

dos

system manual

- system architecture
- internal operations
- maintenance

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DEC-15-ODFFA-B-D

DOS-15
SYSTEM MANUAL

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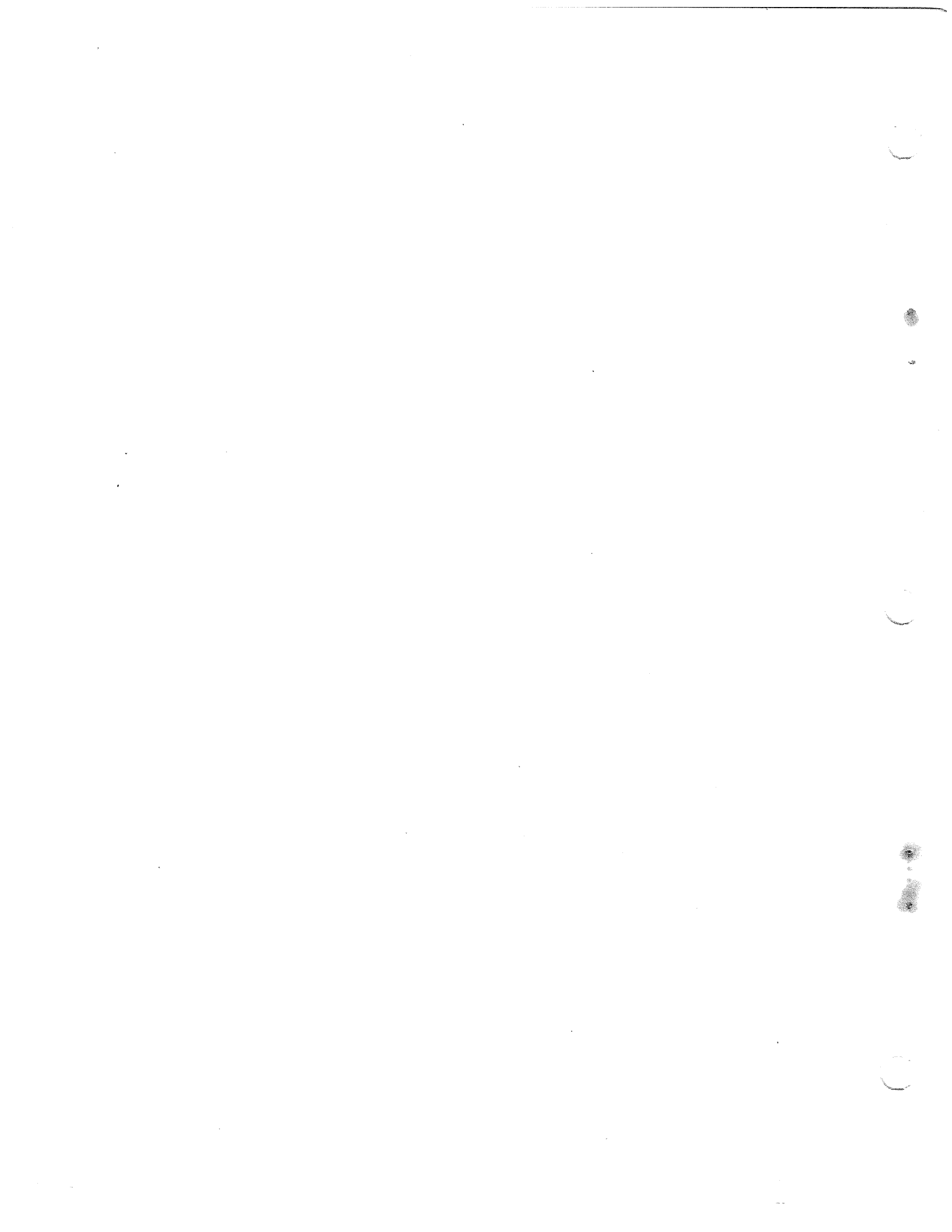
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PREFACE

This manual was written for customer systems programmers, DEC Software Specialists, and internal maintenance programmers. Readers must be familiar with the DOS User's Manual, DEC-15-ODUMA-B-D. In addition, chapter 8 requires familiarity with the BOSS Reference Manual, DEC-15-OBUMA-A-D.

Technical changes reflected in this revision are indicated by a bar (|) in the appropriate page margin.



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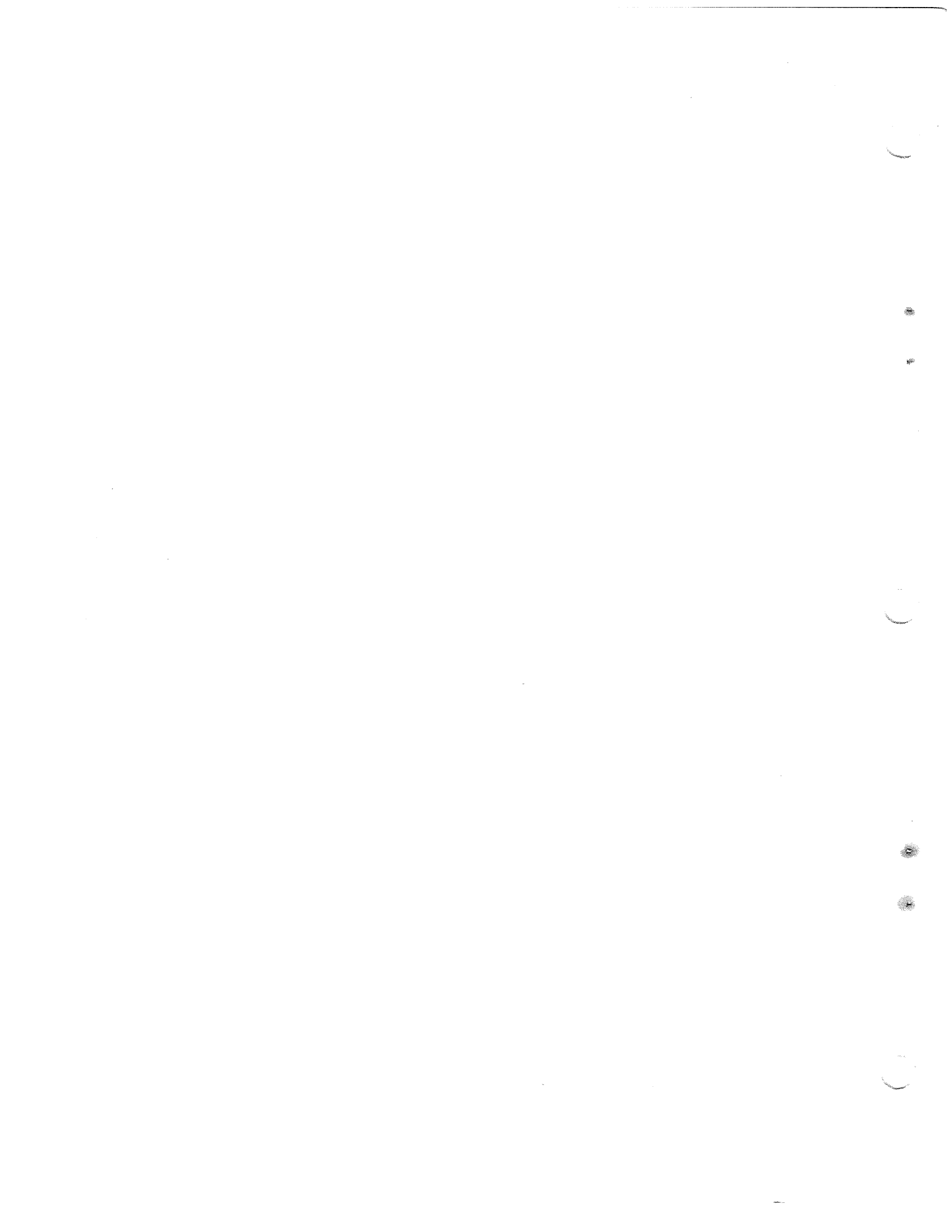
CHAPTER 1
DOS OPERATION

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The System Manager must use DOSSAV in order to load DOS-15 for the first time. The DOS System Generator manual, DEC-USGNA-A-D, describes DOSSAV operation in its appendix. After successful DOSSAV operation, the System Manager should load the Bootstrap into the highest bank of core memory; the bootstrap informs the DOS-15 monitor how many banks of core memory can be used. Before bootstrapping UC15, RK05 based systems, PIREX must first be loaded and running in the PDP-11 local memory (refer to UC15 Software Manual DEC-15-XUCMA-A-D). The bootstrap loads the Resident Monitor and the System Loader, which in turn load the Nonresident Monitor. In order to ensure a working system, the System Manager should place the DOS-15 Checkout Package tape (for RF15, DEC-15-ORFCA-A-PA; for RP02, DEC-15-ORPCA-A-PA; and for RK05, DEC-15-ORKCA-A-PA) into the Paper Tape Reader, and type BATCH PR). Operating instructions for the Checkout Package, and the tape itself, are distributed as part of the DOS-15 system.

Once the system has been checked out, the System Manager should use DOSGEN, the DOS System Generator program, to tailor the system to his needs. As mentioned in the System Generator manual, a complete tailoring of the system may also involve use of PATCH, PIP and UPDATE.

Commands to the Nonresident Monitor allow temporary modification of the system, in order to suit the needs of a particular program. The Nonresident Monitor modifies the system by changing information in the .SCOM Table. The System Loader examines the .SCOM Table, along with three disk-resident information blocks, SYSBLK, COMBLK and SGNBLK, and carries out all operations necessary to fulfill the operator's commands. The System Loader "builds" the Resident Monitor by relocating and linking those routines indicated by the .SCOM table as needed by the next core load. The Resident Monitor then retains general control over the system.



THE RESIDENT MONITOR

2.1 INTRODUCTION

The Resident Monitor gets its name because it seems resident to the user. Strictly speaking, however, the only part of the system that is always resident is the Bootstrap. There are two parts of the system that are refreshed only after manual Bootstrap loads and re-starts: .SCOM and the Resident Monitor Patch Area. Every time an operator or program changes certain key system parameters, the system will build a new Resident Monitor from blocks stored on the system device.

The Resident Monitor is the interface between the operator and the active devices on one hand, and the program which is running (the Nonresident Monitor), on the other. The Resident Monitor always contains the following routines and tables:

Chapter 5	{	.DAT
		.UFDT
		.SCOM
	{	The CAL Handler, which routes all System and I/O Macro calls
		The Startup routine, called after using the Bootstrap
		.MED, the Monitor's standard error routine
		The Expanded Error Processor, for more flexibility with error messages
		Handlers for the following error conditions:
		Nonexistent Memory
		Memory Protect
This Chapter	{	Interrupt-Memory Parity
		Power-Fail
		Software API not set up
		The Monitor's TRAN routine (different from I/O .TRAN's)
		A clock handler
		A poller for UNIBUS device error messages (for UC15 systems, RK05 based or RF15/RP02 based with UC15 option only)
		The .GTBUF and GVBUF processor
		The CTRL Q processor
		The .USER processor
		The .OVRLA processor
		TTA.
		The Resident Monitor's Patch Area
		Task Control Blocks (for UC15 systems, RK05 based or RF15/RP02 based, with UC15 option)

In addition, the user can request the system to retain certain other routines in a resident Monitor status:

- The CTRL X Feature, including a driver for the VT-15
- The Paper Tape or Card Reader Handler for Batch
- The Resident Batch Code

BOSS-15 also has resident routines, which are covered in Chapter 8.

2.2 THE CAL HANDLER

The CAL instruction transfers control to register 21, bank 0, and loads register 20 with the address of the next instruction after the CAL. All DOS I/O and system macros take the form of a CAL instruction (possibly with some code in the low-order bits), and the next sequential register contains a dispatch code. Some macros require more information in succeeding registers. Figure 2-1, Resident Monitor CAL Handler, illustrates the operation of that portion of the Resident Monitor. The CAL Handler does only minimal error checking -- for a legal function code and for a legal .DAT slot. Aside from that and ensuring the clock is turned on, the CAL Handler is only a dispatcher to other routines.

2.3 IOPS ERROR HANDLER AND THE EXPANDED ERROR PROCESSOR

2.3.1 .MED

There are two error processors in the Resident Monitor: .MED and the Expanded Error Processor. Figure 2-2 illustrates those routines. Figure 2-3 shows two subroutines used by the error routines. .MED (location 3, bank 0) processes IOPS errors from all device handlers except the disk handlers, CDB., MTF., TTA., and LPA. Calls to .MED should take the following form, if not IOPS 4:

```
LAC   INFO   /ARGUMENT OF ERROR
DAC*  (.MED  /ADDRESS OF CAL IS ALREADY IN .MED,
        /IF DESIRED
LAW   N      /N IS ERROR CODE 0 ≤ N ≤ 777. AC MUST BE NEGATIVE.
JMP*  (.MED+1
```

IOPS 4 messages may take the following form:

```
LAC   (4     /AC MUST BE POSITIVE
JMS*  (.MED
```

.MED+1 contains a JMP to the Monitor Error Diagnostic Routine. The above calls to .MED will cause the following printouts:

```
IOPSN (contents of .MED)
IOPS4
```

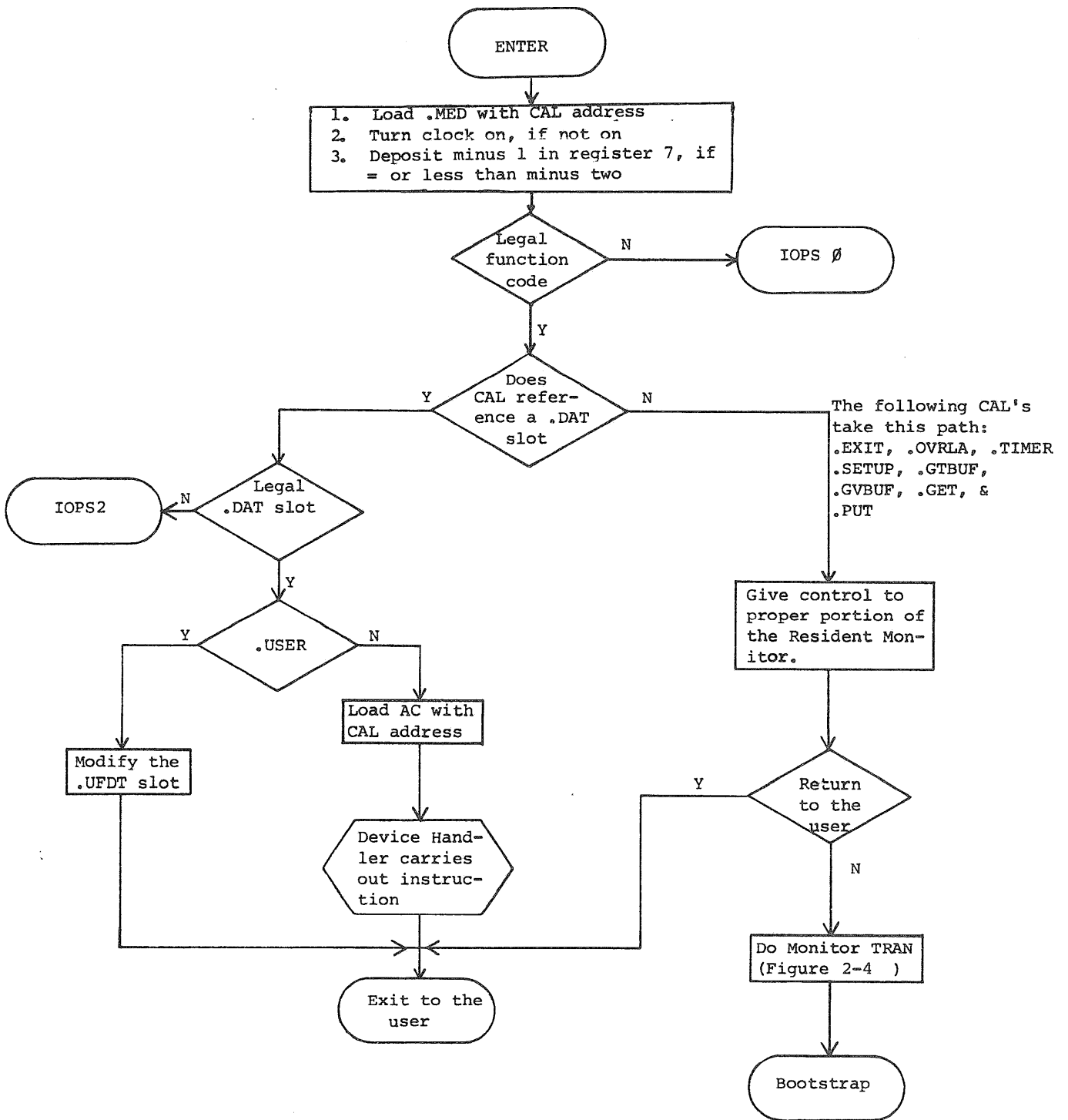


Figure 2-1
Resident Monitor CAL Handler

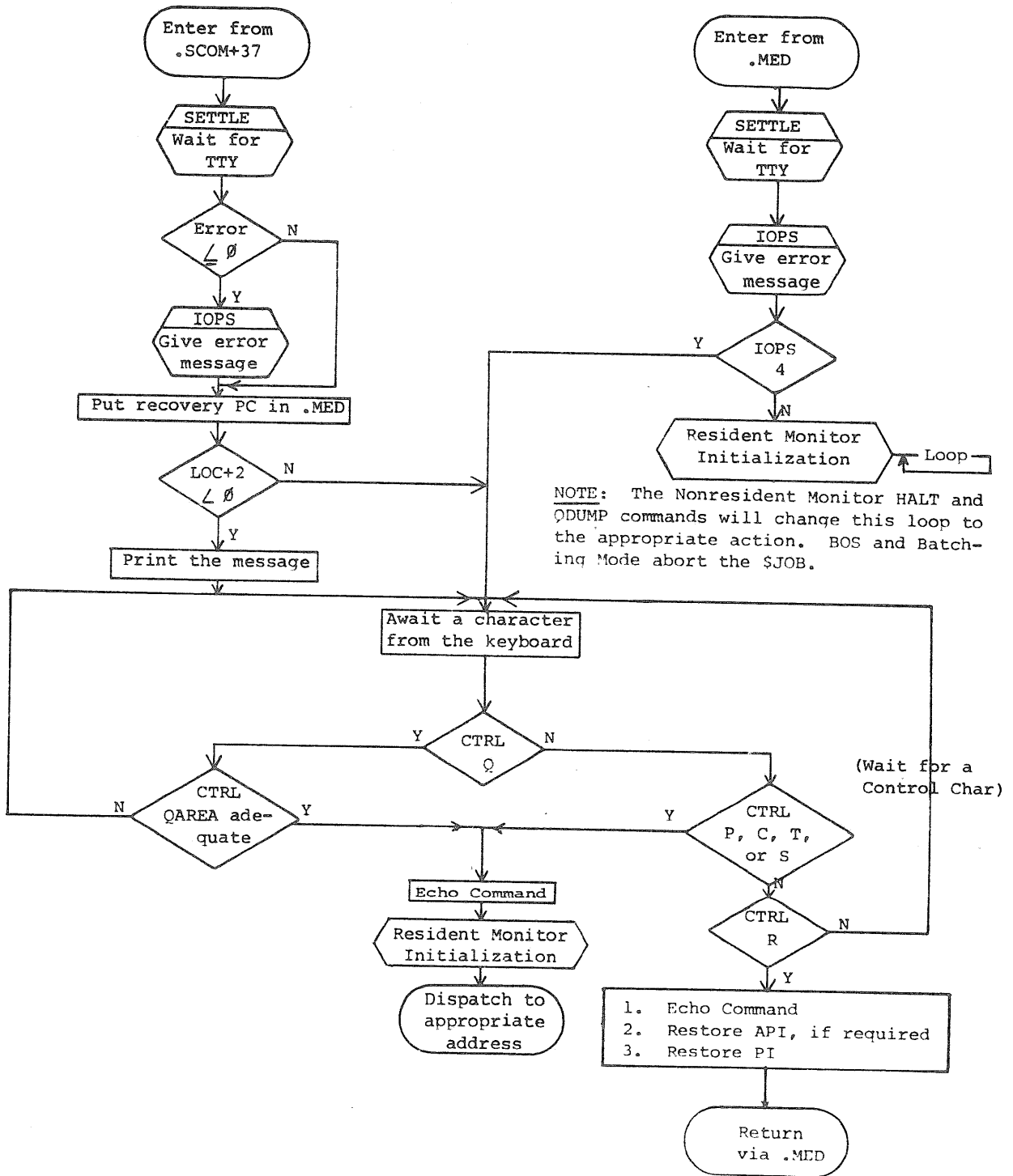


Figure 2-2
Expanded Error Processor
and
Monitor Error Diagnostic Routine
.MED

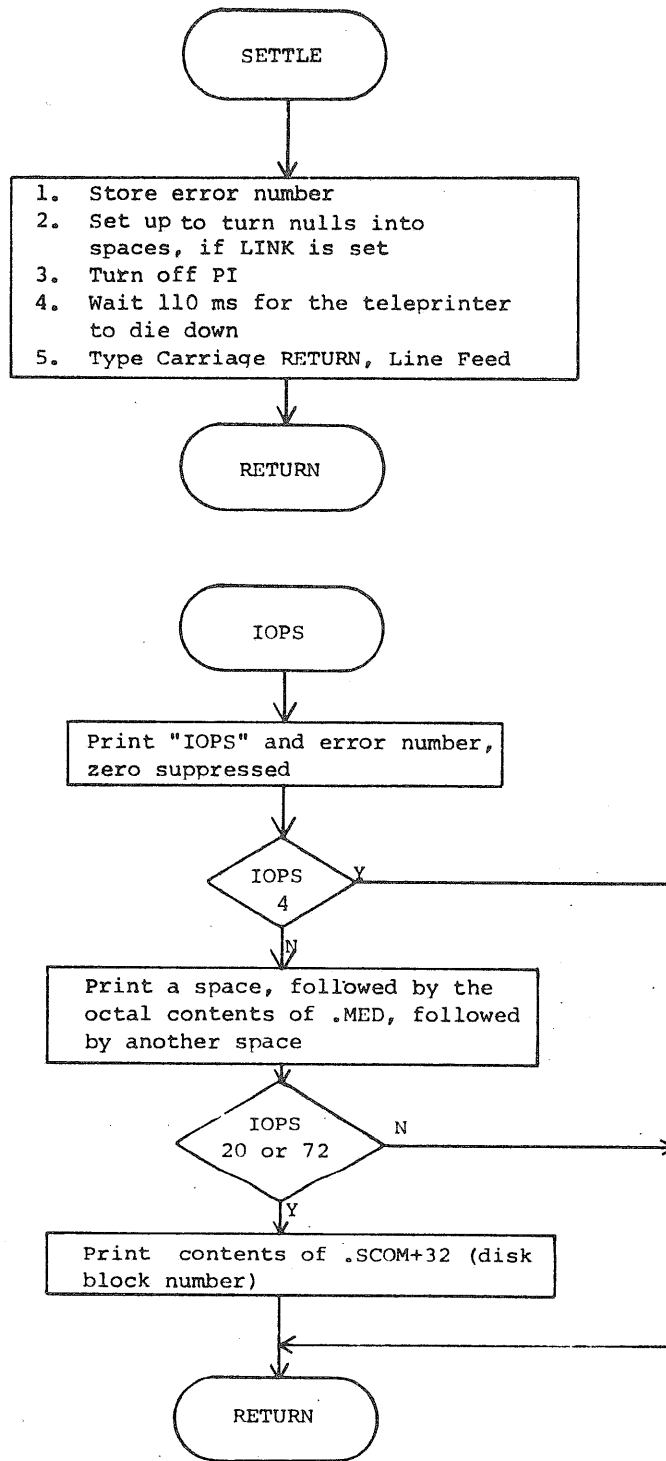


Figure 2-3
Resident Monitor Subroutines

2.3.2 The Expanded Error Processor

The disk handlers (except the Bootstrap), CDB., MTF., TTA., and LPA. use the Expanded Error Processor. Each error message is "potentially" recoverable by typing CTRL R. That is, the Resident Monitor always returns control to the caller upon a CTRL R. It is up to the caller to respond accordingly. All handlers supplied with the system simply repeat the error message if the error is unrecoverable.

The Expanded Error Processor gives the capability of printing additional information after the standard IOPS message. As with .MED, the AC must contain the error number ($0 \leq \text{number} \leq 777$) in bits 9-17. Control must be passed, however, via JMS* (.SCOM+37, not JMP* (.MED+1.

The following information pertains to the message: LOC+2 must contain the two's complement of the number of message words to be typed after the standard "IOPSNN nnnnnn" message. If the number is zero or positive, no message will be printed. If the LINK is set, nulls will be printed as spaces. If the LINK is zero, nulls will be ignored. If the AC is positive on calling the expanded error facility, only the special message will be printed. The "IOPS" part will be omitted. The message itself must be packed in .SIXBT.

The following are examples of use of the Expanded Error Processor:

Example a:

```
UNREC  LAC  STATUS      /STATUS REGISTER B
      DAC* (.MED        /CAL ADDRESS IS NOW OVERWRITTEN
                        /BY CONTENTS OF STATUS REGISTER
SZL
LAW  ERRNUM      ^ERRNUM ^1000
JMS* (.SCOM+37
JMP  UNREC      /THIS IS AN UNRECOVERABLE ERROR.
                        /JMP -.1 WILL NOT DO -- EXPANDED
                        /ERROR PROCESSOR CHANGES THE
                        /CONTENTS OF .MED.
LAW      -6      /6 DATA WORDS FOLLOW
.SIXBIT 'DKA'    /DEVICE NAME
40
.SIXBT  'FIL'    /FILE NAME (2 WORDS)
.SIXBIT 'E'
40
.SIXBT  'SRC'    /NULL, NULL, SPACE
                        /EXTENSION
```

The printout from that code will be as follows:

```
IOPS777 nnnnnn DKA FILE SRC
```

where nnnnnn is the contents of .MED, and equals the Status Register B, and ERRNUM is 777.

Example b:

```
PARITY LAW 61
      STL                               /TURNS NULLS INTO SPACES
      JMS* (.SCOM+37
      JMP  RETRY                       /THIS IS A RECOVERABLE ERROR
      LAW  -1
      .SIXBT 'DTA'
```

The printout from that code will be as follows:

```
IOPS61 nnnnnn DTA
```

where nnnnnn is the contents of .MED, the address of the last CAL, deposited by the CAL Handler.

2.4 THE SYSTEM BOOTSTRAP

The System Bootstrap is nothing more than a disk driver. It may load the System Loader and Resident Monitor from Hardware Readin or manual restart. All other Bootstrap operations result from the use of the Monitor TRAN routine. The Monitor TRAN routine sets up the Bootstrap to read or write any block or set of contiguous blocks from the disk to or from any location in core. Before calling the Bootstrap, the Monitor TRAN does a .WAIT to all .DAT slots in the Mass Storage Busy Table, clears all flags, turns off the VT if it were on, and allows the clock to tick positive, so that it will keep time but not interrupt. After the Bootstrap has finished, it calls the Monitor Initialization Routine, which updates the clock and turns on the VT, if necessary.

The Monitor TRAN Routine requires the following parameter table:

PARADD	LOC+0	BLKNUM	/FIRST BLOCK NUMBER
	LOC+1	FIRSTA-1	/FIRST ADDRESS OF BUFFER, MINUS ONE
	LOC+2	-SIZE	/# OF WORDS TO BE TRANSFERRED IN 2'S COM
	LOC+3	START	/STARTING ADDRESS AFTER DISK I/O
			/COMPLETION

The following code illustrates the use of the Monitor TRAN:

```
UNIT=1000000                                /MONITOR TRAN WILL USE UNIT ONE1
.
.
.SCOM=1000
.
.
LAC (PARADD                                /MONITOR TRAN REQUIRES ADDRESS OF
XOR  UNIT                                  /PARAMETER TABLE IN BITS 3-17 AND
                                           /UNIT NUMBER IN BITS 0-2 OF AC
STL                                       /NONZERO LINK GIVES TRAN OUT
JMP* (.SCOM+55                          /.SCOM+55 IS USER ENTRY POINT FOR
                                           /MONITOR TRAN
```

See also paragraph 5.7.

¹DECdisk TRANS ignore unit number, use block number.

.OVLRA, .EXIT, and manual Q dumps all use the Monitor TRAN routine. Figure 2-4, .OVLRA, .EXIT and CTRL Q, illustrates their operation, and also the Monitor TRAN.

For the RF DECdisk, the user can reference a specific platter just by identifying the block number he wants. That is, the block numbers do not automatically go to zero at the beginning of every platter. The block numbers and platter relationships are shown below:

Table 2-1

RF Platter-Block Number Correspondence

Platter Number	Block Number
0	0-1777
1	2000-3777
2	4000-5777
3	6000-7777
4	10000-11777
5	12000-13777
6	14000-15777
7	16000-17777

(All numbers are in octal)

2.5 SYSTEM I/O INITIALIZATION

There are two routines that do DOS I/O initialization: the startup routine after Bootstrap manual loads and restarts, and the startup routine performed after Monitor TRAN's and after a CTRL C, P, T or S for an error. The startup routine after Bootstrap loads is described in Figure 4-1, The System Loader Interface Routine. Figure 2-5, Resident Monitor Initialization, describes the other routine.

2.6 RESIDENT MONITOR TIMING FEATURES

Figure 2-6, The Resident Monitor Clock Routine, describes the Resident Monitor's time functions. There are three places in DOS which start or try to update the clock -- (1) the first-time initialization after manual Bootstrap loads and restarts, (2) the Resident Monitor Initialization, and (3) the CAL Handler. The following .SCOM registers contain timing information:

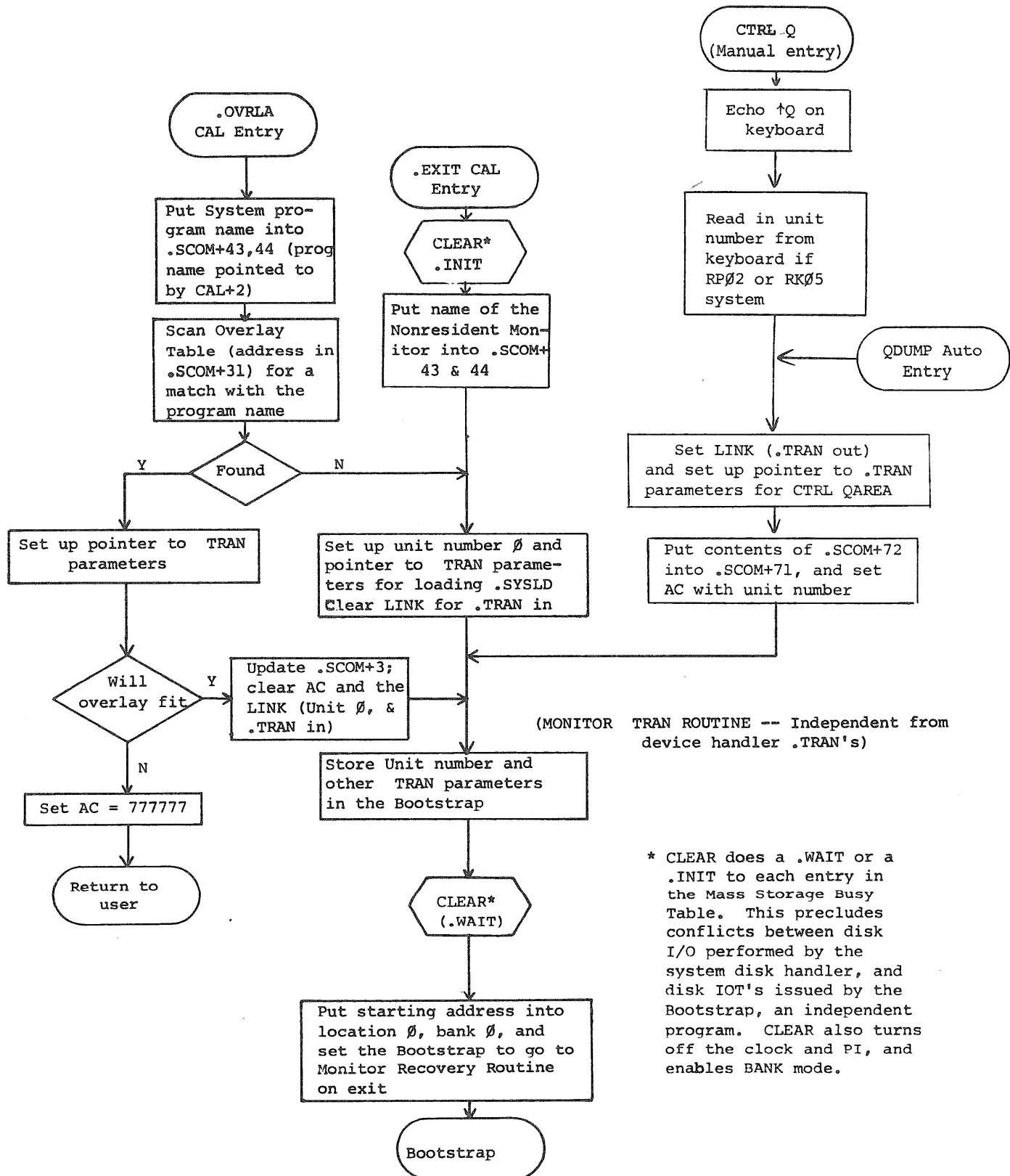


Figure 2-4
.OVRLA, .EXIT and CTRL Q

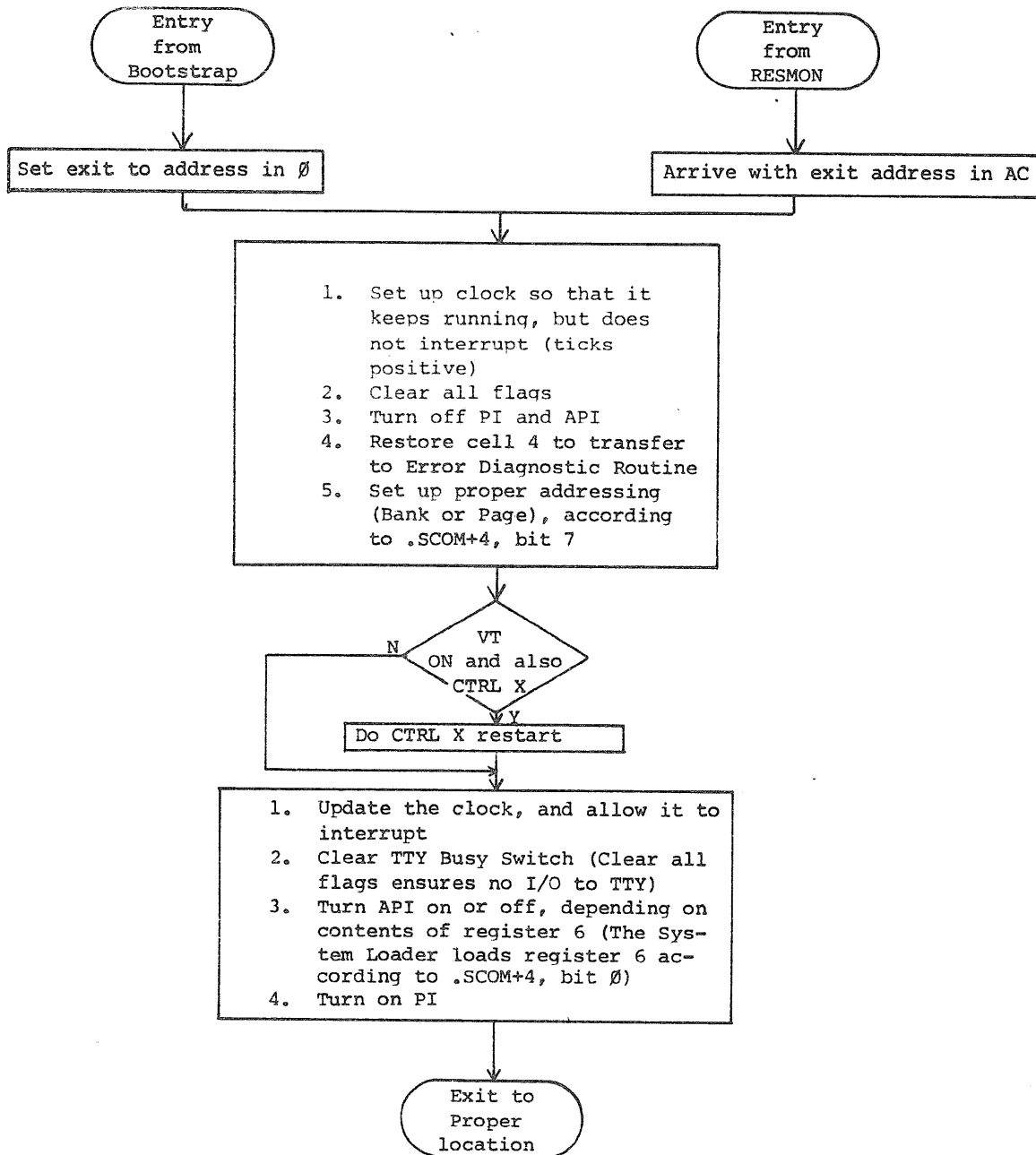
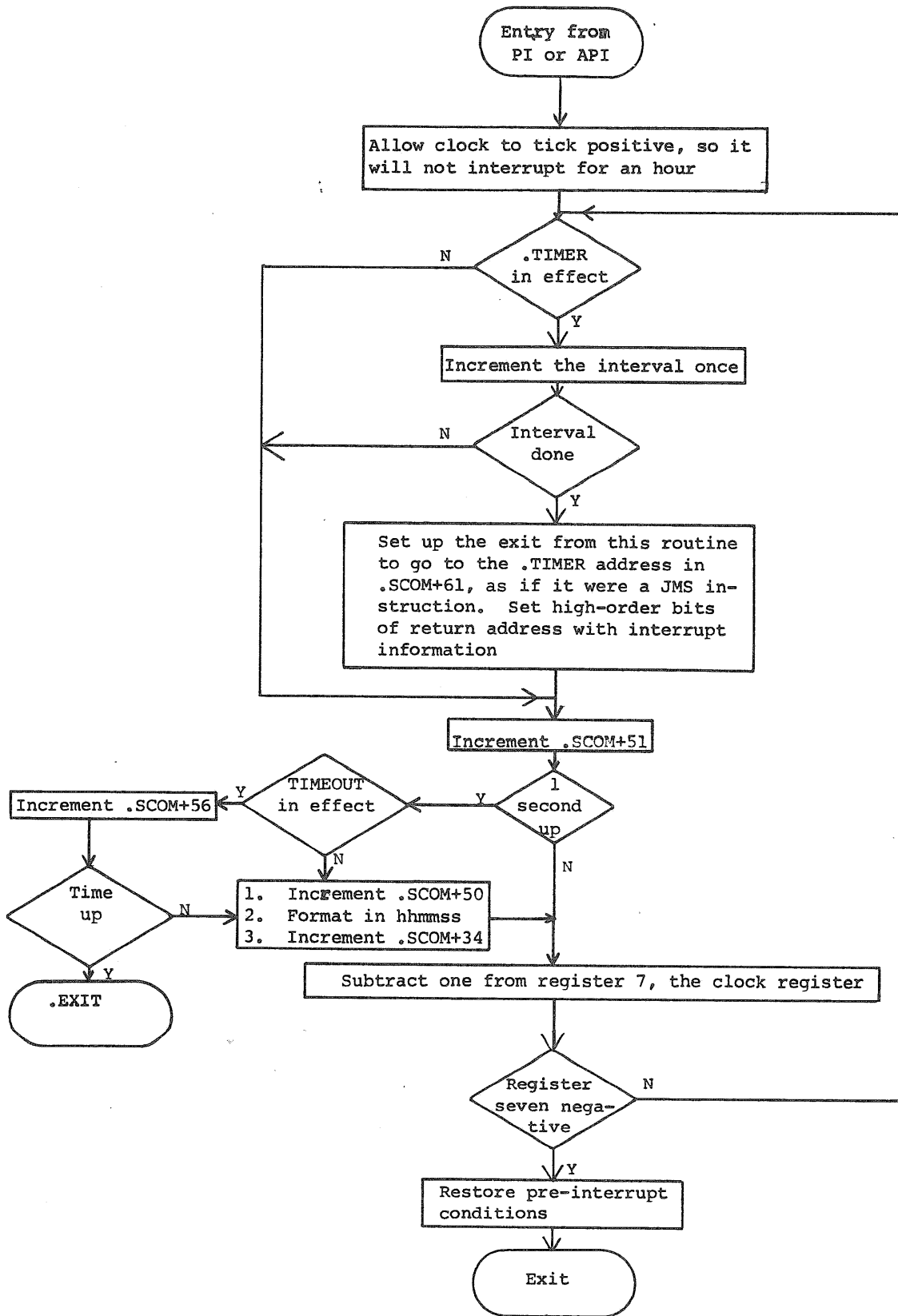


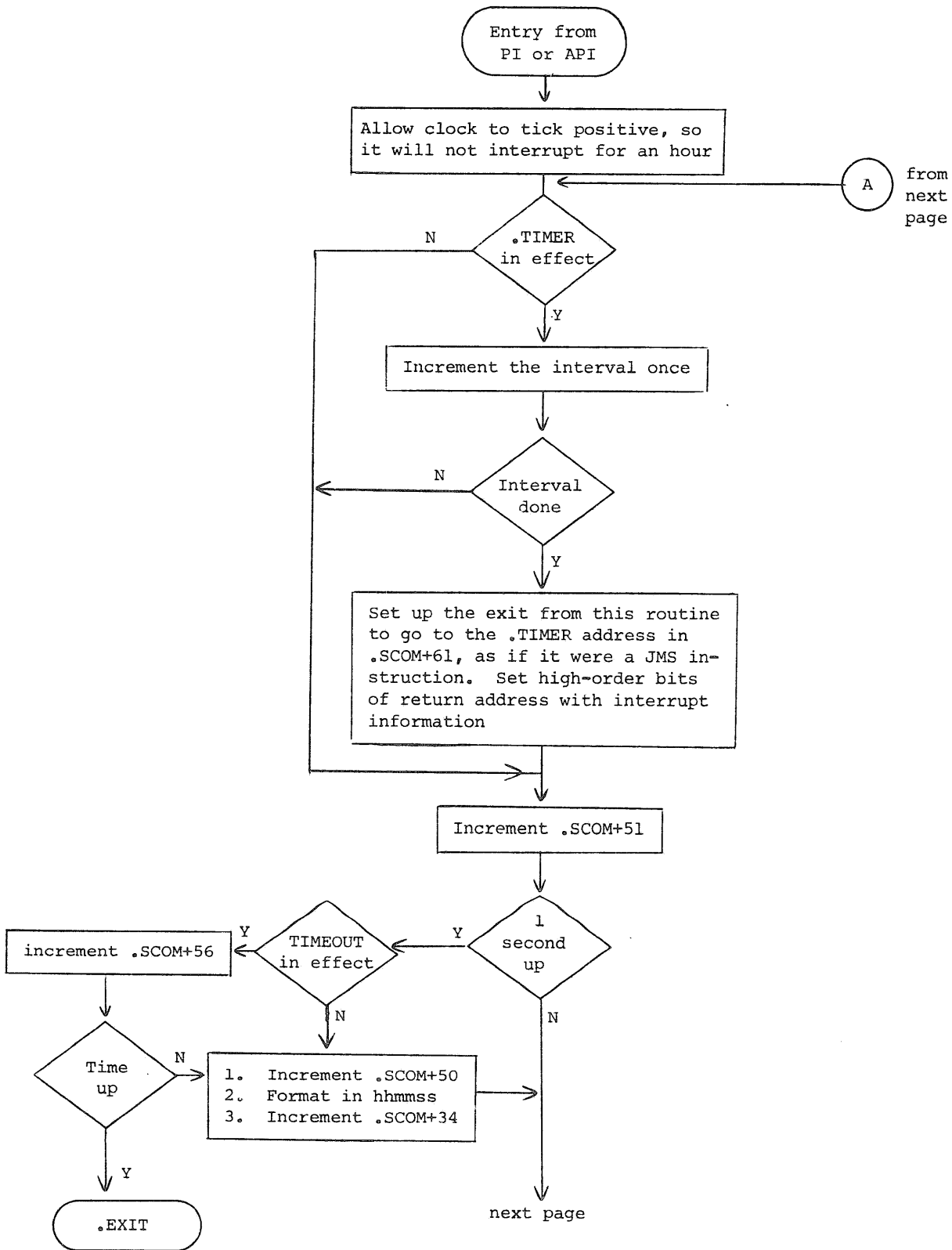
Figure 2-5
Resident Monitor Initialization



Note: The Clock Routine will use PI if API is busy, or down.

Figure 2-6

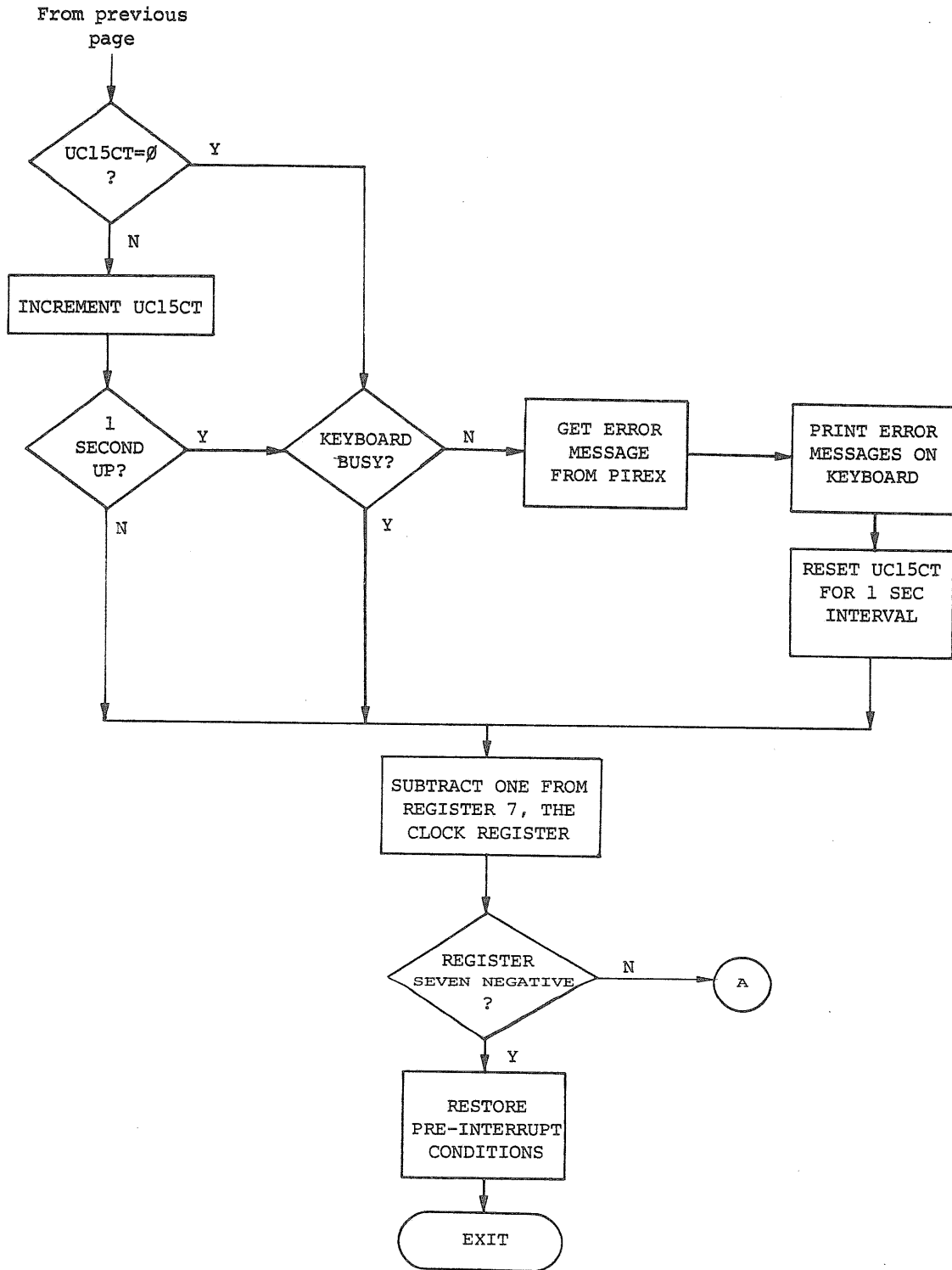
The Resident Monitor Clock Routine for non-UC15 Systems



Note: The Clock Routine will use PI if API is busy, or down.

Figure 2-7

The Resident Monitor Clock Routine for UC15 systems (RKØ5 based or RF15/RPØ2 based with UC15 option)



Note: The Clock Routine will use PI if API is busy, or down.

Figure 2-7 (Cont'd.)

The Resident Monitor Clock Routine
for UC15 systems (RK05 based or
RF15/RF02 with UC15 option)


```

.SCOM+50 Time of day, in hhmmss (six bits each)
.SCOM+51 Elapsed time, in ticks
.SCOM+56 Time limit, in seconds (zero, if no limit)
.SCOM+60 Time left for .TIMER interrupt (zero, if
        .TIMER not in effect)
.SCOM+61 Address of .TIMER user interrupt routine
.SCOM+73 Number of ticks left in the next second
.SCOM+74 Line frequency, in ticks per second

```

2.6.1 Clock Operation

The Nonresident Monitor's TIME command changes or senses .SCOM+50. .SCOM+51 is not used by any system program. The clock handler simply increments it upon each clock tick. User programs may deposit a known quantity into .SCOM+51, in order to time events. The Non-resident Monitor deposits the argument for a TIMEST command into .SCOM+56. If .SCOM+56 is nonzero, the Resident Monitor will issue an ISZ .SCOM+56 command each second, until it reaches zero. At such a time, the Resident Monitor will perform a .EXIT. MICLOG, LOGIN, and LOGOUT clear .SCOM+56.

2.6.2 .TIMER

.TIMER allows users to schedule routines for a specified time from "now". These routines may return to the interrupted code, if the programmer desires. .TIMER users should take care that the time-dependent code follows certain rules:

- a. When a programmer does not wish to reset the .TIMER mechanism, but wishes to return to the interrupted program, his code should look like this:

```

C      Ø          /C+1 REACHED VIA JMS
      DAC      SAVEAC /MUST NOT USE NON-REENTRANT CODE
      .        .     /POSSIBLY USED BY THE INTERRUPTED
      .        .     /PROGRAM. (INCLUDES THE CAL IN-
      .        .     /STRUCTION)
      LAC      C     /RESTORE THE LINK
      RAL
      LAC      SAVEAC /RESTORE THE AC
XIT   JMP*    C

```

- b. When the programmer does wish to reset the .TIMER mechanism, and return to the interrupted code, his routine should look like this:

```

        .SCOM=1000
        CLON=700044
        CLOF=700004
        INTRVL=-1000 /THIS ROUTINE WILL RUN EVERY 10008+
        . /TICKS
C      0
        DAC    SAVEAC
        .
        .
        LAC    ADDRES /RETURN TO THE NEXT ROUTINE
        DAC*   (.SCOM+61
        CLOF   /TURN THE CLOCK OFF TO ENSURE NO
                /REENTRANCE BEFORE .TIMER RESET AND
                /RETURN
        LAC    INTRVL /DESIRED INTERVAL IN TWO'S COMPLEMENT
        DAC*   (.SCOM+60
        LAC    C      /RESTORE THE LINK
        RAL
        LAC    SAVEAC /RESTORE THE AC
        CLON   /TURN THE CLOCK BACK ON (AFTER NEXT
                /INSTRUCTION)
        JMP*  C

```

- c. When a programmer does not wish to return to the interrupted program, he need not save the AC, and he may use the CAL instruction. He should beware of using I/O buffers that may still be modified by a handler's interrupt section. In many cases, a .INIT to an active .DAT slot will terminate I/O. Teleprinter I/O should be terminated by the following:

```
XCT* (.SCOM+35
```

The user should program a delay of at least 110 milliseconds after such an instruction before he attempts teleprinter I/O.

Note: The interrupt routine will run at the level of the interrupted code, with the same addressing mode and memory protect status. Thus, no debreak and restore is required.

2.7 THE RESIDENT MONITOR PATCH AREA

There are two types of patch area:

1. That allocated by using PATCH
2. That allocated when answering the Patch Area question in system generation

Patch area one is the place for permanent changes to the Resident Monitor. It is always refreshed when the System Loader comes into core. Patch area two is only refreshed on manual Bootstrap loads and restarts. The second area would be appropriate for communication between successive programs loaded by the System Loader. This area should be used because the System Loader refreshes all of core, except the Bootstrap, .SCOM, the CTRL X buffer, and the patch area two.

The combined size is limited by the current assembly at 3000_8 for RP02 and RF15 systems, and, for RK05 system. Both areas can be initialized, using PATCH. The important dividing line between area one and area two is register 101 (.SCOM+1) of RESMON. The way to allocate more space in part one is to increase the value of register 101. The way to change the area in part two is to use DOSGEN. The second part will start at the address in register 101. The upper bound of the second area will be the sum of the contents of register 101, and the number specified to DOSGEN.

2.8 CONTROL CHARACTERS

CTRL C, P, R, S, and T are all special characters that interrupt the current program and transfer control. The Resident Monitor ignores CTRL R except after IOPS 4 and any call to the Expanded Error Processor. CTRL S always transfers control to the address in .SCOM+6. In the case of core-image system programs and EXECUTE, a CTRL S will transfer to register zero, and result in an IOPS 3. The Linking Loader places the starting address of the first load module into .SCOM+6.

A .INIT macro to the teleprinter handler will change the address of either CTRL C, P or T. The Resident Monitor is always initialized to

perform a .EXIT after CTRL C, and ignore CTRL P and T. DDT uses CTRL T, and CTRL P is ordinarily used by programs for restarts. MACRO-15 expands .INIT to change the CTRL P address. If the programmer expands .INIT without the aid of the assembler, a 10 in bits zero and one of LOC+2 will change the address of CTRL T. A 01 in those bits will change the address of CTRL C. It should be obvious that special care should be taken with CTRL C. In addition, modifications to the CTRL T address should not be made when debugging with DDT. There are cases, however, when such modifications are desirable. In particular, all zeroes in LOC+2 (2-17) will cause the teleprinter handler to ignore CTRL C, P, or T. This address might be used when sensitive code is being executed, as in DOSGEN. The following .INIT expansion will cause the Resident Monitor to ignore CTRL C:

```
CAL-2&777
1
2000000
```

2.9 TASK CONTROL BLOCKS (only for UC15 system - RK05 based or RF15/RP02 based with UC15 option)

In the UNICHANNEL-15 system communication between the PDP-15 and the PDP-11 is through blocks of information called Task Control Blocks. These blocks are resident in the common/shared memory space (memory that can be addressed both by the PDP-15 and the PDP-11). The TCB contains all the information necessary (like the addressed task code, the method of indicating the completion of a request, memory address, word count, operation etc.) for the PIREX system to process that request (refer to UC15 Software Manual, DEC-15-XUCMA-A-D for more details).

Handlers for the devices on the UNIBUS communicate with the driver tasks running under PIREX through TCB's. In order to permit these handlers to be loaded anywhere in core (not restricting them to the common/shared memory), these TCB's are part of the Resident Monitor. .SCOM+100 points to a table in the Resident Monitor which contains the start address of the various TCB's present in the system as indicated below:

	NAME	SIZE (octal words)
.SCOM+100	TCBTAB	
	RKTCB	21
TCBTAB	LPTCBF	117
	CDTCBF	65
	PLTCBF	117
	S1TCB	24
	S2TCBF	120
	S3TCBF	170

The following are available for use when the handlers are in operation.

RKTCB - TCB for the RK05 disk cartridge handler
LPTCBF - TCB and buffer space for the LP11/LS11 line printer handler
CDTCBF - TCB and buffer space for the CR11 card reader handler
PLTCBF - TCB and buffer space for the XY11 plotter handler

The following are available for new devices or for other purposes as desired by the user

S1TCB - Spare TCB space
S2TCBF, S3TCBF - Spare TCB and buffer space

The TCB and buffer space starts below this table and .SCOM+1 points to the end of the TCB and buffer space. Users can add entries to this table for TCB's or TCB and buffers by suitable updating .SCOM+1 and the table.

