MOSTEK®

Z80 MICROCOMPUTER SYSTEMS

Operations Manual

FLP-80DOS FLEXIBLE DISK OPERATING SYSTEM V2.1

FLP-80DOS Operations Manual

VERSION 2.1

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NOTE: Certain sections of this manual refer to specific hardware configurations existing on the MOSTEK AID-80F Development System. In the future, FLP-80DOS will also be implemented on other hardware configurations. Since there will be minor differences in hardware implementation (e.g. I/O port numbers) the user should refer to the appropriate hardware manual for information concerning his system configurations.

PART 1

USER INFORMATION

SECTION 1

FLP-80DOS

GENERAL DESCRIPTION

1-1. INTRODUCTION

NOTE: This section should be read in its entirety. It discusses concepts which are used throughout the system.

1-2. FLP-80DOS is the MOSTEK Disk Operating System for the Z80. It is a software package designed to work with the following minimum hardware configuration:

1. Z80 CPU with a minumum of 16K Bytes of RAM
2. 4K Byte EPROM and a 256 Byte Scratchpad RAM
3. Floppy Disk Interface and 1 to 4 flexible disk units.

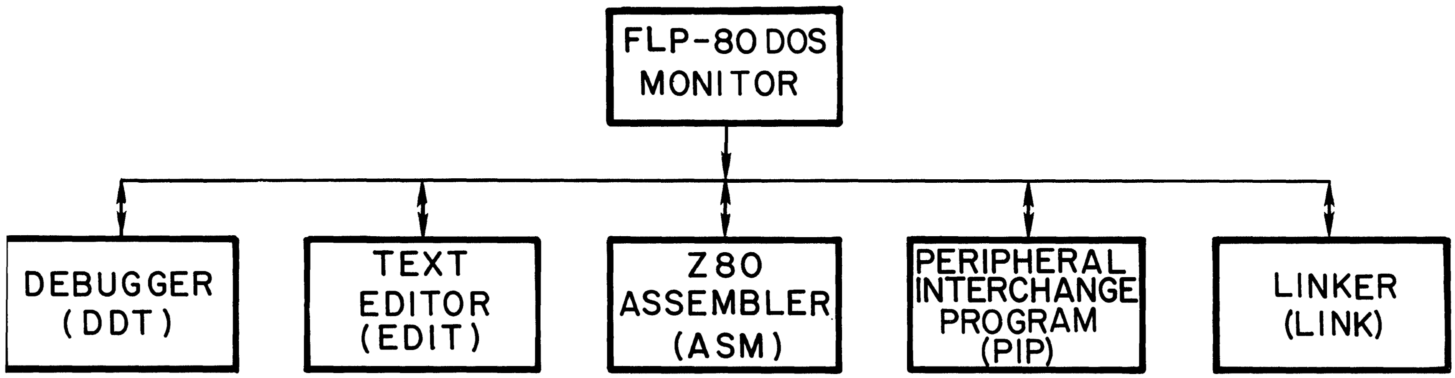
1-3. FLP-80DOS consists of development system software and OEM software. The development system programs are diagrammed in Figure 1-1. Each of these programs is discussed in detail in the next 6 sections of this manual. These programs provide state-of-the-art software for developing Z80 programs. The complete FLP-80DOS system is diagrammed in Figure 1-2. The component parts of the system establish a firm basis for OEM products. This diagram is discussed in detail in Sections 8 through 13 of this manual. The following programs are supplied in the FLP-80DOS package:

1. Monitor
2. Debugger
3. Text Editor
4. Z80 Assembler
5. Peripheral Interchange Program

6. Linker
7. A generalized I/O system for peripherals

These programs provide state-of-the-art software for developing Z80 programs as well as establishing a firm basis for OEM products.

FIGURE 1-1. DEVELOPMENT SYSTEM PROGRAMS



1-4. MONITOR. The Monitor provides a user interface from the console to the rest of the software. The user can load and run system programs, such as the Assembler, using one simple command. Programs in binary format can be loaded into and dumped from RAM. All I/O is done via channels which are identified by Logical Unit Numbers. The Monitor allows any software device handler to be assigned to any Logical Unit Number. Thus, the software provides complete flexibility in configuring the system with different peripherals.

1-5. DESIGNER'S DEVELOPMENT TOOL - DDT. The DDT debugger program is supplied in PROM. It provides a complete facility for interactively debugging relative and absolute Z80 programs. Standard commands allow displaying and modifying memory and CPU registers, setting breakpoints, and executing programs. Additional commands allow use of the MOSTEK AIM-80 to interactively debug a target system. Mnemonics are used to represent Z80 registers, thus simplifying the command language.

1-6. TEXT EDITOR - EDIT. The FLP-80DOS Editor permits random access editing of ASCII character strings. The Editor works on blocks of characters which are rolled in from the disk. It can be used as a line or character-oriented editor. Individual characters may be located by position or context. Each edited block is automatically rolled out to disk after editing. Although the Editor is used primarily for creating and modifying Z80 assembly language source statements, it may be applied to any ASCII text delimited by "carriage returns."

1-7. Z80 ASSEMBLER - ASM. The FLP-80DOS Assembler reads Z80 source mnemonics and pseudo-ops and outputs an assembly listing and object code. The assembly listing shows address, machine code, statement number, and source statement. The code is in industry-standard, hexadecimal format modified for relocatable, linkable assemblies. The Assembler supports conditional assemblies, global symbols, relocatable programs, and a printed symbol table. It can assemble any length program, limited only by a symbol table size which is dependent on available RAM. Expressions involving arithmetic and logical operations are allowed. Although normally used as a two-pass assembler, the Assembler can also be run as a single-pass assembler.

1-8. LINKER-LINK. The Linker provides capability for linking object modules together and creating a binary (RAM image) file on disk. A binary file can be loaded using the Monitor GET or IMPLIED RUN command. Modules are linked together using global symbols for communication between modules. The Linker produces a global symbol table and a global cross-reference table which may be listed on any output device. The Linker also provides a library search option for all global symbols undefined after the specified object modules are processed. If a symbol is undefined, the Linker searches the disk for an object file having the filename of the symbol. If the file is found, it is opened and linked with the main module in an attempt to resolve the undefined symbol.

1-9. PERIPHERAL INTERCHANGE PROGRAM - PIP. The Peripheral Interchange Program provides complete file maintenance facilities for the system. In addition, it can be used to copy information from any device or file to any other device or file. The command language is easy to use and resembles that used on DEC minicomputers.

1-10. I/O SYSTEM. The I/O software, which is the heart of the FLP-80DOS development system, can be used directly in OEM applications. The software consists of two programs which provide a complete disk-handling facility.

1-11. The first package is called the I/O Control system (IOCS). This is a generalized blocker/deblocker which can interface to any device handler. Input and output can be done via the IOCS in any of four modes:

1. single byte transfer.
2. line at a time, where the end of a line is defined by carriage return.
3. multibyte transfers, where the number of bytes to be transferred is defined as the logical record length.
4. continuous tranfer to end-of-file, which is used for binary (RAM-image) files.

The IOCS provides easy application of I/O oriented packages to any device. There is one entry point, and all parameters are passed via a vector defined by the calling program. Any given device handler defines the physical attributes of its device which are, in turn, used by the IOCS to perform blocking and deblocking.

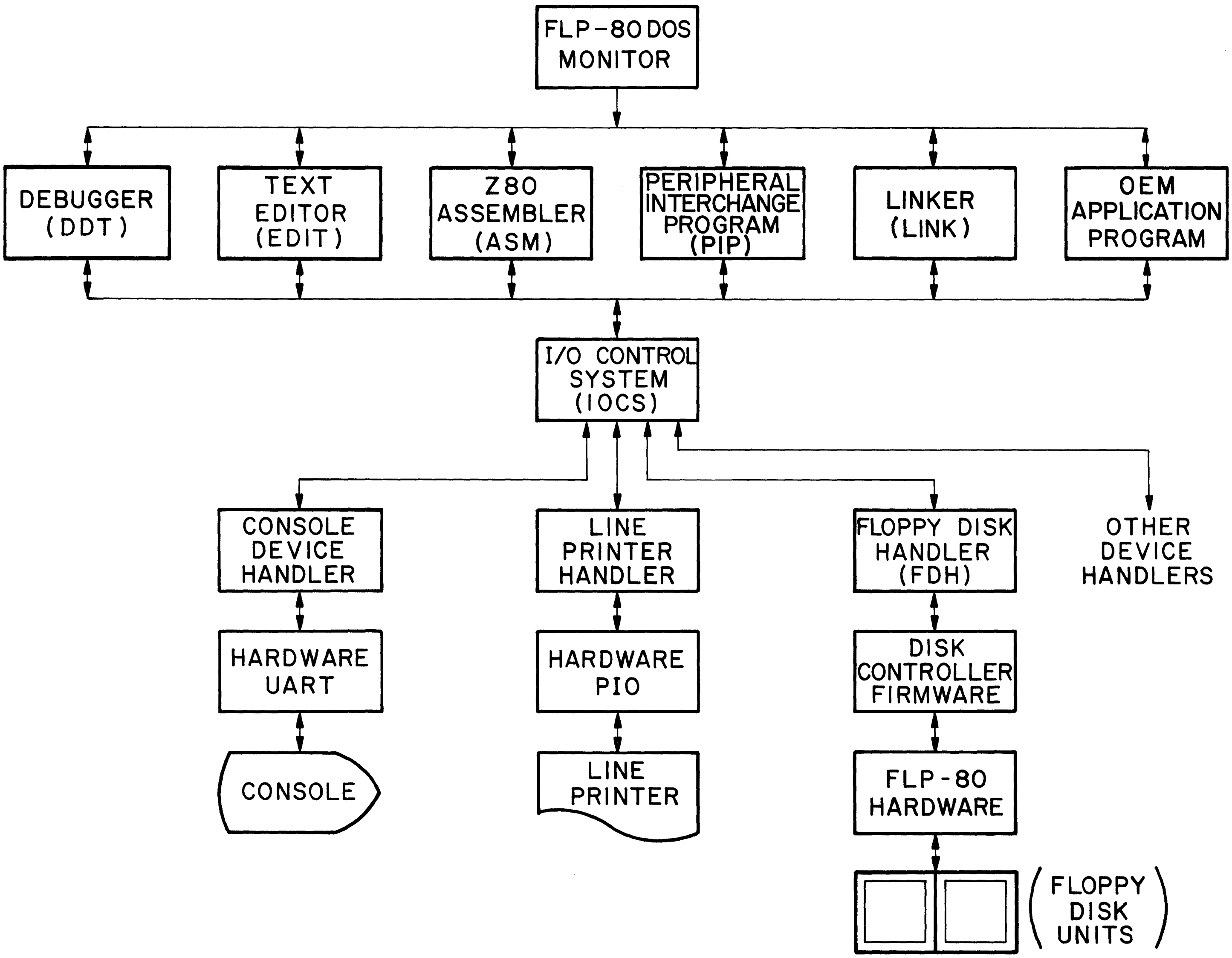
1-12. The Floppy Disk Handler (FDH) interfaces from the IOCS to a firmware controller for up to 4 floppy disk units. The FDH provides a sophisticated command structure to handle advanced OEM products. The firmware controller interfaces to MOSTEK's Disk Controller Board. The disk format is soft-sectored. The software directly handles double-sided disks. The FDH has advanced error recovery capability. It supports a bad sector map and an extensive directory which allows multiple users. The file structure is doubly linked to increase data integrity on the disk. A bad file can be recovered from either its start or end.

1-13. OTHER PROGRAMS

1-14. MOSTEK offers a number of programs which work with FLP-80DOS. These programs are purchasable options for the Microcomputer. The following programs will be of interest to many users:

FZCASM	-The 3870/F8 Cross Assembler allows assembly of all F8 opcodes on the AID-80F. The FLP-80DOS Text Editor and Linker can be used with the Cross Assembler to produce programs which can be debugged.
ZAIM-72	-This 3870 family debugger program is to be used with the MOSTEK AIM-72 board for debugging 3870, 3872, or 3876 programs.
MOSTEK LIBRARY	-The Library consists of a set of utilities which are used at Mostek. Programs include a word processor, Lawrence Livermore Laboratory BASIC (oriented to controller applications), a disk recovery utility, an 8080 to Z80 source translator, a hexadecimal dump utility, and others. Complete source files are included.
BASIC	-MOSTEK BASIC features string and array manipulation, random access disk, and a complete set of standard BASIC commands.
FORTRAN IV	-MOSTEK FORTRAN is ANSI X3.3(1966) standard FORTRAN IV. It features an extensive run-time library.
MACRO-80	Powerful Macro Assembler for Z80.
MACRO-70	Powerful Macro Assembler for 3870/F8.

FIGURE 1-2. FLP-80DOS SYSTEM



1-15. REFERENCE DOCUMENTS

AID-80F Operations Manual	MK78569
SDB-80 Software Development Board Operations Manual	MK78544
SDB-80E (European version)	MK78548
FLP-80 Hardware Operations Manual	MK78560
FLP-80E (European version)	MK78561
RAM-80B Operations Manual	MK78545
RAM-80BE (European Version)	MK78555
DSS-80 Development System Software Program Listing (OEM users only - restricted distribution)	MK78588
DOPS-80 Disk Operating Software Program Listing (OEM users only - restricted distribution)	MK78589

1-16. DEFINITION OF SYMBOLS USED IN THIS MANUAL

1-17. The following conventions are used throughout this manual:

All user input from the console device is underlined.

All hexadecimal numbers are identified by a subscript H, except where an example of program input or output is given.

(CR) means carriage return.

aaaa means any hexadecimal number.

1-18. CONSOLE INTERACTION

1-19. ENTERING DATA ON THE CONSOLE. Each line of input from the console is terminated with a carriage return in FLP-80DOS. The maximum length of a line of input is 160 characters. Before ending a line with carriage return, the user can modify the line with the following keys (Note that these standards do not apply to DDT, the debugger):

1. TAB (ASCII 09_H) -move the console cursor over mod-8 spaces. Tabs are set every 8 spaces.

2. RUBOUT (ASCII $7F_H$) -delete the previous character entered. A blackslash is printed on either side of the characters which are deleted.

CNTL H

3. BACKSPACE (ASCII 08_H) -delete the previous character. It is erased from the (CRT) screen by overprinting with a blank, and the cursor is moved backward. Backspacing over a tab character will back the cursor to the correct screen position.

4. CNTL-U (ASCII 15_H) -delete the current line of input and reprompt for another line.

5. SPACE BAR -used to alternately start and stop listing to console device. This is useful when a long file is being spooled to a CRT screen and the user wishes to view the file a page at a time.

1-20. CONSOLE ESCAPE ("Minimal Listener"). Any executing program in FLP-80DOS can be interrupted from the console device. (This feature is inhibited while DDT, the debugger, is being used.) The following key inputs are allowed:

1. CNTL-X (ASCII 18_H) - Monitor Escape. Entering this code from the console keyboard immediately reboots the system software and returns control to the FLP-80DOS Monitor. After a brief delay while the disk is

accessed, the Monitor prompt will appear on the console. The Monitor prompting character is a $. The Monitor escape cannot be used during use of the Debugger (DDT) or the Editor (EDIT).

NOTE: Monitor Escape is designed to provide an immediate reboot of the Monitor without finishing the currently executing program. Any output files which were open when the Monitor Escape was performed will not be closed. This means that those files will have no information stored in them.

2. CNTL-C (ASCII 03_H)- Debugger Escape. Entering this code from the console keyboard immediately returns control to the debugger (DDT). The current Z80 registers will be printed on the console, and DDT will wait for a command. To resume execution, enter a dot (.), then the command 'E'. For further details on using DDT as a debugging aid, please see Section 7 of this manual. This escape cannot be used if DDT is called up by the Monitor, or during use of the Editor.

NOTE Debugger Escape is designed to allow a program to be suspended by the user. It also provides a software asynchronous interrupt which is useful in debugging programs. It is <u>not</u> active during usage of DDT, the debugger (i.e., the user cannot use

Debugger Escape when using DDT). It may be used any number of times during the execution of a program.

1-21. CONCEPT OF DATASET

1-22. A dataset is a logical grouping of data associated with an I/O device. Throughout FLP-80DOS a dataset is identified as follows:

DEV:FILENAME.EXT[UIC]

where:

DEV = The device mnemonic consisting of two letters and a decimal digit terminated by a colon. The letters identify the device and the digit identifies the unit (e.g.,DK1: is disk unit 1). If no digit is entered, unit 0 is assumed. If the device mnemonic itself does not appear, the system disk (DK0:) is assumed. The following devices can be handled by FLP-80DOS supplied to you:

DEVICE NAMES	DESCRIPTION
CP:	Line Printer (Centronics)
CR:	Documation M300 card reader
DK0:	System Disk Unit (right hand unit)
DK1:	User Disk Unit (left hand unit)
LP:	Line Printer (Data Products)
PP:	High-Speed Paper Tape Punch
PR:	High-Speed Paper Tape Reader
TI:	Silent 700 Cassette Tape Reader Input
TO:	Silent 700 Cassette Tape Output
TT:	Teletype Typehead, CRT Screen, or Silent 700 Printer
TK:	Terminal Keyboard

Additional devices and their corresponding software handlers can be added by the user.

FILENAME = The file name specification consists of one or more letters or digits. The first six letters or digits specify the name. The first character must be a letter. All letters or digits in excess of 6 are ignored. The file name is not used if the device is not a file device (e.g., the line printer).

EXT = The extension specification consists of a period, followed by one or more letters or digits. The first three letters or digits specify the extension. All letters or digits in excess of three are ignored. If an extension does not appear in the dataset, a default extension of 3 blanks is assumed. The extension does not appear if the device is not a file device. The extension 'BIN' is reserved for binary (RAM image) files. The extension 'OBJ' is reserved for object files. The extension 'TMP' is reserved for temporary files by the Editor. The extension 'CRS' is used by the Assembler and the Linker for cross-reference files. The extension 'LST' is used by the Assembler for listing files.

UIC = The user identification code UIC consists of a left square bracket, followed by one to three decimal digits, followed by a right square bracket. The largest valid decimal number is 255. If the user identification code does not appear, a default code of 1 is assumed. The UIC is maintained on all disk files. It can be used to identify files of different users. The UIC does not appear if the device is not a file device.

1-23. CONCEPT OF LOGICAL UNIT NUMBERS

1-24. All FLP-80DOS input and output is done in terms of logical unit numbers, just as in FORTRAN. A Logical Unit Number (LUN) is any number in the range 0 - FF_H. Any dataset can be assigned to any Logical Unit Number (LUN) (using the Monitor ASSIGN command). The LUN acts as a channel through which a program performs input and output. This is diagrammed in Figure 1-3.

1-25. Logical Unit Numbers 0-5 are always pre-assigned when the system is powered up or reset. These are all "default" LUN's and they are assigned the following meanings:

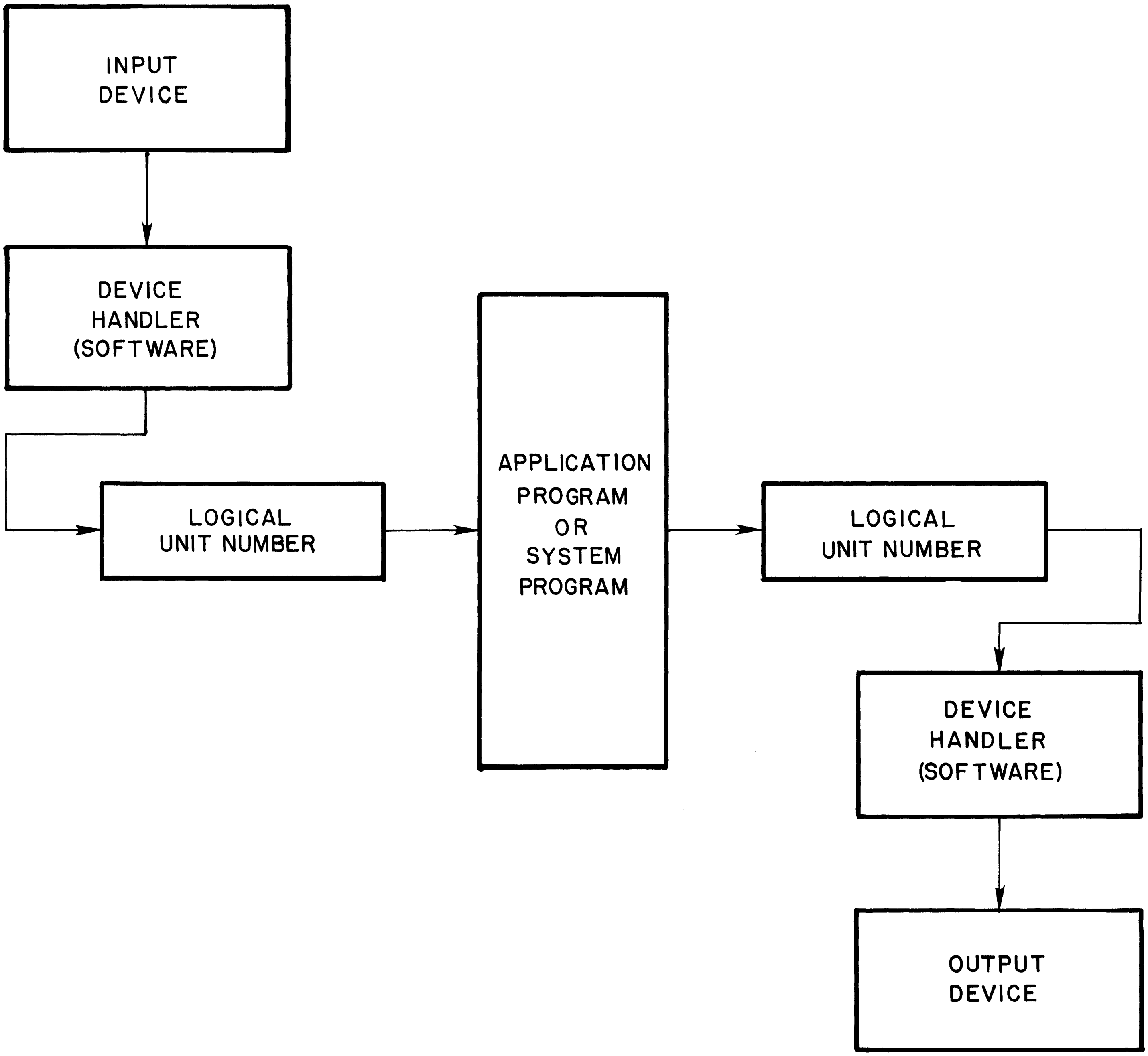
LUN	meaning
0	console input
1	console output
2	object input
3	object output
4	source input
5	source output

1-26. LUN 0 and 1 are always assigned to the user console device. LUN's 0-5 have special features which make them useful for writing your own programs (more detail is given in Sections 8 and 9 of this manual). LUN FF_H cannot be reassigned to a device. This means that any program using LUN FF_H is responsible for making the device assignment. Further detail is given in Section 2 under the Monitor "ASSIGN" command.

