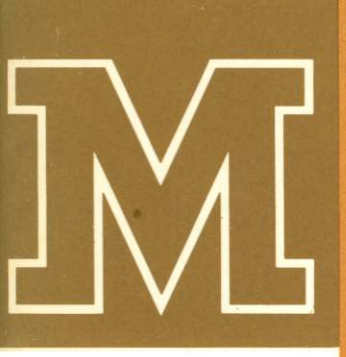

IBM

General Information Manual

7080 Data Processing System

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Preface

The IBM 7080 Data Processing System is a high-performance, solid-state data processing system adaptable to both commercial and scientific applications. The design of the 7080 is founded upon the proven logical concepts of the IBM 705 family and the most recent advances in technology and machine organization. It provides many new and improved machine features.

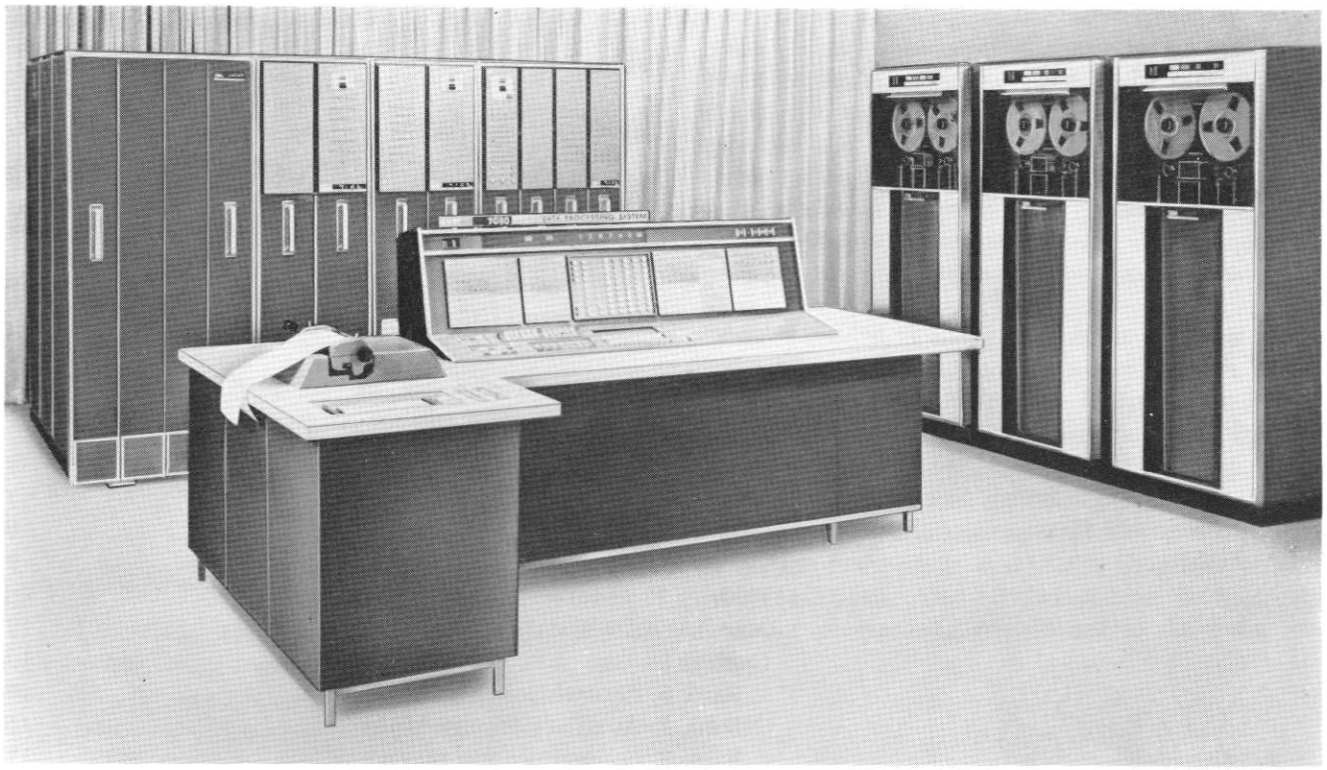
The 7080 system offers instruction compatibility with existing 705 systems; also any 705 I or II input-output device can be attached. The 7080 can process 705 I, II, or III programs unaltered. Thus, conversion from a 705 to a 7080 can be made with a minimum of effort and expense.

The major features of the 7080, in addition to those already provided by the 705 systems, are summarized below:

1. Increased internal processing speeds in the 7080 are approximately six times as fast as those of the 705 III and ten times as fast as those of the 705 I or II.
2. Input-output capacity is expandable, with up to five simultaneous input-output operations overlapped with processing.
3. Priority Processing maximizes communication channel utilization and total system efficiency.
4. The 729 II and IV multi-function tape units provide a high input-output rate as well as two-gap head reliability.
5. Magnetic core storage is expandable to a capacity of 160,000 character positions.
6. Accumulator and auxiliary storage units have been supplemented by two new banks of storage. Central storage now includes four banks, each with a capacity of 256 character positions. One new bank is available as communication storage for input-output channel operation. The second is an extra set of channel auxiliary storage units for input-output routines.
7. The 7080 has 18 new and improved operations, including a simultaneous transmit instruction which overlaps core-to-core transmission with processing and tape reading or writing.
8. A redesigned console improves operator efficiency and provides digital display of registers.

This manual describes the new features of the IBM 7080 Data Processing System. Because of programming similarity between the 7080 and the IBM 705 Data Processing System, a prior knowledge of the 705 is assumed. Complete information may be obtained from the reference and general information manuals concerning the 705.

Contents



IBM 7080 Data Processing System

IBM 7080 Data Processing System

The basic IBM 7080 Data Processing System is made up of the following units:

1. IBM *7102 Central Processing Unit (CPU).*

2. IBM *7302 Core Storage.* Model I provides 160,000 character positions and Model II provides 80,000 character positions.

3. IBM *7153 Console.*

4. IBM *7621 Tape Control.* The 7621 provides power for IBM 729 II or IV Magnetic Tape Units used with the 7080 system and serves to control and synchronize the transfer of data between the communication channels and the tape units. In the Model I tape control, as many as ten 729 II or IV tape units can be connected to a communication channel in any combination. In Model II, a maximum of twenty 729 II or IV tape units can be connected to two communication channels, ten units in any combination to each channel. The multifunction feature of the 729 II and IV units can be program-controlled by the 7080.

As many as five communication channels, with 7621 tape controls attached, can be installed with the 7102 central processing unit. Reading and writing of tape records can be performed simultaneously on separate channels.

5. IBM *7622 Signal Control.* This device converts the signal level of input-output units available on the 705 I and II to transistor signal levels, and vice versa. The 7080 operates with all such equipment, including the IBM 714 Card Reader, 722 Card Punch, 727 Magnetic Tape Units, 760 Control and Storage, 717 Printer, and so on. The IBM 777 Tape Record Coordinator may also be used, but field modification is required.

Any practical number of input-output units may be connected to the 7080. Figure 1 is a schematic of the maximum variety of units in the system configuration. Note that the IBM 767 Data Synchronizer is not used. Its functions are performed by the 7102 central processing unit and the 7621 tape control. Only the 729 II and IV tape units can be connected to the 7621 tape control.

6. IBM *7800 Power Converter* and IBM *7801 Power Control.* These units supply power at the proper voltage levels to the system.

Program Compatibility

The 7080 can operate as any one of three systems. Program compatibility is simple and straightforward. However, compatibility assumes that, in all cases, a proper configuration of input-output equipment is available as required by the program.

705 I-II Mode

A compatibility switch is provided on the console to establish this mode. When the switch is on, the 7080 operates internally as a 705 I or II until program-instructed to enter the 7080 mode. Therefore, programs written for the 705 I or II will operate in the 7080 with no modification required.

1. All 705 I or II input-output units must be connected to the central processing unit through the 7622 signal control.

2. The 705 III transfer instructions, which are not in the 705 I or II, are deactivated. All transfer instructions will function exactly as they do in a 705 I or II.

3. The indirect method of addressing in the 705 III does not apply. Zoning over the units position of an instruction address is ignored.

4. Operations such as add, subtract, and add to memory are terminated in the same manner as in the 705 I or II.

5. If the console 40K memory size switch is off, the size of memory available to the program is restricted to 20,000 positions, and wrap-around of MAC I, MAC II and the instruction counter will be at 20,000. If this switch is on, 40,000 positions will apply.

6. Communication channels may not be selected.

7. The internal processing is carried out at the increased speeds of the 7080.

705 III Mode

When the compatibility switch is off, the 7080 operates internally as a 705 III until program-instructed to enter the 7080 mode. Therefore, programs written for the 705 III will operate in the 7080 with no modification required.

