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BACKGROUND / FOREGROUND MONITOR SYSTEM, PROGRAMMER'S REFERENCE MANUAL

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PDP-9

BACKGROUND / FOREGROUND MONITOR SYSTEM

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SECTION 1

BACKGROUND/FOREGROUND MONITOR

1.1 INTRODUCTION

The reader is assumed to be familiar with the Keyboard Monitor environment as described in the Advanced Software Monitors Manual, DEC-9A-MADO-D. It should also be noted that all material presented herein supersedes the information given in the Monitor Manual.

1.2 BACKGROUND/FOREGROUND MONITOR FUNCTIONS

The Background/Foreground Monitor is designed to control processing and I/O operations in a real-time or time-shared environment. It is, essentially, an extension of the Keyboard Monitor and allows for time-shared use of a PDP-9 by a protected, priority, user FORE-GROUND program and an unprotected system or user BACKGROUND program.

The Background/Foreground Monitor greatly expands the capabilities of PDP-9 ADVANCED Software and makes optimum use of all available hardware. It permits recovery of the free time (or dead time) that occurs between input/output operations, thus promoting 100% utilization of central processor time.

FOREGROUND programs are defined as the higher-priority, debugged user programs that interface with the real-time environment. They normally operate under Program Interrupt (PI) or Automatic Priority Interrupt (API) control, and are memory protected. At load time they have top priority in selection of core memory and I/O devices, and at execution time they have priority (according to the assigned priority levels) over processing time. Depending upon system require-

ments, the user's FOREGROUND program could be an Executive capable of handling many real-time programs or subprograms at four levels of priority (with API present).

BACKGROUND processing is essentially the same as the processing normally accomplished under control of the Keyboard Monitor. That is, it could be an assembly, compilation, debugging run, production run, editing task, etc. BACKGROUND programs may use any facilities (for example, core, I/O and processing time) that are available and not simultaneously required by the FOREGROUND job. Under certain circumstances, I/O devices may be shared by both the FOREGROUND and the BACKGROUND jobs.

The Background/Foreground Monitor system is externally a keyboard-oriented system; that is, FOREGROUND and BACKGROUND requests for systems information, core, I/O devices, programs to be run, etc., are made via the Teletype keyboards. At run time, the Monitor internally controls scheduling and processing of I/O requests, while protecting the two resident users.

The Background/Foreground Monitor performs the following functions as it controls the time-shared use of the PDP-9 central processor by two co-resident programs:

a. Schedules processing time.
b. Protects the FOREGROUND job's core and I/O devices.
c. Provides for the sharing of multi-unit device handlers, such as DECtape, by both FOREGROUND and BACKGROUND jobs.
d. Allows convenient use of API software levels by FOREGROUND jobs.

e. Provides for convenient and shared use of the system Real Time Clock.

f. Allows communication between the BACKGROUND and FOREGROUND jobs via core-to-core transfers or by the shared use of bulk storage devices.

1.2.1 Scheduling of Processing Time

At run time, the FOREGROUND job retains control except when it is I/O bound; that is, when completion of an I/O request must occur before it can proceed any further. In the following example, if the .WAIT is reached before the input requested by the .READ has been completed, control is transferred to a lower priority FOREGROUND segment or to the BACKGROUND job until the input for the FOREGROUND job is completed.

```
.READ 3, 0, LNBUF, 48              /READ TO .DAT SLOT 3
     .
     .
     .
     .
.WAIT 3                            /WAIT ON .DAT SLOT 3
```

Since multi-unit device handlers can be shared by FOREGROUND and BACKGROUND programs, there is a mechanism by which a FOREGROUND I/O request will cause a BACKGROUND I/O operation to be stopped immediately so that the FOREGROUND operation can be honored. On completion of the FOREGROUND I/O, the BACKGROUND I/O is resumed with no adverse effects on the BACKGROUND job.

The FOREGROUND program can also indicate that it is I/O bound by means of the .IDLE or .IDLEC command (Section 6.3 - 6.4).

This is useful when the FOREGROUND job is waiting for real-time input from any one of a number of input devices. Consider the following example (see Section 6.1 for description of real time read .REALR command).

```
.REALR 1, 0,LNBUF1, 32, CTRL1, N1      /REAL
.REALR 2, 2,LNBUF2, 42, CTRL2, N2      /TIME
.REALR 3, 3, LNBUF3, 36, CTRL3, N3     /READS
    .
    .
    .
    .
.IDLE
```

If .IDLE is reached before any of the input requests have been satisfied, control is transferred to a lower priority FOREGROUND segment or to the BACKGROUND job. The lower priority job retains control until one of the FOREGROUND input requests is satisfied. Control is then returned to the FOREGROUND job by executing the subroutine at the specified completion address (CTRL1, CTRL2, CTRL3) and at the priority level specified by N1, N2, N3 which may be:

Value of N		Level
0	=	Mainstream (lowest level)
4	=	Current level (level of .REALR)
5	=	Software level 5
6	=	Software level 6
7	=	Software level 7

NOTE

If real-time reads (.REALR), real-time writes (.REALW), or interval timer (.TIMER) requests are employed in the BACKGROUND, N may be set to 0, 4, 5, 6, or 7, but is converted to 0 since the BACKGROUND job can run only on the mainstream level. This allows the value of N to be preset in cases where a BACKGROUND program is to be subsequently run in the FOREGROUND.

1.2.2 Protection of FOREGROUND Core and I/O

The FOREGROUND job's core is protected by the Memory Protection Option (Type KX09A). The BACKGROUND job runs with memory protect enabled; the FOREGROUND job runs with memory protect disabled.

Protection of the FOREGROUND job's I/O devices is accomplished via the hardware by the memory protect option, which prohibits IOT and Halt instructions in the BACKGROUND area; and the software since the Monitor and IOPS screen all I/O requests made via I/O Macros. Also, the Monitor and the BACKGROUND Loaders prevent the BACKGROUND job from requesting I/O which would conflict with that of the FOREGROUND job (for example they would not honor a BACKGROUND request for a paper tape handler being used by the FOREGROUND job).

1.2.3 Sharing of Multi-Unit Device Handlers

The Background/Foreground Monitor allows sharing of multi-unit, mass-storage device handlers (such as, DECtape, Magnetic Tape, and Disk between BACKGROUND and FOREGROUND jobs). Using these

multi-unit handlers, n files can be open simultaneously, where n equals the number of .DAT slots associated with the particular bulk storage device. Some multi-unit handlers require external data buffers (assigned at load time), one for each open file. These buffers are acquired from and released to a pool by the handler as needed.

When this count is not accurate (because of the .DAT slots not being used simultaneously), the keyboard command FILES (Section 2.5.2) can be used to specify the actual number of files simultaneously open. Both the FOREGROUND and BACKGROUND jobs can indicate their file requirements by means of the FILES keyboard command.

The multi-unit handlers are capable of stacking one BACKGROUND I/O request. This provision is made to simulate exactly program operation as it would occur under Keyboard or I/O Monitor (i.e., single user) control. Thus, control is returned to the BACKGROUND job to allow non-I/O related processing when the handler is preoccupied with an I/O request from the FOREGROUND job. For example, if the FOREGROUND job has requested DECtape I/O with a .READ, and is waiting for its completion on a .WAIT, control is returned to the BACKGROUND job. If the BACKGROUND job then requests DECtape I/O with a .READ, the handler will stack the request and return control to the BACKGROUND job following the .READ. The BACKGROUND job can then continue with non-I/O related processing as though the .READ were being honored.

1.2.4. Use of Software Priority Levels

In hardware configurations which include the Automatic Priority Interrupt (API) option, the Background/Foreground Monitor allows convenient use of software priority levels of the API by the FOREGROUND job. The BACKGROUND job is permitted to use only the mainstream level.

1.2.5 Use of Real-Time Clock

The Background/Foreground Monitor provides for convenient and shared use of the system real-time clock. It will effectively handle many intervals at the same time; thus, the real-time clock can be used simultaneously by both BACKGROUND and FOREGROUND jobs.

1.2.6 Communication Between BACKGROUND and FOREGROUND Jobs

The Background/Foreground Monitor allows communication between BACKGROUND and FOREGROUND jobs via core-to-core transfers. This is accomplished by means of a special "Core I/O device" handler within IOPS. Complementing I/O requests are required for a core-to-core transfer to be effected; for example, a FOREGROUND .READ (.REALR) from core must be matched with a BACKGROUND .WRITE (.REALW) to core.

Two possible uses of this feature are:

a. The BACKGROUND job could be related to the FOREGROUND job, and as a result of its processing,

pass on information that would affect FOREGROUND processing, or vice-versa.

b. The BACKGROUND job could be a future FOREGROUND job, and the current FOREGROUND job, being its predecessor, could pass on real-time data to create a true test environment.

Communication between two jobs can also be done by storing and retrieving data on shared bulk storage devices.

1.3 HARDWARE REQUIREMENTS AND OPTIONS

The following hardware is required to operate the Background/Foreground Monitor System:

a. Basic PDP-9 with Teletype,

b. Memory Extension Control, Type KG09A,

c. Additional 8192-Word Core Memory Module, Type MM09A,

d. Memory Protection Option, Type KX09A,

e. External Teletype System, including at least*:

(1) One Teletype Control, Type LT09A or LT19A,

(2) One Teletype Line Unit, Type LT09B or LT19B,

(3) One Teletype, Model KSR33, KSR35 or equivalent**,

---

*The basic system Teletype is normally assigned to the BACKGROUND environment. One Teletype of the external Teletype system must be reserved for the FOREGROUND job; additional Teletypes may be assigned to either BACKGROUND or FOREGROUND functions. If the API option is available, a Type LT19A Teletype Control and a Type LT19B Line Unit are recommended.

**Model 37 Teletypes are not supported. Model 33 or 35ASR Teletypes are supported only to the extent that they operate as KSR's only; their paper tape input and output facility cannot be used. LT09's and LT19's may not both appear in the same configuration.

f. Bulk Storage System, comprising either:

(1) One DECtape Control, Type TC02, and two DECtape Transports, Type TU55 (three recommended), or

(2) One Disk System, Type RB09 (and one DECtape Control, Type TC02, and at least one DECtape Transport, Type TU55), or

(3) One Disk System, Type RF09/RS09 (and one DECtape Control, Type TC02, and at least one DECtape Transport, Type TU55)

The following options currently supported by software may be added to improve system performance (as noted):

Options	Effect
Additional 8192-Word Core Memory Modules, Type MM09B and MM09C (to a maximum of 32,768 words)	Increase the maximum size of both BACKGROUND and FOREGROUND programs that can be handled by the system.
Automatic Priority Interrupt, Type KF09A	Allows for quicker recognition of requests for service by I/O devices.
Extended Arithmetic Element, Type KE09A	Increases speed of arithmetic calculations.
Additional DECtape Transports, Type TU55, or IBM-compatible Magnetic Tape Transports, Type TU20 or TU20A and Tape Control Type TC59	Allows greater bulk storage capability, simultaneous use of storage media by more programs. Since only one file may be open at a time on IBM-compatible magnetic tape transports, more than two Type TU20 or TU20A transports may be desirable for some applications.

Automatic Line Printer, Type 647	Provides greater listing capabilities.
200 CPM Card Reader, Type CR03B[1]	Allows card input and control cards for BACKGROUND Batch processing.
Additional Teletype Line Units, Type LT09B, (or LT19B) and Teletypes, Type KSR33, KSR35 or equivalent** (up to a maximum of 16 LT09B or LT19B units, requiring four LT09A or LT19A controls).	Provides additional output devices if multiple FOREGROUND jobs may require simultaneous output or BACKGROUND jobs wish to use multiple devices.

---

1 The Type CR01E and Type CR02B Card Readers, although no longer sold by the Company, are supported by software in the BACKGROUND/FOREGROUND System.

Note: The 339 Programmed Buffered Display is supported by software.

SECTION 2

BFKM9 - NON-RESIDENT BACKGROUND/FOREGROUND MONITOR

2.1 INTRODUCTION

BFKM9 is the title of the non-resident portion of the Background/Foreground Monitor. It is identical in nature to the Keyboard listening section of the Keyboard Monitor, with which the reader is assumed to be familiar. BFKM9 reads and interprets commands typed by the user at a control teletype (there is one Background control teletype and one Foreground control teletype).

There are three kinds of commands which the user may type:

a. Requests for information, such as, a directory listing of unit Ø of the system device;

b. Allocation parameters, such as, core size, number of open files, and I/O devices to be used;

c. Load a system or user program.

2.2 LOCATION AND WHEN CALLED

BFKM9 is loaded from register 12000 of the highest core bank to the top of memory and is transparent to the user since it is always overlayed.

When the Background /Foreground system is loaded or re-loaded to start a new Foreground job, the Resident Monitor is first loaded into lower core from unit Ø of the system device, either by use of the paper tape bootstrap or by typing CTRL C at the Foreground control teletype. The Resident Monitor then brings the Non-resident Monitor into the top of memory. When

operating in the Foreground, BFKM9 runs with memory protect disabled.

After the Foreground user program has been loaded and has started to run, the Non-resident Monitor is re-loaded, with memory protect enabled, to converse with the user at the Background control teletype. BFKM9 is also re-loaded whenever the Background job exits or the user types CTRL C at the Background control teletype.

In both the Foreground and Background, after the user has given a command to load a program, the Non-resident Monitor brings the System Loader into memory from the system device, overlaying the Non-resident Monitor.

2.3 INITIAL OPERATION

When BFKM9 is started for the Foreground job, it must perform some initialization of which the following is of interest:

a. Set the contents of .SCOM+25 to 2. This sets the initial size of free core to be allotted to the Foreground job, in addition to the space required by the Foreground user programs. The user may assign more free core by issuing the FCORE command, described in section 2.5.3.

b. BFKM9 checks the entire Foreground Device Assignment Table (.DATF) to see if any of those .DAT slots request the teletype handler and the unit number currently assigned to the Background control teletype. If so, those slots are changed to the Foreground control teletype and a message is output as in the following example.

EXAMPLE 1: The Foreground control teletype is TT1, the Background control teletype is TTØ, and the initial contents of .DATF slots 1 and 3 refer to TTAØ. .DATF slots 1 and 3 will be changed to refer to TTA1 and the following message will be printed on the Foreground control teletype:

```
FGD .DATS CHANGED TO TTA1:

 1  3

FKM9 V1A
$
```

The Non-resident Monitor identifies itself to the Foreground user by printing FKM9 V1A and types $ whenever it is ready to accept a command.

When BFKM9 is started for the Background job, it performs initialization of which the following is of interest:

a. It builds the initial configuration of the Background .DAT table (.DATB). Any .DATB slots which request a single user version of a device handler (for example, DTB or DTC) will be changed to the multi-unit handler (DTA in this case) if it is already in core for the Foreground job or if it is the resident system device handler.

b. BFKM9 will check all Background .DAT slots to make certain that they do not conflict with Foreground I/O. The Resident Monitor contains, for this purpose, a table (.IOIN) which lists all I/O handlers and unit numbers in use. The following occurs:

   (1) If a handler for this I/O device is not already in core, the Background .DAT slot is left untouched.

   (2) If a single user handler for this device is already in core for use by the Foreground job, by definition the Background job may not use this device. Therefore

the Background .DAT slot is cleared (set to zero).

(3) If the multi-unit handler for this device is in core, but the device unit number in question is not assigned to the Foreground job, Background is allowed to share that handler. Unit Ø of the system device may always be used by the Background job.

(4) If the Background .DAT slot requests a multi-unit handler and unit number already assigned to the Foreground, normally this is illegal and that .DAT slot will be cleared. However, some users may wish to allow both jobs to access the same unit. This is permitted only for bulk storage devices (DECtape, Disk, etc.) provided that the Foreground user typed the command SHARE, explained in section 2.5.7.

If the initial Background .DAT table was altered by clearing .DAT slots for the reasons given above, a message will be output to the Teletype as in the following example.

EXAMPLE 2: The Foreground job is running and has been assigned device handlers and unit numbers DTA1, DTA2, TTA1, TTA2, and LPA (line printer handler - not shareable). The initial Background .DAT table contains conflicting requests as follows:

.DAT SLOT	CONTENTS
-15	DTA1
-12	LPAØ
-4	DTA2
3	TTA2

The following will be printed on the Background control teletype when BFKM9 is first loaded:

```
BGD .DATS CLEARED BECAUSE OF FGD I/O:

 -15 -12 -4 3

FCONTROL  = TTA1
```

```
FGD DEV-UNITS:

 TTA2
 DTA1
 DTA2

BKM9 V1A
$
```

FCONTROL indicates which unit is the Foreground control teletype. The remainder of the message indicates what I/O is being used by the Foreground job. The Monitor identifies itself to the Background job user as BKM9 V1A and signals that it is ready to accept a command by printing $.

2.4 INFORMATION COMMANDS

The following information commands exist in Background/Foreground:

COMMAND	USE
LOG	To print a comment
REQUEST	To examine .DAT slots
DIRECT	To obtain a directory listing
INUSE	To list information about core and I/O in use by the Foreground.

2.4.1 The LOG Command (L)

This command is legal in both Foreground and Background and may be abbreviated by the single letter L. It is used to record comments on the Teletype. Unlike all other commands, LOG is terminated only by the character ALTMODE, so that multiple comment lines may be typed.

EXAMPLE 3:

```
$ LOG     THIS LINE)
    AS WELL AS THIS ONE)
    AND THIS ONE ARE IGNORED (ALTMODE)
$
```

2.4.2 The REQUEST Command (R)

This command is legal in both Foreground and Background and may be abbreviated by the single letter R. It is used to examine the contents of all or part of the user's .DAT table. The Foreground user may examine only the Foreground .DAT table and the Background user only the Background .DAT table.

FORM 1: R)

This requests a printout of the entire .DAT table. No example is given since R is essentially the same request as in the Keyboard Monitor System.

FORM 2: R␣USER)

This requests a printout of the contents of all the positive numbered .DAT slots. The result, again, is the same as in the Keyboard Monitor System.

FORM 3: R␣XYZ)

Here, XYZ stands for the name of a system program; e.g., MACRO, PIP, F4, LOAD, etc. The names given must be identical to those used to load the programs. The information printed, as in the Keyboard Monitor System, is those .DAT slots used by the given system program. Since, at present, the only system program load commands allowed in the Foreground are LOAD, GLOAD, PIP and EXECUTE, only these four may be used in Foreground REQUEST commands.

FORM 4: R␣.DAT␣j, k, l, ... , r, s)

Here, j, k, l, etc., are .DAT slot numbers.

EXAMPLE 4:

```
$R␣.DAT␣-3, -1, 4, 7)
TTA1 DTA2 NONE LPAØ
$
```

2.4.3 The DIRECT Command (D)

This command is legal in both Foreground and Background and may be abbreviated as D. The format is:

D␣n)

where n = a unit number (Ø through 7) on the system device. Directory listings have been altered in BFKM9 to print the number of free blocks before the file names. The background user may not request directory listings of any units owned by the Foreground job unless the Foreground user typed the SHARE command (see below).

2.4.4 The INUSE Command (I)

This command is legal only in the Background and may be abbreviated by the single letter I. It causes the Monitor to print the first free core location above the Foreground job, the Foreground control teletype unit number and any other I/O used by Foreground.

EXAMPLE 5:

```
$ I)
1ST REG ABOVE FGD = 323Ø1
FCONTROL = TTA2
FGD DEV-UNITS:
     DTA1
     LPAØ
$
```

2.5 ALLOCATION COMMANDS

The following commands assign parameters, control and conditions:

COMMAND	PURPOSE
ASSIGN	To assign I/O handlers to .DAT slots
FILES	To specify handler file capacity
FCORE	To set up Foreground free core
FCONTROL	To select Foreground control teletype
BCONTROL	To select Background control teletype
NEWDIR	To write a new file directory
SHARE	To allow jobs to share same I/O units
NOSHAPE	To nullify effect of SHARE
7CHAN	To specify 7-channel MAGtape operation
9CHAN	To specify 9-channel MAGtape operation
VC38	To load the VC38 character table
MPOFF	To let Background access all of core
MPON	To nullify effect of MPOFF

2.5.1 The ASSIGN Command (A)

This command is legal in both Foreground and Background and may be abbreviated by the single letter A. Its format and function are, with a few exceptions, identical to the same command in the Keyboard Monitor System.

The format is: A␣DDLN␣m, n, ..., p/ .../DDLN␣m, n, ..., p)
where DD stands for the two letter device name; e.g., DT for DECtape, LP for line printer, etc.

L is the third letter of a device handler name and is optional. If not given, the letter A is assumed; e.g., DT1 = DTA1. The "A" version of a handler is the multi-unit, shareable handler, provided that one exists. LPA, for example, is not a multi-unit handler.

N is the unit number to go with the device handler and is also optional. If missing, N is assumed to be Ø, e.g., DTA = DTAØ. Therefore, DT = DTØ = DTA = DTAØ. The letters m, n, ..., p stand for .DAT slot numbers. The slash (/) separates handlers.

To clear out a .DAT slot, assign NONE to it. If any error is detected in the command, none of the assignments will be made.

The Foreground and Background users may make assignments only to their respective .DAT tables. Foreground may not assign TTAØ if, for example, that is the Background control teletype. Since DTA is permanently in core with the Resident Monitor (assuming that DECtape is the system device) DTB, DTC, etc., when assigned, will automatically be changed to DTA. This applies as well to handler assignments made in the Background whenever the multi-unit version of the handler is in core for Foreground use.

Background .DAT slot assignments are tested to insure that they do not conflict with Foreground I/O, as explained in section 2.3. Whenever the Monitor detects such a conflict, it will print the message:

OTHER JOB's DEV-UNIT

To insure that no conflict can occur when assigning the core-to-core handler, COA., the unit number, independent of what the user typed, is set to Ø for Foreground and 1 for Background. The core-to-core handler disregards the unit number.

2.5.2 The FILES Command (F)

This command is legal in both Foreground and Background and may be abbreviated as F. The purpose of this command is to save core space by limiting the number of I/O buffers assigned to multi-unit device handlers.

The format of the FILES command is:

FILES␣DD␣N)

where DD stands for the multi-unit handler or device name (e.g., DTA or DT) and N for an octal file count.

EXAMPLE 6: Assume that the Foreground user programs are being loaded into core by the Foreground Linking Loader and that these programs use .DAT slots 1 through 1Ø. (.IODEV 1, 2, 3, ..., 1Ø). Further, assume that all 1Ø slots were assigned to DECtape, DTAn (the unit numbers are unimportant to this discussion).

Most multi-unit handlers, DTA being one of them, require that I/O buffers be assigned to them externally. This is done by the various loaders. In this example, the Foreground Linking Loader, seeing that no FILES command was given for the handler DTA, must assume that the user wants 1Ø files open simultaneously. This will require 1Ø buffers, each 6ØØ octal words in size.

The FILES command is used to tell the loaders to assign a given number of buffers for a particular multi-unit handler based on the maximum number of files that the user programs will have open simultaneously. Each multi-unit handler has a maximum open file capacity; for example, DTA may have up to 2Ø octal. If 1Ø I/O buffers are assigned for DTA in the Foreground, then only up to 1Ø may be assigned for Background. The FILES command issued in the Foreground specifies only Foreground I/O buffers. Thus, to limit the number of I/O buffers assigned to the Background, the FILES command, for the same multi-unit device, must also be issued in the Background.

At load-time, I/O buffers are set aside in core by the Loaders. The buffers are recorded in a table within the Resident Monitor, .BFTAB, but are not flagged for the exclusive use of particular device handlers. At run-time, each multi-unit handler which needs a buffer must request a buffer from the Monitor. The handler must also release the buffer to the pool when it is no longer needed.

The resident buffer, permanently assembled into the Resident Monitor, is always available to the Background job. This buffer is assumed to be as large as the largest I/O device buffer (6ØØ octal words). In the event that the Background job were to .IODEV only one .DAT slot which is linked to a multi-unit handler

that requires external buffers, (DTA. for example) the user could save 6ØØ registers by typing: $FILES␣DT␣Ø. That is, assign one less buffer than is needed.

In the FILES command, the pseudo-device .. is recognized. The size of the external buffer for this pseudo-device is 1ØØ octal. Some functions in multi-unit handlers may require a smaller buffer size than others. If the user were only to use the former function type, he could type, for example, $FILES␣DT␣Ø and $FILES .. n. In DTA., .TRAN and .MTAPE commands only require the smaller buffer.

2.5.3 The FCORE Command

This command is legal only in the Foreground and may not be abbreviated.

The format of the FCORE command is:

FCORE␣N)

where N is the amount (in octal) of free core requested for the Foreground job.

As in the Keyboard Monitor System, unused (free) core is defined by the address pointers in the registers .SCOM+2 and .SCOM+3, the lowest and the highest free core location, respectively. Since both the Foreground and the Background jobs have their own separate free core areas, the values in .SCOM+2 and .SCOM+3 are changed appropriately whenever control passes from one job to the other.

The FCORE command allows the Foreground user to specify how much free core his program will need, in addition to that required to load his program. It is possible for all of core to be assigned to Foreground. This means, however, that there will be nc room for Background to run, which is perfectly legal. If this is the case, the message:

SORRY, NO ROOM FOR BGD

is printed on the control teletype:

2.5.4 The FCONTROL Command

This command is legal only in the Foreground and may not be abbreviated. It is used to transfer the control teletype to some other teletype unit.