CHAPTER 3

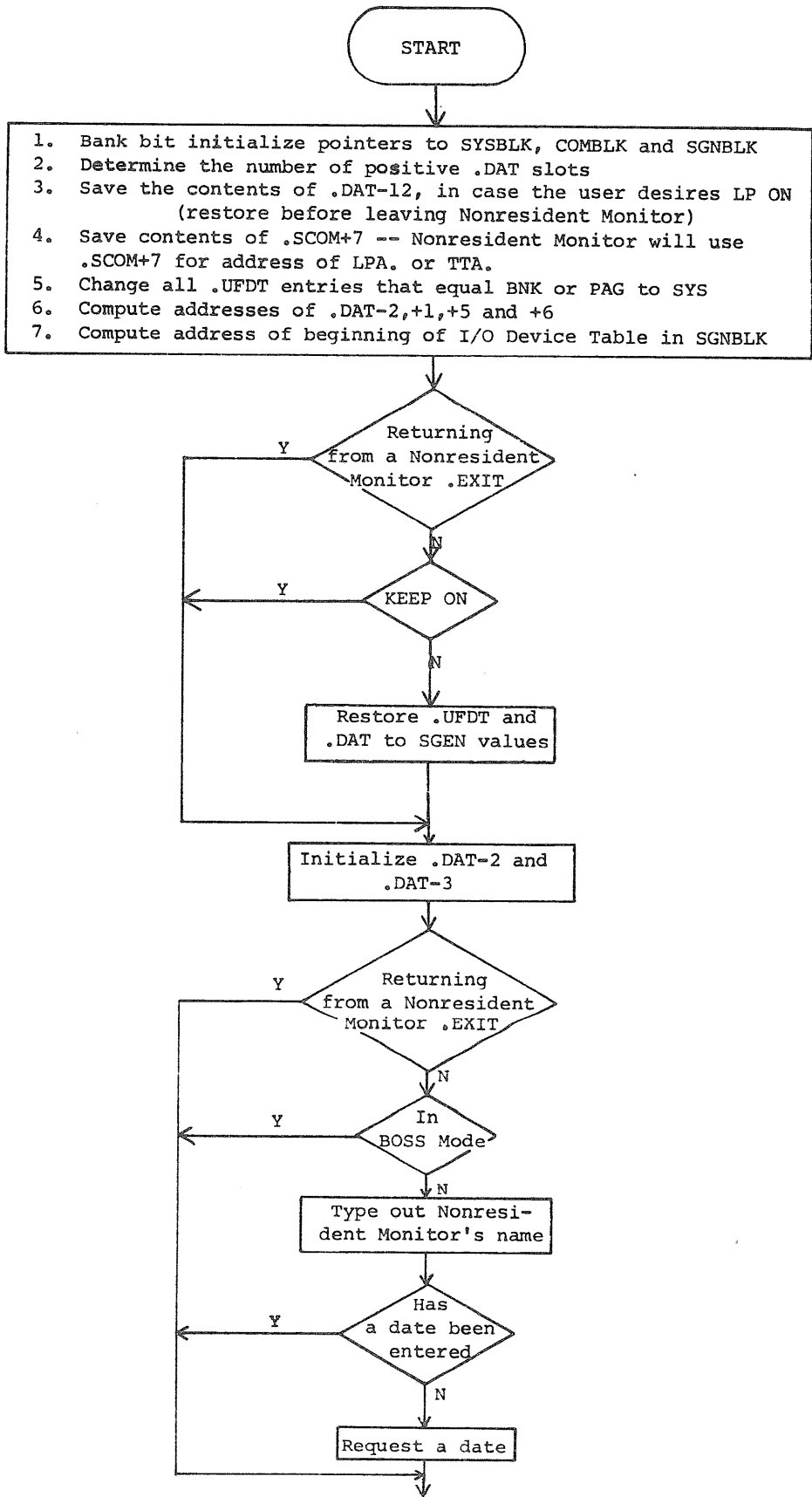
THE NONRESIDENT MONITOR

3.1 INTRODUCTION

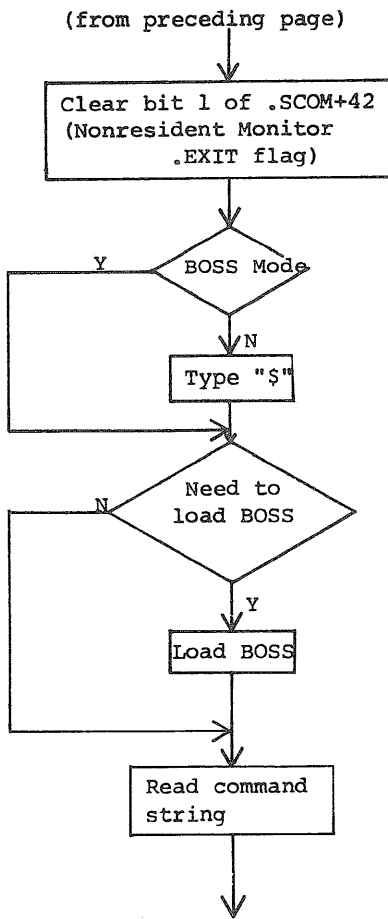
The System Loader brings the Nonresident Monitor into core after a hardware readin, a manual restart, a CTRL C, or a .EXIT. The RCOM Table, SGNBLK, SYSBLK and COMBLK are always coresident with the Nonresident Monitor. This gives the Nonresident Monitor access to all important system parameters.

The Nonresident Monitor announces its presence by typing DOS-15 Vnn on the teleprinter. It remains in core until the operator requests another system program, or until the operator's command implies a refreshed configuration of the Resident Monitor is necessary.

The Nonresident Monitor's actions are limited to (1) decoding commands, (2) manipulating or examining bits and registers in .SCOM, .DAT, .UFDT, SYSBLK, COMBLK, and SGNBLK, and (3) calling the System Loader, when necessary. The Nonresident Monitor has only one entry, which starts an initialization section. Figure 3-1, Nonresident Monitor Initialization, describes that logic. Every time the System Loader brings in the Nonresident Monitor, it passes control to the initialization section. After initialization, and after all commands that do not require the System Loader, the Nonresident Monitor types a \$ and awaits an input line, terminated by a Carriage RETURN or an ALT MODE. It then examines the first six characters (or those up to the first blank) and tries to find an entry in the Nonresident Monitor's Command Table. If a match is found, control passes to the appropriate routine, and thence to the next command or the System Loader. If the typed command does not correspond to an entry in the command table, the Nonresident Monitor temporarily assumes the operator wishes a new core-image system program and checks COMBLK for a corresponding entry. If there is no corresponding entry in COMBLK, the Nonresident Monitor will type an error message and await the next command. If COMBLK contains a matching entry, the Nonresident Monitor composes a .OVRLA and passes control to the System Loader via that .OVRLA.



(next page)
Figure 3-1
Nonresident Monitor Initialization



(Continue to Command Decoder)

Figure 3-1 (Cont.)
Nonresident Monitor Initialization

3.2 COMMANDS TO THE NONRESIDENT MONITOR

This paragraph discusses legal commands listed in the Nonresident Monitor's Command Table. Table 3-1, Effects and Exits for Nonresident Monitor Commands, describes all commands that do not request a new program.

There are five entries in the Command Table that load relocatable system programs. They are DDT, EXECUTE, GLOAD and LOAD. The Nonresident Monitor treats these commands separately, because SYSBLK does not list them. All information necessary for loading these programs resides in the Nonresident Monitor itself.

3.3 CONSIDERATIONS FOR ADDITIONS TO THE NONRESIDENT MONITOR

Programmers should not attempt to add commands to the Nonresident Monitor unless they have access to a copy of the source code. The source code may be purchased from Digital Equipment Corporation, 146 Main Street, Maynard, Massachusetts, under one of the order numbers listed in the footnote. They should then use the EDITOR program to put in the indicated changes, and reassemble.

New additions to the Nonresident Monitor require the following actions:

1. Update the Nonresident Monitor's Command Table.
The Command Table is in two parts:
 - a) The .SIXBT names of the commands
 - b) The corresponding transfer vector
2. Write the code for the command.
3. Consider the kind of exit the command will take:
 - a) Commands that end with a request for a new command should end with JMP KLCOM
 - b) Commands that re-configure the Nonresident Monitor should end with JMP NRMEX1.

DEctape, DEC-15-ODSRA-A-UA1
Magtape (7 track), DEC-15-ODS1A-A-MA7
Magtape (9 track), DEC-15-ODS1A-A-MA9

Table 3-1

Effects and Exits
for Nonresident Monitor Commands¹

COMMAND	MODIFIER	ACTION TAKEN	EXIT
API	ON OFF	Set bit 0 of .SCOM+4. Clear bit 0 of .SCOM+4.	.EXIT .EXIT
ASSIGN	handler (and/or) UIC	Check whether handler is available. If yes, load .DAT slot with proper handler code. (The proper loader will load the handler, and insert its starting address into the .DAT slot. Load proper slot via a .USER	Next Command Next Command
BANK	ON OFF	Set bit 11 of .SCOM+4. Clear bit 11 of .SCOM+4.	Next Command
BATCH	PR CD	Set bit 0 and clear bit 2 in loca- tion 1777 of the Bootstrap's bank. If bit 2 of .SCOM+33 is set (i.e., if VT is ON) and bit 17 of .SCOM+33 is set (i.e., CTRL X is set for VT), set bit 1 of .SCOM+33 in order to tell the Resident Monitor Initializa- tion to start up CTRL X. Set bits 0 and 2 of location 1777 of the Bootstrap's bank, and set bit 1 of .SCOM+33 as with BATCH PR.	.EXIT .EXIT
BUFFS	number	Put number indicated into .SCOM+26, and set Nonresident Monitor Initial- ization to leave .SCOM+26 alone.	Next Command
CHANNEL	7 9	Clear bit 13 of .SCOM+4. Set bit 13 of .SCOM+4	Next Command
DATE	date no date	Enter date into .SCOM+47. Print date from .SCOM+47.	Next Command

¹This table assumes error-free input

Table 3-1 (cont.)

Effects and Exits
for Nonresident Monitor Commands

COMMAND	MODIFIER	ACTION TAKEN	EXIT
GET GETP GETS GETT		See Section 3.4.	
HALF	ON OFF	Set bit 0 of .SCOM+33. Clear bits 0 and 1 of .SCOM+33.	.EXIT .EXIT
HALT		If not in BOSS-15 mode, put a HLT instruction (instead of a JMP) into the exit from non-IOPS 4 errors to .MED. If in BOSS mode, do nothing.	Next Command
INSTRUCT	none ERRORS	Print INSALL SRC } By loading Print INSERR SRC } INSTRC BIN	.EXIT Command
KEEP	ON OFF	Set bit 16 of .SCOM+42. Clear bit 16 of .SCOM+42. Initialize to SGEN default values all entries in .DAT and .UFDT, except change SCR default values to current UIC.	Next Command
LOG		Output five spaces after Carriage RETURNS. After ALT MODE, go to next command.	Next Com- mand (after ALT MODE)
LOGIN	uic	Make specified UIC current (.SCOM+41). *Then set up .UFTD entries; set .DAT entries and system parameters (.SCOM+4, 20, 26, and 33) to SYSGEN default values; clear .SCOM+42 and 56.	.EXIT
LOGOUT		Set current UIC to SCR. Then same as LOGIN (above) from *.	.EXIT
LOGW		For BOSS-15, print message. In all cases, after a Carriage RETURN, output five spaces. After ALT MODE, type four bells ↑P, and await CTRL P. After CTRL P, go to next command.	Next Com- mand (after ALT MODE)

Table 3-1 (cont.)

Effects and Exits
for Nonresident Monitor Commands

COMMAND	MODIFIER	ACTION TAKEN	EXIT
LP	ON OFF	Set bit 3 of .SCOM+42. Clear bit 3 of .SCOM+42.	.EXIT .EXIT
MICLOG	mic	Check mic with SGNBLK. If correct set bit 0 of .SCOM+42 and make 'SYS' the current UIC. Then same as LOGIN (above) from * (except .SCOM+42 not cleared). If incorrect, ignore command.	.EXIT
PAGE	ON OFF	Clear bit 11 of .SCOM+4. Set bit 11 of .SCOM+4.	Next Command
PROTECT	n	If n is between 0 and 7, inclusive, enter it into .SCOM+54.	Next Command
PUT		See Section 3.4.	
QDUMP		Enter MANSAV, the address of the manual CTRL Q, into the exit from non-IOPS 4 errors to .MED.	Next Command
REQUEST	none USER prog	Print the current assignments for .DAT and .UFDT. Print the current assignments for all positive .DAT and .UFDT slots. Print required .DAT and .UFDT slots, and the assignments and use for each.	Next Command
.SCOM		Print the information for the current system.	Next Command
TIME	time none	Enter time into .SCOM+50. Print time from .SCOM+50.	Next Command
VT	ON OFF	Set bit 2 of .SCOM+33. Clear bits 1, 2, and 17 of .SCOM+33. Execute STDP.	.EXIT
X4K	ON OFF	Enter 400000 into .SCOM+20. Deposit zero into .SCOM+20.	Next Command
33TTY	ON OFF	Clear bit 2 of .SCOM+4. Set bit 2 of .SCOM+4.	.EXIT
LA30	ON OFF	Set bit 2 of .SCOM+20 and clear bit 2 in .SCOM+4. Clear bit 2 of .SCOM+20 and set bit 2 in .SCOM+4.	.EXIT

4. After assembly, the programmer must call PATCH, in order to make his relocatable binary program absolute. Commands to PATCH should be as follows:

```
>DOS15 )
```

```
>READR 16077 DOSNRM BIN)
```

16077 indicates the highest location the new monitor can occupy. (SYSBLK begins at 16100.) DOSNRM BIN happens to be the file name used by program development. The programmer may, of course, substitute his own file name. More information may be found in the PATCH manual -- DEC-15-UPATA-A-D.

3.4 QFILE

QFILE is a system program that allows users to (1) store core images in named files, and (2) retrieve such core images for examination via DUMP (or possibly for a slow, core-swapping capability). QFILE implements the following Resident Monitor system macros and Nonresident Monitor commands:

```
.GET, GET, GETP, GETS, GETT, .PUT and PUT
```

Users can not obtain QFILE by typing its name to the Nonresident Monitor. The Resident Monitor will load QFILE as part of its response to the commands and macros listed above.

PUT creates a file that contains the data in the CTRL QAREA; .PUT creates a file from the current core image. GET, GETP, GETS, GETT and .GET all overlay core with the contents of the QAREA or file. (The different commands specify different startup locations.) In addition to the above capabilities, the Resident Monitor provides the capability of overlaying core with the contents of the CTRL Q area. The following instructions show how to use that routine:

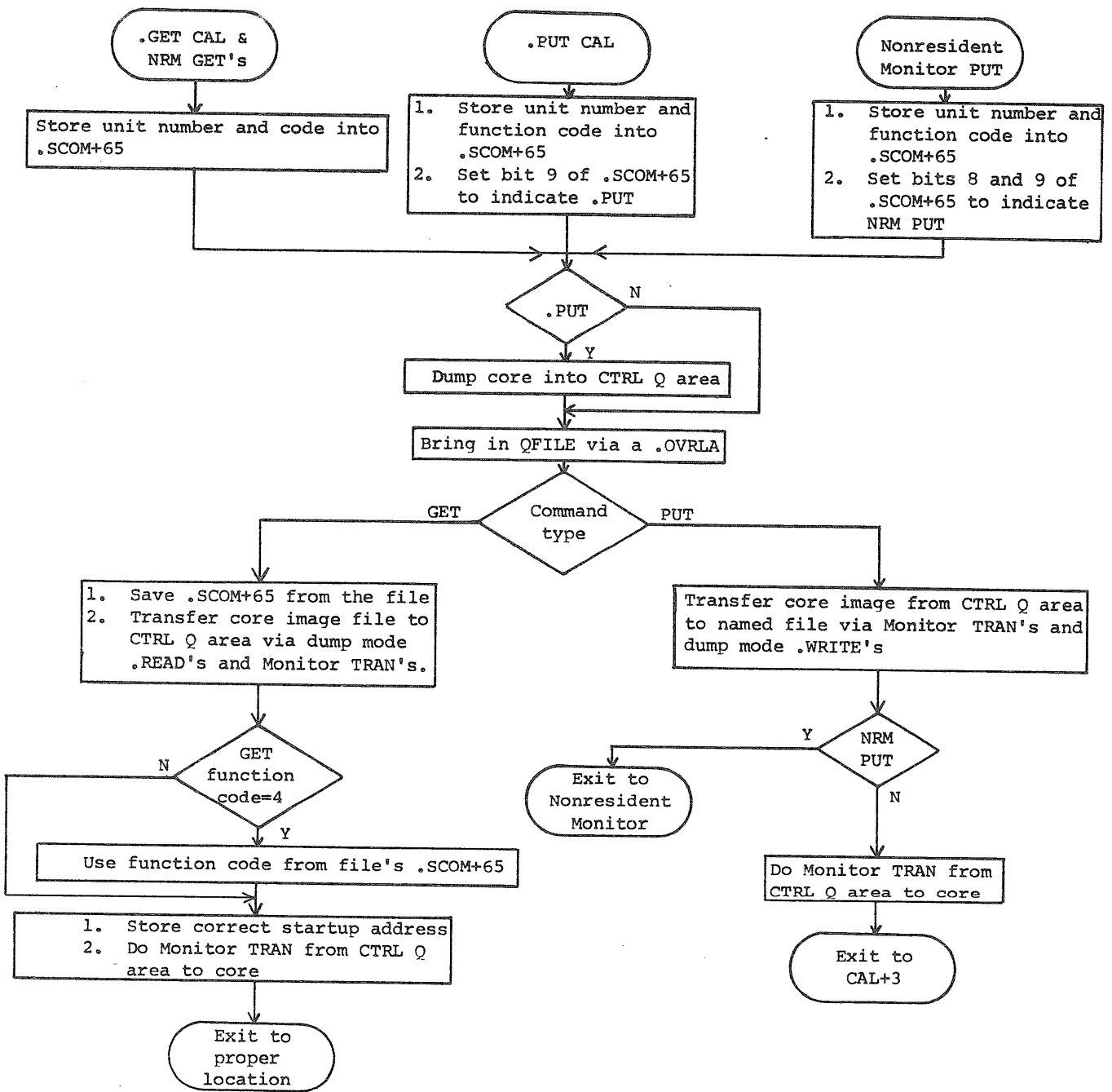
```
UNITNO=4000000          /UNIT FOUR
.SCOM=100
.
.
LAC      START          /STARTING ADDRESS AFTER THE CTRL Q
                        /GET
XOR      UNITNO         /UNIT NUMBER IN HIGH-ORDER THREE BITS
JMP*    (.SCOM+64      /ADDRESS OF CTRL Q GET ROUTINE
```

Figure 3-2, QFILE, and Implementation of GET and PUT Logic, shows the information flow associated with QFILE. QFILE uses the following registers:

.SCOM+7,10 & 11	.SIXBT Filename and Extension
.SCOM+65	Command parameters, packed as follows: Bits 0-2 Device unit number Bit 8 NRM PUT, when set Bit 9 PUT logic, when set Bits 15-17 Function Code
.SCOM+66-71	CTRL Q Area parameters
.DAT-14	File must be on the device assigned to this .DAT slot.

NOTE

All GET and .GET operations change all of core, except registers 0 through 4 of bank zero.



Note: This chart assumes error free input.

Figure 3-2
QFILE, and Implementation of GET and PUT Logic

CHAPTER 4

THE SYSTEM LOADER AND THE LINKING LOADER

The System Loader is the third major part of the DOS-15 Monitor. The other two are the Resident and Nonresident parts. The Resident and Nonresident Monitors communicate with the System Loader by manipulating certain .SCOM registers. When commands to either part imply a new configuration is needed, that part sets up the appropriate .SCOM registers, and passes control to the System Bootstrap via the Monitor TRAN routine. The Bootstrap then loads the System Loader into high core, and gives it control.

The System Loader examines the .SCOM registers, and loads a fresh copy of the Resident Monitor, including any features that the user wishes to be resident, such as the CTRL X feature. It will also load the desired system program and all handlers required by the new configuration. In addition, it will allocate all required buffers. The Nonresident Monitor is treated like any other core-image system program.

The System Loader never loads user programs. It only loads core-image system programs, the INSTRUCT command processing program, the Linking Loader and Execute. The latter two load user programs.

The System Loader uses two device handlers to interface with the disk: the System Bootstrap, and the System Loader Disk Handler (DKL./DPL./RKL.). xxL. arrives in core along with SYSBLK, COMBLK and SGNBLK, as well as the loader itself. The Bootstrap loads core-image programs only. The xxL. takes care of relocatable programs and any handlers loaded by the System Loader. Those include all handlers for core-image system programs, the Linking Loader's own handlers, and any needed by the Execute file. The Linking Loader loads some handlers needed by user programs it links.

There are two parts to the System Loader: the System Loader Interface, and the System Loader Proper (.SYSLD). Figure 4-1 describes the System Loader Interface. Figure 4-2 describes the System Loader Proper, and Figure 4-3 describes the Linking Loader.

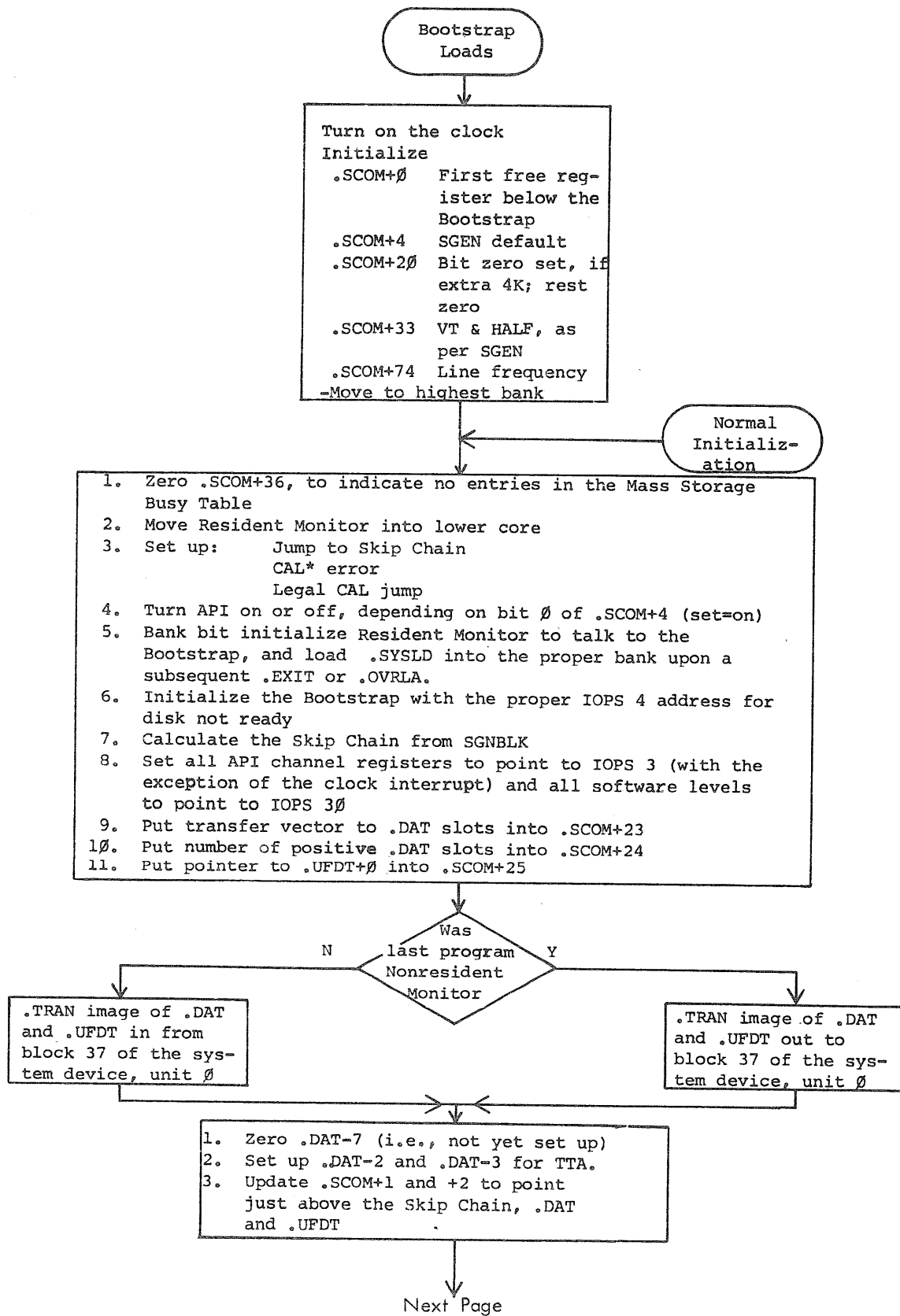
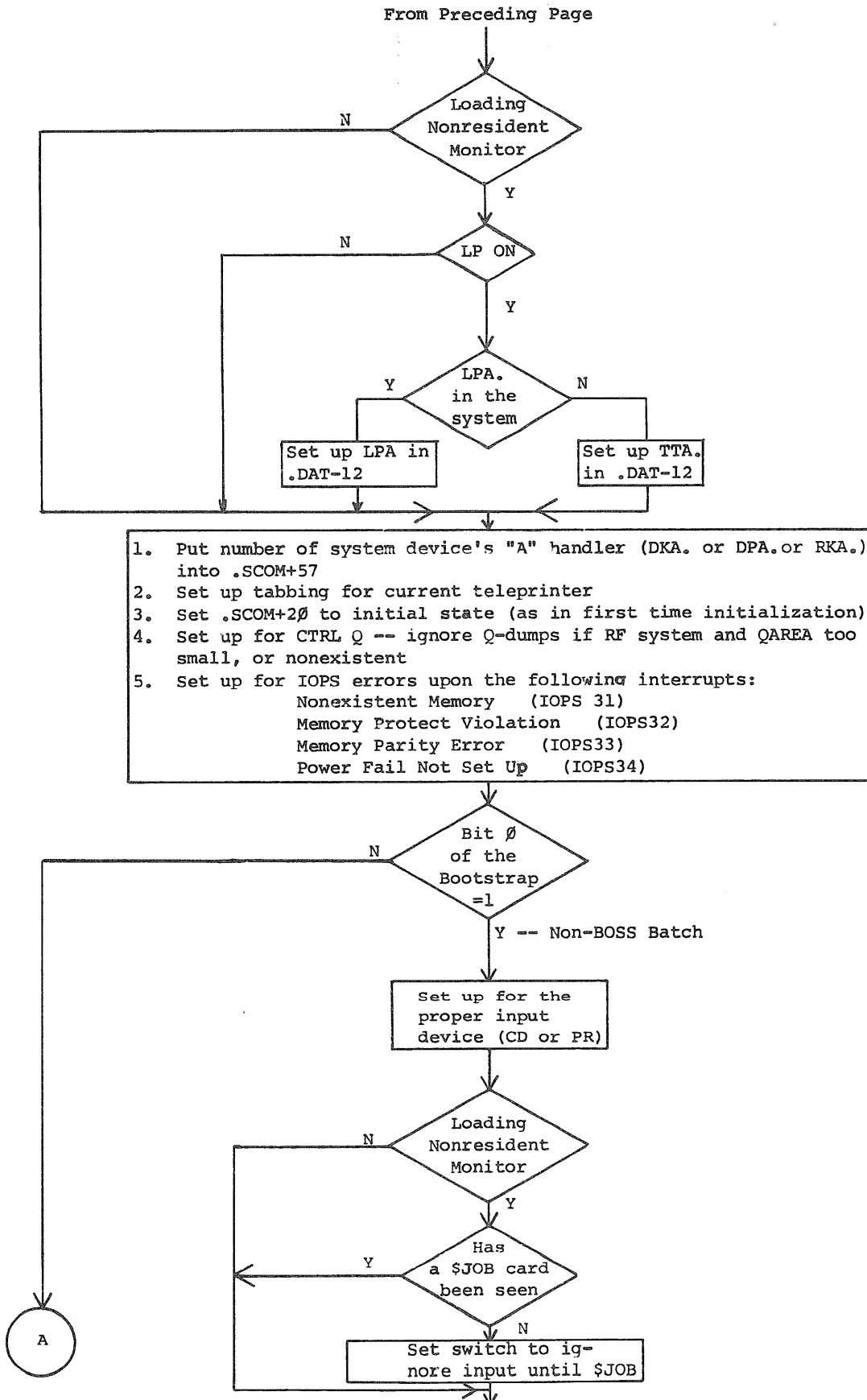


Figure 4-1
System Loader Initialization

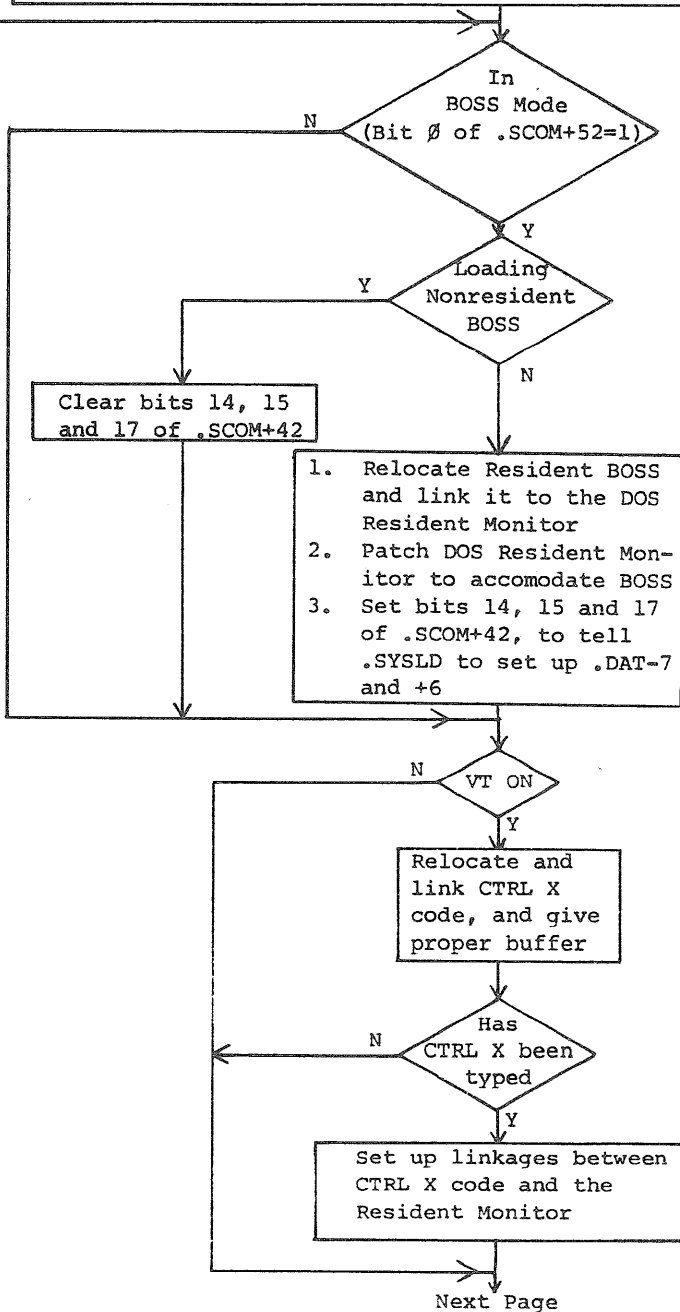


Next Page
Figure 4-1 (Cont.)
System Loader Initialization

From Preceding Page

A

1. Set up CTRL C to clear the Batch Switch (bit 1 of 17777 of the Bootstrap)
2. Set up CTRL T to abort current job, and start the Batch Monitor looking for the next \$JOB line
3. Relocate proper batch handler (PR or CD) to low core
4. Put handler entry point into .DAT-2
5. Set IOPS errors to abort job -- effectively a CTRL T
6. Set up all batch device .DAT slots to refer to the handler currently in core. That is, only one batch input device is allowed at any one time
7. Clear \$JOB read switch (bit 1 of Bootstrap 17777)
8. Perform .INIT to .DAT-2



Next Page

Figure 4-1 (Cont.)
System Loader Initialization

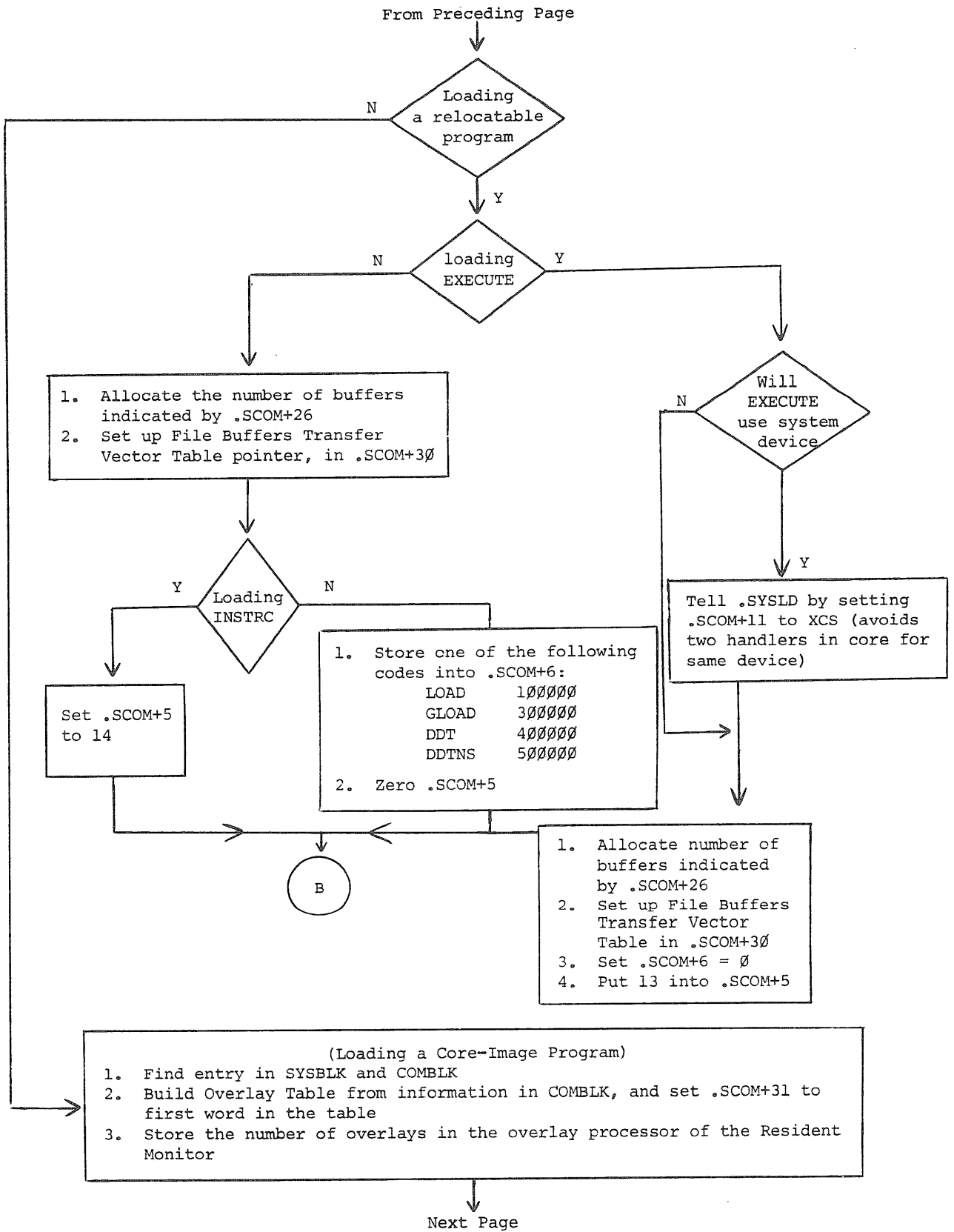


Figure 4-1 (Cont.)
System Loader Initialization

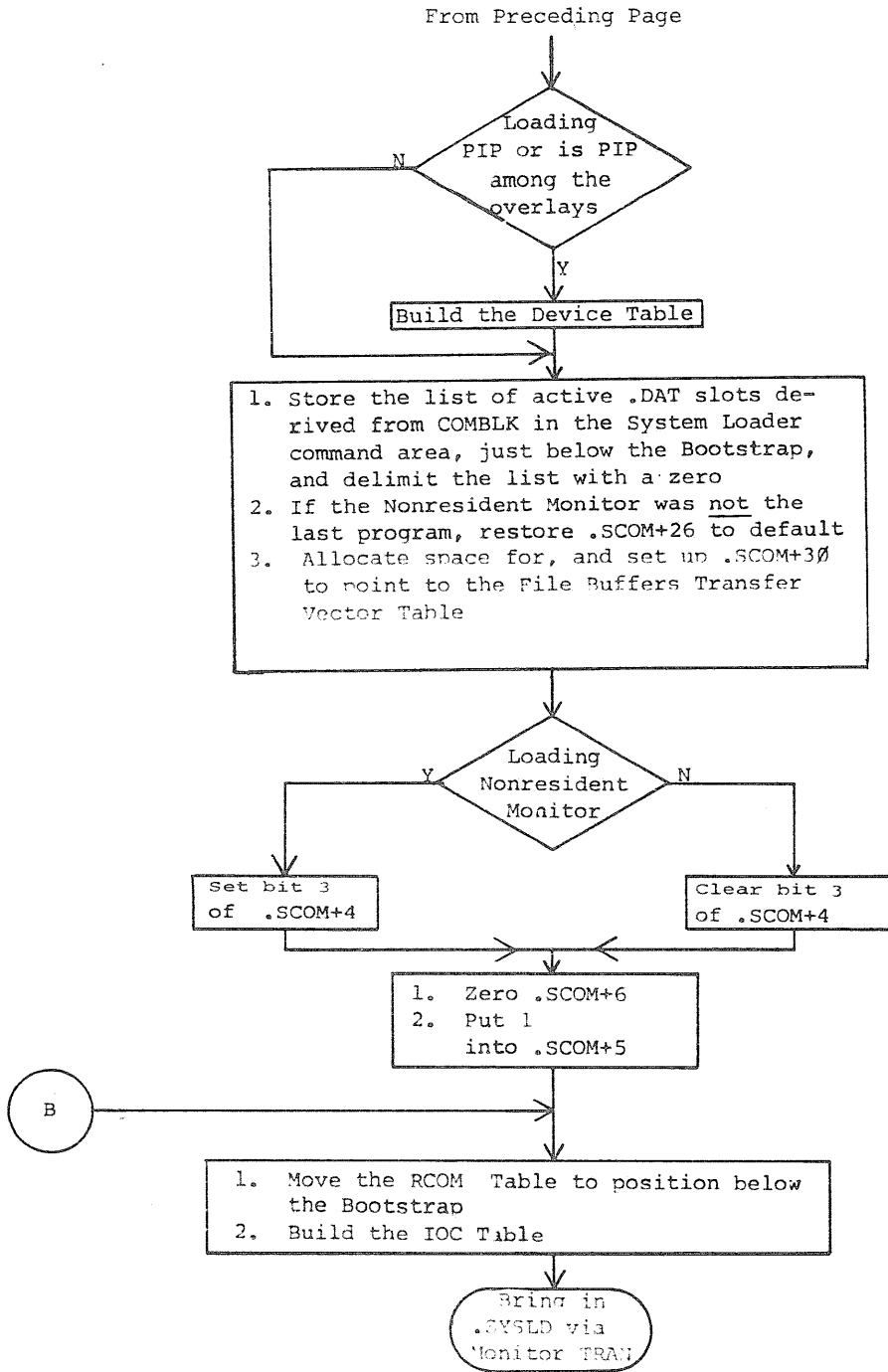
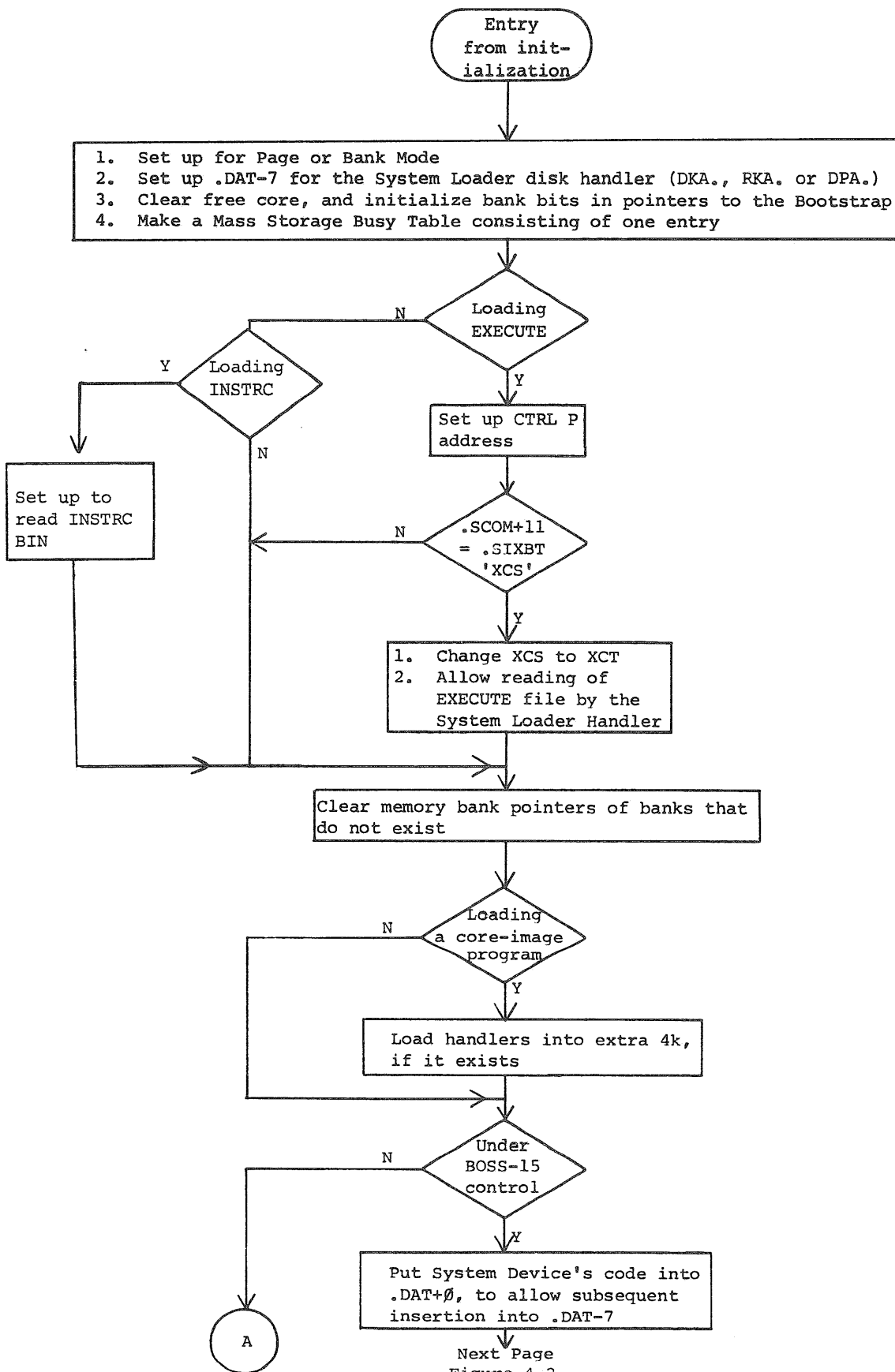
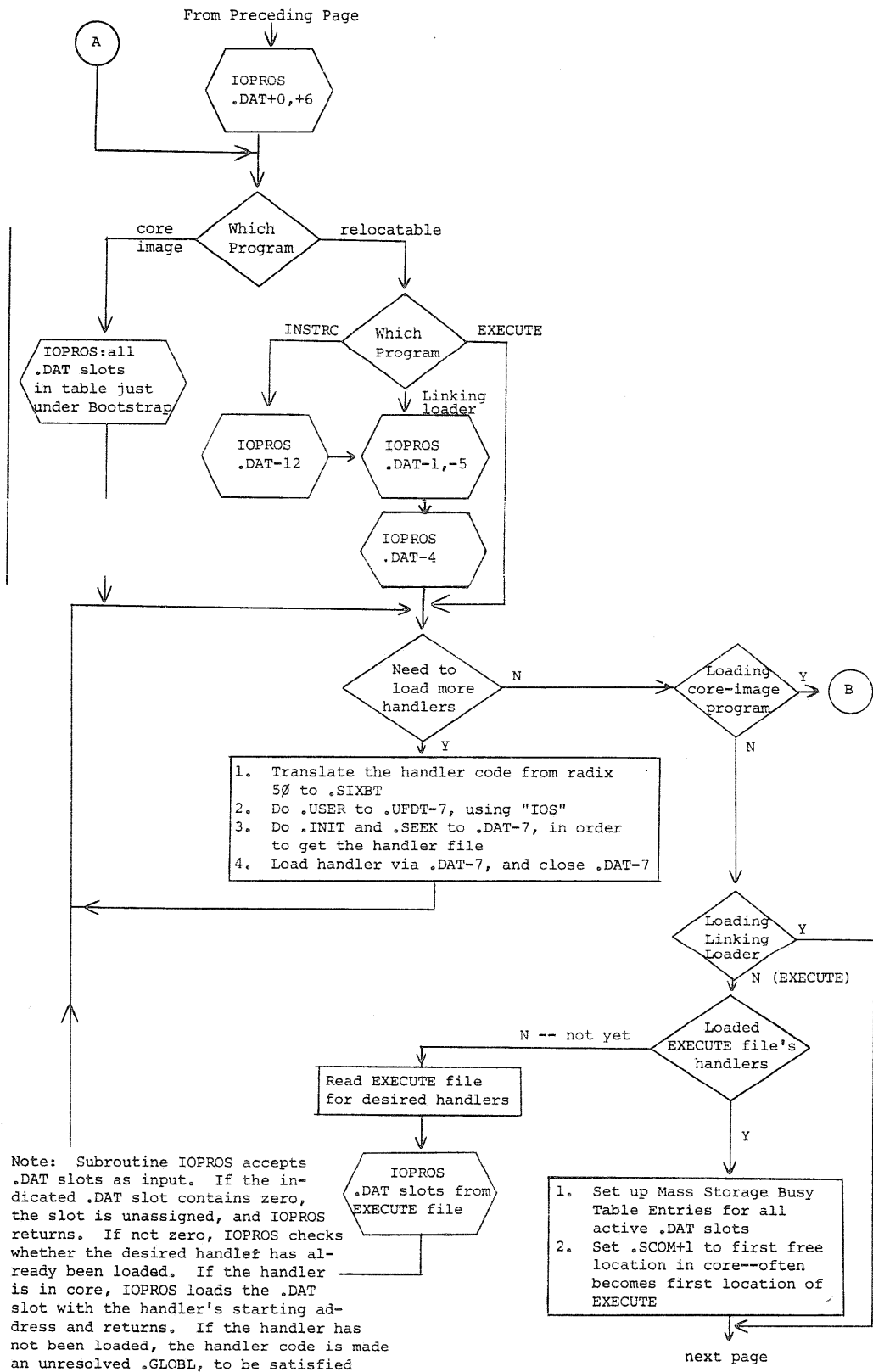


Figure 4-1 (Cont.)
System Loader Initialization

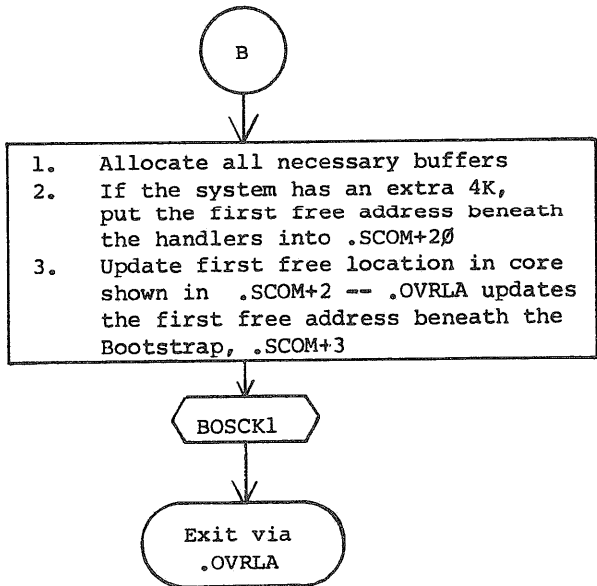
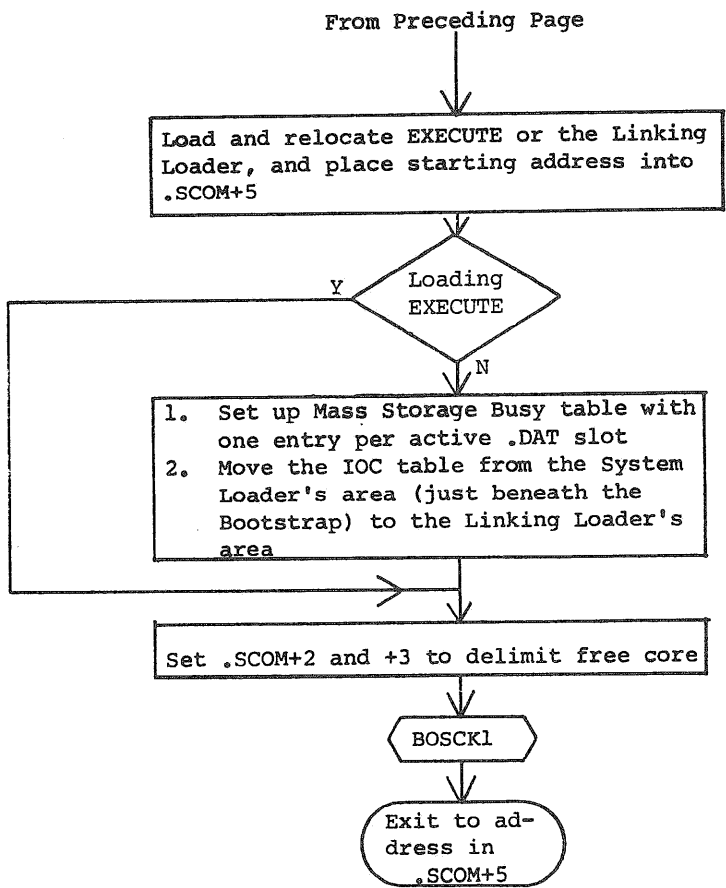


Next Page
Figure 4-2
The System Loader



Note: Subroutine IOPROS accepts .DAT slots as input. If the indicated .DAT slot contains zero, the slot is unassigned, and IOPROS returns. If not zero, IOPROS checks whether the desired handler has already been loaded. If the handler is in core, IOPROS loads the .DAT slot with the handler's starting address and returns. If the handler has not been loaded, the handler code is made an unresolved .GLOBL, to be satisfied by the loop that follows immediately.

Figure 4-2 (Cont.)
The System Loader



Note: Subroutine BOSCK1 does the following, if loading a program under BOSS-15:
 (1) .USER to .UFDT-7, (2) .SEEK to .DAT-7 for PRCFIL PRC.