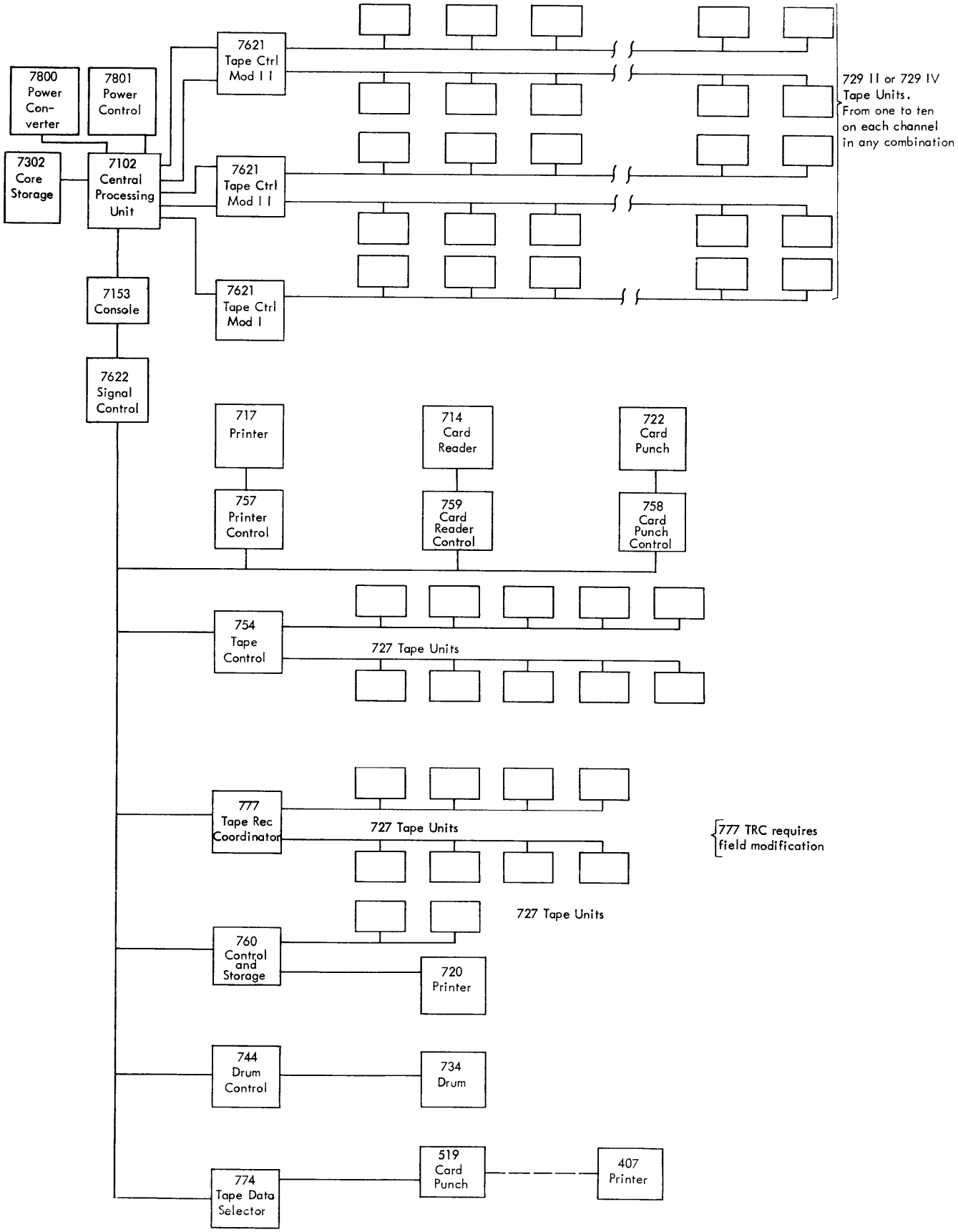


Figure 1. IBM 7080 System Diagram

1. The 729 II or IV tape units, a 7621 tape control, and a communication channel are substituted for the 729 I or III tape units and a 767 data synchronizer. Complete 705 III program compatibility is maintained regardless of this substitution of tape units and controls. Function of a 767 data synchronizer is simulated by the new communication storage and a communication channel in the 7102.
2. All 705 III transfer instructions are activated.
3. The indirect method of addressing is activated and zoning over the units position of an instruction address is treated in the same way as in the 705 III.
4. If the console 40K memory size switch is off, the size of memory available to the program is restricted to 80,000 positions, and wrap-around of MAC I, MAC II and the instruction counter will be at 80,000. If this switch is on, 40,000 positions will apply.
5. The internal processing is carried out at the increased speeds of the 7080.

7080 Mode

When the system is instructed to enter the 7080 mode, all the existing features of the 705 are available together with the new features of the 7080. These features are explained in the following sections.

In the 7080 mode, the capacity of memory is 160,000 positions for the 7302 Model I and 80,000 positions for the 7302 Model II regardless of the settings of the console switches. *Wrap-around of* MAC I, MAC II *and the instruction counter will always be at 160,000 positions when in this mode.*

Data Flow

The method by which the 7102 central processing unit internally handles data is shown schematically in Figure 2.

Information is moved to and from memory through a five-character memory data register. Five characters can be obtained or stored through this register in any 2.18-microsecond memory cycle.

A five-character memory buffer register is provided between the data register and the arithmetic section. From this register, data are operated upon serially, character by character, by the single-digit adder, with results placed in a result register.

Information is moved to and from central storage through an eight-character storage word register. Eight characters can be obtained or stored through this register in any 1.09-microsecond storage cycle.

Data passing between central storage and the arithmetic section are transferred to an eight-character storage buffer register where these data can also be operated upon serially by the adder. Results are placed in a result register and the proper buffer registers, and are then returned either to central storage or to memory depending upon the type of operation to be performed.

The use of the buffer registers reduces the number of memory and central storage cycles required to perform many operations. Information contained in the buffer registers may be acted upon by the arithmetic section independently of the movement of data between central storage and memory and the input-

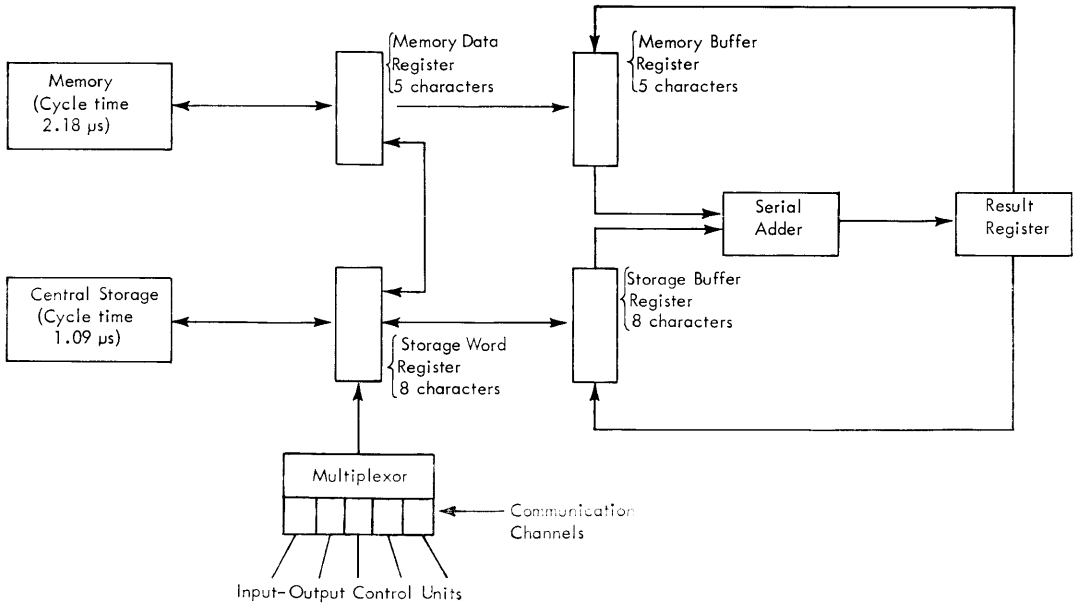


Figure 2. Schematic of Data Flow

output channels. Also, data may be transmitted from one section of memory to another while computation takes place.

Some typical operation times for the 705 I and II, the 705 III, and the 7080 are shown below. Operation times are expressed in microseconds.

	705 I, II	705 III	7080
Add (6 digits + 6 digits)	136 μs	95.8 μs	12.8 μs
Multiply (6 digits × 6 digits)	1054	770	140
Transfer (unconditional)	34	22	3.3

A comparison of the above execution times indicates that internal processing speeds in the 7080 are approximately six times faster than in the 705 III, and ten times faster than in the 705 I and II.

A one-instruction loop, such as LOC A, TR LOC A, should not be used in 7080 programs. Repeated references to the same location in memory in such short intervals of time will produce erratic results.

The central storage unit of the 7080 includes communication storage, which provides for all the data registers and address counters that require separate storage in the 767 data synchronizer.

A multiplexor unit serves to control the transmission of data, one character at a time, between the communication channels and communication storage, and five characters at a time between communication storage and memory.

Priority Processing

Priority processing is provided in the 7080 to furnish a means by which the machine can respond quickly to signals that occur while the main processing program is in progress. These signals are received from an input-output device and signify that some operation has been completed; e.g., reading a tape record. Processing continues while waiting for these signals to be received. When the signal is received, a transfer of control (interrupt) is automatically made to a suitable special program (interrupt program).

The operator may periodically wish to record or examine the progress of the program for checking or control purposes. He may interrupt the program by depressing the console interrupt key to execute a special routine for this purpose.