1-27. DATE FEATURE

1-28. The date feature in FLP-80DOS V2.1 allows you to record the date of creation or last update of a file. This is done automatically by the system except for binary files.

FIGURE 1-3. INPUT/OUTPUT LOGICAL UNIT NUMBERS



1-29. At power-up time, after system reset, the date can be entered at the system's request. (See start-up procedures in paragraph 1-36 for information on entering the date). Once the date has been entered correctly, it will remain in the system until turned off. A system reset does not destroy the date. In this case the date will appear after the sign-on message and no request to enter it will appear. If the user wishes to change the current date for any reason, it can be done through the DATE command in PIP. (see paragraph 3-18).

1-30. When a new file is created or an old one is updated, for example through the Editor, the current date is stored in its directory entry at the load-address bytes, with the exception of binary files in which case the load-address bytes contain that information and no date is recorded. We recommend that the user create a cross-reference file along with his binary file through the Linker, using option C. (see paragraph 6-9).

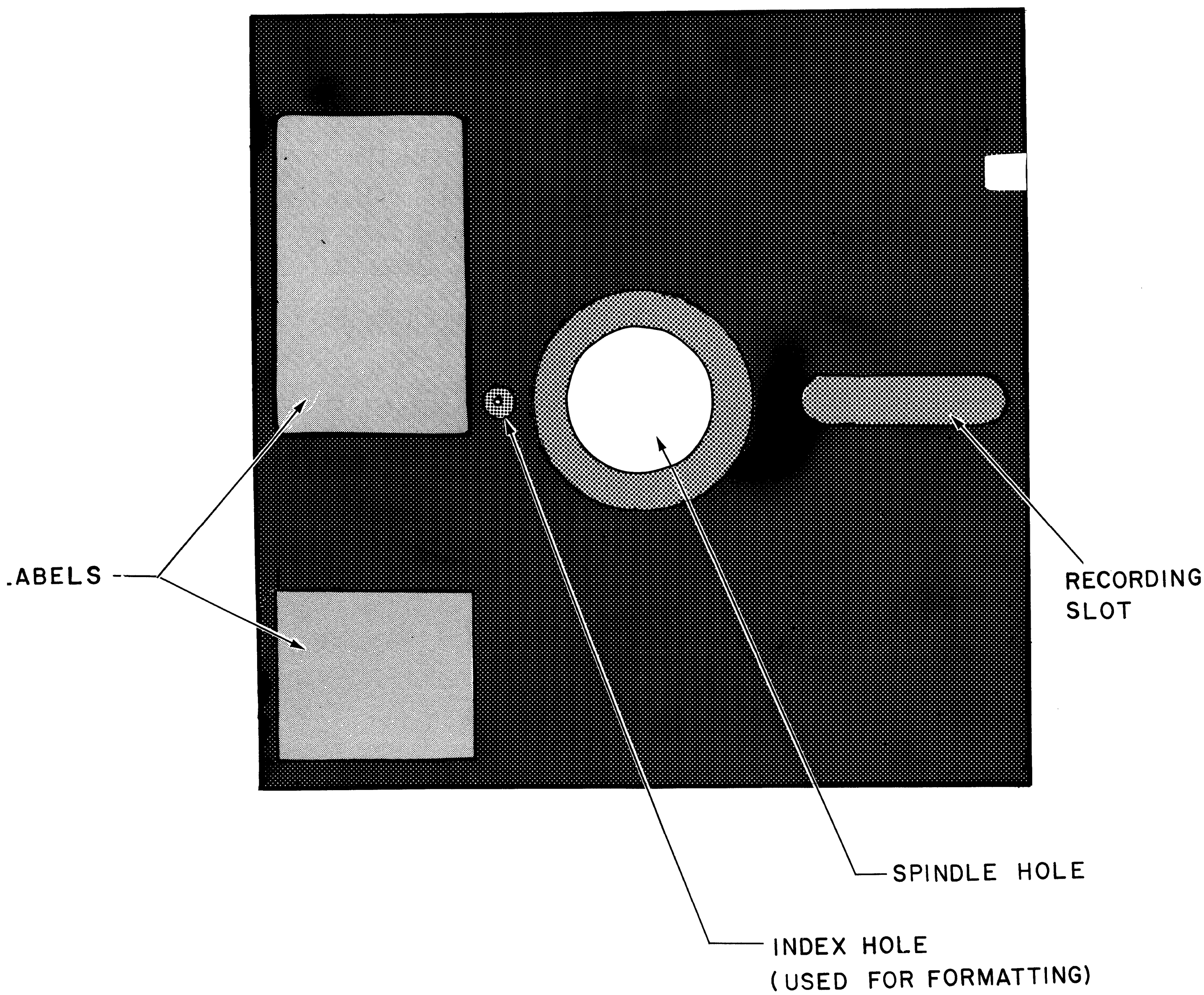
1-31. FLEXIBLE DISK HANDLING PROCEDURE

1-32. The 2 diskettes supplied with the system are both system diskettes. That is, each contains all of the FLP-80DOS software. The format is soft-sectored. It is recommended that burnished and qualified diskettes be used with FLP-80 system. New diskettes do not have to be pre-formatted because the system provides formatting capability. Each diskette in the system has all the system software on it. Each has 1964 available sectors of 124 data bytes (243536 bytes total). The capacity is double this for double-sided diskettes.

1-33. Figure 1-4 shows the diskette. The following precautions should be followed in handling the diskettes:

1. Do not bend or fold the diskette.

FIGURE 1-4. DISKETTE



2. Do not touch the exposed recording area of the diskette.
3. Do not place heavy materials on or write on the diskette with other than a felt-tip marker.
4. Do not place the diskette near strong magnetic fields.

1-34. Diskettes are inserted into the drives as follows:

1. Insert the diskette as far as it will go into the disk unit slot. The recording slot should be to the rear and the label should be on the right-hand side.
2. Slowly close the door until it latches.

1-35. Diskettes are removed from the disk unit by depressing the latch button. The disk unit door should spring open and the diskette should be pushed out of the unit.

CAUTION: Do not power up or power down the system with a diskette inserted in a disk unit. Doing so may destroy the integrity of the data on the diskette.

NOTE: It is recommended that all user files be backed up on separate diskettes whenever changes are made. This precaution guards against loss of a file in case a non-recoverable disk error occurs.

1-36. START UP PROCEDURES

1-37. Configure the hardware system as explained in the System Operations Manual. Power up. Insert the FLP-80DOS diskette into the right-hand disk drive, disk unit zero (DK0:), and close the door. Depress the 'carriage return' key on the console device. There should be a slight delay while the system software is read into RAM from disk. Then the Monitor prompt should be printed on the console:

MOSTEK FLP-80DOS V2.1
$

A. PLEASE ENTER DATE (DD-MMM-YY) -->

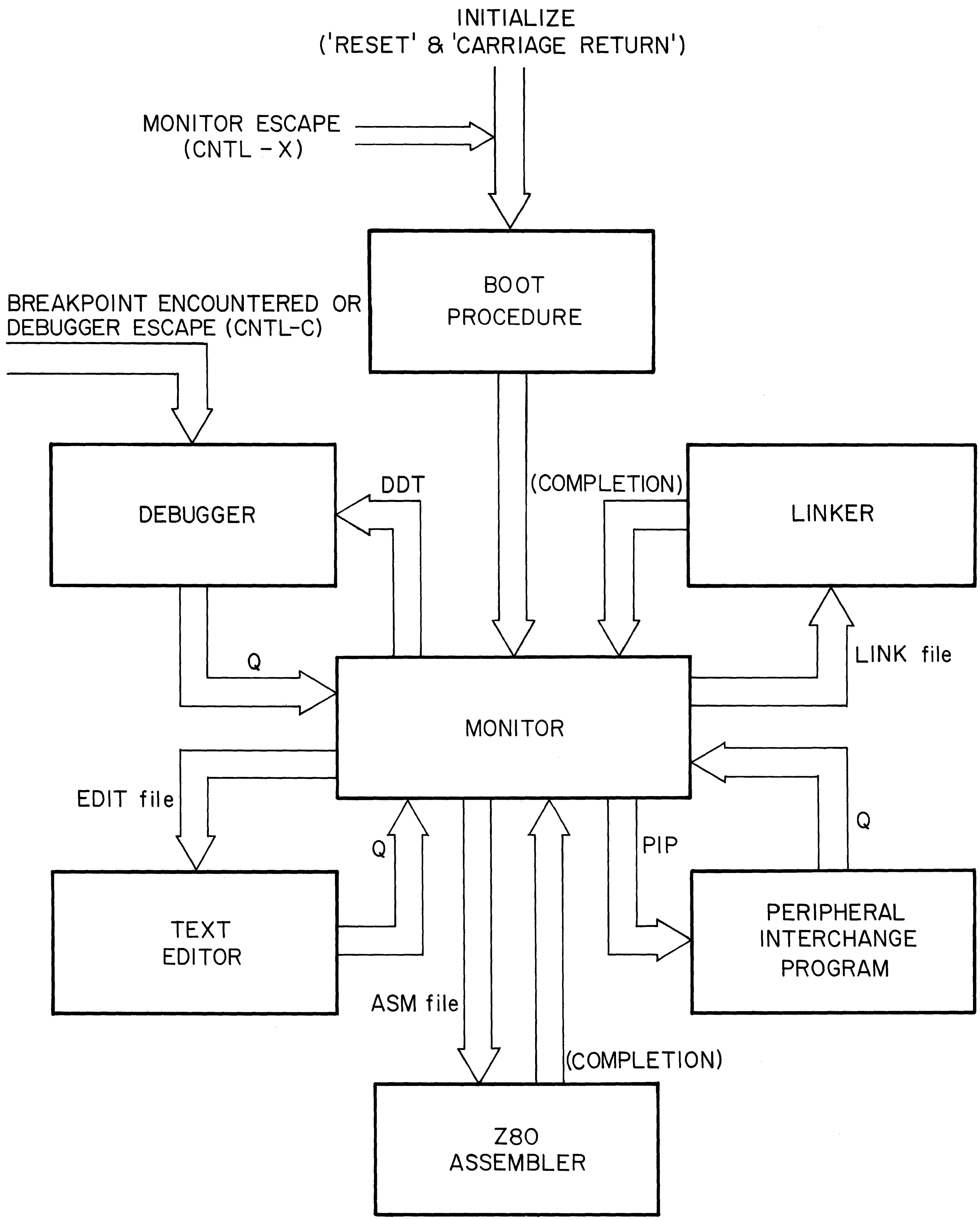
B. The user enters the date by typing first the day of the month, followed by the first three letters of the month, and then by the last two digits for the year; each item is separated from the next by a hyphen. The entered line can be edited using rub-out, backspace, and control-u. If the user enters an invalid date, a syntax error message is printed, and the date is ignored. If the user does not wish to use the date option he can enter just a carriage return.

Example: PLEASE ENTER DATE (DD-MMM-YY) 7-APR-79 (CR)

1-38. Figure 1-5 shows the relationships among the programs in FLP-80DOS. The user initializes the system by depressing the 'RESET' button on the system and 'carriage return' on his console device. The Boot Procedure reads the system software into RAM from disk and gives control to the Monitor. From the Monitor, any system program can be executed by entering its name (plus any other required information) from the console device.

The Debugger, Text Editor, and Peripheral Interchange Program can be exited by entering 'Q' (for a 'Quit'), at which point control is given back to the Monitor. The Z80 Assembler and Linker return control to the Monitor when their tasks are completed. In the system programs the system can be rebooted by entering CNTL-X (Monitor Escape) except EDIT. The Debugger can be entered

FIGURE 1-5. RELATIONSHIP OF SYSTEM PROGRAMS IN FLP-80DOS



1-39. You now have one of the most powerful Z80 development systems at your finger tips. You will probably first wish to create a file on diskette. If so, proceed to Section 4 of this manual.

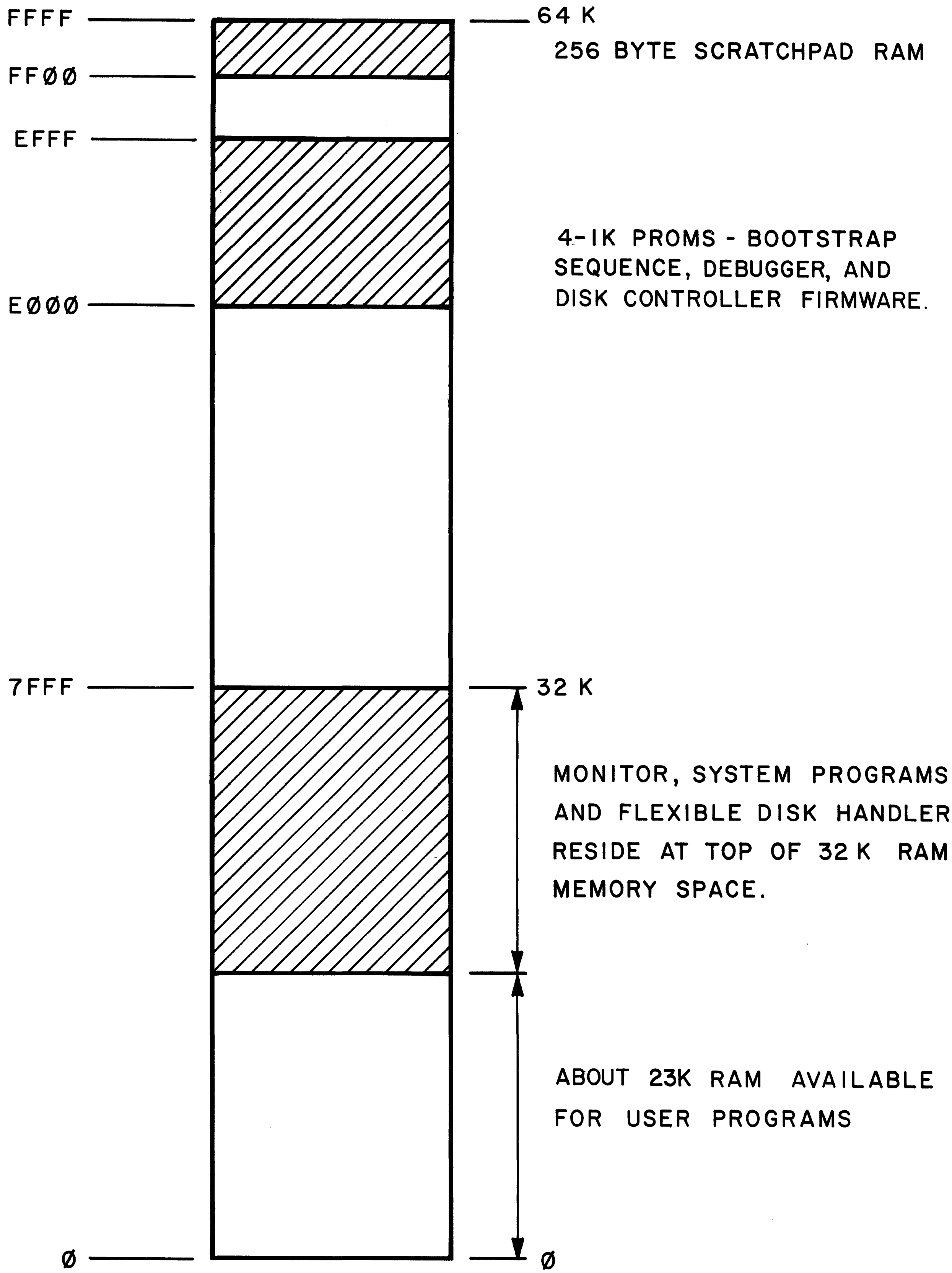
1-40. If the prompt does not appear on the console, see the troubleshooting section (Appendix D).

1-41. **MEMORY SUMMARY**

1-42. MEMORY MAP. Figure 1-5 depicts the memory map of the FLP-80DOS software. The standard system is supplied with 32K of RAM starting at address zero, 4-1K PROM's starting at $E000_H$, and 256 bytes of "scratchpad" RAM starting at $FF00_H$.

1-43. The PROM located at $EC00_H$ is the Disk Controller Firmware. It has the responsibility of translating track and sector information into commands to control the FLP-80 board. The three PROM's starting at $E000_H$ contain the power up procedure and the DDT debugger. The rest of the system software is read into the upper 9K of RAM from disk. This leaves the first 23K of RAM free for user programs and debugging (in a 32K system). The Editor, Assembler, PIP and the Linker also use this area. The 256 byte "scratchpad" RAM, located at $FF00_H$, is used by the DDT debugger and the Monitor.

FIGURE 1-6. STANDARD FLP-80DOS MEMORY MAP



1-44. PORT MAP. Figure 1-6 defines the port allocation on the SDB-80. Ports D0-D7 are the PIO ports that come out to top edge connectors on the SDB-80. Ports D8-DB are the counter timer circuit ports; port D8 is the timer for the UART baud rate. Port DE is used for controlling dataset ready (DSR), clear to send (CTS), and reader step (RS). Also, Port DE is used for sensing the state of data terminal ready (DTR), request to send (RTS), and serial bit string of measuring baud rate (used by the operating system). Ports DC and DD are the UART ports. Ports E2-E7 are the disk controller ports. MOSTEK is reserving ports $E8_H$ thru FF_H for future expansion of its development system. Ports 7C-7D are also used by the FLP-80DOS Software Version 2.1 and above. It is recommended that the user limit his development system application to ports 00_H thru CF_H. Of course, for an OEM application all 256 ports are available to the user. In the event any development system add-on peripheral would exceed the assigned number of ports, MOSTEK would start with CF_H and work down.

FIGURE 1-7. OEM-80 PORT ALLOCATION

Port	Allocation
FF – E0	FUTURE SDB-80 EXPANSION
E7	DISK CONTROLLER
E6	DISK CONTROLLER
E5	DISK CONTROLLER
E4	DISK CONTROLLER
E3	DISK CONTROLLER
E2	DISK CONTROLLER
E1	FUTURE EXPANSION
E0	FUTURE EXPANSION
DF	DEBUG CONTROL
DE	SYSTEM CONTROL
DD	UART CONTROL
DC	UART DATA
DB	CTC CHANNEL 3
DA	CTC CHANNEL 2
D9	CTC CHANNEL 1
D8	CTC CHANNEL 0
D7	PIO-D6 CONTROL
D6	PIO-D6 DATA
D5	PIO-D4 CONTROL
D4	PIO-D4 DATA
D3	PIO-D2 CONTROL
D2	PIO-D2 DATA
D1	PIO-D0 CONTROL
D0	PIO-D0 DATA
CF – 00	USER DEFINED PORTS

FIGURE 1-8. FLP-80DOS COMMAND SUMMARY

POWER UP OR RESET

Depress "CARRIAGE RETURN"

CONSOLE INTERACTON (Except DDT)

DEL	- delete the previous character
BACKSPACE	- delete the previous character.
CNTL-U	- delete the current line.
CNTL-C	- suspend operation.
CNTL-X	- abort to Monitor and reinitialize.
RETURN	- end of command line.
CNTL-I	- tab over 8 spaces.

MONITOR

$ASSIGN	lun, dataset	- assign dataset to LUN
$BEGIN	[aaaa]	- start execution at address aaaa.
$CLEAR	lun	- clear an assignment in the redirect table.
$DDT		- enter DDT, the debugger.
$DTABLE		- print default LUN table.
$DUMP	aaaa,bbbb,dataset[.OBJ]	- dump absolute object module to dataset.
$GET	dataset[.BIN]	- load binary file into RAM.
$INIT		- initialize disk.

```
$RTABLE                                  - print redirect table
                                           of LUN's.
$SAVE     aaaa,bbbb,dataset[.BIN]        - save binary file from
                                           RAM.
```

ASSEMBLER

```
$ASM   source dataset [TO listing dataset[,object dataset]]
```

OPTIONS

C - Print cross reference listing
K - no listing
L - listing (default)
N - no object output
O - object output (default)
P - pass 2 only
Q - quit - return to Monitor
R - reset symbol table (pass 2 only operation)
S - print symbol table.

DESIGNER'S DEVELOPMENT TOOL

```
$DDT
```

NOTE: The console interaction for DDT is slightly different from the rest of FLP-80DOS.
Terminator = Carriage return, ∧,/ , or dot.
The space between command and operands is printed by the system.

M aaaa,bbbb	-Display, update, or tabulate the contents of memory.
P aa	-Display and/or update the contents of an I/O port.
E [aaaa]	-Transfer control from DDT-80 to a user's program.

H ±aaaa±bbbb=...	-Perform 16 bit hexadecimal addition and/or subtraction.
C aaaa,bbbb,cccc	-Copy the contents of a block of memory to another location in memory.
B aaaa	-Insert a breakpoint in the user's program.
R 1,X	-Display the contents of the user registers x=0 short, x=1-long.
O aaaa	-Set the offset constant.
L aaaa,bbbb,cccc	-Locate all occurrences of an 8 or 16 bit data pattern.
F aaaa,bbbb,cc	-Fill memory limits with an 8 bit data pattern.
V aaaa,bbbb,cccc	-Verify that 2 blocks of memory are equal.
W aaaa,nn,xxx	-Software single step (walk) for nn steps. xx=HD means print register heading.
Q	-Quit DDT-80 and return to the system Monitor.

EDITOR

$EDIT file

An	Advance n records
Bn	Backup n records.
Cn/string1/string2/	Change n occurrences of string 1 to string 2.
Dn	Delete n records, starting with current record.
En	Exchange n records with inserted records.
Fn	Flag print option: 0=no print, not 0=print
G dataset	Get dataset and insert after current record.
I	Insert records after current record.
Ln	Line: Access record number n.
Mn	Macro: Place command string into alternate command buffer 1 or 2.

Pn dataset	Put n records out to a different dataset (file).
Q	Quit: Save the file on disk and terminate the editor.
Sn/string/	Search for nth occurrence of the string.
T	Top: Insert at top of file before the first record.
Vn	Verify n records on the console device.
Wn	Write n records with record numbers to LUN 5.
Xn	Execute alternate command buffer n (1 or 2).

In all commands, except Fn and Ln, if n is zero or if n is not entered, it is assumed to equal one (1). n can take the form n_1 thru n_2 by entering n_1 - n_2.

LINKER

$LINK dataset 1 ,..,datasetn [TO dataset B [,dataset C]]
where dataset 1 and datasetn are object files, dataset B is binary file, and dataset C is a load map and cross reference listing.

A - enter starting link address.
C - global cross reference table output to dataset C.
L - Library search on a disk unit.
S - global symbol table output to dataset C.
U - print list of undefined global symbols.

PERIPHERAL INTERCHANGE PROGRAM

$PIP
APPEND   dataset1 TO dataset 2   -append.