Figure 4-2 (Cont.)
 The System Loader

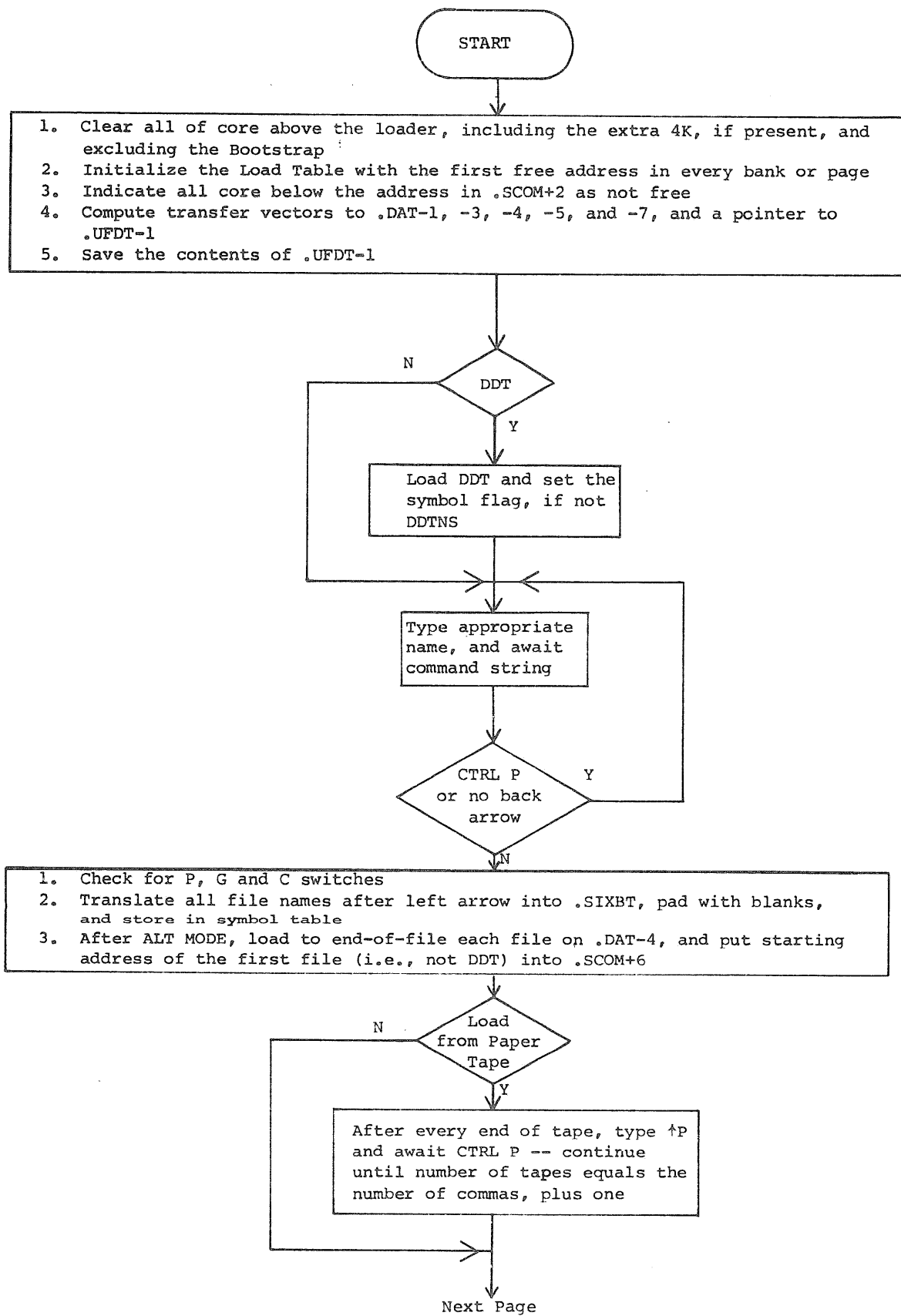


Figure 4-3
The Linking Loader

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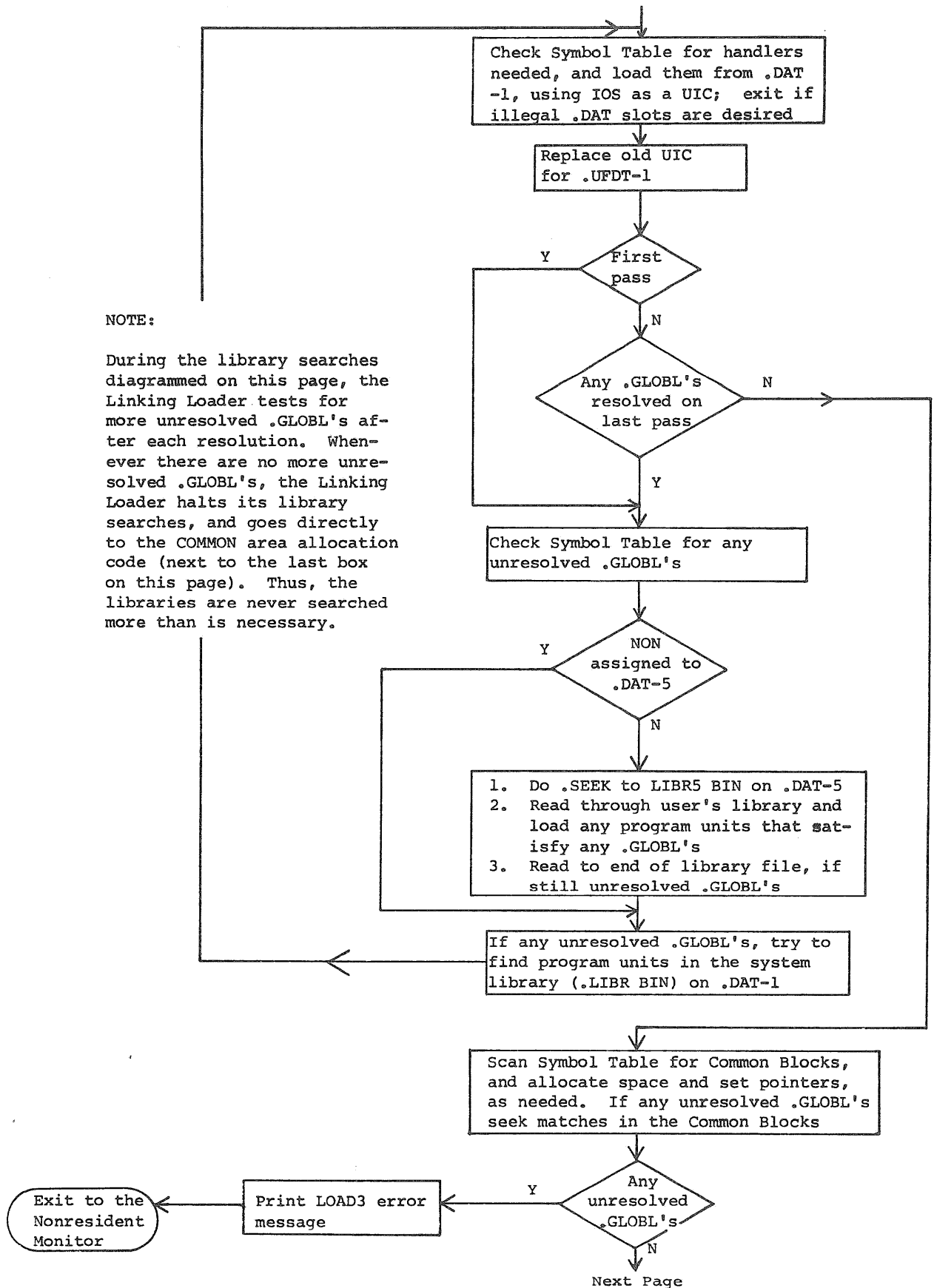


Figure 4-3 (Cont.)
The Linking Loader

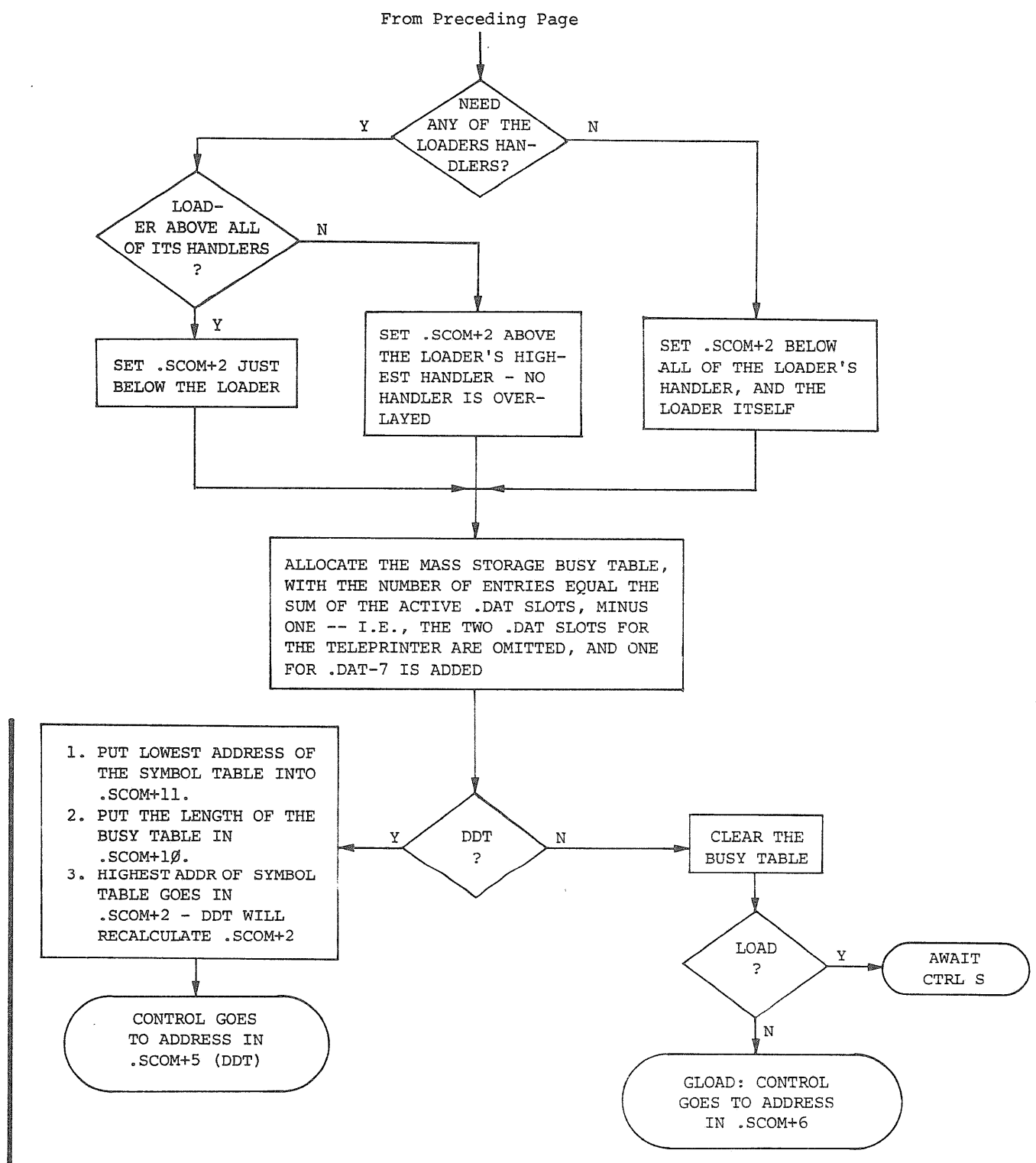


Figure 4-3 (Cont.)
The Linking Loader

4.1 MANUAL BOOTSTRAP LOADS AND RESTARTS

Manual Bootstrap loads and restarts bring blocks 0-36 of the system device into the lowest bank. These blocks contain the Resident Monitor, the System Loader Interface Routine, and SYSBLK, COMBLK and SGNBLK. Figure 4-4 illustrates the core load after manual Bootstrap loads and restarts. The Interface sets up .SCOM+0, 4, 20, 27, 33, 54 and 74 from SGNBLK values determined at system generation time, and then transfers the whole core image of the Interface to the Bootstrap's bank. (DOS requires 16K, because this bank must be different from bank 0.) At all other times, the Bootstrap loads the System Loader into its own bank. This preserves the image of .SCOM, part two of the Resident Monitor patch area, and the CTRL X buffer. For UC15 systems (RK05 based and RF15/RP02 based with UC15 option) this has no effect on the core layout in the PDP-11 local memory. PIREX is reinitialized meaning all permanent tasks are put in a 'WAIT' state while temporary tasks are put in a 'EXIT' state and all pending PDP-15 requests are flushed (refer to UC15 Software Manual, DEC-15-XUCMA-A-D for more information).

4.2 LOADING SYSTEM PROGRAMS

The System Loader Interface Routine gets control in the highest bank, either by a transfer from the lowest bank, or by load from the Bootstrap. After setting up for the System Loader Proper (.SYSLD), according to the program to be loaded and the settings of certain SCOM registers, the Interface Routine brings it in as a complete overlay. Figure 4-5 illustrates the core configuration of the Interface when it is in the highest bank. (The addresses provided are for a 16K system.) The System Loader loads handlers from the lowest part of free core up, with the exception that the extra 4K is filled first, if it exists. Core image system programs are usually loaded just beneath the Bootstrap (always in the highest bank). Such core images must be wholly within the top bank of core, and above register 17 of that bank. Figure 4-6 illustrates the core maps for system programs.

Whenever the Linking Loader is loaded (LOAD, GLOAD, DDT, and DDTNS), the System Loader loads all handlers for .DAT slots -1, -4, and -5, and then loads the Linking Loader itself. (DDT is loaded by the Linking loader.) Wherever INSTRC (\$INSTRUCT command processing program) is loaded, the handler assigned to .DAT slot-12 is also loaded. Figure 4-7 illustrates the core maps for the Linking Loader and INSTRC.

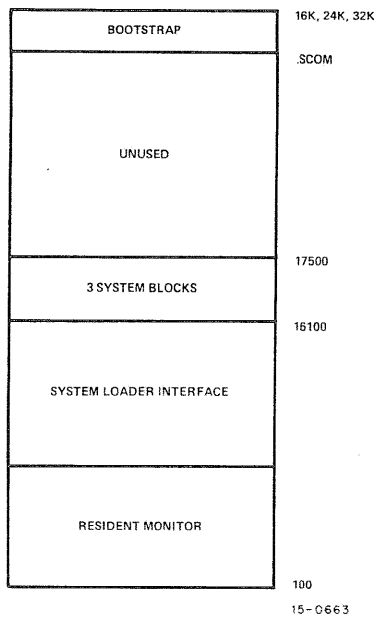


Figure 4-4
Bootstrap Load

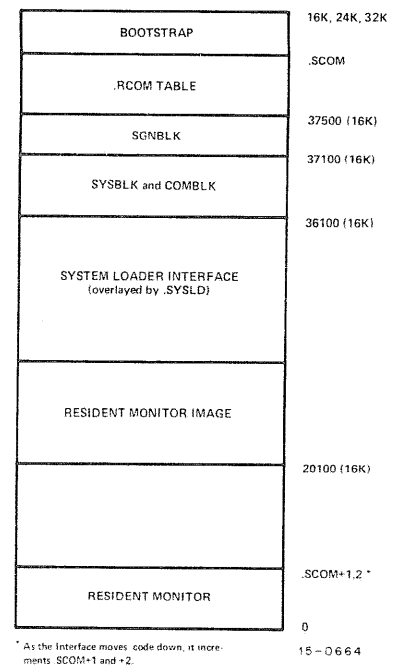
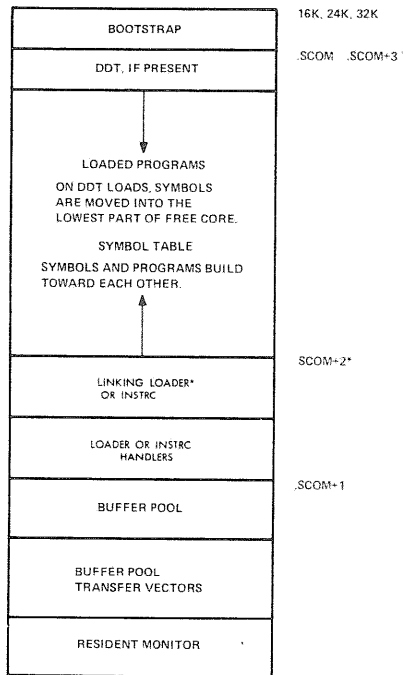


Figure 4-5
Standard
Interface Load



*Placement of .SCOM+2 depends on relative positions of the Linking Loader and its handlers. When control is transferred to loaded program, .SCOM+2 and +3 bracket free core.

Figure 4-7
Linking Loader

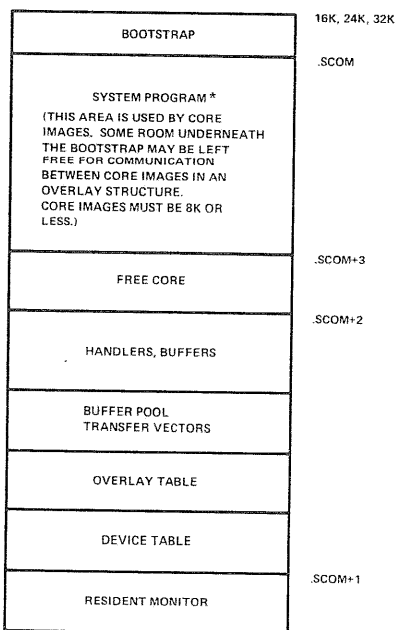


Figure 4-6
System
Program Load

* All system programs except MACII, which is always loaded in Bank 1 regardless of the size (16K, 24K, 32K) of the system.

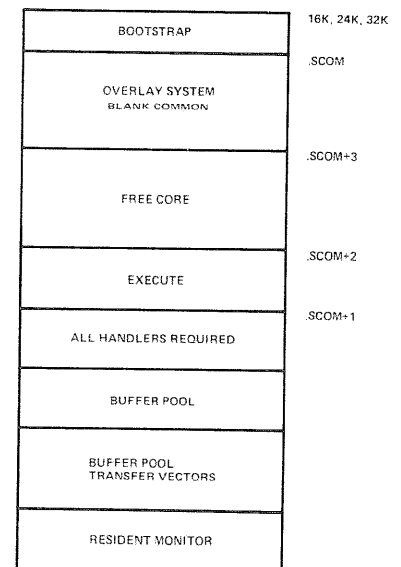


Figure 4-8
Execute

For EXECUTE, the System Loader loads EXECUTE's handler, and reads the EXECUTE file, in order to determine the active .DAT slots. The System Loader then loads all the handlers required, and sets up the .DAT slots. Figure 4-8 illustrates core maps for EXECUTE.

BOSS-15 Mode operation requires the system "A" handler be assigned to .DAT-7. This requires a sleight of hand on the part of the System Loader, which needs the "L" handler on .DAT-7. It therefore loads the "A" handler as if it were assigned to .DAT+Ø, and transfers the set up .DAT slot Ø contents to .DAT-7 before transferring control to the program being loaded. .DAT+Ø is then restored to its original status.

4.3 TABLES AND INFORMATION BLOCKS USED AND BUILT BY LOADERS

The System Loader uses SYSBLK, COMBLK, SGNBLK, block 37 of the system device, .SCOM, the RCOM Table, the IOC Table, the Device Table, the Mass Storage Busy Table, the File Buffers Transfer Vector Table, the Overlay Table, .DAT, .UFDT and three bits in the Bootstrap. Tables 4-1, 4-2, and 4-3 describe how the Loaders use these blocks and tables.

4.4 .DAT SLOT MANIPULATION BY THE SYSTEM LOADER

The System Loader maintains the .DAT slot device handler assignments as they were the last time the Nonresident Monitor was in core. The Loader saves the .DAT and .UFDT on the system device whenever the Nonresident Monitor was the last program in core. Thereafter, the Loader refreshes .DAT and .UFDT from the image on the disk. If KEEP is off, the Nonresident Monitor's initialization routine restores the .DAT and .UFDT to default values.

When loading core-image system programs, the System Loader determines the active .DAT slots by examining COMBLK. When loading EXECUT, the System Loader sets up .DAT-4, and any active slots indicated by the Execute file itself. When loading the Linking Loader, the System Loader sets up .DAT-1, -4, and -5 and also .DAT-12, if loading INSTRC. The Linking Loader will set up other active .DAT slots according to the .IODEV commands in the assembly of the program units being loaded.

Both the System Loader and the Linking Loader set up .DAT slots in this manner: (In the following procedure, "loader" refers to either one.)

Table 4-1

Tables and Blocks
Used by the Loaders

NAME	USE	LOCATION
SYSBLK	The System Loader obtains Monitor TRAN parameters from SYSBLK when it builds	16500 of .SYSLD's bank
COMBLK	Indicates number of buffers required, the active .DAT slots, and the names	17100 down, in .SYSLD's bank
SGNBLK	Default settings for .SCOM registers, number of words per buffer, size of Resident Monitor's patch area (part two), Skip Chain, .DAT and .UFDT default contents, and handler information.	16100 of .SYSLD's bank
Block 37 of the System Device	Image of .DAT and .UFDT, when last program was loaded (excluding the Nonresident Monitor).	
.SCOM Table	See Table 4-II.	100 of 1st bank
RCOM Table	Moved for use by the Nonresident Monitor.	17500 of the highest bank
IOC Table	Built by Interface Routine for .SYSLD itself.	Just beneath the System Loader
Device Table	Built by Interface Routine if loading PIP, or if PIP is among the overlays listed in COMBLK	Just above .SCOM+1
Mass Storage Busy Table	Built by the System Loader itself.	Pointed to by .SCOM+62
File Buffers Transfer Vector Table	Allocated by the Interface Routine, and initialized by it for non-core Image programs. System Loader proper initializes for core-image programs.	Pointed to by .SCOM+30
Overlay Table	Built by the Interface Routine	Pointed to by .SCOM+31
.DAT and .UFDT	Image stored and restored from block 37 of the System Device. The System Loader loads all handlers for core-image programs and EXECUTE Files, and sets up the appropriate .DAT slots. The System Loader also loads handlers assigned to .DAT-1, -4, and -5 when loading the Linking Loader, and .DAT-7 and +6 for BOSS-15.	Pointed to by .SCOM+23 and .SCOM+25
BOOTSTRAP	Bits 0, 1, and 2 of location 17777 in the Bootstrap's bank used for Batch (non-BOSS) information.	

Table 4-2

.SCOM Registers Used by the System Loader

.SCOM+	Description of Use by the System Loader
0	Set in first-time initialization routine. Used to locate the System Loader Command Area, which is just below the Bootstrap.
1	System Loader Interface routine updates this indication of the first free register above the Resident Monitor each time it moves a piece down to low core.
2	The Interface and .SYSLD itself continually update this indication of the first free location as they move code and build tables.
3	Updated as with .SCOM+2. Last free location in core.
4	First Time Initialization routine sets this register according to a SGNBLK parameter. Refer to Table 4-III.
5	Interface Routine stores code of program to be loaded into .SCOM+5. .SYSLD uses .SCOM+5 for starting address when loading EXECUT or LOAD. The .OVLRA routine loads .SCOM+5 with starting address of the Monitor Recovery Routine. The Bootstrap transfers to the address in .SCOM+5 after all its operations.
6	Interface Routine stores codes for DDT, DDTNS, LOAD and GLOAD into .SCOM+6. For other programs, the Interface Routine zeroes .SCOM+6.
7	.SYSLD saves contents of .DAT-1 in .SCOM+7, when loading the Linking Loader. When loading EXECUT, .SCOM+7 contains the first three characters of the Execute file's name. Contains .DAT-12 when loading Nonresident Monitor.
10	.SYSLD saves contents of .DAT-4 in SCOM+10, when loading the Linking Loader. When loading EXECUT, .SCOM+10 contains the second three characters of the Execute file's name.
11	.SYSLD saves contents of .DAT-5 in .SCOM+11, when loading the Linking Loader. When loading EXECUT, .SCOM+11 contains the extension of the Execute file's name. (The Interface routine sets .SCOM+11 to XCS, telling .SYSLD that EXECUT will be using the system device. .SYSLD then restores .SCOM+11 to XCT.)
12-15	The Interface routine initializes these transfer vectors for API software levels to point to SERR, an error routine that will produce an IOPS30.
16, 17	Unaffected.

Table 4-2 (Cont.)

.SCOM Registers Used by the System Loader

.SCOM+	Description of Use by the System Loader
20	Bit zero set in first time initialization, if system contains an extra 4K. If the system does contain an extra 4K, the System Loader will load handlers in that page -- from the bottom up -- when loading a core-image program. Whenever there is an extra 4K, the System Loader will update bits 3-17 with the address of the first free cell in the extra 4K. If bit 2 is set, change Resident Monitor so that it will tab for a KSR33, and send filler characters when outputting carriage returns.
21	Unaffected.
22	Unaffected.
23	The Interface Routine refreshes this pointer to .DAT.
24	The Interface Routine refreshes this indication of the number of positive .DAT slots.
25	The Interface Routine refreshes this pointer to .UFDT+0.
26	When the Nonresident Monitor was the last program, the System Loader allocates the number of buffers indicated by the contents of .SCOM+26. If the Nonresident Monitor was not the last program, the System Loader restores .SCOM+26 to the default value if program to be loaded is core image. Otherwise, untouched.
27	The first time initialization routine sets this indication of the number of words per file buffer.
30	The Initialization Routine loads this pointer to the File Buffer Transfer Vector Table.
31	When loading a core-image program, the Interface Routine loads .SCOM+31 with the pointer to the Overlay Table, or with zero, if there is none.
32	Unaffected.
33	See Interface Routine table, to determine how that routine reacts to the bits in .SCOM+33.
34, 35	Unaffected.
36	System Loader loads with the number of active .DAT slots assigned to the system device.
37-42	Unaffected.
43, 44	Contains name of the program to be loaded.
45-56	Unaffected.
57	System Loader loads with the number of entries in the Mass Storage Busy Table.
60, 61	Unaffected.
62	System Loader loads with the address of the first entry in the Mass Storage Busy Table.
63-	Unaffected.

Table 4-3

Use of .SCOM+4 by the System Loader

Bit	
0	If set, place "API ON" constant into 000006. If clear, place "API OFF" constant in same register.
1	Ignored.
2	If set, change the Resident Monitor so it will tab with the KSR 35/37 tabbing mechanism.
3	Loader will set this bit, if loading the Nonresident Monitor; clear it otherwise.
4-6	Ignored.
7	Loader sets this bit if bit 11 is cleared, and loading the Linking Loader or Execute. Otherwise clear.
8	Sets or clears, after comparing current core size (known by location of Bootstrap, and status of bit 0, .SCOM+20) with SGNBLK parameter. Also, modifies Resident Monitor to give IOPS77 after attempts to use CTRL Q.
9, 10	Ignored
11	Indicates whether to clear or set bit 7, when loading Linking Loader or Execute.
12-17	Ignored

1. Each .DAT slot will contain a handler number -- either the system default, or one inserted via an ASSIGN command to the Nonresident Monitor. This handler number is the relative location of the handler name in the IOC Table, which the Interface Routine builds. (The IOC Table contains handler names in Radix 50.)
2. For each active .DAT slot, the loader uses the handler number in that slot to find the name in the IOC table, and converts the name to .SIXBT.
3. If the handler is already in core, the loader simply inserts the starting address of the handler into the .DAT slot.
4. If the handler is not yet in core, the loader does a .SEEK to <IOS> UIC for the handler, reads it into core, relocates it, and places the starting address of the handler into the .DAT slot.

The System Loader always sets up .DAT-2 and -3. (It reserves .DAT-7 for its own use.) When not in non-BOSS Batch Mode, -2 is assigned to TTA. In non-BOSS Batch Mode, the batch input device goes to -2. If loading the Nonresident Monitor and bit three of .SCOM+42 is set, the System Loader will set up .DAT-12 for the LPA, if it is in the system, or else for TTA. If in BOSS mode, the Nonresident Monitor assigns LPA. to .DAT+6, and the System Loader assigns .DAT-7 to the system device "A" handler. The System Loader then ensures that both handlers are in core. The Resident BOSS set up routine subsequently routes all .DAT slots connected to TTA. to Resident BOSS.

4.5 BUFFER ALLOCATION BY THE SYSTEM LOADER

The System Loader allocates space for buffers equal to the contents of .SCOM+26 times the contents of .SCOM+27. The first time initialization routine sets .SCOM+27 to the standard number of locations per buffer. Before the Nonresident Monitor does an .OVRLA to a software system program, it checks whether a BUFFS command has been issued. If so, it leaves .SCOM+26 as is. If not, it uses the default number of buffers for that program, as shown in SYSBLK.

CHAPTER 5

SYSTEM INFORMATION BLOCKS AND TABLES

5.1 CORE-RESIDENT NON-REFRESHED REGISTERS

The .SCOM table, the Bootstrap and the resident Patch Area are the only registers not refreshed by the System Loader. Table 5-1 describes the .SCOM Table.

5.2 DISK-RESIDENT UNCHANGING BLOCKS: SYSBLK, COMBLK AND SGNBLK

SYSBLK, COMBLK and SGNBLK occupy blocks 34, 35, and 36 (octal) on the system device (unit zero). SYSBLK and COMBLK (blocks 34 and 35) contain the parameters for loading all core image system programs. SGNBLK contains all the other information needed to run DOS. All three arrive in core along with the Resident Monitor and the System Loader Interface, and start at location 16100 of the highest bank. The Nonresident Monitor and System Loader use them, and DOSGEN and PATCH modify them, when necessary.

5.2.1 SYSBLK

SYSBLK contains the parameters required for implementation of .OVRLA to any system program, or any of the system program overlays.

The order of entries in SYSBLK is unimportant, except for the first three permanent entries: RESMON, .SYSLD, and ↑QAREA. The first word of SYSBLK contains the block address (the unrelocated address) of the first free word after itself. Figure 5-1 describes SYSBLK.

5.2.2 COMBLK

COMBLK contains information the System Loader and the Nonresident Monitor need to remember about the current core-image system programs. The last location in COMBLK (that is, location 377 of block 35) contains the block address of the first entry in COMBLK. The remainder of COMBLK consists of variable-length entries associated with the system programs. The Nonresident Monitor searches COMBLK when it finds no match for a typed command in its own Command Table. Figure 5-1 illustrates the organization of COMBLK. The System Generator adds

Table 5-1

.SCOM Registers

REGISTER	BIT	MEANING
0		First register below the Bootstrap (set by the System Loader Interface)
1		First register above the Resident Monitor (set by the System Loader Interface)
2		Lowest free register available for storage (set by the System Loader or the Linking Loader)
3		Highest free register available for storage (set by the System Loader, the Linking Loader or DDT)
4		Initialized from SGNBLK values by the "first time" section of the System Loader Interface Routine, and by the LOGIN, LOGOUT and MICLOG logic of the Nonresident Monitor; modified by the Nonresident Monitor, unless otherwise indicated.
	0 = 1	API is available.
	1 = 1	EAE is available (always set)
	2 = 1	Teleprinter is Model 35 or 37
	3 = 1	Nonresident Monitor is in core
	4,5	Reserved
	6 = 1	9-Channel Magnetic Tape System
	7 = 1	Page Mode Operation
	8 = 1	QAREA inadequate for current core size (set by the System Loader Interface Routine)
	9 = 1	DOS disk file structure (always set)
	10 = 1	RB09 disk is system device.
	11 = 1	Bank Mode System
	12,13	Line Printer Line Size: 00 No Line Printer 01 80 Characters 10 120 Characters 11 132 Characters
	14 = 1	Background/Foreground System (always clear)
	15- 17	Drum size (ignored -- DOS does not support drum)

Table 5-1 (Cont.)

.SCOM Registers

REGISTER	BIT	MEANING
5		Core Image System Program Starting address.
6	$\emptyset = 1$	DDT in core.
	1 = 1	GLOAD
	2 = 1	DDTNS
	3-17	User program starting address.
7-11		<p>When using the Linking Loader, .SCOM+7, 10 and 11 contain the handler numbers for handlers needed by the Linking Loader in .DAT -1, -4, and -5 respectively.</p> <p>When the Linking Loader passes control to DDT, SCOM+10 contains the size of the Busy Table (for later clearing by DDT) and .SCOM+11 has the starting address of the symbol table.</p> <p>When using EXECUTE, 7-11 contain the .SIXBT representation of the name and extension of the Execute File.</p> <p>When using QFILE (for implementation of .GET, .PUT and the Nonresident Monitor GET and PUT commands), 7-11 contain the .SIXBT representation of the name and extension of the core image file.</p>
12		API Level 4 service routine entry point
13		API Level 5 "
14		API Level 6 "
15		API Level 7 "
16		Program Counter on Keyboard Interrupts.
17		AC on Keyboard Interrupts.
20	$\emptyset = 1$	20K or 28K system.
	1 = 1	UC15 system - RK05 based or RF15/RP02 based
	2 = 1	30 CPS LA30 console device.
	3-17	First free address in top page.
21		Magtape Status Register.
22		Reserved for Magtape Handler.
23		Pointer to .DAT+0.
24		Number of positive .DAT slots.
25		Pointer to .UFDT+0.
26		Number of buffers.
27		Number of words per buffer.
30		Pointer to Buffer Transfer Vector Table.

Table 5-1 (Cont.)

.SCOM Registers

REGISTERS	BIT	MEANING
31		Pointer to first entry in the Overlay Table (zero, if none).
32		Bad block number on IOPS 20 and 72.
33		CTRL X status register.
	0 = 1	HALF ON
	1 = 1	Display Buffer already set up.
	2 = 1	VT ON
	17 = 1	If VT ON, display mode is on.
34		If in BOSS mode, elapsed time in seconds.
35		Instruction to clear TT Busy Switch.
36		Number of Entries in the Mass Storage Busy Table.
37		Entry point for Expanded Error Processor.
40		JMP to Expanded Error Processor.
41		The logged-in UIC.
42		Bit Register.
	0 = 1	MICLOG successful.
	1 = 1	.EXIT from Nonresident Monitor.
	2 = 1	.OVRLA from Nonresident Monitor.
	3 = 1	LP ON -- LPA to .DAT-12 when loading Nonresident Monitor.
	4 = 1	Dump core on calls to .MED (except IOPS 4).
	5 = 1	Halt on calls to .MED (except IOPS 4).
	6-13	Unused.
	14 = 1	Set up .DAT+6 (use by Batch mode)
	15 = 1	Load System Device Handler into .DAT-7.
	16 = 1	KEEP ON.
	17 = 1	Batch Mode.
	43,44	
45,46		.SIXBT Representation of the name of the Non-resident Monitor

Table 5-1 (Cont.)

.SCOM Registers

REGISTERS	BIT	MEANING
47		Date [mm (bits 0-5), dd (6-11), yy (12-17, module 1970 decimal)]
50		Time [hh (bits 0-5), mm (6-11), ss (12-17)]
51		Elapsed time, in ticks.
52		BOSS Bit Register
	0 = 1	BOSS15 Mode.
	1 = 1	Control Card Read by user, 5/7 ASCII image saved in first block of NRBOSS.
	2 = 1	Resident BOSS reached "EOF" on run time file (RTF).
	3 = 1	User exceeded time estimate.
	4 = 1	I/O CAL to go to TTY (.DAT-3 and positive .DAT slots).
	5 = 1	Terminal IOPS error by user.
	6 = 1	QDUMP to be given to user on IOPS errors.
	7 = 1	Operator abort (Control T).
	8 = 1	Job active.
	9 = 1	Exit from BOSS15 Mode.
	10 = 1	User tried to do a .PUT. Core will be dumped and a listing given on LP.
	11 = 1	User tried to do a .GET.
	12	Not defined.
	13	Not defined.
14-16	.SYSLD error number.	
17 = 1	Job abort.	
53		Reserved for CTRL X code.
54		Default Protection Code.
55		Entry to Monitor TRAN routine.
56		Two's complement of time limit, in seconds (zero, if no limit).
57		System Device Code, for use by the Linking Loader.
60		Number of ticks until clock interrupt specified in last .TIMER (zero, if .TIMER not in use).

Table 5-1 (Cont.)

SCOM Registers

REGISTER	BIT	MEANING
61		.TIMER address.
62		Address of the first word in the Mass Storage Busy Table.
63		Number of words per Mass Storage Busy Table Entry.
64		JMP to CTRL Q GET routine.
65		QFILE Communication Register.
66		First Block of the CTRL Q Area.
67		Starting Address minus one of the CTRL Q Area.
70		Two's complement of number of word in Qdump
71		Starting Address after DUMP or GET.
72		Starting Address after CTRL Q.
73		Two's complement of the number of ticks left in the next second.
74		Two's complement of the line frequency.
75		Number of RTF Lines (for BOSS Mode).
76*	0=1	SPOOLER ENABLED
	1=1	SPOOLER RUNNING
	3 5-17	MAC11 Communication Bit SPOOLER area disk start block number
77*	6-17	SPOOLER area size (in blocks)
100*	6-17	pointer to TCB and Buffer Table
101-105		unused

*For RK05 system only. Unused for RP02 and RF15 systems.

	Word #	Value	Description
S Y S B L K ↓	0	000nnn	Pointer to first free word after SYSBLK (There is one set of seven words/core image program.)
	7N+1	.SIXBT	Name of System Program or overlay
	7N+2	.SIXBT	
	7N+3	nnnnnn	Number of first block on system device occupied by this program or overlay.
	7N+4	0000nn	Number of blocks occupied by this program or overlay
	7N+5	address	Thirteen-bit first address for this program or overlay
	7N+6	0nnnnn	Program size
7N+7	address	Thirteen-bit starting address for this program or overlay	
	.	.	.
	.	.	.
	.	.	.
(free area)			
C O M B L K ↑	500	000010	Number of words in this entry (in this case, 10)
	501	.SIXBT	Name of this system program (left-justified and zero-filled)
	502	.SIXBT	
	503	.SIXBT	Name of an overlay (left-justified and zero-filled) -- overlays are optional
	504	.SIXBT	
	505	000002	Number of buffers required by this system program (Bits 0-6 = 0 means the end of any overlay names. This is why program and overlay names must be left-justified.)
	506	.DAT&777	Active .DAT slot
	507	.DAT&777	Active .DAT slot (Note: 777777 for a .DAT slot means all positive .DAT slots.)
	510	000005	Number of words for this entry (in this case, 5)
	511	.SIXBT	Name of this system program
	512	.SIXBT	
	513	000001	Number of buffers required by this program (Note that this program has no overlays.)
	514	2 .DAT&777	.DAT slot for this program
.	.	.	.
.	.	.	.
777	000500	Pointer to first word in COMBLK (equals count from first word in SYSBLK). The two contiguous blocks on the system device that hold SYSBLK and COMBLK are treated by the system as one large block. In this case, COMBLK happens to start at location 500 of the two blocks combined.	

Figure 5-1

SYSBLK and COMBLK

names of core-image system programs by making them the new first entry. In this way, SYSBLK and COMBLK build toward the center.

5.2.3 SGNBLK

SGNBLK (block 36 on the system device) contains all the system parameters not directly associated with core-image system programs. The bulk of SGNBLK is concerned with I/O (.DAT slots, .UFDT slots, Skip Chain Order, Handlers, and skip IOT codes and mnemonics). The first few registers hold such important system information as the system device, .SCOM+4 contents, and so on. The very first word in SGNBLK points to the block address of the first free word after SGNBLK. The next entry is an offset word indicating the total length (including itself) of the miscellaneous system parameter table to follow. This table includes the size of the .DAT and the size of the skip chain. The end of the handler and skip IOT table is the first free entry of the block.

The .DAT slot table corresponds to the legal range of .DAT slots, with the maximum negative set to 15₈, and the maximum positive set to a number not to exceed 77₈. The .DAT slots are in the form in which they appear when the Nonresident Monitor is in core. That is, the unit number is in bits 0-2, and the number of the handler right-justified in bits 3-17. The handler number for the first handler in the Device Handler-Skip IOT Table is zero, for the pseudo-handler NON, TTA. is one, and so on. The constant 1000000 indicates a fixed or illegal .DAT slot (such as -2, -3, and 0). DOSGEN will not modify such slots.

The .UFD Table is in one-to-one correspondence with the .DAT slot Table. An entry of .SIXBT 'UIC' indicates that the logged in UIC is to be substituted for the name UIC in the table. An entry of .SIXBT 'SYS' indicates BNK or PAG is to be substituted, in accordance with the current addressing mode. Otherwise, the contents of each location will be the .SIXBT representation of the corresponding .UFD slot.

The Skip Chain Table lists the system skip IOT's in order. A negative skip (one that skips on "off", not "on") is represented in one's complement. Not all skips in the handler Skip IOT Table (described below) need to be included in the Skip Chain Table.

The Device Handler/Skip IOT Table contains all the handler names and skip IOT numbers and mnemonics for each I/O device identified to the system. Every such device has an entry in the table. A handler name must be exactly three characters in length, with the last character not an octal digit. The device code for a device is exactly two characters. The first two characters of each handler name for a device must be the device code. This fact is essential for understanding the format of a device entry, since the device code is never stored as such in an entry, but is inferred from the device handler name. The typical entry for a device is the following:

1. The first words of an entry contain the handler names for a device in .SIXBT. Each handler name is different, and the end of the list of handlers is determined by a word with zeros in bits 0-5 (the first character position).
2. The word that terminated the list of handler names contains the number of skip IOT's for the device. For each skip IOT, there are three words in the table: two for the skip mnemonic and one for the actual code.

The next device entry follows the last skip for the previous device. Handlers may be entered without any skips, but no devices may be entered without at least one handler name. Figure 5-2 illustrates the organization of SGNBLK. Appendix D of SGEN-DOS Utility Programs, DEC-15-USGNA-A-D, lists SGNBLK, SYSBLK and COMBLK, as they are supplied by Digital Equipment Corporation.

5.3 DISK-RESIDENT CHANGING BLOCKS

The System Loader uses block 37 of the system device to store an image of .DAT and .UFDT. Other disk-resident changing blocks are the storage Allocation Table and the Bad Allocation Table. These tables are described in Chapter 6.

5.4 TEMPORARY TABLES BUILT FROM DISK-RESIDENT TABLES

5.4.1 The Overlay Table

The System Loader builds the Overlay Table from the entries in SYSBLK referenced by a core-image system program's entry in COMBLK. That is, the Overlay Table contains an entry for the system program itself, and one for each of its overlays. Figure 5-3 illustrates the format of an entry in the Overlay Table. The first entry in the Overlay Table is

Location	Value	Description
0	000nnn	Pointer to first free entry in SGNBLK
1	000015	Number of miscellaneous parameters
2	000nnn	Size of .DAT plus size of .UFDT = (number of positive .DAT slots+16 ₈)*2. (Initial value is 20 ₈ positive .DAT slots.)
3	000nnn	Number of skips in Skip Chain
4	041300 042000	System device code in .SIXBT
5	nnnnnn	Original contents of .SCOM+4
6	nnnnnn	Original contents of .SCOM+20
7	nnnnnn	Number of words per buffer (.SCOM+27)
10	nnnnnn	Default number of buffers (.SCOM+26)
11	.SIXBT	Monitor Identification Code
12	nnnnnn	Information on VT and CTRL X (.SCOM+33)
13	00000n	Default files protection code (.SCOM+54)
14	00nnnn	Size of the Resident Monitor Patch Area
15	7777nn	Minus the number of clock ticks in a second (-74 for 60 hz, -62 for 50 hz.)
16	000nnn	Device assignments for the .DAT (made by handler numbers). (Termination at 53 assumes 20 ₈ positive slots.)
.	.	
53	000nnn	
54	.SIXBT	UIC assignments for the .UFDT. (Termination at 111 assumes 20 ₈ positive slots.)
.	.	
111	.SIXBT	
112	nnnnnn	Skip Chain Table (Negative skips in one's complement.) (Termination at 137 assumes 26 ₈ skips in chain.)
.	.	
137	nnnnnn	
140	.SIXBT	The last part of the SGNBLK is the Device Handler-Skip IOT Table. Each entry starts with the .SIXBT representations of all handlers for a particular device. (First two characters equal device code, for all handlers.) Zeros in the first six bits of a word indicate the end of the handler names, and says that the rest of the word contains the number of skips for this entry's device. The skip IOT's follow immediately. As above, one's complement skips indicate negative skips. Note, however, the confusing fact that a one's complement of a skip IOT is a positive number. Thus, 70nnn complemented is 07nnnn.
.	.	
.	.	
.	.SIXBT	
.	.SIXBT	
.	.	
.	.SIXBT	
.	000003	
.	nnnnnn	
.	nnnnnn	
.	nnnnnn	
.	.SIXBT	
.	000001	
.	nnnnnn	
.	.	
.	.	
312	.	SGNBLK ends at 312, in the DOS-15 RP02 and RF15 system distributed by Digital Equipment Corporation.

Figure 5-2

SGNBLK for RP02 and RF15 Systems

Location	Value	Description
0	000nnn	Pointer to first free entry in SGNBLK
1	000015	Number of miscellaneous parameters
2	000nnn	Size of .DAT plus size of .UFDT = (number of positive .DAT slots + 16 ₈)*2. (Initial value is 20 ₈ positive .DAT slots.)
3	000nnn	Number of skips in Skip Chain
4	221300	System device code
5	nnnnnn	Original contents of .SCOM+4
6	nnnnnn	Original contents of .SCOM+20
7	nnnnnn	Number of words per buffer (.SCOM+27)
10	nnnnnn	Default number of buffers (.SCOM+26)
11	.SIXBT	Monitor Identification Code
12	nnnnnn	Information on VT and CTRL X (.SCOM+33)
13	00000n	Default files protection code (.SCOM+54)
14	00nnnn	Size of the Resident Monitor Patch Area
15	7777nn	Minus the number of clock ticks in a second (-74 for 60 hz, -62 for 50 hz)
16	0nnnnn	Spooler area last block number.
17	00nnnn	Spooler area size.
20	000nnn	Device assignments for the .DAT (made by handler numbers). (Termination at 55 assumes 20 ₈ positive slots.)
.	.	
55	000nnn	
56	.SIXBT	UIC assignments for the .UFDT. (Termination at 113 assumes 20 ₈ positive slots.)
.	.	
113	.SIXBT	
114	nnnnnn	Skip Chain Table (Negative skips in one's complement.) (Termination at 145 assumes 32 ₈ skips in chain.)
.	.	
145	nnnnnn	
146	.SIXBT	The last part of the SGNBLK is the Device Handler-Skip IOT Table. Each entry starts with the .SIXBT representations of all handlers for a particular device. (First two characters equal device code, for all handlers.) Zeroes in the first six bits of a word indicates the end of the handler names, and says that the rest of the word contains the number of skips for this entry's device. The skip IOT's follow immediately. As above, one's complement skips indicate negative skips. Note, however, the confusing fact that a one's complement of a skip IOT is a positive number. Thus, 70nnnn complemented is 07nnnn.
.	.	
.	.	
.	.	
.	.SIXBT	
.	000003	
.	nnnnnn	
.	nnnnnn	
.	nnnnnn	
.	.SIXBT	
.	000001	
.	nnnnnn	
.	.	
.	.	
.	.	
344	.	SGNBLK ends at 344, in the DOS-15 RK05 system distributed by Digital Equipment Corporation.

Figure 5-3

SGNBLK for RK05 Based System

pointed to by .SCOM+31. .SCOM+31 will contain zero, if there are no entries in the Overlay Table. This will occur during Linking Loader or EXECUTE loads.

.OVRLA is the only Monitor function that looks at the Overlay Table. If the .OVRLA processor finds a match to the .OVRLA argument in the Overlay Table, it uses the parameters listed in the table to bring it in via a Monitor TRAN. Note that this bypasses the System Loader, and does not change the handler load. Thus, the overlay must use only those .DAT slots required by the original program, the one listed in COMBLK.

If the .OVRLA processor does not find a match in the Overlay Table, it calls in the System Loader, which searches COMBLK for the requested program. This type of overlay request does not require that .DAT slot assignments be the same. On the other hand, the System Loader refreshes all of core except .SCOM, etc. Thus, communication between overlays is more difficult. The resident patch area, however, can be used for this purpose.

5.4.2 The Device Table

The Device Table is built by the System Loader interface whenever PIP is being loaded, or when PIP is listed in COMBLK among the overlays for a program. It is located just above the register pointed to by .SCOM+1, and has an entry for each positive .DAT slot. If a slot has an assigned device, the low-order twelve bits of the corresponding entry in the Device Table will contain the device's code, in .SIXBT. Bit 3 is set when the slot is busy. If no device is assigned to a slot, the corresponding entry in the Device Table will contain zero.

5.4.3 The Input/Output Communication (IOC) Table

The System Loader Interface builds the IOC Table and locates it just below the first register of the System Loader. It contains an entry for each handler in the system, in the order that they appear in SGNBLK. The entries themselves contain the handler name in Radix 50. The System Loader and the Linking Loader use the handler number supplied by the Nonresident Monitor to index down the IOC Table. They use the contents of the entry for a .SEEK to the IOS UIC.

5.4.4 The Device Assignment Table (.DAT)

The Device Assignment Table makes the association between logical and physical devices. The Monitor knows its location by the contents of .SCOM+23, which points to the entry zero in the Table. Specific slots are found by indexing on the contents of .SCOM+23. The number of negative slots is fixed at 15_8 . The number of positive slots is specified by .SCOM+24, and may be any positive number less than 100_8 . It is specified at system generation time.

The Nonresident Monitor places the handler number in the low order bits and the unit number in the high order bits. It derives the handler number from SGNBLK. As mentioned above, the System Loader and the Linking Loader subsequently use the IOC Table to determine the handler name. After either loader has loaded and relocated a handler, it places the handler's starting address in all .DAT slots that reference that handler. The unit number remains in the high-order three bits. Slots with no handler (NON) contain zero. Active .DAT slots are designated by COMBLK, for core-image system programs, and by .IODEV pseudo-ops for the Linking Loader and EXECUTE.

5.4.5 The User File Directory Table (.UFDT)

.UFDT+0 is offset from .DAT+0 (pointed to by .SCOM+23) by the sum of the positive and negative .DAT slots. Each .DAT slot has a corresponding .UFDT slot. UIC's in the .UFDT are packed in .SIXBT. The address of .UFDT+0 is stored in .SCOM+25.

5.4.6 The Skip Chain

Register 1 of Bank 0 contains a jump to the beginning of the Skip Chain. The Skip Chain is defined during System Generation, is located in SGNBLK, and is rebuilt every time the System Loader is called in. The System Generator Manual (DEC-15-USGNA-A-D) describes considerations for constructing the Skip Chain.

5.5 TEMPORARY TABLES BUILT FROM SCRATCH

5.5.1 File Buffer Transfer Vector Table

The System Loader allocates space for the buffer pool, and creates the File Buffer Transfer Vector Table. .SCOM+30 points to the first entry

in the table, and the number of entries is specified by .SCOM+26. Each entry in the table contains the address of a buffer, or its one's complement. Negative addresses indicate a busy buffer. Since references to buffers must be indirect anyway, buffers are allocated without regard to bank boundaries.

5.5.2 The RCOM Table

The Nonresident Monitor requires certain information about the Resident Monitor that does not warrant reserving additional .SCOM registers. The System Loader therefore puts this information into the RCOM table, whenever it is loading the Nonresident Monitor. The RCOM Table starts at register 17500 of the highest bank. QFILE uses the RCOM Table when processing a GET command.

5.5.3 The Mass Storage Busy Table

Entries in this table are allocated by the System Loader or the Linking Loader. The Mass Storage Busy Table is pointed to by .SCOM+62. .SCOM+63 contains the number of words per entry in the table, and .SCOM+36 contains the current number of entries. Generally speaking, there are as many entries in the Busy Table as there are active .DAT slots, although the disk handlers are the only ones that currently refer to the Busy Table.

The .INIT command to a disk handler establishes a Busy Table entry. The .CLOSE command (or the Rewind .MTAPE command) deletes the corresponding entry. Figure 5-4 illustrates a typical Busy Table Entry.

The first word of an active entry in the Busy Table contains the .DAT slot in bits 9-17. The disk handlers save information about the UFD current for this .DAT slot in the Mass Storage Busy Table. They save information about the file current to the .DAT slot (if any) in the buffer pointed to by word 1 of the Busy Table Entry. More information on the disk handlers and file structure is contained in Chapter 6.

5.6 RESERVED WORD LOCATIONS

Word locations 0 through 77 are dedicated systems locations and cannot be employed by the user. The contents of these locations are described in Table 5-4.

Table 5-2
Overlay Table

Word #	Contents
N,N+1	.SIXBT name of Overlay
N+2	First block number
N+3	First address, minus 1
N+4	Size, in two's complement
N+5	Fifteen-bit starting address

Table 5-3
Mass Storage Busy Table Entry

Word #	Contents
N	Device Type ₀₋₂ , Unit Number ₃₋₅ , Write Check ₆ , .DAT ₉₋₁₇
N+1	Buffer Address, or \emptyset , if none allocated
N+2	Three-character UIC
N+3	First UFD block for this UIC
N+4	UFD Entry size for files in this UFD

Table 5-4
Reserved Address Locations

ADDRESS	USE
\emptyset	Stores the contents of the extended PC, link, extend mode status, and memory protect status during a program interrupt
1	EEM (for PDP-9 compatibility)
2	JMP to Skip Chain
3	.MED, entry to Monitor Error Diagnostic routine
4	JMP to error handler
5	Stores system type (Bank or Page) indicator during Teletype interrupts
6	Used for API ON/OFF indicator
7	Stores real time clock count
10-17	Autoindex registers
20	Stores the contents of the extended PC, link, mode status, and memory protect status on a CAL instruction.
21	JMP to CAL handler
22-37	Seven pairs of word counter-current address registers for use with 3-cycle I/O device data channels.
40-77	Store unique entry instructions for each of 32 ₁₀ automatic priority interrupt channels

5.7 BOOTSTRAP NON-BOSS BATCH BITS.

The high-order three bits of word 17777 in the Bootstrap are reserved for the Monitor, and have the following meanings:

- | | |
|-------|---|
| Bit 0 | 1 = In non-BOSS Batch Mode
0 = Not in non-BOSS Batch |
| Bit 1 | 1 = \$JOB ASCII line or card just read by batch device
0 = Last line or card not \$JOB |
| Bit 2 | 1 = Batch device is card reader
2 = Batch device is paper tape reader |

CHAPTER 6

FILE STRUCTURES

6.1 DECTAPE FILE ORGANIZATION

DECTape can be treated either as a directoried or non-directoried device.

6.1.1 Non-Directoried DECTape

A DECTape is said to be non-directoried when it is treated as magnetic tape by issuing the .MTAPE commands: REWIND or BACKSPACE, followed by .READ or .WRITE. No directory of identifying information of any kind is recorded on the tape. A block of data (255_{10} word maximum), exactly as presented by the user program, is transferred into the handler buffer and recorded at each .WRITE command. A .CLOSE terminates recording with a software end-of-file record consisting of two words: 001000.776773

Because braking on DECTape allows for tape roll, staggered recording of blocks is employed in DOS to avoid constant turnaround or time-consuming back and forth motion of physically sequential block recording. When recorded as a non-directoried DECTape, block 0 is the first block recorded in the forward direction. Thereafter, every fifth block is recorded until the end of the tape is reached, at which time recording, also staggered, begins in the reverse direction. Five passes over the tape are required to record all 1100_8 blocks.

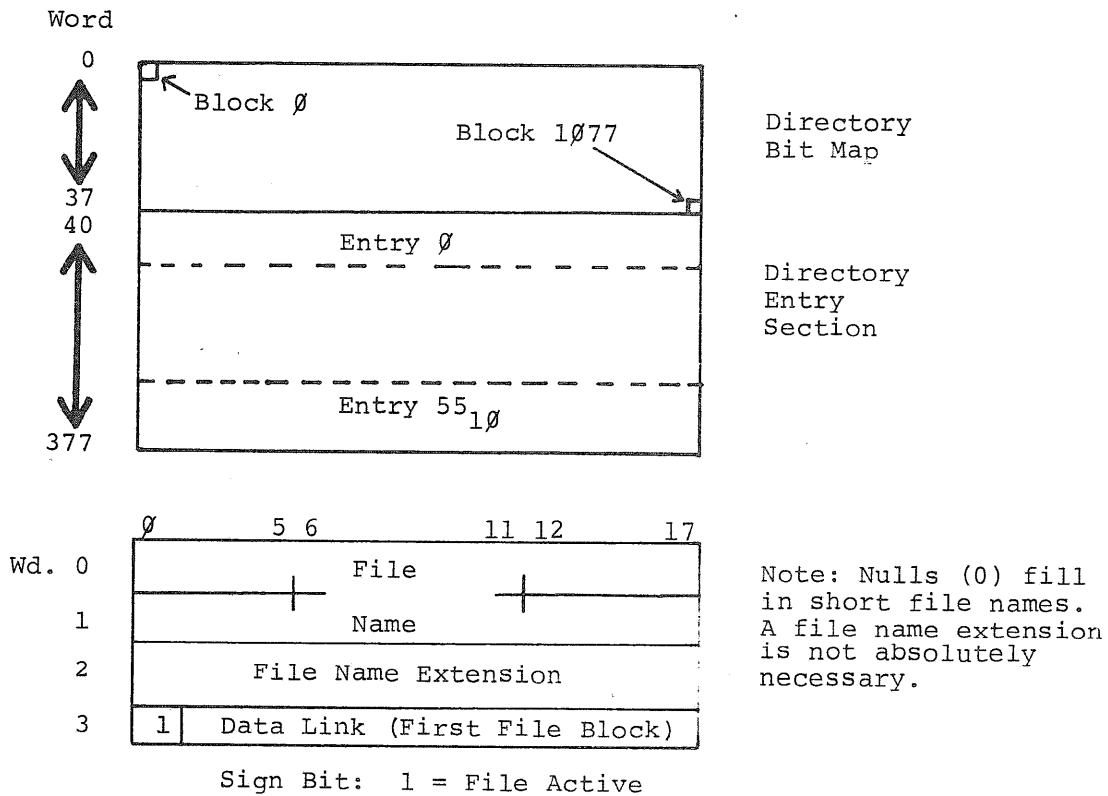
6.1.2 Directoried DECTape

Just as a REWIND or BACKSPACE command declares a DECTape to be non-directoried, a .SEEK or .ENTER implies that a DECTape is to be considered directoried. A directory listing of any such DECTape is available via the (L)ist command in PIP. A fresh directory may be recorded via the N or S switch in PIP.

The directory of all DECTapes except system tapes occupies all 400_8 words of block 100_8 . It is divided into two sections: (1) a 40_8 word Directory Bit Map and (2) a 340_8 word Directory Entry Section.

The Directory Bit Map defines block availability. One bit is allocated for each DECTape block (1100_8 bits = 40_8 words). When set to 1, the bit indicates that the DECTape block is occupied and may not be used to record new information.

The Directory Entry Section provides for a maximum of 56_{10} files on a DECTape. Each file on the DECTape has a four-word entry. Each entry includes the three-word file name and extension, a pointer to the first DECTape block of the file, and a file active or present bit. Figure 6-1 illustrates the DECTape directory.



A DIRECTORY ENTRY

Figure 6-1

DECTape Directory

Additional file information is stored in blocks 71 through 77 of every directoried DECTape. These are the File Bit Map Blocks. For each file in the directory, a 40_8 -word File Bit Map is reserved in block 71 through 77. The bit maps are contiguous, and the N^{th} file uses the

Nth bit map. Each block is divided into eight File Bit Map Blocks. A File Bit Map specifies the blocks occupied by that particular file and provides a rapid, convenient method to perform DECTape storage retrieval for deleted or replaced files. Note that a file is never deleted until the new one of the same name is completely recorded on the .CLOSE of the new file. When a fresh directory is written on DECTape, blocks 71 through 100 are always indicated in the Directory Bit Map as occupied. Figure 6-2 illustrates DECTape file bit maps.

Block 71 ₈	Bit Map for File 0
	Bit Map for File 7
Block 72 ₈	Bit Map for File 8
	Bit Map for File 15 ₁₀
	.
	.
Block 77 ₈	Bit Map for File 48 ₁₀
	Bit Map for File 56 ₁₀

Figure 6-2

DECTape File Bit Map Blocks

Staggered recording (at least every fifth block) is used on directoried DECTapes, where the first block to be recorded is determined by examination of the Directory Bit Map for a free block. The first block is always recorded in the forward direction; thereafter, free blocks are chosen which are at least five beyond the last one recorded. The last word of each data block recorded contains a data link or pointer to the next block in the file. When turnaround is necessary, recording proceeds in the same manner in the opposite direction. When reading, turnaround is determined by examining the data link. If reading has been in the forward direction, and the data link is smaller than the last block read, turnaround is required. If reverse, a block number greater than the last block read implies turnaround.

A software end-of-file record (001005, 776773) terminates every file. The data link of the final block is 777777.

Data organization for each I/O medium is a function of the data modes. On directoried DECTape there are two forms in which data is recorded: (1) packed lines - IOPS ASCII, IOPS Binary, Image Alphanumeric, and Image Binary, and (2) dump mode data - Dump Mode.

In IOPS or Image Modes, each line (including header) is packed into the DECTape buffer. In IOPS Binary, a 2's complement checksum is computed and stored in the second word of the header. When a .WRITE which will exceed the remaining buffer capacity is encountered, the buffer is output, after which the new record is placed in the empty buffer. No record may exceed 254₁₀ words, including header, because of the data link and even word requirement of the header word pair count. An end-of-file is recorded on a .CLOSE. It is packed in the same manner as any other line.

In Dump Mode, the word count is always taken from the I/O macro. If a word count is specified which is greater than 255₁₀ (note that space for the data link must be allowed for again), the DECTape handler will transfer 255₁₀ word increments into the DECTape buffer and from there to DECTape. If some number of words less than 255₁₀ remain as the final element of the Dump Mode .WRITE, they will be stored in the DECTape buffer, which will then be filled on the next .WRITE, or with an EOF if the next command is .CLOSE. DECTape storage is thus optimized in Dump Mode since data is stored back-to-back. See Appendix A.

6.2 MAGNETIC TAPE

DOS provides for industry-compatible magnetic tape as either a directoried or non-directoried medium. The magnetic tape handlers communicate with a single TC-59D Tape Control Unit (TCU). Up to eight magnetic tape transports may be associated with one TCU; these may include any combination of transports TU-10A or B and TU-30A or B.

There are a number of major differences between magnetic tape and DECTape or Disk; these differences affect the operation of the device handlers. Magnetic tape is well suited for handling data records of variable length. Such records, however, must be treated in serial fashion. The physical position of any record may be defined only in relation to the preceding record. Three techniques available in I/O operations to block-addressable devices are not honored by the magnetic tape handlers:

- a. The user cannot specify physical block numbers for transfer. In processing I/O requests that have block numbers in their argument lists (i.e., .TRAN) the handler ignores the block-number specification.
- b. The only area open for output transfers in the directoried environment is that following the logical end of tape.
- c. Only a single file may be open for transfers (either input or output) at any time on a single physical unit.