The format of the FCONTROL command is:

FCONTROL␣N)

where N is the number (octal) of any teletype on the system.

If N is already the Foreground control teletype, the command is ignored. If N is the current Background control teletype, the two teletypes are swapped but no message will be printed to this effect. Changing the Background control teletype may affect Foreground .DAT slots and an appropriate message will be printed on the Foreground control teletype. This is fully explained in the next section on the BCONTROL command.

When FCONTROL changes the Foreground control teletype, the following action takes place:

a. The following message is printed on the old control unit:

```
CONTROL RELINQUISHED
ABORT
```

b. The system is reloaded from the system device.

c. The Monitor prints

```
FKM9 V1A
$
```

on the new Foreground control unit and is ready to accept commands there.

2.5.5 The BCONTROL Command

This command is legal both in the Foreground and in the Background and may not be abbreviated. It is used to transfer the Background control teletype to some other teletype unit.

The format of the BCONTROL command is:

```
BCONTROL␣N)
```

where N is the number (octal) of any teletype on the system. This command is illegal and is ignored if unit N belongs to the Foreground job. Even though unit N may have been assigned to a Foreground .DAT slot, it does not belong to the Foreground job unless it happens to be the Foreground control teletype or unless the Foreground user programs contained an .IODEV to that .DAT slot. This command is also ignored if unit N is already the Background control teletype.

If BCONTROL is issued in the Foreground or if the Background control teletype is changed because of an FCONTROL command, all Foreground .DAT slots which now refer to the new Background control unit will be changed to the Foreground control unit to avoid I/O conflict. Should that situation occur, the following example shows what would be printed on the Foreground control unit:

```
FGD .DATS CHANGED TO TTA1
 -6 2 7 1Ø
```

If BCONTROL is issued in the Background, the following action takes place:

a. The following message is printed on the old control unit:

   CONTROL RELINQUISHED

b. ↑C is printed on the new unit,

c. The Non-resident Monitor (BFKM9) is reloaded for Background from the system device

d. The Monitor prints

   ```
   BKM9 V1A
   $
   ```

   on the new Background control teletype and is ready to accept commands there.

2.5.6 The NEWDIR Command (N)

This command is legal in both Foreground and Background and may be abbreviated by the single letter N. Just as in the Keyboard

Monitor System, this command allows the user to write a new file directory on some unit of the system device. However, space will not be reserved for a ↑Q (CTRL Q) area.

The format of the NEWDIR command is:

N␣M)

where M is some unit number (octal) on the system device. Unit Ø may not be used. The Background may not write a new file directory on a unit that belongs to the Foreground unless the Foreground has issued the SHARE command (see below).

2.5.7 The SHARE Command (S)

This command is legal only in the Foreground and may be abbreviated by the single letter S. Its purpose is to allow the Background job to assign and to use the same units of any I/O devices that belong to the Foreground job, provided that they are bulk storage devices (DECtape, Disk, Magtape, etc.) and that the device handlers are the multi-unit versions. The user must be careful when allowing this condition to occur. The "tape" could be fouled if both jobs were to try to use the same unit for output at the same time.

The SHARE command also removes the restriction that the Foreground user program may not use unit Ø on the system device. Normally, this unit is reserved for the Background.

The format for this command is:

SHARE)

2.5.8 The NOSHARE Command

This command is legal both in Foreground and in Background and may not be abbreviated. It nullifies the effect of any previous SHARE command; i.e., does not allow the Background to share device units with the Foreground.

When NOSHARE is issued in the Background it may cause some Background .DAT slots to be cleared. A message, as in Example 2, will be printed to that effect.

The command format is: NOSHARE)

2.5.9 The 7CHAN Command (7)

This command is legal only in the Foreground and may be abbreviated by the single character 7. The effect of this command is to clear bit 6 in .SCOM+4 to inform the Magtape device handlers that the default assumption is 7-channel operation.

The format of the 7CHAN command is:

7CHAN)

2.5.10 The 9CHAN Command (9)

This command is legal only in the Foreground and may be abbreviated by the single character 9. It sets bit 6 in .SCOM+4 to inform the Magtape device handlers that the default assumption is 9-channel operation.

The format of the 9CHAN command is:

```
9CHAN)
```

2.5.11 The VC38 Command (V)

This command is legal in both Foreground and Background and may be abbreviated by the single letter V. No action is taken until a command has been given to load a program. At that time, if the VC38 command was given, the Non-resident Monitor will seek and load the file VC38TB DMP from unit Ø of the system device. The VC38 character table is used in conjunction with the 339 display handler, DYA., when the system does not have a VC38 hardware character generator.

The table is loaded into core such that its base address is a multiple of 1ØØØ octal. The base address is stored as the first word in the 339 Pushdown List. The address of the Pushdown List is in .SCOM+12.

The VC38 command given in the Background will be accepted but ignored if the 339 display handler is assigned to the Foreground.

The format of the VC38 command is:

```
VC38)
```

2.5.12 The MPOFF Command

This command is legal only in the Foreground and may not be abbreviated.

Format:

```
MPOFF )
```

Normally, Background may not modify nor transfer to registers within the Resident Monitor and the Foreground job; it also cannot issue IOT's. The MPOFF command signals the Resident Monitor to set the hardware protect bound to zero and also allows Background IOT's to be issued.

2.5.13 The MPON Command (M)

This command is legal in both Foreground and Background and may be abbreviated by the letter M.

Format:

```
MPON )
```

The MPON command nullifies the effect of MPOFF, thereby protecting the Foreground job from the Background job in the normal manner.

2.6 PROGRAM LOAD COMMANDS

In the Foregound, only four load commands are legal: LOAD), GLOAD), PIP) and EXECUTE ␣ XXX). EXECUTE may be abbreviated by the single letter E. LOAD and GLOAD have the same meaning and effect as in the Keyboard Monitor System.

The following program load commands exist in the Background:

PATCH)
CHAIN)
F4)
F4A)
EDIT)
PIP)
EXECUTE␣XXX)

LOAD)
GLOAD)
DDT)
DDTNS)
SGEN)
DUMP)
UPDATE)
CONV)

2.7 FINAL OPERATION

After BFKM9 has received a program load command from either the Foreground or Background, it will bring the System Loader (.SYSLD) into the top of core overlaying BFKM9. In the Foreground, .SYSLD is actually the Foreground Linking Loader. In the Background, .SYSLD loads Background System Programs, including the Background Linking Loader.

2.8 CONTROL CHARACTERS

While control is in BFKM9, the user may type CTRL P to terminate execution of the current command and to restart. Restart in this manner does not nullify the effect of

previously executed commands; e.g., will not reset the .DAT table to its initial configuration. To reload the Monitor for the current job, the user may type CTRL C.

2.9 SUMMARY OF COMMANDS

LEGAL IN	ABBREVIATION	COMMAND EXAMPLE
F B	A	ASSIGN␣DTA1␣2, 3/TT1␣1, 4/DT␣-4)
F B		BCONTROL␣2)
F B	D	DIRECT␣Ø)
F		FCONTROL␣1)
F		FCORE␣14ØØ)
F B	F	FILES␣DT␣3)
B	I	INUSE)
F B	L	LOG␣..... (ALTMODE)
F B	N	NEWDIR␣5)
F B		NOSHARE)
F B	R	REQUEST␣XXX) or REQUEST␣USER)or REQUEST␣.DAT j,k,l) or REQUEST)
F	S	SHARE)
F	7	7CHAN)
F	9	9CHAN)
F		MPOFF)
F B	M	MPON)
F B	V	VC38)
B		CHAIN)
B		CONV)
B		DDT)
B		DDTNS)
B		DUMP)
B		EDIT)
F B	E	EXECUTE␣XXX)
B		F4)
B		F4A)
F B		GLOAD)
F B		LOAD)
B		MACRO)
B		MACROA)
B		PATCH)
F B		PIP)
B		SGEN)
B		UPDATE)

SECTION 3

CONTROL CHARACTERS

3.1 PURPOSE

Control characters are single characters typed by the user at a teletype which request special action by the Monitor. Except for the character RUBOUT, all control characters are formed by holding down the control key CTRL while striking the appropriate letter key.

The characters CTRL U and RUBOUT are used as "erase" characters during teletype input or output. CTRL C, CTRL P, CTRL S, and CTRL T are used to interrrupt the operation of the current program and to transfer control elsewhere. CTRL R is used to restart I/O after a not-ready condition has been detected for some device. CTRL Q stops the current job and dumps memory onto a specified area of some unit of the system device. CTRL D effects an end-of-file condition during teletype input.

3.2 CONTROL TELETYPE

In the Background/Foreground System, which may accommodate up to 17 (decimal) teletype units, two teletypes are designated as control teletypes (one for Background and one for Foreground). Initially, it is assumed that unit Ø (the console teletype) is the control teletype for Background and unit 1 is the control unit for Foreground.

Control teletypes differ from the other units in two ways:

a. They are used to converse with the Non-resident Monitor and system programs in order to set up parameters and conditions for a job and to initiate the loading and execution of programs.

b. Certain control characters are recognized only at control teletypes; i.e., are ignored if they are typed on the other teletype units (see section 3.4 and following).

3.3 TELETYPE HANDLER

The multi-unit teletype handler (TTA) which is imbedded in the Resident Monitor, makes special tests for control characters when it receives typed input. Normally, when no .READ request has been issued to a teletype, characters received from that unit are ignored unless they are control characters. A description of the action taken in each case is given in the following paragraphs.

3.4 CTRL C (↑C)

This character is ignored unless typed at a control teletype. It will be echoed to the teleprinter as ↑C.

If CTRL C is typed at the Background control teletype, the Background job will be aborted and the Non-resident Monitor will be loaded to start a new Background job. Foreground is not affected.

CTRL C typed at the Foreground control teletype aborts both the Foreground and the Background jobs. In this case, the entire

system is restarted; that is, the Resident Monitor and the Non-resident Monitor are reloaded to start a new Foreground job and the message ABORT is printed on the Background control teletype.

3.5 CTRL S (↑S)

CTRL S is recognized only at a control teletype and, specifically, only after the Monitor has printed ↑S. This is the result of loading a user program by giving the command $LOAD (instead of $GLOAD) to the Non-resident Monitor. Both commands bring in the Linking Loader to load user programs. $GLOAD means LOAD-AND-GO. $LOAD means load the user programs, signal the user that this has been done (by printing ↑S), and then wait for the go-ahead signal (when the user types CTRL S).

This feature allows the user to set up I/O devices before starting his program. When CTRL S is typed by the user and is accepted by the Monitor, ↑S is echoed back to the teleprinter.

3.6 CTRL T (↑T)

This character is recognized only at the Background control teletype when the user has called in the system program DDT. When CTRL T is typed and accepted, it is echoed to the teleprinter as ↑T.

CTRL T provides a means of interrupting the execution of a user program and transferring control to DDT. When CTRL T is typed, the Monitor saves the status of the Link, extend memory,

and memory protect along with the interrupted PC in .SCOM+7 so that DDT will be able to return control to the user program at the point at which it was interrupted. The contents of the AC at the time of interruption is returned in the AC and saved by DDT.

3.7 CTRL P (↑P)

CTRL P is the interrupt and restart character available to user and system programs. When it is typed on some teletype and is accepted by the Monitor, ↑P is echoed to the teleprinter on that unit.

In the Background/Foreground system there are two types of CTRL P functions:

1) NORMAL CTRL P and
2) REAL TIME CTRL P.

The two CTRL P functions are described, individually, in paragraphs 3.7.1 and 3.7.3.

Setting a CTRL P restart address (ADDR) is accomplished by issuing the I/O MACRO .INIT to any .DAT slot linked to the Teletype handler.

The format of the .INIT macro is:

```
.INIT A,M,P+ADDR
```

which is expanded by the MACRO assembler into the following machine code:

```
LOC       CAL M8+A9_17
LOC+1     1
LOC+2     P+ADDR9_17
LOC+3     Ø
```

where A = a .DAT slot number (octal radix)

M = transfer mode
- Ø = Input
- 1 = Output

ADDR = a 15-bit address (octal) of a restart point in the program or of the entry point of a closed real-time subroutine.

P = priority code
- Ø = Normal CTRL P
- 1ØØØØØ = Mainstream (REAL-TIME)
- 2ØØØØØ
- 3ØØØØØ = No change to CTRL P
- 4ØØØØØ = Priority level of the .INIT
- 5ØØØØØ = API level 5
- 6ØØØØØ = API level 6
- 7ØØØØØ = API level 7

Background requests to an API level (4ØØØØØ - 7ØØØØØ) will be converted to Mainstream since Background programs cannot use the API software levels.

3.7.1 NORMAL CTRL P

A .INIT to set up a NORMAL CTRL P (priority code Ø) may be done only to a control teletype. NORMAL CTRL P was so named because the action taken when the user types CTRL P is nearly the same as in the Keyboard Monitor System.

When a control teletype has been set up for a NORMAL CTRL P and that character is typed by the user, the teletype handler

will abort all Teletype I/O for that job (Background or Foreground). The Monitor will, when control is at Mainstream, save the status of the Link, extend memory, and memory protect with the interrupted PC in .SCOM+10 (whose contents are swapped in and out for Background and Foreground), return the interrupted AC to the AC, and transfer control to the restart address ADDR as specified by the last .INIT.

Note: When the Monitor processes a CTRL T or a NORMAL CTRL P, it kills any pending mainstream real-time routines to be run by zeroing the contents of .SCOM+57 (Foreground) or .SCOM+61 (Background). The user's program (if NORMAL CTRL P) or the user (if CTRL T) must zero the entry points of all his mainstream real-time routines. CTRL P and CTRL T do not affect API level real-time requests.

If the restart address ADDR = Ø, CTRL P to the given teletype will be disabled; i.e., ignored if typed (except if P = 3ØØØØØ).

3.7.2 No Change

If .INIT for a given teletype unit contains the priority code 3ØØØØØ, the restart address is ignored and the status of CTRL P to that unit is not changed.

3.7.3 REAL-TIME CTRL P

A .INIT to set up a REAL-TIME CTRL P may be done to any teletype unit. When so set up and the user types CTRL P, I/O to that teletype is aborted. Control eventually goes to a closed real-time subroutine, ADDR, at the priority level defined by P,

in the same manner as for a .REALR, .REALW or .TIMER request.

If the restart address ADDR = Ø, CTRL P to the given teletype will be disabled; i.e., ignored if typed.

REAL-TIME CTRL P is useful for multi-user programs, for instance, multi-user FOCAL, where each teletype has the ability to interrupt and restart.

3.8 CTRL R (↑R)

In the Background/Foreground system, I/O device handlers which detect a not-ready condition will request the Monitor to print a message on the appropriate control teletype. The line printer handler message, for instance, would be:

LPØ NOT READY

The unit number has no significance for the line printer. Some single-unit handlers, such as the card reader handler, use the unit number designation to indicate the cause of the not-ready condition. After the message has been printed, the user should ready the device and then type CTRL R, which is echoed as ↑R. I/O for that device is then resumed.

While the Monitor is waiting for the user to type CTRL R, the user's program continues execution provided that it is not hung up waiting for completion of I/O from the not-ready device. The Monitor can handle one not-ready condition per job. Should a second not-ready request occur while another is being processed,

job execution will be aborted with a .ERR ØØ4 terminal error.

3.9 CTRL Q (↑Q)

CTRL Q may be typed at any time, but it is ignored if it is not issued at a control teletype.

The purpose of typing CTRL Q is to stop program execution and to dump all of core memory onto a specified area of some unit on the system device. The dump starts with block 1Ø1 octal on the given unit and overlays any data that may have existed in that area on the output device. A 16K system will dump 1ØØ octal blocks (1Ø1-2ØØ); a 24K system, 14Ø octal blocks (1Ø1 - 24Ø); a 32K system, 2ØØ octal blocks (1Ø1-3ØØ).

To insure that CTRL Q will not overlay useful data, the user must employ the system program PIP to write a new file directory on that unit, using the (S) switch to reserve space for CTRL Q. For example:

```
>N␣XXu␣(S)
```

where XX is the device name and u the unit number. Note that the size of the CTRL Q area reserved is based on the amount of core existing in the system in which the new directory is written. The area reserved on a DECtape in a 16K system is not sufficient to do a protected CTRL Q in a 24K or 32K system.

When the Monitor accepts CTRL Q, it first terminates execution of the job (Foreground if Foreground CTRL Q, Background if Background CTRL Q). This involves calling all device handlers tied to that job to stop I/O, clearing all Monitor queues of entries for that job and disabling all control characters for that job except CTRL C.

The Monitor then prints ↑Q on the appropriate control teletype and reads one character. The user must then type the number of the unit on which the dump is to occur. Unit zero may not be used. If the SHARE command is not in effect, a dump may not be done to a unit which belongs to the other job. If the Monitor rejects the typed character, it prints ↑Q again and waits for another character.

When the unit number is accepted, the dump takes place; then the Monitor is automatically reloaded. A Background CTRL Q does not affect Foreground. A Foreground CTRL Q, on the other hand, aborts the Background job. It is not possible to load and restart a core dump in Background/Foreground.

3.1Ø CTRL U (@)

CTRL U may be typed at any teletype unit. If a .READ or .REALR was issued to some teletype and the user decides he wants to "erase" everything he has typed for that read request, he may type CTRL U, which will be echoed to the teleprinter as @.

The .READ or .REALR will still be in effect and he may then retype the input.

While output to a teletype is being done as a result of a .WRITE or .REALW, the user may type CTRL U to terminate the write. In this case nothing is echoed to the teleprinter.

3.11 RUBOUT

This character is recognized only while the user is typing input to satisfy a .READ or .REALR request. When typed, RUBOUT deletes the last input character. For example, if the user has typed ABC and then RUBOUT, the C will be "erased". If he now types another RUBOUT, the B will be "erased". Every time a character is so removed, the character is echoed to the teleprinter.

3.12 CTRL D (↑D)

The character CTRL D is recognized at all teletypes and is echoed back as ↑D. When typing input, CTRL D effects an end-of-file condition by terminating the .READ or .REALR request and storing the end-of-file, ØØ1ØØ5, in the input line buffer header. Since the word pair count returned is a 1, any characters typed prior to the CTRL D for the same read request will be lost.

SECTION 4

LOADERS

4.1 INTRODUCTION

There are three program Loaders in the Background/Foreground system. On the system file directory they are listed as .SYSLD SYS, BFLOAD BIN and EXECUT BIN.

.SYSLD is an absolute system program that functions as two loaders: when it is called in for Foreground loading, it is the Foreground Linking Loader; when it is called in for Background loading, it is the Background System Program Loader. BFLOAD is the Background Linking Loader.

EXECUTE operates in both Foreground and Background as a loader of overlay programs (XCT files) built by the CHAIN system program. A description of CHAIN and EXECUTE is given in the utility manual.

4.2 FOREGROUND LINKING LOADER

Link loading of the Foreground job is initiated by typing GLOAD (Load-and-Go) or LOAD (Load-and-Pause) to the Monitor at the Foreground control teletype. The Foreground Link Loader (.SYSLD) is then brought into the top of memory, overlaying the Non-resident Monitor. The following message will then be printed:

```
FGLOAD V1A
>
```

The > signals the user that he may now type in his command string.

The command string format is nearly the same as for the Linking Loader in the Keyboard Monitor System. The only

change is the addition of memory map options, which must precede the list of user program names. The format is as follows:

```
>options←mainprog, others,... ALTMODE
```

4.2.1 Option Characters And Their Meanings

Character	Meaning
P	Print program names and their assigned relocation factors
C	Print common block names and their assigned locations
G	Print global symbol names and their definitions

4.2.2 Use of ← Terminator

Prior to the terminator ← all characters except option characters are ignored. Carriage return preceding the ← starts a continuation line headed by >. ALTMODE preceding the ← restarts the Loader; therefore, no loading is done unless the character ← appears in the command string.

If no option characters precede the ←, the default assumption is that no memory map is to be printed.

After the ←, type the program names (main program first - no extensions) separated by comma or carriage return. Terminate the command string with ALTMODE. Before the terminating ALTMODE has been typed, the Loader may be restarted by typing CTRL P.

4.2.3 Sequence of Operation

Once the command string has been accepted, the Loader will perform the following sequence of operations:

a. Load all user programs, specified in the command string, from .DATF -4. These programs are loaded from the bottom of core up, starting at the top of the Resident Monitor. Calls to external library routines via .GLOBL, common block definitions, and .IODEV requests are saved in the Loader's symbol table, built from the bottom of the Loader down. Programs containing executable code (which excludes BLOCKDATA subprograms) are relocated such that they do not overlap core bank boundaries.

b. If a library search is necessary and the contents of .DATF -5 is non-0, the Loader will seek the user library, .LIBR BIN, via that .DAT slot, and will load all requested library routines which it finds. I/O device handlers must not be in the user library.

c. If a library search is still necessary for non-I/O routines, the Loader will search the system arithmetic Library, .F4LIB BIN, via .DATF -7 in the same manner as above. I/O device handlers must not be in .F4LIB.

d. If any I/O handlers must be loaded, the Loader searches through the system I/O Library, .IOLIB BIN, via .DATF -7. After this has been done, program loading has terminated.

e. At this point, all undefined common blocks are defined and assigned core space. Common blocks are allowed to overlap core banks.

f. If there are still some undefined global symbols, they will be matched with common block names and, if a match is found, defined as the base address of the matching common block.

g. For all multi-unit device handlers in use for the user's programs, external I/O buffers are assigned core space (if necessary) and recorded in .BFTAB within the Resident Monitor. The number of such buffers depends on the $FILES counts

given by the user to the Non-resident Monitor or, if no counts given, the number of .IODEV'ed .DAT slots calling those handlers. I/O buffers are allowed to overlap core boundaries.

h. The amount of free core assigned to the Foreground job (contents of .SCOM + 25) is added to the current size of assigned Foreground core to determine the upper limit of the Foreground job. Pointers to the first and last registers in Foreground free core are then stored in .SCOM+2 and .SCOM+3, respectively.

i. The Loader now exits to the Resident Monitor. The Resident Monitor prints ↑S and waits for the user to type CTRL S, if the Loader is called by the LOAD command. Control then is given to the start address of the user's main program, which was stored in .SCOM+6 by the Loader.

4.3 BACKGROUND SYSTEM LOADER

Loading of all system programs is done by the System Loader (.SYSLD), which also performs link loading for the Foreground. Initiation of the loading cycle is done when the user, in the Background, types a request to the Non-resident Monitor to load a system program; e.g., $PIP, $EDIT, etc.

The Non-resident Monitor puts a code number in .SCOM+5 to tell the System Loader which program to load. The System Loader is then loaded into upper core overlaying the Non-resident Monitor.

.SYSLD contains a table which lists the .DAT slots used by each system program. Information about the load address, start address, size and initial block number on the system device for each system program is available in block 1Ø1 (SYSBLK).

To load in a system program in the Background, .SYSLD performs the following operations:

a. For each .DAT slot (with non-0 contents) required by a system program, it determines which device handlers are needed; and, if a library search is necessary, it brings in the handlers from the file .IOLIB BIN on the system device through .DATB -7. They are loaded starting immediately above the top of the Foreground job.

b. I/O buffers are then assigned core space immediately above the handlers as in the description in paragraph 4.2g. The hardware memory protect bound is set above the handlers and buffers.

c. If the load command was $LOAD, $GLOAD, $DDT or $DDTNS, the Background Link Loader (BFLOAD), a relocatable file, is loaded starting just above the new hardware protect bound.

d. For all other system programs, .SYSLD builds a short routine just above the hardware protect bound to bring in the program overlaying the System Loader.

e. Finally, .SYSLD exits to the Resident Monitor which establishes the new hardware protect bound and then passes control to the system program via the address stored by .SYSLD in .SCOM+5.

The Loader allows the loading of absolute .LOC programs prior to loading any relocatable files. This permits the user to load programs which may overlay parts of the Resident Monitor. Mixing of absolute and relocatable .LOC's in the same program file is not allowed and will be flagged as an error. The Loader insures that the relocatable programs do not overlay any of the absolute programs.

The Foreground Linking Loader is also responsible for loading the system program PIP in the Foreground. The Foreground version of PIP exists in the system as the relocatable file PIP BIN. It is loaded by typing PIP as a command to the Non-resident Monitor.

4.4 BACKGROUND LINKING LOADER

Externally, the Background Linking Loader (BFLOAD) looks nearly the same to the user as the Foreground Linking Loader. When it has been loaded, it prints the following message on the Background control teletype:

```
BGLOAD V1A
>
```

The command string processing is identical with that of the Foreground Linking Loader (see 4.2).

If the Load command was $DDT or $DDTNS, the system program DDT (a relocatable file) has already been loaded into the top of core via .DATB -1, prior to reading in the command string.