COPY	dataset2,...,dataset n TO dataset 1	-copy.
DATE		-examine/change date.
DIRECT	dataset 1 [TO dataset 2]	-print directory.
ERASE	dataset 1 ,...,dataset n	-erase a file.
FORMAT	name	-format a disk in disk unit 1.
INIT		-initialize disk units.
RENAME	dataset 1 TO dataset 2	-rename file.
STATUS	dataset 1 TO dataset 2	-print status of disk.
QUIT		-return to Monitor

SECTION 2

MONITOR

2-1. INTRODUCTION

2-2. The Monitor provides communication with the user via the console terminal enabling him to load and start execution of either system (e.g., PIP, EDITOR, ASM, LINKER) or user programs. In addition, the Monitor provides utility functions such as reassignment of logical unit devices and the creation of RAM image files. After power up or reset, the system automatically enters the Monitor environment awaiting entry of user commands. The prompting character for the Monitor is a $.

2-3. OPERATIONS SUMMARY

2-4. SYSTEM RESET.

2-5. The FLP-80DOS operating system may be reset by depressing the system RESET switch and then typing a "carriage return" on the console terminal. This starts the system reset sequence which first calculates the terminal baud rate and then loads the operating system into memory from the file OS.BIN[255] and begins execution at its starting address. The Monitor which is the first module in the operating system (See Figure 15-1) begins by initializing the following system parameters.

1. Default logical units 0-5
2. Logical unit redirect table
3. RAM mnemonic table (see Paragraph 15-10).
4. IOCS buffer allocation table (see paragraph 9-46)
5. All disk units containing diskettes (DK0,DK1 and etc.)

After the initialization sequence is completed, the Monitor prints the system sign on message followed by the date or a prompt to enter the date if the system does not have a valid date stored, (this will always occur after power-up). Then a $ prompt will appear on the console.

2-6. POWER UP SEQUENCE. The power up sequence is identical to reset (See paragraph 2-4).

2-7. MONITOR COMMAND SUMMARY

2-8. Some of the Monitor commands utilize dataset specifications (See para. 1-21). A dataset can consist of device specifications (e.g. PR:) or file specifications (e.g. DK1:BINDEC.OBJ). When entering a monitor command name, only the number of characters required for uniqueness must be entered. These characters are underlined in the command syntax definition. Monitor commands can be divided into the following functional categories.

1. File Creation and Loading
   SAVE - Saves a binary file on disk.
   GET - Loads a binary file into RAM.
   DUMP - Saves an absolute object file.
   BEGIN - Begins execution of a loaded program.

2. Logical Unit Assignment and Table Functions.
   $DTABLE - Lists the logical unit default table.
   $ASSIGN - Assigns the redirect of a logical unit.
   $CLEAR - Clears the redirect of a logical unit.
   $RTABLE - Lists the logical unit redirect table.

3. Miscellaneous
   $DDT - Enters DDT environment.
   $INIT - Initialize system for newly inserted diskettes.

2-9. IMPLIED RUN COMMAND. As the user types a command, its characters are entered directly into the command buffer. After a carriage return is entered, the Monitor compares the command name in the buffer with a list of Monitor commands. If a Monitor command is not entered, the Monitor assumes the command name is a binary file (extension = BIN) on the system disk. The system disk which is disk unit 0 (DK0:) is then searched for the specified file. If the file is not found, the following message is printed on the console.

    ****ERROR 04 FILE NOT FOUND

If the file is found, it is loaded and execution is started at its load address. The implied run command also enables the "minimal listener" which provides a console escape during program execution (see paragraph 2-45).

2-10. The implied run command provides the facility for loading and executing both system programs and user programs. The following commands transfer control from the Monitor to system programs which reside on the system disk (DK0:).

$EDIT	- Enter Editor
$PIP	- Enter Peripheral Interchange Program
$ASM	- Enter Assembler
$LINK	- Enter Linker

2-11. A user program can also be executed in an identical manner by entering a program filename. The filename must be a valid dataset (See Paragraph 1-21) and cannot contain imbedded blanks. A binary extension (BIN) or a blank extension which defaults to binary are the only allowed extensions. The file can reside on any supported disk unit (e.g. DK0, DK1). The following examples illustrate execution of user programs using the implied run command.

    PROG1
    DK1:PROG2.BIN

Upon entry into the user program, the DE register points to the next location (blank or carriage return) in the command buffer after the program name. Using the implied run command, a convenient facility is available for adding either new commands or user extensions to the Monitor.

2-12. COMMAND ENTRY. When entering a command from the terminal the command line may exceed the maximum terminal line length (usually 80 characters). If this occurs, the terminal output driver (TT) will automatically issue a CR and LF to enable continuation of the command on the next line. Since a carriage return input from the keyboard is interpreted by the Monitor to be the terminator of the command string, the user should not enter a carriage return until the entire command has been entered. The maximum command length is set by the command buffer size which is 160 characters.

2-13. DEFINITIONS.

1. DEFAULT TABLE - the default logical unit table. After power up or system reset a default logical unit table consisting of logical units 0 through 5 is created. This provides the user with 6 predefined I/O channels which can be used by application programs. The system subroutines RDCHR and WRCHR (see section 8) can be used for I/O transfers by specifying the logical unit in the E register. After power up or reset, logical unit 0 is always assigned the console input device (TK:) and logical unit 1 is assigned the console output device (TT:). Logical units 2-5 are initialized on power up or reset to values which are defined during the system SYSGEN procedure (See paragraph 15-12). At execution time the default table may be modified if a device is

opened after being redirected by the ASSIGN command (See paragraph 2-14). In this case system reset can be used to initialize the table.

2. REDIRECT TABLE - the logical unit redirect table. If the user wishes to change a logical unit device specification, he can redirect it to a new device using the Assign command. The redirect table consists of a list of all the currently redirected logical units.

3. BINARY FILE - A RAM-image file created by either the SAVE command or the Linker. A binary file generally contains executable machine code but may also contain data. A binary file has the extension BIN.

4. OBJECT FILE - a file created by the object output of either the Assembler or the DUMP command. The object module is in ASCII (See Mostek Object Format, Appendix B). The object module contains data and may also contain relocating and linking information for use by the Linker. An object file has the extension OBJ.

2-14. ASSIGN COMMAND

2-15. SYNTAX: ASSIGN N,Dataset

2-16. The ASSIGN command assigns a dataset to a logical unit number. This reassignment enables the user to change a logical unit device specification at run time. A dataset contains a device specification and a filename if the device is file structured. The logical unit number N is a hexadecimal number between 0 and FE (254 decimal). The ASSIGN command places the logical unit number and dataset into the Redirect Table. After an open request (See IOCS Section 9) is executed, the assigned dataset is copied into the I/O vector being referenced. All future I/O transfers for the specified logical unit number use the newly assigned dataset.

EXAMPLE 1. Assign logical unit 2 to the paper tape reader device.

$ASSIGN 2,PR:(CR)

EXAMPLE 2. Assign logical unit 0 to a batch input file containing system commands (See Section 14 for batch mode operation).

$ASSIGN 0,DKO:BATCH.CMD(CR)

2-17. BEGIN COMMAND

2-18. SYNTAX: BEGIN [aaaa]

2-19. The BEGIN command starts execution of a previously loaded program. The hexadecimal address aaaa is the starting address which may be specified by the user. If this address is not specified, execution begins at the starting address of the previously loaded program. The program starting or execution address is stored in the user's PC (program counter) register (address $FFFE_H$) after loading a program with the GET command. The BEGIN command also enables the "minimal listener" providing a console escape during program execution (See paragraph 2-45).

EXAMPLE 1. Begin program execution at location 0100_H.

$BEGIN 100(CR)

2-20. CLEAR COMMAND

2-21. SYNTAX: CLEAR [N]

2-22. The CLEAR command removes logical unit N from the redirect table. This cancels any previous reassignment of a logical unit made with the ASSIGN command. If N is not entered, all entries in the Redirect Table are removed.

EXAMPLE 1. Clear logical unit 3.

$CLEAR 3(CR)

2-23. DDT COMMAND

2-24. SYNTAX: DDT

2-25. The DDT command transfers control to the DDT environment (See Section 7).

2-26. DTABLE COMMAND

2-27. SYNTAX: DTABLE

2-28. The DTABLE command lists the default logical unit table on the console output device. After power up or reset the default logical unit table consisting of logical units 0 through 5 is created. Logical unit 0 is always assigned the console input device (TK:) and logical unit 1 is assigned the console output device (TT:). Default values for logical units 2-5 are defined when the operating system is created using the SYSGEN procedure (See Paragraph 15-12).

EXAMPLE List default logical unit table.

```
$DTABLE(CR)
LU DATASET
00 TK0:
01 TT0:
02 TK0:
03 CP0:
04 TK0:
05 CP0:
```

2-29. DUMP COMMAND

2-30. SYNTAX: DUMP aaaa,bbbb,Dataset

2-31. The DUMP command outputs the contents of memory in absolute object format (See Appendix B) to the specified output dataset. The hexadecimal address aaaa is the beginning address and bbbb is the ending address of the data in memory. The addresses aaaa and bbbb can be terminated by a comma or a space and any number of spaces may be entered between command elements. The dataset specification can be any supported output device. If the dataset is an output file, the extension must be either OBJ or blank. If the extension is not entered (blank), the Monitor assumes OBJ.

EXAMPLE 1. Create the object file BINDEC which resides between locations 1000 and 1400, then dump it to paper tape.

```
$DUMP 1000, 1400, BINDEC(CR)
$PIP(CR)
#C BINDEC.OBJ TO PP:(CR)
#Q(CR)
```

2-32. GET COMMAND

2-33. SYNTAX: GET Dataset

2-34. The GET command loads a binary file specified by the dataset into memory. The program execution address is also loaded into the user's PC (program counter) register. This enables program execution to be initiated using the BEGIN command (See Section 2-17) without specifying the starting address. The execution address of a binary file is the first address or lowest program address in memory. The dataset extension must be either BIN or blank. If the extension is not entered (blank), the Monitor assumes BIN.

EXAMPLE 1. Load the binary file BINDEC from disk unit DK0.
$GET BINDEC(CR)

EXAMPLE 2. Load the binary file PROG22 from disk unit DK1 and begin execution at the starting address.
$GET DK1:PROG22.BIN(CR)
$BEGIN(CR)

2-35. INIT COMMAND

2-36. SYNTAX: INIT

2-37. THE INIT COMMAND MUST BE GIVEN ANYTIME A DISKETTE IS NEWLY INSERTED AND THE USER WISHES TO CONTINUE EXECUTING MONITOR COMMANDS. This guarantees that the proper sector and track maps are in memory during file operations on the newly inserted diskette. If the user fails to give this command, files on the newly inserted diskette may be irretrievably lost. During power up or reset the INIT command is automatically executed by the Monitor. The INIT command may also be given from the PIP environment (See Section 3).

2-38. RTABLE COMMAND

2-39. SYNTAX: RTABLE

2-40. The RTABLE command lists the logical unit redirect table on the console output device. The redirect table contains a list of all the currently redirected logical units.

EXAMPLE List redirected logical units.
$RTABLE(CR)
LU DATASET
02 CR0:
05 DK1:FILE22.MAC[1]

2-41. SAVE COMMAND

2-42. SYNTAX: SAVE aaaa,bbbb,Dataset

2-43. The SAVE command outputs the contents of memory in a RAM image form to the disk file specified by the dataset. The hexadecimal address aaaa is the beginning address and bbbb is the ending address of the data in memory. The addresses aaaa and bbbb can be terminated by a comma or a space and any number of spaces may be entered between command elements. The dataset extension must be either BIN or blank. If the extension is not entered (blank), the Monitor assumes BIN.

EXAMPLE 1. Save the memory contents from 0 to 0100 by creating a binary file FILE1.BIN.

$SAVE 0,100,FILE1(CR)

EXAMPLE 2. Create the binary file BINDEC.BIN on disk unit 1.

$SAVE 1000,1400,DK1:BINDEC.BIN(CR)

2-44. The SAVE command creates a binary file which can be up to 255 sectors in length. Each sector contains 124 bytes allowing a maximum file length of 31620 decimal or 7B84 hexadecimal bytes. When loading a binary file the GET command loads a fixed number of sectors into memory. A save block size (bbbb-aaaa) will not always equal an integral number of sectors. This can cause (worst case) up to 123 extra bytes to be loaded beyond the end address bbbb.

2-45. CONSOLE ESCAPE

2-46. The "Minimal Listener" is a background interrupt processor which detects the console input codes Control-X and Control-C. This provides the facility for a console exit from an executing program to either the Monitor or DDT. The console escape can be a very useful tool during program debugging. The console input of Control-X suspends execution of a program and reboots the operating system returning control to the Monitor (prompt=$). A console input of Control-C suspends execution and enters DDT (prompt=.). DDT displays the program registers (similar to breakpoint) and execution can be resumed from DDT using the E command. (See Section 7-45).

2-47. The Minimal Listener is enabled only by the BEGIN and IMPLIED RUN commands (See paragraphs 2-9 and 2-17). It is disabled within the Monitor enviroment, and in the Editor and DDT.

SECTION 3

PERIPHERAL INTERCHANGE PROGRAM (PIP)

3-1. INTRODUCTION

3-2. The transferring of files and data between devices is the primary function of the Peripheral Interchange Program (PIP). PIP uses the device independent features of the I/O control system (IOCS), allowing data to be transferred from any system input device to any output device. In addition, PIP performs utility functions such as listing disk directories, renaming files, and formatting diskettes.

3-3. ENTERING PIP

3-4. The user can enter the PIP environment by typing the file name PIP as a command in the Monitor environment. The Monitor then loads the file PIP.BIN from disk unit DK0 and starts its execution. The PIP prompting character is a #. To return to the Monitor the operator enters the QUIT command as illustrated in the following example.

```
EXAMPLE     $PIP(CR)          ;Enter PIP environment
            #Q(CR)            ;Return to Monitor
```

3-5. PIP COMMAND SYNTAX

3-6. Each PIP command contains a command name followed by a command operand field. The command names which are up to 6 characters in length denote the function to be performed. Only the first character of each name has to be entered to execute the selected function.

COMMAND NAMES

APPEND	DIRECT	INIT	QUIT
COPY	ERASE	RENAME	
DATE	FORMAT	STATUS	

COMMAND SYNTAX

NAME Input Datasets(1...N) TO Output Dataset

3-7. The second part of each command is the command operand field which consists of a single dataset or a series of datasets depending upon the selected command. The keyword 'TO' has special significance in the command operand field. A dataset appearing to the right of 'TO' is defined as an output dataset. A dataset on the left of 'TO' is defined as an input dataset. There can be only one output dataset designation although there can be any number of input datasets (limited only by the command line length of 160 characters). The character '>' can be used in place of the keyword 'TO', performing the identical function.

3-8. A dataset can contain a single device (e.g. PR:) or a device, filename, extension and user number (e.g. DK1:FILE22.MAC [2]) if the device is file structured. The form of a dataset is described in paragraph 1-21. An asterisk can be used to replace the filename, extension or user number in an input dataset, but it is illegal in the output dataset. The asterisk specifies all occurrences of an element.

3-9. **APPEND COMMAND**

3-10. SYNTAX: APPEND Dataset 1 TO Dataset 2

3-11. The Append command attaches a copy of dataset 1 to the end of dataset 2. Dataset 1 remains unchanged. Both datasets must contain file structured devices (e.g.DK) and neither can be a binary file (Extension = BIN).

EXAMPLE

Append the file F1 on disk unit DK0 to the file F2 on DK0.

#APPEND F1 TO F2(CR)

3-12. COPY COMMAND

3-13. SYNTAX: COPY Dataset 2,.....Dataset N TO Dataset 1

3-14. The Copy command can be used for a variety of purposes such as listing files, concatenating individual files, or copying all the files from one device (e.g. DK0) to a second device (e.g. DK1). The Copy command copies the contents of the input datasets (Datasets 2,..,N) to the output dataset (Dataset 1). If the file in the output dataset already exists, the following message appears on the console:

Dataset, ALREADY EXISTS
ERASE?

If the operator responds by entering a Y (followed by a carriage return) PIP deletes the file in the output dataset. The input datasets are then copied to the output dataset, assuming its name. No action is performed if a response other than Y is given. If a file specified in the input datasets does not exist, the following message is sent to the console:

Dataset, NO SUCH FILE

3-15. The Copy command does not permit binary (extension = BIN) and non-binary file types to be mixed. If an attempt to copy a binary file to a source file is made, the error message INCOMPATIBLE EXTENSIONS is output to the console.

3-16. If a Copy is executed to a file-structured device with no filename (e.g.DK1), then the filename, extension and user number of the input dataset remains unchanged after transfer to the output device. However, if a filename is specified in an output dataset, the input datasets are concatenated and copied to the output file. In any case the file date of the output file will be the same as in the input file.

3-17. An asterisk can be used to replace the filename, extension, or user number in a Copy input dataset. The asterisk specifies all occurrences of an element. If an asterisk is specified in an input dataset, PIP automatically prints on the console each input file as it is copied. In order to illustrate the many possible uses of the Copy command, the following examples are given, classified according to output dataset types.

EXAMPLE 1. Copy to a non-file structured output device.

a. Transfer data from the paper tape reader to the paper tape punch. Input data from the paper tape reader is terminated by either an EOF mark of 04_H or by 50 trailing nulls after the end of data.

   #COPY PR: TO PP:(CR)

b. List the contents of FILE1 on DK1 to the line printer.

   #C DK1:FILE1 TO LP:(CR)

EXAMPLE 2. Copy to a file structured device with no filename (e.g.DK1:).

a. Transfer the files F1, F2 and F3 from disk unit DK0 to disk unit DK1.

   #C F1,F2,F3 TO DK1:(CR)

b. Transfer all files from disk unit DK0 to disk unit DK1. The diskette in DK0 contains 5 files.

```
#C *.*[*] TO DK1:(CR)
DK0:ASM   .SRC[1]
DK0:ASM   .BIN[1]
DK0:PIP   .BIN[1]
DK0:EDIT  .SRC[1]
DK0:EDIT  .BIN[1]
```

c. Copy all the files with the extension SRC from user number 1 to user number 2.

   #C *.SRC[1] TO DK0:[2] (CR)

DK0:ASM   .SRC[1]
DK0:EDIT .SRC[1]

EXAMPLE 3. Copy to a specified filename on a file structured device.

a. Copy FILEA.OBJ on DK1 to FILEB.OBJ on disk unit DK0.
#C DK1:FILEA.OBJ TO FILEB.OBJ(CR)

b. Concatenate the three source files F1,F2 and F3 and copy them to F123.
#C F1,F2,F3 TO F123(CR)

3-18. DATE COMMAND

SYNTAX: DATE

The DATE command is used to examine and/or modify the system's date. After entering the command, the date on the system will be printed if it exists and the following message will allow you to change it if desired:

ENTER DATE (DD-MMM-YY)

If only a carriage return is entered then the current system date is retained. Otherwise, type the day of the month first, then the first 3 letters of the month, and then the last 2 digits of the year with each item separated by a dash (-). This date will be stored in the directory of non-binary files when they are created or updated for reference by the user and will be displayed by a Directory command (see DIRECT).

3-19. DIRECT COMMAND

3-20. SYNTAX: DIRECT [Dataset 1 TO Dataset 2]

3-21. The DIRECT command is used to list the directory of disk devices. The input dataset (Dataset 1) is used to specify the disk unit (DK0,DK1 and etc.) for which the directory listing will be generated. If the input dataset is omitted, DK0 is assumed. If a filename, extension or user number is specified, only those files with the specified filename, extension and user number will be listed. An asterisk can replace a dataset element (e.g.Filename=*) to specify all or every occurrence of that element (e.g. All Filenames). The output dataset (Dataset 2) is optional and can be used to output the directory listing to any specified device. The default output device is the console.

3-22. The heading of the directory listing contains the disk unit (e.g. DK0) and the Diskette Name which were entered when the disk was formatted (See Paragraph 3-27). A file is identified in the directory by its filename, extension and user number. The directory listing also specifies the number of records used by each file and the starting track and sector location of the file, and the date of creation or last update.

To prevent information from being scrolled off the screen when listing large directories to a video terminal, the listing may be stopped by entering a space from the keyboard. The listing will resume when a second space is entered. The following examples illustrate the DIRECT command.

EXAMPLE 1. List entire directory of system disk on the console device.

```
 #D(CR)
DIRECTORY DK0: DISKETTE BACK UP 1     Listed on 8-MAR-79
FILENAME EXT USER RECORDS TRK SECT         Date
PIP     .BIN   1     25   09H 01H
BINDEC  .SRC   1      5   0BH 04H         4-MAR-79
```

```
    BINDEC  .OBJ   1    3   OBH OBH        4-MAR-79
    BINDEC  .BIN   1    2   OBH OEH
    #
```

EXAMPLE 2. List all files of disk unit 1 with the extension OBJ on the line printer.

```
#D DK1:*.OBJ[1] TO LP:(CR)
DIRECTORY DK1: DISKETTE BACK UP 2       On 15-Jun-79
FILENAME EXT USER RECORDS TRK SECT           Date
FADD    .OBJ   1     3    09H 01H         10-APR-79
FMUL    .OBJ   1     3    09H 04H         1 -JUN-79
  #
```

3-23. ERASE COMMAND

3-24. SYNTAX: ERASE Dataset 1 [, Dataset 2 ,...,Dataset N]

3-25. The Erase command removes the specified file or files from the disk unit and makes the space available for use. A filename must be entered for the ERASE command. The extension and user number if not entered will default to a blank extension and a user number of 1. After the ERASE command is entered, PIP will print the following message on the console:

    ERASE?

If the operator responds by entering a Y (followed by a carriage return) PIP deletes the specified file or files. No action is performed if a response other than Y is given. If the file specified in the dataset does not exist, the following message is sent to the console:

    Dataset, NO SUCH FILE

3-26. An asterisk can be used to replace the filename, extension or user number in the dataset to be erased. The asterisk specifies all occurrences of an element. The following examples illustrate the ERASE command:

EXAMPLE 1. Erase the files F1 and F2 on the disk in DK0. Note the device defaults to DK0 and the user number to 1.

#ERASE F1,F2(CR)

EXAMPLE 2. Erase an object file from DK1 with a user number of 3.

#ERASE DK1:F1.OBJ[3](CR)

EXAMPLE 3. ERASE all binary files (EXT=BIN) with a user number of 1 on DK1.

#ERASE DK1:*.BIN(CR)

EXAMPLE 4. Erase all files on disk DK0.

#ERASE *.*[*](CR)

3-27. FORMAT COMMAND

3-28. SYNTAX: FORMAT Name

3-29. The Format command formats each track and sector of a diskette in unit DK1 with the information necessary for proper accessing of data from the disk. The operand name used by the Format command gives each formatted disk an identifier for future reference. The name is eleven characters in length and can contain any printable characters. The DIRECT and STATUS commands output this name as a part of their headings to aid in referencing individual diskettes. After the FORMAT command is entered, PIP will print the following message on the console:

FORMAT?

