) Any operation in which each of the operands and the result take one of two values. (2) An operation that follows the rules of boolean algebra.

bootstrap. A technique or device designed to bring itself into a desired state by means of its own action; for example, a machine routine whose first few instructions are sufficient to bring the rest of itself into the computer from an input device.

bps. Bits per second.

BSC. Binary synchronous communications.

buffer. (1) An area of storage that is temporarily reserved for use in performing an input/output operation, into which data is read or from which data is written. Synonymous with I/O area. (2) A portion of storage for temporarily holding input or output data.

bus. One or more conductors used for transmitting signals or power.

byte. (1) A sequence of eight adjacent binary digits that are operated upon as a unit. (2) A binary character operated upon as a unit. (3) The representation of a character.

C. Celsius.

capacitor. An electronic circuit component that stores an electric charge.

Cartesian coordinates. A system of coordinates for locating a point on a plane by its distance from each of two intersecting lines, or in space by its distance from each of three mutually perpendicular planes.

CAS. Column address strobe.

cathode ray tube (CRT). A vacuum tube in which a stream of electrons is projected onto a fluorescent screen producing a luminous spot. The location of the spot can be controlled.

cathode ray tube display (CRT display). (1) A CRT used for displaying data. For example, the electron beam can be controlled to form alphanumeric data by use of a dot matrix.
(2) Synonymous with monitor.

CCITT. International Telegraph and Telephone Consultative Committee.

Celsius (C). A temperature scale. Contrast with Fahrenheit (F).

central processing unit (CPU). Term for processing unit.

channel. A path along which signals can be sent; for example, data channel, output channel.

character generator. (1) In computer graphics, a functional unit that converts the coded representation of a graphic character into the shape of the character for display. (2) In word processing, the means within equipment for generating visual characters or symbols from coded data.

character set. (1) A finite set of different characters upon which agreement has been reached and that is considered complete for some purpose. (2) A set of unique representations called characters. (3) A defined collection of characters.

characters per second (cps). A standard unit of measurement for the speed at which a printer prints.

check key. A group of characters, derived from and appended to a data item, that can be used to detect errors in the data item during processing.

clipping. In computer graphics, removing parts of a display image that lie outside a window.

closed circuit. A continuous unbroken circuit; that is, one in which current can flow. Contrast with open circuit.

CMOS. Complementary metal oxide semiconductor.

code. (1) A set of unambiguous rules specifying the manner in which data may be represented in a discrete form. Synonymous with coding scheme. (2) A set of items, such as abbreviations, representing the members of another set. (3) To represent data or a computer program in a symbolic form that can be accepted by a data processor. (4) Loosely, one or more computer programs, or part of a computer program.

coding scheme. Synonym for code.

collector. An element in a transistor toward which current flows.

color cone. An arrangement of the visible colors on the surface of a double-ended cone where lightness varies along the axis of the cone, and hue varies around the circumference. Lightness includes both the intensity and saturation of color.

column address strobe (CAS). A signal that latches the column addresses in a memory chip.

compile. (1) To translate a computer program expressed in a problem-oriented language into a computer-oriented language. (2) To prepare a machine-language program from a computer program written in another programming language by making use of the overall logic structure of the program, or generating more than one computer instruction for each symbolic statement, or both, as well as performing the function of an assembler.

complement. A number that can be derived from a specified number by subtracting it from a second specified number.

complementary metal oxide semiconductor (CMOS). A logic circuit family that uses very little power. It works with a wide range of power supply voltages.

computer. A functional unit that can perform substantial computation, including numerous arithmetic operations or logic operations, without human intervention during a run.

computer instruction code. A code used to represent the instructions in an instruction set. Synonymous with machine code.

computer program. A sequence of instructions suitable for processing by a computer.

computer word. A word stored in one computer location and capable of being treated as a unit.

configuration. (1) The arrangement of a computer system or network as defined by the nature, number, and the chief characteristics of its functional units. More specifically, the term configuration may refer to a hardware configuration or a software configuration. (2) The devices and programs that make up a system, subsystem, or network.

conjunction. Synonym for AND operation.

contiguous. Touching or joining at the edge or boundary; adjacent.

control character. A character whose occurrence in a particular context initiates, modifies, or stops a control operation.

control operation. An action that affects the recording, processing, transmission, or interpretation of data; for example, starting or stopping a process, carriage return, font change, rewind, and end of transmission.

control storage. A portion of storage that contains microcode.

coordinate space. In computer graphics, a system of Cartesian coordinates in which an object is defined.

cps. Characters per second.

CPU. Central processing unit.

CRC. Cyclic redundancy check.

CRT. Cathode ray tube.

CRT display. Cathode ray tube display.