6.2.1 Non-directoried Data Recording (MTF)

MTF is intended to satisfy the requirements of the FORTRAN programmer while still providing the assembly language programmer maximum freedom on the design of his tape format. MTF writes out a record to the tape each time the main program issues a .WRITE. The length of the record is always two times the word pair count in the header word pair. FIOPS records are always as long as the buffer size returned on a .INIT (up to 256_{10} words). MTF returns a standard buffer size of 377_8 , after a .INIT. The FORTRAN user may dynamically change this size, however, via the following instructions

Example:

(FORTRAN STATEMENTS)		(MACRO STATEMENTS)
.		.TITLE SETMTB
.		.GLOBL .DA, MTBSIZ, SETMTB
CALL SETMTB (IBFSIZE)	SETMTB	Ø
.		JMS* .DA
.		JMP START
.	IBFSIZE	Ø
	START	LAC* BUFSIZ (any buffer size)
		DAC* MTBSIZ
		JMP* SETMTB
		.END

6.2.2 Directoried Data Recording (MTA., MTC.)

The programmer can make the fullest possible use of those features peculiar to magnetic tape by using MTF. On the other hand, MTF does not offer the powerful file-manipulation facilities available in the system. Directoried I/O allows device independence, and extensive use of the storage medium with a minimum of effort.

MTA. and MTC. do not support non-directoried data recording.

Every block recorded by MTA. (with the exception of end-of-file markers, which are hardware-recorded) includes a two-word Block Control Pair and not more than 255_{10} words of data. The data will contain the records from one or more .WRITE's.

The Block Control Pair serves three functions: it specifies the character of the block (label, data, etc.), provides a word count for the block, and gives an 18-bit block checksum. The Block Control Pair has the following format:

Word 1:

Bits 0 through 5: Block Identifier (BI). This 6-bit byte specifies the block type. Values of BI may range from 0 to 77_8 . Current legal values of BI, for all user files, are as follows:

<u>BI Value</u>	<u>Block Type Specified</u>
00	User-File Header Label
10	User-File Trailer Label
20	User-File Data Block

Bits 6 through 17: Block Word Count (BWC). This 12-bit byte holds the 2's complement of the total number of words in the block (including the Block Control Pair). Legal values of BWC range from -3 to -401_8 .

Word 2:

Bits 0 through 16: Block Checksum. The Block Checksum is the full-word, unsigned, 2's complement sum of all the data words in the block and word 1 of the Block Control Pair.

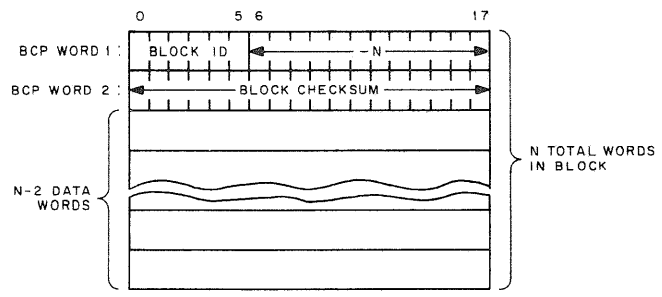


Figure 6-3

Block Format, File-Structured Mode

One of the main file functions of MTA. and MTC. is that of identifying and locating referenced files. This is carried out by two means: first, names of files recorded are stored in a file directory at the beginning of the tape; and second, file names are contained in the file's header and trailer labels.

6.2.2.1 Magnetic Tape File Directory

The directory, a single-block file (and the only unlabeled file on any file-structured tape), consists of the first recorded data block on the tape. It is a 257_{10} word block with the following characteristics:

- a. Block Control Pair (words 1 and 2)

Word 1

Block Identifier = 74_8 = File Directory Data Block

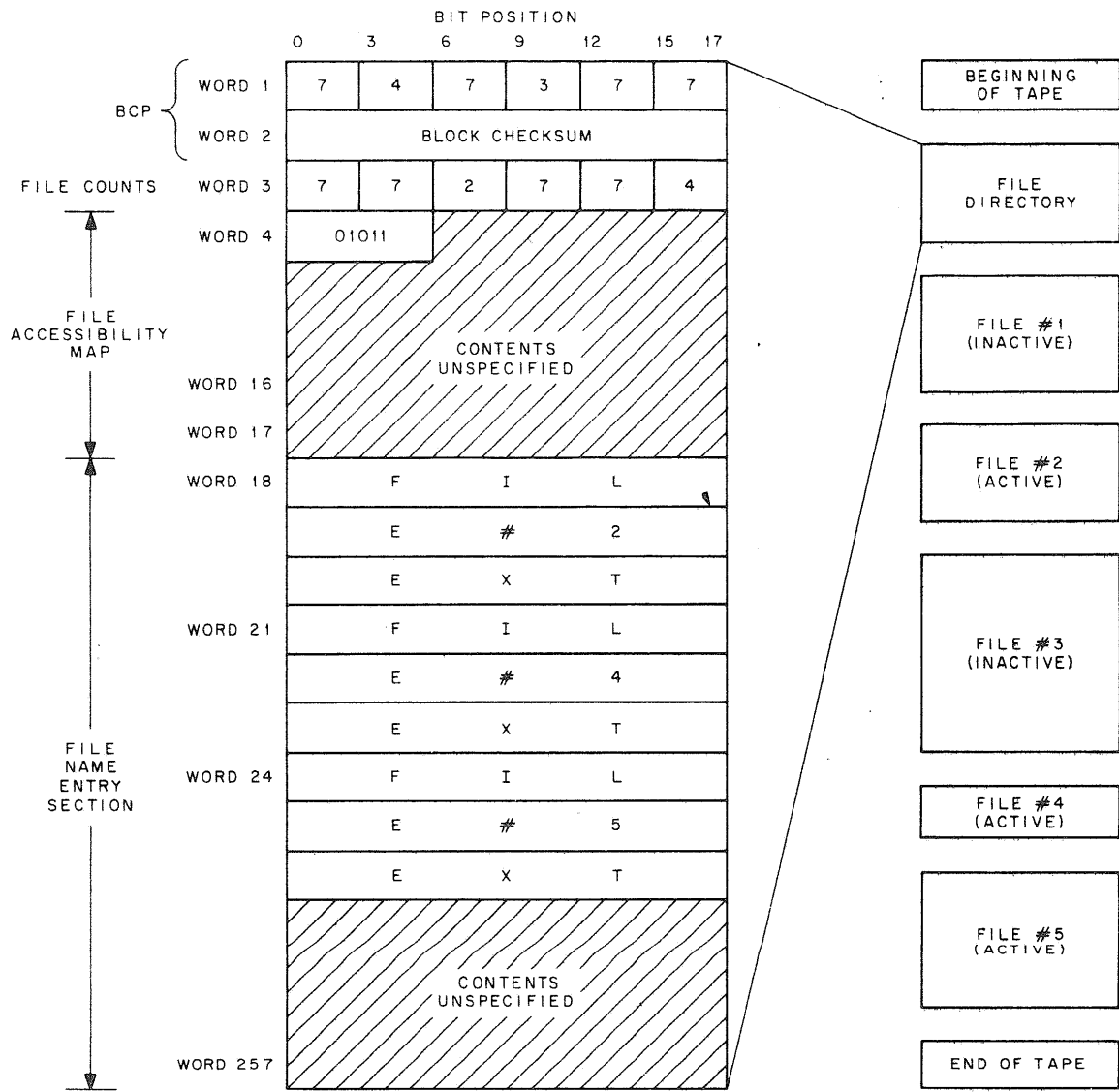
Block Word Count = -401_8 = 7377_8 .

Word 2:

Block Checksum: As described above.

- b. Active File Count (Word 3, Bits 9 through 17) 9-bit one's complement count of the active file names present in the File Name Entry Section (described below).
- c. Total File Count (Word 3, Bits 0 through 8) 9-bit one's complement count of all files recorded on the tape, including both active and inactive files, but not the file directory block.
- d. File Accessibility Map (Words 4 through 17): The File Accessibility Map is an array of 252_{10} contiguous bits beginning at bit 0 of word 4 and ending as bit 17 of word 17. Each of the bits in the Accessibility Map refers to a single file recorded on tape. The bits are assigned relative to the zeroth file recorded; that is, bit 0 of word 4 refers to the first file recorded; bit 1, word 4, to the second file recorded; bit 0, word 6, to the 37_{10} th file recorded; and so on, for a possible total of 252_{10} files physically present.

A file is only accessible for reading if its bit in the Accessibility Map is set to one. A file is made inaccessible for reading (corresponding bit = 0) by a .DELETE of the file, by a .CLOSE (output) of another file of the same name, or by a .CLEAR. A file is made accessible for reading (corresponding bit = 1) by a .CLOSE (output) of that file. Operations other than those specified above have no effect on the File Accessibility Map.



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Figure 6-4a. Format of the File Directory Data Block, showing relationship of active and inactive files to file name entries and to Accessibility Map

Figure 6-4b. Format of file-structured tape, showing directory block and data files.

- e. File Name Entry Section (Words 18 through 257): The File Name Entry Section, beginning at word 18 of the directory block, includes successive 3-word file name entries for a possible maximum of 80 entries. Each accessible file on the tape has an entry in this section. Entries consist of the current name and extension of the referenced file in .SIXBT (left-adjusted and, if necessary, zero-filled).

The position of a file name entry relative to the beginning of the section reflects the position of its accessibility bit in the map. That bit, in turn, defines the position of the referenced file on tape with respect to other (active or inactive) files physically present. Only active file names appear in the entry section, and accessibility bits for all inactive files on the tape are always set to zero; accessibility bits for all active files are set to one.

To locate a file on the tape having a name that occupies the second entry group in the File Name Entry Section, the handler must (a) scan the Accessibility Map for the second appearance of a 1-bit, then (b) determine that bit's location relative to the start of the map. That location specifies the position of the referenced file relative to the beginning of the tape. The interaction of the File Name Entry Section and the Accessibility Map are shown in Figure 6-4.

6.2.2.2 User-File Labels

Associated with each file on tape is one label, the header label. It precedes the first data block of the file. Each label is 27₁₀ words in length. Label format is shown in Figure 6-5.

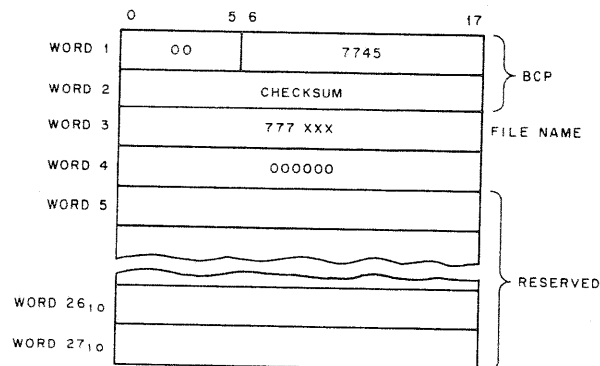


Figure 6-5

User File Header Label Format

6.2.2.3 File-Names in Labels

The handler will supply the contents of the file-name fields (Word 3) in labels. These are used only for control purposes during the execution of .SEEK's. The name consists simply of the two's complement of the position of the recorded file's bit in the Accessibility Map; the "name" of the first file on tape is 777777, that of the third file is 777775, and so on. A unique name is thus provided for each file physically present on the tape. Since there may be a maximum of 252_{10} files present, legal file-name values lie in the range 777777 to 777404.

6.2.3 Continuous Operation

Under certain circumstances, it is possible to perform successive I/O transfers without incurring the shut-down delay that normally takes place between blocks. The handler stacks transfer requests, and thus ensures continued tape motion, under the following conditions:

- a. The I/O request must be received by the CAL handler before a previously-initiated I/O transfer has been completed.
- b. The unit number must be identical to that of the previously initiated I/O transfer.
- c. The I/O request must be one of those listed below to ensure successful completion. The handler in processing requests in continuous mode depends on receiving control at the CAL level in order to respond to I/O errors. The functions for which continuous operation is attempted include only the following:
 1. .MTAPE
 2. .READ
 3. .WRITE
 4. .TRAN
- d. With MTA, more than one logical record may be in a physical block, so tape motion may stop if fewer successive .READ's or .WRITE's are issued than there are records in a block.
- e. The previously-requested transfer must be completed without error. In general, successive error-free READ's (WRITE's) to the same transport will achieve non-stop operation. The following examples illustrate this principle.

Example 1: Successful Continued Operation

```
SLOT = 1
INPUT = 0
BLOKNO = 0
READ1      .TRAN SLOT, INPUT, BLOKNO, BUFF1, 257
READ2      .TRAN SLOT, INPUT, BLOKNO, BUFF2, 257
RETURN     JMP READ1
```

The program segment in Example 1 will most probably keep the referenced transport (.DAT slot 1) up to speed. The probability decreases as more time elapses between READ1 and READ2, and between READ2 and RETURN. Each .TRAN request causes an implicit .WAIT until its operation is completed.

Example 2: Unsuccessful Continued Operation

```
SLOT = 1
INPUT = 0
BLOKNO = 0
READ      .TRAN SLOT, INPUT, BLOKNO, BUFF, 257
STOP      .WAIT SLOT
RETURN    JMP READ
```

The program segment in Example 2 will not keep the tape moving because the .WAIT at location STOP prevents control from returning to location READ until the transfer first initiated at READ has been completed.

Example 3: Unsuccessful Continued Operation

```
SLOT1 = 1
SLOT2 = 2
INPUT = 0
BLOKNO = 0
READ1   .TRAN SLOT1, INPUT, BLOKNO, BUFF1, 257
READ2   .TRAN SLOT2, INPUT, BLOKNO, BUFF2, 257
RETURN  JMP READ1
```

This program segment will not provide non-stop operation because of the differing unit specification at READ1 and READ2.

6.2.4 Storage Retrieval on File-Structured Magnetic Tape

The use of a file accessibility map as well as block identifiers in Magtape file directories makes it almost impossible to retrieve the area of a deleted file from a magnetic tape. The execution of the deletion command (i.e., .DELETE) removes the name of the object file from the file directory, and clears the corresponding bit in the File Accessibility Map.

The only circumstance under which a file area may be easily retrieved is when the deleted file is also the last file physically on the tape. Under these conditions, the handler can retrieve the area occupied by the deleted file when the next .ENTER - .WRITE - .CLOSE sequence is executed. Users may also copy the active files to another device, re-new the directory, and recopy the files.

6.3 DISK FILE STRUCTURE

6.3.1 Introduction

The DOS-15 disk file structure is in some ways analogous to DECTape file structure. Ordinarily, each disk user has a directory which points to named files, just as each DECTape has a directory. The DECTape has only one directory, but the disk has as many directories as users have cared to establish. A single user's disk directory might correspond to a single DECTape directory. A single disk file's size is also limited only by the available space, as is true with DECTape. Although DECTape directories may reference a maximum of 56₁₀ files, the number of files associated with any one directory on the disk is limited only by the available disk space.

The DECTape directory is in a known location -- at block 100. Since the disk may have a variable number of directories, the Monitor must know how to find each user's directory. It therefore maintains a Master File Directory (MFD) at a known location¹, and the Master File Directory points to each User File Directory (UFD). DOS-15 allows only those users who know the Master Identification Code to have access to any protected UFD's within the MFD. Figure 6-6 illustrates the MFD. Appendix B is a flowchart of the Disk "A" Handlers.

6.3.2 User Identification Codes (UIC)

The Monitor finds User File Directories by seeking associated User Identification Codes (UIC's), which are all listed in the Master File Directory. The UIC is a three-character code that is necessary for all non-.TRAN I/O to the disk. .TRAN macros use no directory references. A programmer may operate under as many UIC's as he wishes, provided all are unique and none is reserved². He may establish a new User File Directory by (1) logging in his new UIC to the Monitor via the LOGIN command, (2) calling PIP, and (3) issuing an N DK command. This establishes a new User File Directory, or refreshes (wipes clean) an old directory under that UIC. (.ENTER will also create a new MFD entry and/or a UFD, if none exists.) Figure 6-7, User File Directory, illustrates the organization of a UFD.

¹On the RF and RK disk, the first block of the MFD is 1777 octal.

On the RP disk, the first block of the MFD is 47040 octal.

²The following are reserved UIC's: @@, ???, PAG, BNK, SYS, IOS, CTP.

Word #	Contents	Description
0	777777	Dummy UIC used by system.
1	nnnnnn	Bad Allocation Table's first block number, or 777777, if there is none.
2	nnnnnn	SYSBLK's first block number, or -1, if there is none.
3	$4^{\emptyset-2} + \text{blknum}$	MFD entry size in bits $\emptyset-2$, plus the block number of the first submap
⋮	⋮	⋮
4N	.SIXBT	UIC for this UFD
4N+1	nnnnnn	Block number for the first block of this UFD or 777777, if no UFD exists (as after PIP's N _{LDK})
4N+2	$P_{\emptyset} + M$	Protection code in bit \emptyset , plus the UFD entry size for each file
4N+3	spare	Unused at this writing
⋮	⋮	⋮
376	nnnnnn	Pointer to previous MFD block, or 777777 if none.
377	nnnnnn	Pointer to next MFD block, or 777777 if none.

Figure 6-6

Master File Directory

Word #	Contents	Description
⋮	⋮	⋮
8N	.SIXBT	Name of this file
8N+1	.SIXBT	and its
8N+2	.SIXBT	extension
8N+3	$T_{\emptyset} + \text{blknum}$	Truncation code in bit \emptyset , plus the number of the first block of the file
8N+4	nnnnnn	Number of blocks in this file
8N+5	ribptr	Pointer to the first block of the Retrieval Information Block
8N+6	$P_{\emptyset-1} + \text{ribwrdr}$	Protection code in bits $\emptyset-1$, plus the first word in ribptr used by the RIB-- if the last block of the file has room for the RIB, the handlers will put it there, and load word 8N+6 accordingly.
8N+7	crdate	Date of file's creation -mmddy (yy modulo 70)
⋮	⋮	⋮
376	nnnnnn	Pointer to previous block, or 777777 if none
377	nnnnnn	Pointer to next UFD block, or 777777 if none

Figure 6-7

User File Directory

6.3.3 Organization of Specific Files on Disk

The Disk Handlers write out files in almost the same way that a DEC-tape handler does. Disk file blocks, however, have a forward and backward link. (Non-dump records are therefore limited to lengths of 254_{10} words.) Further, upon receipt of a .CLOSE I/O macro, the disk handlers fill out a Retrieval Information Block (RIB). The RIB performs the same functions as the file bitmap on DECTape, and also associates the logical sequence of blocks in the file with the physical locations of the blocks on the disk. The disk handler uses the RIB to implement .RTRAN commands and to delete files. Figure 6-8, The Retrieval Information Block, illustrates a RIB.

After a user has created a disk file he can access logical records sequentially via .READ commands, just as with DECTape files. He can also access physical blocks of that file by referencing relative block numbers in the .RTRAN command. (The .RTRAN commands require the file be opened with the .RAND command.)

6.3.4 Buffers

The handlers break buffers from the pool into three parts: (1) File Information (about 40_8 words)*, (2) the Block List -- addresses of pre-allocated blocks (between 4 and 253_{10} addresses, inclusive), and (3) data buffer (256_{10} words). Figure 6-9, Disk Buffer, illustrates the breakdown of disk buffers.

6.3.4.1 Commands That Obtain And/or Return Buffers

The following commands obtain buffers from the pool, and return them immediately after execution:

```
.DELETE  
.RENAM  
.CLEAR
```

The following commands obtain a buffer from the pool and do not return it until a subsequent .CLOSE is performed:

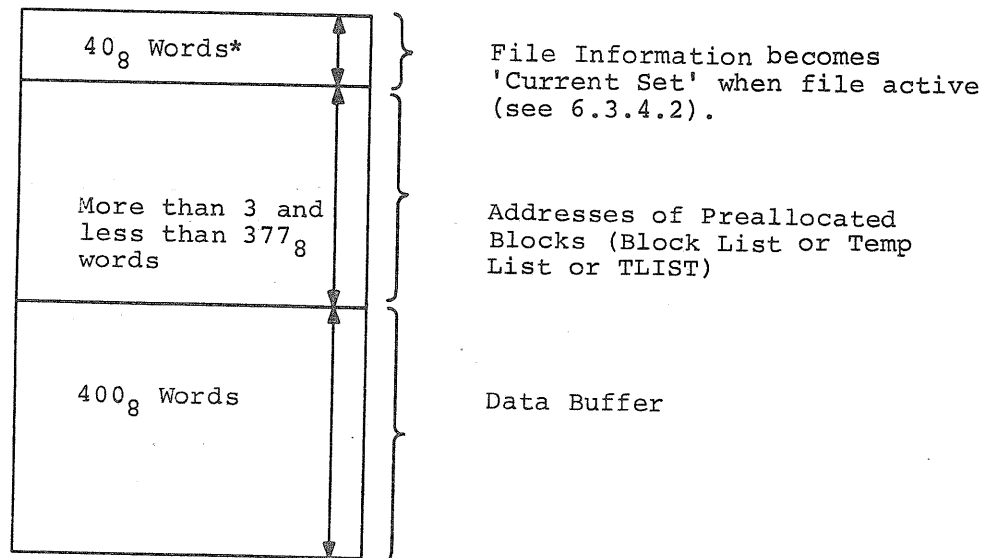
```
.FSTAT  
.ENTER  
.SEEK  
.RAND
```

*This number is determined by assembly parameters.

Word #	Contents	Description
0*	nnnnnn	Total number of blocks described by this physical block.
1	nnnnnn	First data block pointer.
2	nnnnnn	Second data block pointer.
3	nnnnnn	Third data block pointer.
.	.	.
.	.	.
376	nnnnnn	Pointer to previous RIB block or -1 if no previous RIB block.
377	nnnnnn	Pointer to next RIB block or -1 if no next RIB block.

* Zeroth word of the RIB may not be zeroth word of physical block. This occurs whenever the entire RIB will fit in the last data block of the file.

Figure 6-8
Retrieval Information Block



*This is not a fixed number. It is different for RP, RK and RF.

Figure 6-9
Disk Buffer

The following commands return a buffer to the pool, if any was allocated.

```
.INIT  
.CLOSE  
.MTAPE (rewind)
```

6.3.4.2 The Current Set

The handlers retain information about the last file and .DAT slot processed in an internal storage area. This area is called the "Current Set", and is swapped back to the file's buffer whenever a command to a different file is used. Thus,

```
.WRITE to .DAT slot A  
.WRITE to .DAT slot B
```

will swap the Current Set, but...

```
.WRITE to .DAT slot A  
.TRAN to .DAT slot A  
.WRITE to .DAT slot A
```

will not swap the Current Set.

6.3.5 Pre-allocation

The handlers pre-allocate blocks on the disk upon all .ENTER commands, and whenever sufficient .WRITE commands have been issued to use up the pre-allocated blocks. The number of pre-allocated blocks will be the minimum of the number of free blocks on the device and the number of address slots available in the Temp List (block list).

When the handlers pre-allocate blocks, they fill out the bit maps, and immediately fill out the RIB and write it out in one of the pre-allocated blocks.

Upon a .CLOSE command, the handlers give back unused blocks, and re-write the RIB.

The number of blocks in the Block List depends on the size of the buffer, which is determined at system generation by setting the buffer size. The larger the Block List, the faster will be output. Smaller Block Lists may give more efficient allocation of core and disk space. Smaller buffers save core. Further, the number of pre-allocated blocks may affect concurrently opened files on a disk that is tight for space. Thus, if the Block List is sixty entries long, and there are forty blocks left on the disk, a .ENTER to .DAT slot will pre-allocate all forty, leaving none for any subsequent .ENTER's to different .DAT slots.

IOPS 70 will occur when there are less than four free blocks on the disk when a handler tries to pre-allocate blocks.

6.3.6 Storage Allocation Tables (SAT's)¹

The disk handlers use a Storage Allocation Table, in order to distinguish between allocated and free blocks. If more than one physical block is required, the individual blocks are called Submaps.

Unlike DEctape, the Storage Allocation Table is never held in core. When the handlers wish to preallocate some blocks, they read in the required Submap, and write out the updated one.

Storage Allocation blocks use the following format:

WORD 0	Total blocks on the disk
WORD 1	Number of blocks described by this Submap
WORD 2	Number of blocks occupied in this Submap
WORD 3	First word of the bit map (eighteen blocks per word)
.	.
.	.
WORD 376	Pointer to previous Submap (or 777777)
WORD 377	Pointer to next Submap (or 777777)

The bit maps refer to blocks in numerical order. Thus, bit 0 of word three of a Submap will refer to block N, bit 1 will refer to block N+1, and so on. The block is free if the corresponding bit equals 0. Starting and ending block numbers for all Submaps are retained in the handlers. Bit 0 of word three in the first submap, refers to block zero.

¹The first SAT block is located at 1776₈ for the RF and RK system and 764₈ for the RP system.

6.3.7 Bad Allocation Tables (BAT's)

Occasionally, a particular block on the disk will not record data correctly. In such instances, the handlers should be prevented from using the bad blocks. Accordingly, PIP maintains a Bad Allocation Table. Whenever a user updates that table, PIP will set the appropriate bit in the Storage Allocation Table. The block is thus made unavailable. Refer to PIP manual (DEC-15-UPIPA-A-D) for more information.

CHAPTER 7

WRITING NEW I/O DEVICE HANDLERS

This chapter contains information essential for writing new I/O device handlers to work in DOS.

7.1 I/O DEVICE HANDLERS, AN INTRODUCTION

All communications between user programs and I/O device handlers are made via CAL instructions followed by an argument list. The CAL Handler in the Monitor (Figure 2-1) performs preliminary setups, checks the CAL calling sequence, and transfers control via a JMP* instruction to the entry point of the device handler. When the control transfer occurs (see Figures 7-1 and 7-2), the AC contains the address of the CAL in bits 3 through 17 and bits 0, 1, and 2 indicate the status of the Link, Bank/Page mode, and Memory Protect, respectively, at the time of the CAL. Note that the contents of the AC at the time of the CAL is not preserved when control is returned to the user.

On machines that have an API, the execution of a CAL instruction automatically raises the priority to the highest software level (level 4). Control passes to the handler while it is still at level 4, allowing the handler to complete its non-reentrant procedures before debreaking (DBK) from level 4. This permits the handler to receive reentrant calls from software levels higher than the priority of the program that contained this call. Device handlers which do not contain reentrant procedures (including all handlers supplied with DOS) may avoid system failure caused by inadvertent reentries by remaining at level 4 until control is returned to the user.

If the non-reentrant method is used, the debreak and restore (DBR) instruction should be executed just prior to the JMP* which returns control to the user, allowing debreak from level 4 and restoring the conditions of the Link, Bank/Page mode, and Memory Protect. Any IOT's issued at the CAL level (level 4 if API present, mainstream if no API) should be executed immediately before the

DBR
JMP*

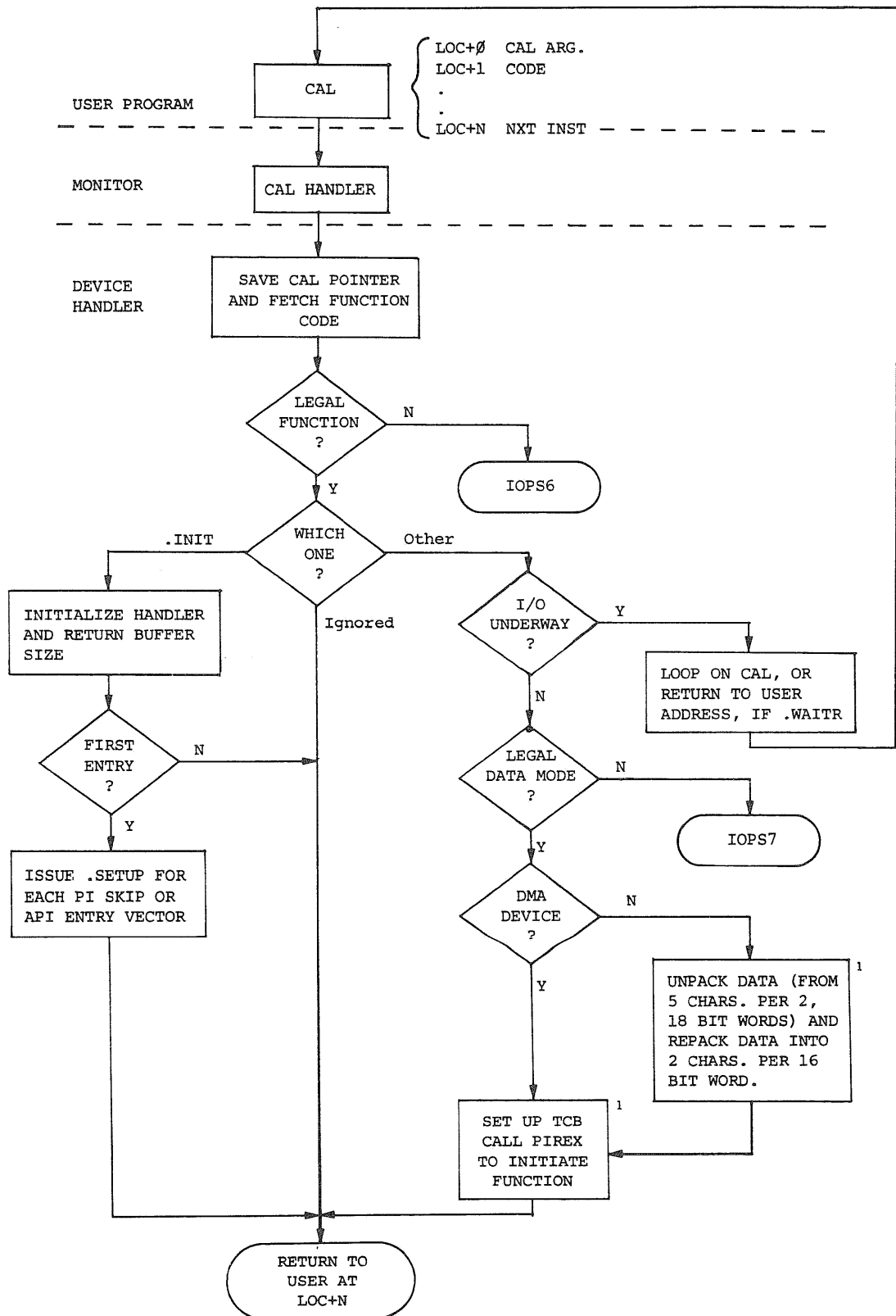


Figure 7-1
CAL Entry to Device Handler

¹For non-unibus devices both these branches would be replaced by a single initiate function routine.

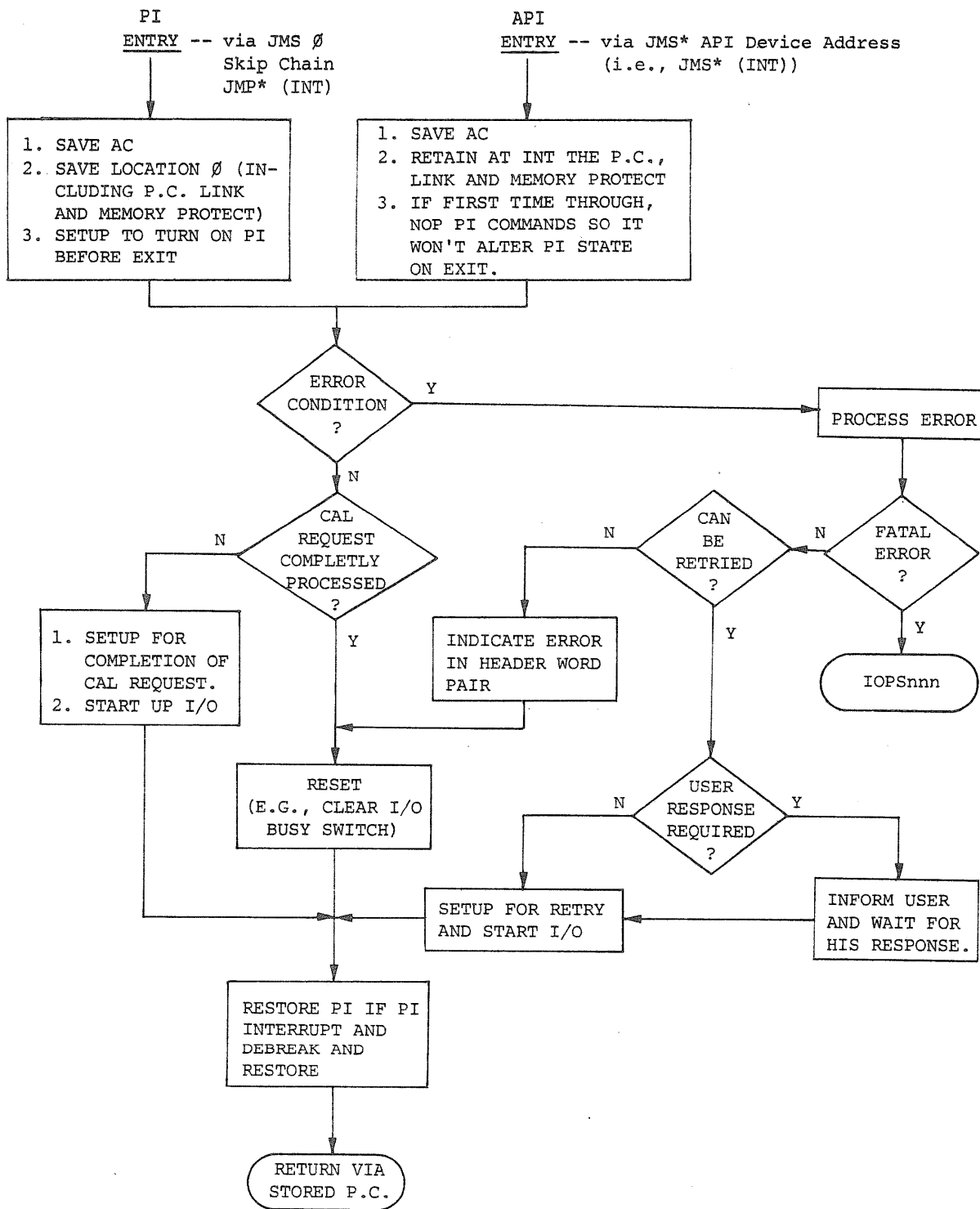


Figure 7-2
PI and API Entries to Device Handlers¹

¹On a PI or API interrupt, the device handler is entered in Bank or Page mode, depending on the setting of bit 11 in .SCOM+4. If = 1, Bank mode; if = 0, Page mode.

exit sequence in order to ensure that the exit takes place before the interrupt from the issued IOT occurs.

The CAL instruction must not be used at any level (API or PIC) that might interrupt a CAL. A CAL at such a level will destroy the content of location 00020 for the previous CAL.

Care must also be taken when executing CALS at level 4. For example, a routine that is CALed out of level 4 must know that if a debreak (DBR or DBK) is issued, control will return to the calling program (which had been at level 4) at a level lower than level 4.

7.1.1 Setting Up the Skip Chain and API (Hardware) Channel Registers

When the Monitor is loaded, the Program Interrupt (PI) Skip Chain and the Automatic Priority Interrupt (API) channels are set up to handle the TTY keyboard and printer and clock interrupts only. The Skip Chain contains the other skip IOT instructions, but indirect jumps to an error routine result if a skip occurs, as follows:

```
SKPDTA          /Skip if DEctape flag.
SKP
JMP* INT1       /INT1 contains error address.
SKPLPT         /Skip if line printer flag.
SKP
JMP* INT2       /INT2 contains error address.
SKPTTI         /Skip if teleprinter flag.
SKP
JMP TELINT     /To teleprinter interrupt handler.
.
.
.
```

All unused API channels, memory protect, memory parity, and powerfail, also contain JMP's to the error address.

When a device handler is called for the first time in a core load, it must call a Monitor routine (.SETUP) to set up its skip(s) in the Skip Chain, or its API channel, prior to performing any I/O functions.

The calling sequence is as follows:

```

CAL N          /N = API channel register 40 through 77 (see User's
               Handbook Vol. 1, for standard channel assign-
               ments),
               /0 if device not connected to API.
16            /.SETUP function code.
SKP IOT       /Skip IOT for this device.
DEVINT        /Address of interrupt handler.
              (normal return)

```

7.1.2 Handling the Interrupt

DEVINT exists in the device handler in the following format to allow for either API or PI interrupts. The following is for UNIBUS devices only:

```

ONLY1  LAC      (NOP      /LEAVE PI ALONE.  WHEN API IS RUNNING
        DAC      DEVION   /THESE REGISTERS
        DAC      DEVIOF   /ARE AVAILABLE
        DAC      IGNRPI   /THIS IS ONCE ONLY CODE
        JMP      COMMON
DEVPIC  DAC      DEVAC    /SAVE AC
        LAC*     (Ø
        DAC      DEVOUT   /SAVE PC, LINK, ADDRESSING MODE AND
                          /MEMORY PROTECT
        JMP      COMMON
DEVINT  JMP      DEVPIC   /PI ENTRY
        DAC      DEVAC    /API ENTRY; SAVE AC
        LAC      DEVINT
        DAC      DEVOUT   /SAVE PC, LINK, ADDRESSING MODE AND
IGNRPI  JMP      ONLY1    /API IS OPERATING, SO LEAVE PI ALONE.
                          /PI INTERRUPTS ARE NOT POSSIBLE, BE-
                          /CAUSE .SETUP EFFECTIVELY NOP'S PI
                          /SKIPS.
COMMON  CAPI-     /CLEAR API LEVEL '-' DONE FLAG.
DEVION  ION      /PI ALLOWS INTERRUPTS; API DOES A NOP.
        .
        .
DEVIOF  IOF      /API DOES NOP; PI TURNS IO OFF TO ENSURE
                          /NON-REENTRANCE AFTER ISSUING IOT'S.
        LAC      (TCB    /GET ADDRESS OF TCB IN AC
        SIOA     /PREVIOUS TCB ACCEPTED?
        JMP      .-1     /NO
        LIOR     /YES.  LOAD REGISTER IN INTERRUPT LINK
        .        /THIS CAUSES A BR7 (HIGHER LEVEL)
/DISMISS ROUTINE /INTERRUPT ON THE PDP-11.
        .
        .
DVSWCH  LAC      DEVAC    /RESTORE AC.
        ION      /ION OR NOP.
        DBR     /DEBREAK AND RESTORE CONDITIONS
        JMP*    DEVOUT   /OF LINK, ADDRESSING MODE AND MEMORY
                          /PROTECT.

```

If the Index, Autoincrement, or EAE registers are used by the I/O device handler, it is necessary to save and restore them.

The following is for non-UNIBUS devices:

ONLY1	LAC	(NOP	/LEAVE PI ALONE. WHEN API IS RUNNING
	DAC	DEVION	/THESE REGISTERS
	DAC	DEVIOF	/ARE AVAILABLE
	DAC	IGNRPI	/THIS IS ONCE ONLY CODE
	JMP	COMMON	
DEVPIC	DAC	DEVAC	/SAVE AC
	LAC*	(Ø	
	DAC	DEVOUT	/SAVE PC, LINK, ADDRESSING MODE AND
			/MEMORY PROTECT
	JMP	COMMON	
DEVINT	JMP	DEVPIC	/PI ENTRY
	DAC	DEVAC	/API ENTRY; SAVE AC
	LAC	DEVINT	
	DAC	DEVOUT	/SAVE PC, LINK, ADDRESSING MODE AND
IGNRPI	JMP	ONLY1	/API IS OPERATING, SO LEAVE PI ALONE.
			/PI INTERRUPTS ARE NOT POSSIBLE, BE-
			/CAUSE .SETUP EFFECTIVELY NOP'S PI
			/SKIPS.
COMMON	DEVCF		/CLEAR DEVICE DONE FLAG.
DEVION	ION		/PI ALLOWS INTERRUPTS; API DOES A NOP.
	.		
	.		
	.		
DEVIOF	IOF		/API DOES NOP; PI TURNS IO OFF TO ENSURE
			/NON-REENTRANCE AFTER ISSUING IOT'S.
	DEVIOT		
	.		
	.		
	.		
	/DISMISS	ROUTINE	
	.		
	.		
	.		
DVSWCH	LAC	DEVAC	/RESTORE AC.
	ION		/ION OR NOP.
	DBR	-	/DEBREAK AND RESTORE CONDITIONS
	JMP*	DEVOUT	/OF LINK, ADDRESSING MODE AND MEMORY
			/PROTECT.

If the Index, Autoincrement, or EAE registers are used by the I/O device handler, it is necessary to save and restore them.

.SETUP allows either API or PI, but not both for a single device. The System Generator Manual gives the method for incorporating new handlers and associated Skip Chain entries into the Monitor.

7.2 API SOFTWARE LEVEL HANDLERS, AN INTRODUCTION

The information presented in the following paragraphs assumes that the reader is familiar with the system input/output considerations described in the PDP-15 User's Handbook Vol. 1.

7.2.1 Setting Up API Software Level Channel Registers

When the Monitor is loaded, the API software-level channel registers (40 through 43) are initialized to

```
JMS*      .SCOM+12      /LEVEL 4
JMS*      .SCOM+13      /LEVEL 5
JMS*      .SCOM+14      /LEVEL 6
JMS*      .SCOM+15      /LEVEL 7
```

where .SCOM is equal to absolute location 000100 and .SCOM+12 through .SCOM+15 (000112 through 000115) each contains the address of an error routine.

Therefore, prior to requesting any interrupt at these software priority levels, the user must modify the contents of the .SCOM registers so that they point to the entry point of the user's software level handlers.

Example:

```
.SCOM=100
      LAC      (LV5INT      / set level 5 entry.
      DAC*     (.SCOM+13
      .
      .
      .
```

LV5INT exists in the user's area in the following format:

```
LV5INT  0          /PC, LINK, BANK/PAGE MODE, MEM. PROT.
      DAC      SAV4AC /SAVE AC
      /SAVE INDEX, AUTOINCREMENT AND EAE REGISTERS, IF LEVEL 5
      /ROUTINES USE THEM AND LOWER LEVEL ROUTINES ALSO USE THEM.
      /SAVE MQ AND STEP COUNTER, IF SYSTEM HAS EAE AND IT IS USED
      /AT DIFFERENT LEVELS.
      .
      /RESTORE SAVED REGISTERS.
      DBR          /DEBREAK FROM LEVEL 5 AND RESTORE
      JMP*      LV5INT      /L, BANK/PAGE MODE, MEM. PROT.
```

7.2.2 Queueing

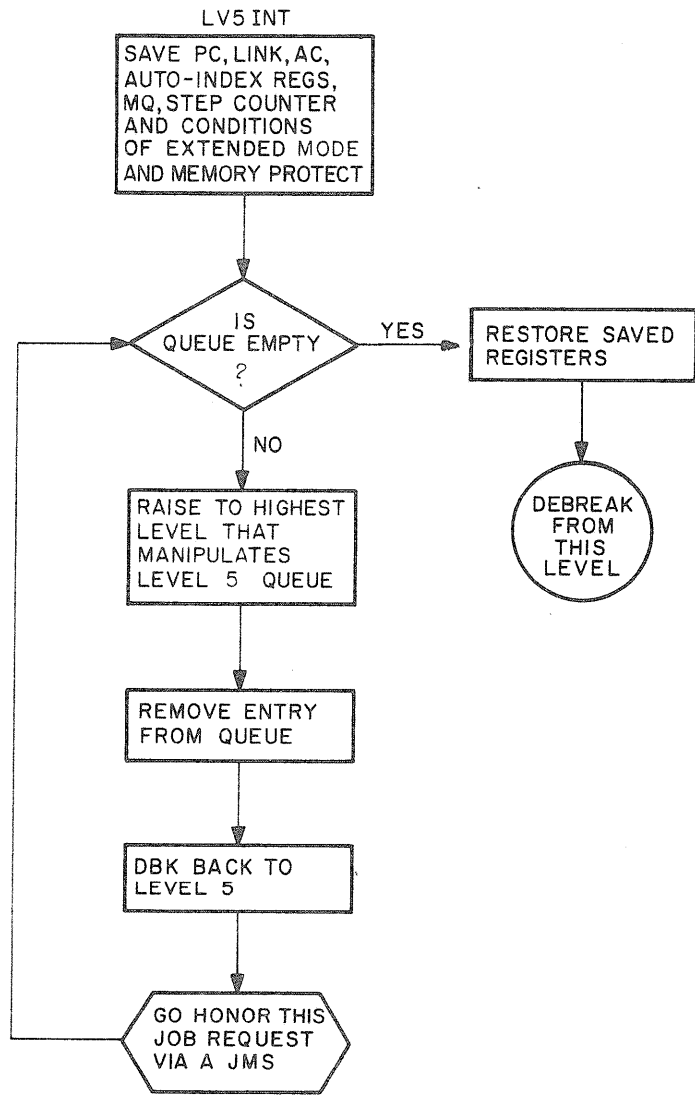
High priority/high data rate/short access routines cannot perform complex calculations based on unusual conditions without holding off further data input. To perform the calculations, the high priority program segment must initiate a lower priority (interruptable) segment to perform the calculations. Since many data handling routines would generally be requesting calculations, there will exist a queue of calculation jobs waiting to run at the software level. Each data handling routine must add its job request to the appropriate queue (taking care to raise the API priority level as high as the highest level that manipulates the queue before adding the request) and issue an interrupt request (ISA) at the corresponding software priority level. The general flow chart, Figure 7-3, depicts the structure of a software handler involved with queued requests.

Care must be taken about which routines are called when a software level request is honored; that is, if a called routine is "open" (started but not completed) at a lower level, it must be reentrant, or errors will result.

NOTE

The DOS hardware I/O device handlers do not contain reentrant procedures and must not be reentered from higher levels.

Resident handlers for Power Fail, Memory Parity, nonexistent memory violation, and Memory Protect violation have been incorporated into the system and effect an IOPS error message if the condition is detected. The user can, via a .SETUP, tie his own handler to these skip IOT or API channel registers.



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Figure 7-3

Structure of API Software Level Handler

7.3 WRITING SPECIAL I/O DEVICE HANDLERS

This section contains information prepared specifically to aid those users who plan to write their own special I/O device handlers for DOS.

DOS is designed to enable users to incorporate their own device handlers. Precautions should be taken when writing the handler however, to ensure compatibility with the Monitor.

Here is a summary of handler operation. The handler is entered via a JMP* from the Monitor as a result of a CAL instruction. The contents of the AC contain the address of the CAL in bits 3 through 17. Bit 0 contains the Link, bit 1 contains the Bank/Page Mode status, and bit 2 contains the Memory Protect status. The previous contents of the AC and Link are lost.

In order to show the steps required in writing an I/O device handler, a complete handler (Example B) was developed with the aid of a skeleton handler (Example A). In addition, Appendices A and B are complete flowcharts of the DTA and the A version of the disk handlers. The skeleton handler is a non-reentrant type (discussed briefly at the beginning of this chapter) and uses the Debreak and Restore Instruction (DBR) to leave the handler at software priority level 4 or at a hardware level for interrupt servicing (if API), and restore the status of the Link, Bank/Page Mode, and Memory Protect. Example A is referenced by part numbers to illustrate the development of Example B, a finished Analog-to-Digital Converter (ADC) I/O Handler. The ADC handler shown in Example B was written for the Type AF01B Analog to Digital Converter. This handler is used to read data from the ADC and store it in the user's I/O buffer.

The reader, while looking at the skeleton of a specialized handler as shown in Example A, should make the following decisions about his own handler. (The decisions made in this case are in reference to developing the ADC handler):

- a. Services that are required of the handler (flags, receiving or sending of data, etc.) - By looking at the ADC IOT's shown in the Reference Manual, it can be seen that there are three IOT instructions to be implemented. These instructions are: Skip if Converter Flag Set, Select and Convert, and Read Converter Buffer.

The only service the ADC handler performs is that of receiving data and storing it in user specified areas. This handler will have a standard 256-word buffer.

- b. Data Modes used (for example, IOPS ASCII, etc.) - Since there is only one format of input from the Type AF01B ADC, mode specification is unnecessary in Example C.
- c. Which I/O macros are needed for the handler's specific use; that is, .INIT, .CLOSE, .READ, etc. For an ADC, the user would be concerned with four of the macros.
 - (1) .INIT would be used to set up the associated API channel register or the interrupt skip IOT sequence in the Program Interrupt Skip Chain. This is done by a CAL (N) as shown in Part III of Example A, where (N) is the channel address.
 - (2) .READ is used to transfer data from the ADC. When the .READ macro is issued, the ADC handler will initiate reading of the specified number of data words and then return control to the user. The analog input data received is in its raw form. It is up to the programmer to convert the data to a usable format.
 - (3) .WAIT detects the availability of the user's buffer area and ensures that the I/O transfer is completed. It would be used to ensure a complete transfer before processing the requested data.
 - (4) .WAITR detects the availability of the user's buffer area as in (3) above. If the buffer is not available, control is returned to a user specified address, which allows other processing to continue.
- d. Implementation of the API or PIC interrupt service routine - Example A shows an API or PIC interrupt service routine that handles interrupts, processes the data and initiates new data requests to fully satisfy the .READ macro request. Note that the routines in Example A will operate with or without API. Example B uses the routines exactly as they are shown in Example A.

During the actual writing of Example B, consideration was given to the implementation of the I/O macros in the new handler in one of the following ways:

- (1) Execute the function in a manner appropriate to the given device as discussed in(c). .INIT, .READ, .WAIT, and .WAITR were implemented into the ADC handler (Example B) under the subroutine names ADINIT, ADREAD, ADWAIT (.WAIT and .WAITR).

Wait for completion of previous I/O. (Example B shows the setting of the ADUND switch in the ADREAD subroutine to indicate I/O underway.)

- (2) Ignore the function if meaningless to the device. See Example B (.FSTAT results in JMP ADIGN2) in the dispatch table DSPCH. For ignored macros, the return address must be incremented in some cases, depending upon the number of arguments following the CAL (see Chapter 3).
- (3) Issue an error message in the case where it is not possible to perform the I/O function - (An example would be trying to execute a .ENTER on the paper tape reader.) In Example B, the handler jumps to DVERR6 which returns to the Monitor with a standard error code in the AC.

e. Special considerations for UNIBUS device handlers

When new handlers are written for devices on the UNIBUS in a UC15 system (RK based or RF/RP based UC15 option) the following has to be considered.

Since communication between the device handler on the PDP-15 and the driver task running under PIREX on the PDP-11 is through Task Control Blocks (TCB), space in the Common Memory (memory that can be addressed by the PDP-15 and the PDP-11) must be provided. The system as supplied by DEC has space reserved in the Resident Monitor for 3 user defined devices/programs/tasks, (refer to Section 2.9 for more information). This TCB must be properly setup (refer to the UC15 Software Manual, DEC-15-XUCMA-A-D for more information) before the handler calls PIREX to initiate the operation.

Driver tasks (TTT)¹ running under PIREX report errors by setting the appropriate code (XX) in the device error status table in PIREX (refer to UC15 Software Manual, DEC-15-XUCMA-A-D for more information). DOS-15 system prints out this error message, which appears as follows:

```
IOPSUC TTT XX
```

Users have to decipher this message. An example of this is,

```
IOPSUC LPU 4
```

which reports that the LP11/LS11 line printer is not ready. There is no error message type out from the handler. This method of error handling is incorporated to permit error report during operation of these devices/tasks etc., under PIREX when their corresponding handlers are not present in core on the PDP-15 (e.g., during Spooling).

¹Each task running under PIREX has a 3 character code assigned to it which is present in the PIREX error table at assembly time.

After the handler has been written and assembled, the Monitor must then be modified to recognize the new handler. This is accomplished by the use of the System Generator Program (DOSGEN) described in the DEC-15-USGNA-A-D manual.

When the system generation is complete, the PIP program (refer to DEC-15-UIIPA-A-D) must be used to add the new handler to the IOS UFD. At this time, the user is ready to use his specialized device handler in the DOS-15 system.

7.3.1 Discussion of Example A by Parts

- Part 1 Stores CAL pointer and argument pointer, and picks up function code from argument string.
- Part 2 By getting proper function code in Part 1 and adding a JMP DSPCH, the CAL function is dispatched to the proper routine.
- Part 3 This is the .SETUP CAL used to set up the PI skip chain or the API channel register.
- Part 4 Shows the API and PI handlers. It is suggested these be used as shown.
- Part 5 This area reserved for processing interrupt and performing any additional I/O.
- Part 6 Interrupt dismiss routine.
- Part 7 Increments argument pointer in bypassing arguments of ignored macro CAL's.