Priority processing is designed so that the main program will be as efficient and simple as the concept of overlapping operation will allow. The status of the CPU is automatically placed in central storage when control is changed from the main program to an interrupt program. Change of status is automatic and requires no additional programming. Once an interrupt has occurred, no other interrupt is allowed until the interrupt program has been completed. When it is, additional interrupts which may have been withheld are taken in turn. When all have been satisfied, the status of the main program is restored.

Therefore, the main program need not monitor the progress of the input-output device since an interrupt occurs as soon as the input-output operation is completed. When this happens, and the machine has entered a special routine pertaining to the interrupting condition, the full flexibility of the stored program may be utilized.

Memory Address System

The four-character single-address system used in all models of the 705 is retained in the 7080. Zoning in the thousands and units positions of an instruction address designates the 10,000-character section of the 7302 core storage unit. The numerical portion of the address indicates the specific character position within a section.

In the 7080 mode, an A bit in the units position of the address indicates the memory locations from 80,000 to 159,999. In the 705 III mode, an A bit in this position indicates an indirect address. Indirect addressing in the 7080 mode is accomplished by an "enable indirect address" instruction.

When executed in the 7080 mode, the address modification instructions (load address, unload address, add address to memory) automatically handle the six-digit addresses of the 160,000 position memory. In the 705 III mode, the five-digit address size applies.

Central Storage

The 7080 is provided with four 256-character banks of central storage as shown in Figure 3. Banks 0 and 1 of storage are normally used only as accumulator and auxiliary storage, respectively, in all modes of operation: 705 I and II, 705 III, and 7080.

Bank 0, Accumulator

This is used in the same manner as, and is identical to, the accumulator in all models of the 705.

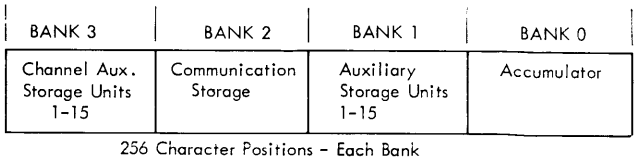


Figure 3. Central Storage Banks

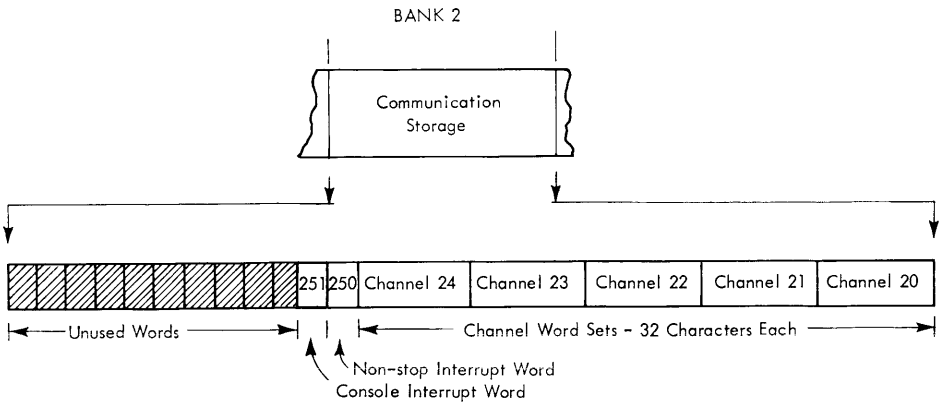


Figure 4. Communication Storage

Bank 1, Auxiliary Storage Units

These units are used in the same manner as, and are identical to, the ASU's in all models of the 705.

Bank 2, Communication Storage

This bank is divided into two logical parts (Figure 4). The first part consists of five "channel word sets," each containing four 8-character words. There is a channel word set for each of the communication channels (20-24). The remainder of the bank is divided into twelve words of eight characters each and will be explained later.

Figure 5 shows the subdivision of a channel word set into the four 8-character words.

Words 2 and 3. Positions 0-4 (from right to left) of each of these two words serve as data buffers. Information reading into the channel from tape is placed serially, one character at a time, into one of these buffers. When a buffer is filled, the five characters are transmitted as one 5-character block into memory while the alternate buffer is being filled. When information is written on tape from memory, the process is reversed. Character position 5 of each word contains a character control digit which controls the positioning of characters, one at a time, as they are received or sent to tape. Positions 6 and 7 of both words are not used.

The data buffers operate in an identical manner in both the 7080 and the 705 III modes. They perform a function similar to that of the input-output buffers in the 767 data synchronizer.

Word 1. Positions 0-3 contain the address in memory to or from which the next five-character block in the data buffer is to be transmitted. For example, in reading a tape record, the address of the read instruction is initially placed in positions 0-3. After the first five characters are read into memory, this address is incremented by five for each additional block in the record until the end-of-record gap is sensed on tape. In writing on tape, the write address is incremented in the same manner until the writing operation is terminated by sensing a group mark in memory at the end of a record. If the number of characters in the record being read is not divisible by five, additional group mark characters are inserted in the data buffer and transferred to memory. Positions 4-7 are not used.

This word performs the same functions as the SMAC in the 767 data synchronizer. At the end of a read or write operation, the counter contains a memory address five positions higher than the last memory reference, that is, the 0 or 5 address of the last group of five memory characters handled by the instruction. For a write instruction, the last group handled is the group after the one containing the group mark.

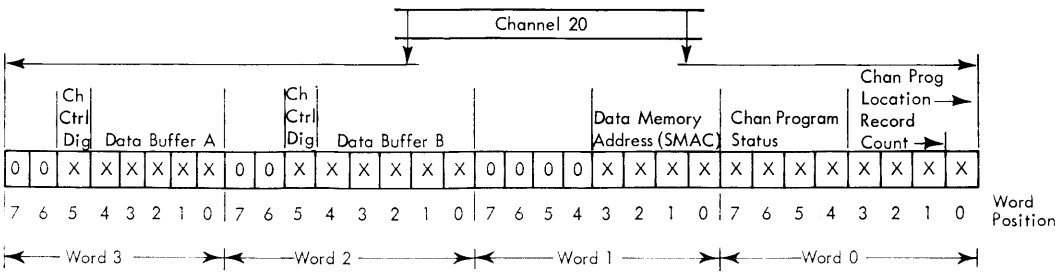


Figure 5. Channel Word Set

The contents of this word may be placed in memory by an RD 02 instruction.

Word 0. The reading or writing of data through a communication channel is normally controlled by a separate subroutine, called the interrupt program. Positions 0-3 of word 0 contain the location of the next instruction to be executed when an automatic interrupt occurs for that particular channel.

When an automatic interrupt occurs, status indicators in the 7080 are set in accordance with the bit configuration contained in positions 4-7 of word 0 for that channel. This information includes the status of indicators for high and low comparison, accumulator plus and zero, auxiliary storage units plus and zero, indicators 0900 to 0905 on or off, transfer-any indicator on or off, and the 7080 mode indicator on or off. The storage of machine status is as follows:

STATUS INDICATOR	STORAGE WORD CHARACTER	BIT POSITION	INDICATOR CONDITION, BIT STATE = 1
High comparison	7	1	on
Low comparison	7	2	on
Overflow check (0904)	6	1	on
Sign check (0905)	6	2	on
Transfer any	6	4	on
7080 mode	6	8	on
Instruction Check (0900)	5	1	on
Machine check (0901)	5	2	on
Read-write check (0902)	5	4	on
Record check (0903)	5	8	on
Accumulator sign	4	1	minus
ASU sign	4	2	minus
Accumulator zero	4	4	zero
ASU zero	4	8	zero

Thus, whenever an interrupt program is to be executed, the 7080 is automatically placed in the proper status for that particular program. All indicators are restored to the status they registered *after the completion* of the *last instruction executed* in the interrupt program. The initial status for the program is established by appropriate housekeeping.

The fifth channel word set (channel 24) has an alternate use and format for the simultaneous transmit instruction, which is described under "New Operations."

When a WR 02 instruction is executed, word 0 has an alternate use from that described above. Positions 1-3 are used to simulate the action of the record counter in the 767 Data Synchronizer. Positions 0 and 4-7 are not used. This instruction is normally used only in the 705 III mode and when the machine is not in the interrupt mode. The counter is set to the quantity contained in the tens, hundreds, and thousands positions of the instruction address. Each time a reading or writing operation takes place, the contents of the counter are reduced by one. Reading or writing is then repeated until the counter is set to zero.

Interrupt Words

The portion of bank 2 which is not used for channel word sets is divided into twelve 8-character words (Figure 4). The first two of these are interrupt words. The format and function of these words are identical to those of word 0 in a channel word set (Figure 5). Positions 0-3 contain the location of the next instruction to be executed when an interrupt occurs. Positions 4-7 are used for storage of machine status (Figure 6).

Each interrupt word is associated with a specific type of interrupting condition as follows:

Interrupt Word 250. This word is associated with the non-stop operation feature and its function is explained under that section.

Interrupt Word 251. This word is associated with the console interrupt key. Depression of the key causes an automatic program interrupt to the location specified in positions 0-3 of the word.