If the operator responds by entering a Y (followed by a carriage return) PIP formats the diskette in unit DK1. No action is performed if a response other than Y is given.

3-30. To provide additional file protection, it is recommended that each diskette be formatted with a unique name. The disk operating system prior to an Erase or Close operation verifies that the name of the diskette in a unit (DK0 or DK1) agrees with the name of the last previously initialized diskette in that unit. All disk units are initialized when entering PIP from the Monitor or after execution of the INIT command (See paragraph 3-34).

3-31. Formatting of a diskette initializes all sectors making them available for use (See STATUS paragraph 3-41). A disk must be formatted before it can be used the first time in the system. An unformatted diskette should not be inserted into the the system until just prior to execution of the format command. A previously used diskette can be reformatted; however, any files on the diskette will be destroyed.

3-32. The format command requires that an operational system disk is resident in unit DK0. A system disk is defined as a previously formatted disk containing the required operating system programs. The diskette to be formatted is placed in disk unit 1. The system programs are automatically copied to the new diskette in DK1 during the execution of format.

3-33. The following examples illustrate the Format command:

EXAMPLE 1. Format the disk in unit DK1 giving it a name of BACK UP 1.

#<u>FORMAT BACK UP 1(CR)</u>

EXAMPLE 2. Format a new disk and also copy the FLP-80DOS Assembler, Editor, Linker and PIP programs to the newly-formatted disk.

#<u>FORMAT SYS DISK 1(CR)</u>

#C ASM.BIN, EDIT.BIN, LINK.BIN, PIP.BIN TO DK1:(CR)

NOTE: Using the above procedure the user can generate his own system disks containing only the system application programs (E.G.ASM and PIP) which he desires.

3-34. INIT COMMAND

3-35. SYNTAX: INIT

3-36. The Init command should be issued any time a new diskette is inserted and the user wishes to continue executing PIP commands. This guarantees that the proper sector and track maps are in memory during file operations on the newly inserted diskette. When entering PIP from the Monitor, the Init command is automatically executed by PIP.

3-37. RENAME COMMAND

3-38. SYNTAX: RENAME Dataset 1 TO Dataset 2

3-39. The Rename command is used to change the name of a specified file. The filename, extension and user number in Dataset 1 is changed to the filename, extension and user number in Dataset 2. If the file in the output dataset (Dataset 2) already exists, the following message appears on the console:

    Dataset, ALREADY EXISTS
    ERASE?

If the operator responds by entering a Y (followed by a carriage return) PIP deletes the file in Dataset 2. The file in Dataset 1 is then renamed to the name specified in Dataset 2. No action is performed if a response other than Y is given.

3-40. The RENAME command does not permit a binary extension (BIN) to be changed to a nonbinary extension or a nonbinary extension to be changed to a binary extension. The following examples illustrate the Rename command:

EXAMPLE 1. Rename the file FILE1 on disk unit DK0 to FILE2.SRC.

#RENAME FILE1 TO FILE2.SRC(CR)

EXAMPLE 2. Rename the file FILEX1.OBJ on disk unit DK1.

#RENAME DK1:FILEX1.OBJ[1] TO DK1:FILEX2.OBJ[3](CR)

3-41. STATUS COMMAND

3-42. SYNTAX: STATUS [Dataset 1 TO Dataset 2]

3-43. The Status command is used to list the diskette name, the total number of sectors available, the number of sectors used and the number of bad sectors. The diskette name which identifies the individual disk is entered when the disk is formatted (See paragraph 3-27). The input dataset (Dataset 1) of the status command identifies the disk unit (DK0 or DK1) for which status is desired. The output dataset is optional and can be used to output the status listing to any output device. The default is the console device. The following examples illustrate the STATUS command.

EXAMPLE 1. List the status of disk unit DK1 to the line printer.

```
#STATUS DK1: TO LP:(CR)
STATUS DK1: DISKETTE BACK UP 2
SECTORS AVAILABLE   1668
SECTORS USED         152
SECTORS BAD            0
```

EXAMPLE 2. List the status of disk unit DK0. Note if the input dataset is not specified it defaults to DK0.

```
The diskette name is 'BACK UP 1'
#S(CR)
STATUS DK0: DISKETTE BACK UP 1
SECTORS AVAILABLE   1020
SECTORS USED         800
SECTORS BAD            0
```

3-44. QUIT COMMAND

3-45. SYNTAX: QUIT

3-46. The Quit command exits PIP and returns control to the FLP-80DOS Monitor.

SECTION 4

FLP-80DOS TEXT EDITOR (EDIT)

4-1. INTRODUCTION

4-2. The FLP-80DOS Text Editor assists the user in origination and modification of assembly language source programs and English text documentation. The Editor resides on the FLP-80DOS System Diskette. It permits random access editing of ASCII diskette files. The Editor is designed for usage with the MOSTEK FLP-80 system, but it can be adapted to other systems for OEM uses.

4-3. CAPABILITIES

4-5. The FLP-80DOS Text Editor permits random access editing of ASCII diskette files on a line and character basis. Whole lines and character strings embedded within lines can be accessed, changed, deleted, or added to an existing or new diskette file. The size of the file to be edited is limited only by diskette capacity. All I/O operations to the diskette are transparent to the user.

4-5. SOFTWARE CONFIGURATION

4-6. The Editor is resident on diskette. When loaded, it starts at RAM address zero. Figure 4-1 shows the memory map for the Editor. Editor buffers and variables are placed in RAM between the top of the Editor and bottom of the Flexible Disk Handler.

4-7. The Editor uses Logical Unit Numbers 0 and 1 for console interaction and Logical Unit Number 5 for outputting records with line numbers. Logical Unit Number 5 is typically assigned to a line printer device. All I/O to the disk is via LUN FF_H, which cannot be reassigned via the Monitor 'ASSIGN' command. Figure 4-2 depicts this structure.

4-8. DEFINITIONS

1. SOURCE - ASCII characters comprising a Z80 assembly language program or some other text.

2. RECORD - A single source statement ending with a carriage return.

3. FILE - A diskette file which contains the source.

4. POINTER - the position in the source where the next action of the Editor will be initiated.

5. CURRENT RECORD - the record in the source pointed to by the pointer.

6. RECORD NUMBER - the decimal number of a record, beginning at one (0001) for the first record in a file and increasing sequentially for each record.

7. INSERT - Installation of record(s) in a file immediately following the current record. Inserted records are assigned sequentially increasing line numbers.

8. DELETE - removal of the current record from a file.

FIGURE 4-1. EDITOR MEMORY MAP

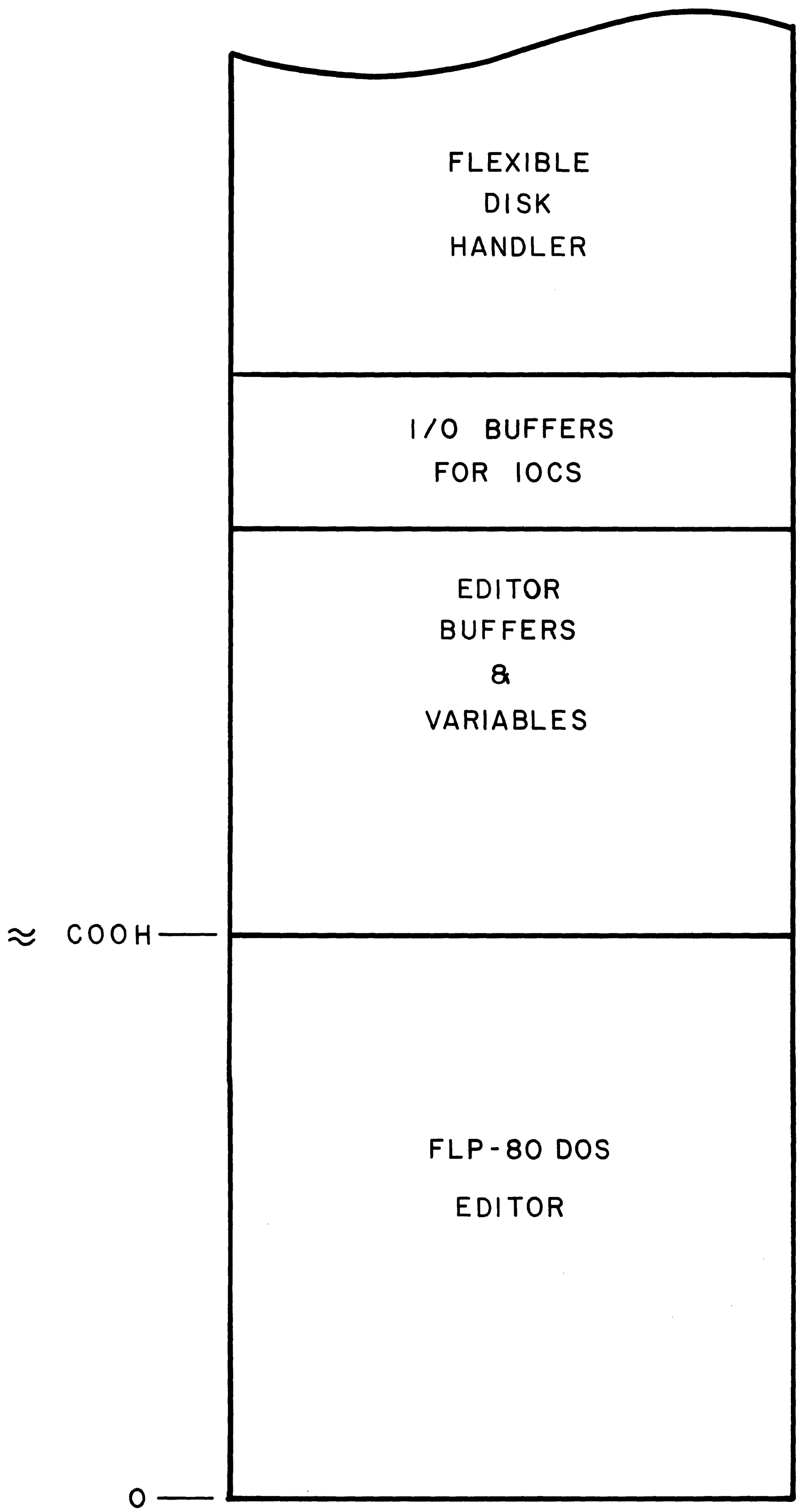
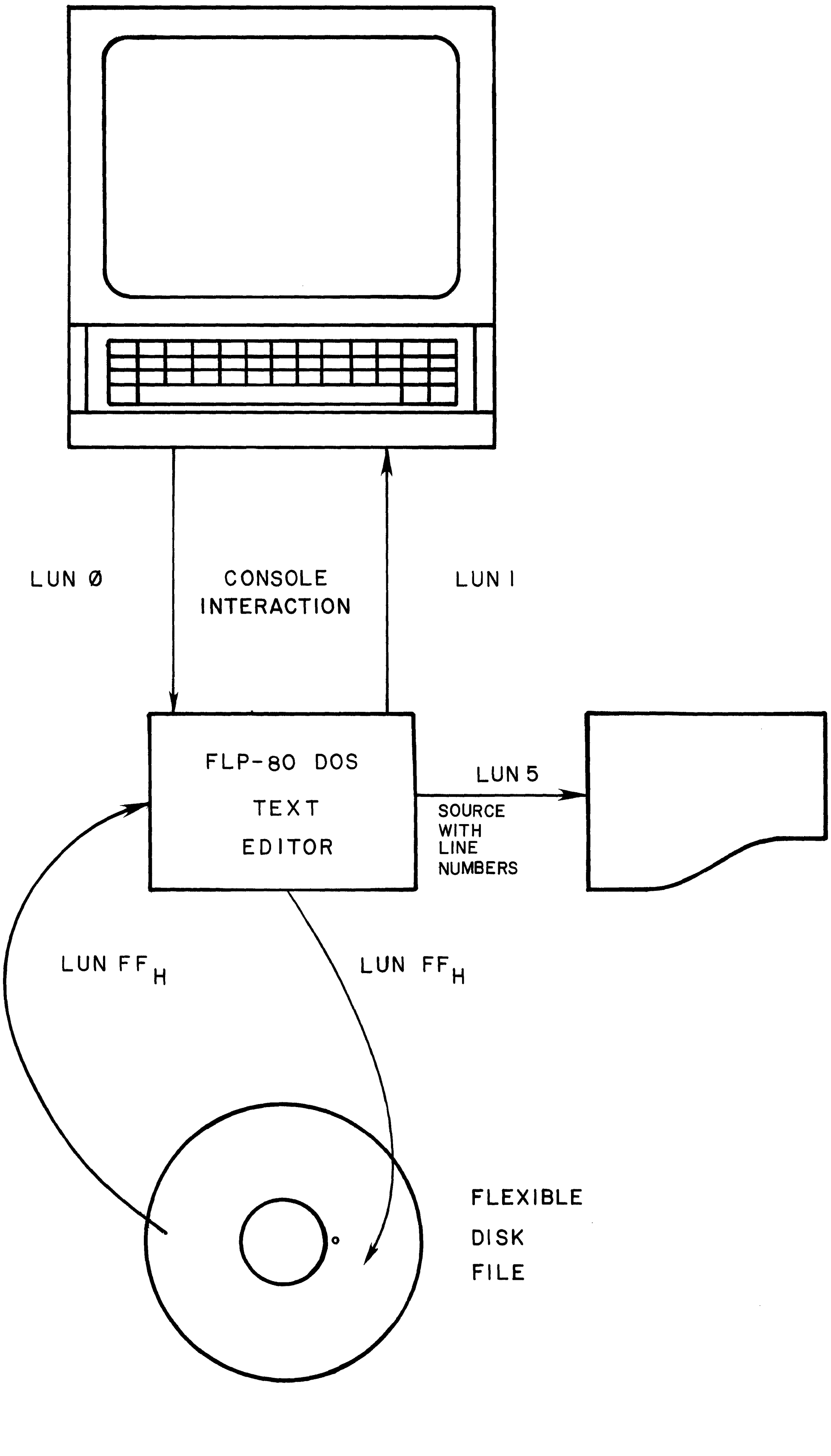


FIGURE 4-2. LOGICAL UNIT NUMBER STRUCTURE



4-9. USING THE TEXT EDITOR - CONSOLE INTERACTION

4-10. All user interaction with the EDITOR is via the console device. The Editor issues prompts and messages to direct the user. The user responds by entering commands or data via the console keyboard. Each command or data record is terminated by a carriage return. The user can modify a record before depressing carriage return with the following console keys:

1. DEL: RUBOUT (ASCII $7F_H$). Delete the previous character. Successive characters may be deleted by entering more than one 'rubout'. The characters which are deleted will be printed on the console device between two backslash characters (\).

2. CNTL-H: BACKSPACE (ASCII 08_H). Performs the same function as RUBOUT, but the backslash is not printed on the console device.

3. CNTL-U: NEGATIVE ACKNOWLEDGE (ASCII 15_H). Deletes the current line of entered information and reprompts the user for a new record of input.

4-11. USING THE TEXT EDITOR - ENTERING COMMANDS

4-12. When the Editor prompts for a command (>), the user may enter commands via the console. Modification of the input is allowed with RUBOUT, BACKSPACE, and CNTL-U functions. All commands can be entered in lower case as well as upper case. Multiple commands may be entered on one line if they are separated from each other by blanks or commas. A command line is terminated by a carriage return. A command line may have up to 80 characters in it, including carriage return.

```
EXAMPLE   >I(CR)
                    - insert mode command
          >B  I(CR)
                    - backup and insert
          >b  i(CR)
                    - backup and insert
          >L10(CR)
                    - go to line number 10.
          >L 10,I(CR)
                    - go to line 10 and insert.
```

Several commands allow an operand n to be entered with the command. The operand may be a decimal number in the range 0-9999. It may be entered immediately following the command or separated from the command by one or more blanks or commas.

```
EXAMPLE
          >L 10(CR)
          >L10(CR)
                    - go to line number 10.
```

Alternatively, the operand may be two decimal numbers separated by a minus sign. In this case, the line number specified by the first number is accessed, then the operation is performed from that line through and including the line specified by the second number. If the first number is greater than the second number, then an error prompt is printed and the command is not done.

EXAMPLE >V10-20(CR)

- verify lines numbered 10 through 20 on the user console.

4-13. USING THE TEXT EDITOR - FIRST STEPS

4-14. The FLP-80DOS Text Editor is executed by the following monitor command:

$EDIT filename(CR) - where filename is the name of the disk file to be edited.

The Editor responds with the following message:

FLP-80DOS EDITOR V2.1

If the user does not enter the filename with the EDIT command, then the Editor requests it:

ENTER FILE NAME TO BE EDITED>

The user then types in the name of the file to be edited. If the file does not exist, then a new one with that name is created.

EXAMPLE: $EDIT DK1:MYFILE(CR)

EXAMPLE: $EDIT NEWFIL.SRC(CR)

- defaults to device DK0:.

EXAMPLE: $EDIT(CR)

ENTER FILE NAME TO BE EDITED>NEWFILE(CR)

The only restriction on the file name is that it cannot have extension 'BIN' or extension 'TMP'. Further, files with extension 'OBJ' are reserved for object files.

If the file does not exist, then the Editor outputs the following message:

```
-->NEW FILE
0001<
```

- Editor prompts for insert records (see "INSERT COMMAND").

At the end of Editing, the new file will automatically be created. If the file does exist on disk, then editing of that file will be done. The Editor prompts for a command:

```
>
```

- Editor prompts for a command. See list of commands.

4-15. USING THE TEXT EDITOR - BASIC COMMANDS

4-16. I - INSERT

FORMAT: >I(CR)

or

>i(CR)

This command is used to insert records following the current record or to build new files.

The Editor responds with:

```
-->INSERT MODE
```

The user then enters records ending with carriage returns. After each record which is inserted, the Editor reprompts with the next line number. To terminate the insertions, the user enters a single carriage return. Note that blank lines must be entered as 'space, carriage return' because a single carriage return terminates the insert mode. If an unprintable character is entered, than a warning message is printed on the console. After the user terminates the insert mode, the Editor prompts for a new command (>).

EXAMPLE	>I(CR)	-user selects insert mode.
	-->INSERT MODE	-Editor prompts user.
	0002<THIS IS AN INSERTED LINE (CR)	-user enters record to be inserted.
	0003<(CR)	-user terminates insert mode.
	>	-Editor prompts for another command.

Note that modification of entered records can be done with RUBOUT, BACKSPACE, and CNTL-U. Inserted records are automatically assigned sequential record numbers. Inserted records can be up to 160 characters long, including the carriage return.

4-17. An - ADVANCE

4-18. This command is used to advance the record pointer a specified number of records.

```
Format:    or > An(CR)
              > an(CR)
```

If n is zero or if n is omitted, the pointer will be positioned to the next record in the file. The record which is accessed is printed on the console after this command.

```
EXAMPLE  > A5(CR)             - advance record pointer 5 records.
         0015 ANY STATEMENT   - the new current record of the file
                                is printed on the console device
                                by the Editor.
EXAMPLE  > A(CR)              - advance to next record.
         0016 NEXT STATEMENT  - the next record in the file is
                                printed.
```

4-19. Bn - BACKUP

```
FORMAT:     or > Bn(CR)
               > bn(CR)
```

This command is used to backup the record pointer a specified number of records.

If n is zero or if n is omitted, then the pointer is position to the previous record in the file. The record which is accessed is printed on the console after this command.

```
EXAMPLE  > B3(CR)             - backup record pointer 3 records.
         0012 SOME STATEMENT  - the new current record of the file
                                is printed on the console device
                                by the Editor.
EXAMPLE  > B(CR)              - backup to previous record.
         0011 A STATEMENT     - the previous record in the file is
                                printed.
```

4-20. Dn - DELETE

```
FORMAT:    or  > Dn(CR)
               > dn(CR)
```

This command deletes the specified number of records from the file starting with the current record.

If the the constant n is not entered or if n is equal to zero, only the current record will be deleted.

EXAMPLE > D5(CR) - the current record and the following 4 records will be deleted from the file.

EXAMPLE > D(CR) - only the current record will be deleted from the file.

4-21. Ln - GO TO RECORD NUMBER n

FORMAT: or > Ln(CR)
> ln(CR)

This command positions the pointer to the record numbered n.

The constant n must be entered and it must be greater than zero. The record which is accessed is printed on the console device.

EXAMPLE > L10(CR)
0010 LINE NUMBERED 10.

If the record number cannot be found because it is larger than the last record number in the file, then the pointer will be positioned at the last record of the file.

EXAMPLE > L2001(CR)
-->EOF
0943 LAST LINE OF FILE

4-22. Vn-VERIFY

FORMAT: or > Vn(CR)
> vn(CR)

This command prints the specified number of records on the console device. The record pointer is updated to the last record printed. If n is zero or if n is not entered, one record (the current record) is printed on the console. Unprintable characters are printed as dots (.) to identify them.

EXAMPLE > V2(CR)

0005 CURRENT STATEMENT

0006 NEXT STATEMENT

- two records are verified, i.e., printed on the console device. The current record is number 6.

4-23. TEXT EDITOR ADVANCED COMMANDS

4-24. Cn /string1/string2/- CHANGE

FORMAT: > Cn /string 1/string 2/(CR)

or > cn /string 1/string 2/(CR)

where n indicates the number of occurrences to change, string 1 represents the characters to be changed, string2 represents the substitute or new characters, and / represents a delimiter character which does not appear in either string.

This command changes the next n occurrences of character string 1 to string 2 starting with the current record. Any character which does not appear in either string 1 or string 2 may be used as a delimiter. All three delimiters must be identical. If n is zero or if n is not entered, then only one occurrence of string 1 is changed. Each record which is changed will be printed on the console device. If string 2 is not entered, then string 1 will be deleted when it is found. The record pointer will be positioned at the record of the last occurrence of the change. If n is one or is not entered, then only the current record will be searched for string 1. If string 1 is not present, then a question mark prompt will be printed and the record pointer will remain at the same record:

```
          ?>
```

For n greater than 1, if string 1 is not found before the end of the file, then an end-of-file warning message is printed on the console and the pointer will be positioned at the last record in the file.

```
EXAMPLE    > V(CR)
           0010 THIS IS A RECORD.
           > C /THIS/THAT/(CR)
           0010 THAT IS A RECORD.
           > C /IS/WAS/(CR)
           0010 THAT WAS A RECORD.
           > C /WAS A /(CR)
           0010 THAT RECORD.
           > C2 /T/V/(CR)
           0010 VHAV RECORD.

EXAMPLE    > C2/XENON/ARGON/(CR)
           --> EOF
                  -The string 'XENON' cannot be found by the
                   Editor.
```

4-25. En - EXCHANGE

```
FORMAT:    > En (CR)
        or > en (CR)
```

This command exchanges the specified number of records (starting with the current record) with records to be inserted. It is exactly equivalent to the command sequence:

```
>Dn (CR)          - delete n records.
>B1 (CR)          - back up one record.
>I (CR)
-->INSERT MODE    - enter insert mode.
```

4-26. Fn - PRINT FLAG OPTION

```
FORMAT:   >F0 (CR)      - n=0, inhibit printing after all but
       or >f0 (CR)        the 'Vn-VERIFY' command.
          >Fn (CR)      - n not=0, allow printing after all
                          change
          >fn (CR)        or access commands.
```

The Editor normally prints on the console device any record which is accessed or changed. Thus, the following commands print out a record: An, Bn, Cn, Ln, Sn, Vn. In order to reduce print out time on a slower console device (such as a teleytype), this command can be used to inhibit print out on all of the commands except Vn - VERIFY.