7.3.2 Example A, Skeleton I/O Device Handler

```

/CAL ENTRY ROUTINE
.GLORL DEV,
/MUST BE OF FORM AAA,
.MED=3 /,MED (MONITOR ERROR DIAGNOSTIC)
DEV,   DAC      DVCALP /SAVE CAL POINTER
      DAC      DVARGP /AND ARGUMENT POINTER
      ISZ      DVARGP /POINTS TO FUNCTION CODE
      LAC*     DVARGP /GET CODE
      AND      (77777) /REMOVE UNIT NO IF APPLICABLE
      ISZ      DVARGP /POINTS TO CAL*2
      TAD      (JMP DSPCH
DSPCH  XX      DSPCH   /DISPATCH WITH
      JMP      DVINIT  /MODIFIED JUMP
      JMP      DVFSAT  /1 = ,INIT
      JMP      DVSEEK  /2 = ,FSTAT, ,DELETE, ,RENAM
      JMP      DVENTR  /3 = ,SEEK
      JMP      DVCLER  /4 = ,ENTER
      JMP      DVCLOS  /5 = ,CLEAR
      JMP      DVMTAP  /6 = ,CLOSE
      JMP      DVREAD  /7 = ,MTAPE
      JMP      DVWRTE  /10 = ,READ
      JMP      DVWAIT  /11 = ,WRITE
      JMP      DVTRAN  /12 = ,WAIT
      JMP      DVTRAN  /13 = ,TRAN

/ILLEGAL FUNCTIONS IN ABOVE TABLE CODED AS:
/      JMP      DVERR6

/FUNCTION CODE ERROR
DVERR6 LAC*     6      /ERROR CODE 6
      JMP*     (,MED+1 /TO MONITOR

/DATA MODE ERROR
DVERR7 LAC*     7      /ERROR CODE 7
      JMP*     (,MED+1 /TO MONITOR

/DEVICE NOT READY
DVERR4 LAC      (RETURN /RETURN (ADDRESS IN HANDLER)
      /TO RETURN TO WHEN NOT READY
      /CONDITION HAS BEEN REMOVED

      DAC*     (,MED
      LAC      (4      /ERROR CODE 4
      JMP*     (,MED+1 /TO MONITOR

/I/O UNDERWAY LOOP
DVBUSY DBR      /BREAK FROM LEVEL 4
      JMP*     DVCALP /LOOP ON CAL

/NORMAL RETURN FROM CAL
DVCK   DBR      /BREAK FROM LEVEL 4
      JMP*     DVARGP /RETURN AFTER CAL AND
      /ARGUMENT STRING

/THE DVINIT ROUTINE MUST INCLUDE
/ A ,SETUP CALLING SEQUENCE FOR

```

/EACH FLAG CONNECTED TO API
 /AND/OR PI A(AT SGEN TIME),
 /THE SETUP CALLING SEQUENCE IS:

```

OVINIT  CAL      N      /N = API CHANNEL REGISTER
                               /((47 - 77), N = 0 IF NOT CONNECTED
                               /TO API

          16
          SKPIOT    /IOPS FUNCTION CODE
          DEVINT    /SKIP IOT TO TEST THE FLAG
                               /ADDRESS OF INTERRUPT
                               /HANDLER (PI OR API)
  
```

/THIS SPACE MAY BE USED FOR I/O SUBROUTINES

/INTERRUPT HANDLER FOR API OR PI

```

ONLY1   LAC      (NOP
        DAC      DEVION
        DAC      DEVIOF
        DAC      DVSWCH
        DAC      IGNRPI
        JMP      COMMON
DEVPIC  DAC      DEVAC      /SAVE AC
        LAC*     (7
        DAC      DEVOUT    /SAVE IPC, LINK, BANK/PAGE MODE
                               /AND MEMORY PROTECT
DEVINT  JMP      COMMON
        JMP      DEVPIC    /PI ENTRY
        DAC      DEVAC    /API ENTRY; SAVE AC
        LAC      DEVINT   /SAVE I PC, LINK, BANK/PAGE MODE
        DAC      DEVOUT   /MEMORY PROTECT
IGNRPI  JMP      ONLY1    /LEAVE PI ALONE
COMMON  DEVCF
DEVION  ION      /ENABLE PI OR NOP
                               /ENABLE PI OR NOP
  
```

/THIS IS THE AREA DEVOTED TO PROCESSING INTERRUPT AND
 /PERFORMING ANY ADDITIONAL I/O DESIRED,

```

DEVIOF  IOF
        DEVINT    /DISABLE PI OR NOP
                               /DISMISSAL BEFORE INTERRUPT
                               /FROM THIS IOT OCCURS
  
```

/INTERRUPT HANDLER DISMISS ROUTE

```

OVDISM  LAC      DEVAC    /RESTORE AC
DVSWCH  ION      /ION OR NOP
        JBR
        JMP*     DEVOUT   /DEBREAK AND RESTORE
                               /LINK, BANK/PAGE MODE, MEMORY
                               /PROTECT
  
```

/IF THE HANDLER USES THE AUTOINCREMENT, INDEX
 /OR EAE REGISTERS, THEIR CONTENTS
 /SHOULD BE SAVED AND RESTORED, FUNCTIONS
 /POSSIBLY IGNORED SHOULD CONTAIN
 /PROPER INDEXING TO BYPASS
 /CAL ARGUMENT STRING
 /

/CODE TO BYPASS IGNORED FUNCTIONS
 /

```

OVIGN2  ISZ      OVARGP   /BYPASS FILE POINTER
        JMP      DVCK
  
```

7.3.3 Example B, Special Device Handler for AF01B A/D Converter

```

PAGE 1 R 321

1 /ADC HANDLER
2 /
3 /SKIP IF CONVERSION FLAG IS SET
4 /SELECT AND CONVERT (ADC FLAG IS CLEARED
5 /AND A CONVERSION IS INITIALISED)
6 /READ CONVERTER BUFFER INTO AC AND CLEAR FLAG
7 /
8 .GLOBL ADC,
9
10 /MED (MONITOR ERROR DIAGNOSTIC)
11
12 /
13 /
14 /
15 /
16 /
17 /
18 /
19 /
20 /
21 /
22 /
23 /
24 /
25 /
26 /
27 /
28 /
29 /
30 /
31 /
32 /
33 /
34 /

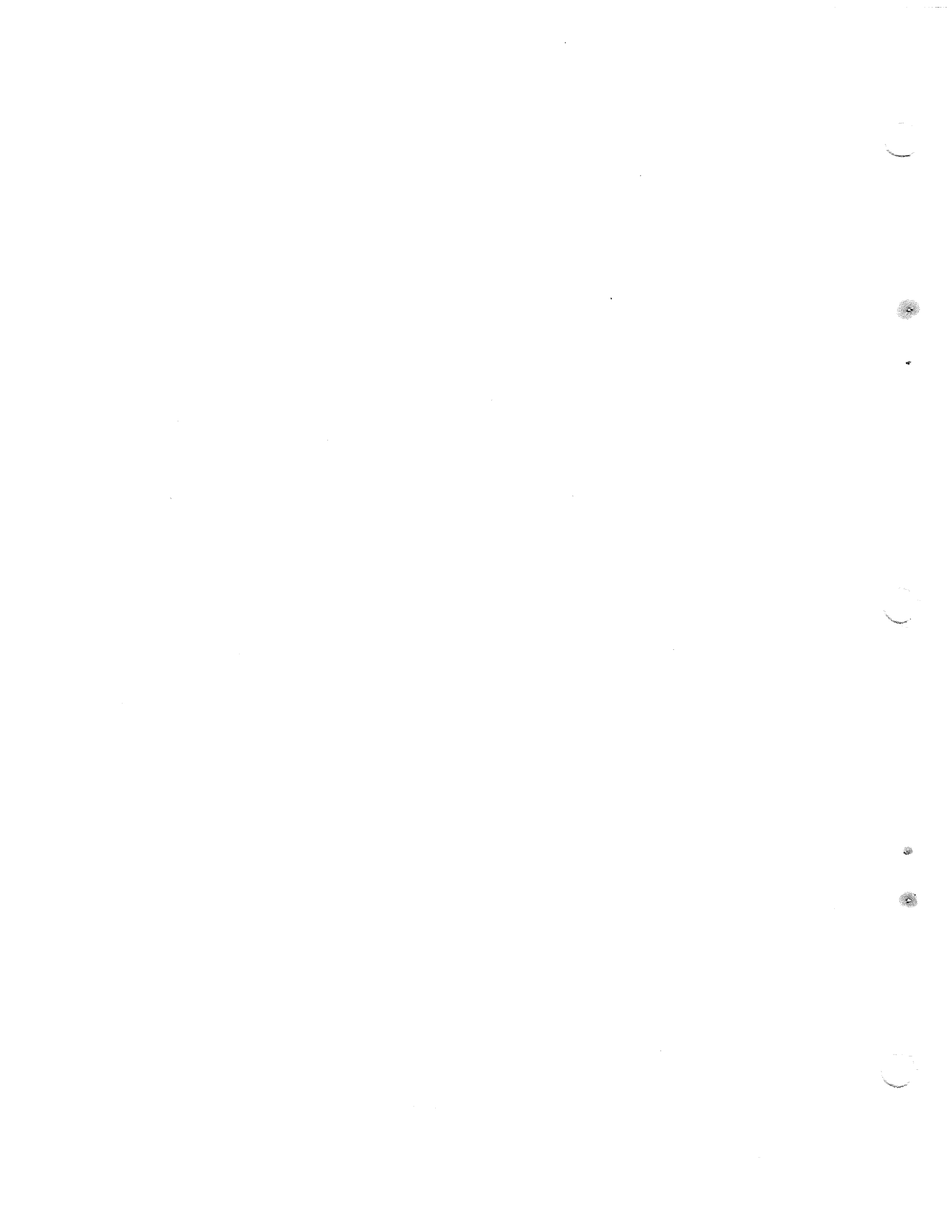
```

```

35 /FUNCTION CODE ERROR
36 /
37 /
38 /ADERR6 LAW 6 /ERROR CODE 6
39 /JMP* (%MED+1 /TO MONITOR
40 /DATA MODE ERROR
41 /ADERR7 LAW 7 /ERROR CODE 7
42 /JMP* (%MED+1 /TO MONITOR
43 /THE ADINT ROUTINE MUST INCLUDE A .SETUP
44 /FOR EACH FLAG ASSOCIATED WITH THE DEVICE
45 /
46 /ADINIT IDX ADARGP /IDX TO RETURN BUFF SIZE
47 /
48 /LAC (%256 /STANDARD BUFFER SIZE (DECIMAL)
49 /
50 /DAC* ADARGP /RETURN IT TO USER
51 /
52 /IDX ADARGP
53 /CAL 57 /57=APT CHANNEL
54 /ADCKSM 16 /SETUP IOPS FUNCTION CODE
55 /ADCRP ADSP /ADC SKIP ICT
56 /ADLBHP ADCINT /ADDR. OF INTERRUPT
57 /ADUND LAC *2 /SETUP PINCE ONLY
58 /ADWC DAC ADCKMD /SKIP SETUP CODE IF MORE
59 /ADWPCT JMP ADSTOP /INIYS ARE DONE
60 /STOP ADC ROUTINE CLEARS I/O UNDERWAY SWITCH
61 /
62 /ADSTOP %ZM ADUND
63 /JMP ADIG 1 /RETURN
64 /
65 /THE PREVIOUS TAGS IN THE CAL AREA ARE USED FOR
66 /STORAGE DURING THE ACTUAL .READ FUNCTION
67 /
68 /ADCKSM IS FOR STORING THE CHECKSUM
69 /ADCRP IS THE CURRENT BUFFER POINTER
70 /ADLBHP IS THE LINE BUFFER HEADER POINTER
71 /ADUND IS FOR DEVICE UNDERWAY SWITCH
72 /ADWC IS USED AS THE COMPUTER
73 /ADWPCT IS USED TO STORE CURRENT WORD COUNT
74 /
75 /EJECT

```


PAGE	R	CROSS REFERENCE	50	51	92	95
ADARGP	00151	13 14 15 16 155*				
		96 104 106	46			
ADBUSH	00247	86				
ADCAC	00153	115 121 149 157*				
ADCALP	00151	12 81 88 154*				
ADCBP	00235	54* 93 100 101 127 128				
ADCONT	00111	55 120* 122				
ADCTION	00117	110 126*				
ADCKSN	00234	53* 99 130 131 141				
ADCMOD	00033	52* 57				
ADCONT	00142	111 133 145*				
ADCCUT	00152	117 123 153 156*				
ADCPIC	00105	115* 120				
ADC.	00000	8 12*				
ADDISM	00144	144 149*				
ADERR6	00223	23 24 28 30 38*				
ADERR7	00026	41* 91				
ADIGN1	00076	25 26 63 78 105*				
ADIGN2	00074	21 22 104*				
ADINIT	00027	20 46*				
ADLRHP	00034	55* 94 139 140 142				
ADRR	701312	6* 125				
ADREAD	00051	27 84*				
ADSC	701504	4* 103 146				
ADSF	701501	3* 54				
ADSTOP	00042	58 62*				
ADSWCH	00145	112 151*				
ADUND	00037	56* 62 76 84 87 143				
ADWAIT	00044	29 76*				
ADWC	00040	57* 97 132				
ADWPCT	00041	58* 98 129 134				
COMMON	00116	114 119 125*				
DSPCH	00007	17 18 19*				
IDX	40000	9* 14 16 46 51 95 100 101 104 140				
IGNRPI	00115	128 129 140				
ONLY1	00077	115 124*				
.MED	00000	100* 124 129 139* 140 39 42				



CHAPTER 8

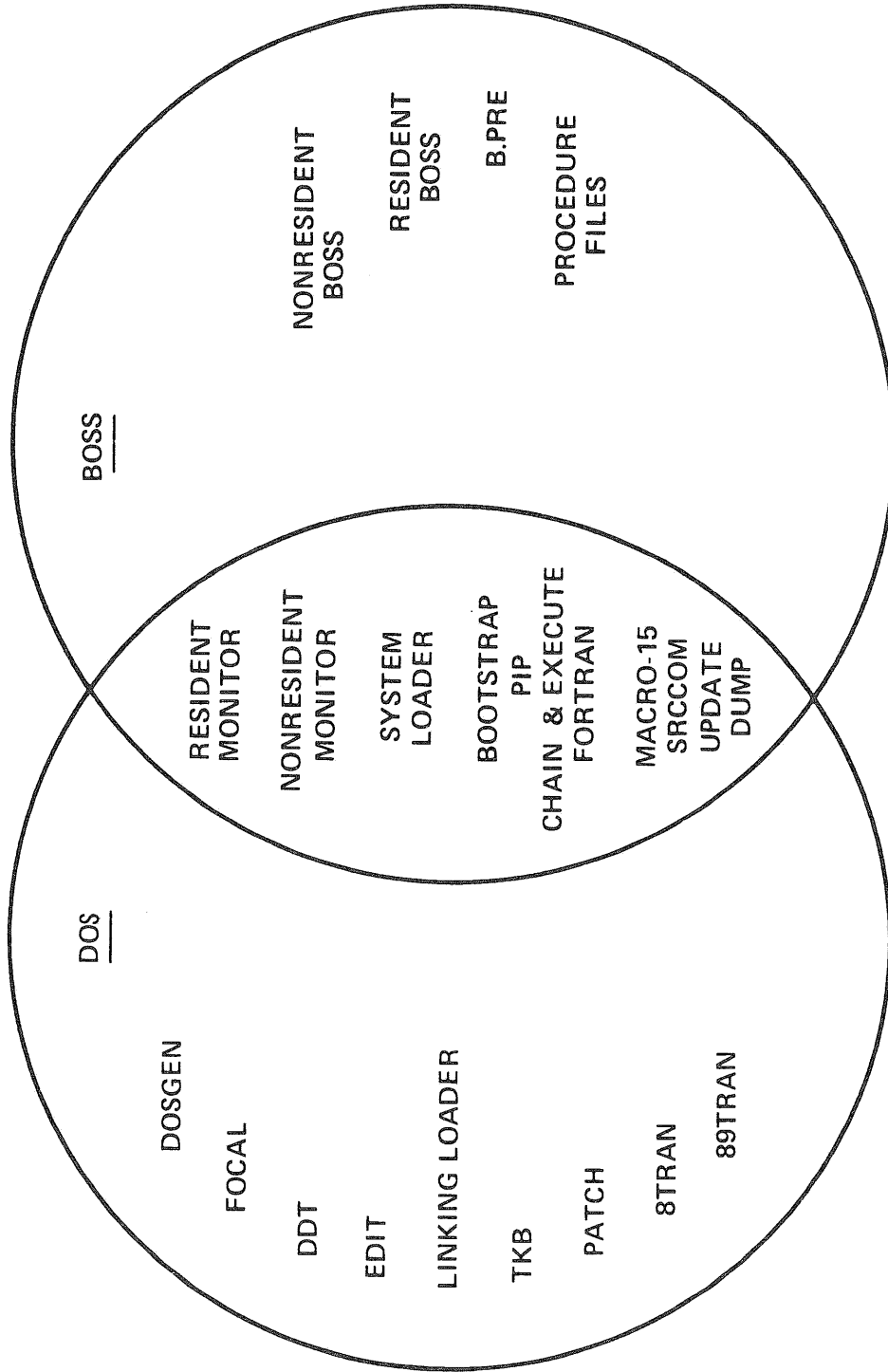
BOSS-15

BOSS enables DOS users with a card reader and a line printer to run jobs sequentially, with a minimum of operator intervention. BOSS supports a subset of the DOS system programs, and adds a line editor, its own resident and nonresident routines (called Resident BOSS and Nonresident BOSS), and the Procedure Files. Paragraph 8.1 describes Procedure Files. Figure 8-1 shows which monitor supports each system program.

The DOS programs run by BOSS are identical to those run by DOS. Exceptions are the Resident and Nonresident Monitors, which are explained later. BOSS expands the information on Control Cards into a series of commands in the format expected by the DOS system programs. Nonresident BOSS does this command expansion, and stores the expanded commands in a disk file, the Run Time File (RTF). Since DOS programs expect to communicate with an operator at a teleprinter, BOSS feeds the expanded commands to the programs via .DAT slots assigned to TTA. In BOSS mode, therefore, BOSS attaches .DAT-2 to the Run Time File, and directs most teleprinter output to the Line Printer. Programs can force I/O to the teleprinter by setting bit 4 in .SCOM+52, and proceeding with macros directed to TTA.

Whenever bit 0 of .SCOM+52 is set, the System Loader Interface attaches the Resident BOSS code to the Resident Monitor. The main purposes of Resident BOSS are to (1) ensure that BOSS will retain control of the teleprinter, (2) feed commands to programs via the Run Time File, (3) properly route internal Monitor commands, such as .EXIT, .GET and .PUT, and (4) direct teleprinter output to the Line Printer. Figure 8-2 illustrates the connections between the DOS Resident Monitor and the BOSS Resident Monitor that accomplish these changes. Figure 8-3, the flowchart for Resident BOSS, further describes Resident BOSS.

Resident BOSS communicates with Nonresident BOSS by TRANIg information to and from the first block of Nonresident BOSS. Nonresident BOSS gains control on all error conditions, such as IOPS, operator abort, Time Estimate exceeded, and after a BOSS15 command. Figure 8-4 is a flowchart of Nonresident BOSS.



15-0658

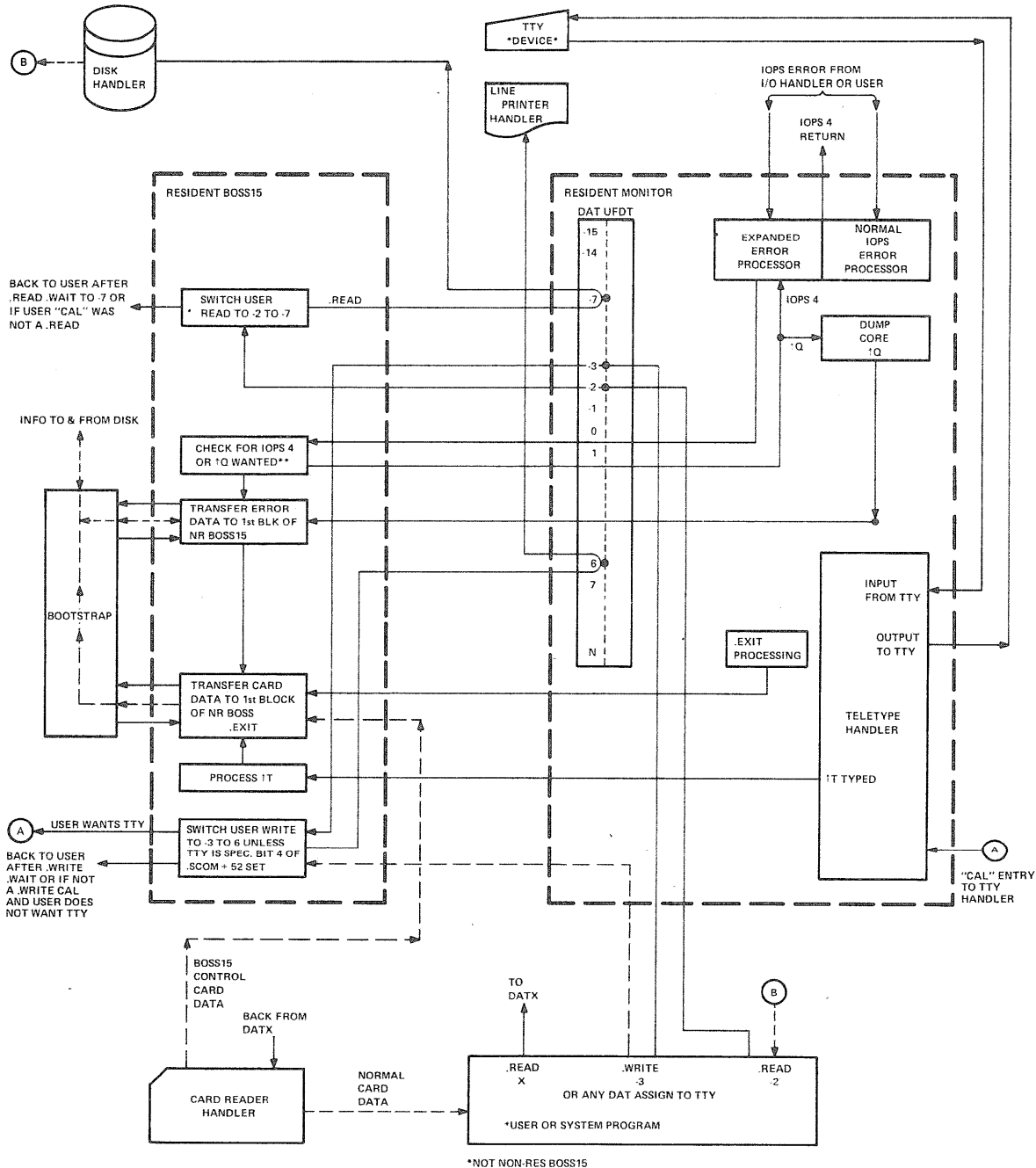
Figure 8-1, BOSS/DOS Intersection

RESIDENT BOSS15 INTERFACE TO RESIDENT MONITOR
AND USER PROGRAM OR SYSTEM PROGRAM

———— PROGRAM CONTROL
- - - - INFORMATION FLOW

**IF QDUMP WAS SPECIFIED THEN THE DUMP
WILL TAKE PLACE BEFORE GOING TO
RESIDENT BOSS15

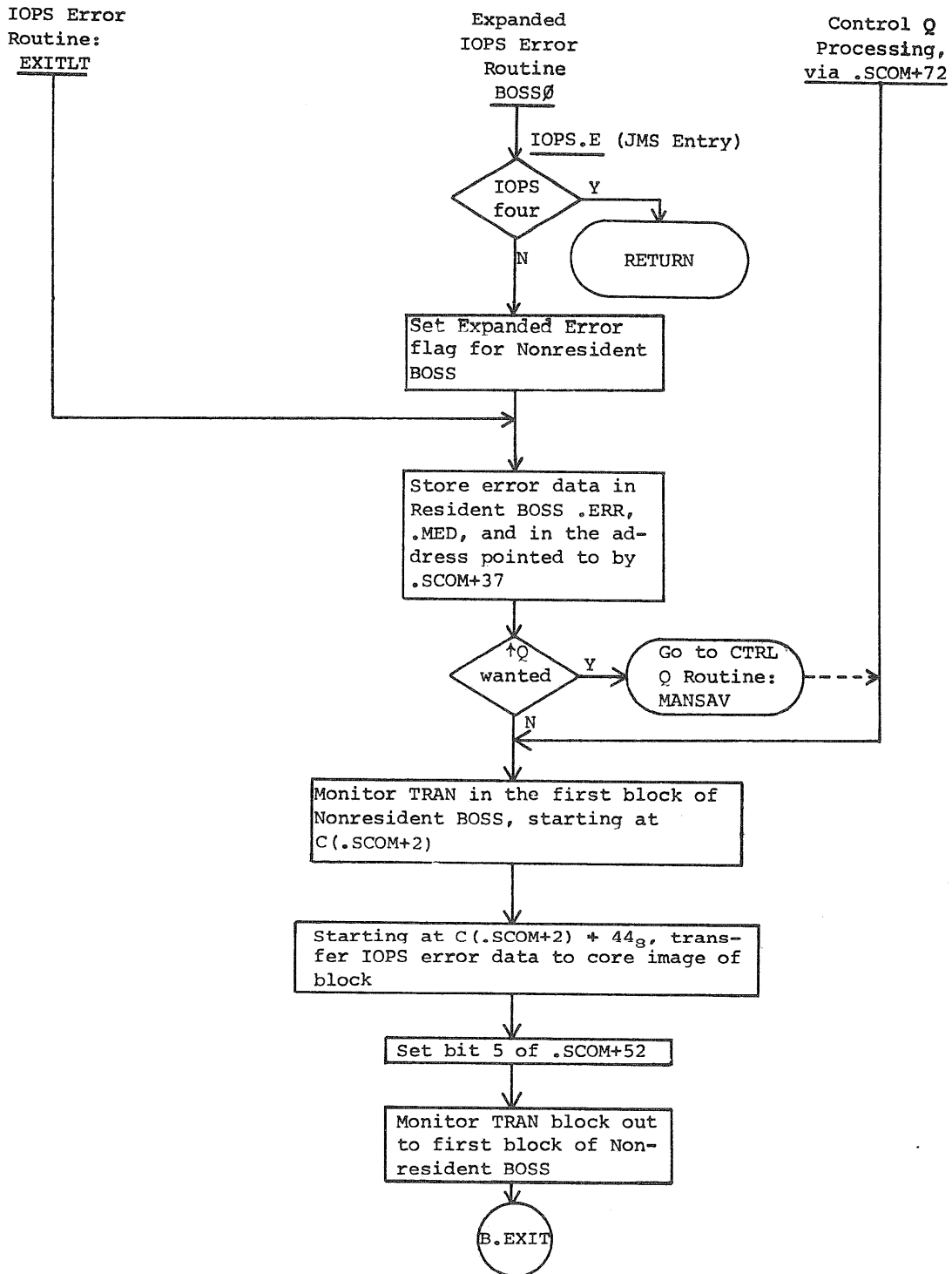
NOTE: SEE RESIDENT BOSS FLOW CHARTS
FOR DETAILS.



*NOT NON-RES BOSS15

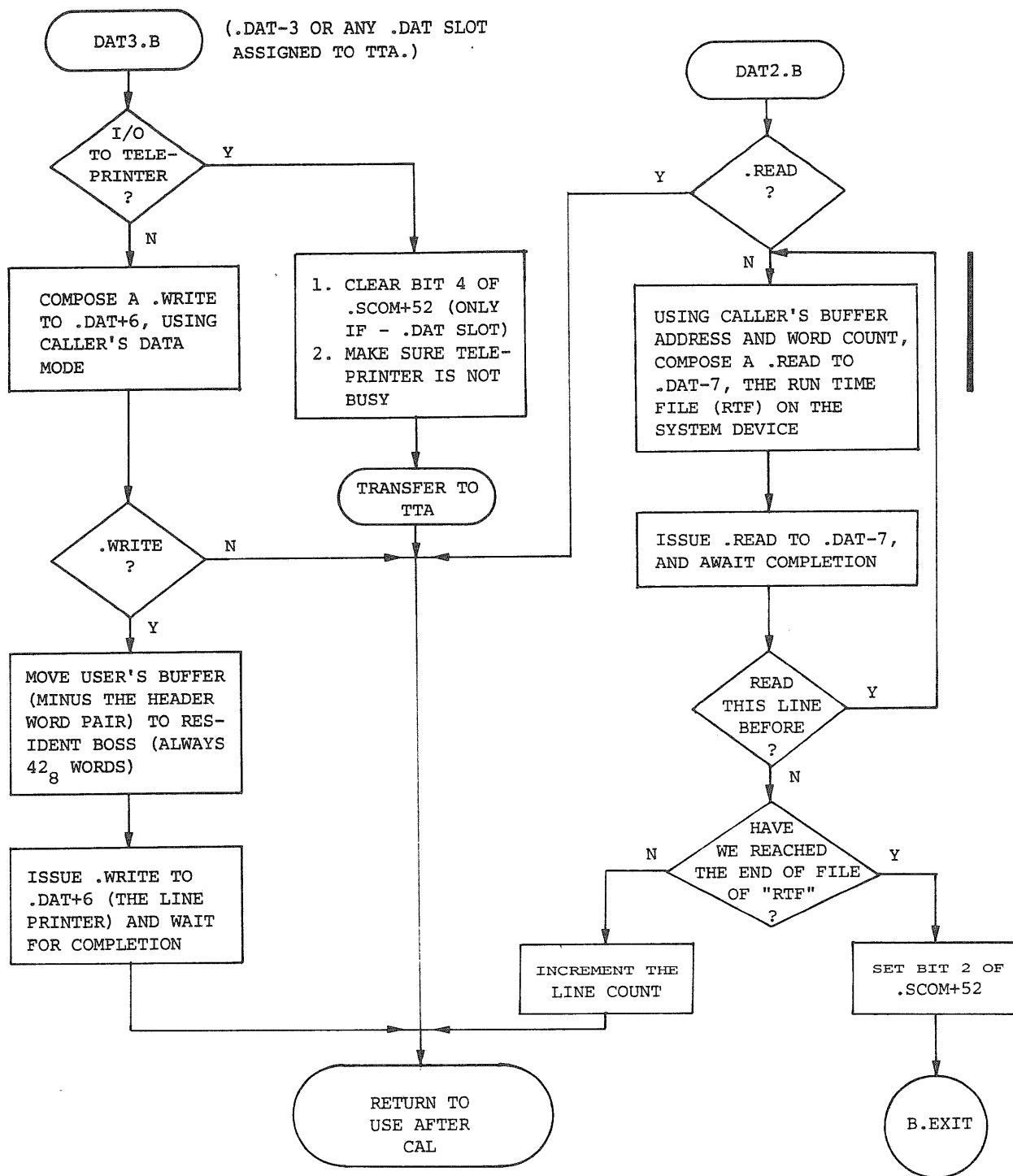
15-0659

Figure 8-2
Connections Between DOS Resident
Monitor and BOSS Resident Monitor



Points within the Resident Monitor which transfer control to Resident BOSS - 15

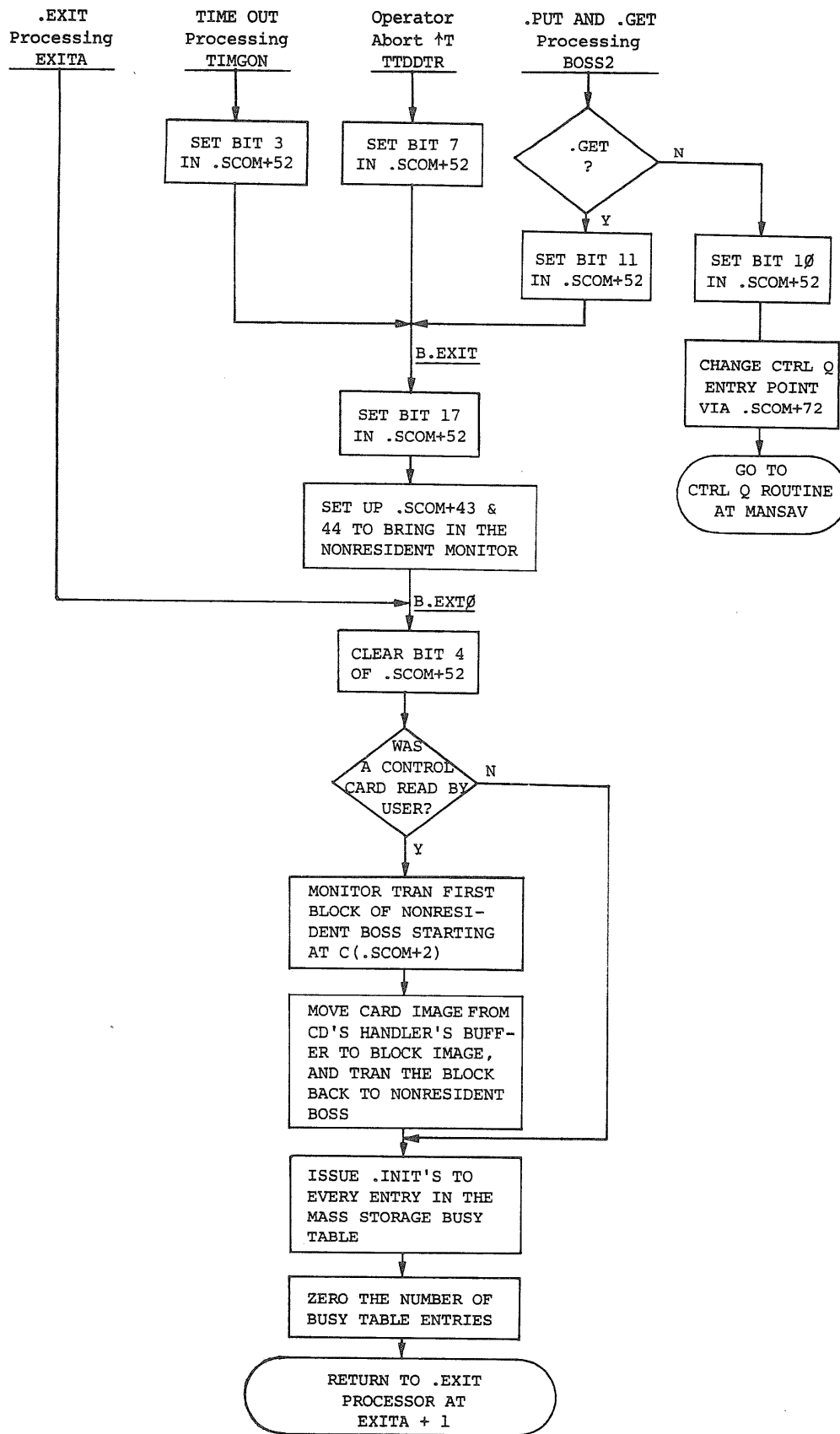
Figure 8-3
Resident BOSS-15



Processing for I/O Macros addressed to .DAT slots -2 or -3, or any slot assigned to TTA.
 Points within the Resident Monitor which transfer control to Resident BOS-15.

Figure 8-3 (Cont.)

Resident BOSS-15



Points within the Resident Monitor which transfer control to Resident BOSS-15

Figure 8-3 (Cont.)
RESIDENT BOSS-15

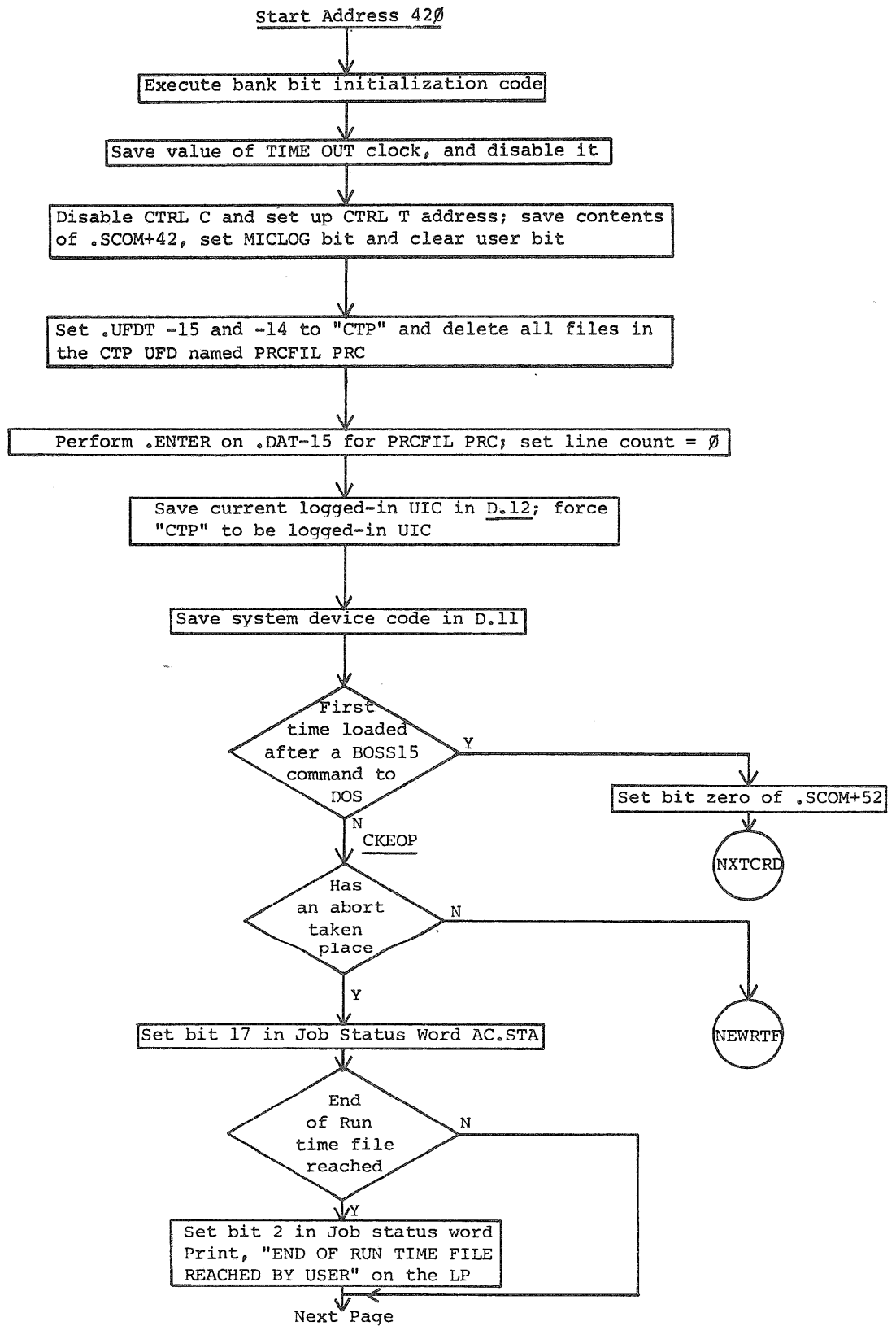


Figure 8-4
Nonresident BOSS

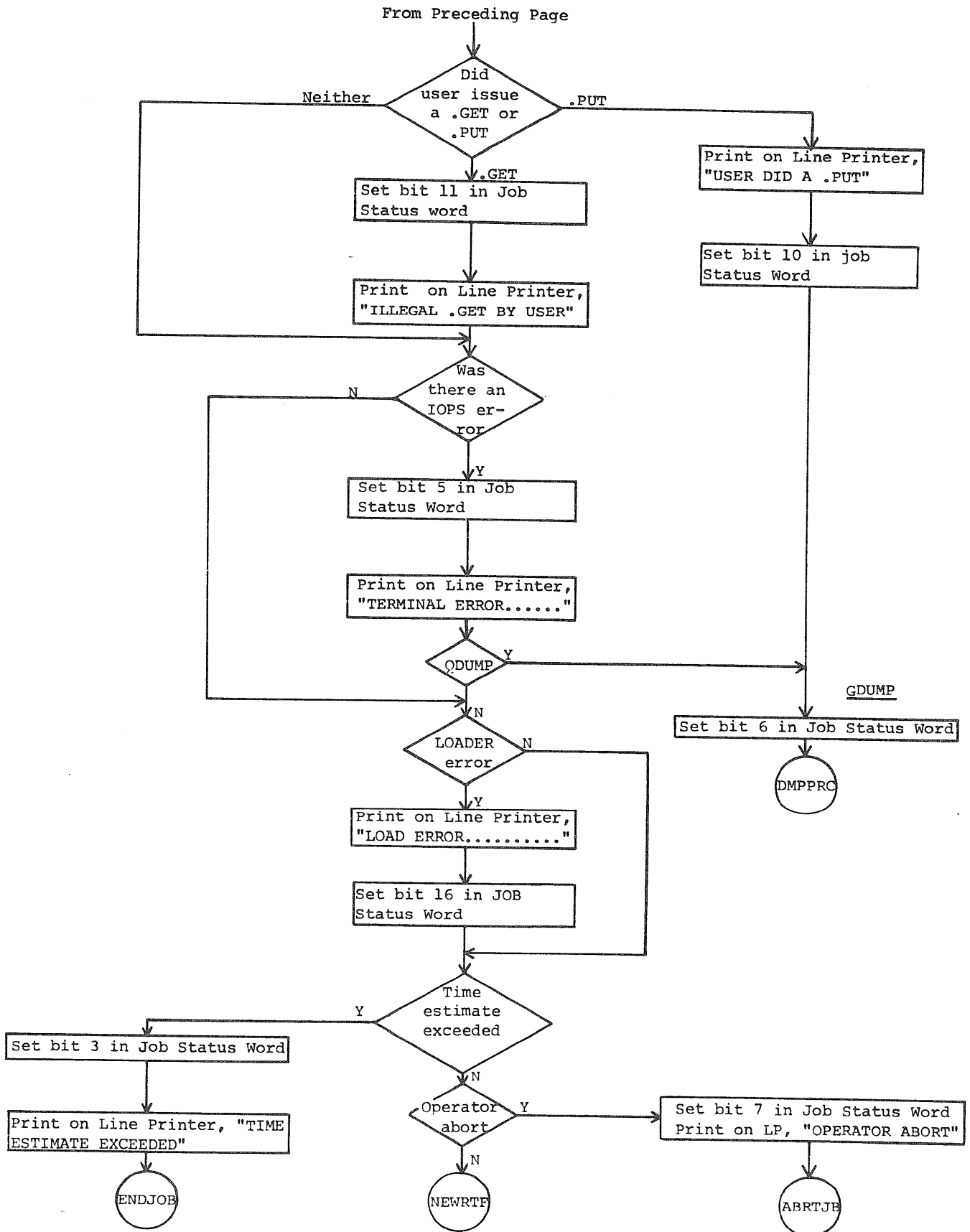


Figure 8-4 (Cont.)
Nonresident BOSS

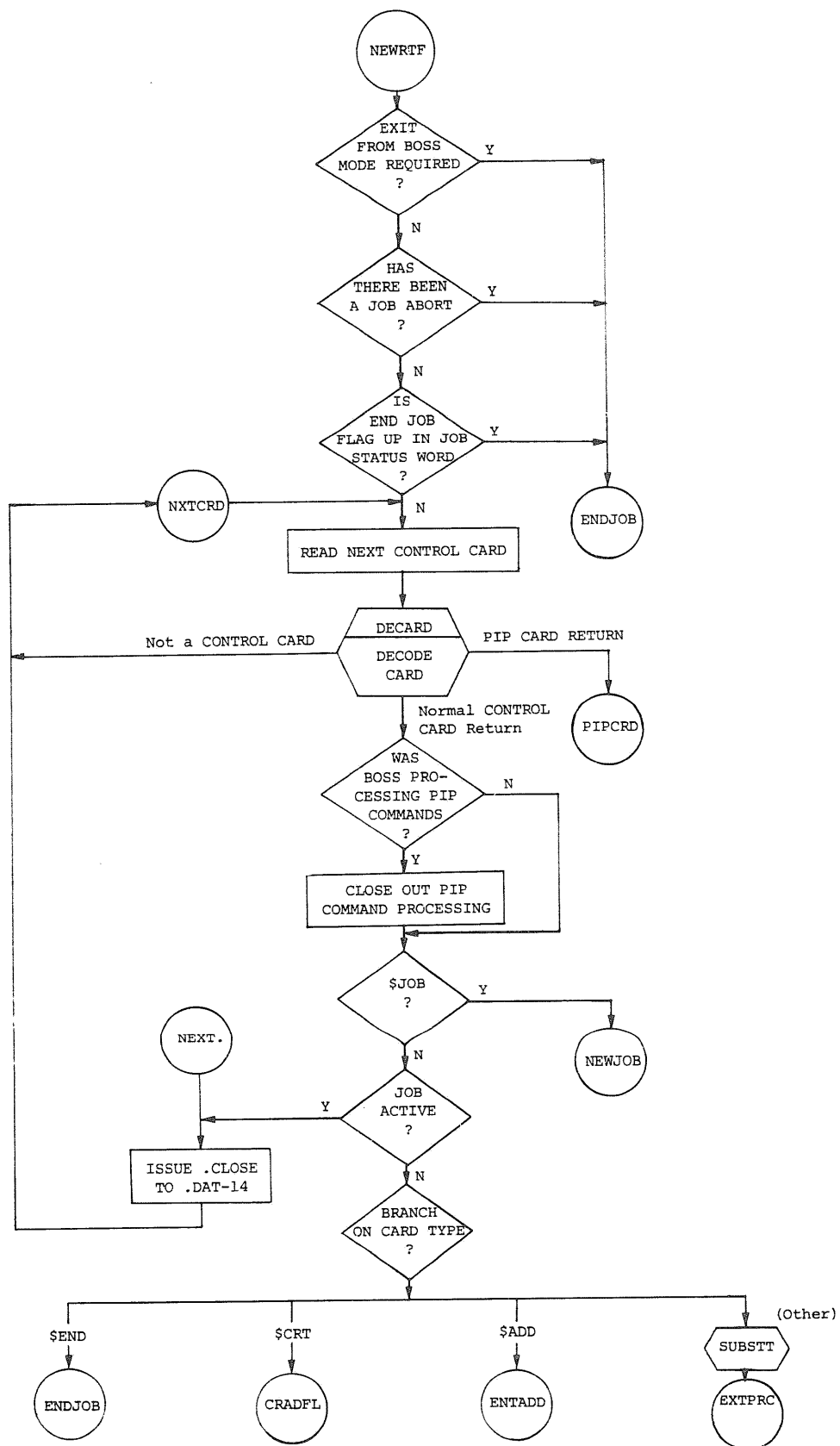


Figure 8-4 (Cont.)
Nonresident BOSS

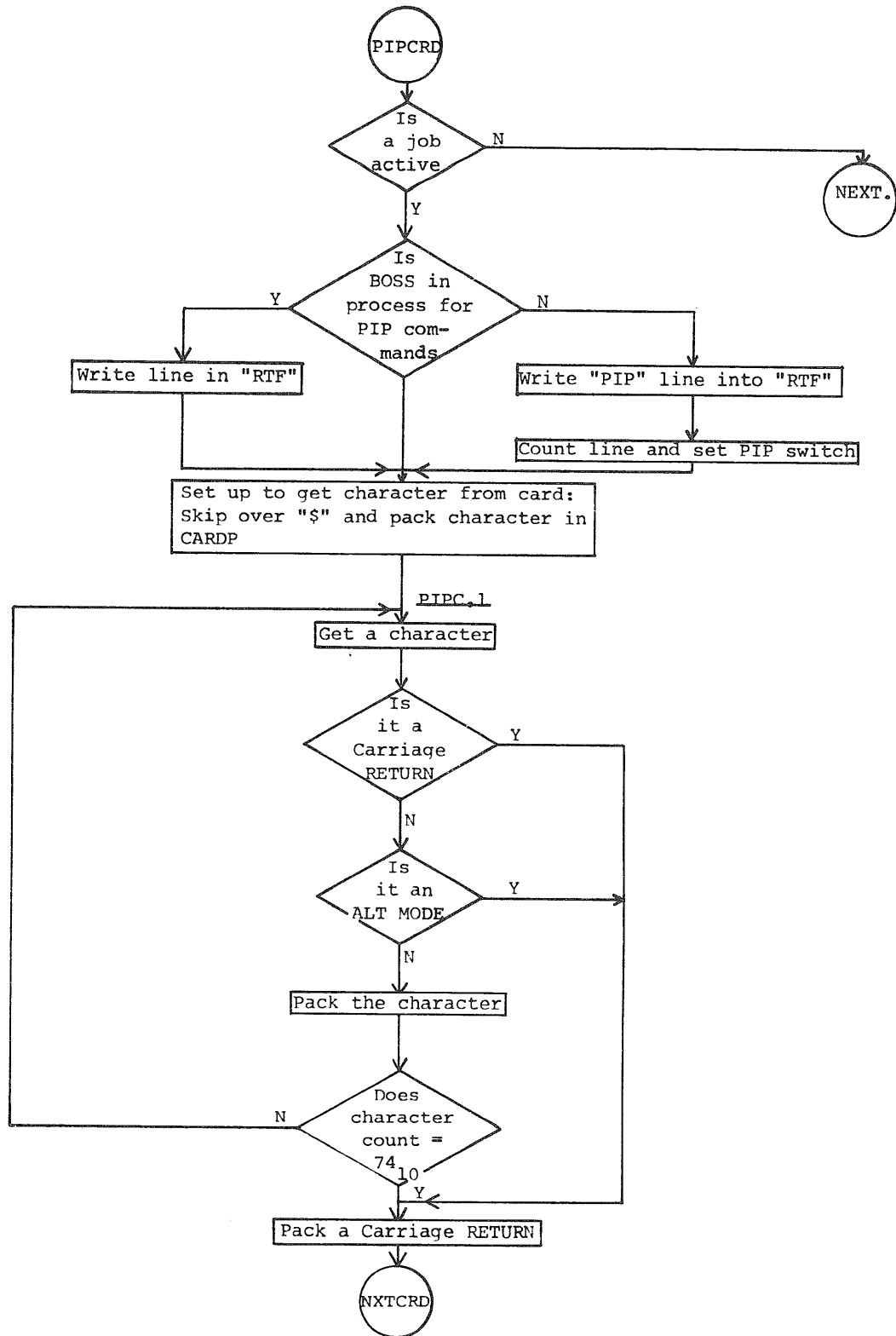


Figure 8-4 (Cont.)
Nonresident BOSS

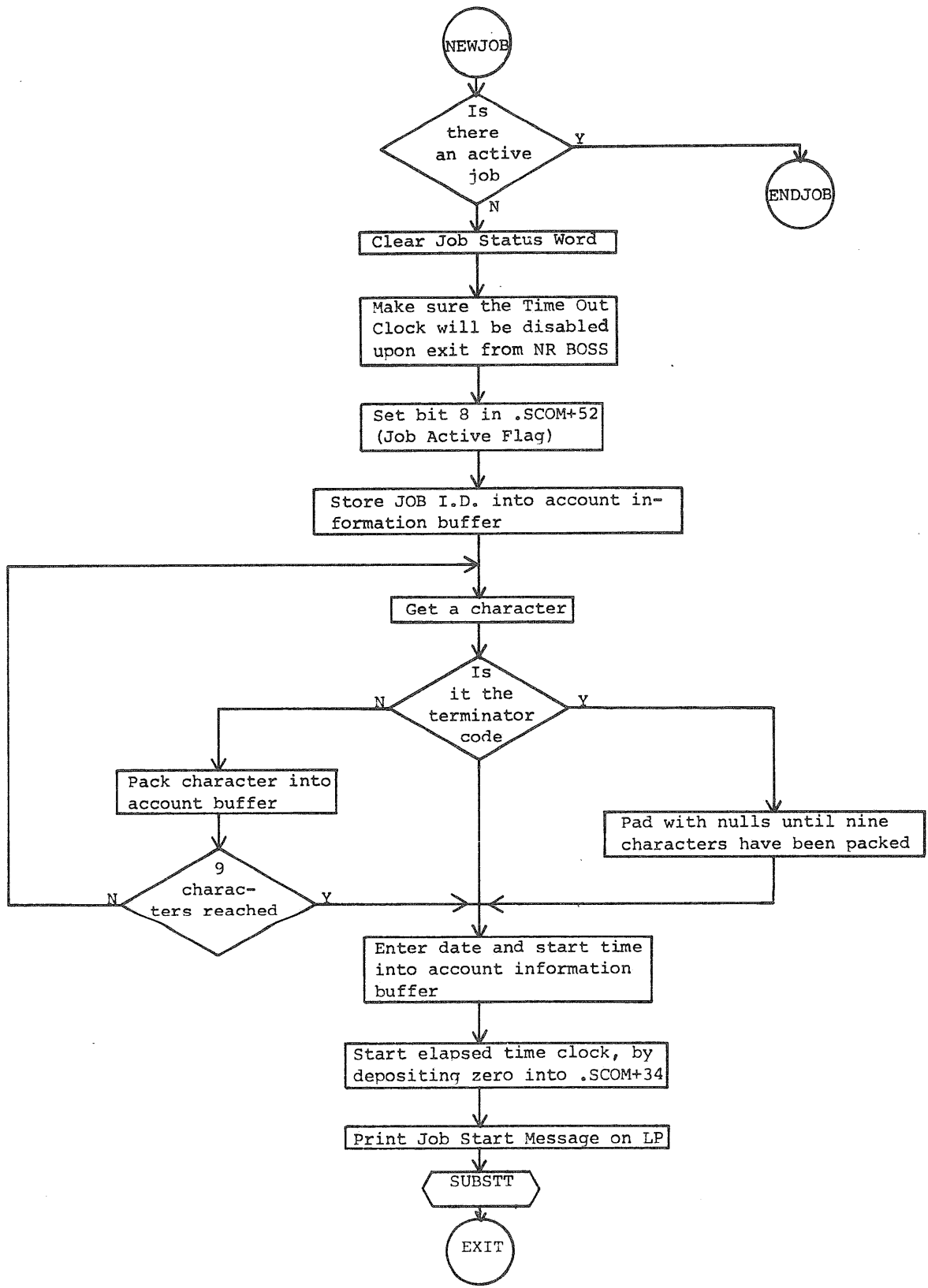


Figure 8-4 (Cont.)
Nonresident BOSS

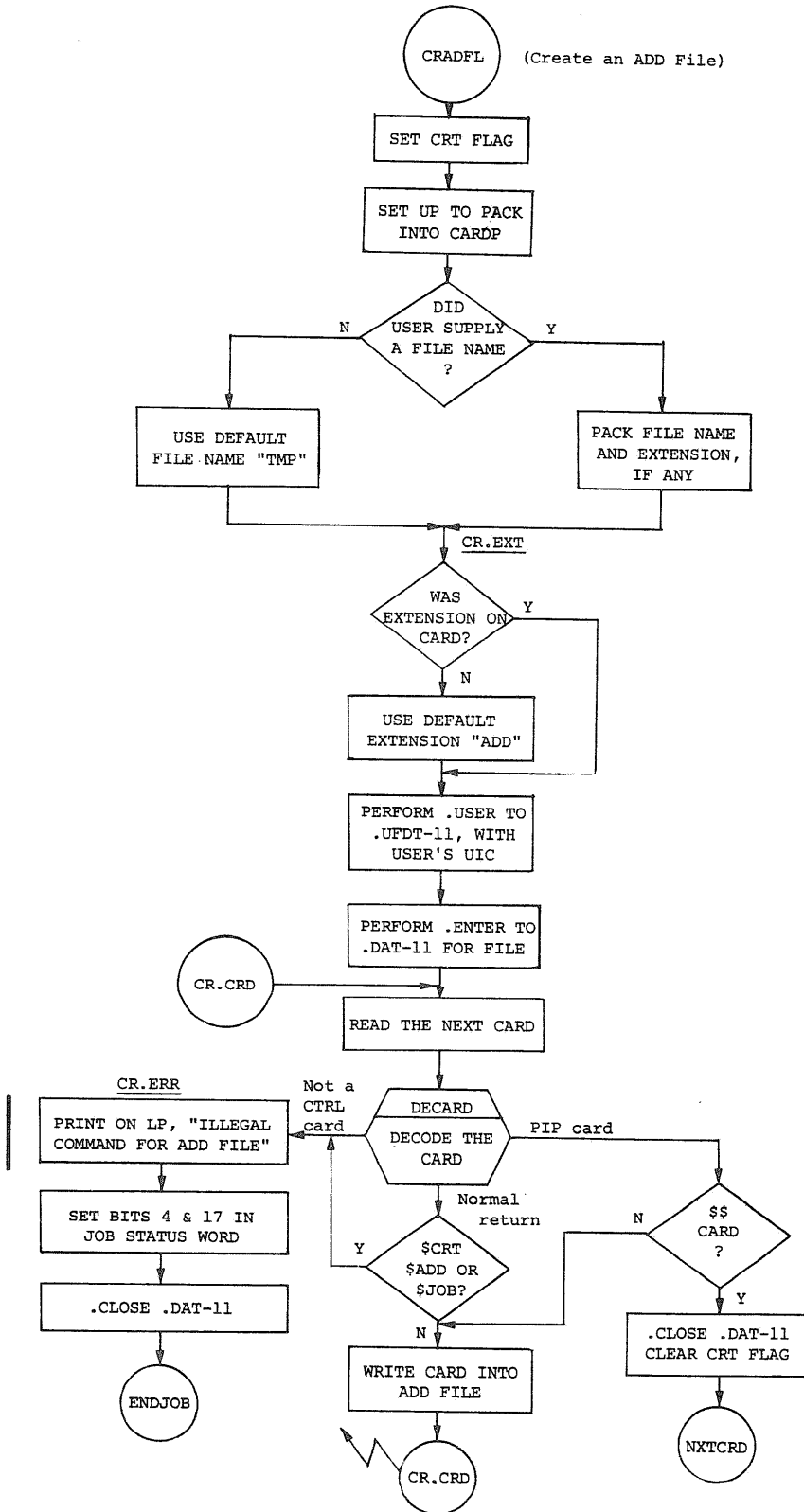
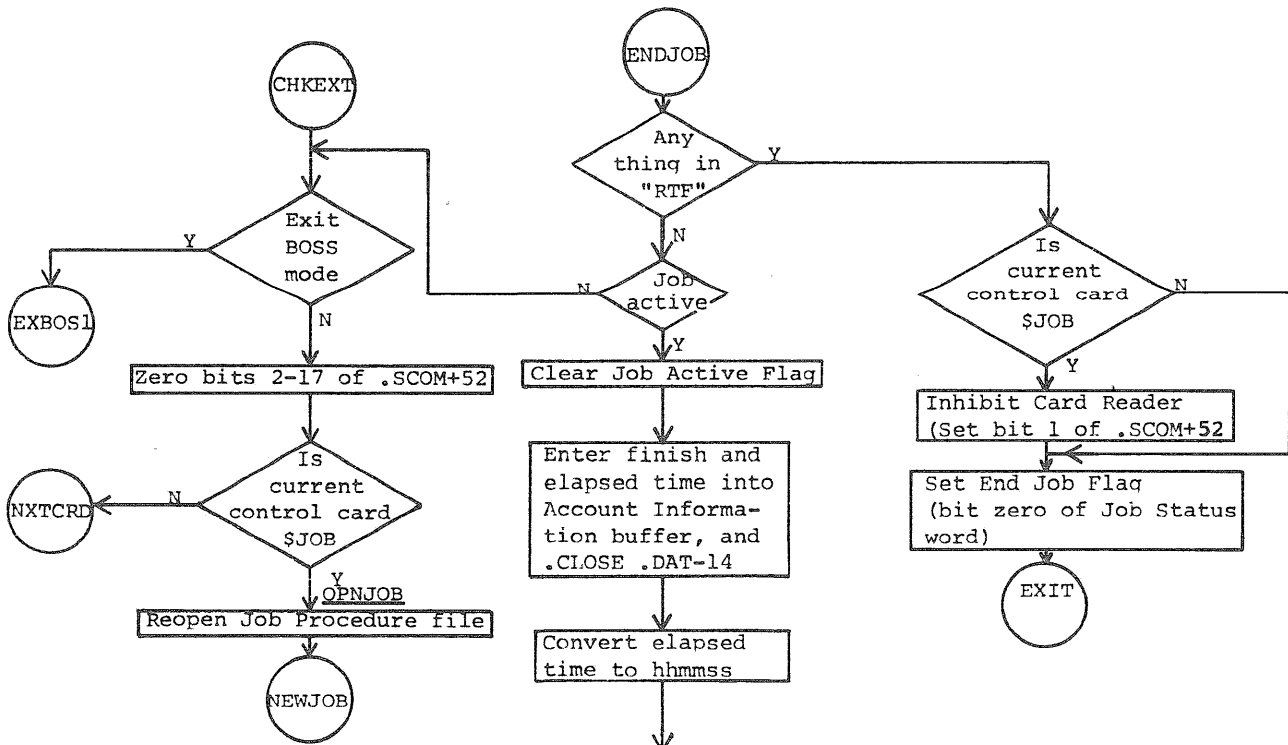
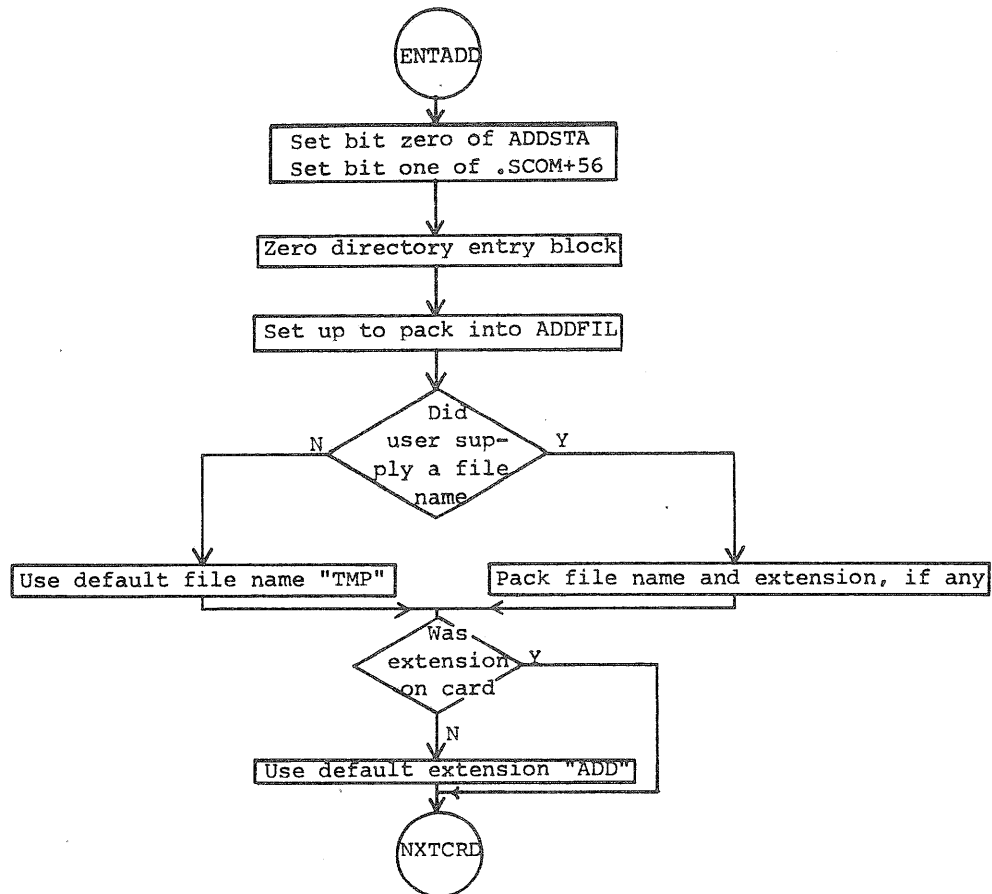