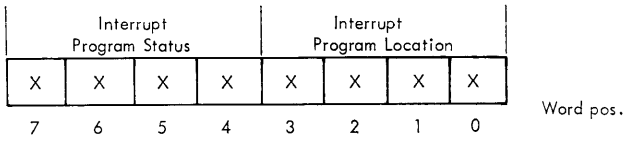


Figure 6. Interrupt Word

Bank 3, Channel Auxiliary Storage Units (CASU)

Instructions in an interrupt program which specify the use of auxiliary storage automatically use these units unless special instructions are used to refer to the normal ASU's in storage bank 1. They operate in the same manner as those in storage bank 1. However, CASU 15 is used to store the status of the main program before a transfer is made to the interrupt program. For this purpose, CASU 15 is divided into four 8-character words as follows (Figure 7):

Word 0. Positions 0-3 contain the location of the next instruction to be executed in the main program when control is transferred from the interrupt program back to the main program. Positions 4-7 contain the status of indicators as previously explained for these positions in word 0 of a channel word set.

Word 1. Positions 0-3 contain the setting of the starting point counter. Positions 4-7 are not used.

Word 2. Positions 0-3 contain the address indicated by MAC II. Positions 4-7 are not used.

Word 3. The contents of the select register are stored in positions 0-3; storage marks are placed in positions 4-7.

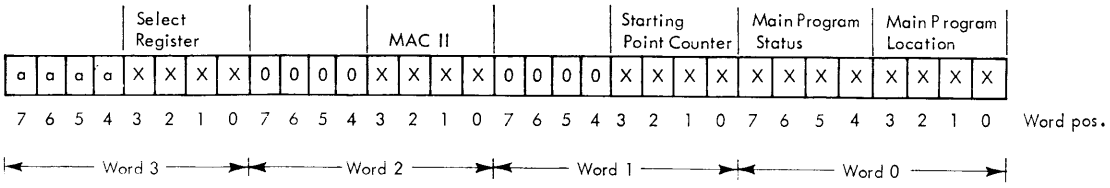


Figure 7. Channel ASU 15

Input-Output Component Address System

All addresses of 705 input-output devices are unchanged when these units are used with the 7080. The units are operated in the same manner as if they were attached to a 705 system.

705 I and II Mode. Only input-output equipment attached to the 7622 signal control may be selected in this mode. Addresses remain the same as when this equipment is attached to a 705 I or II. Communication channels are not available to the program.

705 III Mode. A 705 III program may call for the use of data synchronizers with either 729 I or III tape units. As previously stated, the data synchronizer cannot be used with the 7080 system. Tape select addresses in such a program will select instead a 7621 tape control and the attached 729 II or IV tape units. Address switches provided on the 7621 units must be set to correspond with the addresses specified by the program. For example, a 705 III select address 0214 specifies tape operation, DS 1, tape unit 4. On the 7080, SEL 0214 will specify tape operation, tape unit 4 on the communication channel whose associated 7621 address switch is set to 1. The channel word set used to simulate operation of the DS will be the one associated with the selected communication channel. This may be any one of the five communication channels available with the 7080.

When both 754 tape controls and a data synchronizer are called for by the program, the address switch of the 754 must be set to a number which does *not* correspond with the address switch of *any* 7621. For example, assume that the address switch of the 754 is 0, and that the address switches of a 7621, Model II, are set to 1 and 2. In this case, a SEL 0204 will operate tape unit 4 attached to the 754. SEL 0214 will operate tape unit 4 attached to the first communication channel with which the 7621 is associated; SEL 0224 will operate tape unit 4 attached to the second communication channel with which the 7621 is associated.

7080 Mode. In the 7080 mode, a tape operation using a communication channel is initiated by specifying the channel number in the two high-order positions of the select address, digits 20-24. The tens position of the address must always be zero; the units position specifies the particular tape unit required, digits 0-9. The setting of the address switch on the 7621 attached to the selected channel is immaterial. For example, SEL 2004 initiates tape operation on channel 20, tape unit 4, regardless of the setting of the 7621 address switch. The channel word set used corresponds to the channel selected.

When 705 I or II input-output units are also used in the 7080 mode, their addresses remain the same as when used with the 705.

Nonstop Operation

The nonstop operation feature of the 7080 permits continuous operation of the machine in automatic status.

When execution of an instruction is not completed within approximately two seconds, or when manual status would normally be entered for reasons other than a manual stop, the machine may be conditioned to interrupt to a program in a location specified by interrupt word 250. In this way, a transfer can be made automatically to a special routine which may analyze the instruction being executed or attempted and may then take appropriate programmed action.

This feature is under the control of a console nonstop switch. When the nonstop switch is off, the 7080 stops under the following conditions:

1. A halt instruction.
2. Any condition which turns on one or more of the 0900-0905 check indicators, provided the corresponding switch for these indicators is set to automatic.
3. Any condition which turns on the automatic restart indicator.

Automatic Restart Indicator. This indicator is provided on the 7080 in addition to the 0900-0905 check indicators. There is no corresponding console switch. The indicator is turned on whenever the machine does not complete the execution of an instruction in approximately two seconds. When the nonstop switch is set to ON, the transfer-any indicator is also turned

on, in addition to the automatic restart indicator, and an automatic restart takes place. The automatic restart indicator can be interrogated and reset by means of the transfer auto restart instruction (TAR, TRS 09) when the machine is in the 7080 mode. (Refer to the section "New Operations.")

When the nonstop operation switch is on, and one of the above conditions occurs, machine operation depends on whether or not the 7080 is processing an interrupt program. When in the main program, the machine will not stop for any of the above conditions, but will automatically interrupt to the location specified by interrupt word 250. All of the normal interrupt procedures will be followed.

When in the interrupt program at the time any of the above conditions occur, the machine will stop *only* if a halt instruction is executed. Under all other conditions, the machine will continue processing the interrupt program as though no error had occurred; in the case of the 0900-0905 indicators, as though their corresponding console switches were set to PROGRAM. A test of the ANY indicator at the end of each interrupt program will determine whether or not such a condition occurred during the interrupt program. If so, a transfer may be made to an appropriate routine to take corrective action before returning to the main program.

When a program is executed with the nonstop switch on, *the 7080 should always be in the interrupt mode* as conditioned by the instruction enter interrupt mode (EIM).

An interrupt associated with interrupt word 250 takes precedence over all other types of interrupts. Console and communication channel interrupts will be taken in turn after the interrupt with word 250 has been satisfied.

After an interrupt with word 250 has occurred, channel ASU 15 contains the status of the main program at the time the interrupt took place. The check indicators 0900-0905 are reset according to the status bits stored in the interrupt word. In order to test whether one of these indicators caused the interruption, it is necessary to test the proper status bit in CASU 15. Then, to turn off an indicator before returning to the main program, the appropriate status bit must be set to zero. This is also the case for the transfer-any indicator.

The automatic restart indicator is not altered as a result of the interrupt nor is it stored in CASU 15. The indicator is tested and turned off in the interrupt program by execution of the TAR instruction.

Depression of the stop, machine stop, instruct, store, or display keys on the console will effect a stop regardless of the setting of the nonstop switch.

Console Features

A number of improvements and new features have been included on the 7080 console which contribute to operator accuracy and efficiency.

Visual Display

1. Operations are displayed in alphabetic mnemonic characters projected on a screen, rather than by single lights. The select register, initial address register (formerly MAR), memory address counters I and II, instruction counter, storage address register and the designated ASU are also projected on a screen in digital form. A binary coded decimal display of these operating features is also provided as on present 705 consoles.

2. The number of display lights has been reduced by displaying only one of the six above-mentioned registers and counters. Manual switches are provided to select the desired register or counter for display.

3. All lights are incandescent for better viewing contrast.

4. Many indicators formerly positioned on the 705 for customer engineering use have been repositioned for more convenient reference by the operator.

Utility Storage

Punched card file storage is provided at the console. This space may be used for convenient storage of utility or other frequently used card-loaded programs.

Also, drawer space provided for storage of miscellaneous items such as pencils, clips, and rubber bands contributes to neater and more orderly appearance of the console.

Operating Keys

1. Auxiliary storage units are designated by decimal keys rather than binary to improve operator accuracy.

2. Auxiliary storage keys automatically reset to home position (00) after manually keyed operations to prevent incorrect use of storage in subsequent operations.

3. Operating keys (store, instruct, and so on) are combined with their corresponding lights.

4. An interrupt key is provided on the console. This key is associated with interrupt word 251 in storage bank 2. By the use of the key, the operator can interrupt a running 7080 program at will to initiate subroutines, utility programs, or multi-programs.

5. A 705 I-II switch and a 40K memory size switch are provided for 705 compatibility and memory size. Their settings are shown below.

705 I-II SWITCH	40K MEMORY SIZE SWITCH	MODE	MEMORY SIZE
On	Off	705 I	20,000 positions
On	On	705 II	40,000 positions
Off	On	705 III	40,000 positions
Off	Off	705 III	80,000 positions

6. The machine stop key provides the additional function of carriage return on the typewriter (if in motion) but does not perform the function of the channel reset key.

7. The channel reset key stops all action of the multiplexor and resets its indicators.

8. Additional keys are provided to facilitate the display of the expanded storage and the addressing of the enlarged memory.

New Operations

There are 18 new operations in the 7080. Of these, five are new control operations and one is a new transfer signal. The new comma (,) operation code, combined with ASU coding, provides the other 12 instructions which can be used only when in the 7080 mode. In the following instruction titles, the ASU coding follows the instruction mnemonic.