CTS. Clear to send. Associated with modem control.

cursor. (1) In computer graphics, a movable marker that is used to indicate position on a display. (2) A displayed symbol that acts as a marker to help the user locate a point in text, in a system command, or in storage. (3) A movable spot of light on the screen of a display device, usually indicating where the next character is to be entered, replaced, or deleted.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) A system of error checking performed at both the sending and receiving station after a block-check character has been accumulated.

cylinder. (1) The set of all tracks with the same nominal distance from the axis about which the disk rotates. (2) The tracks of a disk storage device that can be accessed without repositioning the access mechanism.

daisy-chained cable. A type of cable that has two or more connectors attached in series.

data. (1) A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by human or automatic means. (2) Any representations, such as characters or analog quantities, to which meaning is, or might be assigned.

data base. A collection of data that can be immediately accessed and operated upon by a data processing system for a specific purpose.

data processing system. A system that performs input, processing, storage, output, and control functions to accomplish a sequence of operations on data.

data transmission. Synonym for transmission.

dB. Decibel.

dBa. Adjusted decibels.

dc. Direct current.

debounce. (1) An electronic means of overcoming the make/break bounce of switches to obtain one smooth change of signal level. (2) The elimination of undesired signal variations caused by mechanically generated signals from contacts.

decibel. (1) A unit that expresses the ratio of two power levels on a logarithmic scale. (2) A unit for measuring relative power.

decoupling capacitor. A capacitor that provides a low impedance path to ground to prevent common coupling between circuits.

Deutsche Industrie Norm (DIN). (1) German Industrial Norm. (2) The committee that sets German dimension standards.

digit. (1) A graphic character that represents an integer; for example, one of the characters 0 to 9. (2) A symbol that represents one of the non-negative integers smaller than the radix. For example, in decimal notation, a digit is one of the characters 0 to 9.

digital. (1) Pertaining to data in the form of digits.
(2) Contrast with analog.

DIN. Deutsche Industrie Norm.

DIN connector. One of the connectors specified by the DIN committee.

DIP. Dual in-line package.

DIP switch. One of a set of small switches mounted in a dual in-line package.

direct current (dc). A current that always flows in one direction.

direct memory access (DMA). A method of transferring data between main storage and I/O devices that does not require processor intervention.

disable. To stop the operation of a circuit or device.

disabled. Pertaining to a state of a processing unit that prevents the occurrence of certain types of interruptions. Synonymous with masked.

disk. Loosely, a magnetic disk.

diskette. A thin, flexible magnetic disk and a semirigid protective jacket, in which the disk is permanently enclosed. Synonymous with flexible disk.

diskette drive. A device for storing data on and retrieving data from a diskette.

display. (1) A visual presentation of data. (2) A device for visual presentation of information on any temporary character imaging device. (3) To present data visually. (4) See cathode ray tube display.

display attribute. In computer graphics, a particular property that is assigned to all or part of a display; for example, low intensity, green color, blinking status.

display element. In computer graphics, a basic graphic element that can be used to construct a display image; for example, a dot, a line segment, a character.

display group. In computer graphics, a collection of display elements that can be manipulated as a unit and that can be further combined to form larger groups.

display image. In computer graphics, a collection of display elements or display groups that are represented together at any one time in a display space.

display space. In computer graphics, that portion of a display surface available for a display image. The display space may be all or part of a display surface.

display surface. In computer graphics, that medium on which display images may appear; for example, the entire screen of a cathode ray tube.

DMA. Direct memory access.

dot matrix. (1) In computer graphics, a two-dimensional pattern of dots used for constructing a display image. This type of matrix can be used to represent characters by dots. (2) In word processing, a pattern of dots used to form characters. This term normally refers to a small section of a set of addressable points; for example, a representation of characters by dots.

dot printer. Synonym for matrix printer.

dot-matrix character generator. In computer graphics, a character generator that generates character images composed of dots.

drawing primitive. A group of commands that draw defined geometric shapes.

DSR. Data set ready. Associated with modem control.

DTR. In the IBM Personal Computer, data terminal ready. Associated with modem control.

dual in-line package (DIP). A widely used container for an integrated circuit. DIPs have pins in two parallel rows. The pins are spaced 1/10 inch apart. See also DIP switch.

duplex. (1) In data communication, pertaining to a simultaneous two-way independent transmission in both directions.
(2) Contrast with half-duplex.

duty cycle. In the operation of a device, the ratio of on time to idle time. Duty cycle is expressed as a decimal or percentage.

dynamic memory. RAM using transistors and capacitors as the memory elements. This memory requires a refresh (recharge) cycle every few milliseconds. Contrast with static memory.

EBCDIC. Extended binary-coded decimal interchange code.

ECC. Error checking and correction.

edge connector. A terminal block with a number of contacts attached to the edge of a printed-circuit board to facilitate plugging into a foundation circuit.