Once the command string has been accepted, the Loader will perform the following sequence of operations:

a. Load all user programs specified in the command string from .DATB -4. These programs are loaded from the top of core down. Calls to external library routines via .GLOBL, common block definitions, and .IODEV requests are saved in the Loader's symbol table, built from the top of the Loader upwards in core. Programs containing executable code (which excludes BLOCKDATA subprograms) are relocated such that they do not overlap core boundaries.

b. Same action as described in 4.2b, using .DATB -5.

c. Same action as described in 4.2c, using .DATB -7.

d. If any I/O handlers must be loaded, the Loader searches through .IOLIB BIN via .DATB -7. The handlers are relocated to run in lower core, that is, as if they were being loaded upwards in core starting just above the Foreground job. They may, however, be loaded above the Loader at this point in time because the Loader is in the way.

e. Same action as described in 4.2 e,f,g. Common blocks are assigned space in upper core; I/O buffers, in lower core.

f. The hardware memory protect bound is established above the I/O handlers and buffers. Common blocks may go below the hardware protect bound.

g. If DDT was loaded and a symbol table was requested (not $DDTNS), the symbol table is compacted to delete entries not needed by DDT. The Loader determines where the symbol table should be moved; and, along with the I/O handlers which were loaded into upper core, builds a special .EXIT list which tells the Resident Monitor where to block transfer each segment. The DDT symbol table may be loaded below the hardware protect bound.

h. The Loader then exits to the Resident Monitor, which performs the block transfers, sets the new hardware memory protect bound, and transfers control to DDT (via .SCOM+5) or to the user program (via .SCOM+6), pausing to print ↑S and waiting for the user to type CTRL S if the Load command was $LOAD.

4.5 LOADING XCT FILES

XCT files are overlay programs built by the system program CHAIN and run by the system program EXECUTE. Loading of an XCT file in either the Foreground or the Background is initiated by

typing E␣XXX or EXECUTE␣XXX to the Monitor (where XXX is the file name without the extension XCT).

The Non-resident Monitor, BFKM9, stores the filename (.SIXBT format) in .SCOM+1Ø7, 11Ø and 111 for the Foreground or .SCOM+112, 113 and 114 for the Background. If EXECUTE's .DAT slot requests the resident system device handler, the Monitor stores "XCS" as the extension. If EXECUTE's handler is different from the resident handler, the Monitor stores the extension "XCT."

The System Loader is then called in, overlaying the Non-resident Monitor in upper core.

4.5.1 EXECUTE in the Foreground

The following operations are carried out when EXECUTE is used in the Foreground:

a. EXECUTE's handler, if different from the resident handler, is loaded immediately above the Monitor.

b. The System Loader, which must open the XCT file, checks the extension. If "XCS", meaning EXECUTE's handler is the resident handler, load the file via .DAT -7. If "XCT", load via .DAT -4. Set the extension to "XCT".

c. Read the XCT file and check that it was indeed built to be run in the Foreground of a PDP-9.

d. Save the upper and lower core limits of the overlay structure and check that it does not overlay the Resident Monitor.

e. Decode the .IODEV bit map in the XCT file. Set the loading bound immediately above the area of core to be occupied by the overlay structure and then load all I/O handlers required by the XCT file. Also, load another copy of EXECUTE's handler (the first copy will be overlayed).

f. Load in EXECUTE.

g. Same action as described in 4.2g and h.

h. The Loader exits to the Resident Monitor. The Monitor gives control to EXECUTE, whose start address is stored in .SCOM+6 by the Loader.

4.5.2 EXECUTE in the Background

The following operations are carried out when EXECUTE is used in the Background:

a. EXECUTE's handler, if different from the resident handler, is loaded immediately above the Foreground job.

b. Same action as described in 4.5.1.b.

c. Read the XCT file and check that it was built to be run in the Background of a PDP-9.

d. Save the lower core limit of the overlay structure and test, when EXECUTE has been loaded, that they do not overlap.

e. Decode the .IODEV bit map in the XCT file and then load any I/O handlers needed by the file.

f. Same action as described in 4.2g.

g. Set the hardware memory protect bound above the I/O buffers and then load EXECUTE starting above this bound.

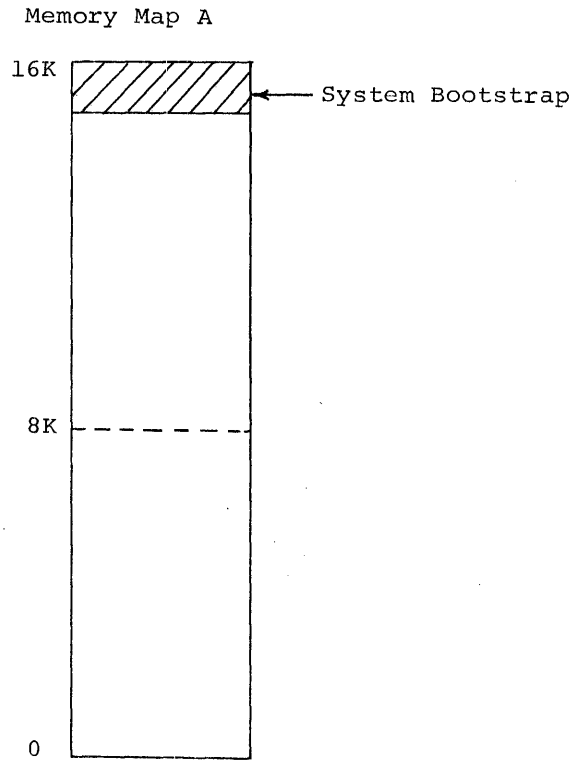
h. Same action as described in 4.3.e.

4.6 ERROR CONDITIONS

The number of different error messages in the Loaders has been expanded in Background/Foreground. These are tabulated in Appendix 2, Section A2.5. The error number is passed on to the Resident

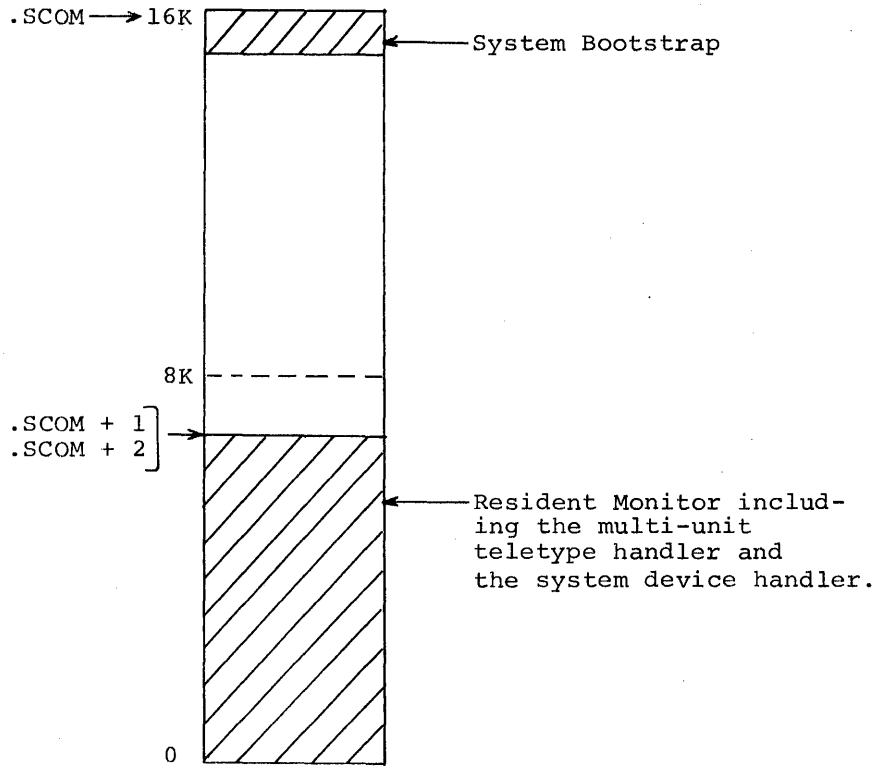
Monitor by a special error .EXIT macro (CAL sequence). Loader errors are non-recoverable. After the error message is printed, the Monitor will automatically be reloaded to start another job.

4.7 SYSTEM MEMORY MAPS



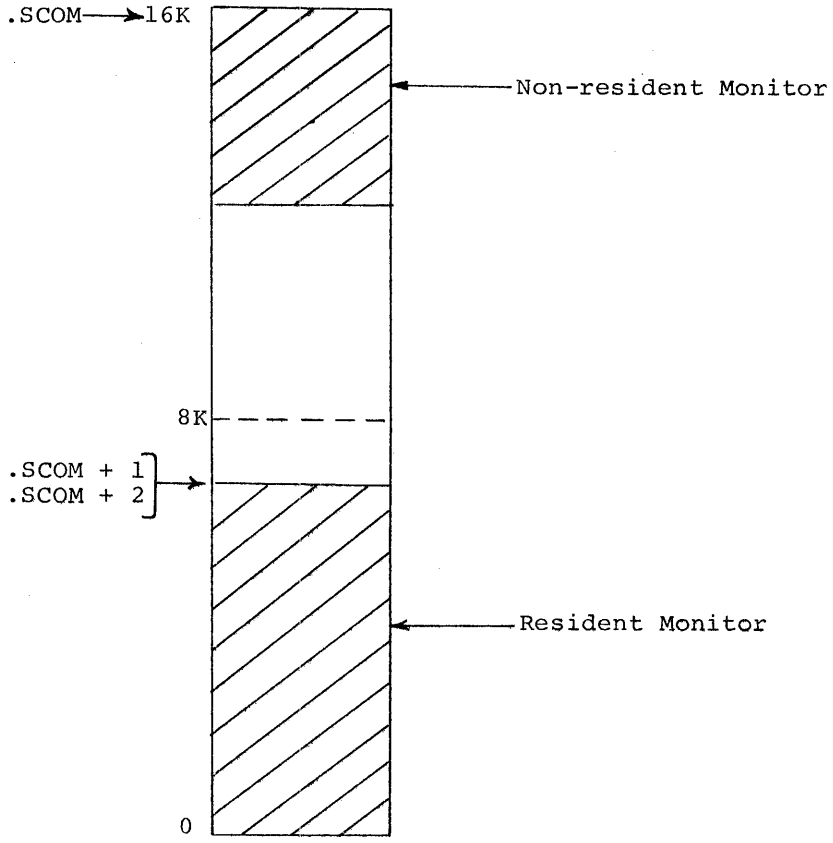
The System Bootstrap is loaded at the top of core via the paper tape reader in HRM format.

Memory Map B



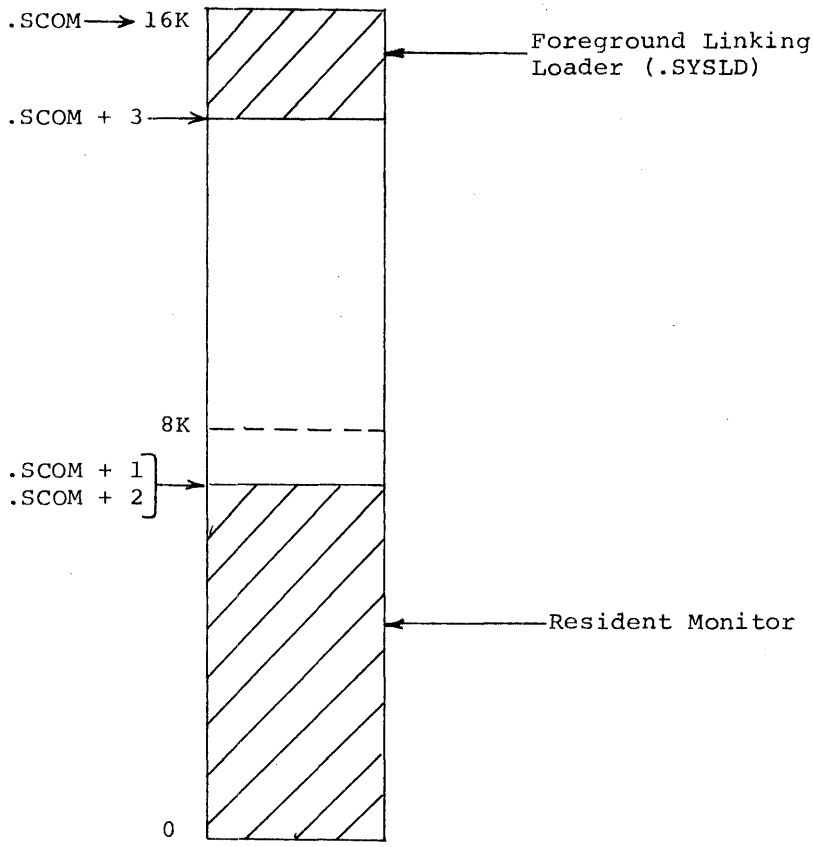
The System Bootstrap automatically loads the Resident Monitor from the system device into lower core.

Memory Map C



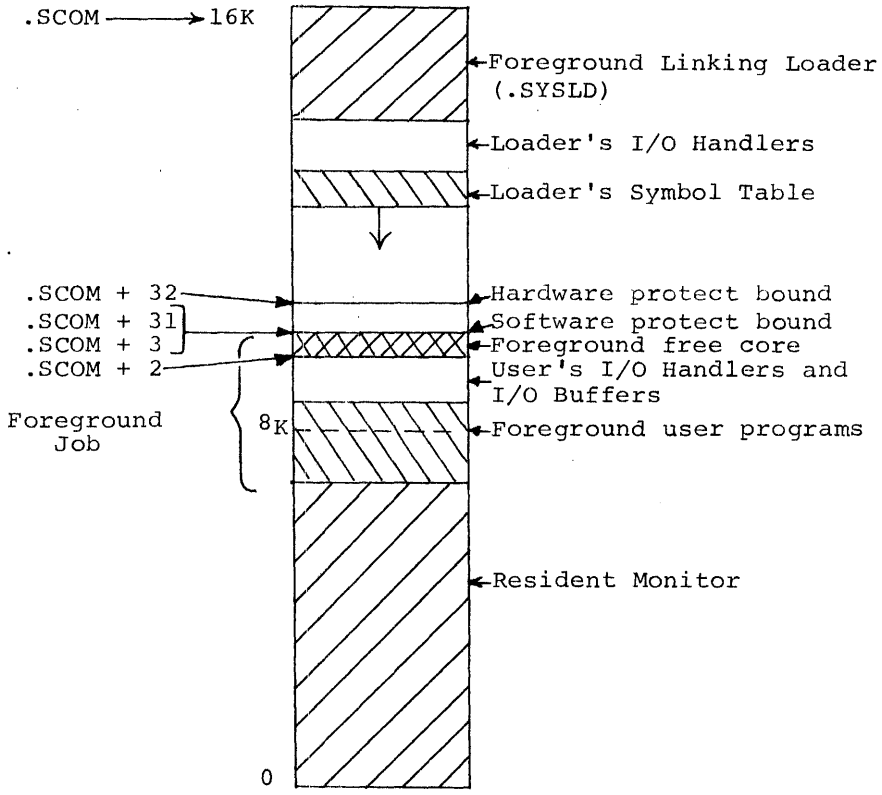
The Resident Monitor loads the Non-resident Monitor (via the resident system device handler) into upper core, overlaying the System Bootstrap.

Memory Map D



To load a user FOREGROUND program, the Non-resident Monitor brings in the Foreground Linking Loader (.SYSLD), overlaying itself.

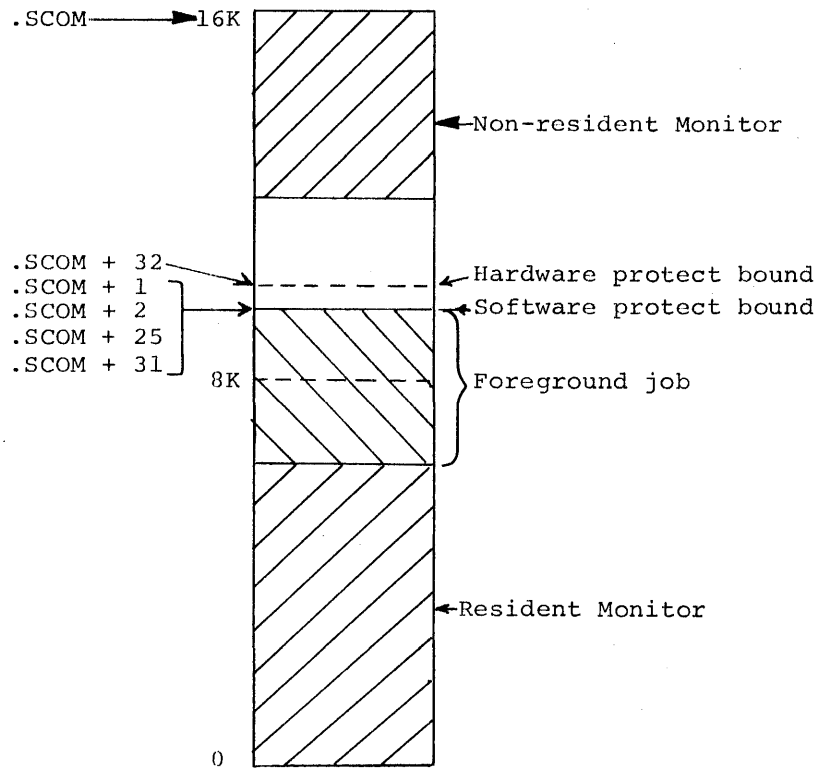
Memory Map E



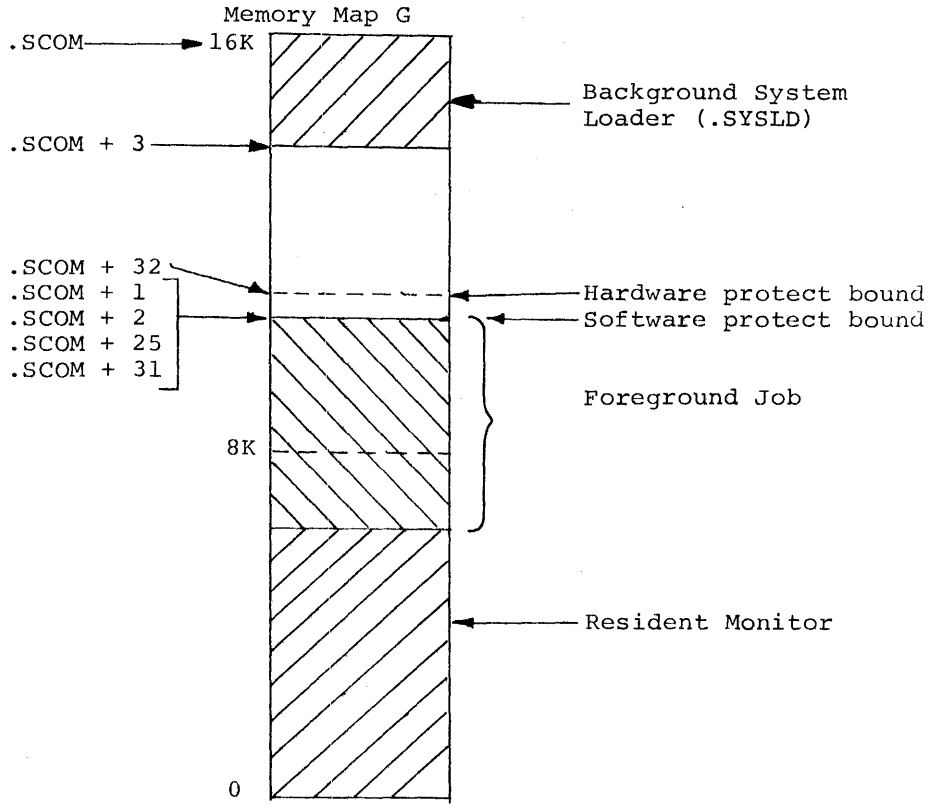
The Foreground Linking Loader first brings in any additional I/O handlers required for loading. Then it loads the user program(s), library routines, user I/O handlers and I/O buffers, and allocates Foreground free core. The software memory protect bound is established just above the Foreground job. The hardware memory protect bound, because it can be set only in increments of 1K decimal, will leave some unused space between it and the Foreground job. The software protect bound allows this space to be used for dynamic data storage by the Background job.

For a description of loading of Foreground XCT files, see Memory Map L.

Memory Map F

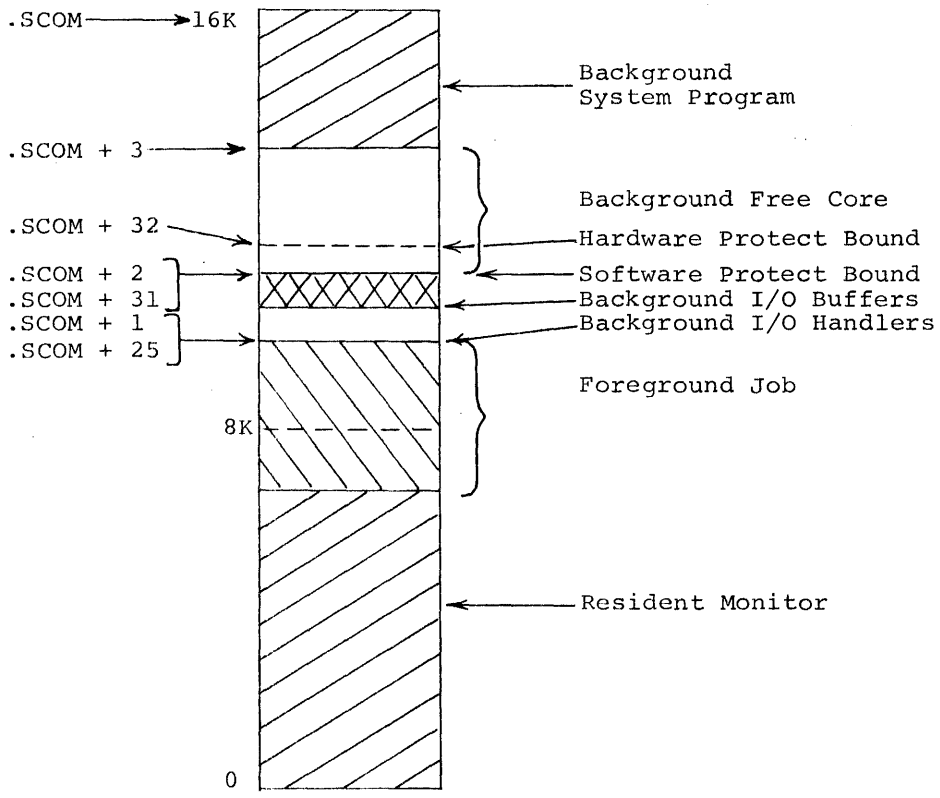


When the FOREGROUND job becomes I/O bound, control is transferred to the BACKGROUND job. The Resident Monitor loads the Non-resident Monitor (via the resident system device handler) into upper core. It then gives control to the Keyboard Listener (within the Non-resident Monitor) to await a BACKGROUND keyboard command. Memory protect is enabled while the Background job is running.



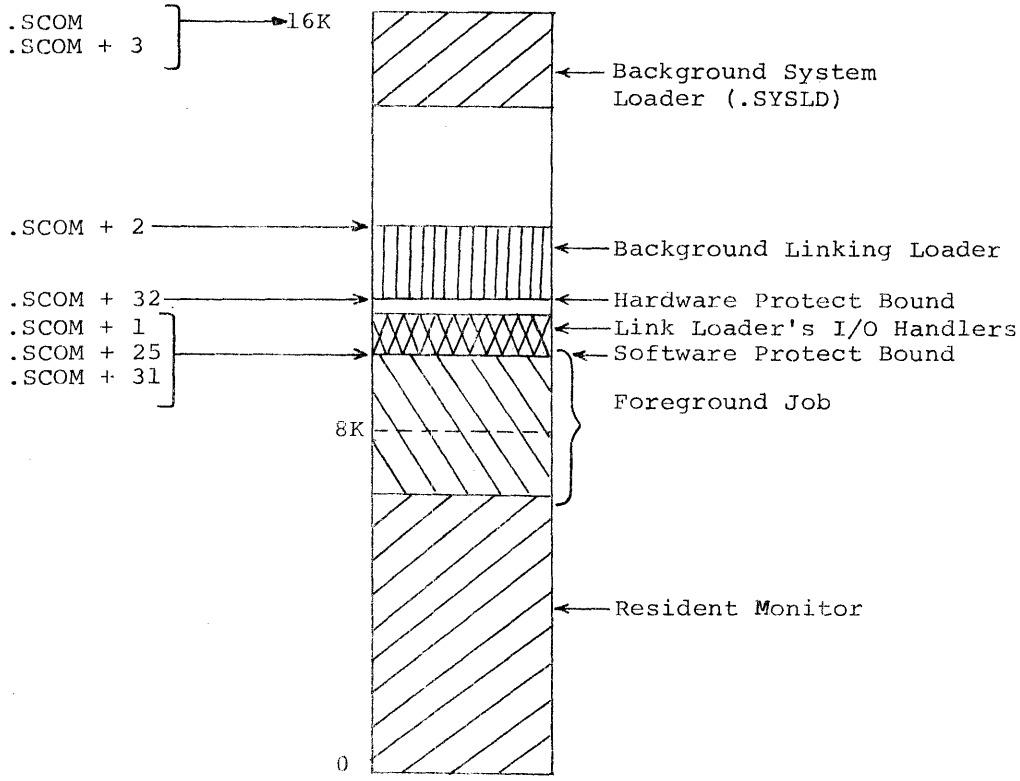
When a BACKGROUND keyboard command requests loading of a system or user program, the Non-resident Monitor brings in the System Loader, overlaying itself. Note that the BACKGROUND System Loader and the FOREGROUND Linking Loader are physically the same program.