Transfer to Interrupt Program (,—TIP 14)

This instruction simulates an automatic interruption. When it is executed, an unconditional transfer is made to the interrupt program. The address of the TIP instruction specifies the memory location of the next instruction to be executed and must always end in 4 or 9.

1. The contents of the instruction counter are stored in the first four positions of word 0, channel auxiliary storage unit 15. The status of indicators is stored as bits in the remaining four positions of word 0, CASU 15 (Figure 7).

2. The contents of MAC II, the starting point counter, and the select register are stored in CASU 15 as shown in Figure 7.

3. An interrupt program indicator is turned on to prevent any further interrupts.

4. Subsequent operations in the interrupt program which designate the accumulator automatically refer to storage bank 2, position 000; those with ASU coding refer to the channel auxiliary storage units in storage bank 3.

5. The instruction counter is reset to the address specified by the TIP instruction.

6. The contents of MAC II and the select register remain unaltered.

The above sequence also takes place when an automatic interrupt occurs, except that the memory location of the interrupt program is obtained from positions 0-3 of word 0 in the appropriate channel word set or from the interrupt word. The address thus obtained is placed in the instruction counter. The status indicators, as stored in positions 4-7, are restored to the state that existed after the *last previously executed* instruction in the interrupt program. A transfer is automatically made to the interrupt program.

If the machine is in the interrupt mode, as conditioned by the enter interrupt mode instruction, an interrupt may occur at any point in the main program, but the transfer is delayed until the current instruction has been completely executed. Two exceptions: after an enable indirect address or after a RWW instruction. These are described under "Enter Interrupt Mode."

Leave Interrupt Program (,—LIP 15)

This operation allows the machine to return to the main program and to continue as though it had not been interrupted. When it is executed, an unconditional transfer is made to the main program.

1. The contents of the instruction counter and the status indicators are placed in the storage word specified by the address of the LIP instruction. This word is usually word 0 of the communication channel which originally initiated the interrupt, and for which a future interrupt is anticipated.

2. The contents of CASU 15 are read and the entire machine status of the main program is restored, including status indicators, MAC II, the starting point counter, and the select register. The instruction counter is set to the location of the next instruction in the main program, as previously stored in the first four positions of word 0 in CASU 15 (Figure 7).

3. The interrupt program indicator is turned off to permit further interrupts.

4. Subsequent operations automatically refer to the accumulator or to auxiliary storage units in the bank specified by the restored value of the starting point counter.

The four-position address of the LIP instruction takes the following form:

Thousands Position. This specifies the storage bank. Usually the digit 2 is used and specifies storage bank 2 in which the channel word sets or interrupt words are located.

Hundreds Position. This specifies the group of four words within the bank. The digits 0-4 specify one of the five channel word sets. The digit 5 refers to the interrupt words.

Tens Position. The digits 0-3 specify the proper eight-character word in a group of four. Normally the digit 0 is used when working with channel word sets.

Units Position. This specifies the character position within a word. A zero designates the first position of the storage word when LIP is used with channel word sets or the interrupt word.

Conventional procedure requires the interrupt program status to be placed in a channel word set. However, the programmer can retain a fixed interrupt address and status by using the LIP instruction with the special address 0009. When this address is used, the contents of the instruction counter and the status triggers are not placed in storage.

Figure 8 is a program schematic showing the use of the TIP and LIP instructions. A transfer from the main program to an input-output interrupt program is executed by the TIP instruction. A channel and a tape unit are selected. A read instruction is given to start the tape record reading into memory. While the record is reading, a LIP instruction transfers back to the main program to continue processing. As processing continues, the tape reading operation is completed, causing an automatic interrupt of the main program. When the current instruction in the main program is executed, a transfer to the next instruction in the interrupt program is made. At this point, the reading operation may be checked, a record count may be incremented, or other manipulation of the record may occur. The next input-output operation for the channel is usually initiated. A LIP instruction is given to re-enter the main program.

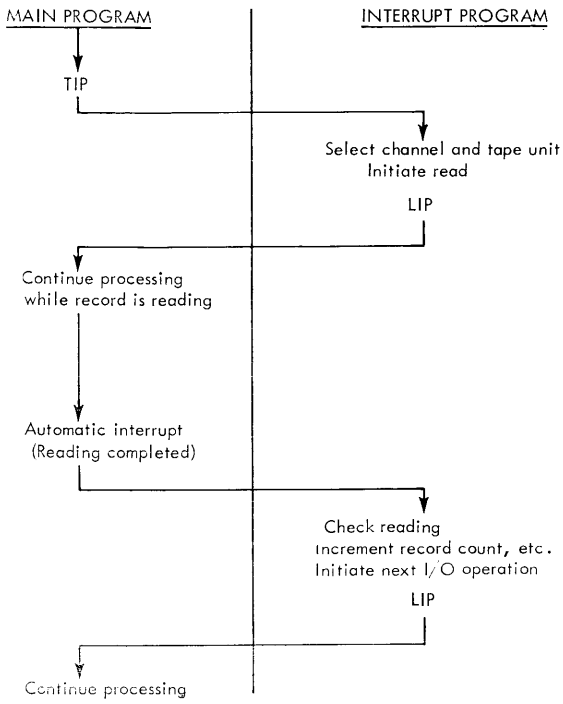


Figure 8. Program Schematic for LIP and TIP Instructions

Set Starting Point Counter (, — SPC 00)

One starting point counter is provided for all banks of central storage. The counter may be positioned by the SPC instruction, thus providing the ability to address any character in central storage.

The format of the four-character address is as follows:

Thousands Position. The digits 0-3 designate one of the four 256-character storage banks.

Hundreds Position. The digits 0-7 identify one of the eight four-word sets within a bank.

Tens Position. The digits 0-3 identify one of the four eight-character words within a set.

Units Position. The digits 0-7 identify one of the eight characters in a word.

1. All instructions which use central storage are handled with reference to the previous setting of the starting point counter. The counter may be positioned within any bank by the SPC instruction. Subsequent storage instruction addresses without ASU coding will automatically specify as an accumulator the bank of central storage indicated by this setting of the counter. Storage instructions with ASU coding will specify (a) bank 1, if the starting point counter is set to *any* position within bank 0 or 1; (b) bank 3, if the counter is set to *any* position within bank 2 or 3.

2. Execution of a TIP instruction or an automatic interruption performs the equivalent of an SPC 2000. Therefore, subsequent instruction references to storage without ASU coding specify communication storage, bank 2. Since bank 2 is involved with the flow of data to and from the channels, all instructions in the interrupt program using central storage should refer to an ASU, thereby properly utilizing the channel ASU's in bank 3 provided for this purpose.

When it is necessary to use an accumulator in the interrupt program (e.g., to execute multiplication or division), an SPC 0000 may be given. Subsequent storage reference instructions without ASU coding will then specify bank 0. The contents of the bank may be

saved by using a USB instruction as explained under the description of this instruction. The programmer must be aware that following storage reference instructions with ASU coding will then specify bank 1 even though the interrupt program is still in process. To return to the channel ASU's, an SPC 2xxx or 3xxx should then be given.

3. The flexibility of central storage is such that any bank may be used as an accumulator, while either bank 1 or 3 may be used as ASU's by proper manipulation of the starting point counter. The fixed divisions of ASU storage are maintained for all storage reference instructions which specify these units, regardless of the bank used. For example, with the starting point counter set to 1000, an RAD XXXX ASU 02 instruction places the memory field in the low-order positions of ASU 02 in bank 1. A subsequent ST XXXX ASU 02 places this field back in memory in the normal manner. The same operation may also be accomplished by the following series of instructions: SPC 1020, RAD XXXX 00, ST XXXX 00.

Bank 0 may also be used for the storage of a number of factors by changing the setting of the starting point counter by a series of instructions, such as SPC 0000, RAD XXXX; SPC 0100, RAD XXXX; SPC 0200, RAD XXXX; and so on. A similar sequence of instructions returns these factors to memory: SPC 0000, ST XXXX; SPC 0100, ST XXXX; SPC 0200, ST XXXX; and so on. In all cases it is assumed that the sign of the factors is identical and that their length is known to be less than 32 positions.

It is also possible to perform multiplication or division in any bank. However, the programmer must be aware that communication storage, bank 2, and channel ASU 15 are involved with the functions of input-output data flow and priority processing. These positions of central storage are normally used only for this purpose. Also, when multiplication or division is executed, two 128-position sections of the storage bank are used. It is therefore usually impractical to perform these operations in any storage unit other than bank 0.

4. The SPC instruction does not affect the setting of the zero indicators. These indicators may be properly set by following SPC with an SHR 0000 instruction.

Load Four Characters (, — LFC 02)

This instruction provides a convenient method of loading four characters, usually an instruction address, into storage without the requirement of first placing a storage mark to the left of the fourth position of the field.

1. The address of the instruction specifies the location of the units position of the four-character memory field. The address should end in 4 or 9 when loading an instruction address.

2. The storage location of the field or characters to be loaded is specified by the setting of the starting point counter which may be positioned by a previous SPC instruction.