EIA. Electronic Industries Association.

electromagnet. Any device that exhibits magnetism only while an electric current flows through it.

enable. To initiate the operation of a circuit or device.

end of block (EOB). A code that marks the end of a block of data.

end of file (EOF). An internal label, immediately following the last record of a file, signaling the end of that file. It may include control totals for comparison with counts accumulated during processing.

end-of-text (ETX). A transmission control character used to terminate text.

end-of-transmission (EOT). A transmission control character used to indicate the conclusion of a transmission, which may have included one or more texts and any associated message headings.

end-of-transmission-block (ETB). A transmission control character used to indicate the end of a transmission block of data when data is divided into such blocks for transmission purposes.

EOB. End of block.

EOF. End of file.

EOT. End-of-transmission.

EPROM. Erasable programmable read-only memory.

erasable programmable read-only memory (EPROM). A PROM in which the user can erase old information and enter new information.

error checking and correction (ECC). The detection and correction of all single-bit errors, plus the detection of double-bit and some multiple-bit errors.

ESC. The escape character.

escape character (ESC). A code extension character used, in some cases, with one or more succeeding characters to indicate by some convention or agreement that the coded representations following the character or the group of characters are to be interpreted according to a different code or according to a different coded character set.

ETB. End-of-transmission-block.

ETX. End-of-text.

extended binary-coded decimal interchange code (EBCDIC). A set of 256 characters, each represented by eight bits.

F. Fahrenheit.

Fahrenheit (F). A temperature scale. Contrast with Celsius (C).

falling edge. Synonym for negative-going edge.

FCC. Federal Communications Commission.

fetch. To locate and load a quantity of data from storage.

FF. The form feed character.

field. (1) In a record, a specified area used for a particular category of data. (2) In a data base, the smallest unit of data that can be referred to.

field-programmable logic sequencer (FPLS). An integrated circuit containing a programmable, read-only memory that responds to external inputs and feedback of its own outputs.

FIFO (first-in-first out). A queuing technique in which the next item to be retrieved is the item that has been in the queue for the longest time.

fixed disk drive. In the IBM Personal Computer, a unit consisting of nonremovable magnetic disks, and a device for storing data on and retrieving data from the disks.

flag. (1) Any of various types of indicators used for identification. (2) A character that signals the occurrence of some condition, such as the end of a word. (3) Deprecated term for mark.

flexible disk. Synonym for diskette.

flip-flop. A circuit or device containing active elements, capable of assuming either one of two stable states at a given time.

font. A family or assortment of characters of a given size and style; for example, 10 point Press Roman medium.

foreground. (1) In multiprogramming, the environment in which high-priority programs are executed. (2) On a color display screen, the characters as opposed to the background.

form feed. (1) Paper movement used to bring an assigned part of a form to the printing position. (2) In word processing, a function that advances the typing position to the same character position on a predetermined line of the next form or page.

form feed character. A control character that causes the print or display position to move to the next predetermined first line on the next form, the next page, or the equivalent.

format. The arrangement or layout of data on a data medium.

FPLS. Field-programmable logic sequencer.

frame. (1) In SDLC, the vehicle for every command, every response, and all information that is transmitted using SDLC procedures. Each frame begins and ends with a flag. (2) In data transmission, the sequence of contiguous bits bracketed by and including beginning and ending flag sequences.

g. Gram.

G. (1) Prefix giga; 1,000,000,000. (2) When referring to computer storage capacity, 1,073,741,824. (1,073,741,824 = 2 to the 30th power.)

gate. (1) A combinational logic circuit having one output channel and one or more input channels, such that the output channel state is completely determined by the input channel states. (2) A signal that enables the passage of other signals through a circuit.

Gb. 1,073,741,824 bytes.

general-purpose register. A register, usually explicitly addressable within a set of registers, that can be used for different purposes; for example, as an accumulator, as an index register, or as a special handler of data.

giga (G). Prefix 1,000,000,000.

gram (g). A unit of weight (equivalent to 0.035 ounces).

graphic. A symbol produced by a process such as handwriting, drawing, or printing.

graphic character. A character, other than a control character, that is normally represented by a graphic.

half-duplex. (1) In data communication, pertaining to an alternate, one way at a time, independent transmission. (2) Contrast with duplex.

hardware. (1) Physical equipment used in data processing, as opposed to programs, procedures, rules, and associated documentation. (2) Contrast with software.

head. A device that reads, writes, or erases data on a storage medium; for example, a small electromagnet used to read, write, or erase data on a magnetic disk.

hertz (Hz). A unit of frequency equal to one cycle per second.

hex. Common abbreviation for hexadecimal. Also, hexadecimal can be noted as X'   '.

hexadecimal. (1) Pertaining to a selection, choice, or condition that has 16 possible different values or states. These values or states are usually symbolized by the ten digits 0 through 9 and the six letters A through F. (2) Pertaining to a fixed radix numeration system having a radix of 16.

high impedance state. A state in which the output of a device is effectively isolated from the circuit.

highlighting. In computer graphics, emphasizing a given display group by changing its attributes relative to other display groups in the same display field.

high-order position. The leftmost position in a string of characters. See also most-significant digit.

hither plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point and that lies between these two points. Any part of an object between the hither plane and the view point is not seen. See also yon plane.

housekeeping. Operations or routines that do not contribute directly to the solution of the problem but do contribute directly to the operation of the computer.