Memory Map H



If the BACKGROUND request is for a system program, the System Loader loads the system program I/O handlers up from the top of the FOREGROUND job, allocates I/O buffer space, and loads the system program at the top of core (overlaying the System Loader). Control is returned to the Resident Monitor, which sets the memory protect bound above the buffer space and given control to the system program.

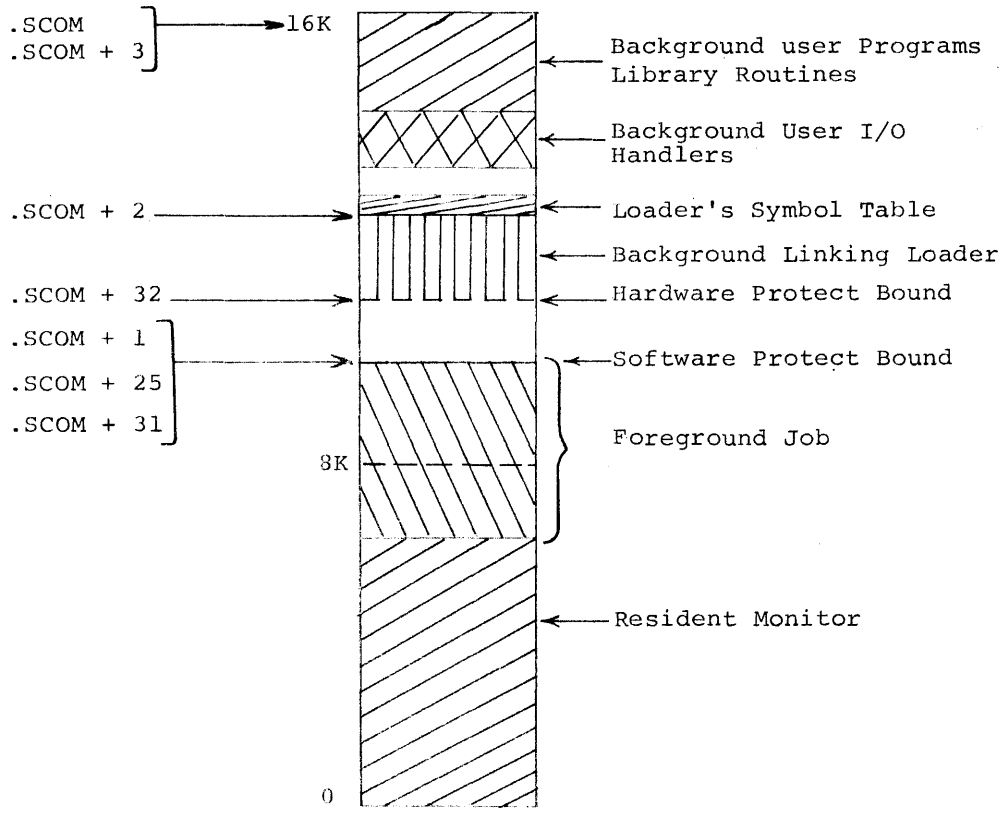
Memory Map I



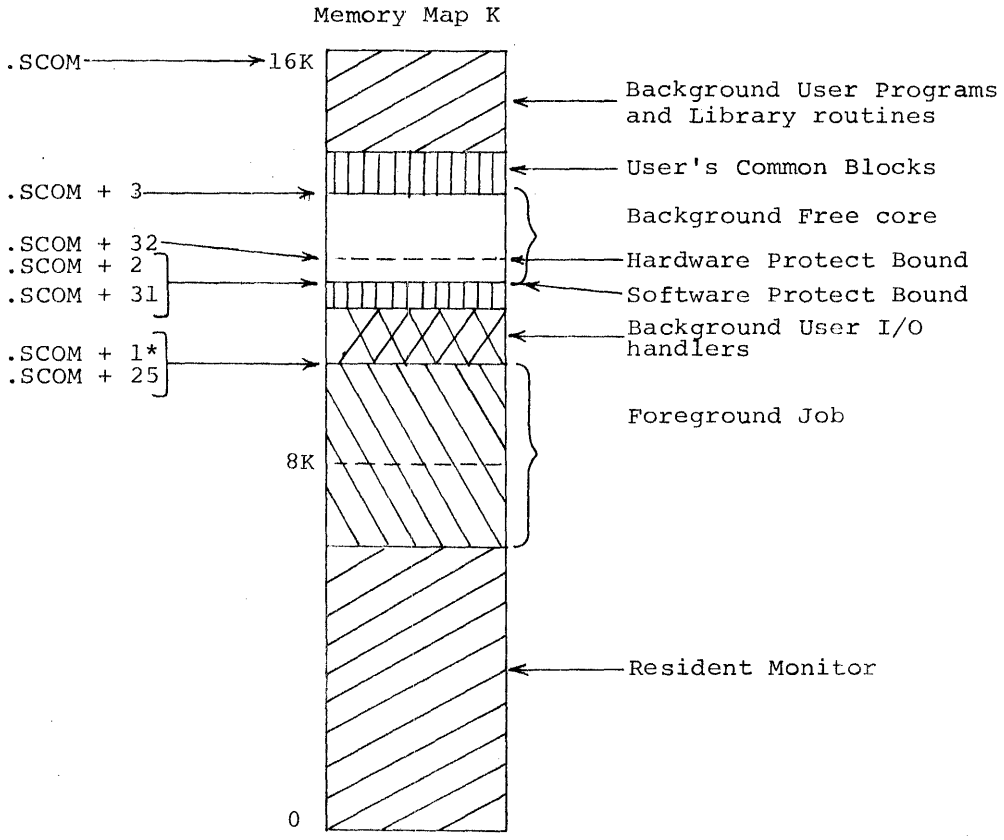
If the BACKGROUND program is a user program*, the System Loader loads the Linking Loader I/O handlers up from the top of the FOREGROUND job and loads the Linking Loader such that the memory protect bound can be set just below it.

*User programs may be loaded along with the system program DDT.

Memory Map J

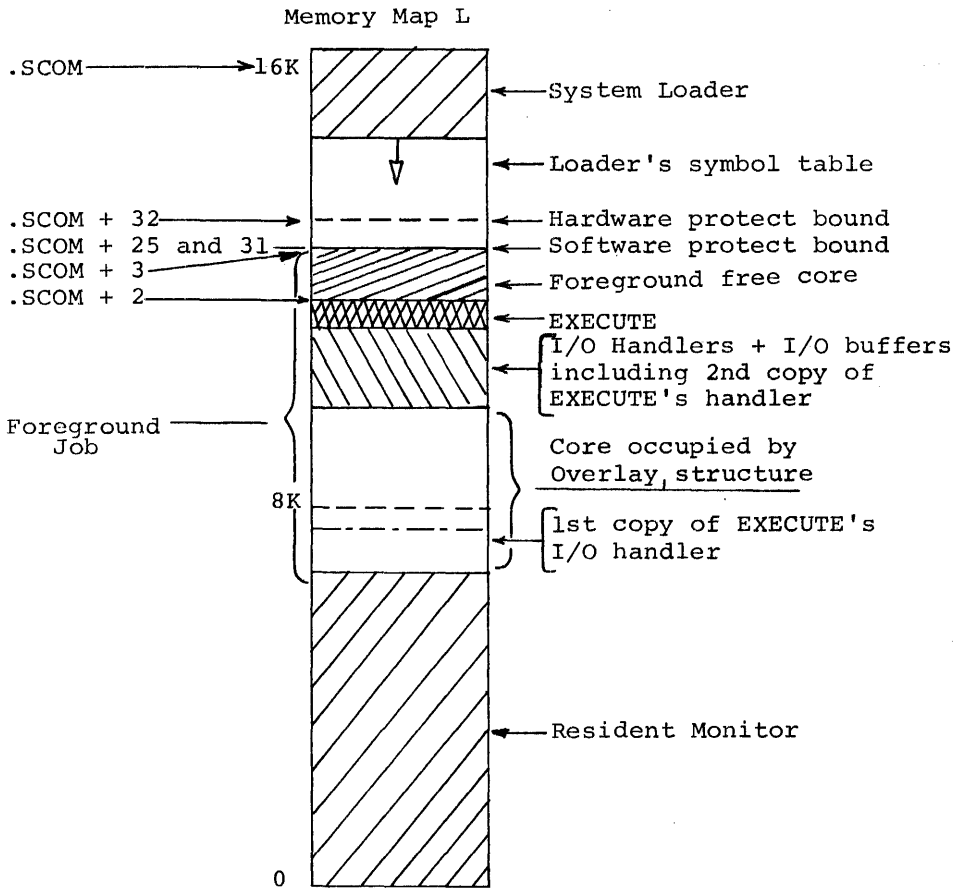


The BACKGROUND Linking Loader overlays the System Loader by loading user programs down from the top of core. User I/O handlers, presuming that they cannot fit in core between the FOREGROUND job and the bottom of the Loader, are loaded into upper core but relocated to run just above the FOREGROUND job so that they memory protect bound can be set above them. Common blocks and I/O buffers are not shown in this memory map.



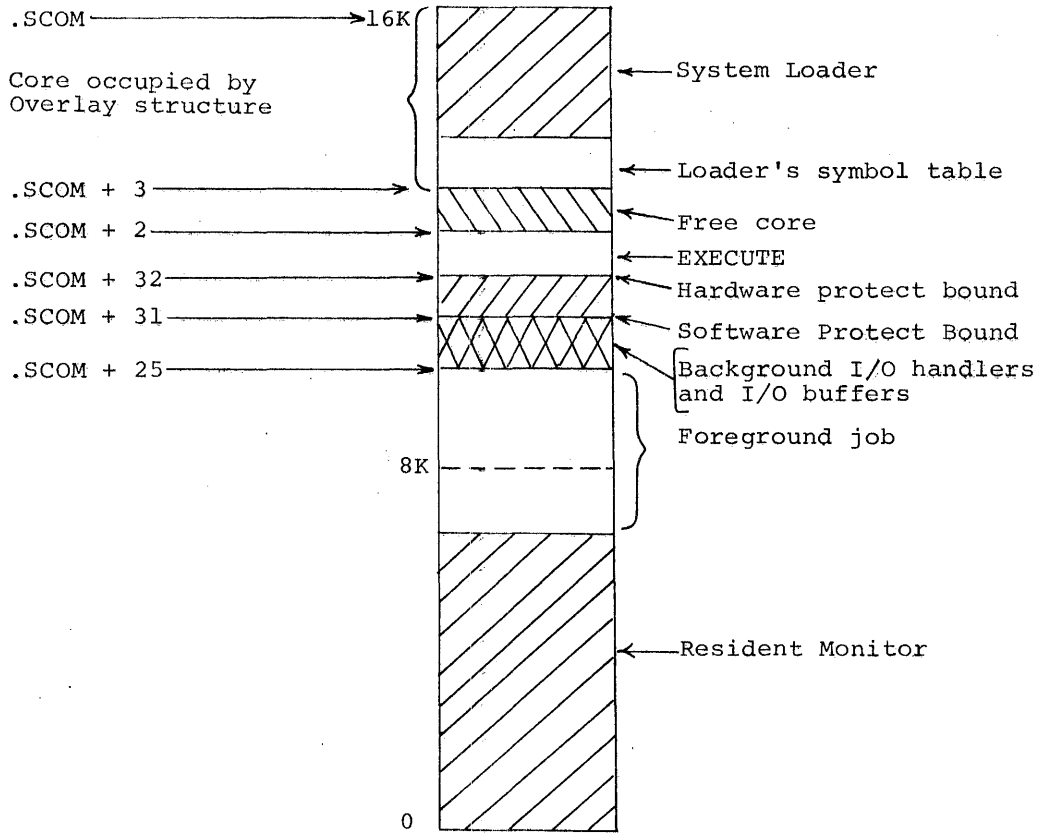
The .EXIT from the Linking Loader causes the user program I/O handlers to be block transferred to their running position, the memory protect bound to be set just above the I/O buffer space, and control given to the user program. if DDT was also loaded, it resides at the top of core, above the user programs. Its symbol table, built by the Loader, is block transferred by the Monitor to start at the software protect bound.

*If DDT is loaded, .SCOM + 1 will be set to point at the start of DDT symbol table.



The System Loader first loads EXECUTE's I/O handler (if not the resident handler) in order to read the XCT file. The core limits of the overlay structure are read from the file as well as the request for I/O from its .IODEV bit map. The requested handlers, including a second copy of EXECUTE's handler, are loaded above the core area to be occupied by the overlay structure. Then I/O buffers are created, if necessary, and EXECUTE is loaded above them. Finally, Foreground free core, the software protect bound and the hardware protect bound are established.

Memory Map M



The System Loader loads EXECUTE's I/O handler (if not in core) in order to read the XCT file. The core limits of the overlay structure and the I/O requests in the .IODEV bit map are read from the XCT file. The user's I/O handlers and I/O buffers are then laoded above EXECUTE's handler, and the hardware protect bound is established above them. EXECUTE is loaded above the bound and Background free core is set up from the top of EXECUTE to the bottom of the overlay area.

SECTION 5

BACKGROUND/FOREGROUND START-UP PROCEDURE

5.1 LOADING THE B/F MONITOR

Before startup procedures can be carried out, the user must generate a working system (using .SGEN) from the master tape supplied with the system. Refer to Section 8 for .SGEN procedures.

In Disk systems, the Monitor and system programs are assumed to be on Unit Ø.

In DECtape systems, mount the working system tape onto DECtape unit 8 (i.e., Ø) and perform the following:

1) Load appropriate paper tape Bootstrap in the reader.
2) Momentarily depress Reader TAPE FEED pushbutton to clear end-of-tape flag.
3) Set console address switches as follows:

If you have a -	Set switches to -
16K System	37637
24K System	57637
32K System	77637

4) Press and release in sequence the console I/O RESET and READ IN switches.

When loaded, the monitor identifies itself and indicates its readiness by outputting the following on the Foreground control Teletype (i.e., normally unit 1)

```
FKM9 V1A
$
```

The paper tape bootstraps used to load the Background/Foreground monitor are identical to those used in the PDP-9 Keyboard Monitor system. The bootstrap restart address, however, is different (i.e., .SCOM+11 = register 111_8) because the resident Monitor contains a copy of the bootstrap.

The three examples given in paragraphs 5.2, 5.3 and 5.4 are intended to get the user "on the air". Note that the symbol $ is output by the Monitor to indicate that it is ready to accept commands, whereas">"and "*" are used by system programs to denote readiness.

The symbol (Ⓢ) in the text below indicates the typing of an ALTMODE terminator.

5.2 .IDLE LOADED AS THE FOREGROUND JOB

An Idle job is loaded in the Foreground to allow immediate use of the Background. Refer to section 6.3 for a discussion of .IDLE.

```
FKM9 V1A
$A [DTAØ]  -4      /The program "IDLE" is on unit
   [DKAØ]          /Ø of the system device
$GLOAD             /Call the Loader to Load-and-Go

FGLOAD V1A         /The Loader is in core
>←IDLE Ⓢ           /Load "IDLE BIN".
```

When IDLE is loaded, no indication is given on the Foreground control teletype. Control passes to the Background and the Non-resident Monitor is loaded into core. The Monitor identifies itself on the Background control teletype as:

```
BKM9 V1A          /The Monitor is now ready to
$                 /accept background commands.
```

5.3 SINGLE-USER FOCAL LOADED INTO THE FOREGROUND

```
FKM9 V1A
$A [DTØ] -4       /FOCAL is on the "system tape".
   [DKØ]
$A DT1  3         /Library input to FOCAL.
$A TT1  5         /Library output to FOCAL.
$FCORE 1ØØØ       /Free core for FOCAL buffer area.
$GLOAD            /Call Loader to Load-and-Go.

FGLOAD V1A        /The Loader is in core.
>←FOCAL, FNEW (S) /Load FOCAL and its library, FNEW

FOCAL V3A         /FOCAL is in core and
*                 /is ready to accept commands.
```

Once FOCAL is running in the Foreground, the Non-resident Monitor will be loaded into core as explained in 5.2.

5.4 TWO-USER FOCAL LOADED IN THE FOREGROUND

```
FKM9 V1A
$A [DTØ]  -4      /FOCAL2  is on the "system tape".
   [DKØ]
$A  TT1    1      /Teletype for user #1.
$A  DT1    2      /Library In/Out for user #1.
$A  TT2    3      /Teletype for user #2.
$A  DT2    4      /Library In/Out for user #2.
$FCORE 3ØØØ       /Assign 14ØØ (Octal) locations of free
                  /core for each user.
$GLOAD            /Call the Loader to Load-and-Go.

FGLOAD V1A        /The Loader is in core.
>←FOCAL2,FNEW (S) /Load two-user FOCAL and its
                  /library, FNEW.
FOCAL V3A         /FOCAL is in core and will
*                 /identify itself on each user's teletype.
```

SECTION 6

BACKGROUND/FOREGROUND MONITOR COMMANDS (SYSTEM MACROS)

6.1 INTRODUCTION

The System MACROS unique to the Background/Foreground Monitor are listed and described briefly in Table 6-1. The Monitor Macros listed are available in addition to the Macros provided in the Advanced Keyboard Monitor System for use in programs that are to be run in the Background/Foreground environment. Detailed descriptions of the Macros are given in the remainder of this Section.

TABLE 6-1

Background/Foreground System Macros

Name	Purpose
.REALR	Real time transfer of data from I/O device to line buffer (real-time READ).
.REALW	Real time transfer of data from line buffer to I/O device (real-time WRITE).
.IDLE	Allows FOREGROUND job to indicate that control can be given to lower levels of the FOREGROUND job or to the BACKGROUND job until completion of any FOREGROUND real-time transfer or clock interval.
.IDLEC	Allows FOREGROUND Mainstream to give control to BACKGROUND job with FOREGROUND continuing after the .IDLEC on completion of any FOREGROUND real-time transfer or clock interval.
.TIMER	Calls and uses real-time clock and allows priority level to be established.
.RLXIT	Accomplishes the exit from all real-time subroutines that were entered via .REALR, .REALW, .TIMER or real-time CTRL P[1] requests.

[1] See Section 3.7.

6.2 .REALR

FORM: .REALR A, M, L, W, ADDR, P

VARIABLES:

A = .DAT slot number (octal radix)

M[1] = Data Mode
- Ø = IOPS binary
- 1 = Image binary
- 2 = IOPS ASCII
- 3 = Image Alphanumeric
- 4 = Dump Mode

L = 15-bit buffer address (octal radix)

W = Line buffer word count (decimal radix), including the two-word header

ADDR[2] = 15-bit address of closed subroutine that is given control when the request made by the .REALR is completed.

P = API priority level at which to go to ADDR

P	Priority Level
Ø	Mainstream
4	Level of .REALR
5	API software level 5
6	API software level 6
7	API software level 7

EXPANSION:

```
LOC     CAL+1ØØØØ+M6-8+A9-17
LOC+1   1Ø
LOC+2   L
        .DEC            /Decimal Radix
LOC+3   -W
        .OCT            /Octal Radix
LOC+4   ADDR+P0-2
```

[1] Data modes 5, 6 and 7 are passed to all I/O handlers.

[2] The subroutine specified by a .REALR, .REALW, .TIMER or real-time CTRL P should not be used at more than one priority level. The subroutine is entered via a JMS and thus cannot be protected against re-entry.

DESCRIPTION: The .REALR command is used to transfer the next line of data from the device assigned to .DAT slot A to the line buffer in the user's program. In this operation, M defines the modes of the data to be transferred, L is the address of the line buffer, W is the number of words in the line buffer (including the two-word header), and ADDR is the address of a closed subroutine which should be constructed as shown in the following example.

EXAMPLE 1: STRUCTURE OF A REAL-TIME SUBROUTINE

```
ADDR    0                           /Entry point
        DAC         SAVEAC          /Save AC
        .                           /Any system Macro may
        .                           /be issued at this point.
        .
        LAC         SAVEAC          /Restore AC
        .RLXIT      ADDR            /Return to interrupted
                                    /point via Monitor CAL
```

6.3 .REALW

FORM: .REALW A, M, L, W, ADDR, P

VARIABLES: A = .DAT slot number (octal radix)

M[1] = Data Mode
- Ø = IOPS binary
- 1 = Image binary
- 2 = IOPS ASCII
- 3 = Image Alphanumeric
- 4 = Dump Mode

L = 15-bit Line buffer address (octal radix).

W = Line buffer word count (decimal radix), including the two-word header

ADDR[2] = 15-bit address of closed subroutine that is given control when the request made by the .REALW is completed.

---

[1]Data modes 5, 6 and 7 are passed to all I/O handlers.
[2]See footnote 2, page 6-2.

P = API priority level at which to go to ADDR

P	Priority Level
Ø	Mainstream
4	Level of .REALW
5	API software level 5
6	API software level 6
7	API software level 7

```
EXPANSION:   LOC     CAL+1ØØØØ+M6-8+A9-17
             LOC+1   11
             LOC+2   L
                     .DEC            /Decimal Radix
             LOC+3   -W
                     .OCT            /Octal Radix
             LOC+4   ADDR+P0-2
```

DESCRIPTION: The .REALW command is used to transfer the next line of data from the line buffer in the user's program to the device assigned to .DAT slot A. In this operation, M defines the mode of the data to be transferred, L is the address of the line buffer, W is the count of the number of words in the line buffer (including the two-word header), and ADDR is the address of a closed subroutine which should be constructed as shown in EXAMPLE 1 above.

6.4 .IDLE

```
FORM:        .IDLE

EXPANSION:   LOC     CAL
             LOC+1   17
```

DESCRIPTION: The FOREGROUND job in a Background/Foreground environment can indicate that it wishes to relinquish control to lower levels of the FOREGROUND job or to the BACKGROUND job by executing this command. This is useful when the FOREGROUND job is waiting for the completion of real-time I/O from any one of a number of I/O requests that it has initiated or for completion of .TIMER requests.

The .IDLE is the logical end of the current level's processing; that is, control never returns to LOC+2. If the .IDLE is issued at a FOREGROUND API software level, it effects a debreak (DBR) from that level so that pending real-time

routines at that level will not be executed until the level is requested again. If the .IDLE is issued at FOREGROUND Mainstream, control goes to the BACKGROUND job. If the .IDLE is issued at BACKGROUND Mainstream, control is returned to the .IDLE CAL.

6.5 .IDLEC

FORM: .IDLEC

EXPANSION:
```
LOC     CAL+1ØØØ
LOC+1
```

DESCRIPTION: Identical to .IDLE except when issued at the FOREGROUND Mainstream level. In this case, control goes to the BACKGROUND job, and LOC+2 is saved as the FOREGROUND Mainstream return pointer. The next time control returns to FOREGROUND (at any priority level), FOREGROUND Mainstream processing will resume at LOC+2 when Mainstream becomes the highest active FOREGROUND level.

6.6 .TIMER

FORM: .TIMER N, ADDR, P

VARIABLES:
N[1] = Number of clock increments (decimal radix)

ADDR[2] = 15-bit address of closed real-time subroutine to handle interrupt at end of interval

P = API priority level at which to go to ADDR

---

[1] To transfer control to subroutine ADDR at priority level P immediately, N should be set equal to zero.

[2] The subroutine specified should not be used at more than one priority level. The subroutine is entered via a JMS and thus cannot be protected against re-entry.

P	Priority Level
Ø	Mainstream
4	Level of .TIMER
5	API software level 5
6	API software level 6
7	API software level 7

```
EXPANSION:    LOC       CAL[1]
              LOC+1     14
              LOC+2     ADDR+P0-2
                        .DEC        /Decimal Radix
              LOC+3     -N
```

DESCRIPTION: .TIMER is used to set the real-time clock to N increments and to start it. Each clock increment represents 1/60s for 60 Hz systems and 1/50s for 50 Hz systems. When the Monitor services the clock interrupt, it passes control to location ADDR+1 with the priority level set to P. The coding at ADDR should be in closed subroutine form, as in EXAMPLE 1.

6.7 .RLXIT

FORM: .RLXIT ADDR

VARIABLES: ADDR = 13-bit entry point address of the real-time subroutine from which an exit is to be made.

```
EXPANSION:    LOC       CAL     ADDR
              LOC+1     2Ø
```

DESCRIPTION: .RLXIT is used to exit from all real-time subroutines that were entered via .REALR, .REALW, .TIMER or real-time CTRL P requests. The instruction just preceding the .RLXIT call should restore the AC with the value of the AC on entrance to this subroutine. .RLXIT will restore the link from bit Ø of the contents of ADDR.

.RLXIT protects against re-entrance to BACKGROUND or FOREGROUND Mainstream real-time subroutines. When the contents of ADDR is non-zero, the subroutine is assumed active; .RLXIT sets the contents of ADDR to Ø, thus making it avail-

---

[1]When bit 8 of CAL is set to 1, an abort .TIMER is effected. All intervals having the same address and priority level (LOC+2) will be aborted.

able again. NOTE: Real-time subroutines should initially have their entry point register set to Ø; and restart procedures, entered via CTRL P or after CTRL T, should reset all entry points to Ø.