3. Storage positions, other than the characters to be loaded, are not altered. Information is placed in central storage exactly as it appears in memory, except when any of the characters is a special configuration (C, B, A, 8, 4 and 2 bits) representing a storage mark in memory. This character is converted to a storage mark.

4. One, two, three, or five characters may also be loaded by ending the LFC instruction address in 1 or 6, 2 or 7, 3 or 8, or 0 or 5, respectively.

Unload Four Characters (, — UFC 03)

The function of this instruction is the reverse of that of LFC.

1. The address specifies the location of the units position of the four-character field in memory. The address should end in 4 or 9 when unloading an instruction address.

2. The storage location of the field to be unloaded is specified by the current value of the starting point counter.

3. The contents of storage remain unaltered. Storage marks are converted to a special character in memory (C, B, A, 8, 4 and 2 bits).

4. Addresses ending in 1 or 6, 2 or 7, 3 or 8, or 0 or 5 unload 1, 2, 3, or 5 characters, respectively.

Unload Storage Bank (, — USB 05)

All 256 characters of a storage bank are placed in memory by this instruction.

1. The bank to be unloaded is specified by the current value of the starting point counter, usually set by a preceding SPC instruction. The setting of the starting point counter is not affected by this instruction.

2. The address of the USB instruction specifies the location of the units position of the 256-character field in memory.

3. Unloading begins at position 000 of the storage bank indicated.

4. Data are placed in memory as in a conventional unload instruction except that all storage marks are

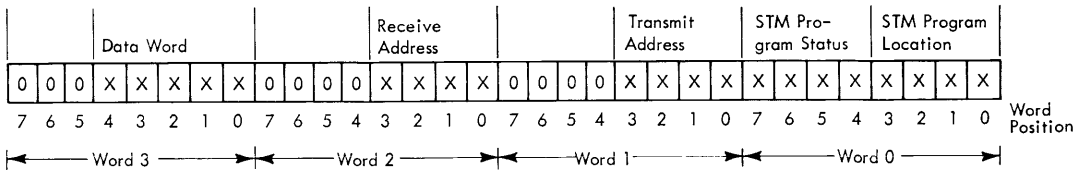


Figure 9. Simultaneous Transmit (Channel Word Set 24)

converted to special characters (C, B, A, 8, 4 and 2 bits).

Load Storage Bank (, — LSB 04)

The entire contents of a 256-character storage bank may be reloaded from memory by this instruction.

1. The bank to be loaded is specified in the same manner as in the USB instruction.

2. The address of the LSB instruction specifies the location of the units position of the 256-character field in memory.

3. Loading begins at position 000 of the storage bank indicated.

4. Data are placed in storage as in a conventional load instruction except that the special characters (C, B, A, 8, 4 and 2 bits) are converted to storage marks.

Simultaneous Transmit (, — STM 08)

Data may be moved from one memory location to another while computation and reading or writing are occurring. Simultaneous transmission is controlled by a subroutine apart from the main program in the same manner as input-output operations through a communication channel.

Channel 24 may be used either as an input-output control or for simultaneous transmission at the programmer's discretion. When channel 24 is used with the STM, the four words in the set are assigned as shown in Figure 9.

Word 0. Positions 0-3 contain the location and positions 4-7 contain the status of the STM program.

Word 1. The transmit address is contained in positions 0-3. This address should specify the leftmost position of the area to be transmitted and must end in 0 or 5. The address is placed in word 1 when the STM instruction is executed and is incremented by five as each five-character record block is moved from this location in memory.

Word 2. Positions 0-3 contain the receive address that is incremented by five as each five-character record block is moved to this location in memory. The address is placed in word 2 by preceding SPC and LFC instructions. This address also must end in 0 or 5. The operation of the address counters in words 1 and 2 is similar to the operation of MAC I and MAC II when a five-character receive and transmit operation is performed using TMT 00.

Word 3. Positions 0-4 act as a data buffer and contain the five-character blocks as they are transmitted, one block at a time, between two memory locations.

The programming considerations for STM are as follows (Figure 10):

1. A TIP instruction is executed to transfer to the STM subroutine. The status of the main program is placed in CASU 15 in the normal manner.
2. In the subroutine a SPC 2420 instruction is executed to place the starting point counter at the first position of word 2 in channel 24. This is the location in storage assigned to the receive address.
3. An LFC instruction is executed to move the receive address from memory to the storage location previously selected by the SPC instruction. The LFC instruction address (must end in 4 or 9) is the location of the receive address (must end in 0 or 5) in memory.

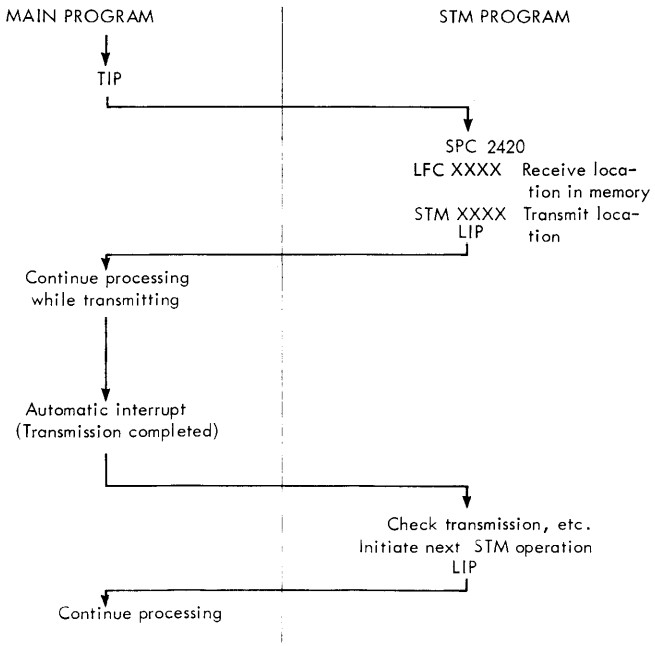


Figure 10. Program Schematic for Simultaneous Transmission

4. An STM instruction is executed to begin transmission. The STM address (must end in 0 or 5) is automatically placed in positions 0-3 of word 1 in channel 24. Transmission of the data then begins.
5. As transmission proceeds, a LIP instruction is executed to return to the main program.
6. Transmission is terminated when a record mark is sensed as the last character of the transmit memory area. An interrupt to the main program is signaled and an automatic transfer to the STM program occurs.
7. Additional instructions in the STM program may then be executed, and further STM operations can be initiated, if desirable.
8. A LIP instruction is executed to return to the main program to continue processing.

Control 0038, Set Density High (3 — SDH 00)

This instruction conditions the previously selected 729 II or 729 IV tape unit to read or write all subsequent records at a density of 556 characters to the inch. Tape processing is then carried out at the rate of 41,667 characters per second in the 729 II and 62,500 characters per second in the 729 IV.

Control 0037, Set Density Low (3 — SDL 00)

This instruction conditions the previously selected 729 II or 729 IV tape unit to read or write all subsequent records at a density of 200 characters to the inch. Tape processing is carried out at the rate of 15,000 characters per second in the 729 II and 22,500 characters per second in the 729 IV.

Enter Eighty Mode (3 — EEM 14)

When the system is instructed to enter the 7080 mode, all the features of the 705 are available together with the additional features of the 7080.

1. The six-digit versions of address modification instructions are activated. The A bit in the units position of an address specifies the memory locations 80,000 to 159,999, not indirect addressing.

2. The 7080 mode of input-output addressing becomes applicable to all SEL instructions that refer to communication channels. The thousands and hundreds positions of the address identify the channel used (20-24). The tens position must be zero. The units position identifies the tape unit number.

3. The capacity of memory is 160,000 positions for the 7302 Model I and 80,000 positions for the 7302 Model II, regardless of the setting of the 40K memory size switch or the 705 I-II compatibility switch. Wraparound of MAC I, MAC II, and the instruction counter will always be at 160,000 positions in the 7080 mode.

4. All comma operation codes are operable, as well as the transfer to automatic restart (TAR).

5. The memory address portion of this instruction is ignored.

Leave Eighty Mode (3 — LEM 15)

When instructed to leave the 7080 mode, the 7080 system operates as a 705 III, provided the 705 I and II console key is not on. All program instructions are executed in the same manner as in the 705 III and input-output operation is identical.

If the LEM instruction is executed with the 705 I and II key on, the machine will operate as a 705 I and II.

Any depression of the clear-memory or auto-load keys performs the same function as the LEM instruction.

The next instruction following the LEM is considered to be located in a memory with capacity limited by the setting of the 40K memory size switch. For example, with the console switches set for a 705 III with 40,000 positions of memory, the instruction following LEM executed in location 150,004 is automatically taken from location 30,009. For this reason the LEM instruction should be located in a section of memory that will be available in the following mode of operation.

The memory address portion of this instruction is ignored.

Enable Indirect Address (, — EIA 10)

When the machine is operating in the 7080 mode, the indirect addressing of a particular instruction is accomplished by preceding it with enable indirect address. This indirect address state applies only to the instruction immediately following EIA, and the machine permits no interruption between such a pair of instructions.

By using this means of designating an indirect address, the 7080 can directly address 160,000 character positions.

When the system is in the 705 III mode, indirect addressing is performed exactly as in the 705 III system. The address portion of the instruction is ignored.