Hz. Hertz

image. A fully processed unit of operational data that is ready to be transmitted to a remote unit; when loaded into control storage in the remote unit, the image determines the operations of the unit.

immediate instruction. An instruction that contains within itself an operand for the operation specified, rather than an address of the operand.

index register. A register whose contents may be used to modify an operand address during the execution of computer instructions.

indicator. (1) A device that may be set into a prescribed state, usually according to the result of a previous process or on the occurrence of a specified condition in the equipment, and that usually gives a visual or other indication of the existence of the prescribed state, and that may in some cases be used to determine the selection among alternative processes; for example, an overflow indicator. (2) An item of data that may be interrogated to determine whether a particular condition has been satisfied in the execution of a computer program; for example, a switch indicator, an overflow indicator.

inhibited. (1) Pertaining to a state of a processing unit in which certain types of interruptions are not allowed to occur.
(2) Pertaining to the state in which a transmission control unit or an audio response unit cannot accept incoming calls on a line.

initialize. To set counters, switches, addresses, or contents of storage to 0 or other starting values at the beginning of, or at prescribed points in, the operation of a computer routine.

input/output (I/O). (1) Pertaining to a device or to a channel that may be involved in an input process, and, at a different time, in an output process. In the English language, "input/output" may be used in place of such terms as "input/output data," "input/output signal," and "input/output terminals," when such usage is clear in a given context. (2) Pertaining to a device whose parts can be performing an input process and an output process at the same time. (3) Pertaining to either input or output, or both.

instruction. In a programming language, a meaningful expression that specifies one operation and identifies its operands, if any.

instruction set. The set of instructions of a computer, of a programming language, or of the programming languages in a programming system.

intensity. In computer graphics, the amount of light emitted at a display point

interface. A device that alters or converts actual electrical signals between distinct devices, programs, or systems.

interleave. To arrange parts of one sequence of things or events so that they alternate with parts of one or more other sequences of the same nature and so that each sequence retains its identity.

interrupt. (1) A suspension of a process, such as the execution of a computer program, caused by an event external to that process, and performed in such a way that the process can be resumed. (2) In a data transmission, to take an action at a receiving station that causes the transmitting station to terminate a transmission. (3) Synonymous with interruption.

I/O. Input/output.

I/O area. Synonym for buffer.

irrecoverable error. An error that makes recovery impossible without the use of recovery techniques external to the computer program or run.

joystick. In computer graphics, a lever that can pivot in all directions and that is used as a locator device.

k. Prefix kilo; 1000.

K. When referring to storage capacity, 1024. (1024 = 2 to the 10th power.)

KB. 1024 bytes.

key lock. A device that deactivates the keyboard and locks the cover on for security.

kg. Kilogram; 1000 grams.

kHz. Kilohertz; 1000 hertz.

kilo (k). Prefix 1000

kilogram (kg). 1000 grams.

kilohertz (kHz). 1000 hertz

latch. (1) A simple logic-circuit storage element. (2) A feedback loop in sequential digital circuits used to maintain a state.

least-significant digit. The rightmost digit. See also low-order position.

LED. Light-emitting diode.

light-emitting diode (LED). A semiconductor device that gives off visible or infrared light when activated.

load. In programming, to enter data into storage or working registers.

look-up table (LUT). (1) A technique for mapping one set of values into a larger set of values. (2) In computer graphics, a table that assigns a color value (red, green, blue intensities) to a color index.

low power Schottky TTL. A version (LS series) of TTL giving a good compromise between low power and high speed. See also transistor-transistor logic and Schottky TTL.

low-order position. The rightmost position in a string of characters. See also least-significant digit.

luminance. The luminous intensity per unit projected area of a given surface viewed from a given direction.

LUT. Look-up table.

m. (1) Prefix milli; 0.001. (2) Meter.