6.8 MAINSTREAM REAL-TIME SUBROUTINES

Mainstream real-time subroutines in the Foreground are not equivalent to those in the Background due to the manner in which I/O busy situations are handled. If the Background becomes I/O busy, the Monitor "sits on" the Background CAL instruction (while Background is in control) until it can be processed. Therefore, Background Mainstream real-time routines can be executed despite the fact that Background Mainstream is I/O busy. If Foreground Mainstream is I/O busy, Foreground Mainstream real-time routines cannot be executed until the busy situation is terminated. This is due to the fact that control is given to the Background whenever Foreground Mainstream becomes I/O busy. The device handler responsible for the busy situation is remembered in the Foreground Mainstream busy flag. Mainstream real-time routines cannot then be run because they too could become busy.

This situation can be avoided either by using .REALR or .REALW in conjunction with .IDLE or .IDLEC, or by using .WAITR to prevent Foreground Mainstream from becoming I/O bound.

SECTION 7

WRITING DEVICE HANDLERS FOR THE BACKGROUND/FOREGROUND MONITOR SYSTEM

7.1 INTRODUCTION

Writing a handler which will run in the Background/Foreground Monitor environment requires adherence to certain established conventions which differ from those in the Keyboard Monitor environment. The CAL handler in the Monitor has been implemented to do as much of the function processing as possible. In giving control to the I/O handler, the CAL handler will have set up registers in the I/O handler with all pertinent information (arguments) of the CAL in the most accessible state, and will then transfer control to the appropriate function processor via the JMP table in the I/O handler which begins at word 20_8. There are three types of I/O device handlers that one may wish to develop to operate under the Background/Foreground Monitor System:

1. Single user --- This handler can be used by either the Foreground job or the Background job but not both during the same core load; that is, it is dedicated to one job and the Monitor System will not permit the other job to be connected to it.

2. Sequential Multi-user --- This handler can be connected to both the Foreground and the Background job and they both can utilize it on a sequential, first come-first served basis.

3. Multi-user --- This handler can be connected to both the Foreground and the Background jobs with the Foreground job having priority on usage. If the Background job is using the handler and Foreground requires it; the Background I/O will be deferred until the Foreground I/O has been completed.

This section will be primarily devoted to describing the development of single-user handlers. After having done this, it will show the transition from single use to sequential multi-use.

I/O handler type 3 (Multi-user) is too involved to be presented without example listings (such as our Multi-user DECtape handler) and personal consultation regarding the philosophies of the Background/Foreground Monitor System. Consultation is available to customers whose applications require type 3 handlers.

7.2 FORMAT OF DEVICE HANDLER'S CAL PROCESSOR

The first 37 (octal) words of the I/O handler must have the format described in the following pages. An assembly listing of the Background/Foreground line printer handler (LPA) is appended to this section for reference.

```
WORD Ø:  JMS    SWAP        /SWAP is in the I/O handler
```

The SWAP subroutine must execute WORD5 which restores the state of the program interrupt and DBK from level Ø of the API. The presence of this routine becomes functionally necessary for type 3 (Multi-user) handlers to accomplish swapping from Background to Foreground usage. The I/O device independence of the system requires that all handlers look alike to the outside world (namely, the CAL handler).

```
WORD 1:  Foreground Busy Register --- must be assembled
                                      with Ø contents
              Ø=Not Busy
           NonØ=Busy (Current .DAT slot number, 18 bits
                      if negative)
```

```
WORD 2:  Background Busy Register --- must be assembled with
                                      Ø contents
              Ø=Not Busy
           NonØ=Busy (Current .DAT slot number, 18 bits
                      if negative)
```

The CAL handler checks the validity of the .DAT slot number for this job (Foreground or Background), checking for its existence, whether or not a device has been assigned to it and if the appropriate handler was loaded.

The CAL handler then checks the appropriate busy register and proceeds as follows:

1) If the flag indicates that the handler is already busy, the job becomes I/O bound at this level.

2) If the flag indicates not busy, it is set to busy and the CAL handler processes the function and passes the request on to the device handler.

Note that .WAIT's and .WAITR's are completely processed by the CAL handler and are not passed on to the I/O handler. If the corresponding flag indicates:

1) BUSY

   a) For .WAIT in the Foreground, control is given to a lower Foreground level or the Background.

   b) For .WAIT in the Background, hang on the CAL.

   c) For .WAITR in either the Background or Foreground, control goes to the address in LOC+2 (which must be above the hardware memory protect bound if in the Background).

2) NOT BUSY - Fall through.

WORD 3: Foreground .CLOSE register -- must be assembled with Ø contents

Ø=.CLOSE not in progress
NONØ=.CLOSE in progress

WORD 4: Background .CLOSE register --- must be assembled with Ø contents

Ø=.CLOSE not in progress

NonØ=.CLOSE in progress

WORD 5[1]: ION or IOF (state of PIC on INTERRUPT or CAL entries).

WORD 6[1]: Same as WORD 5 on CAL entries; DBR on INTERRUPT entries.

WORD 7[1]: Return pointer. The CAL handler places the address of CALXIT in this register.

WORD 1Ø: JMP FUNC

After checking the validity of function and subfunction codes, the CAL handler places a JMP to the appropriate entry in the function JMP table (words 2Ø-32) of the I/O handler in this register.

WORD 11: User CAL in progress. The CAL handler sets this register.

Ø=Foreground

1=Background

WORD 12: .DAT slot number (18-bits if negative). The CAL handler sets this register.

WORD 13: Unit number for Multi-unit devices in Bits Ø-2, with bits 3-17 containing the address of the CAL. The CAL handler sets this register.

---

[1]When a hardware interrupt occurs to this I/O device handler, the interrupt processor must:

a) Save the state of the program interrupt in Word 5
b) Place a DBR in Word 6
c) and place the interrupted program counter (with link, extend mode and memory protect bits) in Word 7.

The CAL handler makes a general check for validity on:

a) File type
b) Data Mode
c) MAGtape subfunction code
d) Transfer directions
e) .OPER subfunction code
f) All addresses
g) Word counts

and will pass on what appears to be legitimate values. Each handler must then make its own validity determination with respect to the device it controls. For example, the CAL handler will always accept data modes Ø through 7; however, the device handler may only accept a subset of these.

The contents of words Word 14 through Word 17 vary with the function being processed. Adjacent to what will appear in each of these words is the limits on the values that will be accepted and passed on by the CAL handler.

```
WORD 14:    .INIT --- File type    Ø=input
                                   1=output

            .READ, .REALR                      Ø=IOPS binary
                                               1=image binary
            .WRITE, .REALW - Data Mode 2       2=IOPS ASCII
                                               3=Image ALPHA
                                               4=DUMP
                                               5=DUMP ALPHA
                                               6=are passed on
                                               7=by the CAL handler

            .MTAPE  --MAGtape function         (Ø-17₈)
            .TRAN   --Transfer direction       (Ø-3
            .OPER   --Subfunction code         (1-3)
```

WORD 15: .INIT --- User restart address plus code bits (Ø-2)

.READ, .REALR
.WRITE, .REALW --- Line buffer address (checked for memory violation on software protect bound (SCOM+31) if Background job.

.DLETE, .RENAM
.FSTAT, .ENTER, .SEEK --- Address of Directory entry block (checked for memory violation on .SCOM+31 if Background job).

.TRAN --- Core starting address (checked for memory violation on .SCOM+31 if Background job.

WORD 16: .INIT --- Address of Register which is to have standard buffer size placed in it (checked for memory violation on .SCOM+31 if Background job).

.TRAN, .READ, .REALR -- Line buffer word count (from CAL ARG. LIST). Counts are checked for core fit and negative value if Background job.

.WRITE, .REALW --- Line buffer word count (from line buffer word pair ct., except for dump mode and Mode 5 which use counts from CAL argument list.) Counts are checked for core fit and negative value if Background job.

WORD 17: .TRAN --- Device address (Block number)

.FSTAT --- Address of register which will have the device code put in bits Ø-2, (checked for memory violation on. .SCOM+31 if Background job).

.REALR, .REALW --- Address to give control to on completion of I/O request and priority level in bits Ø-2[1], (checked for memory violation on .SCOM+32, the hardware protect bound, if Background job).

[1] If it is a Background CAL, bits Ø-2 of this register will always contain Ø, which indicates Background Mainstream. If it is a Foreground CAL and there is no API, bits Ø-2 contain 1, the Foreground Mainstream code.

Function JMP Table

Ignored functions, functions that do not issue IOT's at the CAL level, and error functions must set up to have the Foreground or Background busy flag (Words 1 and 2, respectively) cleared during the protected exit routine (which begins at LPTIO in the line printer handler).

```
WORD 2Ø:     JMP INIT           /Function 1
WORD 21:     JMP OPER           /Function 2
WORD 22:     JMP SEEK           /Function 3
WORD 23:     JMP ENTER          /Function 4
WORD 24:     JMP CLEAR          /Function 5
WORD 25:     JMP CLOSE          /Function 6
WORD 26:     JMP MTAPE          /Function 7
WORD 27:     JMP READ (.REALR)  /Function 1Ø
WORD 30:     JMP WRITE (.REALW)/Function 11
WORD 31:     NOP                /.WAIT or .WAITR never get to
                                   I/O handler
WORD 32:     JMP TRAN           /Function 13

WORD 33:     Ø                  /Storage for .SCOM+35, the "in
                                   an interrupt service" flag.
WORD 34:     SUBRF              /Stop FGRD I/O subroutine
```

When the Foreground job terminates (.EXIT, ↑C, terminal error, etc.) this routine in every Foreground device is called at Mainstream level to effect the controlled shutting down of the device (see 7.4).

```
WORD 35:     SUBRF              /Stop BGRD I/O subroutine
```

For single user device handlers (devices that cannot be shared by Foreground and Background), the same subroutine can be used for FGRD and BGRD STOP I/O.

```
WORD 36:     Ø                  /Handler I.D. code
```

This word has other values (Non-Ø) for devices that require special consideration from the CAL handler.

7.2.1 .SETUP

On the first (and only on the first) .INIT to a device handler, the device handler must call .SETUP to connect the device handler's interrupt service routine to the appropriate API channel register or program interrupt skip chain entries. The address of .SETUP can be found in .SCOM+55 (155_8).

Calling sequence:

```
LAC*        (.SCOM+55
DAC         LPTEMP
JMS*        LPTEMP
LSDF                        /SKIP IOT
LPINT                       /ADDRESS OF INTERRUPT SERVICE
```

If this is not done, the first hardware interrupt for this device will be deemed an illegal interrupt and processed accordingly.

7.2.2 Initiating I/O

It is imperative that all IOT's that initiate hardware operations be executed during protected (API level Ø, IOF) exit from the handler to assure that the exit takes place prior to the hardware operation completing and causing re-entry to the handler at the interrupt level for servicing.

CAL function requests that require more than one hardware operation should cause the 2nd through Nth operations to be initiated at the interrupt level during protected exit. A handler should

not cause sitting on a CAL until the entire function is completed because this prevents optimum usage of central processor time for the duration of the function. The user cannot do other things while the hardware operations proceed.

7.2.3 .OPER Functions

.OPER functions (.FSTAT, .RENAM and .DLETE) are unique in that they return information in the AC. For device handlers that wish to utilize this function, the method is as follows:

> On completion of .OPER operation, the interrupt service level of the handler sets the appropriate close register (Word 3 if Foreground, Word 4 if Background) to:
>
> 1=File not present
>
> INFORMATION+1=File present (where information is the device block number).
>
> The information must not = -1

As at the completion of other I/O requests, it sets up to have the appropriate busy flag (Word 1 if Foreground, Word 2 if Background) cleared during protected exit.

7.3 FORMAT OF DEVICE HANDLER'S INTERRUPT PROCESSOR

Figure 7-1 contains a detailed flow chart of the interrupt service routine of a single-user handler. This is the actual flow chart of the LPA. handler whose listing is appended to this section for reference.

Interrupt Processor of Device
Handler in BACKGROUND/FOREGROUND
MONITOR Environment

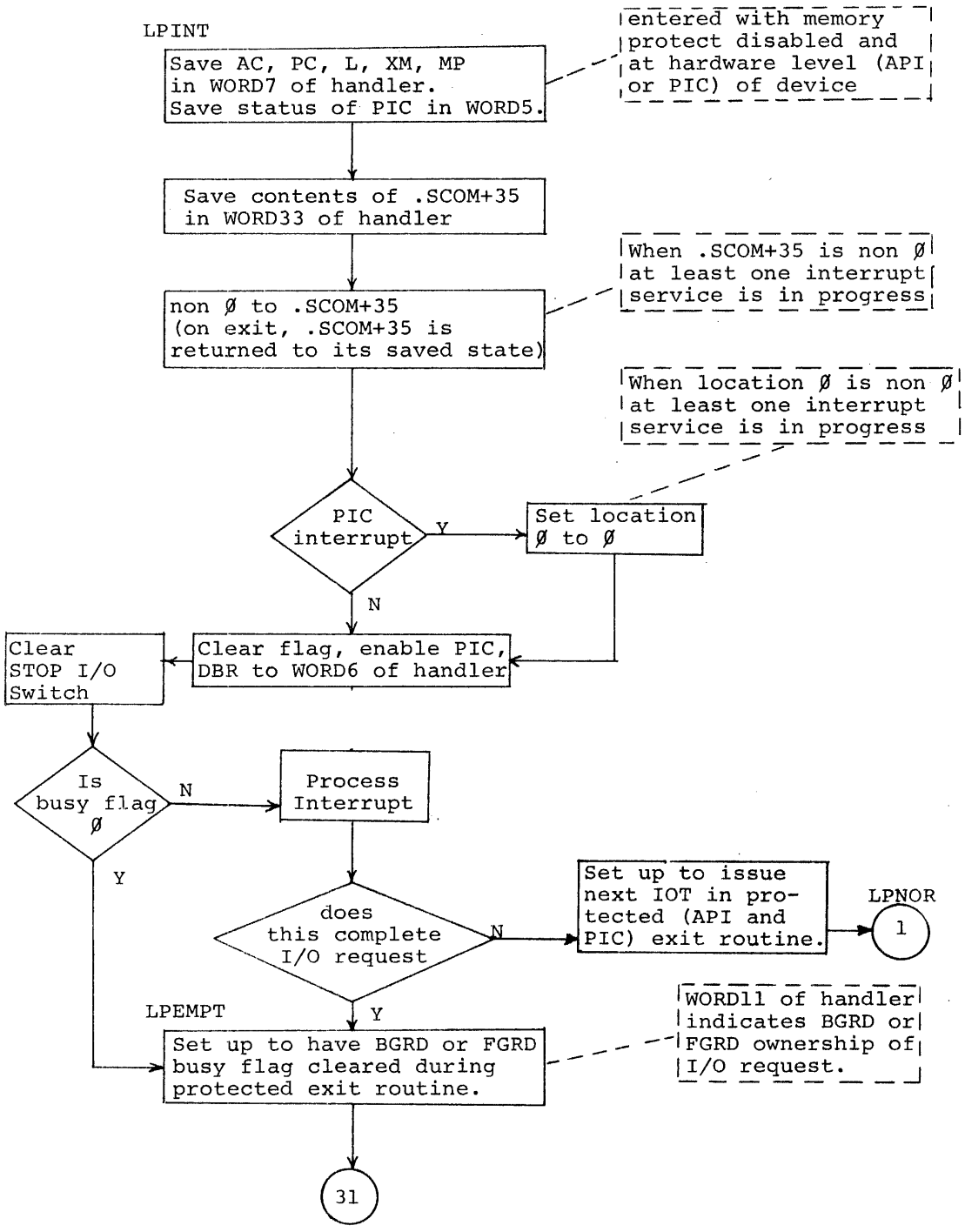


Figure 7-1 Interrupt Service Routine, Flow Chart

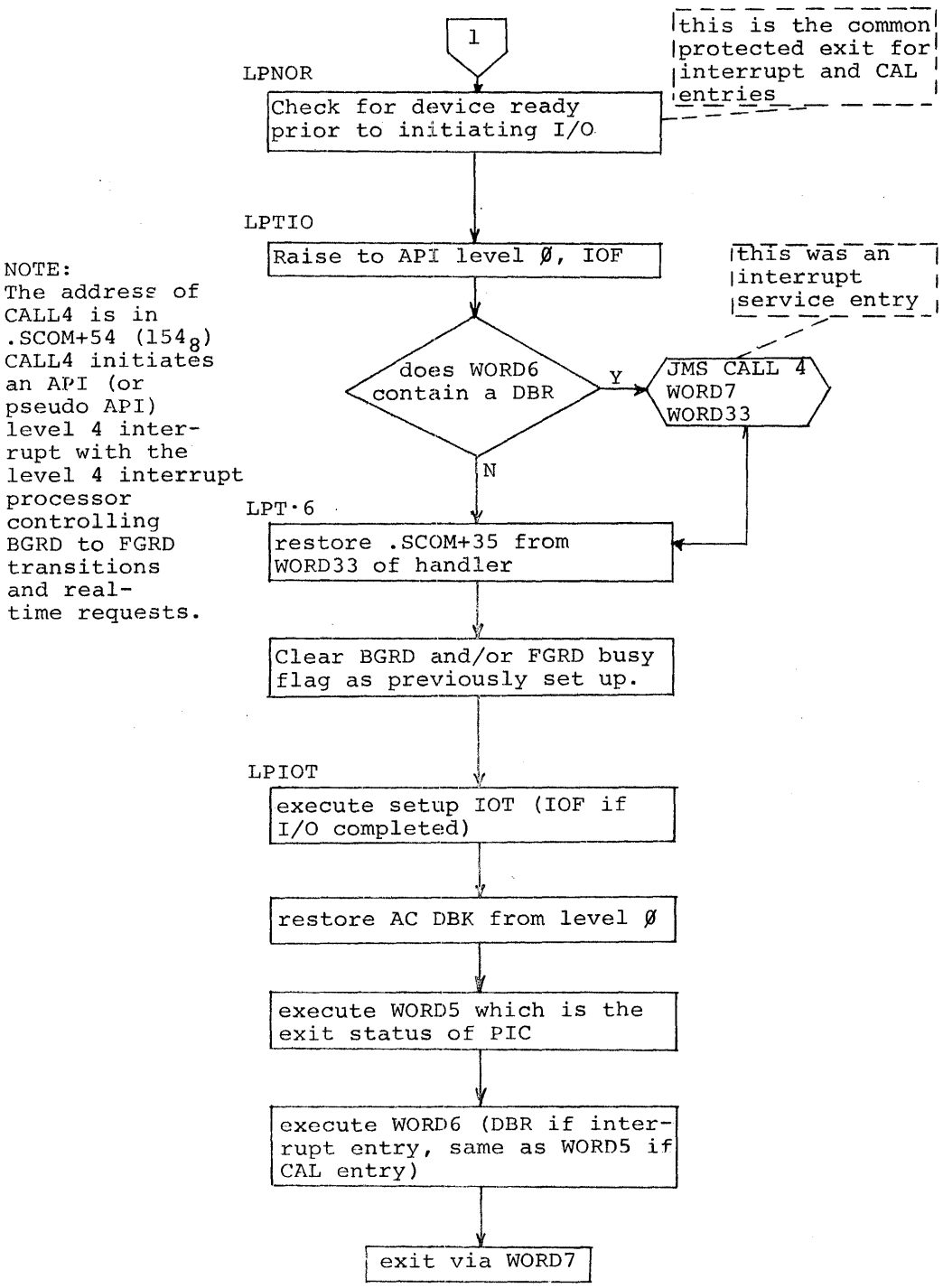
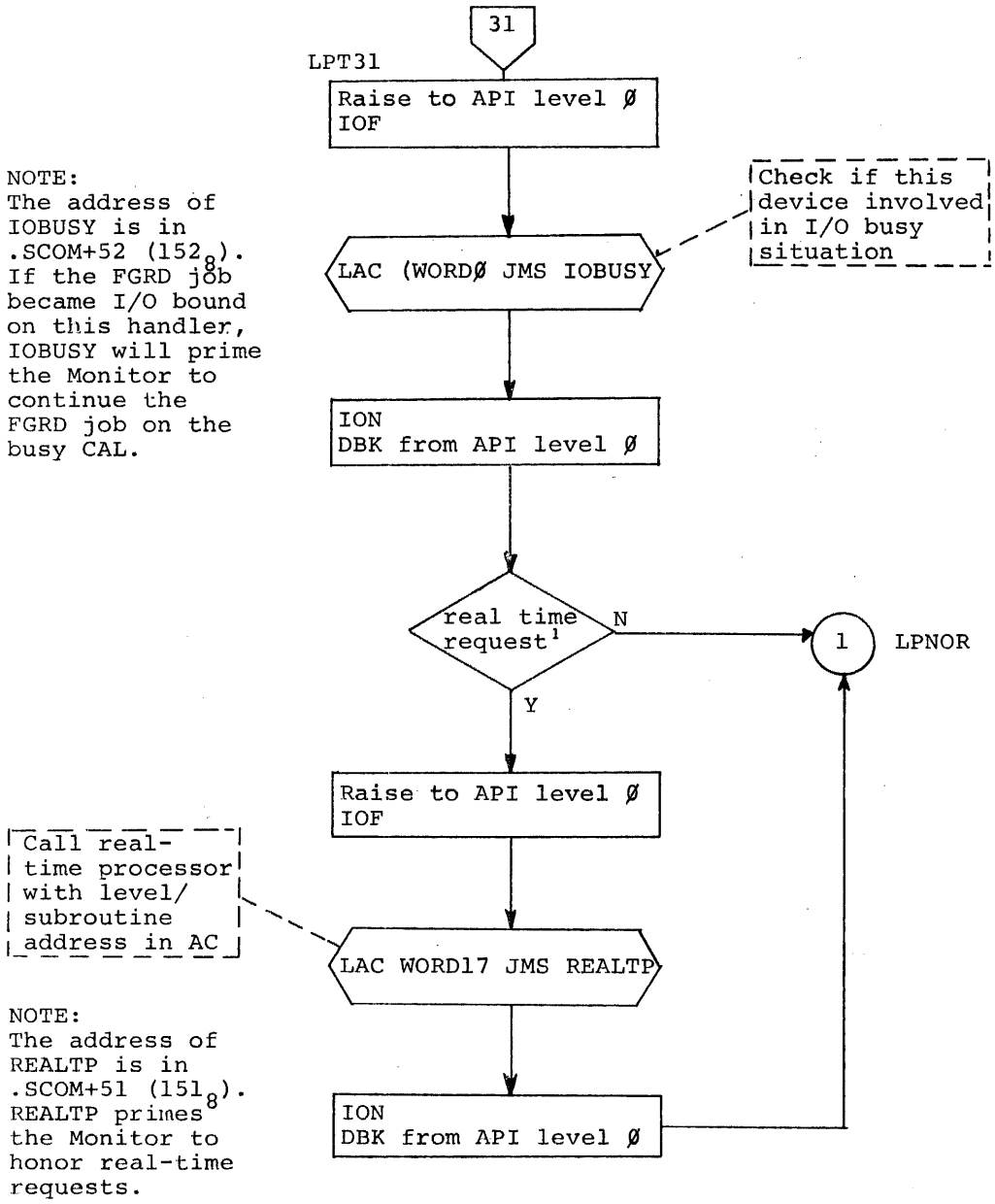


Figure 7-1 (Cont.)



[1]To determine whether the completed operation is real-time:

a) WORD1Ø must contain a JMP to WORD27 (READ or .REALR) or WORD3Ø (.WRITE or .REALW).

b) and WORD17 must be non-Ø.

Figure 7-1 (Cont.)

Please note that interrupt service routines (the code beginning at LPINT in the LPA. handler) must be set up to operate with or without API.

7.4 SYSTEM ANNOUNCEMENTS

7.4.1 Errors

All device handler error messages should be terminal; that is, should terminate the operation of user programs. After the printing of the error message, the user has the option of typing CTRL P (to restart his program at the CTRL P restart address), CTRL T (to return to DDT), CTRL Q (to take a dump of memory), or CTRL C (to return to the Monitor to load another job).

Device handlers that wish to set up an error condition should use the following coding sequence:

```
        LAC*    (.SCOM+66               /POINTER TO ERRORQ
        DAC     TEMP                    /SUBROUTINE.
        LAC     (4ØØ2ØØ                 /RAISE TO API
        ISA                             /LEVEL Ø.
        IOF
        LAW     CODE                    /SEE BELOW.
        JMS*    TEMP                    /CALL ERRORQ.
AUXARG  XX                              /AUXILIARY ARGUMENT.
        DBK                             /RETURN HERE.
        ION
  /CLEAR BUSY FLAG (WORD 1 or WORD 2)
  /EXIT HANDLER VIA PROTECTED EXIT.
```

The first argument, given in the AC to ERRORQ, may be loaded either by LAW code or by LAC code in the following format:

Code

Bits Ø-5 are ignored
Bit 6=1 means terminal error
Bit 7=1 means Background error[1]
Bit 8=1 means Foreground error[1]
Bits 9-17 is a 3-digit error code

The auxiliary argument, following the JMS to ERRORQ, will be printed in the error message as a 6-digit octal number. The error message will be printed in the form:

.ERR NNN XXXXXX

where NNN = the 3-digit error code

XXXXXX = the 6-digit auxiliary information

The actual printing of the error message and processing of the error will be done only after all interrupt processing has ceased and when control is no longer in the CAL handler.