4-27. G dataset - GET RECORDS FROM DATASET

```
FORMAT:   >G dataset (CR)
       or >g dataset (CR)
```

The command inputs records from a dataset (which must be a disk file) and inserts then in sequence after the current record. A carriage return must follow the dataset specification.

```
EXAMPLE   > G FILEX(CR)
            -get records from FILEX in DKO: and insert them
             after the current record in the file being
             edited.
```

4-28. Mn - MACRO

```
         > M1(CR)
       or> m1(CR)
         > M2(CR)
       or> m2(CR)
```

This command allows a command string to be entered into one of two alternate command buffers (labeled '1' and '2'). The alternate command buffers will accept character strings of 80 characters or less. The Editor responds with the following prompt:

```
EXAMPLE    > M1 (CR)
           1>S /OLD/ D1 B1 (CR)
```

- The user enters into alternate command buffer 1 the commands which:
  1. Search for the 1st occurrence of the string 'OLD', starting with the next record.
  2. delete that record.
  3. backup one record.

4-29. Pn dataset - PUT N RECORDS TO DATASET

```
FORMAT:  > Pn dataset (CR)
      or > pn dataset (CR)
```

This command outputs the specified number of records (starting with the current record) to a dataset which must be a disk file. If n is zero or n is not entered, then only the current record is output. The records which are output are not deleted. If the file being output to exists, it will be erased before any records are written to it. This command may be used with the G(GET) command to move records around in a file. A carriage return must follow the dataset specification.

EXAMPLE

>P25 XFILE (CR)

- output the next 25 lines in the file being edited to a new file named XFILE on DK0:

>P100-125DK1:FILE1(CR)

- output lines 100 through 125 from the file being edited to file DK1:FILE1.

4-30. Sn /source image/ - SEARCH

FORMAT: > Sn /source image/ (CR)

or> sn /source image/ (CR)

where n is the number of the occurrence, source image represents any set of characters which is to be search for, and / represents a delimiter character which does not appear in the string.

This command searches the file, starting with the next record, for the nth occurrence of the character string between the delimiters. The pointer is then positioned at the record in which the string is found. This command always searches forward in the file. Any character which does not exist in the source image may be used as delimiter. Both the starting and terminating delimiters must be identical. If n is zero or n is not entered, then the first occurrence of the source image will be sought. The record in which the source image is found will be printed on the console. If the string is not encountered before the end of the file, then an end-of-file warning is printed on the console device and the pointer will be positioned at the last record in the file.

EXAMPLE > S /ORD/ (CR)
0023 SOME RECORD DATA
- Editor searches forward for the character string 'ORD', finds the 1st occurrence, and prints the record on the console.

EXAMPLE > S10 /9AH/(CR)
-->EOF
0048 LAST RECORD -Editor could not find the tenth occurrence of the string '9AH'. A warning is printed indicating end-of-file and the last record in the file is printed.

4-31. T - INSERT AT TOP

FORMAT: >T(CR)
or >t(CR)

This command inserts records at the top of the file before the first record. See the 'I - INSERT' command for proper usage.

4-32. Wn - WRITE

FORMAT: >Wn (CR)
or >wn (CR)

This command performs the same function as the VERIFY command, except that output is directed to LUN 5 which is typically assigned to a line printer device via the following monitor command before the Editor is used:

$ASSIGN 5,LP:(CR)

4-33. Xn - EXECUTE

> X1 (CR)
or > x1 (CR)
> X2 (CR)
or > x2 (CR)

This command executes the commands stored in the alternate command buffer numbered 1 or 2. After an alternate command buffer has been executed, control is returned to the Editor which prints a prompt for a new command (>). The alternate command buffer is not destroyed during the operation. If n is equal to zero or is not entered, then alternate command buffer 1 is selected.

```
EXAMPLE       > M1 (CR)
              > S /OLD/ D1 B1 (CR)
              > X1 (CR)
              0010 FIRST OCCURRENCE OF OLD.
                  - 'OLD' is located and the record is deleted.
              0009 LINE NUMBER 9.
                  - Backup command  prints its record.
```

NOTE The pseudo-macro command capability is executed by the 'M' and 'X' commands. The user puts his macro command string into alternate buffer 1 or 2 and executes that macro string via the 'X' command.

4-34. EDITING LARGE FILES

4-35. Editing of larges file is no different than editing small files. All commands are fully functional. However, diskette access may be required for certain operations and a delay may be apparent before the Editor responds.

4-36. EDITOR MESSAGES

4-37. If the user enters on unrecognizable file name, a syntax error will be indicated and the Editor will reprompt for another file name.

EXAMPLE ENTER FILE NAME TO BE EDITED>LAST=1(CR)

```
*****SYNTAX ERROR
ENTER FILE NAME TO EDITED>
```

4-38. If the user enters an unrecognizable command, then the Editor will print a question mark and another prompt.

```
EXAMPLE    > R20 (CR)
           ?>
```

If the user enters the same name for a put file as the name of the file being edited during a PUT command, the Editor will print: -->USE DIFFERENT FILE NAME FOR PUT and it will reprompt for a new command: ?>

4-39. All I/O errors to and from disk result in termination of the Editor with an appropriate error message. The original file should be backed up on another diskette before using the Editor.

4-40. The Editor prompts the user with several messages to the console device.

--> NEW FILE
- indicates that a new file is being created rather than editing of an old file.

--> INSERT MODE
- indicates that records of data are to be entered rather than Editor commands.

--> TOF
- indicates that the top of file (beginning of file) has been encountered.

--> END OF EDITING
- indicates that the Editor has successfully completed. Control is then returned to the FLP-80DOS Monitor.

--> PLEASE WAIT.
- indicates that a long disk access is taking place.

--> END OF WINDOW. USE 'ADVANCE' TO SEE NEXT RECORD.
- occurs only with VERIFY command. Follow the directions.

-->IS THE OUTPUT DEVICE READY ? (Y/N)

- occurs after the issue of a W command to alert the user that the I/O device assigned to LUN 5 must be configured to his system.

-->THERE MAY NOT BE ENOUGH SPACE IN DISK TO EDIT YOUR FILE. DO YOU WISH TO CONTINUE? (Y/N)

- occurs only if at the start of the editing session the free space on the diskette unit of the input file is not at least equal to 125% of the size of the input file. It serves as a warning against the possible loss of that file because of a disk-full error. (Error 0B).

4-41. SAMPLE EDITING SESSION

4-42. The user is urged to follow the steps given here to become acquainted with the FLP-80DOS Editor.

$EDIT NEWONE(CR)

-user selects to use FLP-80DOS Editor.

(There will be a slight delay while the Editor is read into RAM from disk.)

FLP-80DOS EDITOR V2.1

- user selects to create a new file on DK0: (disk unit zero), with file name 'NEWONE' and no extension.

--> NEW FILE

--> INSERT MODE

0001 < TITLE ECHO PROGRAM (CR)

- Editor prompts for records to be input via the console. User begins keying in a program.

0002< ; THIS PROGRAM READS A CHARACTER (CR)

0003< ; FROM THE CONSOLE AND ECHOS IT.(CR)

0004< ; CNTL-U RETURNS CONTROL TO THE MONITOR.(CR)

0005< ; (CR)

```
0006<    INCLUDE SYSLNK (CR)
0007<    LD E,0 ; CONSOLE LUN (CR)
0008<LOP CALL RDCHR ; READ A CHARACTER (CR)
0009<    CP 15H ; CHECK FOR CNTL-U (CR)
0010<    JP Z,7A00H ; IF SO, RETURN TO MONITOR(CR)
0011<    CALL WRCHR ; ELSE ECHO IT (CR)
0012<    JR LOOP-$ ; AND LOOP FOR MORE (CR)
0013<    END (CR)
0014<(CR)
```

- user terminates insert mode operation

```
>B99V20(CR)
```

- user goes to beginning of file and verifies 20 records in the file.

.

.

.

```
-->EOF
```

- Editor shows that end of file has been encountered.

```
>L8 (CR)
0008    LOP CALL RDCHR ; READ A CHARACTER
```

- user verifies line 8 and observes an error.

```
>C /LOP/LOOP/(CR)
0008   LOOP CALL RDCHR ; READ A CHARACTER
```

- user modifies line.

```
>S  /7A00/(CR)
0010    JP Z,7A00H ; IF SO, RETURN TO MONITOR
```

- user searches for the string 7A00.

```
>C /7A00H/REBOOT/(CR)
0010    JP,Z REBOOT ; IF SO, RETURN TO MONITOR
```

- user changes the record.

```
>Q (CR)
```

- user terminates editing session. The new file will now be on disk unit 0 (DK0) with file name NEWONE.

TABLE 4-1. SUMMARY OF FLP-80 EDITOR COMMANDS

CONSOLE INTERACTION		COMMAND PROMPT >
BACKSPACE	- Delete the previous character.	INSERT PROMPT <
CNTL-U	- Delete the current line.	MESSAGE IDENTIFIER -->

COMMAND	DESCRIPTION
An	Advance n records.
Bn	Backup n records.
Cn /string1/string2/	Change n occurrences of string 1 to string 2
Dn	Delete n records, starting with current record.
En	Exchange n records with inserted records.
Fn	Flag print option: 0 = no print, not 0 = print.
G dataset	Get records from dataset and insert them after current record.
I	Insert records after current record.
Ln	Line: Access record number n.
Mn	Macro: Place command string into alternate command buffer 1 or 2.
Pn dataset	Put n records out to dataset.
Q	Quit: Save the file on disk and terminate the editor.
Sn /string/	Search for nth occurrence of the string.
T	Top: Insert at top of file before the first record.
Vn	Verify n records on the console device.
Wn	Write n records with record numbers to LUN 5
Xn	Execute alternate command buffer n (1 or 2).

In all commands, except Fn and Ln, if n is zero or if n is not entered, it is assumed to equal one (1). The operand n may be entered as $n_1 - n_2$ which performs the operation on lines n_1 through n_2.

SECTION 5

FLP-80DOS ASSEMBLER (ASM)

5-1. INTRODUCTION

5-2. The Mostek FLP-80DOS Assembler is provided on flexible diskette. In conjunction with the resident Text Editor and the Linker it provides the means for editing, assembling, and linking Z80 programs. The Assembler reads Z80 source mnemonics and pseudo-ops and outputs an assembly listing and object code. The object code is in industry standard hexadecimal format modified for relocatable, linkable assemblies.

5-3. The Assembler recognizes all standard Z80 source mnemonics. It supports conditional assemblies, global symbols, relocatable programs, and a printed symbol and cross reference table. The Assembler can assemble any length program, limited only by the symbol table size (which is based on available RAM) and available disk space. In a 16K RAM system, the Assembler supports a symbol table size of about 150 symbols. In a 32K RAM system, the size is over 700 symbols.

5-4. Figure 5-2 shows the Assembler with typical device usage. The source module is read from a disk file, the object output is directed to a disk file, and the assembly listing is directed to a line printer. User interaction is via the console device. Note that the Assembler can interact with any dataset.

5-5. DEFINITIONS

1. SOURCE MODULE - the user's source program. Each source module is assembled into one object module by the Assembler. The end of a source module is defined by an EOT

character (04_H) on input or an 'END' pseudo-op.

2. OBJECT MODULE - the object output of the Assembler for one source module. The object module contains linking information, address and relocating information, machine code, and checksum information for use by the MOSTEK Linker. The object module is in ASCII. A complete definition of the MOSTEK object format is in Appendix B. The object module is typically output to a disk file with extension 'OBJ'.
3. LOAD MODULE - the binary machine code of one complete program. The load module is defined in RAM as an executable program or on disk as a binary file (extension 'BIN'). It is created by the MOSTEK Linker from one or more object modules (extension 'OBJ').
4. LOCAL SYMBOL - a symbol in a source module which appears in the label field of a source statement.
5. INTERNAL SYMBOL - a symbol in a source (and object) module which is to be made known to all other modules which are loaded with it by the Linker. An internal symbol is also called global, defined, public, or common. Internal symbols are defined by the GLOBAL pseudo-op. An internal symbol must appear in the label field of the same source module. Internal symbols are assumed to be addresses, not constants, and they will be relocated by the Linker.
6. EXTERNAL SYMBOL - a symbol which is used in a source module but which does not appear in the label field of a statement. External symbols are defined by the GLOBAL pseudo-op. External symbols may not appear in an expression which uses operators. An external symbol is a reference to a symbol that exists and is defined as internal in another program module.
7. GLOBAL DEFINITION - both internal and external symbols are defined as "GLOBAL" in a source module. The Assembler determines which are internal and which are external.
8. POSITION INDEPENDENT - a program which can be placed anywhere in memory. It does not require relocating informa-

tion in the object module.

9. ABSOLUTE - a program which has no relocation information in the object module. An absolute program which is not position independent can be loaded only in one place in memory in order to work properly.
10. RELOCATABLE - a program which has extra information in the object module which allows the Linker to place the program anywhere in memory.
11. LINKABLE - a program which has extra information in the object module which defines internal and external symbols. The Linker uses the information to connect, resolve or link, external references to internal symbols.

5-9. ASSEMBLY LANGUAGE SYNTAX

5-10. An assembly language program (source module) consists of labels, opcodes, pseudo-ops, operands, and comments in a sequence which defines the user's program. The assembly language conventions are described below.

5-11. DELIMITERS. Labels, opcodes, operands, and pseudo-ops must be separated from each other by one of more commas, spaces, or tab characters (ASCII 09_H). The label may be separated from the opcode by a colon, only, if desired.

5-12. LABELS. A label is composed of one or more characters. If more than 6 characters are used for the label, only the first 6 are recognized by the Assembler. The characters in the label cannot include ' ( ) * + , - 1 = . / : / < > or space. In addition, the first character cannot be a number (0-9). Table 5-1 summarizes the allowed characters in a label or symbol. A label can start in any column if immediately followed by a colon (:). It does not require a colon if started in column one.

FIGURE 5-1. ASSEMBLER MEMORY MAP

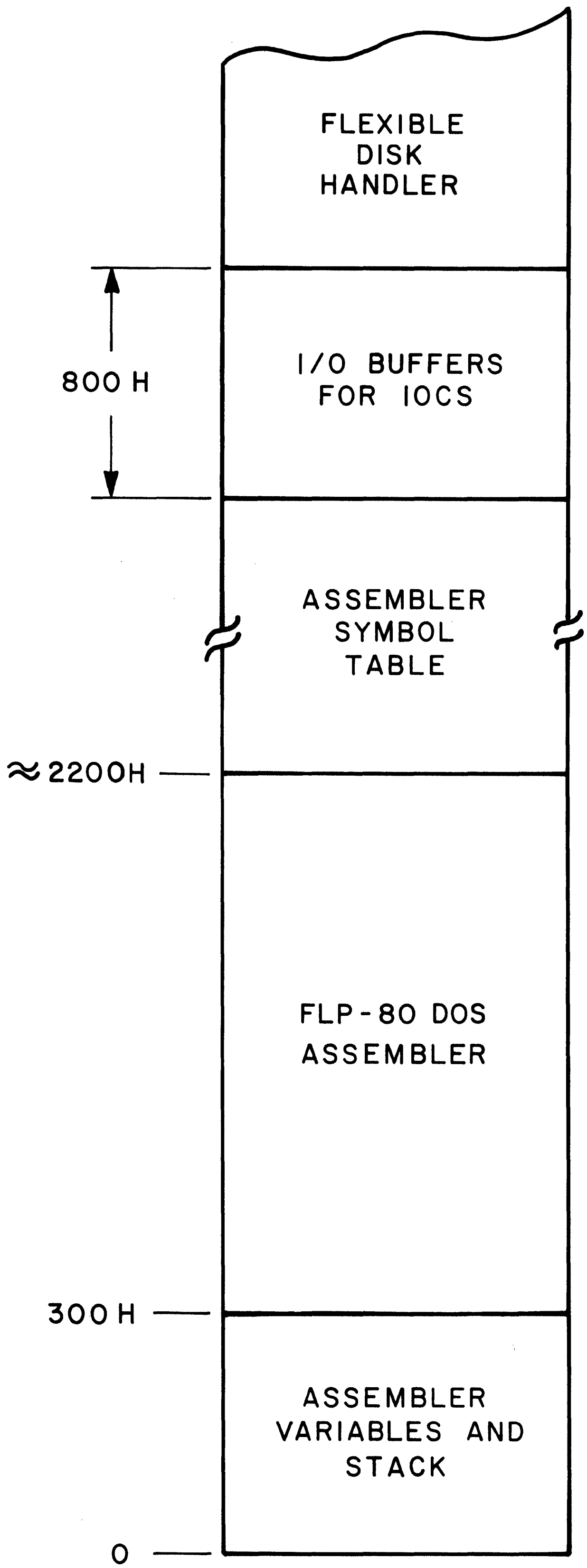
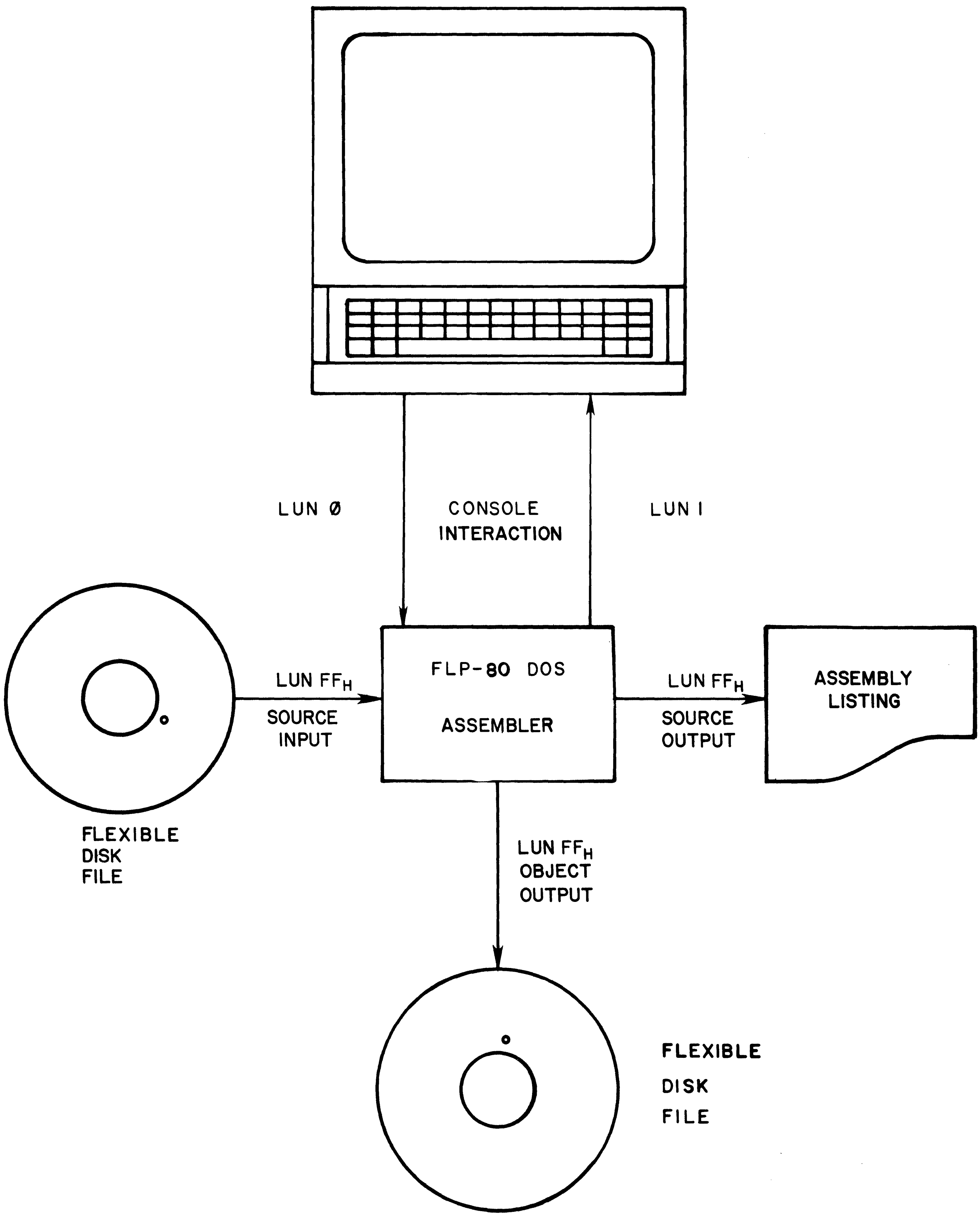


FIGURE 5-2. LOGICAL UNIT NUMBER STRUCTURE



EXAMPLE allowed

```
        LAB
        L923
        $25
        ACCOUNT_PAYABLE

        A25E:
```

not allowed

```
        9LAB    ;STARTS WITH A NUMBER
        L)AB    ;ILLEGAL CHARACTER IN LABEL
        L:ABC   ;ILLEGAL CHARACTER IN LABEL
```

5-13. OPCODES. There are 74 generic opcodes (such as 'LD'), 25 operand key words (such as 'A'), and 693 legitimate combinations of opcodes and operands in the Z80 instruction set. The full set of these opcodes is documented in the "Z80 CPU TECHNICAL MANUAL" and listed in Appendix A of this manual. The FLP-80DOS Assembler allows one other opcode which is not explicitly shown in the Z80 CPU Technical Manual:

```
    IN F,(C)    ;SET THE CONDITION BITS ACCORDING
                ;TO THE CONTENTS OF THE PORT DEFINED BY THE
                 C-REGISTER
```

5-14. PSEUDO-OPS. Pseudo-ops are used to define assembly time parameters. Pseudo-ops appear like Z80 op-codes in the source module. Several pseudo-ops require a label. The following pseudo-ops are recognized by the Assembler:

1. ORG nn -origin - sets the program counter to the value of the expression nn. Each origin statement in a program must be greater than the first origin of the program to assure proper program link-

ing. (See Section 6).

2. label EQU nn -equate - sets the value of a label to nn in the program, where nn is an expression; can occur only once for any label.

3. label DEFL nn -define label - sets the value of a label to nn in the program, where nn is an expression. This may be repeated in the program with different values for the same label. At any point in the program, the label assumes the last previously defined value.