M. (1) Prefix mega; 1,000,000. (2) When referring to computer storage capacity, 1,048,576. (1,048,576 = 2 to the 20th power.)

mA. Milliampere; 0.001 ampere.

machine code. The machine language used for entering text and program instructions onto the recording medium or into storage and which is subsequently used for processing and printout.

machine language. (1) A language that is used directly by a machine. (2) Deprecated term for computer instruction code.

magnetic disk. (1) A flat circular plate with a magnetizable surface layer on which data can be stored by magnetic recording. (2) See also diskette.

main storage. (1) Program-addressable storage from which instructions and other data can be loaded directly into registers for subsequent execution or processing. (2) Contrast with auxiliary storage.

mark. A symbol or symbols that indicate the beginning or the end of a field, of a word, of an item of data, or of a set of data such as a file, a record, or a block.

mask. (1) A pattern of characters that is used to control the retention or elimination of portions of another pattern of characters. (2) To use a pattern of characters to control the retention or elimination of portions of another pattern of characters.

masked. Synonym for disabled.

matrix. (1) A rectangular array of elements, arranged in rows and columns, that may be manipulated according to the rules of matrix algebra. (2) In computers, a logic network in the form of an array of input leads and output leads with logic elements connected at some of their intersections.

matrix printer. A printer in which each character is represented by a pattern of dots; for example, a stylus printer, a wire printer. Synonymous with dot printer.

MB. 1,048,576 bytes.

mega (M). Prefix 1,000,000.

megahertz (MHz). 1,000,000 hertz.

memory. Term for main storage.

meter (m). A unit of length (equivalent to 39.37 inches).

MFM. Modified frequency modulation.

MHz. Megahertz; 1,000,000 hertz.

micro (μ). Prefix 0.000,001.

microcode. (1) One or more microinstructions. (2) A code, representing the instructions of an instruction set, implemented in a part of storage that is not program-addressable.

microinstruction. (1) An instruction of microcode. (2) A basic or elementary machine instruction.

microprocessor. An integrated circuit that accepts coded instructions for execution; the instructions may be entered, integrated, or stored internally.

microsecond (μs). 0.000,001 second.

milli (m). Prefix 0.001.

milliampere (mA). 0.001 ampere.

millisecond (ms). 0.001 second.

mnemonic. A symbol chosen to assist the human memory; for example, an abbreviation such as "mpy" for "multiply."

mode. (1) A method of operation; for example, the binary mode, the interpretive mode, the alphanumeric mode. (2) The most frequent value in the statistical sense.

modeling transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). See also viewing transformation.

modem (modulator-demodulator). A device that converts serial (bit by bit) digital signals from a business machine (or data communication equipment) to analog signals that are suitable for transmission in a telephone network. The inverse function is also performed by the modem on reception of analog signals.

modified frequency modulation (MFM). The process of varying the amplitude and frequency of the 'write' signal. MFM pertains to the number of bytes of storage that can be stored on the recording media. The number of bytes is twice the number contained in the same unit area of recording media at single density.

modulation. The process by which some characteristic of one wave (usually high frequency) is varied in accordance with another wave or signal (usually low frequency). This technique is used in modems to make business-machine signals compatible with communication facilities.

modulation rate. The reciprocal of the measure of the shortest nominal time interval between successive significant instants of the modulated signal. If this measure is expressed in seconds, the modulation rate is expressed in baud.

module. (1) A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading. (2) A packaged functional hardware unit designed for use with other components.

modulo check. A calculation performed on values entered into a system. This calculation is designed to detect errors.

modulo-N check. A check in which an operand is divided by a number N (the modulus) to generate a remainder (check digit) that is retained with the operand. For example, in a modulo-7 check, the remainder will be 0, 1, 2, 3, 4, 5, or 6. The operand is later checked by again dividing it by the modulus; if the remainder is not equal to the check digit, an error is indicated.

modulus. In a modulo-N check, the number by which the operand is divided.

monitor. Synonym for cathode ray tube display (CRT display).

most-significant digit. The leftmost (non-zero) digit. See also high-order position.

ms. Millisecond; 0.001 second.

multiplexer. A device capable of interleaving the events of two or more activities, or capable of distributing the events of an interleaved sequence to the respective activities.

multiprogramming. (1) Pertaining to the concurrent execution of two or more computer programs by a computer. (2) A mode of operation that provides for the interleaved execution of two or more computer programs by a single processor.

n. Prefix nano; 0.000,000,001.

NAND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NAND of P, Q ,R,... is true if at least one statement is false, false if all statements are true.

NAND gate. A gate in which the output is 0 only if all inputs are 1.

nano (n). Prefix 0.000,000,001.

nanosecond (ns). 0.000,000,001 second.

negative true. Synonym for active low.

negative-going edge. The edge of a pulse or signal changing in a negative direction. Synonymous with falling edge.

non-return-to-zero change-on-ones recording (NRZI). A transmission encoding method in which the data terminal equipment changes the signal to the opposite state to send a binary 1 and leaves it in the same state to send a binary 0.

non-return-to-zero (inverted) recording (NRZI). Deprecated term for non-return-to-zero change-on-ones recording.