7.4.2 Recovery from I/O Device Not Ready Condition

The Background/Foreground monitor system is designed to handle simultaneously one not-ready condition per job. This is a limitation but a reasonable one based on Keyboard Monitor (single-user) experience.

I/O handlers that can encounter and detect not-ready conditions must adhere to the following ground rules in their announcement of the non-terminal error and in their continuation once the condition has been corrected.

[1]Bits 7 and 8 may both be set if the error applies to both the Foreground and the Background jobs.

Since all I/O in B/F handlers must be initiated in the common, protected exit routine of the handler (the code beginning at LPNOR in the line printer example), it is there and only there where not-ready conditions should be checked and handled.[1]

Prior to executing the desired IOT, check for not-ready with the code at LPNOR which is as follows:

```
LPNOR           /DO WHATEVER IS NECESSARY
                /TO DETERMINE WHETHER
                /DEVICE (UNIT) IS READY.
JMP LPRDY       /DEVICE READY.
/WITH THE DEVICE (UNIT) NOT READY IT
/IS NOW NECESSARY TO DEFER THE
/DESIRED IOT, ANNOUNCE THE NON-
/TERMINAL ERROR, AND EXIT FROM THE
/HANDLER SET UP TO CONTINUE WHEN
/↑R IS TYPED ON THE USER'S CONTROL
/TELETYPE.
            LAC     LPIOT       /SAVE DESIRED IOT.
            DAC     LPIOTB      /
            LAC     (IOF        /EXECUTE IOF IN
            DAC     LPIOT       /PLACE OF IOT.
            JMS     LPMSG       /INITIATE NOT READY MSG.
LPRDY       .
            .
            .
```

Where the code at LPMSG is as follows:

```
/SUBROUTINE TO CALL A ROUTINE IN THE RESIDENT
/MONITOR TO INITIATE A NOT READY MESSAGE.
/CALLING SEQUENCE:
/       JMS LPMSG
/       RETURN WITH LPCTLR NON-Ø IF
/       REQUEST HONORED, OTHERWISE,
/       LPCTLR IS SET TO Ø AND A
/       TERMINAL ERROR WILL RESULT
/
```

---

[1]The exception to this is when a handler can only determine not ready at the interrupt level; that is, after it has issued the desired IOT and an error flag results.

```
LPMSG           Ø
        /DETERMINE WHICH JOB (FGRD OR BGRD)
        /IS CURRENTLY MANIPULATING THIS DEVICE.
                LAC     LPA.+11         /Ø=FGRD,1=BGRD
                DAC     LPARG1
                LAC     LPCTLR          /EXIT IF MESSAGE
                S%A!CMA                 /ALREADY REQUESTED
                JMP*    LPMSG           /FOR THIS DEVICE.
                DAC     LPCTLR          /SET↑R FLAG.
                LAC     UNITNO          /UNIT NUMBER (BITS
                DAC     LPARG3          /Ø-2) IF APPLICABLE.
                LAC*    (.SCOM+64       /POINTER TO ↑R
                DAC     LPTMP1          /QUEUER IN MONITOR.
                LAC     (4ØØ2ØØ         /RAISE TO API
                ISA                     /LEVEL Ø AND
                IOF                     /TURN OFF PIC.
                JMS*    LPTMP1          /GO TO ↑R QUEUER.
LPARG1          XX                      /Ø=FGRD, 1=BGRD.
                .ASCII  /LP/            /DEVICE NAME
                .LOC    .-1
LPARG3          Ø               /UNIT NUMBER (BITS Ø-2) IF APPLICABLE
                LPFRA +  2ØØØØØ /FGRD↑R SUB AND DEVICE'S API LEVEL
                LPFRA +  2ØØØØØ /BGRD↑R SUB AND DEVICE'S API LEVEL
                D%M     LPCTLR /REQUEST NOT HONORED-TERMINAL ERROR.
                ION             /PIC ON (RETURN HERE IF HONORED).
                DBK             /DEBREAK FROM LVØ
                JMP*    LPMSG
```

Where the code at LPFRA is as follows:

```
/SUBROUTINE ENTERED AT API LEVEL 2, PIC OFF.
/WHEN ↑R IS INPUT FROM KEYBOARD, EVEN IF DEVICE IS
/ONLY CONNECTED TO PIC, AN API HARDWARE
/LEVEL (Ø,1,2,OR 3) MUST HAVE BEEN SPECIFIED.
LPFRA           Ø
                D%M     LPCTLR          /CLEAR ↑R FLAG
        /DO WHATEVER IS NECESSARY
        /TO DETERMINE WHETHER DEVICE (UNIT)
        /IS READY
/IF STILL NOT READY, CALL LPMSG
/TO CAUSE NOT READY MESSAGE TO BE
/OUTPUT AGAIN.
                JMS     LPMSG
                JMP     LPFOUT          /BYPASS IOT.
                LAC     LPIOAC          /AC FOR IOT IF APPLICABLE.
LPIOTB          XX                      /DEFERRED IOT.
LPFOUT          ION                     /PIC ON.
                DBR                     /DEBREAK FROM LEVEL Ø.
                JMP*    LPFRA
/THE CONTROL R(↑R)IN PROGRESS FLAG
/MUST INITIALLY BE CLEARED IN THE
/STOP I/O ROUTINE.
LPCTLR          Ø               /↑R FLAG
```

7.5 STOP I/O TECHNIQUE

In the Background/Foreground Monitor environment, it is necessary to have some orderly means of stopping I/O that is in progress. When a job terminates (.EXIT, ↑C, terminal error, etc.), the Monitor System must assure that all I/O for that job is shut down before it removes the associated device handlers from core. This is accomplished via the following method:

a) Word 34 of every device handler points to the Foreground STOP I/O subroutine which is internal to the handler.

b) Word 35 of every device handler points to the Background STOP I/O subroutine which for single-user handlers can be the same as the Foreground STOP I/O routine.

c) When a job terminates, the Monitor calls the appropriate STOP I/O subroutine at Mainstream level which actually accomplishes the orderly shut down of I/O.

d) For devices that can stop I/O hardwarewise, via an IOT, this plus steps 4, 5, 6, and 9 must be done.

For devices that cannot stop I/O hardwarewise via an IOT, the following procedure can be used:

1) Raise to level Ø of the API and turn off the program interrupt to protect against getting interrupted in mid-decision.

2) Check the ↑R flag. If it is set, clear the software flag that will be tested in Step 8 and bypass Step 3. This is done because no I/O is under way if this handler is waiting on a ↑R.

3) Check the appropriate busy register (WORD1 or WORD2). If it is not set, no I/O is in progress; therefore, we do not have to wait for its completion. If it is set, set a software flag that will be tested in Step 8.

4) Clear the appropriate busy register (WORD1 or WORD2).

5) Clear the appropriate .CLOSE register (WORD3 or WORD4).

6) Clear the ↑R flag (see Section 7.4.2).

7) Debreak (DBK) from API level Ø and turn on the program interrupt to allow servicing of hardware flags that may have or will occur.

8) If the appropriate busy register had been set, sit in a tight loop testing the software flag that was set in Step 3 above,

```
I.E.    LAC         FLAG
        SZA
        JMP         .-2
```

FLAG is the STOP I/O switch that must be cleared (SET=Ø) by the interrupt service routine on all interrupts that are final. Final means that no other flags will occur without more I/O being initiated via an IOT.

The interrupt service routine must also make a decision whether or not to initiate more I/O. When the appropriate busy register (WORD1 or WORD2) has been cleared, (Step 4) this should indicate that no new I/O should be started. (See the flow chart in Section 7.3).

9) Exit from the STOP I/O subroutine.

7.6 SEQUENTIAL MULTI-USER DEVICE HANDLER

To accomplish the transition from a single-user device handler to a sequential multi-user device handler, the following procedures must be adhered to:

a) The device handler must be the "A" version; that is, LPA., MTA., etc. as the Background/ Foreground Monitor System will only allow "A" versions to be connected to both jobs simultaneously. Also, this shareability must be specified to the B/F system at generation time.

b) The SWAP subroutine (pointed to by WORDØ of the handler) must set both busy registers (WORD1 and WORD2) to prevent the Foreground job from forcing itself in before the Background job has completed its operation. This is in addition to and prior to its normal duties as outlined in 7.2.

c) There must be two unique stop I/O subroutines, one for Foreground (pointed to by WORD34) and one for Background (pointed to by WORD35). Before executing the STOP I/O procedures, both subroutines must first determine if the I/O belongs to their respective job. This is done by testing WORD11, (Ø=Foreground I/O, 1=Background I/O). They should do nothing if the other job is in control.

   In Step 2 of the stop I/O Routine, if the ↑R flag is set, the I/O busy routine in the Monitor (pointed to by .SCOM+52) must be called in case the Foreground job is I/O bound on this device.

d) Because the SWAP subroutine sets both busy registers (WORD1 and WORD2), the CLEAR BUSY FLAG routine that sets up to have the flags cleared during protected exit from the device handler must always set up to have both flags cleared. The STOP I/O subroutines should also clear both busy registers.

7.6.1 .WAITR

When a sequential multi-user device handler is being used by the Background job, the Foreground job will become I/O bound if it attempts to use the same handler.

The .WAITR monitor function affords both the Foreground job and the Background job a means of determining that the handler is available before requesting I/O from and to it. This feature is only useful when the job has other things which can be performed while it is waiting for the handler to free up.