No Operation (, — CNO 11)

This instruction (comma no operation) provides a convenient method of forming a program switch with the EIA instruction. It may also be used in the same manner as the NOP instruction available in all modes.

ASU coding for CNO is 11; coding for EIA is 10. Therefore, an SBA instruction specifying the tens position of the CNO address will convert this instruction to EIA. Conversely, an SBA instruction specifying the tens position of the EIA address will convert this instruction to CNO.

Enter Interrupt Mode (, — EIM 06)

The EIM instruction may be executed only in the 7080 mode. The program then becomes "interruptable" by any of the channels or the console interrupt key. The program need not be concerned with interrogating the readiness of the communication channels.

1. Although the machine must be in the 7080 mode in order to execute EIM, the interrupt mode is not turned off if the program should return to a 705 mode.

2. All interrupting conditions which may have occurred prior to the execution of EIM are reset.

3. No interruption is permitted between an EIA instruction and the following instruction. When an RWW instruction is given, no interruption is permitted until the following RD, WR or SND operation has been completed.

4. The address portion of the instruction is ignored.

Leave Interrupt Mode (, — LIM 07)

When the program executes this instruction (possible only while in the 7080 mode), no further interrupts can occur. Channels must be serviced by interrogating their readiness, as in the 705 III system.

When the clear memory and auto load keys are depressed, the machine automatically leaves the interrupt mode status.

Transfer on Signal (O — TAR 09)

This operation interrogates the automatic restart indicator and effects a transfer when the indicator is on.

1. The automatic restart indicator is turned on whenever the 7080 does not complete execution of an instruction within approximately two seconds. When the TAR instruction is executed, the indicator is automatically turned off and the machine transfers to the location specified by the address of the instruction.

2. When the indicator is off, a TAR instruction has no effect and the machine continues to the next sequential instruction.

3. The transfer on signal 09 operates as a TAR instruction only in the 7080 mode. In the 705 III mode, the instruction is considered no operation.

Channel Reset (3 — CHR 13)

This instruction resets all check and status indicators in the communication channels and all tape control units attached. No particular channel need be selected.

This instruction is useful as part of a housekeeping routine at the start of a job, and exactly duplicates the function of the channel reset key on the 7153 console.

The memory address portion of the instruction is ignored.

Programming Example

The following program demonstrates the functions and normal use of the new instructions provided by the 7080. The program reads two tape files into input areas and transmits one of these to an output area. Interrupt routines are shown in detail, but processing routines similar to those for the 705 are omitted.

Figure 11 is the program written with actual instruction locations and addresses.

HOUSEKEEPING ROUTINE

000004. Enter the 7080 mode of operation.

000009-000019. Load the interrupt words with the appropriate interrupt program status and location. The 7080 mode bit is set to 1 in each case, in order that the machine will remain in the 7080 mode when interrupted.

000024. Return the starting point counter to bank 0.

000029. Enter the interrupt mode of operation.

000034-000049. Set the 729 tape units to the proper densities.

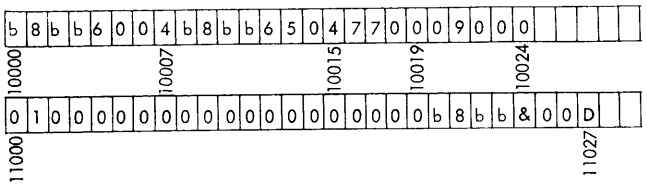
000054. Complete housekeeping.

MAIN ROUTINE

000104. Set switch 1 off by altering instruction to CNO.

000109-000114. Test whether channel 21 is ready.

000119. If channel 21 is busy, transfer to a routine which will link the interrupt program for reading tape unit 2101 to the interrupt program for channel 21 already in progress. In this way, the reading of



INSTR. LOCATION	INSTRUCTION OPER.	INSTRUCTION ADDRESS	STOR. CODE	EXPLANATION
Housekeeping Routine				
000004	EEM			
000009	SPC	002500		
000014	SET	000016		
000019	LOD	010015		
000024	SPC	000000		
000029	EIM			
000034	SEL	002101		
000039	SDL			
000044	SEL	002106		
000049	SDH			
000054	↓			
Main Routine				
000104	SBN	000303	13	
000109	SEL	002101		
000114	TRR	000124		
000119	TR			
000124	TIP	005004		
000129	↓			
000204	SBN	000503	13	
000209	SEL	002106		
000214	TRR	000224		
000219	TR			
000224	TIP	005204		
000229	↓			
000304	(CNO)	000314		Switch 1
000309	TR	000304		
000314	Routine to Process Input from Tape 2101			
	↓			
000404	SBN	000603	13	
000409	SEL	002400		
000414	TRR	000424		
000419	TR			
000424	TIP	005404		
000429	↓			
000504	(CNO)	000514		Switch 2
000509	TR	000504		
000514	Routine to Process Input from Tape 2106			
	↓			
000604	(CNO)	000614		Switch 3
000609	TR	000604		
000614	Routine to Process Transmitted Record			
	↓			
000704	TR	000104		
Communication Channel Interrupt Programs				
005004	SEL	002101		
005009	RD	007000		
005014	TRA			
005019	LIP	002100		
005024	SEL	002101		
005029	TSA			
005034	SPC	002110		
005039	SET	000004		
005044	CMP	010019		Assume 700 char record.
005049	TRE	005104		

INSTR. LOCATION	INSTRUCTION OPER.	INSTRUCTION ADDRESS	STOR CODE	EXPLANATION
005054	Error Routine for Incorrect Record Length			
	↓			
005104	SBA	000303		
005109	(NOP)	005124		
005114	TRA			
005119	LIP	000009		
005124	ADM	005105	01	
005129	TRA			
005134	TR	( )		
005204	SEL	002106		
005209	RD	008000		
005214	TRA			
005219	LIP	002100		
005224	SEL	002106		
005229	TSA			
005234	↓			
005304	SBA	000503		
005309	(NOP)	005324		
005314	TRA			
005319	LIP	000009		
005324	ADM	005305	01	
005329	TRA			
005334	TR	( )		
005404	SPC	002420		
005409	LFC	010024		
005414	STM	007000		
005419	TRA			
005424	LIP	002400		
005429	SEL	002400		
005434	TTC			
005439	SBA	000603		
005444	(NOP)	005459		
005449	TRA			
005454	LIP	000009		
005459	ADM	005440		Switch 4
005464	TRA			
005469	TR	( )		
Interrupt Word Programs				
006004	UNL	012027	15	
006009	LD	011027	15	
006014	SPC	001000		
006019	USB	012283		
006024	LSB	011283		
006029	SPC	000000		
006034	USB	012539		
006039	TRA			
006044	LIP	000009		
006504	TAR	006624		
006509	SPC	003704		
006514	UFC	012604		
006519	RCV	012603		
006524	TZB	006534	01	0900 bit
006529	TR			
006534	TZB	006544	02	0 901 bit
006539	TR			
006544	↓			
006604	SPC	003704		
006609	LFC	012604		
006614	TRA			
006619	LIP	000009		
006624	SPC	003704		
006629	UFC	012604		
006634	SBZ	012602	03	Transfer-any indicator bit
006639	↓			
006704	SPC	003704		
006709	LFC	012604		
006714	TRA			
006719	LIP	000009		

Figure 11. Actual Program

tape 2101 will be started as soon as the present operation on channel 21 is completed. Return to the main program at location 000129.

000124. If channel 21 is ready, transfer to the interrupt program for reading tape unit 2101. The next LIP instruction in the interrupt program will automatically return control to the main program at 000129.

000129. Continue processing.

000204. Set switch 2 off by altering instruction to CNO.

000209-000214. Test whether channel 21 is ready. If it is busy, transfer to a routine which will link the interrupt program for reading tape unit 2106 to the interrupt program for channel 21 already in progress. Return to the main program at 000229.

000224. If channel 21 is ready, transfer to the interrupt program for reading tape unit 2106. The next LIP instruction will automatically return control to the main program at 000229.

000229. Continue processing.

000304-000309. Processing may not continue beyond this point until the record from tape unit 2101 has been read. If the reading is not yet complete, the machine will loop between these two instructions (CNO, TR) until an interrupt is made. In the interrupt program, the CNO is modified to an EIA instruction. The next LIP instruction will return control to one of these two instructions, at which time an indirect transfer will be made to 000314.

000314. Process the input record from tape unit 2101.

000404. Set switch 3 off by altering instruction to CNO.

000409-000414. Test whether channel 24 is ready.

000419. If channel 24 is busy, transfer to a routine that will link the interrupt program for simultaneous transmission to the interrupt program for channel 24 already in progress. Return to the main program at 000429.

000424. If channel 24 is ready, transfer to the interrupt program for simultaneous transmission. The next LIP instruction will automatically return control to the main program at 000429.

000429. Continue processing.

000504-000509. Processing may not continue beyond this point until the record from tape unit 2106 has been read. If the reading is not yet complete, the machine will loop between these two instructions (CNO, TR) until an interrupt is made. In the interrupt program, the CNO is modified to an EIA instruction. The next LIP instruction will return control to one of these two instructions, at which time an indirect transfer will be made to 000514.