NOR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NOR of P, Q, R,... is true if all statements are false, false if at least one statement is true.

NOR gate. A gate in which the output is 0 only if at least one input is 1.

NOT. A logical operator having the property that if P is a statement, then the NOT of P is true if P is false, false if P is true.

NRZI. Non-return-to-zero change-on-ones recording.

ns. Nanosecond; 0.000,000,001 second.

NUL. The null character.

null character (NUL). A control character that is used to accomplish media-fill or time-fill, and that may be inserted into or removed from, a sequence of characters without affecting the meaning of the sequence; however, the control of the equipment or the format may be affected by this character.

odd-even check. Synonym for parity check.

offline. Pertaining to the operation of a functional unit without the continual control of a computer.

one-shot. A circuit that delivers one output pulse of desired duration for each input (trigger) pulse.

open circuit. (1) A discontinuous circuit; that is, one that is broken at one or more points and, consequently, cannot conduct current. Contrast with closed circuit. (2) Pertaining to a no-load condition; for example, the open-circuit voltage of a power supply.

open collector. A switching transistor without an internal connection between its collector and the voltage supply. A connection from the collector to the voltage supply is made through an external (pull-up) resistor.

operand. (1) An entity to which an operation is applied. (2) That which is operated upon. An operand is usually identified by an address part of an instruction.

operating system. Software that controls the execution of programs; an operating system may provide services such as resource allocation, scheduling, input/output control, and data management.

OR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the OR of P, Q, R,...is true if at least one statement is true, false if all statements are false.

OR gate. A gate in which the output is 1 only if at least one input is 1.

output. Pertaining to a device, process, or channel involved in an output process, or to the data or states involved in an output process.

output process. (1) The process that consists of the delivery of data from a data processing system, or from any part of it. (2) The return of information from a data processing system to an end user, including the translation of data from a machine language to a language that the end user can understand.

overcurrent. A current of higher than specified strength.

overflow indicator. (1) An indicator that signifies when the last line on a page has been printed or passed. (2) An indicator that is set on if the result of an arithmetic operation exceeds the capacity of the accumulator.

overrun. Loss of data because a receiving device is unable to accept data at the rate it is transmitted.

overvoltage. A voltage of higher than specified value.

parallel. (1) Pertaining to the concurrent or simultaneous operation of two or more devices, or to the concurrent performance of two or more activities. (2) Pertaining to the concurrent or simultaneous occurrence of two or more related activities in multiple devices or channels. (3) Pertaining to the simultaneity of two or more processes. (4) Pertaining to the simultaneous processing of the individual parts of a whole, such as the bits of a character and the characters of a word, using separate facilities for the various parts. (5) Contrast with serial.

parameter. (1) A variable that is given a constant value for a specified application and that may denote the application. (2) A name in a procedure that is used to refer to an argument passed to that procedure.

parity bit. A binary digit appended to a group of binary digits to make the sum of all the digits either always odd (odd parity) or always even (even parity).

parity check. (1) A redundancy check that uses a parity bit. (2) Synonymous with odd-even check.

PEL. Picture element.

personal computer. A small home or business computer that has a processor and keyboard and that can be connected to a television or some other monitor. An optional printer is usually available.

phototransistor. A transistor whose switching action is controlled by light shining on it.

picture element (PEL). The smallest displayable unit on a display.

polling. (1) Interrogation of devices for purposes such as to avoid contention, to determine operational status, or to determine readiness to send or receive data. (2) The process whereby stations are invited, one at a time, to transmit.

port. An access point for data entry or exit.

positive true. Synonym for active high.

positive-going edge. The edge of a pulse or signal changing in a positive direction. Synonymous with rising edge.

potentiometer. A variable resistor with three terminals, one at each end and one on a slider (wiper).

power supply. A device that produces the power needed to operate electronic equipment.

printed circuit. A pattern of conductors (corresponding to the wiring of an electronic circuit) formed on a board of insulating material.

printed-circuit board. A usually copper-clad plastic board used to make a printed circuit.

priority. A rank assigned to a task that determines its precedence in receiving system resources.

processing program. A program that performs such functions as compiling, assembling, or translating for a particular programming language.

processing unit. A functional unit that consists of one or more processors and all or part of internal storage.

processor. (1) In a computer, a functional unit that interprets and executes instructions. (2) A functional unit, a part of another unit such as a terminal or a processing unit, that interprets and executes instructions. (3) Deprecated term for processing program. (4) See microprocessor.

program. (1) A series of actions designed to achieve a certain result. (2) A series of instructions telling the computer how to handle a problem or task. (3) To design, write, and test computer programs.

programmable read-only memory (PROM). A read-only memory that can be programmed by the user.

programming language. (1) An artificial language established for expressing computer programs. (2) A set of characters and rules with meanings assigned prior to their use, for writing computer programs.

programming system. One or more programming languages and the necessary software for using these languages with particular automatic data-processing equipment.