4. DEFM 'aa' -define message - defines the contents of successive bytes of memory to be the ASCII equivalent code of characters within quotes. Maximum length of the message is 63 characters. The delimiting quote characters are required. A quote character may be placed in a message by a sequence of two quotes (' ').

5. DEFB n,n,n... -define byte - defines the contents of bytes located at the current program counter address to be n, where n is any expression.

6. DEFW nn,nn,nn,...-define word - defines the contents of two-byte words to be the value of any expression nn. The least significant byte is located at the current program counter address. The most significant byte is located at the program counter address plus one.

7. DEFS nn -define storage - reserves nn bytes of memory starting at the current program counter, where nn is an expression. When loaded, these bytes are not overwritten, i.e., they will contain what was previously in memory. This pseudo-op cannot be used at the end of a program to reserve storage.

8. END nn -end statement - defines the last line of the program. The 'END' statement is not required. The expression nn is optional and represents the transfer address (starting execution address) of the program. The transfer address defaults to the first address of the program. Note that for binary files the transfer address must be the same as the starting address of the program.

9. GLOBAL symbol -define global symbol - any symbol which is to be made known among several separately assembled modules must appear in this type of statement. The Assembler determines if the symbol is internal (defined as a label in the program), or external (used in the program but not defined as a label).

10. NAME symbol -module name -This pseudo-op defines the name of the program (source and object). The name is placed in the heading of the assembly listing and is placed in the first record of the object module to identify it. This pseudo-op is designed primarily to

TABLE 5-1. ALLOWED CHARACTERS

LSD \ MSD		0 000	1 001	2 010	3 011	4 100	5 101	6 110	7 111
0	0000	NUL	DLE	SPACE	0	@	P	`	p
1	0001	SOH	DC1	!	1	A	Q	a	q
2	0010	STX	DC2	"	2	B	R	b	r
3	0011	ETX	DC3	#	3	C	S	c	s
4	0100	EOT	DC4	$	4	D	T	d	t
5	0101	ENO	NAK	%	5	E	U	e	u
6	0110	ACK	SYN	&	6	F	V	f	v
7	0111	BEL	ETB	'	7	G	W	g	w
8	1000	BS	CAN	(	8	H	X	h	x
9	1001	HT	EM	)	9	I	Y	i	y
A	1010	LF	SUB	*	:	J	Z	j	z
B	1011	VT	ESC	+	;	K	[	k	{
C	1100	FF	FS	,	<	L	\	l	¦
D	1101	CR	GS	-	=	M	]	m	}
E	1110	SO	RS	.	>	N	^	n	~
F	1111	SI	US	/	?	O	_	o	DEL

NOT ALLOWED

ADDITIONAL CHARACTERS NOT ALLOWED AS FIRST CHARACTER facilitate future compiler design. The name of the module defaults to 6 blanks.

11. PSECT op — -program section - This pseudo-op may appear only once at the start of a source module. It defines the program module attributes for the following operands:
    - REL - relocatable program (defaults).
    - ABS - absolute program. No relocating information is generated in the object module by the Assembler. The module will be loaded where it is origined.

12. IF nn — -conditional assembly - If the expression nn is true (non-zero), the IF pseudo-op is ignored. If the expression is false (zero), the assembly of subsequent statements is disabled. 'IF' pseudo-ops cannot be nested.

13. ENDIF — -end of conditional assembly - re-enables assembly of subsequent statements.

14. COND nn — -same function as IF pseudo-op.

15. ENDC — -same function as ENDIF pseudo-op.

16. INCLUDE dataset — -include source from another dataset - allows source statements from another dataset to be included within the body of the given program. The file is searched for first on DK0:, then on DK1:. If the dataset cannot be opened properly, then assembly is aborted.

The source module must not end with an 'END' pseudo-op (otherwise, assembly would be terminated). The source module must end with an EOT character (04), which is true for all FLP-80DOS ASCII datasets. The INCLUDE pseudo-op cannot be nested, but it can be chained. The means that an included dataset can have an INCLUDE pseudo-op at the end of it. At the end of the last included dataset, assembly continues in the original module.

Note: The INCLUDE pseudo-op cannot be followed by a comment on the same line.

LIST - turn listing on.

NLIST - turn listing off.

EJECT - eject a page of listing.

TITLE S - print title 'S' at top of each page of listing. 'S' may be up to 32 characters long.

5-15. OPERAND. There may be zero, one, or more operands in a statement depending on the opcode or pseudo-op used. Operands in the Assembler may take the following forms:

5-16. GENERIC OPERAND. Such as the letter 'A', which stands for the Accumulator. Table 5-2 summarizes these operands and their meanings.

5-17. Constant. The constant must be in the range 0 through OFFFFH. It can be in the following forms:

1. Decimal -this is the default mode of the Assembler. Any number may be denoted as decimal by following it with the letter 'D'. E.g., 35, 249D.

2. Hexadecimal -must begin with a number (0-9) and end with the letter 'H'. E.g., 0AF1H.
3. Octal -must end with the letter 'Q' or 'O'. E.g., 377Q, 277O.
4. Binary -must end with the letter 'B'. E.g., 0110111B.
5. ASCII -letters enclosed in quote marks will be converted to their ASCII equivalent value. E.g., 'A' = 41_H.

5-18. A LABEL which appears elsewhere in the program. Note that labels cannot be defined by labels which have not yet appeared in the user program (this is an inherent limitation of a two-pass assembler).

<u>not allowed</u>

```
L EQU H
H EQU I

I EQU 7
```

<u>allowed</u>

```
I EQU 7
H EQU I
L EQU H
```

TABLE 5-2. GENERIC OPERANDS

A	_____	A register (accumulator)
B	_____	B register
C	_____	C register
D	_____	D register
E	_____	E register
F	_____	F register
H	_____	H register
L	_____	L register
AF	_____	AF register pair
AF'	_____	AF'register pair
BC	_____	BC register pair
DE	_____	DE register pair
HL	_____	HL register pair
SP	_____	SP Stack Pointer register
$	_____	Program Counter
I	_____	I register (interrupt vector MS byte)
R	_____	Refresh register
IX	_____	IX index register
IY	_____	IY index register
NZ	_____	Not zero
Z	_____	Zero
NC	_____	Not Carry
C	_____	Carry
PO	_____	Parity odd/not overflow
PE	_____	Parity even/overflow
P	_____	Sign positive
M	_____	Sign negative

5-19. AN EXPRESSION-the MOSTEK FLP-80DOS Assembler accepts a wide range of expressions in the operand field of a statement. All expressions are evaluated left to right constrained by the hierarchies shown in Table 5-3. Parentheses may be used to ensure correct expression evaluation. Table 5-3 shows the allowed operators and their hierarchies. The symbol '$' is used to represent the value of the program counter of the current instruction. Note that enclosing an expression wholly in parentheses indicates a memory address. The contents of the memory address equivalent to the expression value will be used as the operand value. Integer two's complement arithmetic is used throughout. The negative (2's complement) of an expression or quantity may be formed by preceding it with a minus sign. The one's complement of an expression may be formed by preceding it with the '.NOT.' operator.

In doing relative addressing, the current value of the program counter must be subtracted from the label if a branch is to be made to that label address.

EXAMPLE:

```
JR LOOP-$
```

...will jump relative to 'LOOP'.

The allowed range of an expression depends on the context of its use. An error message will be generated if this range is exceeded during its evaluation. In general, the limits on the range of an expresson are 0 through $0FFFF_H$. The limits on the range of a relative jump ('JR' or 'DJNZ') are -126 bytes and +129 bytes. The Assembler monitors the number of items in an expression. If an expression is too long, an error message will be output. This limit will probably never be reached by a typical program. For relocatable programs, the Assembler will output relocation information in the object module for those addresses which are to be relocated by the Linker. Expressions are determined to be relocatable addresses or non-relocatable constants according to the following rules:

```
(constant)      (operation)   (constant)    = (constant)
(constant)      (operation)   (relocatable) = (relocatable)
(relocatable)   (operation)   (constant)    = (relocatable)
(relocatable)   (operation)   (relocatable) = (constant)
```

```
EXAMPLE   I EQU 1        ;CONSTANT DEFINITION
            DEFW  I      ;CONSTANT WHICH WILL NOT BE RELOCATED
            LAB EQU $    ;RELOCATABLE DEFINITION
            .
            .
            .
            JP   LAB     ;RELOCATABLE OPERAND
            JR   LAB-$   ;CONSTANT OPERAND
            JR   +5+(I)  ;CONSTANT OPERAND
```

For a further discussion of relocatable values, see paragraph 5-27.

5-20. COMMENTS. A comment is defined as any characters following a semicolon in a line. A semicolon which appears in quotes in an operand is treated as an expression rather than a comment starter. Comments are ignored by the Assembler, but they are printed in the assembly listing. Comments can begin in any column. Note also that the Assembler ignores any statements which have an asterisk (*) in column one.

TABLE 5-3. ALLOWED OPERATORS AND HIERARCHIES IN FLP-80DOS ASSEMBLER

.RES.		0
-reset overflow. Anytime the .RES. operator is found, the overflow indicator will be unconditionally reset after the expression is evaluated. This can be used to prevent overflow errors in certain arithmetic expressions.		
Unary plus	(+)	1
Unary minus	(-) (2's complement)	1
Logical NOT	(.NOT.) (1's complement)	1
Multiplication	(*)	2
Division	(/)	2
Addition	(+)	3
Subtraction	(-)	3
Logical AND	(.AND.)	4
Logical OR	(.OR.)	4
Logical XOR	(.XOR.)	4
Logical shift right	(.SHR.)	4
Logical shift left	(.SHL.)	4
Shift right 8	(.)	4

The shift operators (.SHR. and SHL.) shift their first argument right or left by the number of bit positions given in their second argument. Zeros are shifted into the high-order or low-order bits respectively. The dot operator (.) may be placed at the end of an expression. Its effect is to shift a 16 bit value right by 8 bits so the most significant byte can be accessed. Zeros are shifted into the higher order bits.

5-21. OBJECT OUTPUT

5-22. The object module of the Assembler can be loaded by an Intel hexadecimal loader for non-linkable programs. Extra information is inserted into the object module for linkable and relocatable programs for using the MOSTEK Linker. For a complete discussion of the object format, see Appendix B.

5-23. ASSEMBLY LISTING OUTPUT

5-24. The user must insert tabs in the source to obtain columns in the assembly listing. The value of each equated symbol will be printed with a pointer (>) next to it. Any address which is relocatable will be identified with a quote (') character. The statement number and page number are printed in decimal. Listing control pseudo-ops do not appear in the listing but they are assigned statement numbers. If the listing option is not selected, errors will be output to the console device.

5-25. ABSOLUTE MODULE RULES

5-26. The pseudo-op 'PSECT ABS' defines a module to be absolute. The program will be loaded in the exact addresses at which it is assembled. This is useful for constants, a common block of global symbols, or a software driver whose position must be known. This method can also be used to define a list of global constants.

```
EXAMPLE          PSECT    ABS        ;ABSOLUTE ASSEMBLY
                 GLOBAL   AA
              AA EQU      0
                 GLOBAL   AB
```

```
AB   EQU      0E3H
     GLOBAL   AC
AC   EQU      25H
     GLOBAL   AD
AD   EQU      0AF3H
     END
```

All symbols in the above module will assume constant values which may be used by any other program.

5-27. RELOCATABLE MODULE RULES

5-28. The following rules apply to relocatable programs.

1. Programs default to relocatable if the 'PSECT ABS' pseudo-op is not used or if 'PSECT REL' is specified.
2. Only those values which are 16-bit address values will be relocated. 16-bit constants will not be relocated (internal symbols are exceptions).

```
EXAMPLE     AA   EQU      0A13H      ;ABSOLUTE VALUE
                 LD       A,(AA)     ;AA NOT RELOCATED
            AR   EQU      $          ;RELOCATABLE VALUE
                 LD       A,(AR)     ;AR WILL BE RELOCATED UPON
                                      LOADING
```

5-29. Relocatable quantities may not be used as 8-bit operands. This restriction exists because only 16-bit operands are relocated by the Linker.

```
EXAMPLE     LAB  EQU      $          ;RELOCATABLE DEFINITION
                 DEFB     LAB        ;NOT ALLOWED
                 LD       A,LAB      ;NOT ALLOWED
                 LD       A,(LAB)    ;ALLOWED
                 LD       HL,LAB     ;ALLOWED
```

5-30. Labels equated to labels which are constants will be treated as constants. Labels equated to labels which are relocatable values will relocated. Internal symbols are exceptions.

```
EXAMPLE B8  EQU   20H      ;ABSOLUTE VALUE
        C8  EQU   B8       ;ABSOLUTE VALUE
            LD    A,(C8)   ;C8 WILL NOT BE RELOCATED
        AR  EQU   $        ;RELOCATABLE VALUE
        BR  EQU   AR       ;RELOCATABLE VALUE
            LD    A,(BR)   ;BR WILL BE RELOCATED
```

5-31. Internal symbols will always be marked relocatable. This point is important because an internal symbol will be relocated even though it looks like a constant. This point is discussed further, below.

5-32. External symbols will always be marked relocatable, except for the first usage in the program.

5-33. GLOBAL SYMBOL HANDLING

5-34. A global symbol is a symbol which is known by more than one module. A global symbol has its value defined in one module. It can be used by that module and any other module. A global symbol is defined as such by the GLOBAL pseudo-op. For example:

```
      GLOBAL SYM1
          -  SYM1 is a symbol which is defined as "global".
```

An internal symbol is one which is defined as global and also appears in the label field of a statement in the same program.

```
EXAMPLE  GLOBAL SYM1
         CALL   SYM1
         .
         .
         .
         END
                       -SYM1 is an external symbol
EXAMPLE
                GLOBAL  SYM1
         SYM1   EQU     $
                LD      A,(SYM1)
                .
                .
                .
                END
                       -SYM1 is an internal symbol.  Its value is
                        the address of the LD instruction.
```

If these two programs were linked by the MOSTEK Linker, all global symbol references would be "resolved". This means that each address in which an external symbol was used would be modified to the value of the corresponding internal symbol. The loaded programs would be equivalent (using our example) to one program written as follows.

```
EXAMPLE         CALL   SYM1
                .
                .
                .
         SYM1   EQU     $
```

```
LD      A,(SYM1)
.
.
.
END
```

5-35. Global symbols are used to allow large programs to be broken up into smaller modules. The smaller modules are used to ease programming, facilitate changes or allow programming by different members of the same team. The Assembler has several rules which apply to global symbols. The examples in the following paragraphs should be studied carefully.

5-36. GLOBAL SYMBOL BASIC RULES. Both passes of the Assembler must be done in their entirety if global symbols are used. This restriction exists because symbols are defined as global during pass 1, and an external reference link list is built up during pass 2.

1. Global symbols follow the same syntax rules as labels. They may not start with a number (0-9) or a restricted character. They may not contain restricted characters.

EXAMPLE <u>allowed</u>

```
GLOBAL SYM1
GLOBAL A&&
GLOBAL $BB
```

<u>not allowed</u>

```
GLOBAL 1AB    ;STARTS WITH A NUMBER
GLOBAL A=B    ;CONTAINS A RESTRICTED CHARACTER
```

2. An external symbol may not appear in an expression.

EXAMPLE

```
GLOBAL  SYM1        ;EXTERNAL SYMBOL
CALL    SYM1        ;OK
```

```
        LD      HL, (SYM1)   ;OK
        LD      HL,SYM1+25H  ;NOT ALLOWED
        JP      SYM1+2       ;NOT ALLOWED
```

3. An external symbol is always considered to be a 16-bit address. Therefore, an external symbol may not appear in an instruction requiring an 8-bit operand. It may not be used for a displacement or an 8-bit constant.

```
EXAMPLE GLOBAL  SYM1         ;EXTERNAL SYMBOL
        CALL    SYM1         ;OK
        LD      A,(SYM1)     ;OK
        LD      A,SYM1       ;NOT ALLOWED
        LD      (IX+SYM1),A  ;NOT ALLOWED
        BIT     SYM1,A       ;NOT ALLOWED
```

4. In relocatable assembly, a global symbol is always considered to be a relocatable 16-bit address. This applies to both internal and external symbols. It does not apply to absolute assemblies (PSECT ABS).
5. By definition, an external symbol cannot also be an internal symbol.
6. For a set of modules to be linked, no duplication of internal symbol names is allowed. That is, an internal symbol can be defined only once in a set of modules to be linked together.

5-37. GLOBAL SYMBOL ADVANCED RULES.

1. An external symbol cannot appear in the operand field of a 'EQU' or 'DEFL' pseudo-op. Thus, an external symbol must be explicitly defined as global.

```
EXAMPLE      GLOBAL  SYM1    ;EXTERNAL SYMBOL
        SYM2 EQU     SYM1    ;NOT ALLOWED
        SYM3 DEFL    SYM1    ;NOT ALLOWED
```

2. All references to an external symbol are marked relocatable, except the first reference in a program. The object code for these references is actually a backward link list, terminating in the constant $0FFFF_H$. (See definition of object format in Appendix B) (This rule does not apply to absolute assemblies).
3. An internal symbol is always marked relocatable, except for absolute assemblies. This point is important, because an internal symbol will be relocated even though it looks like a constant.

```
EXAMPLE     PSECT  REL        ;RELOCATABLE MODULE
            GLOBAL YY         ;INTERNAL SYMBOL
        YY  EQU    0AF3H      ;YY WILL ALWAYS BE MARKED RELOCATABLE
            LD     A,(YY)     ;YY WILL BE RELOCATED WHEN LOADED.
     ;THE ABOVE INSTRUCTION LOADS THE CONTENTS OF THE ADDRESS YY,
     ;RELOCATED, INTO THE A-REGISTER.
EXAMPLE     PSECT  ABS        ;ABSOLUTE ASSEMBLY
            GLOBAL YY         ;INTERNAL SYMBOL
        YY  EQU    0AF3H      ;YY IS AN ABSOLUTE VALUE
            LD     A,(YY)     ;THIS LOADS THE CONTENTS OF ADDRESS
                              ;0AF3H INTO THE A-REGISTER
```

4. All other rules that apply to local symbols also apply to internal symbols.

5-38. USE OF THE "NAME" PSEUDO-OP.

5-39. The NAME pseudo-op can be used to identify both a source module and an object module. The name of the module being assembled can be assigned by the NAME pseudo-op. The name is placed in the heading of the assembly listing. The name is also placed in the first record of he object module. The first record is the module definition record (record type 05), and it is described in Appendix B. The name of a module follows the same rules as a local symbol.

5-40. USING THE ASSEMBLER

5-41. The FLP-80DOS Assembler is resident on the FLP-80DOS system flexible diskette. The user first prepares his source modules using the FLP-80DOS Editor. Then the source file may be assembled. The command to invoke the Assembler is:

$ASM dataset 1 [TO datasetL [,dataset0]](CR)

where

dataset 1 = source input dataset.

dataset L = assembly listing output dataset (optional).

dataset 0 = object output dataset (optional).

The Assembler can interact with any dataset. Dataset1 must be a disk file. DatasetL and a dataset0 are optional in the command. DatasetL defaults to the same unit and filename as dataset1 with an extension of 'LST'; dataset0 defaults to the same unit and filename as dataset1 with an extension of 'OBJ'. DatasetL and dataset0 can be specified in the command. If dataset0 is a disk file, it must have an extension of 'OBJ' or a blank extension which defaults to 'OBJ'. Dataset1 and datasetL may not have the following extensions: OBJ, BIN, or CRS. The Assembler then outputs the following message to the console output device:

MOSTEK FLP-80DOS ASSEMBLER V2.1. OPTIONS?

Options are described in paragraph 5-67. If no options are to be entered, the use enters "carriage return". The Assembler then reads the source module for pass 1. During pass 1, the symbol table and external references are defined. The name of the module is defined, and the external symbol link list is built. At the end of reading, the source dataset is rewound, and the following message is printed on the console device:

PASS 1 DONE

The Assembler proceeds into pass 2 automatically. During pass 2, the assembly listing and object module are output. At the end of pass 2, the following message is output on the console output device:

ERRORS = nnnn

where nnnn is the total number of errors (in decimal) which were found by the Assembler. Control is then returned to the FLP-80DOS Monitor.

5-42. ASSEMBLER OPTIONS

5-43. The Assembler allows the user to select the following options from the console. When the Assembler outputs the message:

MOSTEK FLP-80DOS ASSEMBLER V2.1. OPTIONS?

The user may enter any of the following codes. A carriage return terminates the options. Normal editing of a line is allowed.

C-Cross Reference Listing. This option prints a symbol cross reference table at the end of the assembly listing.

K-No listing. This suppresses the assembly listing output. All errors will be output to the console device.

L-Listing (default). The assembly listing is normally output.

N-No object output. This suppresses object output from the Assembler.

O-Object output (default). The object output is normally output.

P-Pass 2 only. This selects and runs only pass 2 of the Assembler.

Q-Quit. This returns control to the FLP-80DOS Monitor.

R-Reset the symbol table. This option clears the symbol table of all previous symbol references. This operation is automatically done for pass 1. It is used primarily for single pass operations (described in paragraph 5-78).

S-Symbol table. The symbol table is normally not output by the Assembler. This option prints a symbol table at the end of the assembly listing.

EXAMPLE

OPTIONS? NS(CR)

- the user has selected no object output and a printed symbol table.

5-44. ERROR MESSAGES

5-45. Any error which is found is denoted in the assembly listing. A message is printed immediately after the statement which is in error. Appendix E defines all Assembler error codes and messages.

EXAMPLE

```
H2:  LC A,B
*****ERROR 41 INVALID OPCODE
```

Several errors abort the Assembler when they are encountered. These are noted in Appendix E. Abort error messages are output only to the console output device. Control is immediately returned to the FLP-80DOS Monitor. Abort errors may occur during pass 1 or pass 2.

5-46. ADVANCED OPERATIONS

5-47. PASS 2 ONLY OPERATION (SINGLE PASS OPERATION). The FLP-80DOS Assembler can be used as a single pass assembler under the following restrictions:

1. No GLOBAL symbols are defined.
2. No forward symbol references occur.
3. The NAME pseudo-op is not in the source.

The Assembler will correctly assemble Z80 programs under the above restrictions during pass 2. This is useful for assembling data tables and certain types of programs. The Assembler symbol table should be initialized to assure proper operation in this mode. This may be done by using the 'R' option to reset the symbol table prior to assembling using pass 2 only as follows:

```
      $ASM MYFILE(CR)
       MOSTEK FLP-80 ASSEMBLER V2.1.  Options?  PR(CR)
              -user selects pass 2 only operation and resets the
               symbol table prior to assembly.

           .
           .
           .
```

The symbol table initialization described above only has to be done after power up and after symbols are left in the table from a previous assembly.

5-49. ASSEMBLING SEVERAL SOURCE MODULES TOGETHER. Several source modules may be assembled together to form one object module. The 'INCLUDE' pseudo-op may be used several times in one module to properly sequence a set of source modules.