000514. Process the input record from tape unit 2106.

000604-000609. Processing may not continue beyond this point until the simultaneous transmission of the record needed is complete. Operation of switch 3 is identical to that of switch 2 described above at 000504-000509.

000614. Process the transmitted record.

000704. Repeat the program.

Communication Channel Interrupt Programs

005004-005009. Select tape unit 2101 and start reading.

005014. Transfer to appropriate routine if automatic restart or 0900-0905 error occurred in interrupt program.

005019. Return to main routine.

005024-005029. When interrupt occurs, reselect tape unit 2101 and transfer to an appropriate routine if an error occurred during reading.

005034-005054. Compare the setting of the data memory address in the channel word set with the expected setting. If they are unequal, enter an error routine which deals with incorrect record lengths. Otherwise, transfer to 005104.

005104. Set switch 1 on by altering instruction to EIA.

005109-005134. If no further operation is required by channel 21 at this time, switch 4 will be set to NOP. After testing for an error condition, control will be returned to the main routine. However, if another input-output operation for channel 21 has been linked to this one, switch 4 will be set to TR. After resetting the switch and testing for an error condition, a transfer will be made to the next interrupt program. In this example, the transfer might be made to 005204.

005204-005334. This interrupt program for reading tape unit 2106 is similar to that described above for reading tape unit 2101.

005404. Set the starting point counter to the receive address word of the channel word set for channel 24.

005409. Load the receive address into storage.

005414. Begin transmission.

005419-005424. Test for an error condition and return to the main routine.

005429-005434. When interrupt occurs, transfer to an appropriate routine if an error occurred during transmission.

005439-005469. These instructions perform a function for channel 24 identical to that performed by the instructions at 005109-005134 for channel 21.

Interrupt Word 251 Program

006004. Unload channel ASU 15 in temporary storage.

006009. Reload channel ASU 15 with the status requirements of a new program.

006014-006019. Unload the ASU's into temporary storage.

006024. Reload the ASU's with new values and settings as required by the new program.

006029-006034. Unload the accumulator into temporary storage.

006039-006044. Test for an error condition and return control to the main routine. Since channel ASU 15 has been altered, the next instruction will be executed at 150004.

Interrupt Word 250 Program

006504. Test whether the automatic restart indicator is on. If on, transfer to 006624.

006509-006514. Unload the main program status from channel ASU 15 into temporary storage.

006519-006544. Test the states of the various status bits to determine the type of error which caused the interrupt and transfer to corrective routines.

006604-006609. When the error has been corrected, return the main program status to channel ASU 15.

006614-006619. After testing for an error in the interrupt program, return control to the main program.

006624-006629. Unload the main program status from channel ASU 15 into temporary storage.

006634. Set the transfer—any indicator bit to zero. This is known to be on because there was an automatic restart.

006639. Analyze and correct condition.

006704-006709. When the error has been corrected, return the main program status to channel ASU 15.

006714-006719. After testing for an error in the interrupt program, return control to the main program.

IBM 7080 Mode Chart

MODE OF 7080 OPERATION	METHOD OF ENTERING MODE	NATURE OF MODE	METHOD OF TERMINATING MODE
705 I-II	If the console 705 I-II compatibility switch is set to ON, this mode may be established by any of the following operations: 1. Depression of the console clear-memory or auto-load keys. 2. Execution of the LEM instruction. 3. Execution of the LIP instruction if the 7080 mode indicator bit in CASU 15 is a zero. 4. An automatic interrupt if the 7080 mode indicator bit in the interrupt word or in word 0 of the channel word set is a zero.	1. Programs written for a 705 I or II may be processed without alteration at the increased speed of the 7080. 2. 705 I and II input-output units required by a program must be connected to the central processing unit through the 7622 signal control unit. 3. Transfer instructions which are not in the 705 I and II are not active. All transfer instructions will function exactly as they do in a 705 I or II. 4. The indirect method of addressing of the 705 III does not apply. Zoning over the units position of an instruction address is ignored. 5. Operations such as add, subtract, and add to memory are terminated in the same manner as in the 705 I or II. 6. The size of memory available to the program is restricted to 20,000 positions, and wrap-around of MAC I, MAC II, and the instruction counter will be at 20,000, if the console 40K memory size switch is off. If this switch is on, 40,000 positions will apply. 7. Communication channels may not be selected.	1. Setting the console 705-I-II switch to OFF. 2. Execution of the EEM instruction. 3. An automatic interrupt if the 7080 mode indicator bit in the interrupt word or in word 0 of the channel word set is a 1.
705 III	If the console 705 I-II compatibility switch is set to OFF, this mode may be established by any of the following operations: 1. Depression of the console clear-memory or auto-load keys. 2. Execution of the LEM instruction. 3. Execution of the LIP instruction if the 7080 mode indicator bit in CASU 15 is a zero. 4. An automatic interrupt if the 7080 mode indicator bit in the interrupt word or channel word set is a zero.	1. Programs written for a 705 III may be processed without alteration at the increased speed of the 7080. 2. 705 III input-output units required by a program, with the exception of the 767 data synchronizer and 729 I or III tape units, must be connected to the central processing unit through the 7622 signal control unit. The 767 DS and 729 I or III tape units may not be attached to the 7080. Their action is simulated by communication storage, a communication channel, a 7621 tape control and 729 II or IV tape units. 3. All instructions which are provided in a 705 III will function exactly as if they were executed by a 705 III. 4. Indirect addressing is designated by an A bit over the units position of an instruction address. 5. The size of memory available to the program is restricted to 80,000 positions, and wrap-around of MAC I, MAC II, and the instruction counter will be at 80,000, if the console 40K memory size switch is off. If this switch is on, 40,000 positions will apply.	1. Setting the console 705 I-II switch to ON. 2. Execution of the EEM instruction. 3. An automatic interrupt if the 7080 mode indicator bit in the interrupt word or in word 0 of the channel word set is a 1.
7080	1. Execution of the EEM instruction. 2. An automatic interrupt if the 7080 mode indicator bit in the interrupt word or in word 0 of the channel word set is a 1.	1. All the features of 705 systems are available to the program together with the additional features of the 7080. 2. All comma operation codes are operable as well as the transfer to automatic restart (TAR) instructions. 3. The A bit in the units position of an instruction address specifies the memory locations 80,000 to 159,999, not indirect addressing. 4. The address modification instructions (LDA, ULA, AAM) automatically handle the six-digit addresses of the 160,000 position memory. 5. The 7080 mode of input-output addressing becomes applicable to all SEL instructions that refer to communication channels. The thousands and hundreds positions of the address identify the communication channel (20-24). The tens position must be zero. The units position identifies the tape unit number. 6. The size of memory available to the program is 160,000 positions for the 7302 Model I and 80,000 positions for the 7302 Model II, regardless of the setting of the console memory size switch. Wrap-around of MAC I, MAC II, and the instruction counter will always be at 160,000.	1. Depression of the console clear-memory or auto-load keys. 2. Execution of the LEM instruction. 3. Execution of the LIP instruction if the 7080 mode indicator bit in CASU 15 is a zero. 4. An automatic interrupt if the 7080 mode indicator bit in the interrupt word or in word 0 of the channel word set is a zero.

MODE OF 7080 OPERATION	METHOD OF ENTERING MODE	NATURE OF MODE	METHOD OF TERMINATING MODE
Interrupt	1. Execution of the EIM instruction.	An interrupt signal is caused either by the completion of a communication channel operation or by an interrupt word condition. With the following exceptions, this signal will initiate an automatic interrupt of the program at the completion of the instruction then in progress. 1. An interrupt may not occur after an EIA instruction. A signal received during the execution of this instruction will be delayed until the subsequent instruction is completed. 2. An interrupt may not occur between a RWW instruction and a subsequent RD, WR, or SND instruction. A signal received in this interval will be delayed until the subsequent RD, WR, or SND instruction is completed. 3. If the machine is in an interrupt program, that is, if an automatic interrupt has been made or a TIP instruction has been executed, no interrupts may occur until the completion of a subsequent LIP instruction. A signal received in this interval will be delayed until the subsequent LIP instruction is completed. An exception is the non-stop interrupt signal to interrupt word 250. This signal will be lost if received in the above interval. A TRA instruction should be executed immediately prior to the LIP instruction to compensate for this exception.	1. Depression of the console clear-memory or auto-load keys. 2. Execution of the LIM instruction.
Non-stop	1. Setting the console non-stop switch to ON.	1. The machine should always be in the interrupt mode. 2. Any condition which turns on the automatic restart indicator also turns on the transfer-any indicator. 3. If the machine is in the main program, the following conditions will not cause a stop, but will initiate an automatic interrupt to interrupt word 250: A halt instruction. A condition which turns on a 0900-0905 check indicator with the corresponding switch set to AUTOMATIC. A condition which turns on the automatic restart indicator. 4. If the machine is in an interrupt program, the machine will stop only if a halt instruction is executed. Under the remaining two above conditions, the program will proceed to the next instruction and continue. An interrupt to interrupt word 250 will *not* be made after the subsequent LIP instruction. A TRA instruction should be executed immediately prior to the LIP instruction to compensate for this condition. 5. The only conditions under which the machine will stop are: A halt instruction in an interrupt program. A manual stop.	1. Setting the console non-stop switch to OFF.

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