PROM. Programmable read-only memory.

propagation delay. (1) The time necessary for a signal to travel from one point on a circuit to another. (2) The time delay between a signal change at an input and the corresponding change at an output.

protocol. (1) A specification for the format and relative timing of information exchanged between communicating parties.
(2) The set of rules governing the operation of functional units of a communication system that must be followed if communication is to be achieved.

pulse. A variation in the value of a quantity, short in relation to the time schedule of interest, the final value being the same as the initial value.

radio frequency (RF). An ac frequency that is higher than the highest audio frequency. So called because of the application to radio communication.

radix. (1) In a radix numeration system, the positive integer by which the weight of the digit place is multiplied to obtain the weight of the digit place with the next higher weight; for example, in the decimal numeration system the radix of each digit place is 10. (2) Another term for base.

radix numeration system. A positional representation system in which the ratio of the weight of any one digit place to the weight of the digit place with the next lower weight is a positive integer (the radix). The permissible values of the character in any digit place range from 0 to one less than the radix.

RAM. Random access memory. Read/write memory.

random access memory (RAM). Read/write memory.

RAS. In the IBM Personal Computer, row address strobe.

raster. In computer graphics, a predetermined pattern of lines that provides uniform coverage of a display space.

read. To acquire or interpret data from a storage device, from a data medium, or from another source.

read-only memory (ROM). A storage device whose contents cannot be modified. The memory is retained when power is removed.

read/write memory. A storage device whose contents can be modified. Also called RAM.

recoverable error. An error condition that allows continued execution of a program.

red-green-blue-intensity (RGBI). The description of a direct-drive color monitor that accepts input signals of red, green, blue, and intensity.

redundancy check. A check that depends on extra characters attached to data for the detection of errors. See cyclic redundancy check.

register. (1) A storage device, having a specified storage capacity such as a bit, a byte, or a computer word, and usually intended for a special purpose. (2) A storage device in which specific data is stored.

retry. To resend the current block of data (from the last EOB or ETB) a prescribed number of times, or until it is entered correctly or accepted.

reverse video. A form of highlighting a character, field, or cursor by reversing the color of the character, field, or cursor with its background; for example, changing a red character on a black background to a black character on a red background.

RF. Radio frequency.

RF modulator. The device used to convert the composite video signal to the antenna level input of a home TV.

RGBI. Red-green-blue-intensity.

rising edge. Synonym for positive-going edge.

ROM. Read-only memory.

ROM/BIOS. The ROM resident basic input/output system, which provides the level control of the major I/O devices in the computer system.

row address strobe (RAS). A signal that latches the row address in a memory chip.

RS-232C. A standard by the EIA for communication between computers and external equipment.

RTS. Request to send. Associated with modem control.

run. A single continuous performance of a computer program or routine.

saturation. In computer graphics, the purity of a particular hue. A color is said to be saturated when at least one primary color (red, blue, or green) is completely absent.

scaling. In computer graphics, enlarging or reducing all or part of a display image by multiplying the coordinates of the image by a constant value.

schematic. The representation, usually in a drawing or diagram form, of a logical or physical structure.

Schottky TTL. A version (S series) of TTL with faster switching speed, but requiring more power. See also transistor-transistor logic and low power Schottky TTL.

SDL. Shielded Data Link

SDLC. Synchronous Data Link Control.

sector. That part of a track or band on a magnetic drum, a magnetic disk, or a disk pack that can be accessed by the magnetic heads in the course of a predetermined rotational displacement of the particular device.

SERDES. Serializer/deserializer.

serial. (1) Pertaining to the sequential performance of two or more activities in a single device. In English, the modifiers serial and parallel usually refer to devices, as opposed to sequential and consecutive, which refer to processes. (2) Pertaining to the sequential or consecutive occurrence of two or more related activities in a single device or channel. (3) Pertaining to the sequential processing of the individual parts of a whole, such as the bits of a character or the characters of a word, using the same facilities for successive parts. (4) Contrast with parallel.

serializer/deserializer (SERDES). A device that serializes output from, and deserializes input to, a business machine.

setup. (1) In a computer that consists of an assembly of individual computing units, the arrangement of interconnections between the units, and the adjustments needed for the computer to operate. (2) The preparation of a computing system to perform a job or job step. Setup is usually performed by an operator and often involves performing routine functions, such as mounting tape reels. (3) The preparation of the system for normal operation.

short circuit. A low-resistance path through which current flows, rather than through a component or circuit.

signal. A variation of a physical quantity, used to convey data.

sink. A device or circuit into which current drains.

software. (1) Computer programs, procedures, and rules concerned with the operation of a data processing system. (2) Contrast with hardware.

source. The origin of a signal or electrical energy.

square wave. An alternating or pulsating current or voltage whose waveshape is square.

square wave generator. A signal generator delivering an output signal having a square waveform.