EXAMPLE

```
        NAME      MYFILE     ;name of final object module
        INCLUDE   FILE1
        INCLUDE   FILE2
        INCLUDE   FILE3
        END
              -the object module named 'MYFILE' will be built by
               the assembly of FILE1 + FILE2 + FILE3.
```

5-50. **SAMPLE ASSEMBLY SESSION**

5-51. Assume that the file to be assembled is named PROG1. The diskette on which PROG1 exists is in disk unit 1 (DK1). The object output of the Assembler is to be directed to file PROG1.OBJ on disk unit 1. The assembly listing is to be directed to a line printer (LP:). A printed symbol table is to be obtained. The following sequence will perform the assembly:

EXAMPLE

```
$ASM DK1:PROG1 TO LP:  (CR)
MOSTEK FLP-80 ASSEMBLER V2.1. OPTIONS?  S(CR)
        -user selects a printed symbol table.
        .
        .
        .
  ERROR = 0000
        - indication of zero assembly errors
  $
        -indication that assembly is done, and control is
         returned to the Monitor.
```

SECTION 6

LINKER

6-1. INTRODUCTION

6-2. The Linker program provides the capability for linking object files together and creating a binary (EXT=BIN) or RAM image file. The Linker concatenates modules together and resolves global symbol references which provide communication between modules. A starting link address may be entered to position a linked module anywhere in the memory map. The Monitor GET or Implied Run command can be used to load binary files allowing fast access of linked modules.

6-3. LINKER COMMAND

6-4. SYNTAX: LINK Dataset 1,..... Dataset N TO Dataset B [,Dataset C](CR)

6-5. The input datasets (Dataset 1....Dataset N) are object files produced by either the Assembler or the Monitor DUMP command. The object files must be on a supported disk unit (e.g. DK0 or DK1). In the Linker command the object input datasets must have an extension of OBJ or blank. If a blank extension is entered the Linker will assume an extension of OBJ. Dataset B is the binary output file which is created by the linker. Specification of Dataset B by the user is optional. If Dataset B is not specified it automatically defaults to a file having an extension of BIN and a filename of Dataset 1 which is the first input dataset. If Dataset B is specified it must be on a supported disk unit (e.g. DK0, DK1) and must have an extension of BIN or blank. If a blank extension is entered, the Linker will assume an extension of BIN. Dataset C is the output file for the global cross reference table and symbol table when the C and S options are specified (See Paragraph 6-9 and 6-11). Dataset C can be any supported output device (e.g. LP:,TT:). Specification of Dataset C is optional. If Dataset C is not specified it automatically defaults to a file having the extension of CRS and the filename of Dataset B.

6-6. When entering the Linker command if a large number of input datasets are specified the command line may exceed the maximum terminal line length (usually 80 characters). If this occurs, the terminal output driver (TT) will automatically issue a CR and LF to enable continuation of the command on the next line. Since a carriage return input from the keyboard is interpreted by the Linker to be the terminator of the command string, the user should not enter a carriage return until the entire Linker command has been entered. The maximum length of the Linker command string is 160 characters, however, the library search option (See Paragraph 6-10) may be used if the user wishes to link additional datasets.

6-7. After a valid command is entered the Linker outputs the following message on the console.

OPTIONS?

The user can then enter any of the supported Linker options (A,C,L,U,S). A carriage return terminates the options list.

6-8. A OPTION. The A option enables the user to enter a starting link address. After the A option is entered the following message is output to the console.

ENTER STARTING LINK ADDRESS >

The user may then specify the starting link address for the first object module. The beginning load address of the first relocatable module is the starting link address plus the module starting address defined by the Assembler ORG pseudo-op. If the

ORG pseudo-op is omitted or its address is 0, then the starting link address equals the beginning load address. If an object module is absolute the A option is ignored and the module is always loaded at its starting address as defined by the ORG pseudo-op. The PSECT pseudo-op of the Assembler defines a module as either relocatable or absolute. If the A option is not specified the Linker assumes a starting link address of 0. The beginning and ending address of each module is printed on the console by the Linker during Pass 2.

6-9. C OPTION. The C option causes the global cross reference table (See Figure 6-1) to be generated and output to the device specified in Dataset C. The global cross reference table contains the symbol name, definition address and reference addresses. A global symbol can be defined only once but can be referenced many times. A symbol is defined by a module if it occurs in the label field of the module and is specified by the GLOBAL pseudo-op. A global symbol is referenced within a module when it occurs in the operand field. When the C option is specified a load map is also output which specifies the object input files linked and their beginning and ending addresses.

6-10. L OPTION. The L option enables the user to perform a library search for undefined global symbols. If any symbols are undefined after linking the input datasets (Dataset 1.... Dataset N) during Pass 1, the Linker prints out the number of undefined symbols. (The U option prints out a list of undefined symbols.) If the L option has been selected the Linker prints the following message on the console.

SEARCH DISK UNIT 1/0?

The user may then initiate a library search by entering a 1 or 0 followed by a carriage return. Any other response terminates the search and Pass 2 execution is started. If a library search has been requested the Linker searches the disk unit specified for an object file having the filename of the first undefined symbol. If the file is found, it is linked into the binary output file and any global references which are defined are resolved. This process is repeated for each undefined symbol in the original list. After the search has been completed for the first list of symbols, the sequence can be repeated for a new list if any symbols remain undefined. After the original list has been searched more undefined symbols might actually exist if a file from the previous list contains additional undefined symbols. Each time the search is repeated either disk unit may be searched. Disks should not be removed or inserted between library searches. The library search option may be used to minimize the number of input files that must be typed in the Link command. This can be done by giving an object file the same name as a global symbol definition within the module.

6-11. S OPTION. The S option causes the global symbol table (See Figure 6-1) to be generated and outputted to the device specified in Dataset C. The global symbol table contains the symbol name and definition address. A symbol is defined by a module if it occurs in the label field of the module and is specified by the GLOBAL pseudo-op. If a global symbol is referenced but not defined it is marked undefined (UNDEF=****). A global symbol is referenced within a module when it occurs in the operand field. When the S option is specified a load map is also output which specifies the object input files linked and their beginning and ending addresses.

6-12. U OPTION. The U option prints out a list of undefined global symbols after the Linker has completed Pass 1.

6-13. LINKER OPERATION

6-14. During Pass 1 the Linker reads the specified object files and places the global symbol definitions in the symbol table. In Pass 2 the global symbols are defined and a binary or ramimage output file is produced. As each object module is read in Pass 2 its beginning and ending address in memory is printed on the console. The module type is also listed as either absolute or relocatable (ABS/REL). Absolute modules are always positioned at their starting address in memory as defined by the ORG pseudo-op. Relocatable modules are positioned at the next location after the end address of the previous module. If the first input module is relocatable, it is positioned by the starting link address (See Para. 6-8). If the starting link address is not specified by the A option it assumes a value of 0.

6-15. LINKER RESTRICTIONS

6-16. When absolute modules are being linked together, the files in the LINK command must appear in sequential order according to their starting addresses in memory. If an absolute module is encountered having a starting address lower in memory than a previous module the following error message is printed on the console.

    ****ERROR 35   MODULE SEQUENCE ERROR

The maximum size allowed for an individual object input module is limited by the linker buffer size which is dynamically allocated depending upon the size of the memory. On the standard system having 32K of RAM, it is 18K bytes in length and on the minimum system having 16K of RAM it is 4.5K bytes. There is no restriction on the length of the binary output file.

When loading a binary file using the Monitor GET or Implied Run commands the entire memory space is available except for 48 bytes in scratchpad RAM starting at 0FF60H. This space is reserved for the Monitor I/O vector and cannot be overlayed during a load sequence.

6-17. EXAMPLES OF LINK COMMAND

EXAMPLE 1. Link the relocatable object modules MAIN1.OBJ, SUB1.OBJ,SUB2.OBJ and SUB3.OBJ together starting at 2000H and produce the binary file TEST.BIN. Also generate a symbol table, cross reference table and load map and store them in the file TEST.CRS. This file may be printed using the PIP copy command (See Figure 6-1).

```
$LINK MAIN1,SUB1,SUB2,SUB3 TO TEST(CR)
      OPTIONS? A C S(CR)
      ENTER STARTING LINK ADDRESS   2000
      DK0:MAIN1  .OBJ[1]
      DK0:SUB1   .OBJ[1]
      DK0:SUB2   .OBJ[1]
      DK0:SUB3   .OBJ[1]
      UNDEFINED SYMBOLS 00
      PASS 2
      DK0:MAIN1  .OBJ[1]   REL   BEG ADDR 2000   END ADDR 2033
      DK0:SUB1   .OBJ[1]   REL   BEG ADDR 2034   END ADDR 20DB
      DK0:SUB2   .OBJ[1]   REL   BEG ADDR 20DC   END ADDR 20F6
      DK0:SUB3   .OBJ[1]   REL   BEG ADDR 20F7   END ADDR 2120

      $
```

EXAMPLE 2. Link the absolute file MAIN.OBJ and the relocatable subroutines SUB1.OBJ, SUB2.OBJ, SUB3.OBJ together producing the binary file MAIN.BIN. Access the object files DK0:SUB1.OBJ, DK0:SUB2.OBJ and DK1:SUB3.OBJ using the library search option.

```
$LINK MAIN (CR)
OPTIONS? L U (CR)
DK0:MAIN  .OBJ[1]
MODNO  MSGBEG  MSGEND  MSGMAI  PRINT
SUB1   SUB2    SUB3
UNDEFINED SYMBOLS 08
```

```
SEARCH DISK UNIT 1/0 ? 0 (CR)
DK0:SUB1   .OBJ[1]
DK0:SUB2   .OBJ[1]
MODNO  SUB3
UNDEFINED SYMBOLS 02
SEARCH DISK UNIT 1/0 ? 1(CR)
DK1:SUB3   .OBJ[1]
UNDEFINED SYMBOLS 00
PASS 2
DK0:MAIN   .OBJ[1]    ABS    BEG ADDR 1000    END ADDR 1025
DK0:SUB1   .OBJ[1]    REL    BEG ADDR 1026    END ADDR 10CD
DK0:SUB2   .OBJ[1]    REL    BEG ADDR 10CE    END ADDR 10E8
DK1:SUB3   .OBJ[1]    REL    BEG ADDR 10E9    END ADDR 1115
```

FIGURE 6-1. EXAMPLES OF LOAD MAP, GLOBAL CROSS REFERENCE, AND GLOBAL SYMBOL TABLE

```
LOAD MAP

DK0:MAIN1 .OBJ[1]    REL    BEG ADDR 2000    END ADDR 2033
DK0:SUB1  .OBJ[1]    REL    BEG ADDR 2034    END ADDR 20DB
DK0:SUB2  .OBJ[1]    REL    BEG ADDR 20DC    END ADDR 20F6
DK0:SUB3  .OBJ[1]    REL    BEG ADDR 20F7    END ADDR 2120

GLOBAL CROSS REFERENCE TABLE

SYMBOL ADDR  REFERENCES
CRLF   2030  211A 20F4
MAIN   2000
MODNO  2109  20E2 20DF 203A 2037 2011 200E
MSGBEG 204D  2006
MSGEND 2073  2023
MSGMAI 2098  2014
MSGMOD 20D0  210F
MSGSB2 20A3  20E5
MSGSB3 20A9  2100
PRINT  20EE  2103 204A 2040 2026 2017 2009
PTEST  2046  2106 20EB
SUB1   2034  201A
SUB123 211D
SUB2   20DC  201D
SUB3   20F7  2020

GLOBAL SYMBOL TABLE

CRLF   2030   MAIN   2000   MODNO  2109   MSGBEG 204D
MSGEND 2073   MSGMAI 2098   MSGMOD 20D0   MSGSB2 20A3
MSGSB3 20A9   PRINT  20EE   PTEST  2046   SUB1   2034
SUB123 211D   SUB2   20DC   SUB3   20F7
```

SECTION 7

DDT-80 DEBUG SYSTEM

7-1. INTRODUCTION

7-2. This section describes the functions and operation of DDT-80 (Designer's Development Tool 80) resident in the FLP-80DOS system. The DDT software provides a complete facility for interactively debugging relative and absolute Z80 programs. Standard commands allow displaying and modifying memory and CPU registers, setting breakpoints, and executing programs. Additional commands allow use of the MOSTEK AIM-80 to interactively debug a target system. Mnemonics are used to represent Z80 registers, thus simplifying the command language.

7-3. SOFTWARE CONFIGURATION

7-4. DDT-80 is a program that resides in PROM (located from $E000_H$ to $EFFF_H$) on the SDB-80 board. In addition to the PROM, DDT uses 256x8 of RAM for scratch RAM and temporary storage. This RAM resides at locations FF00H - FFFFH.

7-5. The 256x8 Scratchpad RAM is used by the DDT for temporary storage and a push down stack (for return address, etc.). This RAM also holds an image (or map) of all the user's internal CPU registers. Figure 7-1 is a detailed memory map of the 256x8 Scratchpad RAM.

7-6. An important concept in DDT is preservation of the user's internal CPU registers. The state of the CPU is described by the contents of the registers. To preserve the state of the CPU for a user's program while debugging, DDT keeps an image or map of all the user's registers. This image or map is referred to as the

User Register Map throughout this documentation. DDT installs or makes the CPU registers equal to the user register map when control is transferred from DDT to a user program (as in the E command discussed in paragraph 7-45). DDT-80 saves the user register map when DDT is commanded (breakpoint command discussed in paragraph 7-34) to interrupt a user program. DDT allows modification to this register map with the display and/or update memory command (M command, discussed in paragraph 7-57). The user register map resides in the 256x8 Scratchpad, locations $FFE6_H$ thru $FFFF_H$, as shown in Figure 7-1. Figure 7-2 shows the data paths between the user register map and the CPU registers. Also shown is the modification path between DDT and the User Register Map.

FIGURE 7-1. DDT USER REGISTER MAP

MEMORY LOCATION		USER REGISTER	
FFFF	PC	PROGRAM	MSB
FFFE		COUNTER	LSB
FFFD		A	
FFFC		F	
FFFB		I	
FFFA		IF	
FFF9		B	
FFF8		C	
FFF7		D	
FFF6		E	
FFF5		H	
FFF4		L	
FFF3		A'	
FFF2		F'	
FFF1		B'	
FFF0		C'	
FFEF		D'	
FFEE		E'	
FFED		H'	
FFEC		L'	
FFEB		IX	MSB
FFEA			LSB
FFE9		IY	MSB
FFE8			LSB
FFE7	SP	STACK	MSB
FFE6		POINTER	LSB

FIGURE 7-2. DDT DATA PATHS

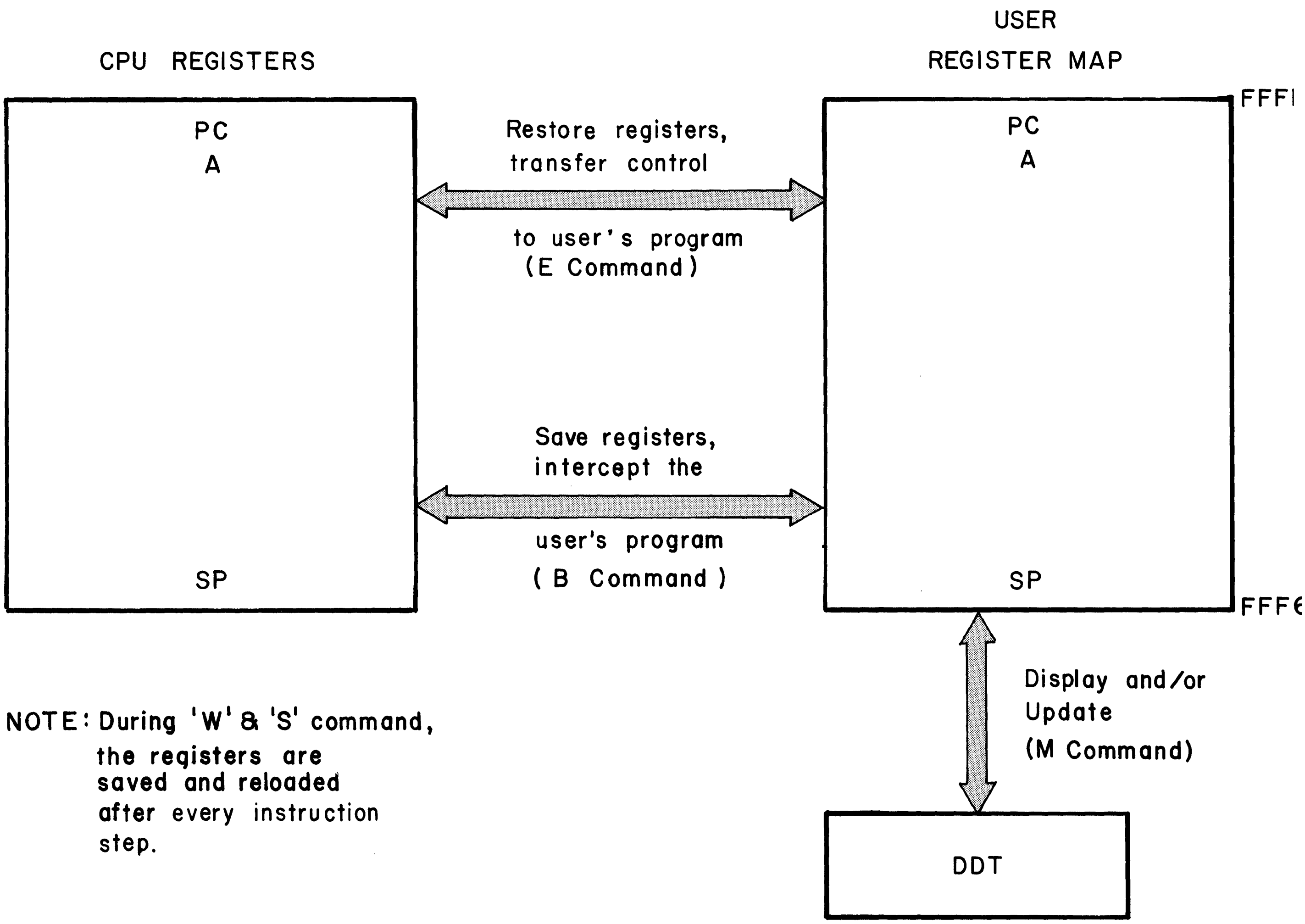


TABLE 7-1. MNEMONICS RECOGNIZED BY DDT-80

Unrecognized mnemonics are resolved with a value of zero.

MNEMONIC	ADDRESS REPRESENTED BY THE MNEMONIC	DATA SAVED AT THAT ADDRESS
:PC*	FFFE	User's PC Register
:A	FFFD	User's A Register
:F	FFFC	User's F Register
:I	FFFB	User's I Register
:IF	FFFA	User's IFF Register
:B	FFF9	User's B Register
:C	FFF8	User's C Register
:D	FFF7	User's D Register
:E	FFF6	User's E Register
:H	FFF5	User's H Register
:L	FFF4	User's L Register
:A'	FFF3	User's A' Register
:F'	FFF2	User's F' Register
:B'	FFF1	User's B' Register
:C'	FFF0	User's C' Register
:D'	FFEF	User's D' Register
:E'	FFEE	User's E' Register
:H'	FFED	User's H' Register
:L'	FFEC	User's L' Register
:IX*	FFEA	User's IX Register
:IY*	FFE8	User's IY Register
:SP*	FFE6	User's SP Register

* = 2 byte mnemonics

7-7. COMMAND SUMMARY

Table 7-2 lists all the DDT commands for reference.

7-8. CONVENTIONS

7-9. Hexadecimal numbers are denoted by the number followed by a subscript H. E.g., $AF3_H$. In a command sequence user input is underlined. (CR) means carriage return. Bracketed items [] in a command line are optional. Items in a command line which must be entered exactly as they appear are shown as upper case. Items in a command line which are variables are shown as lower case.

TABLE 7-2. DDT COMMAND SUMMARY

TO INVOKE DDT:

$DDT(CR)

CONSOLE INTERACTION:

.	prompt character
(CR)	terminate a command
. or cntl-U	abort

COMMANDS:

B	aaaa	insert a breakpoint in user's program.
C	aaaa,bbbb,cccc	copy memory aaaa thru bbbb to cccc and above
E	aaaa	execute user's program
F	aaaa,bbbb,cc	fill memory aaaa thru thru bbbb with data cc.
H	...	hexadecimal arithmetic.
L	aaaa,bbbb,cccc	locate all occurrences of data cccc in memory aaaa thru bbbb.
M	aaaa,bbbb	display, update, or tabulate memory or registers.
O	aaaa	set offset constant for relocatable programs.
P	aa	display and update port.
Q		quit - return to Monitor.
R	a,bb	display user registers.
W	aaaa ,bb	single step starting at address aaaa for bb steps.
V	aaaa,bbbb,cccc	verify that two blocks of memory are identical.

7-10. PREPARATION

7-11. Create, assemble, and link your Z80 program as described in Section 4, 5, and 6 of this manual.

7-12. You should now be ready to debug a binary file which has your Z80 program on it. To debug the program, use the Monitor GET command to load the program into RAM:

```
$GET file(CR)
```

where file is the name of the binary file created by the LINK process.

Then execute DDT:

```
$DDT(CR)
.
```

The dot (.) indicates that DDT is ready to accept commands.

7-13. DESCRIPTION OF DDT COMMANDS

7-14. COMMAND FORMAT.

7-15. DDT recognizes commands which consist of three parts:

1. A single letter command.
2. An operand or operands separated by commas or blanks.
3. A terminator to either abort the command or cause it to be executed.

   EXAMPLE

   ```
   .M 100,102(CR)
   1.  2.      3.
   ```

7-16. In the command mode DDT prompts on the user console with a dot (.). The user may enter any single letter command. A space is then printed on the console. The user may then enter any required operands and a terminator. Operands are separated from each other by a space or a comma. The terminator may be a carriage return, dot (.) or control-U. Carriage return causes execution of the command. A dot or control-U aborts the command, and the user is prompted again.

NOTE The format of entering commands in DDT differs from FLP-80DOS Monitor commands in that DDT automatically inserts a space after a command to separate it from the operands.

7-17. OPERANDS

7-18. Operands are separated from each other by a space or comma. An operand may take any one of the following forms.

7-19. Hexadecimal number. Leading zeros need not be entered. The last four digits are used for the value entered for address values. The last two digits are used for data values.

7-20. ASCII literal value. Any characters preceded by the letter "L" are converted to their ASCII equivalent value. E.G., LA(=41_H), LAB(=4142_H).

7-21. Relative Address. A hexadecimal number preceded by the character "R" causes the offset specified by the O command to be added to the number. A relative address is identified by an apostrophe next to it. E.g., (assuming offset = 100_H) R0(=100_H), R4FF(=$5FF_H$).

7-22. The offset and relative address functions are useful when debugging modules of a program which have been relocated by the Linker.