Figure 8-4 (Cont.)
Nonresident BOSS



Next Page
Figure 8-4 (Cont.)
Nonresident BOSS

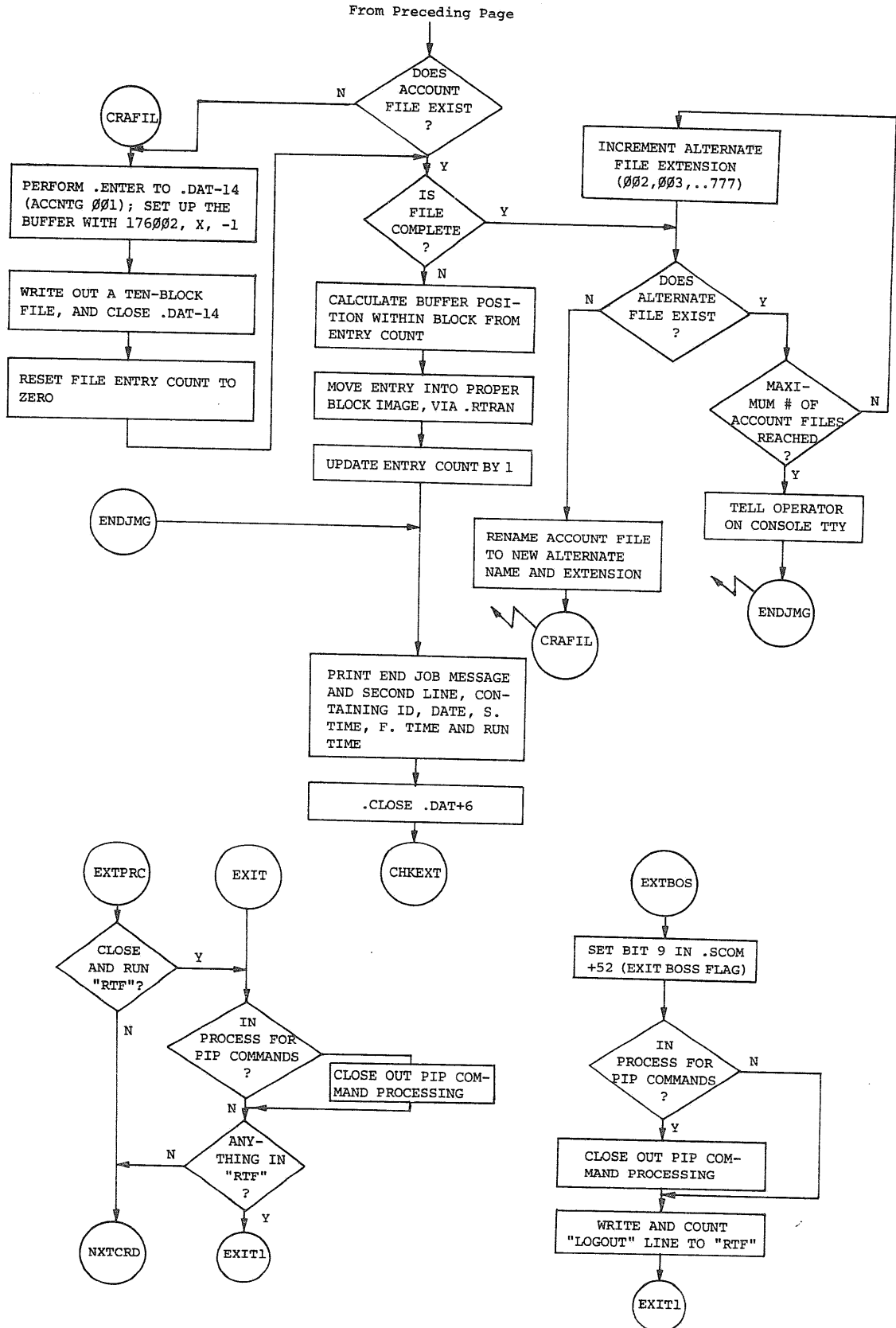


Figure 8-4 (Cont.)
Nonresident BOSS

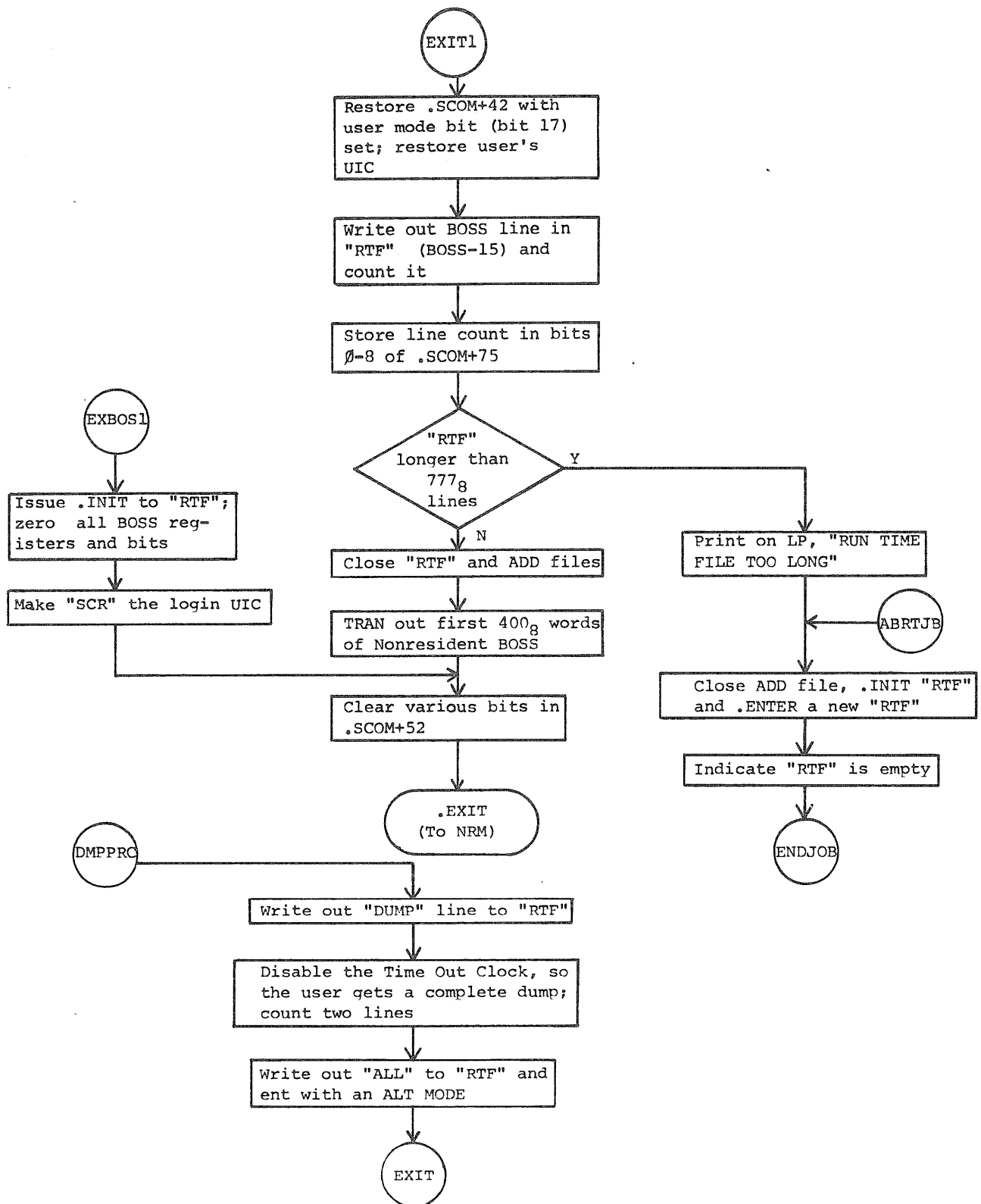


Figure 8-4 (Cont.)
Nonresident BOSS

8.1 PROCEDURE FILES

To each BOSS command there corresponds a disk-resident ASCII file, called a Procedure File. The Procedure File contains DOS commands. When DOS executes the commands in the Procedure File, it carries out the function specified by the BOSS control card. The DOS commands in the Procedure Files contain fields (for instance, a file name) that Nonresident BOSS fills in with text strings from the control card. These fields are called, "Variable Fields". Before executing the DOS commands contained in the Procedure File, all the variable fields have to be resolved. This process is very similar to a macro expansion, where (1) DOS is the assembly language, (2) the BOSS command name is the macro name, (3) the contents of the BOSS control card are the macro arguments, and (4) the Procedure File is the macro definition. The expanded DOS commands are put in a Disk File, called the "Run Time File (RTF)". The RTF can contain the expansion of one or more Procedure Files, up to 777₈ IOPS ASCII records.

BOSS expands Procedure Files strictly on a text string, character basis. It has no knowledge of the intrinsic function of each BOSS control card, except for \$JOB, \$END, \$CRT, and \$ADD (\$END, \$CRT, \$ADD have no Procedure Files) Appendix C contains a listing of all standard Procedure Files.

8.1.1 Procedure File Format

In order to ensure successful expansion, all Procedure Files must follow a strict format. The first record of the Procedure File must be a control record, with parameter information. The first record may also contain comments, because BOSS interprets only pertinent information, and ignores the rest. The numbers 0, 1, 2, 3, and 4 specify different options. All other characters are ignored. The option digits can appear in any order, and anywhere on the record. The option specified by each number is given below:

0 - Expanded Substitution (default, if "3" not given explicitly)

This option specifies that the Procedure File is to be expanded according to the normal rules of substitution, which are given below.

- 1 - Open Ended File (default, if "2" not given explicitly)

This option instructs the Nonresident BOSS Monitor to leave the RTF open after expanding the current Procedure File. BOSS then searches for the next control card.

- 2 - Closed End File

This option instructs Non-resident BOSS to close the RTF after expanding the current Procedure File, and to execute the DOS commands in the RTF. Procedure Files corresponding to commands that may possibly be followed by "Data Cards" should be of Type 2.

- 3 - Direct Substitution

This option indicates the BOSS should not expand the Procedure File according to normal rules. Refer to paragraph 8.1.2 for information on Direct Substitution.

- 4 - Test Mode

This option indicates that BOSS should echo the Procedure File expansion on the Line Printer. This allows a check on the Procedure File.

The following combinations are illegal:

- Ø and 3
- 1 and 2

If BOSS finds an illegal option combination, it will print,

ILLEGAL PROC FILE

and search for the next control card.

BOSS uses all other records in the Procedure File as macro definition records. Records after the first one are all Macro Definition Records. For each such record, a record will be written in the RTF. Each Macro Definition Record has the same format. Two types of fields are used: K-fields and V-fields. K-fields specify constant character strings that will be written into the RTF exactly as they appear in the Procedure File. V-fields specify variable character strings to be substituted from specified strings on the Control Cards. Each Macro Definition Line of a Procedure File can contain any number of K- and V-fields, in any combination. V-fields are delimited by @-signs. K-fields are delimited by adjacent V-fields, or the end or beginning

of the record. Since there are only two types of fields, only one need have delimiters. Two adjacent V-fields, however, require two adjacent @-signs.

K-fields

K-fields may be any string of legal IOPS ASCII characters, except the @-sign.

V-fields

A V-field has the following format*:

$$v = \left\{ \begin{array}{l} A\emptyset n \\ U\emptyset n \\ Dnn \\ O \end{array} \right\} ([\{V\text{-field}\}][\{K\text{-field}\}]) @$$

The two @-signs delimit the field. The first part of the field (A, D, U or O) is a card-position identifier, and must be present. It identifies the position on the current Control Card of the character string to be substituted in the RTF. The legal combinations are:

```
A00,A01,...A09
U00,U01,...U09
D00,D01,...D09,D10,...D17
O
```

With the exception of D10 through D17, each of the above position identifiers corresponds to a unique character string of the Control Card, according to the following scheme:

```
$CMD;O A00:D00(U00);A01:D01(U01);...;A09:D09(U09)
```

The D10...D17 position identifiers do not correspond to character strings found on the Control Card, but rather to character strings defined by BOSS. Thus,

```
D10 - Unused
D11 - .SIXBT representation of the System Device Code
      ('DK' or 'DP' or 'RK')
D12 - Current Logged in UIC
D13 - .SIXBT representation of Carriage RETURN
D14 - .SIXBT representation of ALT MODE
D15 - Unused
D16 - Unused
D17 - Unused
```

* Standards for this format description are identical to those specified in Chapter 5 of the DOS-15 User's Manual, DEC-15-ODUMA-B-D.

The parentheses in a V-field must be present. They are used to specify a default string. The default string is used in case the string on the Control Card specified by the position identifier is null. A set of parentheses must be included, even if the default string is null. The default string itself can be a variable, resulting in nested variables. Nesting has a theoretical limit of 2^{17} variable fields.

8.1.2 Direct Substitution

When processing a Direct Substitution Procedure File, BOSS places the fields on the Control Card into the RTF just as they stand with only leading spaces ignored. That is, BOSS does not necessarily expect to find file names, and so on, as with normal substitution. Fields on the Control Cards are separated by semi-colons (;), and are processed in a serial manner. The ampersand (&) is used for a special purpose. It causes the current record being composed for the RTF to be terminated with a Carriage RETURN, and written out, and a new record started. This is so that the limit of seventy-five characters per line will not be exceeded.

There are only two legal field types within the Procedure File. They are as follows:

1. A00 through A99
2. D10 through D17 (System Defined)

In making up Direct Substitution Procedure Files, the following rules must be followed:

1. The first line must contain a three (3). This declares the file to be direct substitution.
2. The "A" fields must appear in sequential order, starting at A00. Each "A" field can be used only once within the Procedure File.
3. The "D" fields can only be "D10" through "D17". They can be used any number of times, in any order.
4. Variable expressions must follow the standard V-field format, as in expanded substitution.

8.1.3 Example of Procedure File

The following example shows a typical Direct Substitution Procedure File, the Control Cards used to call it, and the resulting lines produced in the Run Time File.

Procedure File¹- Map PRC

```
3 PROCEDURE FILE TO RUN CHAIN WITH NO OVERLAYS
CHAIN
@AØØ(TMPXCT)@@D14()@
@AØ1(SZ)@@D14()@
@AØ2(FILTMP)@@D14()@
@D14()@
```

Control Cards as They Appear

```
$MAP TEST1;SZ,VTC/ABC,DEF,NAM1,&NAM2,;
$*Ø1 NAM3,NAM4,NAM5/;TEST1,SUB1,SUB2,&;
$*Ø2 SUB3,SUB4,SUB5
```

Run Time File Lines

```
CHAIN )
TEST1 (ALT MODE)
SZ,VTC/ABC,DEF,NAM1,)
NAM2,NAM3,NAM4,NAM5/ (ALT MODE)
TEST1, SUB1, SUB2,)
SUB3,SUB4,SUB5 (ALT MODE)
(ALT MODE)
```

Note: D14=Altmode, <ALTMODE> is an Altmode, and <CR> is a Carriage Return.

8.2 BOSS-15 ACCOUNTING

BOSS has a very simple accounting mechanism. It keeps an account record for each job in a random access file in the CTP UFD. Hence, the file is protected, and can only be accessed after successful execution of a \$MIC command.

The name of the accounting file is ACCNTG nnn. (The first has an extension of ØØ1.) Each file is ten physical blocks long, and contains enough information for 31Ø jobs, thirty-one per physical block. When BOSS fills up one file, it increments the extension, and starts a new one. Every time a job ends, BOSS checks whether ACCNTG ØØ1 exists. If it does not, BOSS creates one. If it does, BOSS checks whether it is full. If not full, BOSS makes a new entry; if full, BOSS

¹Direct Substitution File

searches for the first unused extension number. If all extension numbers have been used (up to 999) BOSS prints this message to the operator on the teleprinter:

MAX NUMBER OF ACCOUNTING FILES REACHED
PLEASE PROCESS AND DELETE THEM

Every time the system manager processes an accounting file, he should delete the file.B010

For each completed job, BOSS writes out an eight-word record to the accounting file. The records have the following format:

Word #	Content
1 } 2 } 3 }	{ Job I.D., in .SIXBT
4	Date, packed mmdyy
5	Start Time, in hhmss
6	End Time, in hhmss
7	Run Time, in hhmss
8	Terminal Job Status Word

A word whose contents equal 777777₈ immediately follows the last job accounting record in each physical block of the accounting file.

8.3 B.PRE

Figure 8-5 is a flowchart of B.PRE, the BOSS Line Editor.

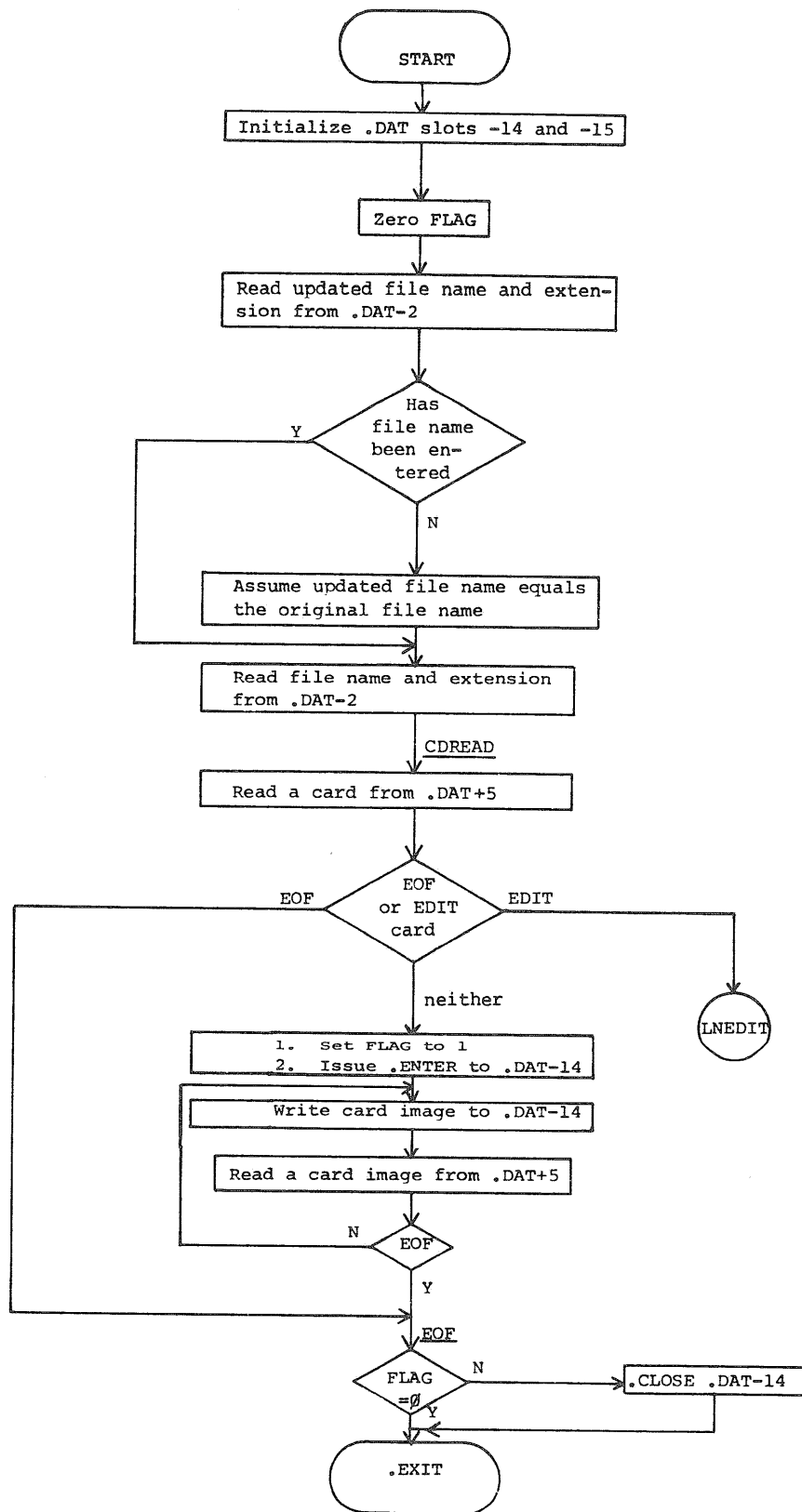


Figure 8-5

B.PRE

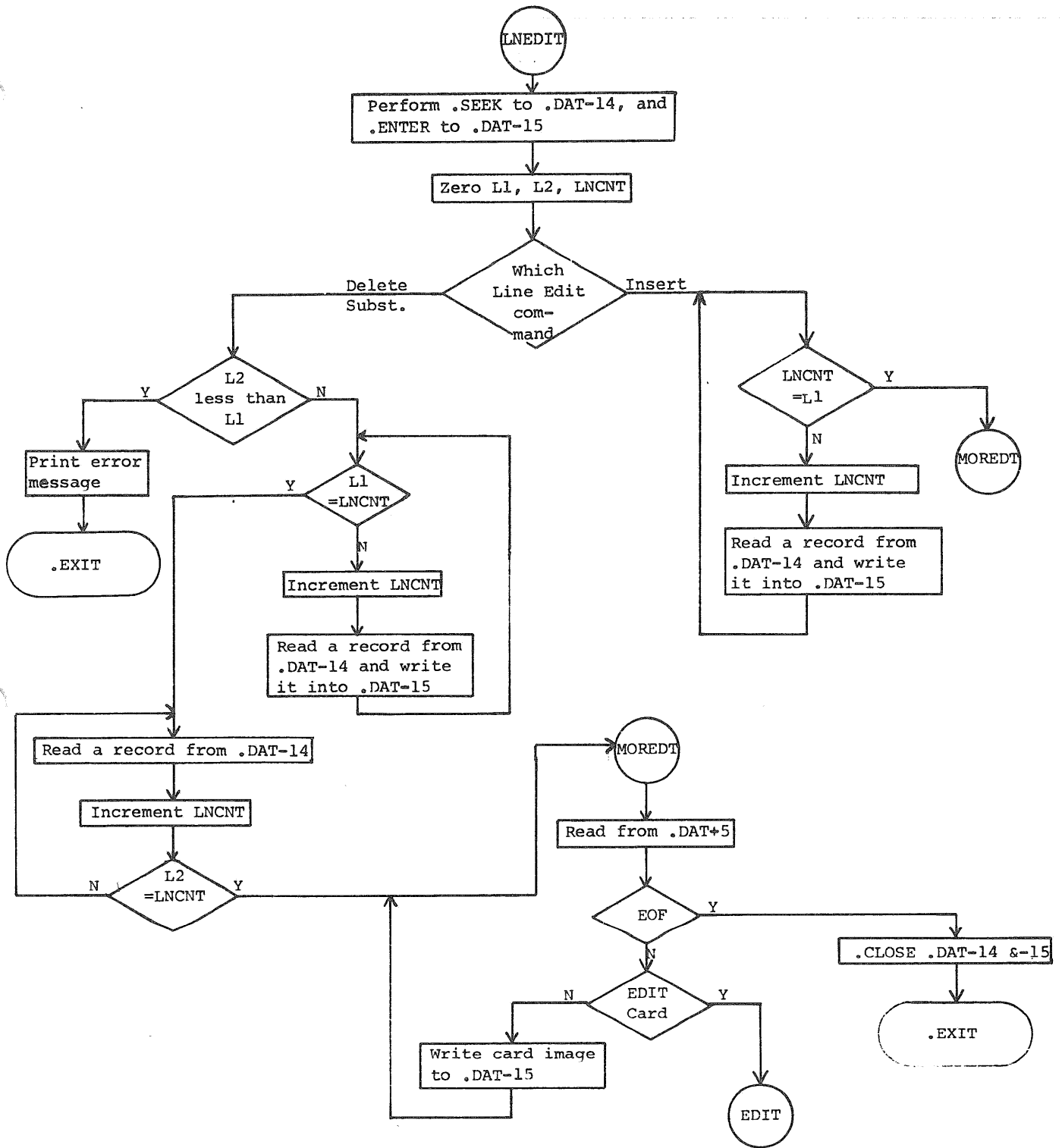
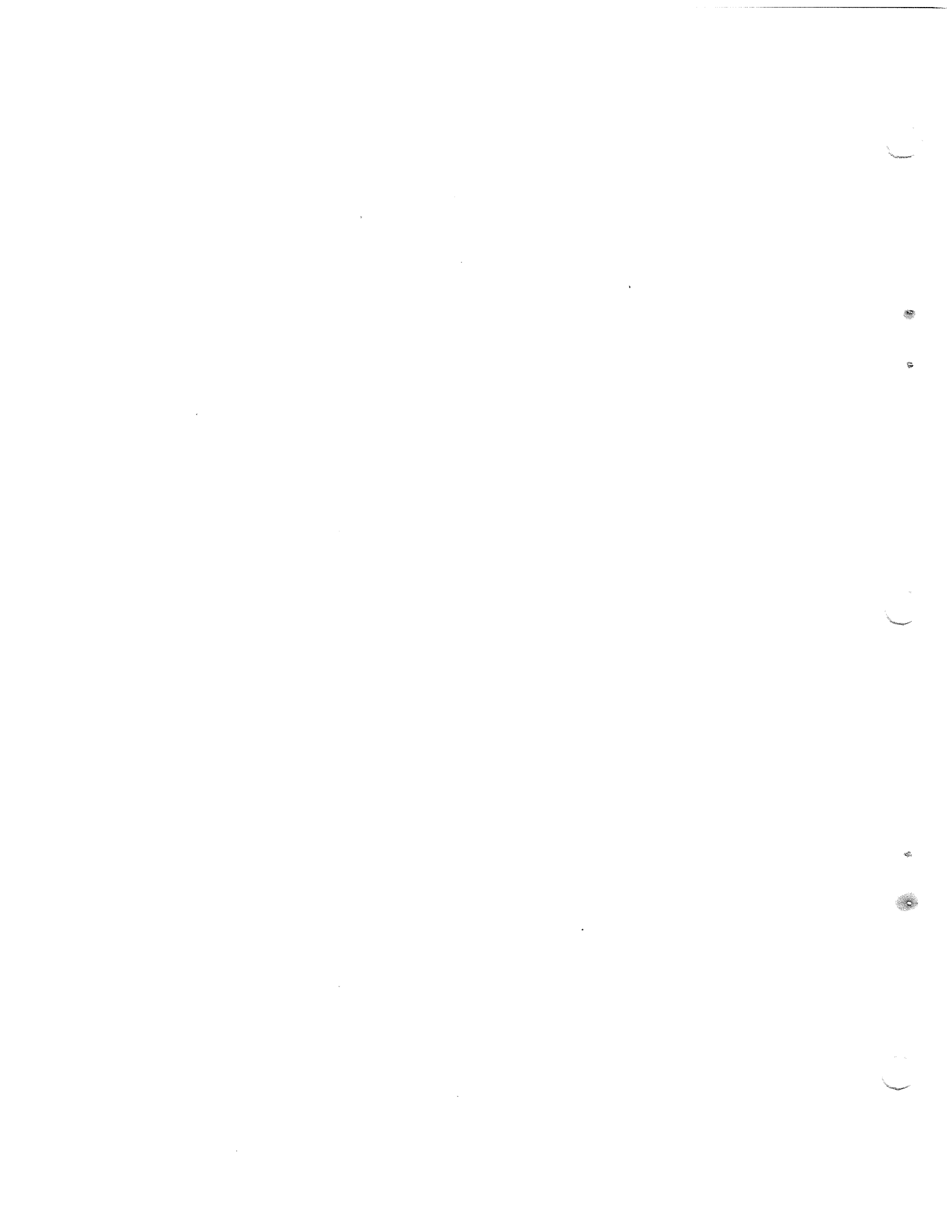


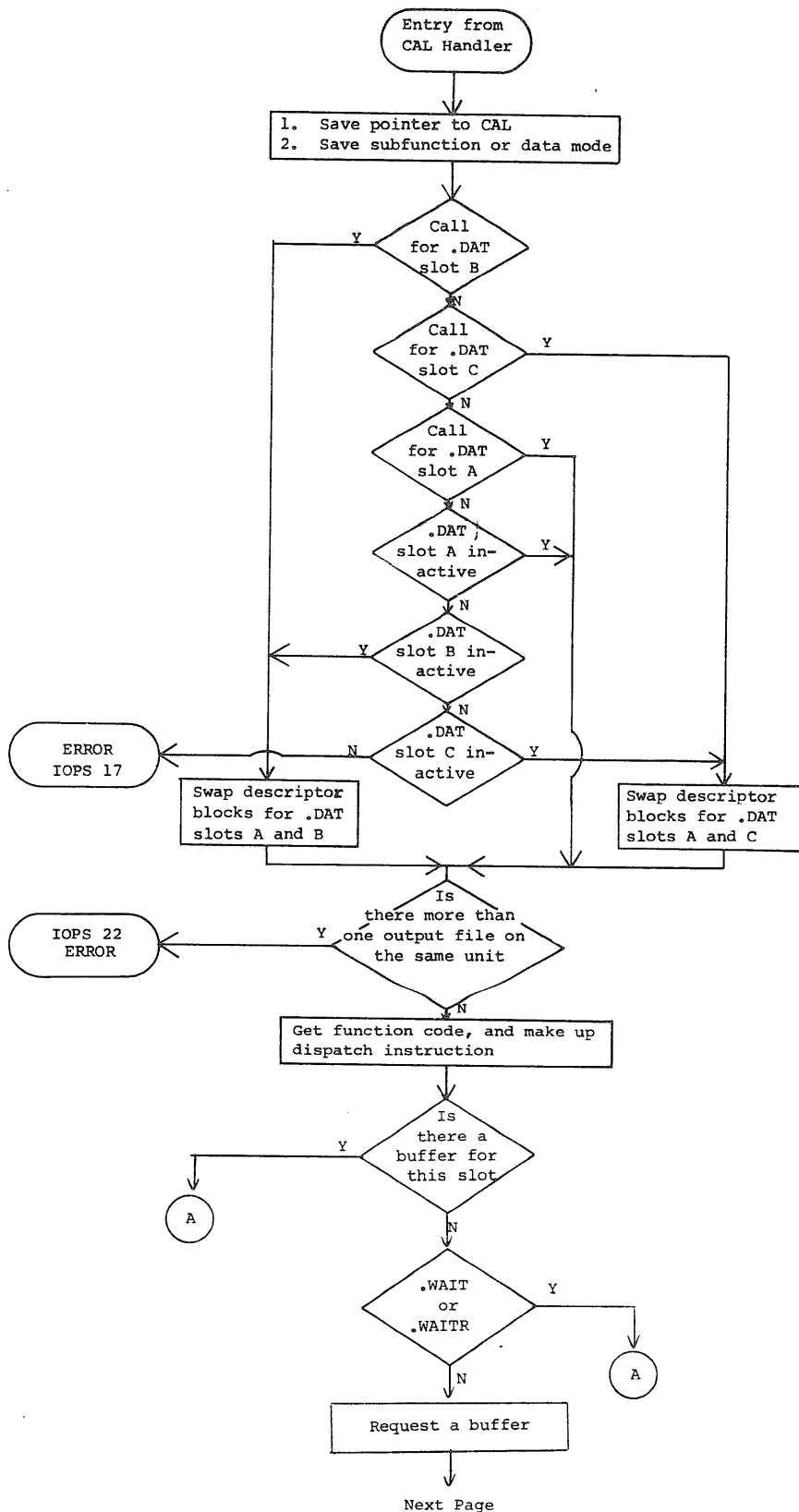
Figure 8-5 (Cont.)
B.PRE

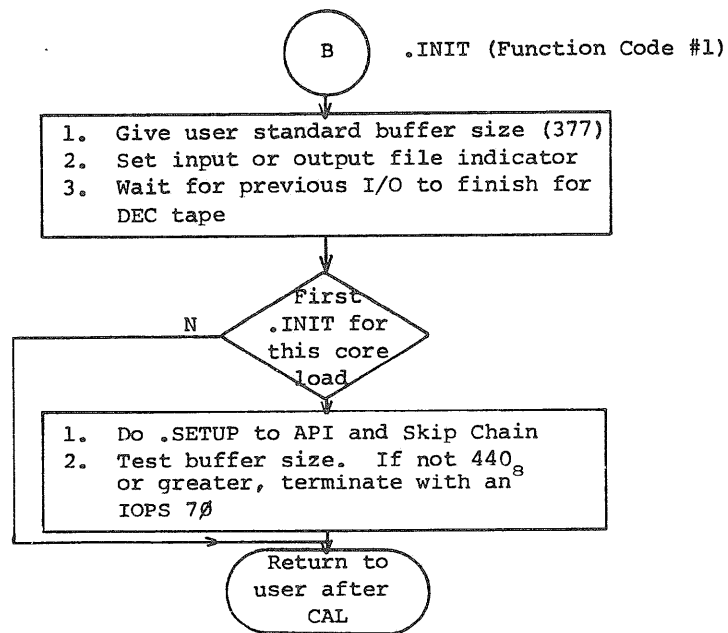
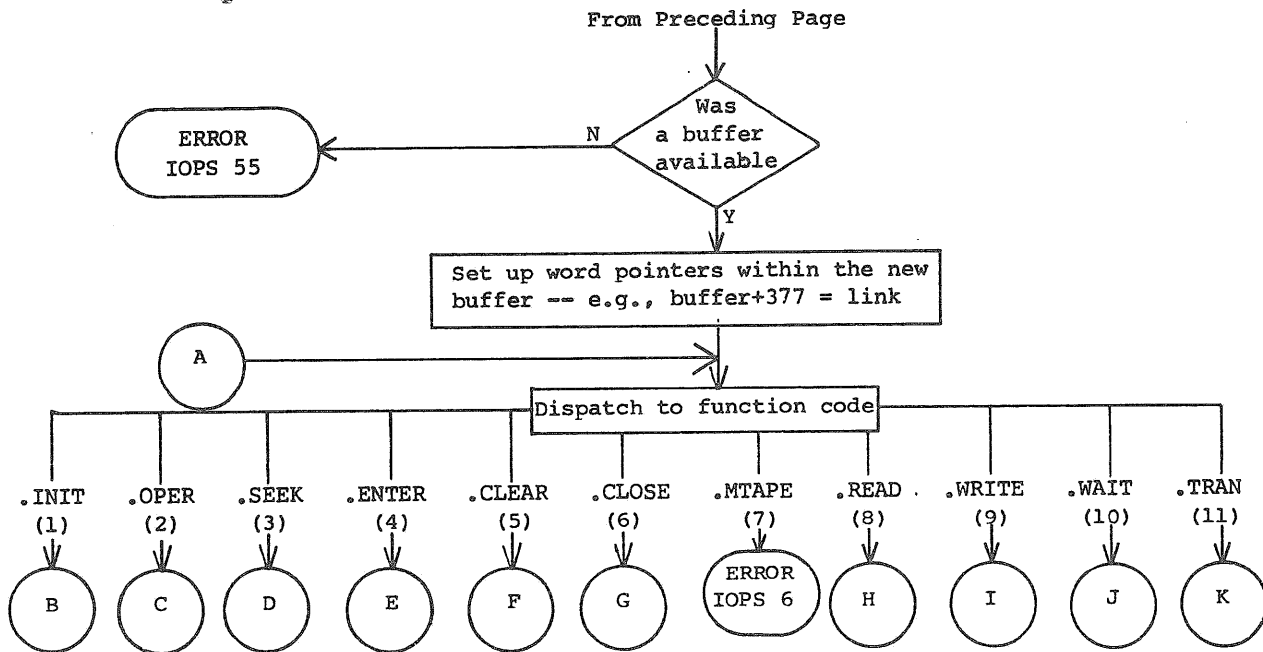


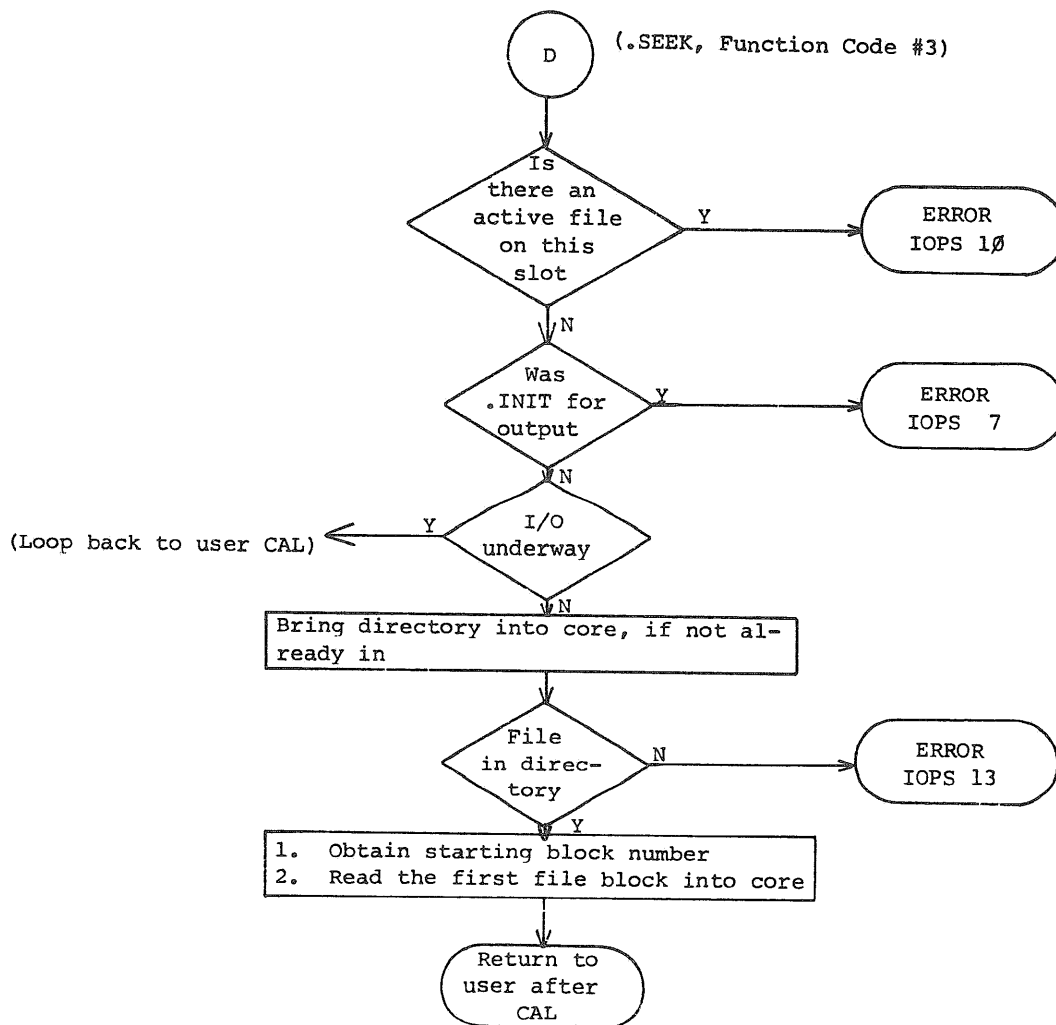
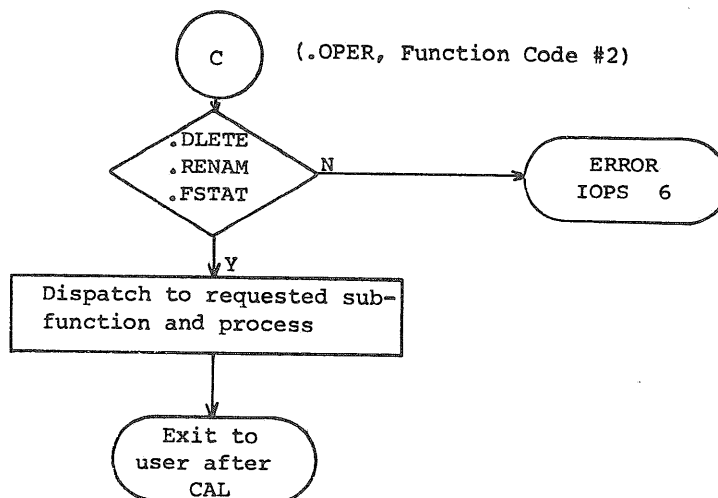
APPENDIX A

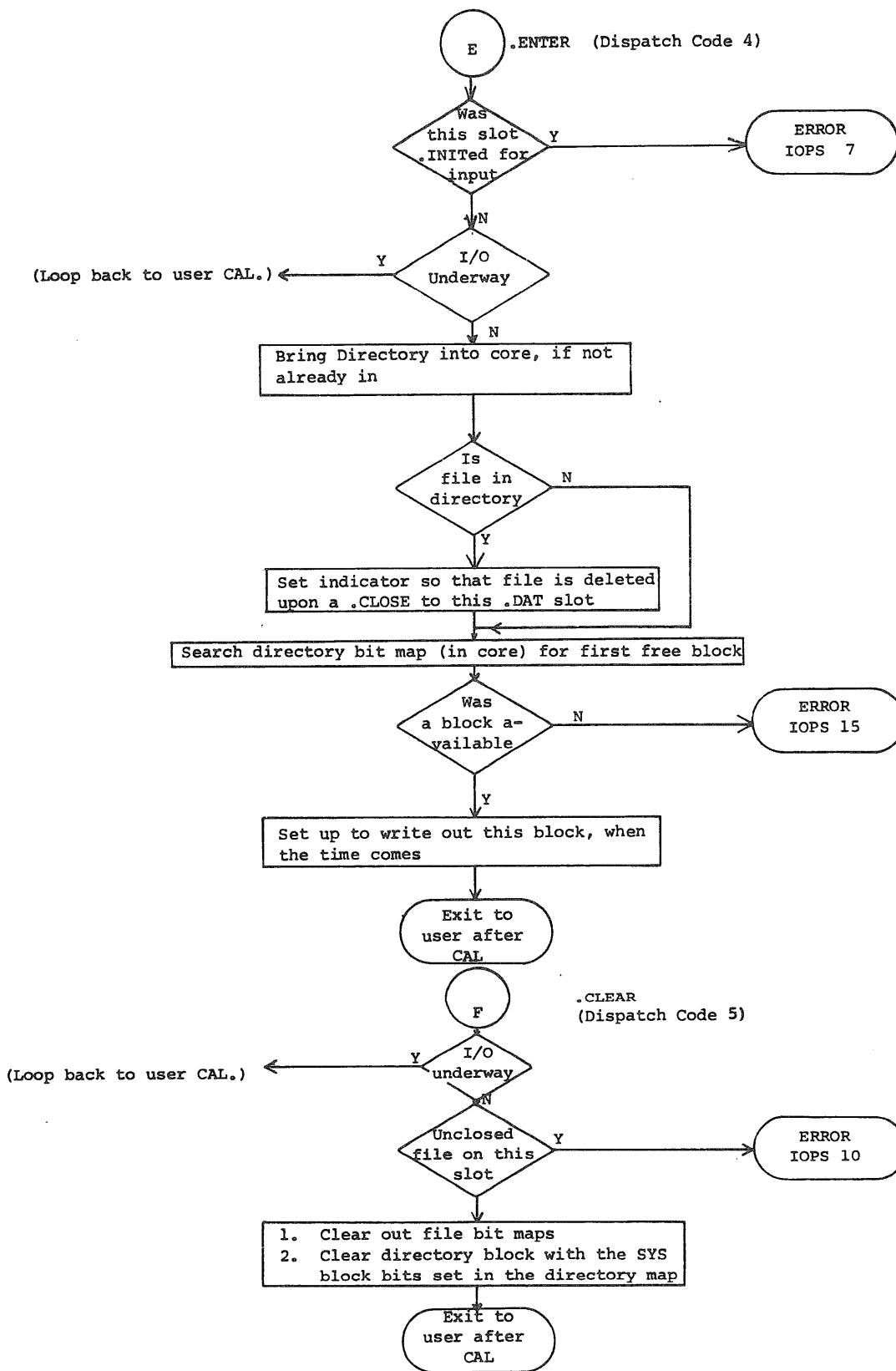
DECTAPE "A" HANDLER (DTA.)

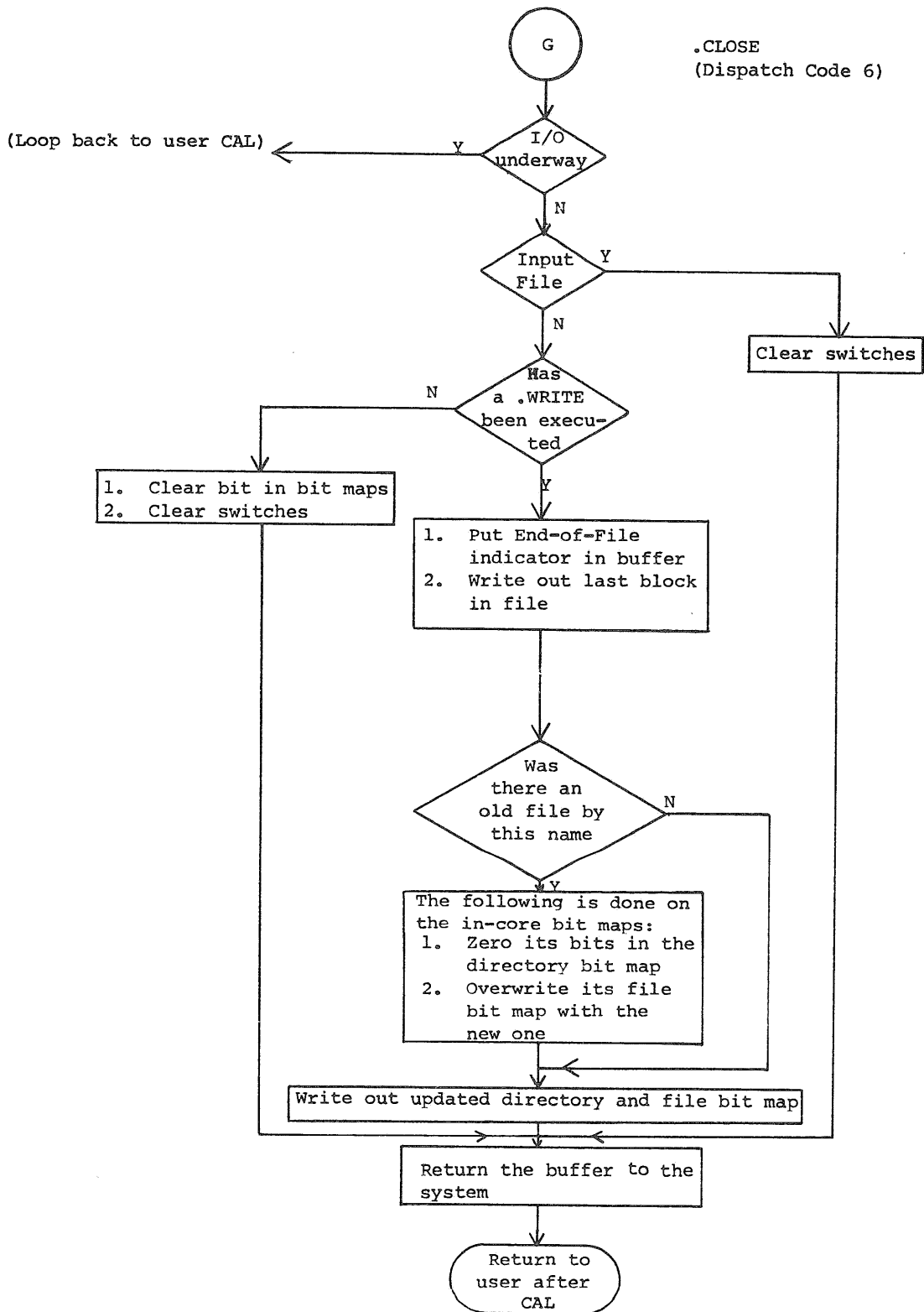
The following flow charts describe the operations of the DECTape "A" Handler.