7.7 DEVICE HANDLER LISTING

A listing of the Background/Foreground line printer device handler (LPA) is given on pages 7-21 through 7-34 of this section.

```
                                .TITLE LPA.
                               / .... EDIT #4 .... 2 DEC 69
                               /LPA.---BACKGROUND/FOREGROUND MONITOR SYSTEM.
                               /LPA.=LINE PRINTER (647) HANDLER.
                               /CALLING SEQUENCE:
                                        /CAL+.DAT SLOT (9-17)
                                        /FUNCTION
                                        /N ARGUMENTS, WHERE N IS A FUNCTION OF FUNCTION.
                                        /NORMAL RETURN
          706501  A     LSDF=706501       /SKIP ON DONE FLAG -CONNECTED TO INTERRUPT
          706502  A     LPCB=706502       /CLEAR DONE FLAG, CLEAR PRINTER BUFFER,
                                          /SET DONE FLAG
          706566  A     LPL1=706566       /LOAD PRINTER BUFFER 1 CHAR (AC 12-17)
          706526  A     LPL2=706526       /LOAD PRINTER BUFFER 2 CHAR (AC 6-11, 12-17)
          706546  A     LPLD=706546       /LOAD PRINTER BUFFER 3 CHAR (AC 0-5,6-11,12-8)
          706601  A     LSEF=706601       /SKIP ON ERROR FLAG -NOT CONNECTED TO
                                          /INTERRUPT
          706602  A     LPCF=706602       /CLEAR DONE FLAG
          706606  A     LPPB=706606       /CLEAR DONE FLAG, SELECT PRINTER,
                                          /PRINT BUFFER, CLEAR BUFFER, SET DONE FLAG
          706626  A     LPLS=706626       /LOAD SPACING BUFFER (AC 15-17), SPACE
                                          /SET DONE FLAG
          000003  A     .MED=3
          000100  A     .SCOM=100
                                .GLOBL LPA.
00000  R  100525  R     LPA.    JMS       SWAP
00001  R  000000  A             0                          /FOREGROUND BUSY REGISTER.
00002  R  000000  A             0                          /BACKGROUND BUSY REGISTER
00003  R  000000  A             0                          /FOREGROUND .CLOSE REGISTER.
00004  R  000000  A             0                          /BACKGROUND .CLOSE REGISTER.
00005  R  740040  A     LPSWCH  XX                         /ION OR IOF
00006  R  740040  A     LPWRD6  XX                         /ION OR IOF OR DBR
00007  R  740040  A     LPTOUT  XX                         /RETURN POINTER
                        /START OF DATA REGISTERS.
                        /FOR SINGLE-USER DEVICES.
00010  R  740040  A     LPWD10  XX                         /JMP FUNCTB
00011  R  740040  A             XX                         /CAL OWNER (0=F,1=B)
00012  R  740040  A     LV2WC   XX                         /.DAT SLOT NUMBER
00013  R  740040  A     LPSVAC  XX                         /UNIT NUMBER (BITS 0-2) CAL ADDRESS (BITS 3-17)
00014  R  740040  A     LPWPC   XX                         /W14
00015  R  740040  A     LPLBHP  XX                         /W15 - LINE BUFFER ADDRESS.
00016  R  740040  A     LP8CT   XX                         /W16
00017  R  740040  A     LPWD17  XX                         /W17
                        /END OF DATA REGISTERS.
                        /BEGINNING OF FUNCTION DISPATCH TABLE.
00020  R  600046  R             JMP LPIN                   /.INIT
00021  R  600523  R             JMP LPIGN                  /.OPER - IGNORED.
00022  R  600512  R             JMP LPERR                  /.SEEK - ERROR.
00023  R  600523  R             JMP LPIGN                  /.ENTER - IGNORED.
00024  R  600523  R             JMP LPIGN                  /.CLEAR - IGNORED.
00025  R  600040  R             JMP LPCLOS                 /.CLOSE
00026  R  600523  R             JMP LPIGN                  /.MTAPE - IGNORED
00027  R  600512  R             JMP LPERR                  /.READ (.REALR) - ERROR
00030  R  600167  R     LWRITE  JMP LPWRT                  /.WRITE (.REALW)
00031  R  740040  A     LV2FC   XX                         /.WAIT (.WAITR) PROCESSED COMPLETELY BY CAL HANDL
```

```
00032 R 600512 R                JMP LPERR                       /.TRAN - ERROR
00033 R 740040 A    SCOM35      XX                              /STORAGE FOR .SCOM+35
00034 R 000531 R                LPSTP               /FGRD STOP I/O SUBROUTINE
00035 R 000531 R                LPSTP               /BGRD STOP I/O SUBROUTINE
00036 R 000000 A    LPZERO      0                   /HANDLER ID
00037 R 000000 A    LPTMP1      0
                    /.CLOSE LPT ROUTINE
00040 R 140212 R    LPCLOS      DZM LV2WC           /FORM FEED.
00041 R 140434 R                DZM PGECNT          /INITIALIZE #LINES/PAGE COUNTER
00042 R 750001 A                CLA!CMA
00043 R 040435 R                DAC LPIOAC
00044 R 200602 R    LPSPCE      LAC (LPLS           /SET UP TO DO I/O DURING
00045 R 600064 R                JMP LPCOMD          /PROTECTED EXIT.
                    /INIT LPT ROUTINE.
00046 R 750001 A    LPIN        CLA!CMA
00047 R 040012 R                DAC LV2WC
00050 R 040031 R                DAC LV2FC           /SET UP FOR FORM FEED ON INTERRUPT FROM LPCB.
00051 R 200603 R                LAC (64             /52 (DECIMAL)---RETURN
00052 R 060016 R                DAC* LPA.+16                    /STANDARD LINE BUFFER SIZE TO USER.
00053 R 220604 R    LPIN2       LAC* (.SCOM+55                  / - ONCE ONLY CODE.
00054 R 040053 R                DAC LPIN2
00055 R 120053 R    LP57T       JMS* LPIN2          /.SETUP - THESE 6 REGISTERS ARE OVERLAYED.
00056 R 706501 A                LSDF
00057 R 000350 R                LPINT
00060 R 200062 R    LPWORD      LAC .+2
00061 R 040053 R    LPHRTB      DAC LPIN2
00062 R 600063 R    LP3CHR      JMP .+1
00063 R 200605 R                LAC (LPCB
00064 R 040110 R    LPCOMD      DAC LPIOT
                    /COMMON EXIT SEQUENCE FOR CAL LEVEL
                    /AND INTERRUPT LEVEL ENTRIES.
                    /
                    /
00065 R 100120 R    LPNOR       JMS         LPNRDY          /CHECK IF DEVICE READY.
00066 R 220606 R                LAC*        (.SCOM+54       /ADDRESS
00067 R 040037 R                DAC         LPTMP1          /OF CALL4
00070 R 100571 R    LPTIO       JMS         LPRAIS          /RAISE TO API LEVEL 0, TURN PIC OFF.
00071 R 200006 R                LAC         LPWRD6
00072 R 540165 R                SAD         LPDBR
00073 R 741000 A                SKP                         /INTERRUPT
00074 R 600100 R                JMP         LPT.6           /CAL
00075 R 120037 R                JMS*        LPTMP1
00076 R 000007 R                LPA.+7                      /PC
00077 R 000033 R                SCOM35
00100 R 200033 R    LPT.6       LAC         SCOM35          /RESTORE IN INTERRUPT
00101 R 060607 R                DAC*        (.SCOM+35       /HANDLER FLAG.
00102 R 740000 A    LPFCLR      NOP                         /NOP IF FGRD BUSY FLAG NOT TO BE CLEARED
00103 R 740000 A    LPBCLR      NOP                         /NOP IF BGRD BUSY FLAG NOT TO BE CLEARED
00104 R 200610 R                LAC         (NOP            /RESET
00105 R 040102 R                DAC         LPFCLR          /SWITCHES.
00106 R 040103 R                DAC         LPBCLR
00107 R 200435 R                LAC         LPIOAC          /AC FOR IOT
00110 R 740040 A    LPIOT       XX                          /IOF OR IOT
00111 R 200013 R                LAC LPSVAC                  /RESTORE AC.
00112 R 703304 A                DBK                         /FROM LEVEL 0.
```

```
00113  R  400005  R                XCT LPA.+5                      /ION OR IOF
00114  R  400006  R                XCT LPA.+6                      /ION OR IOF OR DBR
00115  R  400116  R                XCT .+1
00116  R  400117  R                XCT .+1
00117  R  620007  R                JMP*      LPA.+7                /RETURN POINTER
00120  R  000000  A      LPNRDY    0
00121  R  706601  A                LSEF
00122  R  620120  R                JMP* LPNRDY                     /DEVICE READY.
00123  R  200110  R                LAC LPIOT           /SAVE IOT.
00124  R  040163  R                DAC LPIOTB
00125  R  200574  R                LAC LPIOF           /EFFECTIVELY DEFER IOT.
00126  R  040110  R                DAC LPIOT
00127  R  100131  R                JMS LPMSG           /INITIATE NOT READY REQUEST.
00130  R  620120  R                JMP* LPNRDY
                   /SUBROUTINE TO CALL A ROUTINE IN THE RESIDENT MONITOR TO
                   /INITIATE A NOT READY REQUEST.
                   /CALLING SEQUENCE:
                   /          JMS LPMSG
                   /          RETURN WITH LPCTLR NON-0 IF REQUEST
                   /          HONORED; 0 OTHERWISE.
                   /
00131  R  000000  A      LPMSG     0
00132  R  200556  R                LAC       LPCTLR                /+R FLAG.
00133  R  740201  A                SZA!CMA                         /AVOID DUPLICATE CALL.
00134  R  620131  R                JMP*      LPMSG                 /.ERR 4 ALREADY REQUESTED.
00135  R  040556  R                DAC       LPCTLR                /SET +R IN PROGRESS FLAG.
00136  R  200011  R                LAC       LPA.+11               /0=FGRD, 1=BGRD
00137  R  040144  R                DAC       LPARG1
00140  R  220611  R                LAC*      (.SCOM+64             /POINTER TO +R QUEUER
00141  R  040037  R                DAC       LPTMP1
00142  R  100571  R                JMS       LPRAIS                /TO API LEVEL 0, PIC OFF
00143  R  120037  R                JMS*      LPTMP1                /GO TO +R QUEUER
00144  R  740040  A      LPARG1    XX                              /0=FGRD, 1=BGRD
00145  R  462400  A                .ASCII /LP/
00146  R  000000  A
00146  R                           .LOC      .-1
00146  R  000000  A                0                               /UNIT NUMBER
00147  R  200154  R                LPFRA+200000                    /RETURN ADDRESS AT LEVEL 2
00150  R  200154  R                LPFRA+200000                    /SAME FOR BGRD
                   /
00151  R  140556  R                DZM       LPCTLR                /TERMINAL ERROR. REQUEST NOT HONORED
00152  R  100576  R                JMS       LPLOWR                /PIC ON, DEBREAK FROM LV 0
00153  R  620131  R                JMP*      LPMSG
                   /
                   /SUBROUTINE ENTERED AT API LEVEL 2, PIC OFF, WHEN +R FROM KEYBOARD
                   /IS ASSOCIATED WITH LINE PRINTER.
                   /
00154  R  000000  A      LPFRA     0
00155  R  140556  R                DZM       LPCTLR                /CLEAR +R FLAG
00156  R  706601  A                LSEF
00157  R  600162  R                JMP       .+3
00160  R  100131  R                JMS       LPMSG                 /NOT READY CONDITION
00161  R  600164  R                JMP       LPIOTB+1              /NOT CORRECTED.
00162  R  200435  R                LAC       LPIOAC                /AC FOR IOT
00163  R  740040  A      LPIOTB    XX                              /EXECUTE SAVED IOT.
```

```
00164  R  700042  A                IOS
00165  R  703344  A       LPDBR    DBR                          /FROM LEVEL 2
00166  R  620154  R                JMP*     LPERA
                        /WRITE LPT ROUTINE.
00167  R  750001  A       LPWRT    CLA!CMA
00170  R  040450  R                DAC LP5CH            /INIT BEFORE CALL TO .LPCONV
00171  R  200014  R                LAC LPA.+14                  /DATA MODE BITS 15-17
00172  R  540612  R                SAD (2
00173  R  600176  R                JMP LPOK             /IOPS ASCII
00174  R  765007  A                LAW 5007             /ILLEGAL DATA MODE.
00175  R  600513  R                JMP      LPER06+1
00176  R  220015  R       LPOK     LAC* LPLBHP          /WPC
00177  R  500613  R                AND (377000
00200  R  040014  R                DAC LPWPC
00201  R  140012  R                DZM LV2WC
00202  R  440015  R                ISZ LPLBHP           /MOVE L.B. POINTER (IN USER'S
00203  R  440015  R                ISZ LPLBHP           /AREA) TO 1ST DATA WORD.
00204  R  140031  R                DZM LV2FC            /IOPS ASCII MODE NO FORM CONTROL
00205  R  777770  A                LAW 17770            /INITIALIZE SWITCH AT LPCONV
00206  R  040212  R                DAC LPCONV
00207  R  777775  A       LPTSTR   LAW 17775            /3 CHAR. COUNTER FOR
00210  R  040062  R                DAC LP3CHR           /3/6 WORD.
00211  R  140060  R                DZM LPWORD           /CLEAR DATA WORD.
                                   /THIS ROUTINE GETS THE
                                   /NEXT 7-BIT ASCII CHAR.
                                   /FROM THE 5/7 LINE BUFFER (USER'S AREA)
                                   /IT RETURNS WITH IT RIGHT
                                   /JUSTIFIED IN AN OTHERWISE
                                   /CLEAR AC.
                                   /LP5CH MUST BE SET TO
                                   /777777 BEFORE THE INITIAL
                                   /CALL TO LPCONV, LPWPC TO WPC INCLUDING HEADER.
                                   /LPLBHP TO 1ST DATA WORD IN L.B.(USER'S AREA)
00212  R  777770  A       LPCONV   LAW 17770            /INITIALIZATION
00213  R  040016  R                DAC LP8CT            /FOR
00214  R  200614  R                LAC (SAD LPCTAB      /CONTROL CHAR.
00215  R  040304  R                DAC LPVTST                   /SCANNING.
00216  R  440450  R                ISZ LP5CH            /MODIFIED FOR HOR. TAB.
00217  R  600235  R                JMP LPGET5           /THIS 5/7 PAIR NOT EXHAUSTED.
00220  R  777000  A                LAW 17000
00221  R  340014  R                TAD LPWPC
00222  R  040014  R                DAC LPWPC            /SKIP ON NON 0.
00223  R  741300  A                SNA!SPA
00224  R  600301  R                JMP LPEND            /WORD PAIRS EXHAUSTED
00225  R  220015  R                LAC* LPLBHP          /PICK UP NEXT
00226  R  040055  R                DAC LP57T            /WORD PAIR
00227  R  440015  R                ISZ LPLBHP
00230  R  220015  R                LAC* LPLBHP
00231  R  040056  R                DAC LP57T+1
00232  R  440015  R                ISZ LPLBHP
00233  R  777773  A                LAW 17773            /RESET CHAR. COUNTER
00234  R  040450  R                DAC LP5CH            /FOR THIS WORD PAIR
00235  R  777770  A       LPGET5   LAW 17770
00236  R  040057  R                DAC LP57T+2          /GO THROUGH SHIFT LOOP 7 1/2 TIMES.
00237  R  200056  R       LPGET6   LAC LP57T+1
```

```
00242  R  740010  A                RAL
00241  R  440057  R                ISZ LP57T+2
00242  R  600245  R                JMP .+3
00243  R  500615  R                AND (177              /GOT CHARACTER.
00244  R  600252  R                JMP LPCON1
00245  R  040056  R                DAC LP57T+1
00246  R  200055  R                LAC LP57T
00247  R  740010  A                RAL
00250  R  040055  R                DAC LP57T
00251  R  600237  R                JMP LPGET6
00252  R  540615  R  LPCON1        SAD (177
00253  R  600212  R                JMP LPCONV            /DELETE RUBOUTS.
00254  R  340357  R                TAD LPM40             /-40
00255  R  741100  A                SPA
00256  R  600304  R                JMP LPVTST            /CHAR. <40---CONTROL CHAR.
00257  R  340616  R                TAD (777700           /-100
00260  R  741100  A                SPA
00261  R  340617  R                TAD (40
00262  R  340620  R                TAD (100              /140-176 MAPPED INTO 100-136
00263  R  500621  R  LPCON2        AND (77               /6-BIT TRIMMED.
00264  R  240060  R                XOR LPWORD            /CONSTRUCT 3/6 WORD.
00265  R  440062  R                ISZ LP3CHR            /3 CHARACTER COUNTER.
00266  R  600273  R                JMP LPCON3
                                                         /DATA WORD COMPLETE.
00267  R  440012  R                ISZ LV2WC             /INDEX DATA WORD COUNT
00270  R  040435  R                DAC LPIOAC
00271  R  200622  R                LAC (LPLD
00272  R  600064  R                JMP LPCOMD
00273  R  742010  A  LPCON3        RTL                   /SHIFT CHARS. LEFT
00274  R  742010  A                RTL
00275  R  742010  A                RTL
00276  R  500616  R                AND (777700           /IN CASE LINK WAS ON.
00277  R  040060  R                DAC LPWORD
00300  R  600212  R                JMP LPCONV            /GET NEXT CHAR.
                          /END OF CHARACTER STRING OR CARR. RETURN (IOPS ASCII)
00301  R  200623  R  LPEND         LAC (47
00302  R  040012  R                DAC LV2WC
00303  R  600332  R                JMP LPHT3             /PAD LAST WORD WITH SPACES.
                          /CONTROL CHARACTER ROUTINE, - CHAR. IN AC.
00304  R  740040  A  LPVTST        XX                    /SAD LPCTAB-SAD LPCTAB+7
00305  R  600316  R                JMP LPFORM            /VERTICAL FORM CONTROL CHAR.
00306  R  440304  R                ISZ LPVTST            /SAD LPCTAB+N-SAD LPCTAB+N+1
00307  R  440016  R                ISZ LP8CT
00310  R  600304  R                JMP LPVTST
00311  R  540446  R                SAD LPCTAB+10
00312  R  600301  R                JMP LPEND             /CARRIAGE RETURN.
00313  R  540447  R                SAD LPCTAB+11
00314  R  600321  R                JMP LPHT              /HORIZONTAL TAB.
00315  R  600212  R                JMP LPCONV            /DELETE MEANINGLESS CHAR.
                          /COMPUTE FORM CONTROL CODE AND PLACE
                          /IN LV2FC
00316  R  200016  R  LPFORM        LAC LP8CT
00317  R  040031  R                DAC LV2FC             /L.B.H. IN D.B.
00320  R  600212  R                JMP LPCONV
                          /CONVERT HOR. TAB TO N SPACES, WHERE N IS THE NUMBER
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                        /NECESSARY TO HAVE THE NEXT CHAR. IN COLUMN 11,21,31,41,51...,111.
00321 R 200012 R    LPHT    LAC LV2WC           /DATA WORD COUNT
00322 R 744010 A            CLL!RAL             /X2
00323 R 340012 R            TAD LV2WC           /X3
00324 R 340624 R            TAD (4
00325 R 340062 R            TAD LP3CHR          /CURRENT WORD CHAR. COUNTER.
00326 R 340625 R            TAD (777766         /-10 (DECIMAL)
00327 R 740300 A            SMA!SZA
00330 R 600326 R            JMP .-2
00331 R 340425 R            TAD LPOVRP
00332 R 040061 R    LPHT3   DAC LPHRTB
00333 R 200626 R            LAC (JMP LPHT2
00334 R 040212 R            DAC LPCONV
00335 R 760040 A    LPHT2   LAW 40
00336 R 440061 R            ISZ LPHRTB
00337 R 600263 R            JMP LPCON2
00340 R 777770 A            LAW 17770
00341 R 040212 R            DAC LPCONV
00342 R 600212 R            JMP LPCONV
                        /INTERRUPT HANDLER.
00343 R 040013 R    LPPIC   DAC LPSVAC          /SAVE AC
00344 R 220036 R            LAC* LPZERO
00345 R 040007 R            DAC LPTOUT          /SAVE PC, L, EM, MP
00346 R 200372 R            LAC LPION
00347 R 600361 R            JMP LPSTON
00350 R 600343 R    LPINT   JMP LPPIC           /PIC ENTRY.
00351 R 040013 R            DAC LPSVAC          /API ENTRY, SAVE AC.
00352 R 200350 R            LAC LPINT           /PC, L, EM, MP
00353 R 040007 R            DAC LPTOUT
00354 R 140350 R            DZM     LPINT       /0=API ENTRY
00355 R 700314 A            IORS                /READ I/O STATUS
00356 R 750100 A            SMA!CLA
00357 R 777740 A    LPM40   LAW 17740           /PIC OFF -- BUILD IOF
00360 R 340372 R            TAD LPION           /PIC ON -- ION
00361 R 040005 R    LPSTON  DAC LPSWCH
00362 R 220607 R            LAC* (.SCOM+35
00363 R 040033 R            DAC SCOM35
00364 R 750001 A            CLA!CMA
00365 R 060607 R            DAC* (.SCOM+35
00366 R 200350 R            LAC     LPINT
00367 R 740200 A            SZA
00370 R 160036 R            DZM*    LPZERO      /PIC ENTRY
00371 R 706602 A            LPCF                /CLEAR LPT DONE FLAG
00372 R 700042 A    LPION   ION                 /ENABLE PIC
00373 R 200165 R            LAC LPDBR
00374 R 040006 R            DAC LPWRD6
00375 R 140555 R            DZM     LPSTPS              /CLEAR STOP I/O SWITCH
00376 R 200001 R            LAC     LPA.+1
00377 R 340002 R            TAD     LPA.+2
00400 R 741200 A            SNA                         /DO NOT CONTINUE I/O IF
00401 R 600451 R            JMP     LPEMPT              /BOTH BUSY FLAGS ARE  0
                        /INITIATE MORE OUTPUT IF APPROPRIATE.
00402 R 200012 R    LPTOK   LAC LV2WC
00403 R 741200 A            SNA
00404 R 600451 R            JMP LPEMPT
```

```
00405  R  741100  A                SPA
00406  R  600412  R                JMP LPCLSE
00407  R  540627  R                SAD (50             /BUFFER FULL.
00410  R  600413  R                JMP LPSPPR
00411  R  600207  R                JMP LPTSTR
00412  R  140012  R  LPCLSE        DZM LV2WC
00413  R  777706  A  LPSPPR        LAW 17706           /IS PAGE FULL?
00414  R  340434  R                TAD PGECNT
00415  R  740201  A                SZA!CMA             /YES - FORM FEED
00416  R  200031  R                LAC LV2FC
00417  R  540425  R                SAD LPOVRP
00420  R  600430  R                JMP LPOVER          /OVERPRINT.
00421  R  500630  R                AND (7
00422  R  540630  R                SAD (7
00423  R  140434  R                DZM PGECNT          /INIT #LINES/PAGE CNT
00424  R  040435  R  LPVMOV        DAC LPIOAC          /VERT. SPACING BEFORE PRINTING
00425  R  777776  A  LPOVRP        LAW 17776
00426  R  040031  R                DAC LV2FC
00427  R  600044  R                JMP LPSPCE
                    /WORD COUNT EXHAUSTED.
00430  R  140012  R  LPOVER        DZM LV2WC
00431  R  440434  R                ISZ PGECNT          /INCREMENT #LINES/PAGE CNT
00432  R  200631  R                LAC (LPPB           /PRINT BUFFER.
00433  R  600064  R                JMP LPCOMD
00434  R  000000  A  PGECNT        0          /INITIALIZED TO 0 WHEN AT TOP OF FORM
                                              /INCREMENTED BY 1 UNTIL 58(10) LINES
                                              /  HAVE BEEN OUTPUT OR FORM FEED IS ENCOUNTERED
00435  R  000000  A  LPIOAC        0
                                   /TABLE OF ASCII CONTROL CHAR'S SCANNED BY LPT IN IOPS ASCII MODE
00436  R  777752  A  LPCTAB        777752     /LF-EVERY LINE 0      ---12
00437  R  777761  A                777761     /DC1-EVERY 2ND LINE 1          ---21
00440  R  777762  A                777762     /DC2-EVERY 3RD LINE 2          ---22
00441  R  777753  A                777753     /VT-EVERY 6TH LINE 3           ---13
00442  R  777763  A                777763     /DC3-EVERY 10TH LINE 4         ---23
00443  R  777764  A                777764     /DC4-EVERY 20TH LINE 5         ---24
00444  R  777760  A                777760     /DLE-OVER PRINT 6    ---20
00445  R  777754  A                777754     /FF-TOP ON NEXT FORM 7         ---14
00446  R  777755  A                777755     /CR                  ---15
00447  R  777751  A                777751     /HT                  ---11
00450  R  000000  A  LP5CH         0                             /5/7 COUNTER
                    /SET UP SWITCH IN EXIT ROUTINE TO
                    /CLEAR FOREGROUND OR BACKGROUND BUSY REGISTER AS
                    /A FUNCTION OF WORD11, AND PLACE IOF IN LPT
                    /IOT REGISTER SO THAT NO NEW I/O WILL BE STARTED.
00451  R  100476  R  LPEMPT         JMS        CLFLAG
                    /IS THIS DEVICE INVOLVED IN I/O BUSY SITUATION.
00452  R  220632  R  LPT31          LAC*       (.SCOM+52            /ADDRESS OF
00453  R  040037  R                 DAC        LPTMP1               /I/O BUSY TESTER
00454  R  100571  R                 JMS        LPRAIS               /RAISE TO LEVEL 0 AND TURN OFF PIC
00455  R  200633  R                 LAC        (LPA.
00456  R  120037  R                 JMS*       LPTMP1
00457  R  100576  R                 JMS        LPLOWR
                    /
                    /ROUTINE TO DETERMINE IF THIS I/O
                    /WAS A REAL TIME REQUEST OR NOT.
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00460 R 200017 R            LAC       LPWD17              /NOW 0 IF REAL TIME.
00461 R 741200 A            SNA
00462 R 600065 R            JMP       LPNOR               /NOT .REALW
00463 R 200634 R            LAC       (JMP LWRITE
00464 R 540010 R            SAD       LPWD10              /JMP FUNCTION
00465 R 741000 A            SKP                           /.REALW
00466 R 600065 R            JMP       LPNOR               /NOT REAL TIME REQUEST.
00467 R 220635 R            LAC*      (.SCOM+51           /ADDR. OF
00470 R 040037 R            DAC       LPTMP1              /REAL TIME PROCESSOR
00471 R 100571 R            JMS       LPRAIS
00472 R 200017 R            LAC       LPWD17
00473 R 120037 R            JMS*      LPTMP1
00474 R 100576 R            JMS       LPLOWR
00475 R 600065 R            JMP       LPNOR
                      /SUBROUTINE TO SET UP CLEARING OF THE
                      /APPROPRIATE BUSY FLAG (AT PROTECTED EXIT TIME)
                      /AND NULL (IOF) LINE PRINTER IOT
                      /REGISTER.
00476 R 000000 A      CLFLAG    0
00477 R 200574 R            LAC       LPIOF               /IOF
00500 R 040110 R            DAC       LPIOT
00501 R 200011 R            LAC       LPA.+11             /WORD 11 OF LIVE REGS.
00502 R 740200 A            SZA                           /0=FGRD, 1=BGRD
00503 R 600507 R            JMP       .+4
00504 R 200543 R            LAC       LPFBSY              /FOREGROUND
00505 R 040102 R            DAC       LPFCLR
00506 R 620476 R            JMP*      CLFLAG
00507 R 200544 R            LAC       LPBBSY              /BACKGROUND
00510 R 040103 R            DAC       LPBCLR
00511 R 620476 R            JMP*      CLFLAG
                      /
      000512 R      LPERR=.
00512 R 765006 A      LPER06    LAW       5006                /ILLEGAL FUNCTIONS
00513 R 040037 R            DAC       LPTMP1
00514 R 200013 R            LAC       LPSVAC
00515 R 040566 R            DAC       LPTAUX
00516 R 200011 R            LAC       LPA.+11
00517 R 740200 A            SZA
00520 R 200636 R            LAC       (3000               /BGRD
00521 R 240037 R            XOR       LPTMP1
00522 R 100557 R            JMS       LPTERR
                      /
00523 R 100476 R      LPIGN     JMS       CLFLAG              /CLEAR BUSY FLAG
00524 R 600065 R            JMP       LPNOR
                      /THIS SUBROUTINE IS EXECUTED BY THE
                      /CAL HANDLER VIA WORD 0 OF THIS I/O
                      /HANDLER JUST PRIOR TO GIVING CONTROL
                      /TO THE HANDLER AT THE APPROPRIATE
                      /ENTRY IN THE FUNCTION DISPATCH TABLE.
00525 R 000000 A      SWAP      0
00526 R 400005 R            XCT       LPA.+5              /ION OR IOF
00527 R 703304 A            DBK                           /FROM LEVEL 0
00530 R 620525 R            JMP*      SWAP
                      /STOP I/O SUBROUTINE
00531 R 000000 A      LPSTP     0
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00532  R  100571  R                JMS       LPRAIS              /PROTECT
00533  R  200556  R                LAC       LPCTLR              /DO NOT HANG IF
00534  R  750200  A                SZA!CLA                       /+R IN PROGRESS.
00535  R  600542  R                JMP       LPCLER
00536  R  200001  R                LAC       LPA.+1              /IF I/O IS UNDER WAY SET
00537  R  340002  R                TAD       LPA.+2              /STOP SWITCH.
00540  R  750200  A                SZA!CLA
00541  R  740001  A                CMA
00542  R  040555  R       LPCLER   DAC       LPSTPS
00543  R  140001  R       LPFBSY   DZM       LPA.+1              /CLEAR I/O BUSY SWITCHES.
00544  R  140002  R       LPBBSY   DZM       LPA.+2
00545  R  140003  R                DZM       LPA.+3              /CLEAR CLOSE SWITCHES.
00546  R  140004  R                DZM       LPA.+4
00547  R  140556  R                DZM       LPCTLR              /+R FLAG
00550  R  100576  R                JMS       LPLOWR              /ALLOW INTERRUPTS.
00551  R  200555  R                LAC       LPSTPS              /WAIT UNTILL I/O IS DONE.
00552  R  740200  A                SZA
00553  R  600551  R                JMP       .-2
00554  R  620531  R                JMP*      LPSTP
00555  R  000000  A       LPSTPS   0                             /STOP I/O SWITCH.
00556  R  000000  A       LPCTLR   0                             /+R IN PROGRESS IF NON-0.
                          /
                          /
                          /SUBROUTINE TO CAUSE OUTPUTTING OF ERROR MESSAGE.
00557  R  000000  A       LPTERR   0
00560  R  040564  R                DAC       LPTLAW              /LAW CODE
00561  R  220637  R                LAC*      (.SCOM+66
00562  R  040037  R                DAC       LPTMP1
00563  R  100571  R                JMS       LPRAIS              /RAISE TO API LEVEL 0 AND TURN OF PIC.
00564  R  740040  A       LPTLAW   XX                            /LAW CODE
00565  R  120037  R                JMS*      LPTMP1
00566  R  740040  A       LPTAUX   XX
00567  R  100576  R                JMS       LPLOWR
00570  R  620557  R                JMP*      LPTERR
                          /
                          /SUBROUTINE TO RAISE TO API LEVEL 0
                          /AND TURN OFF PIC.
00571  R  000000  A       LPRAIS   0
00572  R  200640  R                LAC       (400200
00573  R  705504  A                ISA
00574  R  700002  A       LPIOF    IOF
00575  R  620571  R                JMP*      LPRAIS
                          /SUBROUTINE TO DEBREAK FROM API LEVEL 0
                          /AND TURN ON PIC.
00576  R  000000  A       LPLOWR   0
00577  R  703304  A                DBK
00600  R  700042  A                ION
00601  R  620576  R                JMP*      LPLOWR
       000000  A                   .END
00602  R  706626  A *LIT
00603  R  000064  A *LIT
00604  R  000155  A *LIT
00605  R  706502  A *LIT
00606  R  000154  A *LIT
00607  R  000135  A *LIT
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```
00610  R  740000  A *LIT
00611  R  000164  A *LIT
00612  R  000002  A *LIT
00613  R  377000  A *LIT
00614  R  540436  R *LIT
00615  R  000177  A *LIT
00616  R  777700  A *LIT
00617  R  000040  A *LIT
00620  R  000100  A *LIT
00621  R  000077  A *LIT
00622  R  706546  A *LIT
00623  R  000047  A *LIT
00624  R  000004  A *LIT
00625  R  777766  A *LIT
00626  R  600335  R *LIT
00627  R  000050  A *LIT
00630  R  000007  A *LIT
00631  R  706606  A *LIT
00632  R  000152  A *LIT
00633  R  000000  R *LIT
00634  R  600030  R *LIT
00635  R  000151  A *LIT
00636  R  003000  A *LIT
00637  R  000166  A *LIT
00640  R  400200  A *LIT
```

NO ERROR LINES

CLFLAG	00476	R
LPARG1	00144	R
LPA.	00000	R
LPBBSY	00544	R
LPBCLR	00103	R
LPCB	706502	A
LPCF	706602	A
LPCLER	00542	R
LPCLOS	00040	R
LPCLSE	00412	R
LPCOMD	00064	R
LPCONV	00212	R
LPCON1	00252	R
LPCON2	00263	R
LPCON3	00273	R
LPCTAB	00436	R
LPCTLR	00556	R
LPDBR	00165	R
LPEMPT	00451	R
LPEND	00301	R
LPERR	000512	R
LPER06	00512	R
LPFBSY	00543	R
LPFCLR	00102	R
LPFORM	00316	R
LPFRA	00154	R
LPGET5	00235	R
LPGET6	00237	R
LPHRTB	00061	R
LPHT	00321	R
LPHT2	00335	R
LPHT3	00332	R
LPIGN	00523	R
LPIN	00046	R
LPINT	00350	R
LPIN2	00053	R
LPIOAC	00435	R
LPIOF	00574	R
LPION	00372	R
LPIOT	00110	R
LPIOTB	00163	R
LPLBHP	00015	R
LPLD	706546	A
LPLOWR	00576	R
LPLS	706626	A
LPL1	706566	A
LPL2	706526	A
LPMSG	00131	R
LPM40	00357	R
LPNOR	00065	R
LPNRDY	00120	R
LPOK	00176	R
LPOVER	00430	R
LPOVRP	00425	R
LPPB	706606	A

```
LPPIC      00343    R
LPRAIS     00571    R
LPSPCE     00044    R
LPSPPR     00413    R
LPSTON     00361    R
LPSTP      00531    R
LPSTPS     00555    R
LPSVAC     00013    R
LPSWCH     00005    R
LPTAUX     00566    R
LPTERR     00557    R
LPTIO      00070    R
LPTLAW     00564    R
LPTMP1     00037    R
LPTOK      00402    R
LPTOUT     00007    R
LPTSTR     00207    R
LPT.6      00100    R
LPT31      00452    R
LPVMOV     00424    R
LPVTST     00304    R
LPWD10     00010    R
LPWD17     00017    R
LPWORD     00060    R
LPWPC      00014    R
LPWRD6     00006    R
LPWRT      00167    R
LPZERO     00036    R
LP3CHR     00062    R
LP5CH      00450    R
LP57T      00055    R
LP8CT      00016    R
LSDF      706501    A
LSEF      706601    A
LV2FC      00031    R
LV2WC      00012    R
LWRITE     00030    R
PGECNT     00434    R
SCOM35     00033    R
SWAP       00525    R
.MED      000003    A
.SCOM     000100    A
```

```
LPA.       00000    R
.MED       000273   A
LPSWCH     00005    R
LPWRD6     00006    R
LPTOUT     00007    R
LPWD10     00010    R
LV2WC      00012    R
LPSVAC     00013    R
LPWPC      00014    R
LPLBHP     00015    R
LP8CT      00016    R
LPWD17     00017    R
LWRITE     00030    R
LV2FC      00031    R
SCOM35     00033    R
LPZERO     00036    R
LPTMP1     00037    R
LPCLOS     00040    R
LPSPCE     00044    R
LPIN       00046    R
LPIN2      00053    R
LP57T      00055    R
LPWORD     00060    R
LPHRTB     00061    R
LP3CHR     00062    R
LPCOMD     00064    R
LPNOR      00065    R
LPTIO      00070    R
LPT.6      00100    R
.SCOM      000100   A
LPFCLR     00102    R
LPBCLR     00103    R
LPIOT      00110    R
LPNRDY     00120    R
LPMSG      00131    R
LPARG1     00144    R
LPFRA      00154    R
LPIOTB     00163    R
LPDBR      00165    R
LPWRT      00167    R
LPOK       00176    R
LPTSTR     00207    R
LPCONV     00212    R
LPGET5     00235    R
LPGET6     00237    R
LPCON1     00252    R
LPCON2     00263    R
LPCON3     00273    R
LPEND      00301    R
LPVTST     00304    R
LPFORM     00316    R
LPHT       00321    R
LPHT3      00332    R
LPHT2      00335    R
LPPIC      00343    R
```

LPINT	00350	R
LPM42	00357	R
LPSTON	00361	R
LPION	00372	R
LPTOK	00402	R
LPCLSE	00412	R
LPSPPR	00413	R
LPVMOV	00424	R
LPOVRP	00425	R
LPOVER	00430	R
PGECNT	00434	R
LPIOAC	00435	R
LPCTAB	00436	R
LP5CH	00450	R
LPEMPT	00451	R
LPT31	00452	R
CLFLAG	00476	R
LPERR	000512	R
LPER06	00512	R
LPIGN	00523	R
SWAP	00525	R
LPSTP	00531	R
LPCLER	00542	R
LPFBSY	00543	R
LPBBSY	00544	R
LPSTPS	00555	R
LPCTLR	00556	R
LPTERR	00557	R
LPTLAW	00564	R
LPTAUX	00566	R
LPRAIS	00571	R
LPIOF	00574	R
LPLOWR	00576	R
LSDF	706501	A
LPCB	706502	A
LPL2	706526	A
LPLD	706546	A
LPL1	706566	A
LSEF	706601	A
LPCF	706602	A
LPPB	706606	A
LPLS	706626	A

SECTION 8

SYSTEM GENERATION

The system utility program .SGEN, used to tailor a Background/Foreground tape to operate in different hardware configurations, is not available at this time.

APPENDIX I

.SCOM REGISTERS

The function of the .SCOM (System COMmunication) Registers is to provide, among the various program elements of the Background/Foreground Monitor System, an easily accessible set of registers which contain communication pointers, data words, and program flags indicating the state of the system.

The .SCOM table begins at location 100_8 within the Resident Monitor. Location 100 is referred to as .SCOM or .SCOM + 0 and the (N + 1)th register is referred to as .SCOM + N.

Each .SCOM register has a special meaning and format. At present, there are about 115_8 such registers. Slots at the end will be allotted for future expansion as needed.

REGISTER DEFINITIONS: The following list indicates the contents of each .SCOM register. Those which are fixed at assembly or system generation time and never changed are marked by (F). Some .SCOM registers must have a Foreground value and a Background value. Therefore, their contents must be swapped from one to the other, depending upon which job has control. They are flagged by (S). Some .SCOM registers have been reserved for future software. If their contents (format) are as yet unspecified, they will be flagged with (U).

.SCOM + 0 (F) Pointer to the highest register in core (37777, 57777, or 77777).

.SCOM + 1

(a) Address just above the Resident Monitor when the Non-resident Monitor has been loaded for Foreground.

(b) Address just above the Foreground job when the Resident Monitor has loaded the Non-resident Monitor in the Background. If the system program PIP is called, this will be the first location of its .DEV table.

(c) For DDT in the Background this points to the start of its symbol table.

.SCOM + 2 (S)

(a) Same as (a) for .SCOM + 1.

(b) Normally used by user and system programs to indicate the first (lowest) location in free core.

(c) For DDT in the Background this points to the first location after the symbol table, which is also the first Location of free core.

.SCOM + 3 (S)

Normally used by user and system programs to indicate the last (highest) location in free core. For the Foreground, this is also the highest location allocated to the Foreground job.

.SCOM + 4

Bits indicate machine configuration:

(F)	Bit Ø	Ø=No API; 1=API
	Bit 1[1]	Ø=No EAE; 1=EAE
(F)	Bits 2-5	Ø (Reserved and unused)
	Bit 6[2]	Ø=7-channel MAGtape 1=9-channel MAGtape
(F)	Bit 7	Ø=Bank Mode (PDP-9)
(U)	Bits 8-13	Unassigned
(F)	Bit 14	1=Background/Foreground
(F)	Bits 15-17	Drum size for RMØ9= Ø=No drum 1=32K (RMØ9A) 2=65K (RMØ9B) 3=131K(RMØ9C) 4=262K(RMØ9D) 5=524K(RMØ9E)

[1]The presence or lack of EAE is determined dynamically by the Resident Monitor.
[2]7/9-channel default operation may be set by Foreground Keyboard command.