SS. Start-stop.

start bit. (1) A signal to a receiving mechanism to get ready to receive data or perform a function. (2) In a start-stop system, a signal preceding a character or block that prepares the receiving device for the reception of the code elements.

start-of-text (STX). A transmission control character that precedes a text and may be used to terminate the message heading.

start-stop system. A data transmission system in which each character is preceded by a start bit and is followed by a stop bit.

start-stop (SS) transmission. (1) Asynchronous transmission such that a group of signals representing a character is preceded by a start bit and followed by a stop bit. (2) Asynchronous transmission in which a group of bits is preceded by a start bit that prepares the receiving mechanism for the reception and registration of a character and is followed by at least one stop bit that enables the receiving mechanism to come to an idle condition pending the reception of the next character.

static memory. RAM using flip-flops as the memory elements. Data is retained as long as power is applied to the flip-flops. Contrast with dynamic memory.

stop bit. (1) A signal to a receiving mechanism to wait for the next signal. (2) In a start-stop system, a signal following a character or block that prepares the receiving device for the reception of a subsequent character or block.

storage. (1) A storage device. (2) A device, or part of a device, that can retain data. (3) The retention of data in a storage device. (4) The placement of data into a storage device.

strobe. An instrument that emits adjustable-rate flashes of light. Used to measure the speed of rotating or vibrating objects.

STX. Start-of-text.

symbol. (1) A conventional representation of a concept. (2) A representation of something by reason of relationship, association, or convention.

synchronization. The process of adjusting the corresponding significant instants of two signals to obtain the desired phase relationship between these instants.

Synchronous Data Link Control (SDLC). A protocol for management of data transfer over a data link.

synchronous transmission. (1) Data transmission in which the time of occurrence of each signal representing a bit is related to a fixed time frame. (2) Data transmission in which the sending and receiving devices are operating continuously at substantially the same frequency and are maintained, by means of correction, in a desired phase relationship.

syntax. (1) The relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use. (2) The structure of expressions in a language. (3) The rules governing the structure of a language. (4) The relationships among symbols.

text. In ASCII and data communication, a sequence of characters treated as an entity if preceded and terminated by one STX and one ETX transmission control character, respectively.

time-out. (1) A parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time. A time-out condition can be cancelled by the receipt of an appropriate time-out cancellation signal. (2) A time interval allotted for certain operations to occur; for example, response to polling or addressing before system operation is interrupted and must be restarted.

track. (1) The path or one of the set of paths, parallel to the reference edge on a data medium, associated with a single reading or writing component as the data medium moves past the component. (2) The portion of a moving data medium such as a drum, or disk, that is accessible to a given reading head position.

transistor-transistor logic (TTL). A popular logic circuit family that uses multiple-emitter transistors.

translate. To transform data from one language to another.

transmission. (1) The sending of data from one place for reception elsewhere. (2) In ASCII and data communication, a series of characters including headings and text. (3) The dispatching of a signal, message, or other form of intelligence by wire, radio, telephone, or other means. (4) One or more blocks or messages. For BSC and start-stop devices, a transmission is terminated by an EOT character. (5) Synonymous with data transmission.

TTL. Transistor-transistor logic.

typematic key. A keyboard key that repeats its function when held pressed.

V. Volt.

vector. In computer graphics, a directed line segment.

video. Computer data or graphics displayed on a cathode ray tube, monitor, or display.

view point. In computer graphics, the origin from which angles and scales are used to map virtual space into display space.

viewing reference point. In computer graphics, a point in the modeling coordinate space that is a defined distance from the view point.

viewing transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the view of the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). Viewing transformation differs from modeling transformation in that perspective is considered. See also modeling transformation.

viewplane. The visible plane of a CRT display screen that completely contains a defined window.

viewport. In computer graphics, a predefined part of the CRT display space.

volt. The basic practical unit of electric pressure. The potential that causes electrons to flow through a circuit.

W. Watt.

watt. The practical unit of electric power.

window. (1) A predefined part of the virtual space. (2) The visible area of a viewplane.

word. (1) A character string or a bit string considered as an entity. (2) See computer word.

write. To make a permanent or transient recording of data in a storage device or on a data medium.

write precompensation. The varying of the timing of the head current from the outer tracks to the inner tracks of the diskette to keep a constant 'write' signal.

yon plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point, and that lies beyond the viewing reference point. Any part of an object beyond the yon plane is not seen. See also hither plane.

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