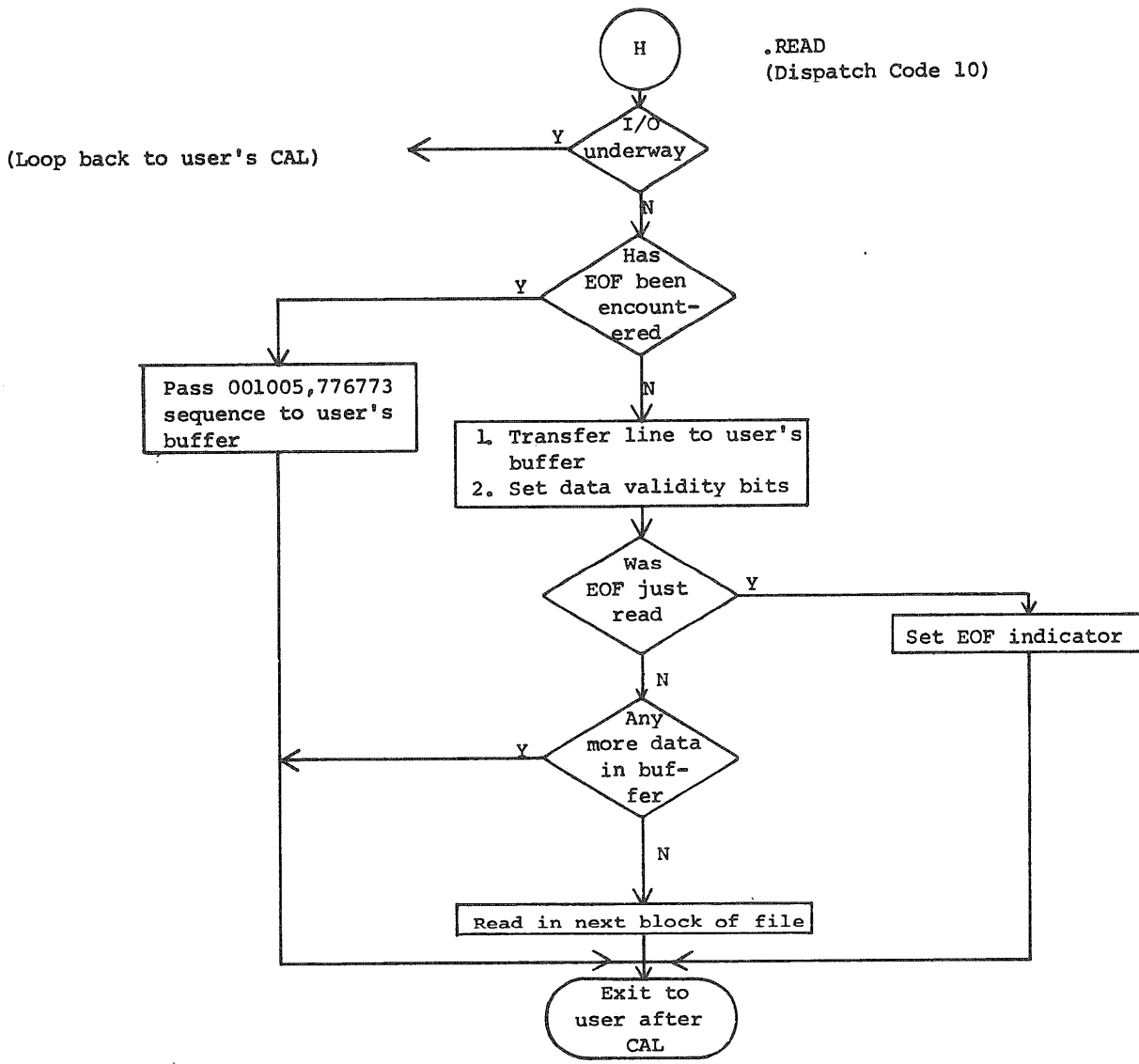


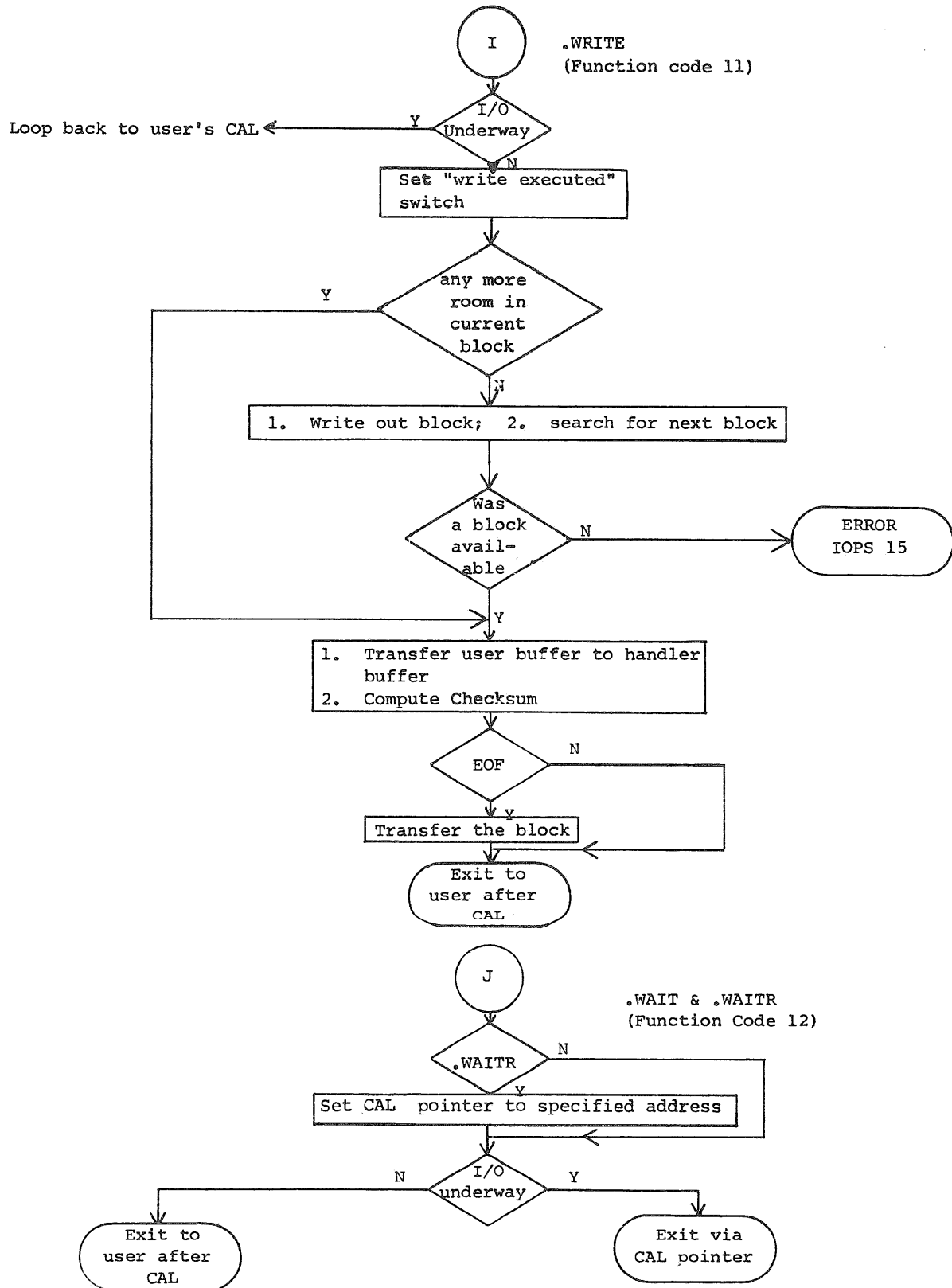


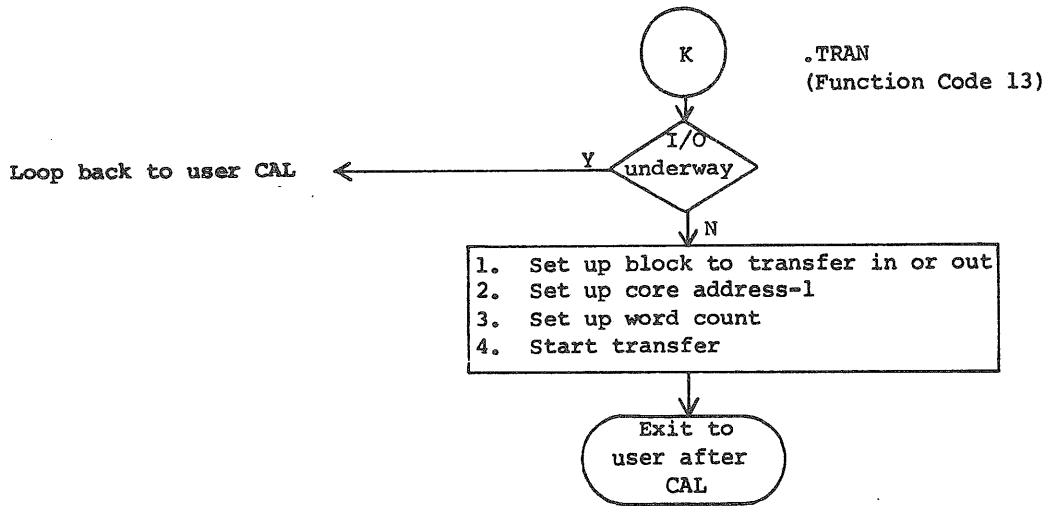




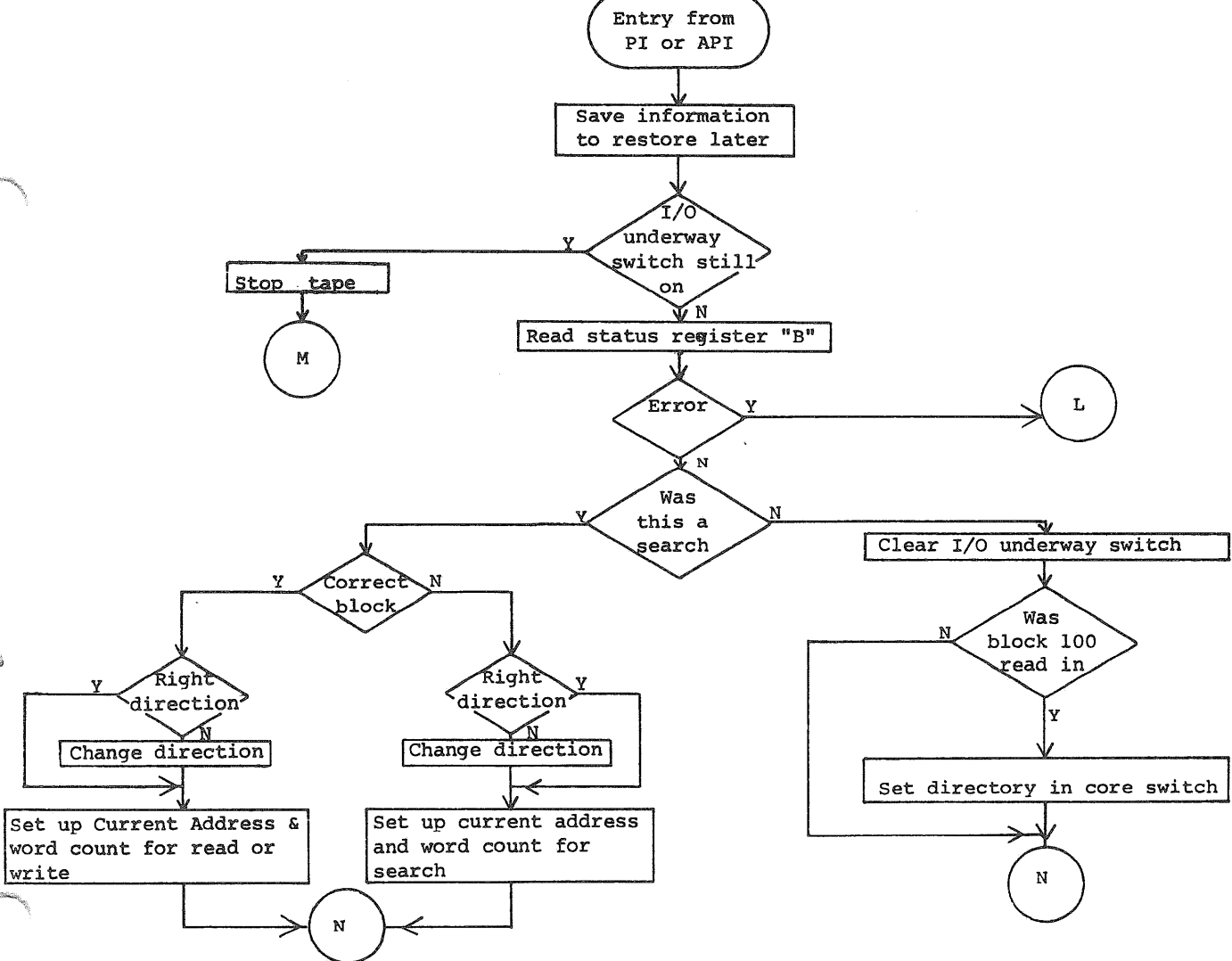


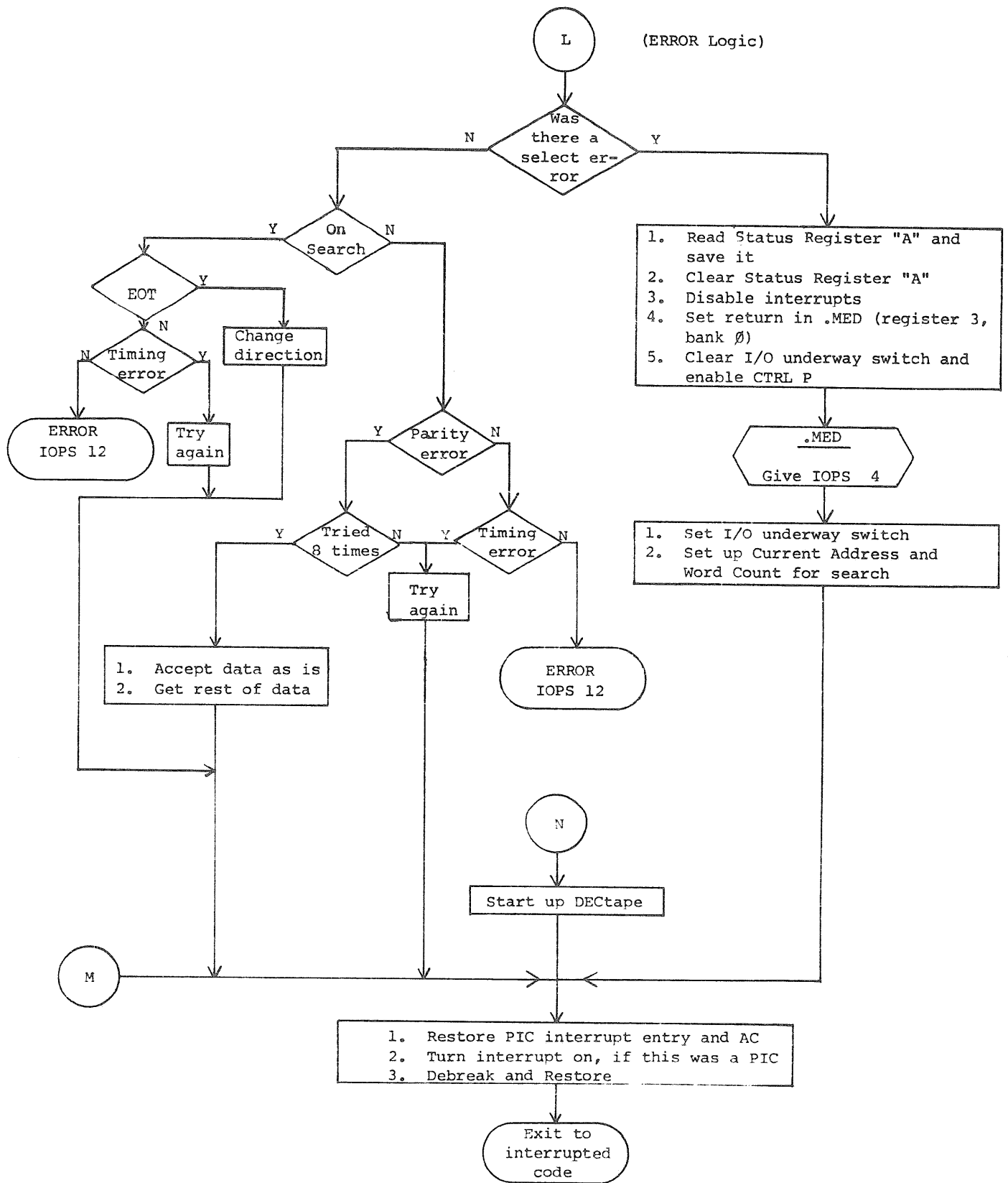






INTERRUPT SECTION

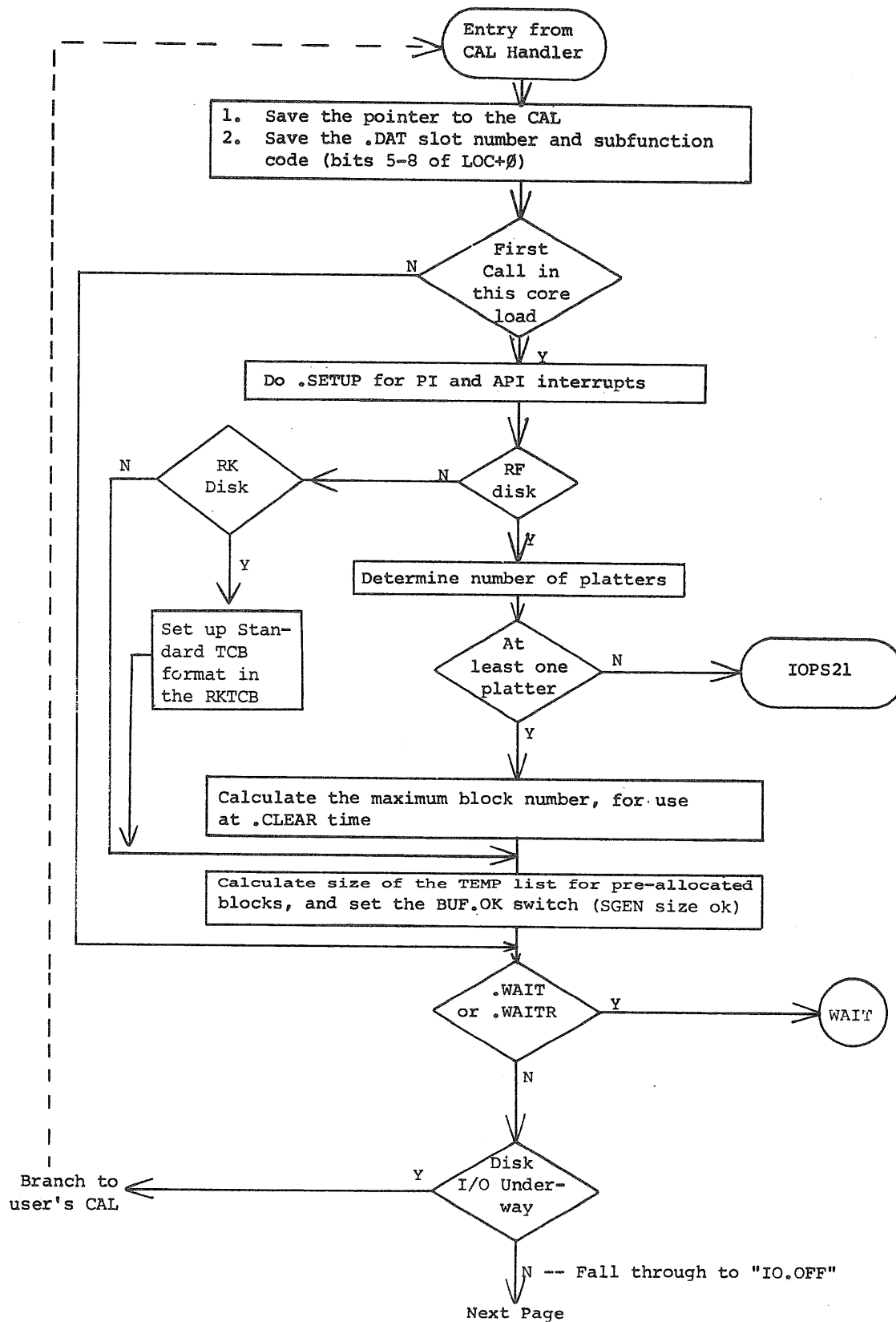




APPENDIX B

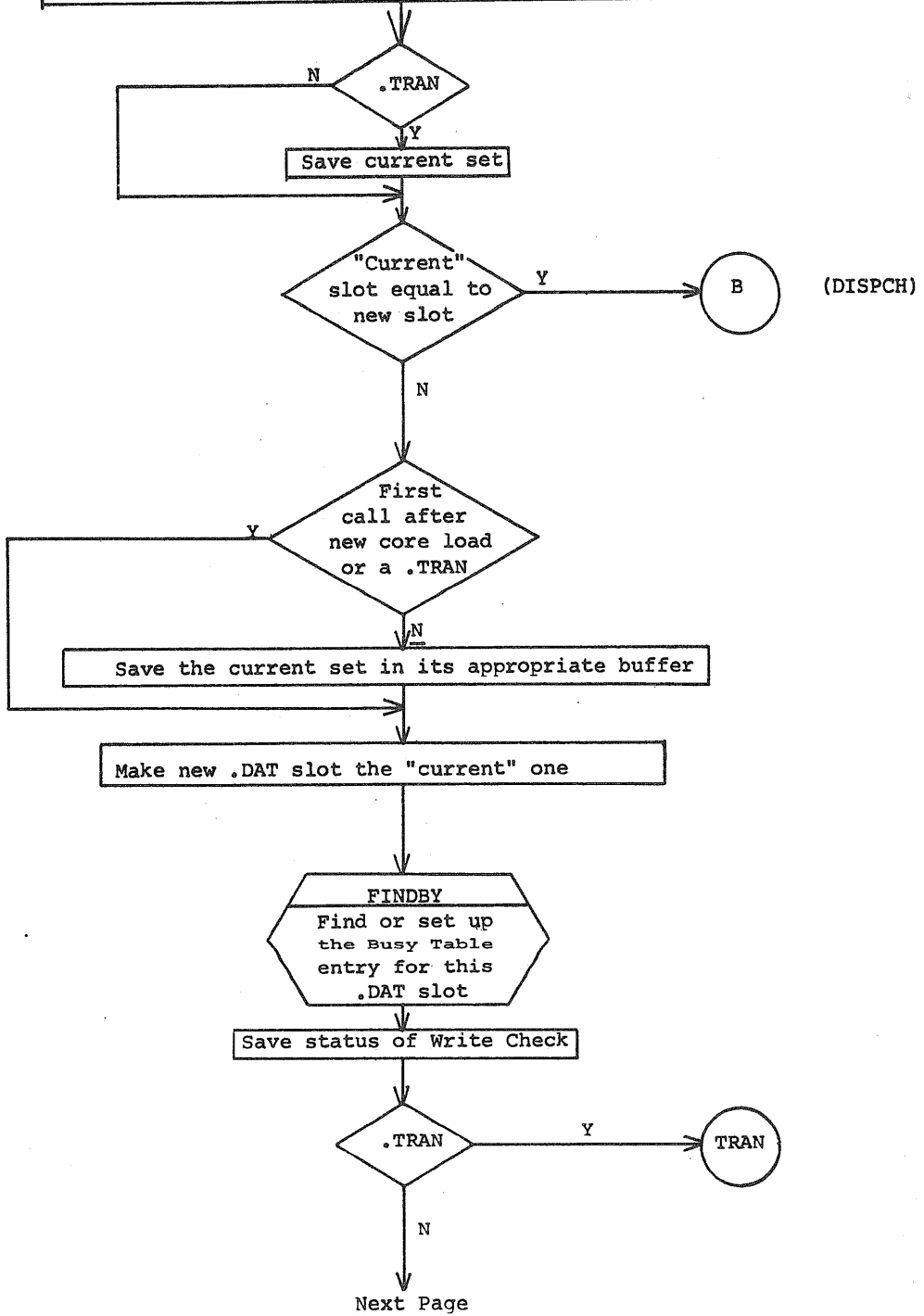
DISK "A" HANDLERS

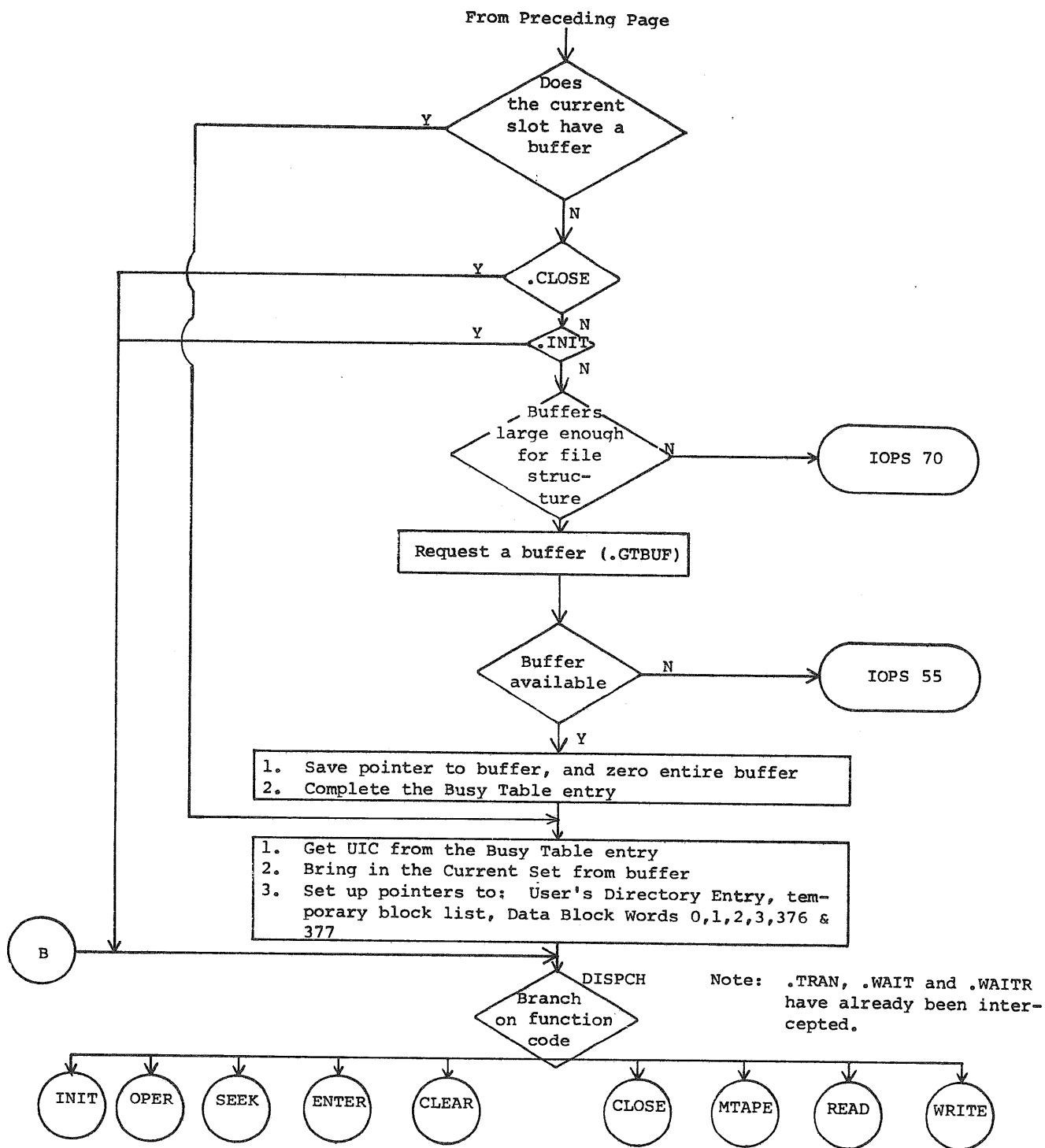
The following flow charts describe the operation of the Disk "A" Handlers.

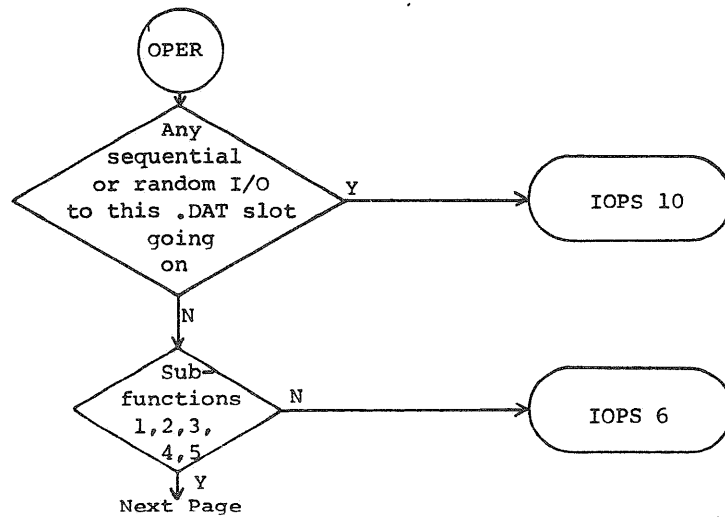
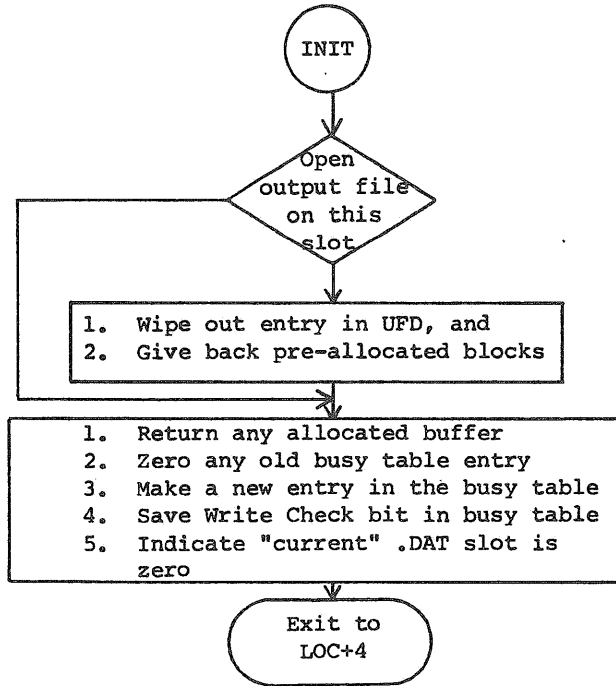


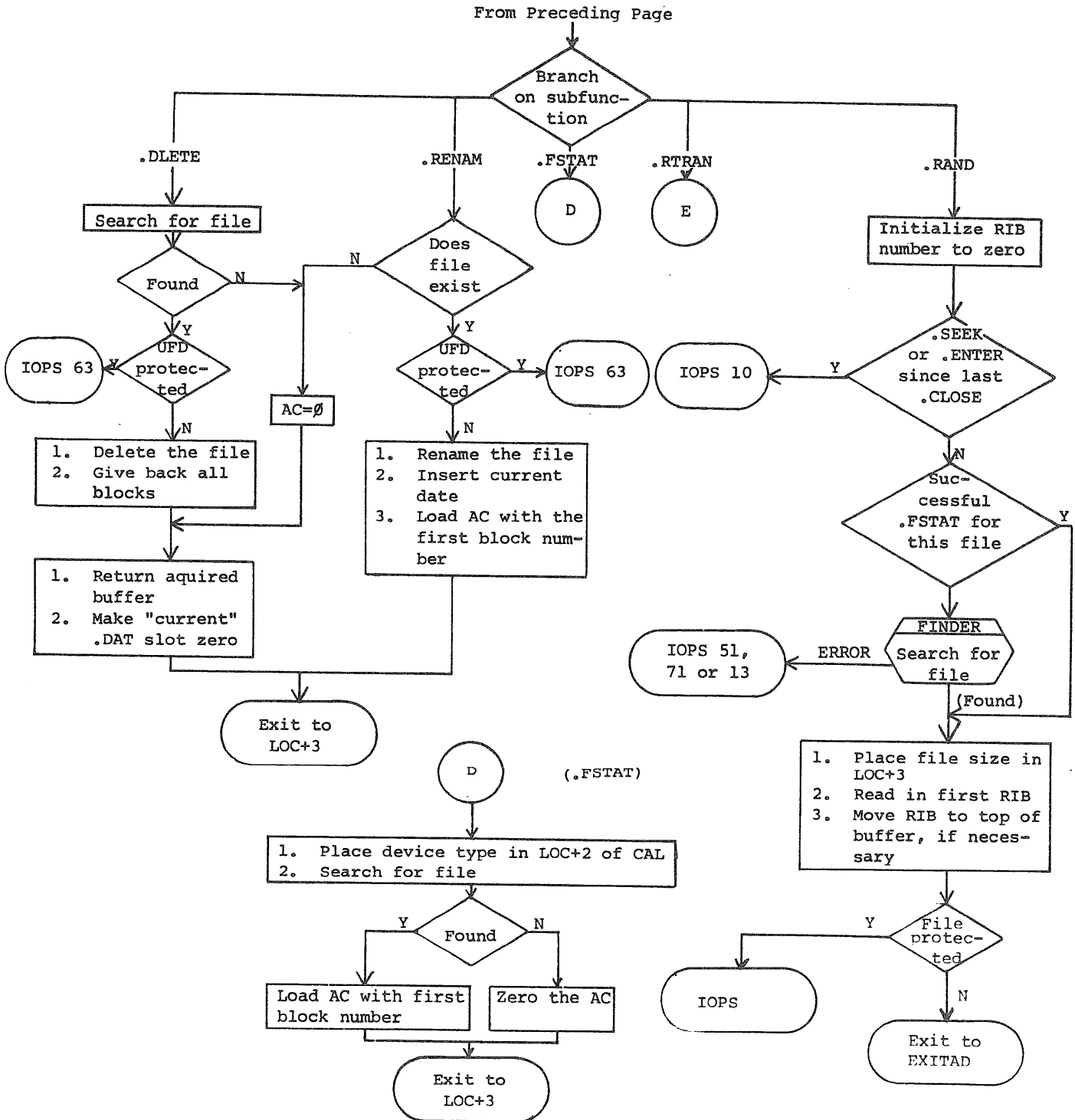
From Preceding Page

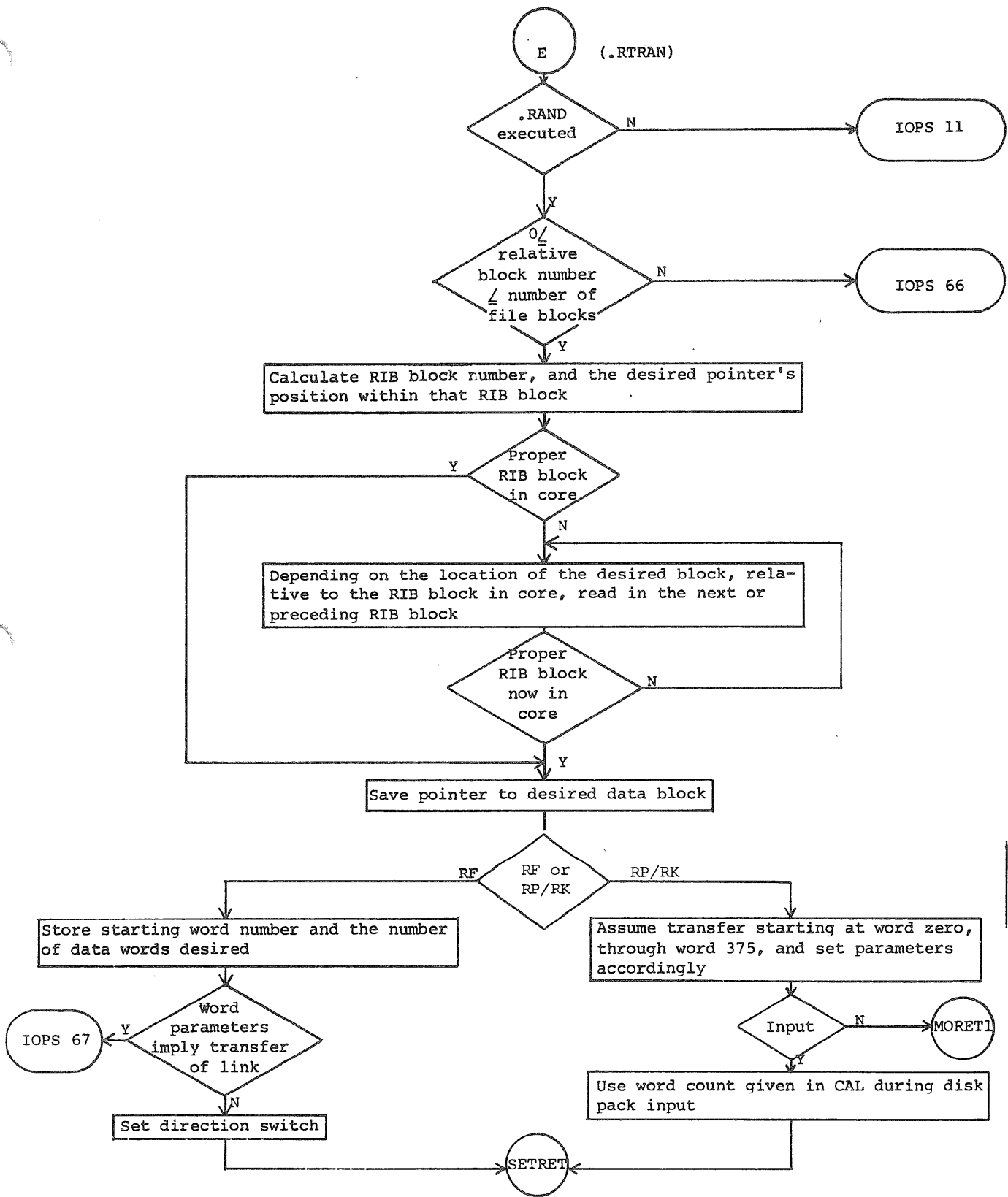
1. Calculate pointers to the arguments of the CAL
2. Save step counter and MQ for EAE

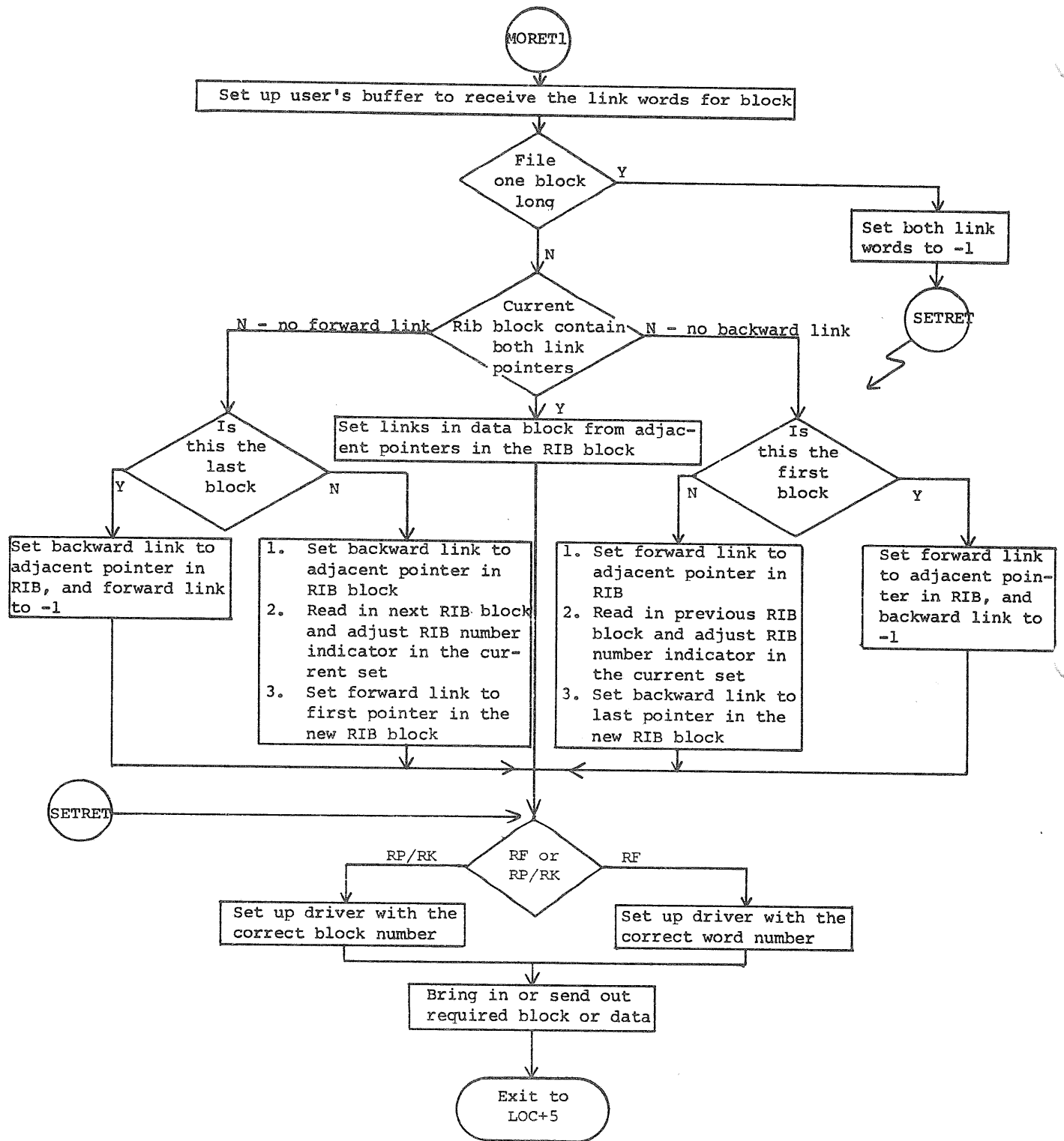


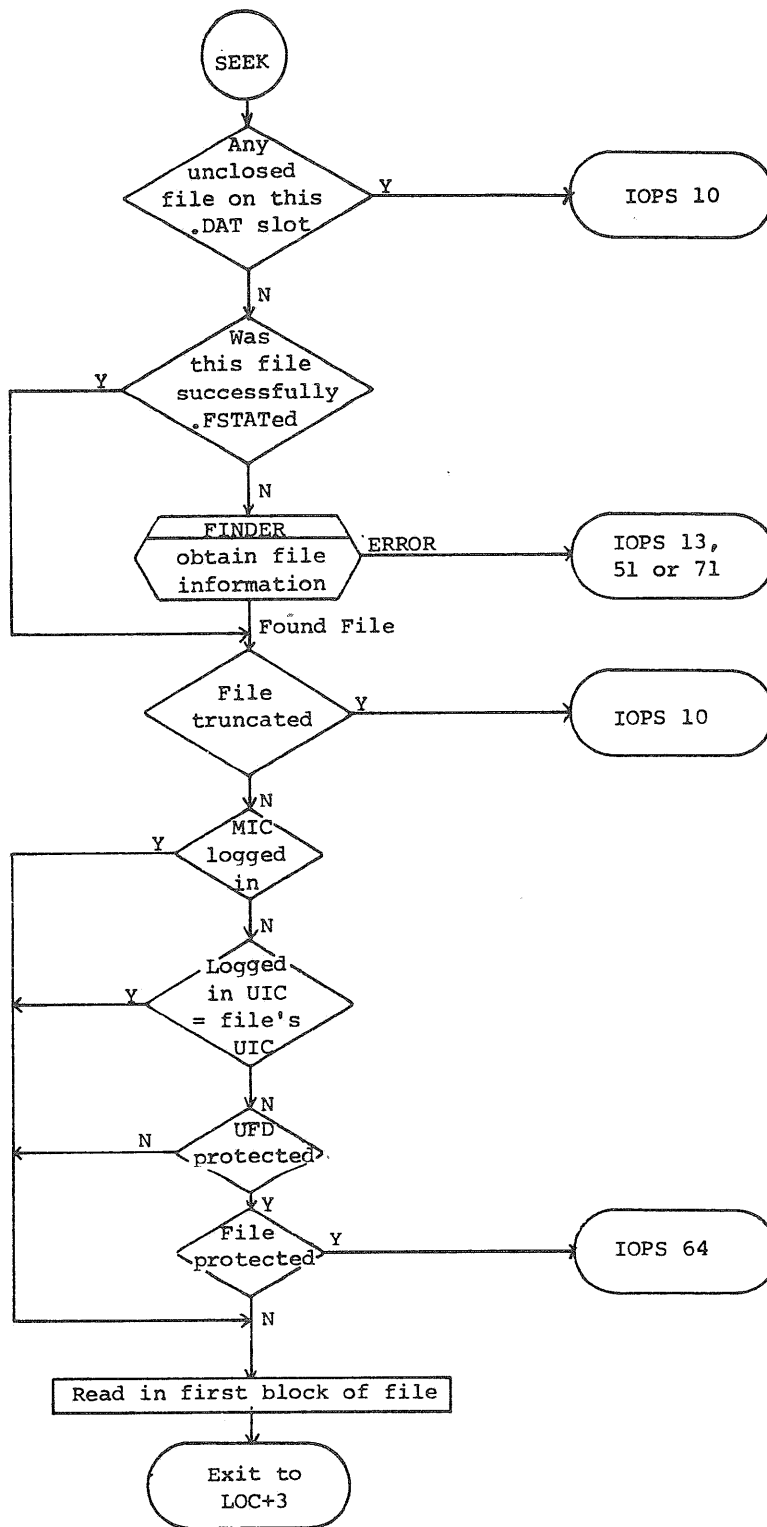


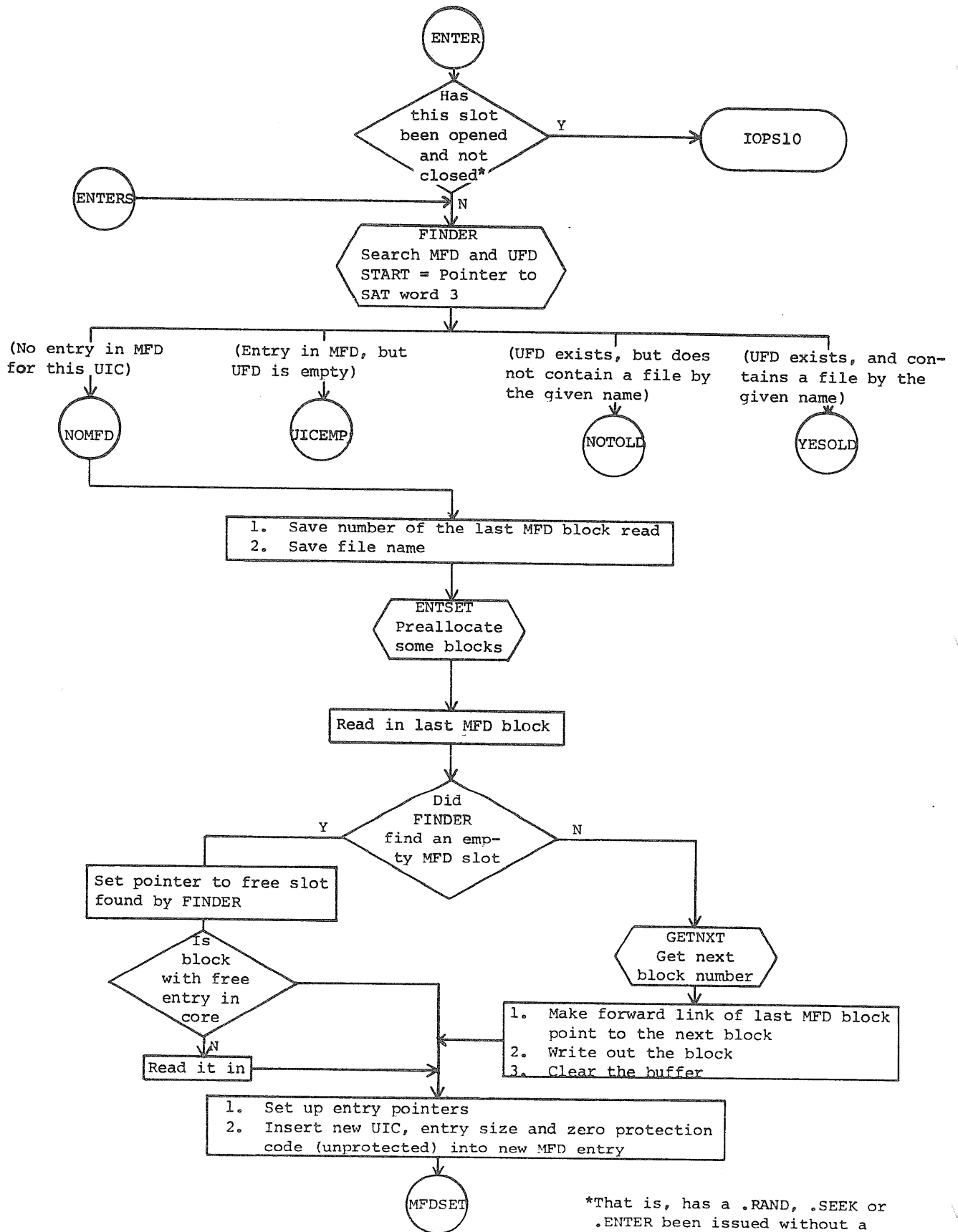




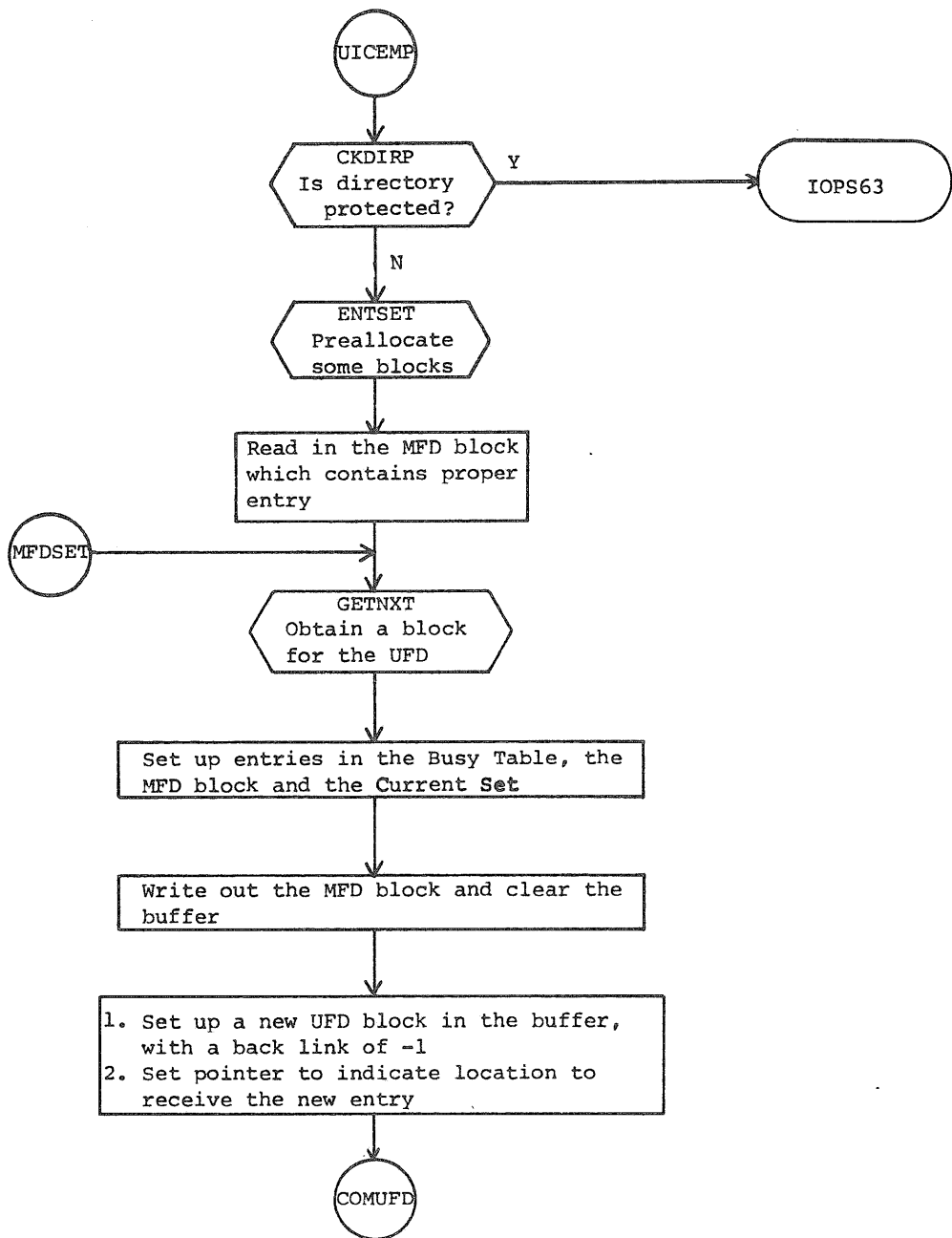


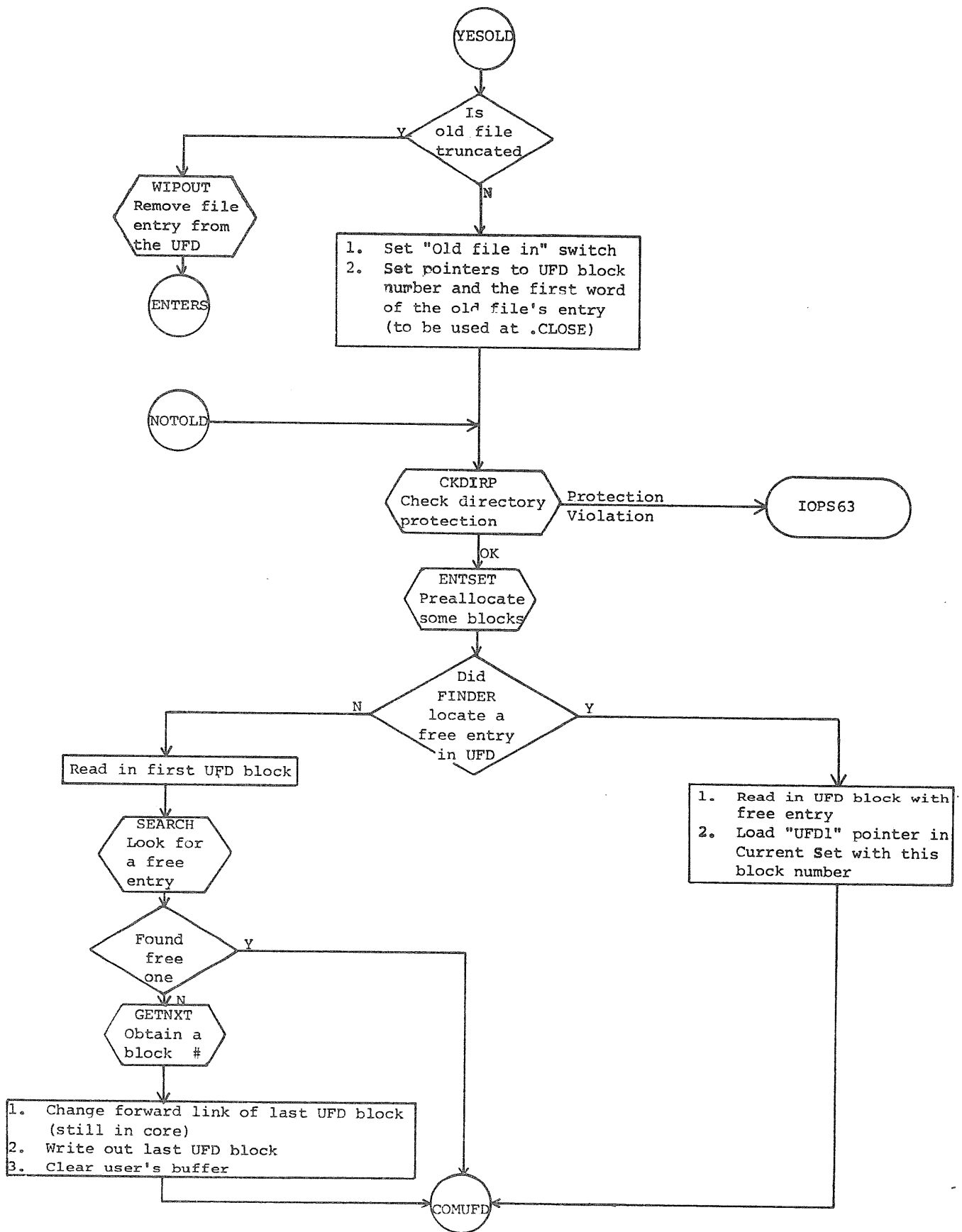


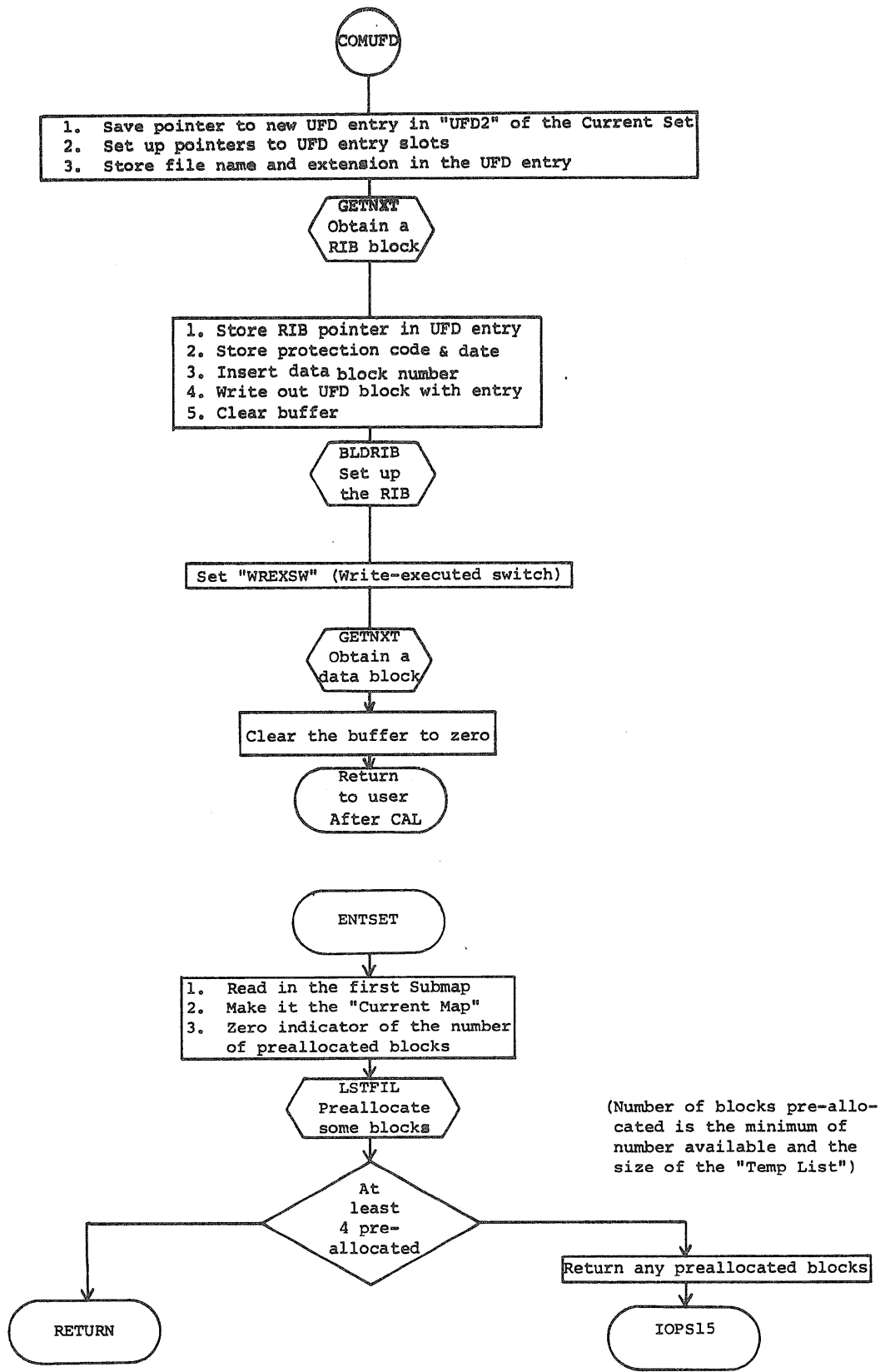


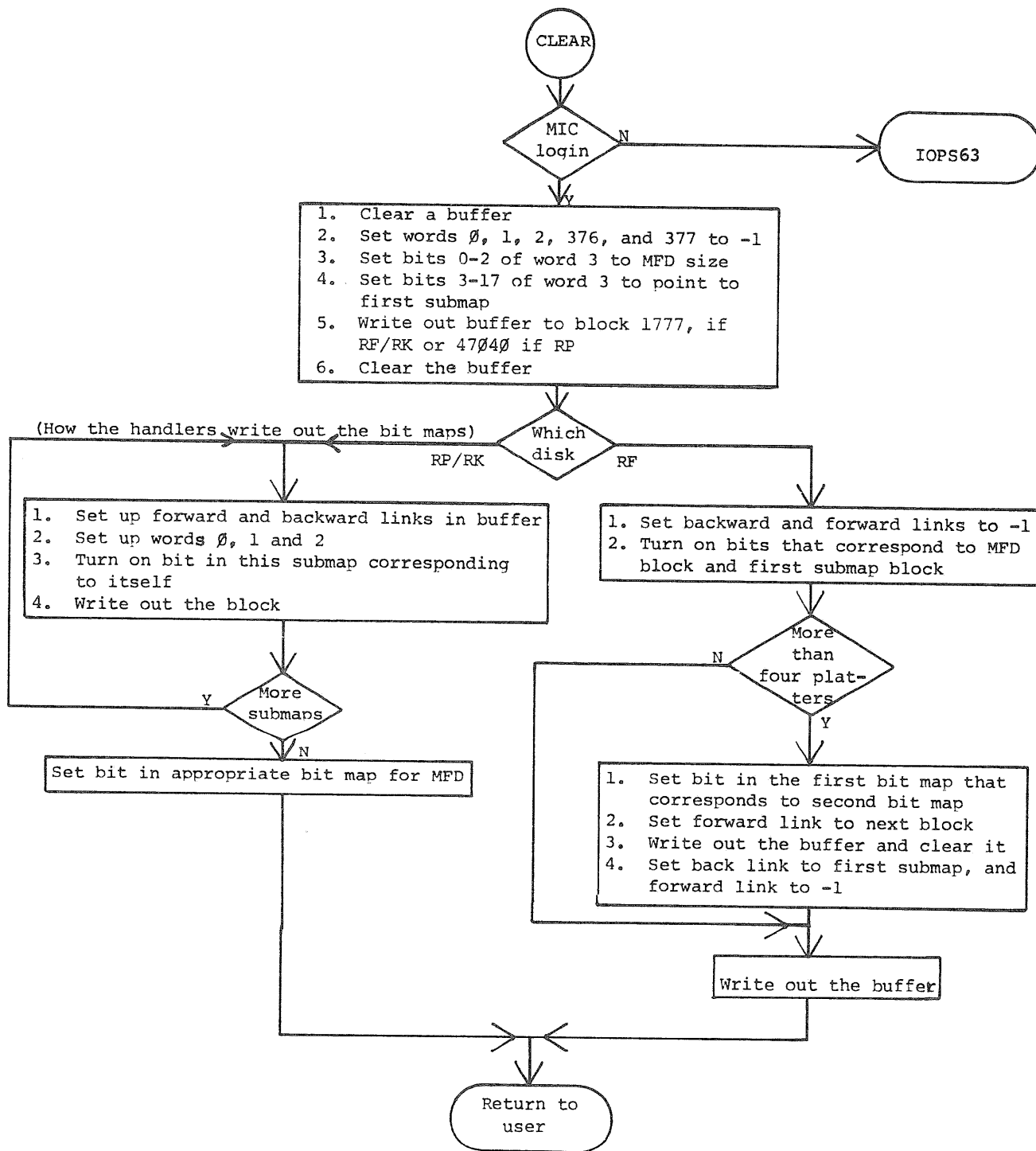


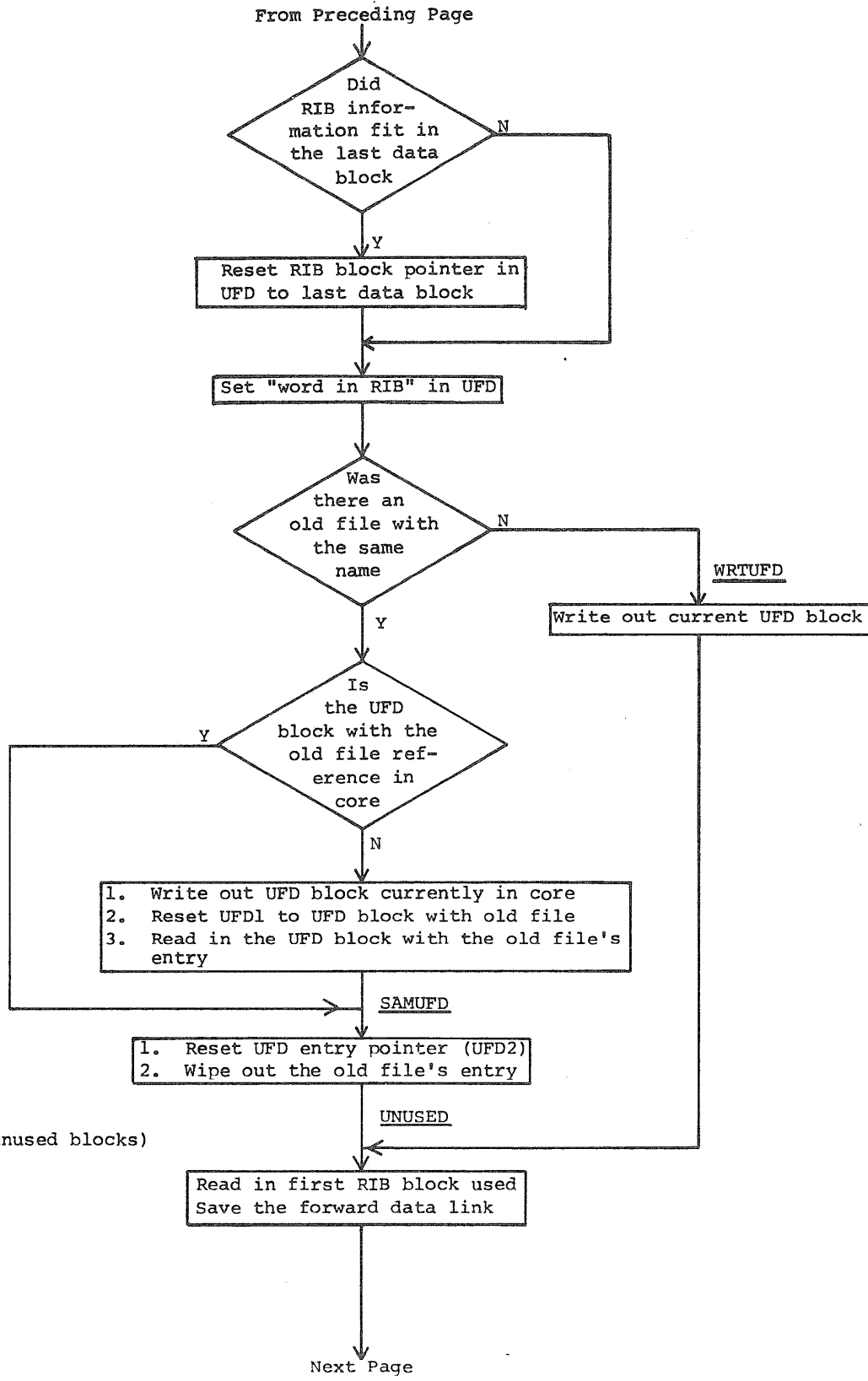
*That is, has a .RAND, .SEEK or .ENTER been issued without a .CLOSE?