.SCOM + 5	(a) Initially this points to RESINT, the address of the initialization section in RESMON. The paper tape bootstrap loader transfers control indirectly through this location. (b) When calling the System Loader to bring in a system program, the Non-resident Monitor stores here the code number of the program to be loaded. (c) When running a system program, its start address is stored here.
.SCOM + 6	(a) When the Non-resident Monitor calls the System Loader to load user programs, bits Ø - 2 indicate which command was given to the Monitor: $LOAD, $GLOAD, $DDT, or $DDTNS. Bit Ø = 1 if $DDT or $DDTNS (DDT load) Bit 1 = Ø if $LOAD; Bit 1 = 1 if $GLOAD Bit 2 = Ø if $DDT; Bit 2 = 1 if $DDTNS (b) When the user programs have been loaded, the start address of the main program is stored here. The load command code bits (Ø-2) remain as in (a).
.SCOM + 7	The interrupted PC plus L,XM,MP are saved here for DDT in the Background when CTRL T has been typed.
.SCOM + 1Ø (S)	The interrupted PC plus L,XM,MP are saved here after a NORMAL CTRL P has been typed and honored.
.SCOM + 11 (F)	Bootstrap restart instruction.
.SCOM + 12 (F)	Pointer to the 339 Pushdown list within the Resident Monitor.

.SCOM + 13 (F)	Pointer to the .IOIN[1] table in the Resident Monitor.
.SCOM + 14 (F)	Pointer to the .MUD[2] table in the Resident Monitor.
.SCOM + 15 (F)	Pointer to the .BFTAB[3] table in RESMON.
.SCOM + 16 (F)	Pointer to .DATF[4], Foreground .DAT slot Ø, in the Resident Monitor.
.SCOM + 17 (F)	Pointer to .DATB[4], Background .DAT slot Ø, in the Resident Monitor.
.SCOM + 2Ø (U)	Reserved for PDP-15.
.SCOM + 21	MAGtape status register.
.SCOM + 22	Reserved for MAGtape handler.
.SCOM + 23 (F)	Twos complement size of the Monitor's transfer vector table (used by system generator).
.SCOM + 24 (F)	Pointer to the Monitor's transfer vector table (used by System Generator).

---

[1].IOIN is the table which indicates which I/O devices are in core, which units on each device are spoken for, and which job (Background or Foreground) owns them.

[2].MUD is a table listing all available multi-unit device handlers, with pertinent information about those handlers.

[3].BFTAB is a buffer table containing pointers to and the sizes of all external I/O buffers that were set up by the loaders.

[4].DATF is the Device Assignment Table for Foreground.
.DATB is the Device Assignment Table for Background.

.SCOM + 25	(a) Prior to loading the Foreground job, the amount of free core requested by the $FCORE command is stored here. If no $FCORE command is given, the default assumption is 2 registers. (b) After the Foreground job has been loaded, this register contains a pointer to the register immediately above the Foreground core area.
.SCOM + 26 (S)	Contains Ø if Foreground is in control and 1 if Background is in control.
.SCOM + 27 (F)	Pointer to IOT Skip literal table in the Monitor (used by System Generator).
.SCOM + 3Ø (F)	Pointer to PI Skip Chain.
.SCOM + 31	(a) The Software Memory Protect Bound set from .SCOM + 25 after the System Loader has loaded the Foreground job. (b) Set to point just above the Background I/O handlers and I/O buffers after the Background job has been loaded.
.SCOM + 32	(a) Pointer to the Hardware Memory Protect Bound (or where it should be set). Contents (.SCOM + 32) ≥ contents (.SCOM + 31).
.SCOM + 33	Background Program Counter, including L,XM,MP.
.SCOM + 34 (F)	Address of the resident teletype handler (TTA).
.SCOM + 35	Interrupt Service Flag. Non-Ø indicates that control is in some interrupt service routine.
.SCOM + 36 (F)	Bits to tell the teletype handler which units are model 33 (specific bit = Ø) and which model 35 (specific bit = 1). Bit Ø corresponds to unit Ø; bit 1 to unit 1; and so on.

.SCOM + 37 (F)

Pointer to CALER. Used to detect attempt to re-enter CAL handler and to trap CAL* instructions.

.SCOM + 4Ø

CAL Flag. Non-Ø if control is in the CAL handler (indication necessary for interrupt servicing).

.SCOM + 41

"Who's running in the Background" Flag.
Bit Ø = 1 if a Loader is running.
Bits 1-17:
17777 = Non-resident Monitor
Ø = user program or DDT
1 = EDIT
2 = MACRO
3 = PIP
4 = F4
5 = SGEN
6 = DUMP
7 = UPDATE
10 = CONV
11 = MACROA
12 = F4A
13 = EXECUTE
14 = CHAIN
15 = PATCH

.SCOM + 42

Level 5 (API, Foreground) busy register. Zero indicates level 5 non-busy. Non-zero indicates that Foreground level 5 is idle waiting for some I/O to complete. Set non-Ø with the initial address of the device handler doing the I/O. If the device is teletype, the unit number + 4ØØØØØ is stored here instead.

.SCOM + 43

Same as .SCOM + 42 for Foreground level 6.

.SCOM + 44

Same as .SCOM + 42 for Foreground level 7.

.SCOM + 45

Same as .SCOM + 42 for Foreground Mainstream level.

.SCOM + 46	Foreground level 5 I/O satisfied flag. Zero indicates that level 5, which was I/O bound, can be started up again.
.SCOM + 47	Same as .SCOM + 46 for level 6.
.SCOM + 5Ø	Same as .SCOM + 46 for level 7.
.SCOM + 51 (F)	Pointer to REALTP[1] in the Resident Monitor.
.SCOM + 52 (F)	Pointer to IOBUSY[2] in the Resident Monitor.
.SCOM + 53 (F)	Pointer to LV4Q[3] in the Resident Monitor.
.SCOM + 54 (F)	Pointer to CALL4[4] in the Resident Monitor.
.SCOM + 55 (F)	Pointer to .SETUP[5] in the Resident Monitor.
.SCOM + 56 (F)	Pointer to GETBUF[6] in the Resident Monitor.

---

[1]REALTP is a subroutine to process real-time requests.

[2]IOBUSY is a subroutine to check for I/O busy termination.

[3]LV4Q queue is a list of I/O handlers which are waiting to complete their interrupt service processing at API level 4.

[4]CALL4 is a subroutine to initiate an API level 4 request.

[5].SETUP is the routine initially called by all I/O handlers to set up skips in the PI skip chain or API channel registers.

[6]GETBUF is a routine called by the I/O handlers which assigns buffer areas to the handlers via .BFTAB.

.SCOM + 57	If non-Ø, a pointer to the entry point of the last Mainstream Foreground real-time subroutine in the chain of subroutines to be run when Foreground Mainstream gets control.
.SCOM + 6Ø	Pointer to the entry point + 1 of the first subroutine in the chain of Foreground Mainstream real-time routines to be run when Foreground Mainstream gets control.
.SCOM + 61	Same as .SCOM + 57 for Background.
.SCOM + 62	Same as .SCOM + 6Ø for Background.
.SCOM + 63	Argument for API instruction ISA when interrupts at API software levels are to be requested.
.SCOM + 64 (F)	Pointer to CR.QR[1] in the Resident Monitor.
.SCOM + 65	Set non-Ø, while a Foreground user program is running, to indicate that the resident buffer may not be used by the Foreground. The resident buffer must be available to the Background, which presumably changes jobs more often, for use by the Monitor and the Loaders.
.SCOM + 66 (F)	Pointer to ERRORQ[2] in the Resident Monitor.
.SCOM + 67 (F)	Pointer to Foreground control character table in TTA.
.SCOM + 7Ø (F)	Pointer to Background control character table in TTA.

---

[1]CR.QR is a routine called by I/O handlers to initiate a device-not-ready request.

[2]ERRORQ is a routine called to enter information in the Foreground and/or Background error queues and to set the error flags in .SCOM + 71.

.SCOM + 71	Error flag. The following conditions exist if the respective bit = 1: Ø - Background error 1 - Foreground error 2 - Background terminal error 3 - Foreground terminal error
.SCOM + 72 (F)	Pointer to the Foreground error processing subroutine plus the 2ØØØØØ bit to turn on extend memory after a DBR.
.SCOM + 73 (F)	Same as .SCOM + 72 for Background error subroutine.
.SCOM + 74	Saved argument for Foreground error routine ISA instruction.
.SCOM + 75 (F)	Contains JMS IGNORE, a call to a dummy interrupt service routine, used during error processing.
.SCOM + 76 (F)	Twos complement count of the number of teletypes on the machine.
.SCOM + 77	$SHARE Flag (to allow Background to share Foreground I/O bulk storage units. Non-zero indicates that SHARING is allowed.
.SCOM + 1ØØ (F)	Pointer to ENTERQ[1] in the Resident Monitor. Will contain Ø, instead, if ENTERQ routine not assembled into the Monitor.
.SCOM + 1Ø1	If set non-zero by the Foreground keyboard command, $MPOFF, Background enters EXEC mode. The memory protect boundary register is zeroed to allow Background to modify and transfer to any location in core. Background IOT's will still trap to the Monitor but the IOT's will be executed.

[1]ENTERQ is a subroutine which makes entries in the API queue.

.SCOM + 1Ø2 (U)	Unused
.SCOM + 1Ø3 (U)	Unused
.SCOM + 1Ø4 (U)	Unused
.SCOM + 1Ø5 (F)	Twos complement size of the PI skip chain. (Used by System Generator).
.SCOM + 1Ø6 (F)	Pointer to the register immediately above the Resident Monitor (set by the Non-resident Monitor after it has built the .MUD table).
.SCOM + 1Ø7 .SCOM + 11Ø .SCOM + 111	Used to store the file directory entry block of the XCT file to be EXECUTE'd in the Foreground.
.SCOM + 112 .SCOM + 113 .SCOM + 114	Used to store the file directory entry block of the XCT file to be EXECUTE'd in the Background.
.SCOM + 115 (F)	Maximum number of teletypes allowed, which is a function of an assembly parameter in the Monitor (Used by System Generator).

APPENDIX II

ERRORS

ERROR HANDLING IN BACKGROUND/FOREGROUND

The processing of errors detected by the Resident Monitor, I/O handlers, the Linking Loader and the System Loader has been changed in the Background/Foreground System from the way they are treated in the Keyboard and I/O Monitor Systems.

The most significant change is the introduction of terminal and non-terminal errors. A terminal error stops execution of the job associated with the error. This causes all I/O handlers assigned to that job to be called to stop I/O that may be in progress and all Monitor queues to be cleared of entries for that job (Background, Foreground or both).

A non-terminal error is one that does not necessarily warrant aborting the operation of the offending job. A non-terminal error message is entered into a queue for the appropriate job and is printed on the appropriate control teletype when that unit is free. While the printing of non-terminal error messages is pending or in progress, operation of the offending job is suspended. This restriction does not apply to I/O handlers, which may continue interrupt processing.

The format for error messages generated by the Resident Monitor, I/O handlers and the Loaders is:

```
.ERR  NNN  XXXXXX
```

where NNN = error code
XXXXXX = auxiliary information

These errors are tabulated on pages 2-4,-5,-6 and -7.

Errors detected by the FORTRAN Object Time System (OTS) are formatted as follows:

.OTS NN

where NN = error code

OTS errors are listed on page 2-8.

CONTINUATION AFTER ERROR

.OTS errors are terminal errors. After OTS has printed the error message, it exits to the Monitor. Therefore, after an .OTS error the user does not have the option of restarting his program.

Non-terminal .ERR errors do not terminate the operation of user programs. Continuation, following the printing of the error message, is automatic.

Terminal .ERR errors terminate the operation of user programs. After the printing of the error message, the user has the option of typing CTRL P (to restart his program at the CTRL P restart address), CTRL T (to return to DDT), CTRL Q (to take a dump of memory), or CTRL C (to return to the Monitor to

load another job). If the error occurred while control was in the Non-resident Monitor or in a Loader, the user does not have the options indicated above. The Monitor will automatically be reloaded.

ERROR CALL

Routines that wish to set up an error condition, I/O device handlers for example, should use the following coding sequence:

```
        LAC*    (.SCOM + 66         /POINTER TO ERRORQ
        DAC     TEMP                /SUBROUTINE.
        LAC     (4ØØ2ØØ             /RAISE TO API
        ISA                         /LEVEL Ø.
        IOF
        LAW     CODE                /SEE BELOW.
        JMS*    TEMP                /CALL ERRORQ.
AUXARG  XX                          /AUXILIARY ARGUMENT.
        DBK                         /RETURN HERE.
        ION
```

The calling program must be operating with memory protect disabled in order to be able to issue IOT's.

The first argument, given in the AC to ERRORQ, may be loaded either by LAW code or by LAC code in the following format:

```
          Bits Ø-5 are ignored
          Bit 6 = Ø means non-terminal error
          Bit 6 = 1 means terminal error
Code      Bit 7 = 1 means Background error      both bits (7 and 8)
          Bit 8 = 1 means Foreground error      may be set to 1
          Bits 9-17 is a 3-digit error code
```

To avoid the possibility of future conflicts, user programs and device handlers should utilize codes 6ØØ - 777.

The auxiliary argument, following the JMS to ERRORQ, will be printed in the error message as a 6-digit octal number. The error message will be printed in the form:

```
.ERR  NNN  XXXXXX
```

where NNN = the 3-digit error code
XXXXXX = the 6-digit auxiliary information

The actual printing of the error message and processing of the error will be done only after all interrupt processing has ceased and when control is no longer in the CAL handler.

BACKGROUND/FOREGROUND MONITOR ERRORS (.ERR)

The following abbreviations are used below in describing the auxiliary information:

L - bit Ø is the status of the link
XM- bit 1 is the status of extend memory
MP- bit 2 is the status of memory protect
CAL ADDR - bits 3-17 contain the address of the CAL in error.

ERROR NO.	ERROR	AUXILIARY INFORMATION	TERMINAL
ØØØ	ILLEGAL CAL FUNCTION	L, XM, MP, CAL ADDR	YES
ØØ1	CAL[1] ILLEGAL	L, XM, MP, CAL ADDR	YES
ØØ2	.DAT SLOT ERROR (erroneous .DAT slot number or .DAT slot not tied to an I/O handler)	L, XM, MP, CAL ADDR	YES
ØØ3	ILLEGAL INTERRUPT	L, XM, MP, PC	YES

[1]The auxiliary information, depending on the source of the error, is sometimes UNIT #, CAL ADDR.

ERROR NO.	ERROR	AUXILIARY INFORMATION	TERMINAL
ØØ4	MORE THAN ONE DEVICE NOT READY	.ASCII /XX/ ; XX = DEVICE NAME	YES
ØØ5	ILLEGAL .SETUP	RETURN ADDRESS FROM .SETUP (ADDRESS IN CALLING DEVICE HANDLER)	YES
ØØ6	ILLEGAL HANDLER FUNCTION	L, XM, MP, CAL ADDR[1]	YES
ØØ7	ILLEGAL DATA MODE or SUBFUNCTION CODE	L, XM, MP, CAL ADDR[1]	YES
Ø1Ø	FILE STILL ACTIVE	UNIT #, CAL ADDR	YES
Ø11	SEEK/ENTER NOT EXECUTED	UNIT #, CAL ADDR	YES
Ø12	UNRECOVERABLE DECTAPE ERROR	STATUS REGISTER B (Bits 0-1) AND UNIT (Bits 15-17)	YES
Ø13	FILE NOT FOUND	UNIT #, CAL ADDR	YES
Ø14	DIRECTORY FULL	UNIT #, CAL ADDR	YES
Ø15	DECTAPE FULL	UNIT #, CAL ADDR	YES
Ø16	OUTPUT BUFFER OVERFLOW	UNIT #, CAL ADDR	YES
Ø17	TOO MANY FILES FOR HANDLER	UNIT #, CAL ADDR	YES
Ø2Ø	DISK FAILURE	DISK STATUS REGISTER	YES
Ø21	ILLEGAL DISK ADDRESS	UNIT #, CAL ADDR	YES
Ø22	TWO OUTPUT FILES ON ONE UNIT	UNIT #, CAL ADDR	YES
Ø23	ILLEGAL WORD COUNT (Either the word count was positive or the starting address plus the absolute value of the word count exceeded existing memory)	L, XM, MP, CAL ADDR	YES

[1]The auxiliary information, depending on the source of the error, is sometimes UNIT #, CAL ADDR.

ERROR NO.	ERROR	AUXILIARY INFORMATION	TERMINAL
Ø27	ILLEGAL DISK UNIT	UNIT #, CAL ADDR	YES
Ø31	NON-EXISTENT MEMORY REFERENCE	L, XM, MP, PC	YES
Ø32	MEMORY PROTECT VIOLATION	L, XM, MP, PC[1]	YES
Ø33	MEMORY PARITY ERROR	L, XM, MP, PC	YES
Ø36	BACKGROUND MEMORY PROTECT VIOLATION ATTEMPT VIA CAL ARGUMENT	L, XM, MP, CAL ADDR	YES
Ø5Ø	.TIMER REQUEST CANNOT FIT IN CLOCK QUEUE OR BACKGROUND REQUEST REMOVED TO MAKE ROOM FOR FGRD REQUEST	ADDRESS OF REAL TIME SUBROUTINE THAT WAS TO GET CONTROL ON COMPLETION OF INTERVAL	NO
Ø52	MAINSTREAM REAL TIME REQUEST IGNORED BECAUSE ROUTINE IS ALREADY ENTERED	PRIORITY LEVEL/SUBROUTINE ENTRY POINT	NO
Ø53	APIQ OVERFLOW	ENTRY THAT WOULD NOT FIT (PRIORITY LEVEL/ SUBROUTINE ENTRY POINT)	NO
Ø55	NO BUFFERS AVAILABLE	RETURN ADDRESS FROM GETBUF (ADDRESS IN CALLING DEVICE HANDLER)	YES
Ø56	ILLEGAL .ERROR CAL[2]	L, XM, MP, CAL ADDR	YES
Ø57	ILLEGAL .EXIT CAL	L, XM, MP, CAL ADDR	YES
Ø6Ø	.INIT NOT EXECUTED	CAL ADDR	YES
Ø61	TOO MANY NON-TERMINAL ERRORS	NUMBER OF ERRORS DISCARDED	NO
2ØØ	ILLEGAL TELETYPE UNIT	L, XM ,MP, CAL ADDR	YES

[1]If a memory protect violation occurs because of a Background JMP instruction, the PC is the effective address rather than the location of the JMP.

[2]A special error call to the Monitor (CAL code 16) is available for use only by the Loaders.

LOADER ERRORS (.ERR)

All Loader errors are terminal. The auxiliary information which is printed is irrelevant.

1ØØ	NO ROOM IN CORE FOR PROGRAM SEGMENT
1Ø1	PROGRAM AND SYMBOL TABLE OVERLAP
1Ø2	.BFTAB OVERFLOW
1Ø3	.IOIN TABLE OVERFLOW
1Ø4	$FILES COUNT OVERFLOW
1Ø5	PARITY ERROR, CHECKSUM ERROR, OR BUFFER OVERFLOW
1Ø6	ILLEGAL LOADER CODE (Bad input data)
1Ø7	COMMON BLOCK SIZE ERROR[1]
11Ø	MISSING GLOBAL(S)
111	ILLEGAL .DAT SLOT NUMBER
112	.DAT SLOT CONTENTS = Ø
113	SAME DEVICE - DIFFERENT HANDLERS[2]
114	ILLEGAL HANDLER CODE (Illegal .DAT slot contents)
115	ABSOLUTE PROGRAM ERROR[3]
116	FOREGROUND CAN'T USE UNIT Ø ON SYSTEM DEVICE[4]
117	NO ROOM TO BUILD .EXIT LIST
12Ø	XCT FILE OVERLAYS EXECUTE
121	XCT FILE OVERLAYS THE MONITOR
122	XCT FILE OVERLAYS THE SYMBOL TABLE
123	XCT FILE NOT BUILT FOR THIS CONFIGURATION[5]

---

[1]COMMON Block size declared differently when Block size previously fixed in BLOCKDATA subprogram.

[2]Only one version of a device handler may be in core. .DAT slot requested a different handler for a device when another handler for that device was already in core.

[3]An absolute .LOC program may not be loaded once relocatable programs have been loaded. Absolute and relocatable .LOC in same program is illegal.

[4]$SHARE command was not given.

[5]Configuration word in "XCT" file indicates if it was built to run on a PDP-9 or PDP-15 and Background or Foreground.

OBJECT TIME SYSTEM ERRORS (.OTS)

All .OTS errors are terminal and no auxiliary information is printed:

Ø-4	UNUSED
5	ILLEGAL REAL SQUARE ROOT ARGUMENT
6	ILLEGAL DOUBLE SQUARE ROOT ARGUMENT
7	ILLEGAL INDEX IN COMPUTED GOTO
1Ø	ILLEGAL I/O DEVICE NUMBER
11	ILLEGAL INPUT DATA
12	ILLEGAL FORMAT STATEMENT
13	ILLEGAL REAL LOGARITHMIC ARGUMENT
14	ILLEGAL DOUBLE LOGARITHMIC ARGUMENT

APPENDIX III

TELETYPE HARDWARE CHARACTERISTICS

SYSTEM REQUIREMENTS AND OPTIONS

The multi-unit teletype handler assumes that the teletype configuration consists of:

a. A Model 33 or Model 35KSR console teletype,

b. from 1 to 4 LT19A or LT09A multi-station teletype controls, and

c. from 1 to 16_{10} Model 33 or Model 35KSR teletypes interfaced to the LT19A or LT09A controls.

The console teletype has its own set of IOTs, operates as half-duplex and is connected to the PIC (Program Interrupt Control). It cannot be connected to the API.

LT09A multi-station teletype controls can handle from 1 to 5 teletype lines and is connected only to the PIC. The LT19A is identical to the LT09A except that if a machine has API it will operate at API level 3, using channel registers 74 and 75.

Teletypes connected to LT09 or LT19 controls are operated in full-duplex mode, which requires the software to echo characters input from the Keyboard back to the teleprinter.

LT09/LT19 IOTs

Whether LT09 or LT19 is used, the IOT's associated with a particular teletype unit are the same. The following tables list

the device and subdevice codes associated with each teleprinter and keyboard and indicate the logical unit numbers which the teletype handler associates with them. The console teletype, which is not connected to the LT09/LT19 controls, is defined to be logical unit Ø.

TABLE 1: 1 to 5 units; 1 LT09A or LT19A

	UNIT #	PRINTER CODE	KEYBOARD CODE	LOGICAL UNIT #
LT09A/ LT19A #1	1	XX400X	XX410X	1
	2	XX402X	XX412X	2
	3	XX404X	XX414X	3
	4	XX406X	XX416X	4
	5	XX420X	XX430X	5

TABLE 2: 6 to 10 units; 2 LT09A's or LT19A's

	UNIT #	PRINTER CODE	KEYBOARD CODE	LOGICAL UNIT #
LT09A/ LT19A #1	1	XX400X	XX410X	1
	2	XX402X	XX412X	2
	3	XX404X	XX414X	3
	4	XX406X	XX416X	4
	5	XX440X	XX450X	11
LT09A/ LT19A #2	1	XX420X	XX430X	5
	2	XX422X	XX432X	6
	3	XX424X	XX434X	7
	4	XX426X	XX436X	10
	5	XX442X	XX452X	12

TABLE 3: 11 to 15 Units; 3 LT09A's or LT19A's

	UNIT #	PRINTER CODE	KEYBOARD CODE	LOGICAL UNIT #
LT09A/ LT19A #1	1	XX400X	XX410X	1
	2	XX402X	XX412X	2
	3	XX404X	XX414X	3
	4	XX406X	XX416X	4
	5	XX460X	XX470X	15

TABLE 3: 11 to 15 units; 3 LT09A's or LT19A's (cont'd)

	UNIT #	PRINTER CODE	KEYBOARD CODE	LOGICAL UNIT #
LT09A/ LT19A #2	1	XX420X	XX430X	5
	2	XX422X	XX432X	6
	3	XX424X	XX434X	7
	4	XX426X	XX436X	10
	5	XX462X	XX472X	16
LT09A/ LT19A #3	1	XX440X	XX450X	11
	2	XX442X	XX452X	12
	3	XX444X	XX454X	13
	4	XX446X	XX456X	14
	5	XX464X	XX474X	17

TABLE 4: 16 units; 4 LT09A's or LT19A's

	UNIT #	PRINTER CODE	KEYBOARD CODE	LOGICAL UNIT #
LT09A/ LT19A #4	1	Unused	Unused	-
	2	Unused	Unused	-
	3	Unused	Unused	-
	4	Unused	Unused	-
	5	XX466X	XX476X	20

(The setup for the first three controls would be as in Table 3).

TELETYPES

In the Background/Foreground System, teletype models are presumed to have certain hardware characteristics:

Model 33: No horizontal tabbing mechanism
No vertical tabbing mechanism
No form feed mechanism

Model 35: Has all three of the above.

The teletypes are assumed to be KSR (Keyboard Send/Receive) units. ASR (Automatic Send/Receive) teletypes may be used; however, their paper tape input and output capability cannot be used. The system will not support Model 37 teletypes.