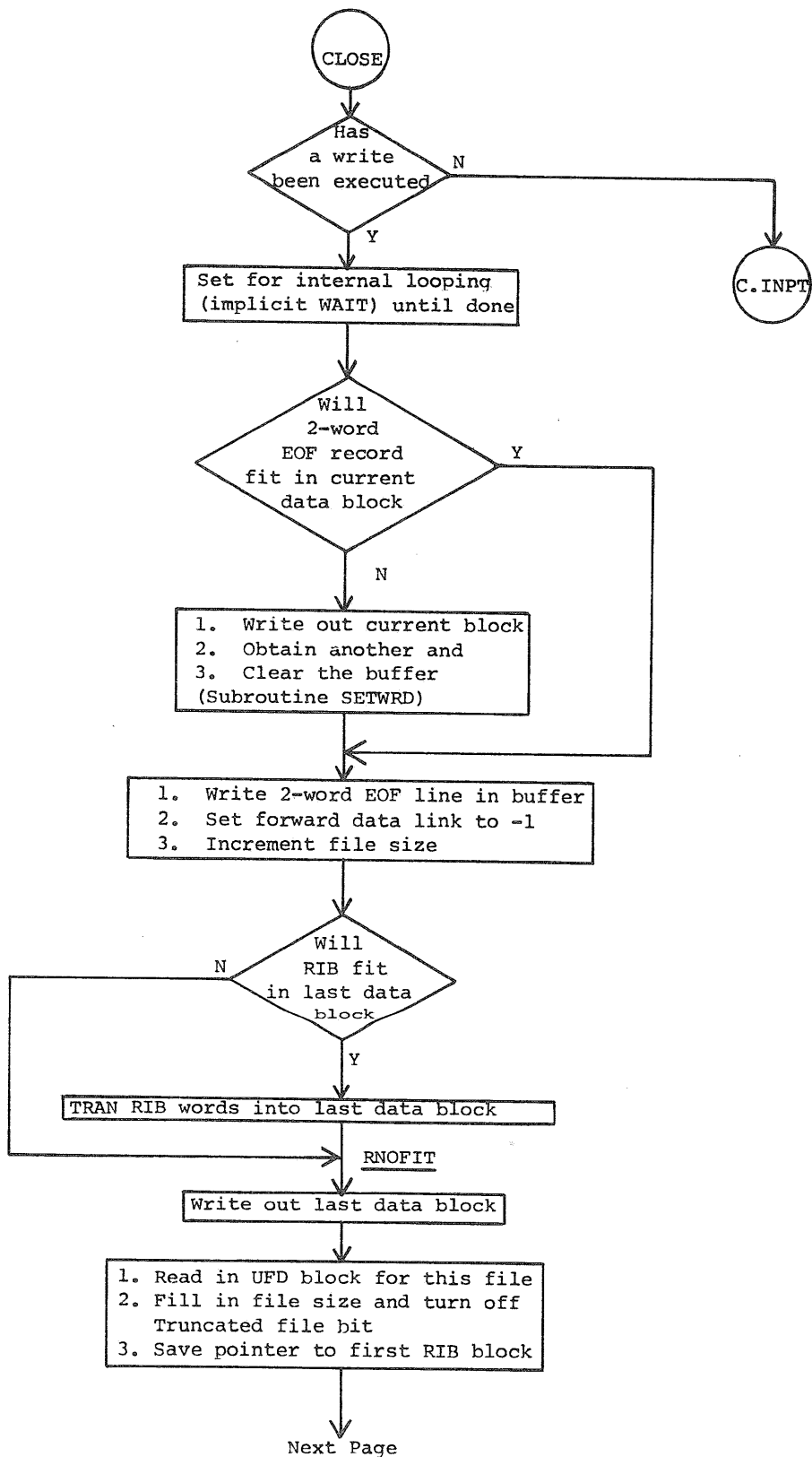


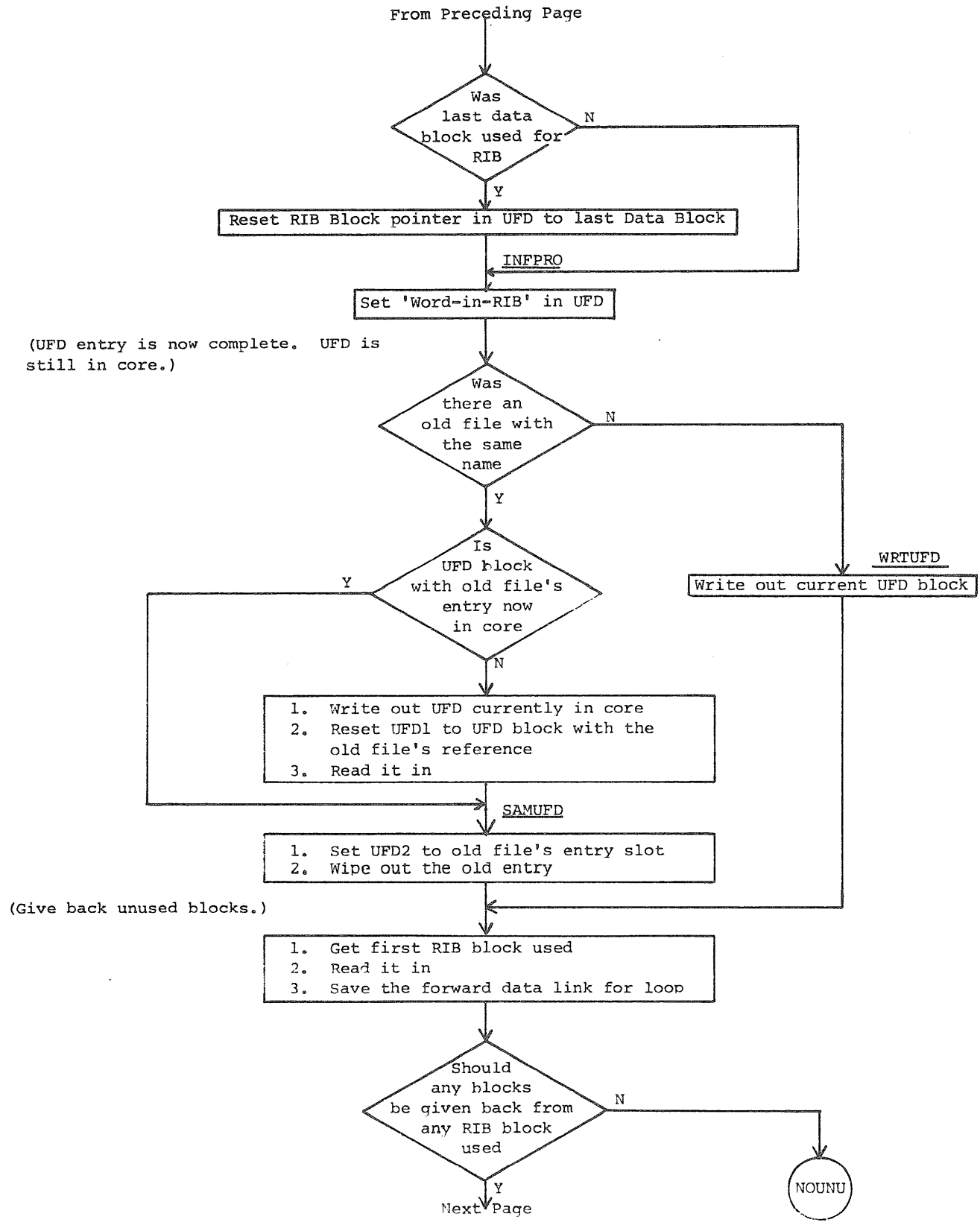


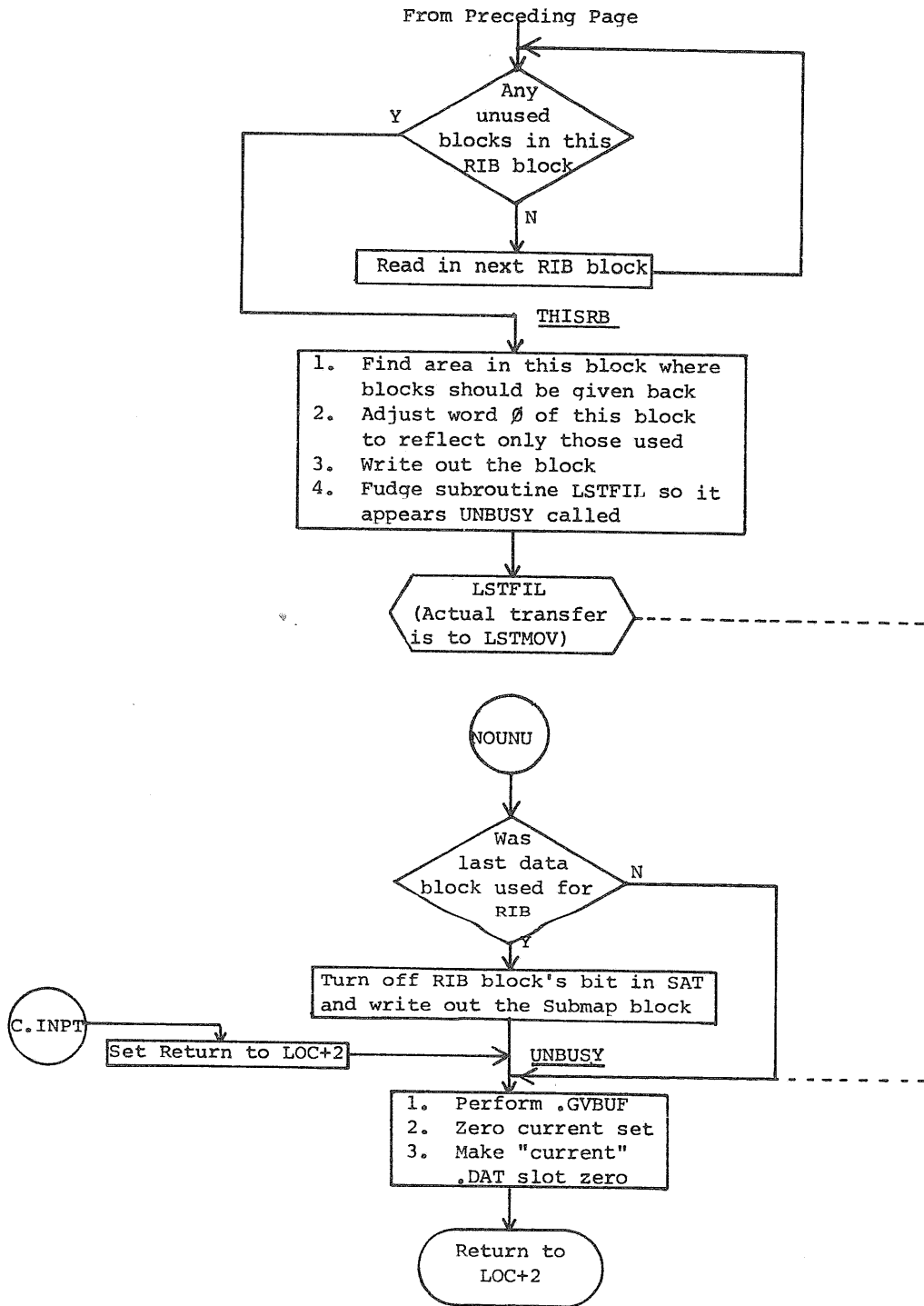


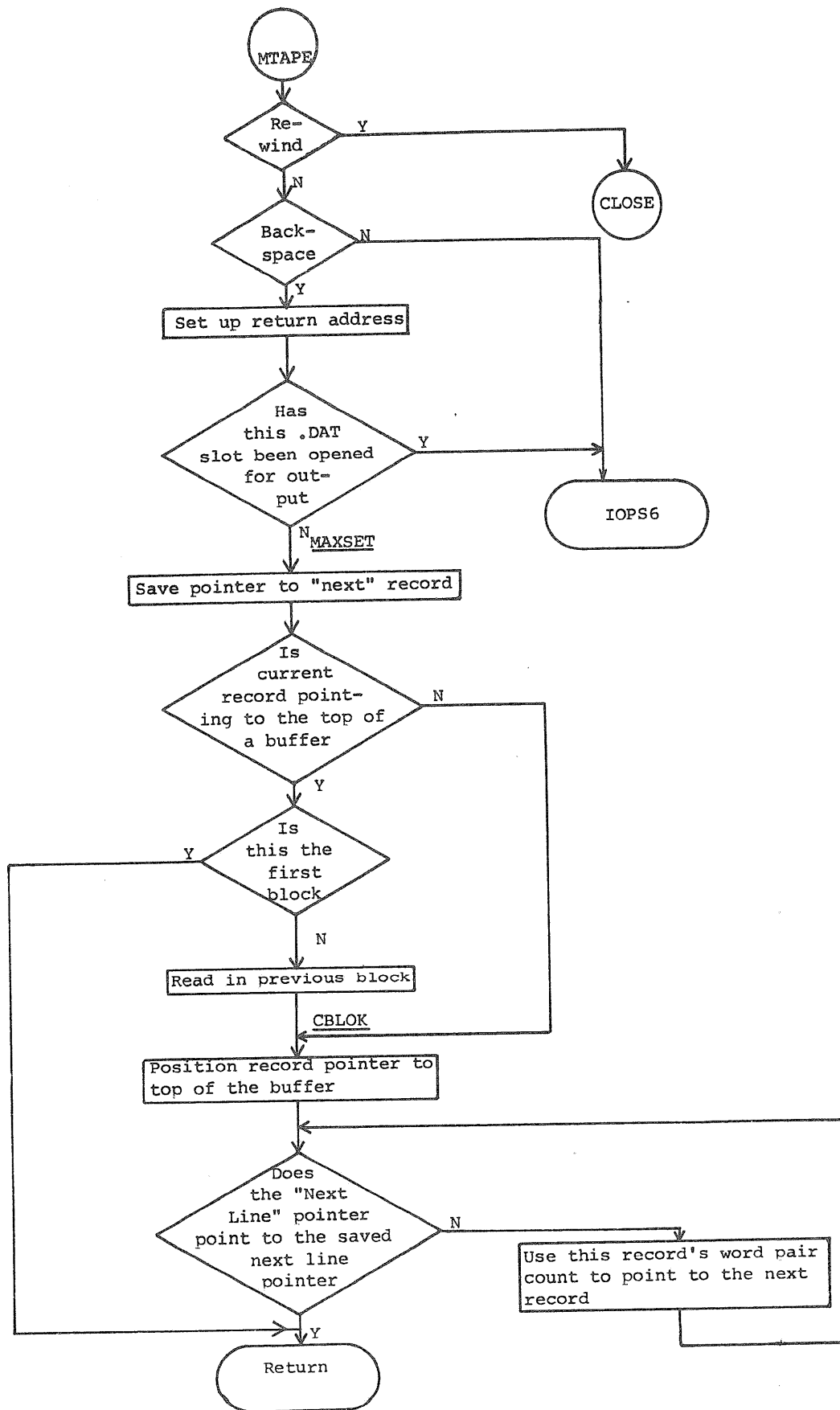


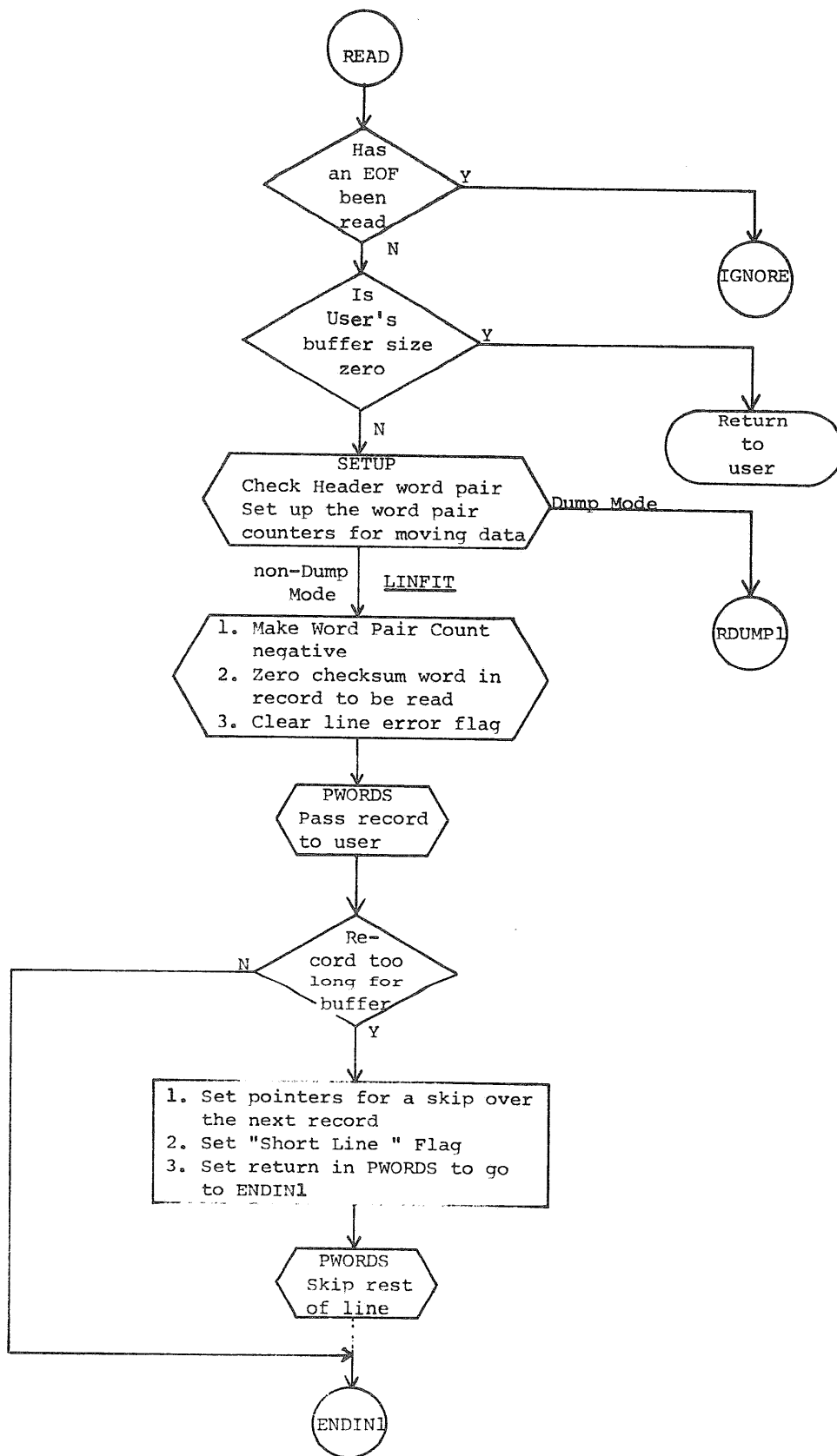
(Give back any unused blocks)

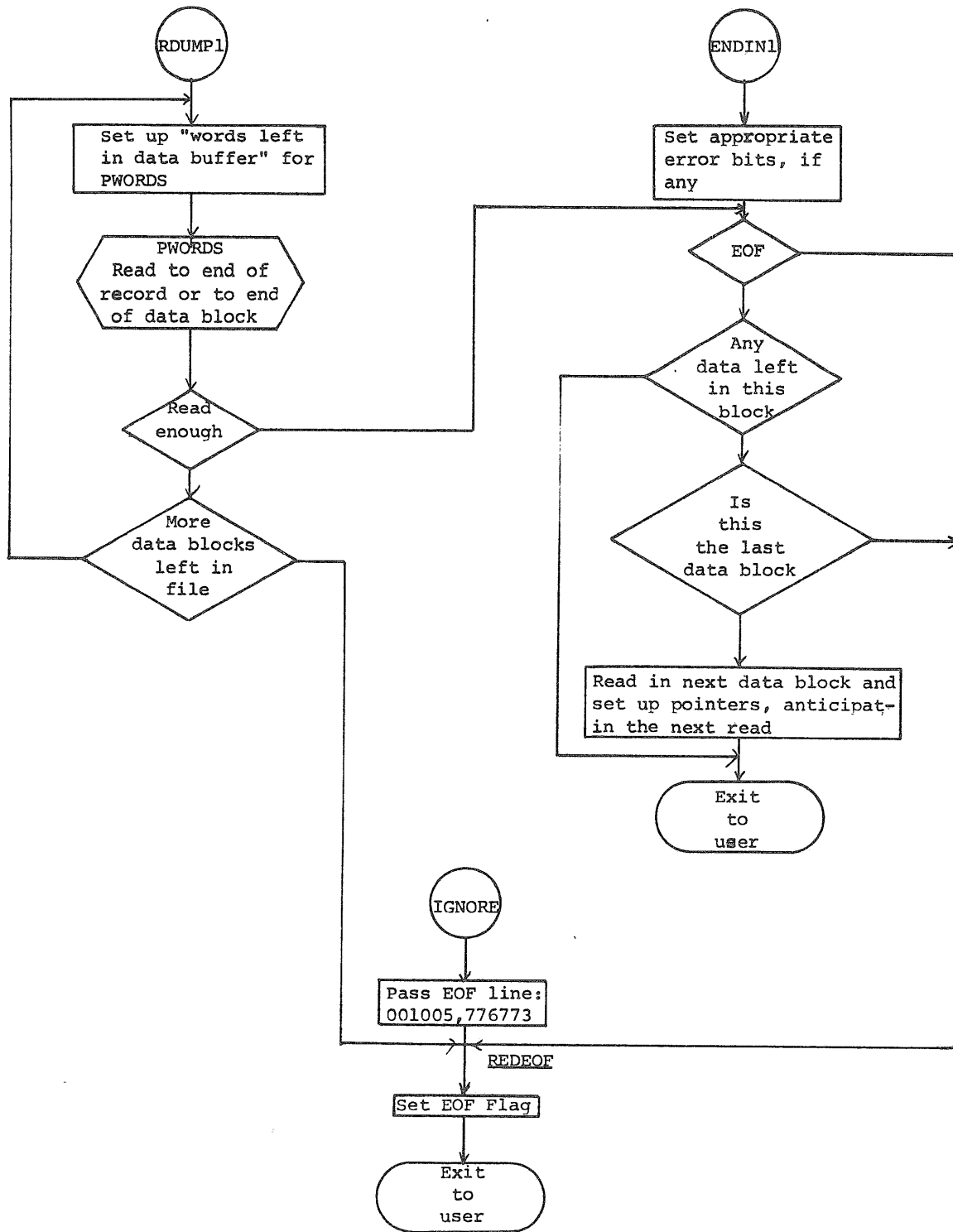












SETUP

READ-WRITE Common Setup Routine

- 1. Save pointer to argument data block
- 2. Set up return address
- 3. Set pointer to checksum word in data buffer
- 4. Save checksum word

Was
a .SEEK
or .ENTER
executed

N

IOPS11

Y

- 1. Set up pointers to "receiver" data buffer
- 2. Index SETUP return pointer past arguments to Dump Mode exit
- 3. Save Word Count from CAL

Dump
Mode

Y

Return

N

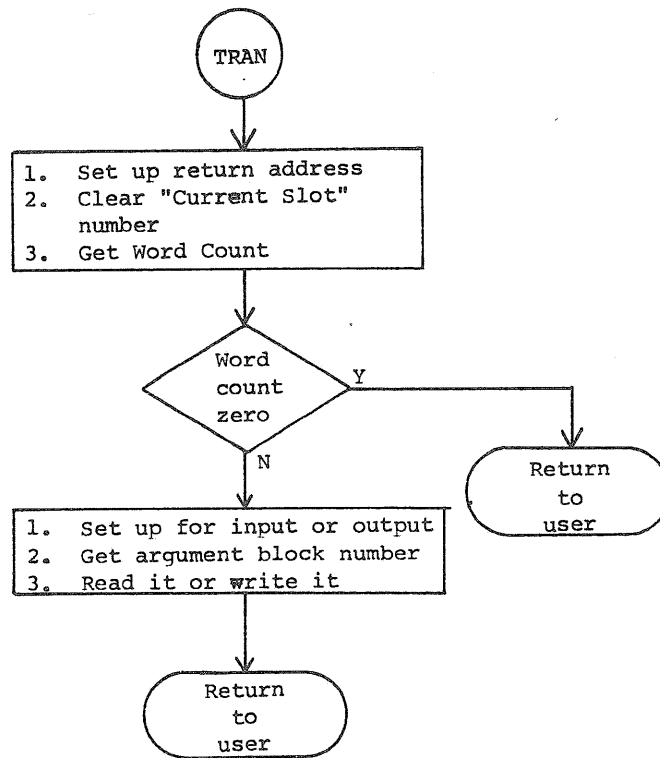
Index return pointer to Non-Dump Mode

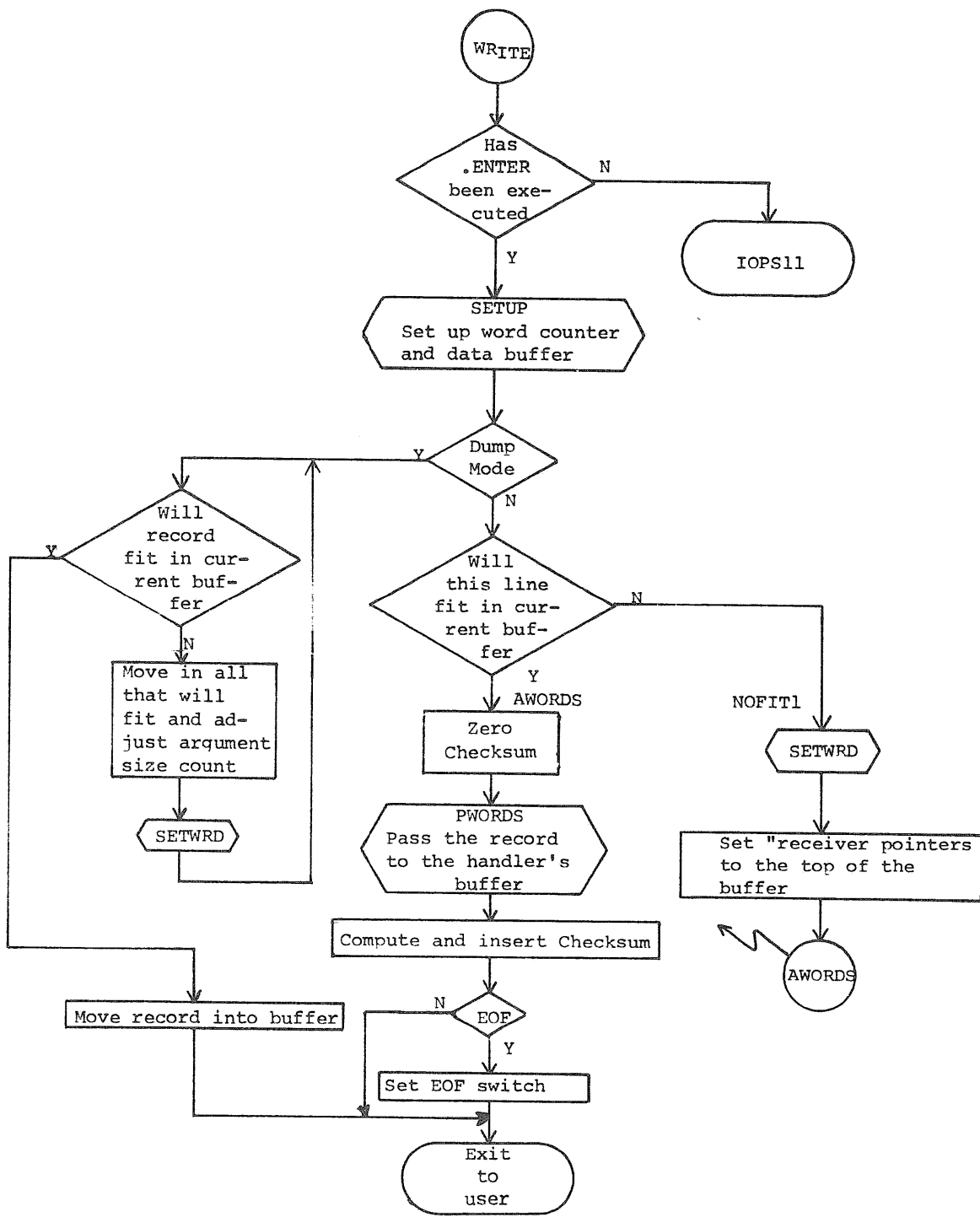
GETWPC
Extract Word Count from line
buffer header word pair

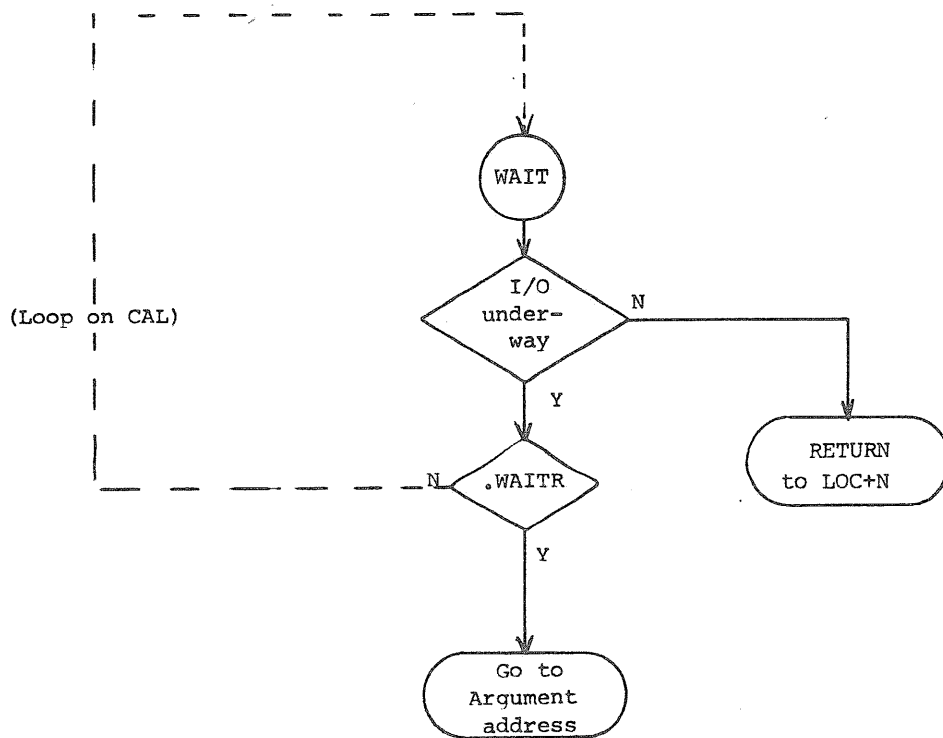
w.p.c.
or w.p.c. is
177₁₀

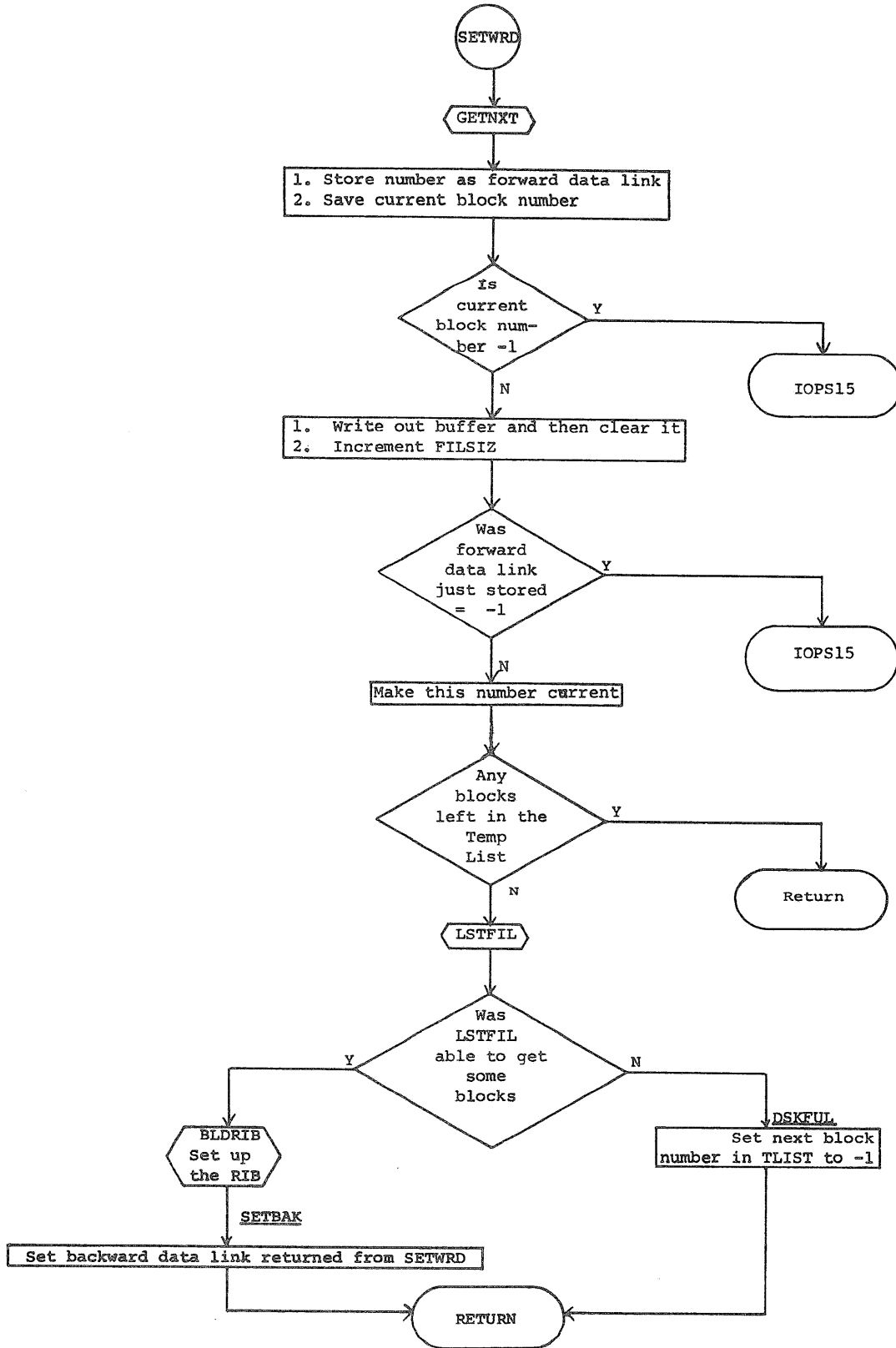
RETURN

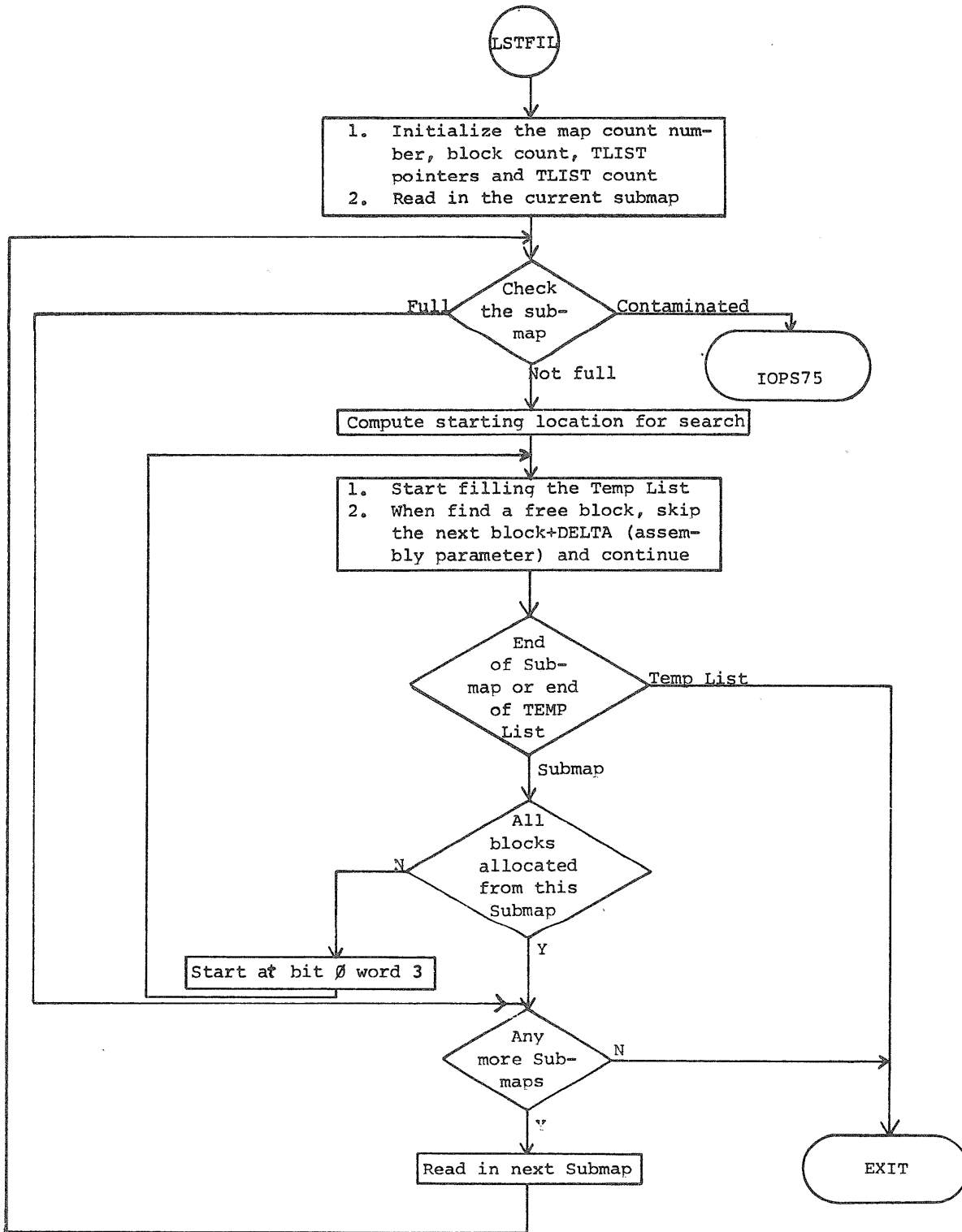
IOPS23

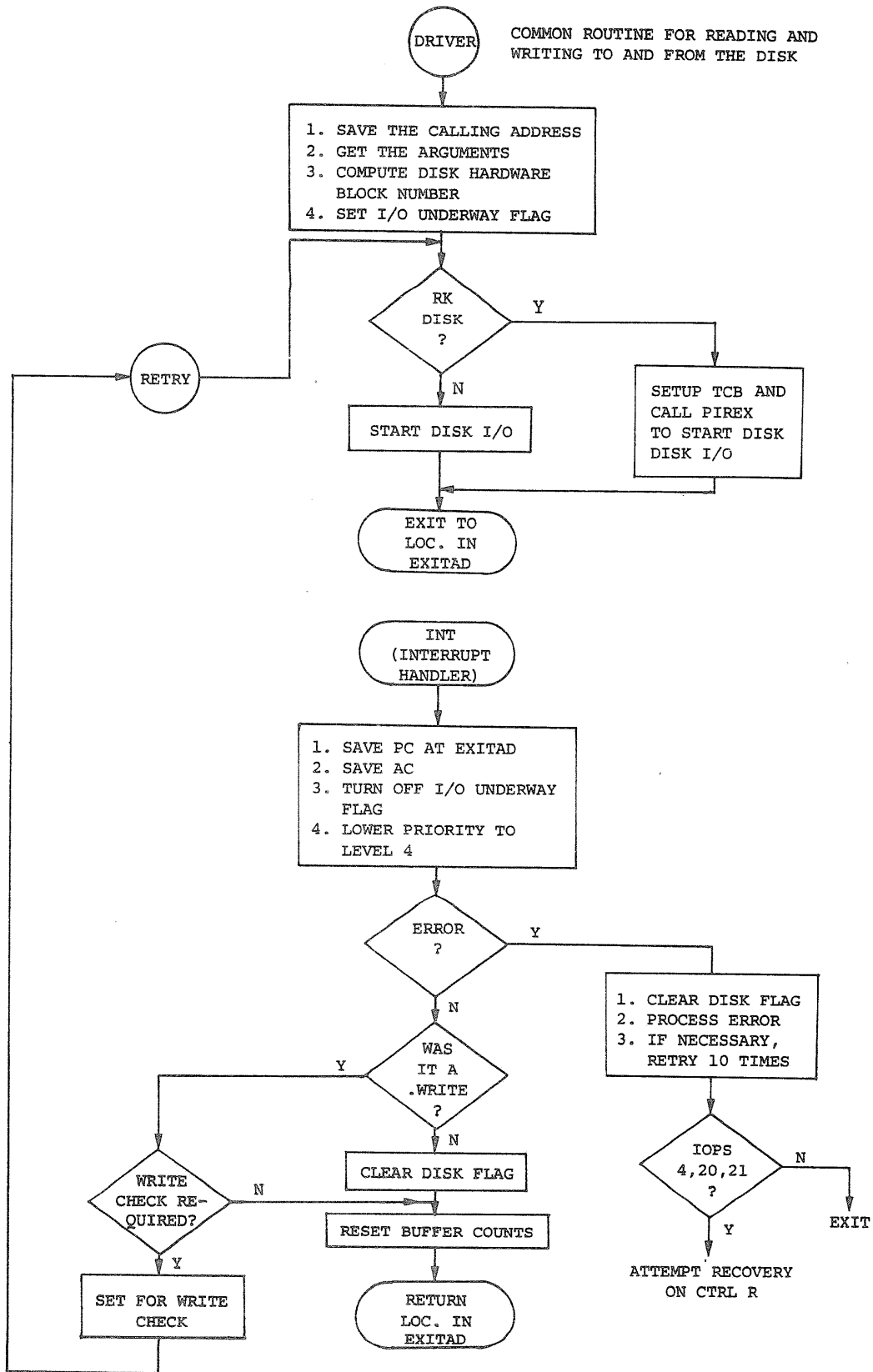












DISK "A" HANDLERS

APPENDIX C
PROCEDURE FILE

ASG

1 ASSIGN DEVICE UIC TO .DAT
A @D00(@D11())@ <@U00(@D12())@> @A00()@

ASM

2 MACRO AND LINE EDITOR
A @D00(@D11())@ <@U00(@D12())@> -14/@D03(@D11())@ <@U03(@D12())@> -15
B,PRE
@A00(FILTMP)@
@A01(@A00(FILTMP)@)@
A @D00(@D11())@ <@U07(@D12())@> -11/@D01(@D11())@ <@U01(@D12())@> -12
A @D02(@D11())@ <@U02(@D12())@> -14/@D05(@D11())@ <@U05(@D12())@> -13
A @D04(LP)@ <@U04(@D12())@> -12
*MACRO
@D(BL)@*@A00(FILTMP)@@D14()@

BNK

2 BANK MODE OPERATION-ON
BANK ON

BUF

1 NUMBER OF BUFFERS
BUFFS @A00()@

CHN

1 SPECIFY 7 OR 9 TRACK MAGTAPE
C @A00()@

CMP

1 SOURCE COMPARE
A @D00(@D11())@ <@U00(@D12())@> -15/@D01(@D11())@ <@U01(@D12())@> -14
SRCCOM
@D()@*@A00()@/@A01()@@D14()@

DIR

1 LIST DIRECTORY
PIP
L LP*@A00(@D11())@ <@U00(@D12())@>@D14()@

DLG

2 LOGOUT UIC
LOGOUT

DMP

Ø1 DUMP UTILITY - EXPANDED SUB_FILE

A @DØØ(@Ø11())@ <@UØØ(@Ø12())@> -14/@ØØ1(LP)@ <@UØ1(@Ø12())@> -12
DUMP
@AØØ(ALL)@ØØ14()@

DOS

1,3, GENERAL PROC FILE FOR GIVING COMMAND STRINGS
@AØØ(ØØ14())@

FIL

2 CREATE A FILE FROM CARDS/EDITOR
A @DØØ(@Ø11())@ <@UØØ(@Ø12())@> -14
A @DØ1(@Ø11())@ <@UØ1(@Ø12())@> -15
R,PRE
@AØØ(FILTMP)@
@AØ1(@AØØ(FILTMP)@)@

FOR

2 FORTRAN IV AND LINE EDITOR
A @DØØ(@Ø11())@ <@UØØ(@Ø12())@> -14/@ØØ1(@Ø11())@ <@UØ1(@Ø12())@> -15
R,PRE
@AØØ(FILTMP)@
@AØ1(@AØØ(FILTMP)@)@
A @DØØ(@Ø11())@ <@UØØ(@Ø12())@> -11/@ØØ1(@Ø11())@ <@UØ1(@Ø12())@> -13
A @DØØ(LP)@ <@UØØ(@Ø12())@> -12
F4
@ØØ(RL)@+@AØØ(FILTMP)@ØØ14()@

JOB

2 START NEW JOB
LOG JOB @AØØ()@ BEGIN @ØØ14()@
T
LOGIN @AØØ(SCR)@
A MØØ 2,3,4,7,1Ø,11,12,13,14,15,16,17,2Ø/@ØØ11()@ 1
ØIP
@ØØ11()@ <(SCR)>@ØØ14()@
@AØØ3()@
KEEP @AØØ4(OFF)@
TIMEST @AØØ1(1)@:ØØ

KEEP

1 RETAIN DEVICE ASSIGNMENTS
KEEP @A00()@

LCM

13 SUPPLEMENT TO LIB PROC-UPDATE .LIRR
@A00(CLOSE@D13())@ @A01(@D13())@ @A02()@

LIB

1
A @D00(@D11())@ <@U00(@D12())@> -14
A @D01(@D11())@ <@U01(@U00(@D12())@)> -15
A @D02(@D11())@ <@U02(@D12())@> -17
A @D03(LP)@ <@U03(@D12())@> -12
UPDATE
@D(LUS)@+@AV*(.LIRR)@@D14()@

LNK

13 DIRECT SUB FILE - BUILDS LINKS FOR EXECUTE FILE-USE WITH OVL PROC
@A02(@D14())@@D14()@

LOG

2 LOGIN JIC
LOGIN @A02(SCR)@

LST

2 LIST CONTENTS OF FILE ON LINE PRINTER
PIP
T LF-@D00(@D11())@ <@U02(@D12())@> @A00(FILTMP)@ (A)@D14()@

MAP

113 DIRECT SUB FILE FOR CHAIN OPTION AND RES CODE ONLY
CHAIN
@A00(TMPXCT)@@D14()@
@A01(SZ)@@D14()@
@A02(FILTMP)@@D14()@
@D14()@

MIC

2 LOGIN MIC JIC
MICLOG @A01()@

MNT

1 MOUNT TAPE# ON DRIVE #
LOGW MOUNT @D(D)@-TAPE# @A00()@ ON DRIVE# @A21()@ - WRITE @A02(LOCK)@

MSG

13 MESSAGE TO OPERATOR-DIRECT SUB FILE
LOG @A00()@

MSW

13 MESSAGE TO OPERATOR W/WAIT-DIRECT SUB
LOGW @A00()@

NDR

1 CREATE NEW DIRECTORY
DIP
* @A00(@D11()@)@ <@A02(@D12()@)@>@D14()@

OVL

13 DIRECT SUB FILE - USE FOR BUILDING OVERLAYS(CHAIN)
CHAIN
@A00(TMPYCT)@D14()@
@A01(SZ)@D14()@
@A02(FI)@D14()@

PAG

2 PAGE MODE OPERATION-ON
PAGE ON

PRT

1 SPECIFY PROTECTION CODE
P @A00(2)

QDP

1 DUMP CORE ON TERMINAL ERRORS-NO ARGUMENTS
QDUMP

XCT

2 EXECUTE
4 @D12(@D11()@)@ <@D12(@D12()@)@> -4
E @A02(TMPXCT)@

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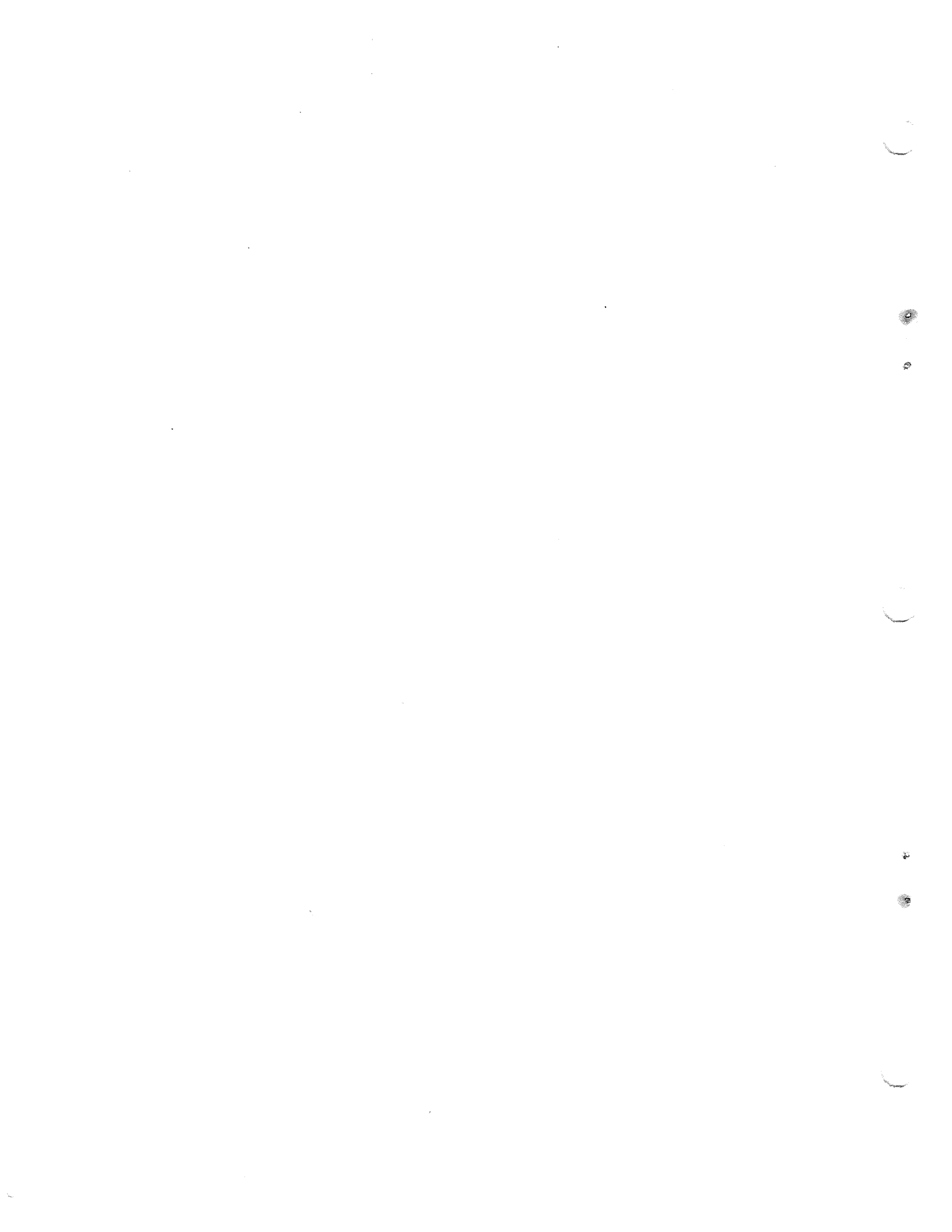
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