7-23. Program Counter. The character "$" is used to represent the current address. It is used with the M command to calculate relative branch displacements.

7-24. Added or subtracted numbers. Hexadecimal numbers may be added to or subtracted from each other to represent an operand. E.g., A + A (=14_H), 5A + A - 10 (=54_H).

7-25. Equal Sign. An equal sign (=) may be entered at any time to display the current value of an operand as 4 hexadecimal digits. E.G., 5A + A -10 = 0054, LAC = 4143.

7-26. Mnemonic. A mnemonic consists of one or two characters following a colon (:). Mnemonics are used to represent Z80 CPU registers. Table 7-1 lists all the allowed mnemonics in DDT and their meanings.

7-27. OPERAND EXAMPLES

4F7F	The operand value is equal to $4F7F_H$.
:PC	The mnemonic PC is equivalent to the save location of the user's program counter.
5038-5000	The operand value is 38_H,
5038-5000=0038	The same as above except "=" was entered to display the operand value.
5038-$	If current address = 5000_H, then $=$5002_H$ and the operand value equals 36_H for relative jump instructions.
5038-$=0036	The same as above except the equal sign was entered.
305038	More than 4 digits entered, therefore only the last 4 have meaning. Operand value = 5038_H.
305038=5038	The same as above except the equal sign was entered.
LAB=4142	Operand is equal to the ASCII value of "AB".
LA=2041	Operand is equal (LSB) to ASCII vlue of 'A'.
R100=1100	Assumes offset = 1000.

7-28. COMMAND TERMINATORS

7-29. The command terminator immediately follows the operand(s) and signals DDT that the command has been entered. Depending on the terminator, DDT will do one of the following

Terminator	Action
(CR)	Carriage return. DDT executes the entered command.
. OR CNTL-U	Period or CNTL-U. DDT aborts the command. The user is prompted for another command.
^	Carat or up arrow. This terminator is valid only for the M and P commands. When updating a memory location (M) or a port (P), it signals DDT to display the contents of the location or port just updated, or if the location was not updated, the previous location.
/	Slash. This terminator is valid only for the M command. This causes the data entered to replace the old data and then return to the command mode. If no data was entered, it is treated as a period.

7-30. SPECIAL KEYS

7-31. Several keys have special meaning in DDT:

period (.)	memory printouts on the console (L,M, or V commands) may be aborted by entering a period. Single stepping (W Command) may also be aborted this way. DDT then enters the command mode.

Space bar	The space bar may be used to start and stop single stepping (W command).

7-32. ERRORS

7-33. Any time erroneous input is detected, a question mark (?) is printed and DDT returns to the command mode.

7-34. B COMMAND, BREAKPOINT COMMAND

7-35. Format:

.B aaaa(CR)	Set breakpoint at memory address aaaa.
.B (CR)	Clear previous breakpoint.

7-36. Overview. When the breakpoint command is used, a "trap" which consists of three bytes is placed into the user's program. The original program bytes are automatically saved.

7-37. The user then uses the E (execute) command to start execution of the program. When the trap is encountered, DDT is signalled and execution is stopped. The registers from the CPU are then transferred to DDT and printed out on the user console. To resume execution of the program, the user must use the E (execute) command again or the W (single step) command.

7-38. Description. The user types the command identifier B followed by the address where it is desired to place a breakpoint "trap". DDT proceeds to remove any pre-existing breakpoint, extracts and saves 3 bytes of the user's program at the breakpoint address, and places a 3 byte trap into the address. DDT then returns to the command mode. The user may start program execution via the E(execute) command. When the breakpoint trap is encountered, execution is stopped and control is transferred back to DDT. DDT then restores the three bytes of user code at the breakpoint address, reads all the target CPU registers and prints them out(see R-register command).

7-39. DDT then waits for the user to enter one of the following characters:

1. Period (.) returns DDT to the command mode.
2. Carriage return causes one program instruction to be

stepped. After the instruction is executed, the target registers will be printed again and DDT will again wait for user input.

3. Line feed has the same effect as carriage return, but a heading to identify the registers will be printed out.
4. Space bar starts automatically single stepping. Single stepping will continue for 256 steps or until the space bar is pressed again. The user can thus start and stop single stepping of his target program. (See W-Step command).

NOTE: The contents of the registers reflect the effect of the last instruction before the breakpoint was encountered.

7-40. One breakpoint can be set at a time before execution is begun. A breakpoint can be reset by entering the B command with no operands. A breakpoint at a specific address can be cleared by executing that address.

7-41. There are certain characteristics of the DDT breakpoint facility which the user should be aware of during debugging:

1. The trap sequence used by DDT-80 is as follows:
   ```
   JP DDT      Jump to DDT Breakpoint Processor
   ```

2. Since DDT replaces three bytes of the user program, a breakpoint should be set such that when the user program is executed, control can only be transferred to the first byte of the trap sequence. In addition, the breakpoint must reference the first byte of an instruction. For example in the following sequence:
   ```
     L1 JR NZ,L3-$
   ```

```
L2 LD A,0
L3 LD B,0FH
```

A breakpoint should not be set at L2 because if the branch condition at L1 is met, control would be transferred to the third byte of the trap sequence.

3. No error indication is given if one attempts to set a breakpoint in ROM.

4. After a breakpoint has been set, it can be changed simply by entering a new breakpoint. The act of entering a new breakpoint automatically clears the previous breakpoint.

5. When a breakpoint is encountered in a user program, DDT-80 saves the state of interrupts (through IFF) in the :IF register. The state of interrupts is restored or set according to the content of :IF when control is transferred to the user program.

6. Breakpoint will not work in areas where executable code is modified by the program.

EXAMPLE

.B 24E(CR)

-Set a breakpoint at location $24E_H$.

.O 100(CR)

-Set offset.

.B R4F3(CR)

-Set breakpoint at relative address $4F3_H$ (=$5F3_H$ absolute).

7-42. C-COPY MEMORY BLOCKS COMMAND

7-43. Format.

.C aaaa,bbbb,cccc(CR)	Copy locations aaaa through bbbb inclusive to the memory block starting at address cccc.

7-44. Description. The user enters the command identifier C followed by the starting address aaaa and ending address bbbb of the block to be moved, followed by the starting address cccc of the block receiving the data. The operands may be absolute or relative and are separated by commas or blanks. Upon terminating with a carriage return, DDT performs the requested copy operation, and returns to the command mode. The copy command permits any block of memory data to be moved to any area of memory. The move may be forward or backward and the new block may or may not overlap with the original memory block. Entire programs or subroutines may be moved around in this way. Care should be taken to copy complete instructions on both ends of the block when copying programs, and any relative jump instructions contained within a block to be moved should not jump outside the block. If the second operand entered (bbbb) is smaller than the first (aaaa), a question mark (?) is printed and control returns to the command mode.

EXAMPLE.

.C 100,200,1200(CR)	Copy memory locations 100H through 200H inclusive to locations 1200H through 1300H.
.C 100,200,150(CR)	Copy memory locations, 100H through 200H inclusive to locations 150H through 250H. (overlapping copy)
.O 100(CR)	Set relative offset to 100H.
.C R0,R100,R50(CR)	This would be the same as the previous example.

7-45. E-EXECUTE COMMAND

7-46. Format.

.E aaaa(CR)	Transfer control to the program starting at address aaaa.
.E (CR)	Transfer control to the address specified by register:PC.

7-47. Description. To cause execution of a program the user types the identifier E followed by the desired entry address of his program. Upon typing carriage return DDT loads the Z80 CPU registers and then transfers control to the program entry point. The contents of the register map reflect the effect of the last instruction before the breakpoint was encountered. If no entry address is specified after the E command, DDT will transfer control to the address specified by the :PC register (program counter).

Example.

.E 1200(CR)	Execute the program starting at location 1200H.

To return control to DDT the user's program must encounter a breakpoint (see B-Breakpoint Command).

.M :PC(CR)	Examine user's program counter (PC).
:PC 62FF 1220(CR)	Set user's PC to 1220H.
.E (CR)	Execute program starting at location 1220H.

The execute command may be used together with the breakpoint command to execute portions of programs while debugging.

7-48. F-FILL MEMORY COMMAND

7-49. Format:

.F aaaa,bbbb,cc(CR)	Fill memory locations aaaa through bbbb inclusive with cc.

7-50. Description. the user enters the command identifier F followed by the starting address aaaa and ending address bbbb, followed by the data cc. The operands are separted by commas or blanks. Upon terminating with a carriage return, DDT performs the requested fill operation and then prints a "." to indicate that DDT is ready to accept another command.

Example

.F 100,1FF,5A (CR)	Insert a 5A in every memory location from 100_H through $1FF_H$.
.O 100(CR)	Set relative offset to 100_H.
.F RO,RFF,5A(CR)	Fill same addresses as first example.
.	DDT waiting for next command.

7-51. H-HEXADECIMAL ARITHMETIC

7-52. Format.

.H +aaaa-bbbb+...+yyyy=zzzz(CR) Perform hexadecimal arithmetic.

7-53. Description. The user enters the command identifier and then enters the arithmetic expression. Only + and - are legal operations. If the sign of the first operand is omitted, it is assumed +. The equal sign causes the 4 digit (least significant 4 digits) result to be displayed. When the terminator is entered DDT returns to accept another command.

EXAMPLES.

.H 5000-4FFF=0001(CR)	Subract 4FFFH from 5000H.
.H 5000+4FFF=9FFF(CR)	Add 4FFFH to 5000H. The equal sign caused the 4 digit result to be printed.
.	DDT waiting for next command.

7-54. L-LOCATE 8-BIT DATA PATTERN COMMAND

7-55. Format.

.L aaaa,bbbb,cccc(CR)	Locate and print the address of every occurrence of cccc from aaaa to and including bbbb.

7-56. Description. The user enters the command identifier L followed by the starting address aaaa and ending address bbbb, followed by the data cccc to be located. Upon terminating with a carriage return, DDT prints every address between aaaa and bbbb which contains cccc. If cccc is less than 100_H, then a one byte comparison is made. If cccc is greater than or equal to 100_H, then a two byte comparison is made. The data to be located should be entered with the most significant two digits of data first followed by the least significant two digits of data (if location 1000_H contained 13 and location 1001_H contained 92, the user would enter 9213 as the data to locate).

EXAMPLE:

.L 0,750,35(CR)	Locate every occurrence of 35H between address 0 and 750H.
0052 35	Every location containing 35 is printed between (and including) 0 and 750_H.
00F3 35	
0542 35	
0750 35	
.L 750,35FF(CR)	Locate every occurrence of the 2 byte value $FF35_H$ between address 0 and 750_H.
00F3 35	Every address where 35FF is found is printed out. The location previous to the location printed out contains the least significant two digits.
0542 35	

7-57. M-DISPLAY AND UPDATE MEMORY OR REGISTER COMMAND

7-58. Format:

.M aaaa(CR)

7-59. Description. The user enters the command identifier M and the operand aaaa followed by a carriage return. DDT prints the memory address or mnemonic on the next line, followed by the contents of that particular address in hexadecimal. If the content is to be changed, the new value is entered. Any number of digits may be entered, but only the least significant two (or four) digits are accepted.

7-60. Terminators. When the user is examining and/or modifying a register or memory location, the accompanying terminator signals the action DDT is to take. The possible operand (new value entered) and terminator combinations are:

Terminator	Meanings
(CR)	No operand entered, display next address or register.
∧	No operand entered, display previous address or register.
/	No operand entered, display next address or register.
aa.	Operand aa entered but "." aborts command with no change to value at address.
aa(CR)	Operand aa entered, change value at address to aa and step to next address.
aa∧	Operand aa entered, change value at address to aa and display same address with the new value aa displayed.
aa/	Operand entered, change value at address to aa then exit to command mode.

7-61. Memory display. Memory locations are accessed as follows:

M 16A(CR)	Examine memory location $016A_H$.
016A 3F(CR)	It contains $3F_H$ do not change, step to next location.
016B 92 ^	Next location contains 92_H, do not change, go back to previous locaton.
016A 3F 34FF^	Change contents of 016A to FF_H and display same location. Note that only the last 2 digits typed are stored in 016A (the entry 34 was in error).
016A FF(CR)	New contents displayed, step to next.
016B 92 .	
.	DDT waiting for next command.

7-62. When accessing relative memory locations, the user sets the offset with the "O" command and uses the "R" prefix with the memory address. Assuming the offset was set to 1000:

.M RO(CR)	
'0000 1000 xx.	The relative address, absolute address and data are printed out.
.	DDT waiting for next command.

7-63. Register display. The user may examine and change his CPU registers. They may be initialized, for example, prior to program execution, or after a breakpoint has been encountered in the program to be debugged. The contents of the user's registers may be accessed through the use of the mnemonics discussed in paragraph 7-26.

M :A(CR)	Examine user's accumulator.
:A 18 25(CR)	Change register A to 25H, examine next location.
:PC 0010 .	User's PC Register, return to command mode.
.M :PC(CR)	Examine user's PC (program counter) register.

:PC 0010 .	Return to command mode.
.	DDT waiting for next command.

7-64. When resuming execution of the user's program, these new values will be inserted into the user's Z80 CPU registers.

7-65. Relative branches. A special feature of DDT allows the user to conveniently compute relative addresses used in relative branch instructions. The value of the symbol "$" is defined as the value of the current location and only has meaning during display and update commands.

7-66. This example shows the entering of a jump relative instruction at location 0_H to branch to location 38_H.

.M 0(CR)	Examine location 0_H.
0000 20 18(CR)	Insert First byte of jump (JR 38H-$)
0001 F8 38-$=0036^	Compute and display relative displacement for branch from 0_H to 38_H.
0001 36 .	Branch displacement of 36 shown.
.	DDT waiting for next command.

7-67. It should be noted that the maximum allowed displacement value for forward branches is $7F_H$ and for backward is 80_H. It is simple to determine if the relative branch is within its range by examining the most significant two digits of the computed displacement. For forward branches, the most significant two digits should be 00_H and for backward branches, the most significant two digits should be FF_H.

7-68. M-TABULATE MEMORY COMMAND

7-69. Format

.M aaaa,bbbb(CR) Display memory location aaaa through bbbb.

7-70. Description. The user enters the command identifier M followed by the starting (aaaa) and ending (bbbb) addresses of the memory block. Upon terminating with a carriage return DDT prints a line feed, and then prints the contents of aaaaH to bbbbH inclusive with up to 16 values per line. DDT then returns to the command mode. The tabulation may be stopped at any time by entering "." on the console. When the 'R' prefix is used, the relative address is printed before absolute.

EXAMPLE

.M 4100,4127(CR) display memory locations 4100_H through 4127_H inclusive

```
4100 2B 90 12 20  00 B7 A5 21  10 94 04 20  CA B7 44 18
4110 81 11 34 21  07 94 17 45  12 55 A5 18  21 80 C5 55
4120 90 0C A5 81  09 21 40 22
```

:O 4100(CR) set offset to 4100.

```
.M R0,R27(CR)
'0000 4100  2B 90 12 20  00 B7 A5 21  10 94 04 20  CA B7 44 18
'0010 4110  81 11 34 21  07 94 17 45  12 55 A5 18  21 80 C5 55
'0020 4120  90 0C A5 81  09 21 40 22
```

7-71. O-SET OFFSET CONSTANT COMMAND

7-72. Format:

.O aaaa(CR)	Set offset equal to aaaa.

7-73. Description. The user enters the command identifier O followed by the offset aaaa. Upon terminating with a carriage return, DDT saves the 16 bit offset. After the offset has been set, both relative and absolute addresses are printed any time addresses are displayed and until the offset is cleared. The offset can be cleared by entering the O command with no operands.

EXAMPLE

.O 200(CR)	Set offset.
.H RO=0200(CR)	Display value of offset.
.	DDT waiting for next command.

7-74. P-DISPLAY AND UPDATE PORTS COMMAND

7-75. Format.

.P aa(CR)

7-76. Description. the user enters the command identifier P followed by the port address aa and a carriage return. DDT responds by printing the port address and the value at that port. If the value at that port is to be changed, the user enters the new value. The new value entered is a 2 hexadecimal digit operand. When the user is examining and/or modifying a port, the terminator signals the action DDT is to take. The possible operand (new value entered) and terminator combinations are:

Terminator	Meaning
(CR)	No operand entered, display next port.
	No operand entered, display previous port.
.	No operand entered, return to command mode.
aa.	Operand aa entered, but "." aborts command with no change to the port.
aa(CR)	Operand aa entered, change the port value to aa and step to display the value at the next port.

EXAMPLE

.P E2(CR)	User displays port $E2_H$.
E2 00 12(CR)	User changes value to 12_H.
E3 15 .	Return to command mode.
.	DDT waiting for next command.

7-77. Q-QUIT COMMAND

7-78. Format

.Q CR)

7-79. Description. The user enters Q to exit DDT and return to the FLP-80DOS Monitor. The Monitor prints $ upon entry.
EXAMPLE.

.Q(CR)	exit DDT.
$	enter Monitor (Monitor prompts $)

7-80. R-DISPLAY CPU REGISTERS COMMAND

7-81. Formats.

.R (CR)	Print the contents of the CPU registers.
.R 1(CR)	Print a heading to label the CPU registers on one line, on the next line print the contents of the CPU registers.
.R 1,aa(CR)	Print a heading to label the CPU registers and set the long/short flag as follows. aa=0 SHORT, aa=1 LONG. Long causes all registers to be printed after breakpoint and single step. Short causes only PC and AF to be printed. The LONG/SHORT FLAG remains set until changed by the 'R' command.

7-82. Description. The user enters the comma command identifier R. If the user wants a heading to be printed that labels the register contents, an operand of 1 is entered. If no heading is desired, then no operand is entered. If the '0' command has been used to set an offset, the relative PC is also printed (PC'). The second operand is optional and has the following meaning:

aa=0 - short form: only the Z80 program counter and AF register will be displayed.

aa=1 - long form. All CPU registers will be displayed.

7-83. Note that aa remains set to the value entered during all following commands until it is reset.

Examples.

```
      .R (CR)
 A000 0100 0104 CFB3 C09A FFEE EDF6 9C3E C3DC FE9B D6ED F1BE FFB4

      .R 1(CR)
 PC   AF   IIF  BC   DE   HL   A'F' B'C' D'E' H'L'  IX   IY   SP
 A000 0181 0104 CFB3 0010 C09A FFEE EDF6 C3DC FE9B D6EC F1BE FFB4
```

```
                                        bit
      PC contains A000H      7                      0
       A contains 01H    F = 1  0  0  0  0  0   0   1
       F contains 81H        S  Z  X  H  X  P/V N   C
       I contains 01H
      IF contains 04  (Bit 3 = 1 implies IFF = 1)
              .
              .
              .              S = sign flag
      IY contains F1BEH      Z = zero flag
                             X = indeterminate flag
                             H = half carry (for BCD operations)

      SP contains FFB4H      P/V = parity or overflow flag
                             N = BCD add/subtract flag
                             C = carry flag
```

7-84. V-VERIFY MEMORY COMMAND

7-85. Format.

.V aaaa,bbbb,cccc(CR)	Compare memory location aaaa to bbbb with the memory starting at cccc.

7-86. Description. The user enters command identifier V followed by the starting address aaaa and ending address bbbb, followed by the starting address cccc of the second memory block. The operands are separated by commas or blanks. Upon terminating with a carriage return, every address from aaaa to bbbb is compared with the corresponding address starting at cccc. Any discrepancies are printed on the console. ("address data address data"). When the comparison is complete, DDT is ready to accept another command. Printing of addresses may be aborted by entering a period (.) from the user console at anytime.
Example.

.V 0,FF,1000(CR)	Compare every location from 0 to FFH inclusive.
.O 100(CR)	Set offset.
.V R0,RFF,R1000(CR)	Compare relative address.
'0000 0100 BC '1000 1100 CC	Relative and absolute address on non-matches.

7-87. W-WALK THROUGH A PROGRAM COMMAND

The walk command, also known as software single-step, allows stepping through a program which is contained in RAM. The user's registers are saved and displayed after each step.

7-88. Format.

.W aaaa,nn,xxx(CR)	Begin software single-step at address aaaa, for nn_H steps, xxx = HD requests register heading, xxx = DIS requests disassembly (AIM-80 required for DIS).
.W Raaaa,nn,xxx(CR)	Relative address.

7-89. Description. The user enters the command identifier W followed by the starting address aaaa, the number of steps to take nn, and the options operand xxx. The operands are separated by commas or spaces. Upon terminating with a carriage return, the DDT begins "walking" through the user's program (RAM resident). After each step the user's registers are displayed (See 'R' command). When nn steps have been taken, DDT waits for the user to enter a carriage return, line feed, space, or ".". A carriage return causes the next instruction to be executed and wait again for input. A line feed causes the register heading to be printed before executing the next instruction. A space causes single stepping to continue for 256 instructions or until another space is entered to stop stepping. If nn is omitted, the default is 1. If aaaa is omitted, the last value of the user's program counter (:PC) is used to begin "walking". The stepping may always be stopped by entering any of the characters described above. When the address entered is relative, the 'PC is also printed (relative PC).

7-90. Restrictions to W Command.

1. Only operates with programs in RAM.
2. Cannot CALL or RESTART to an address one or two locations before the CALL or RESTART.
3. Walking through self modifying code is not allowed.

7-91. DEBUGGER ESCAPE (CNTL-C)

7-92. During normal use of DDT the Debugger Escape is not enabled because the minimal listener is not enabled. However, if execution of the user program is begun with the Monitor Implied Run Command or by the Monitor BEGIN command, the minimal listener is enabled. Debugger Escape can be used to trap out of the executing program as if a breakpoint had been encountered. The CPU registers will be saved and all DDT commands can be used. In this mode, Debugger Escape can be used any number of times.

EXAMPLE

```
      $FILE1(CR)
            -user uses Implied RUN command to load and execute
             his program from disk file FILE1.
      (cntl-C)
            -user depresses cntl-C to cause Debugger Escape.
A000 0100 0103 CFB3 C09A FFEE EDF6 9C3E C3DC FE9B D6ED F1BE FFB4
            -DDT is entered as if a breakpoint had been
             encountered.
```

PART 2

TECHNICAL INFORMATION

SECTION 8

RDCHR AND WRCHR SUBROUTINES

8-1. INTRODUCTION

NOTE: These two routines allow the simplest way of performing device I/O on the FLP-80DOS system. It is suggested that the example shown in this section be programmed to acquaint the user with this system.

8-2. RDCHR and WRCHR are two subroutines which allow simplified byte I/O to any of the 6 default Logical Unit Numbers. RDCHR returns one byte from a device via LUN 0, 2, or 4. WRCHR writes one character to a device via LUN 1,3,or 5. Each subroutine assumes that the selected Logical Unit Number has been assigned to a device handler via the Monitor $ASSIGN command. The following paragraphs define entry and exit parameters. Users of DDT-80 V1.3 and ASMB-80 from the SDB-80 paper-tape system will recognize that this protocol is exactly the same as RDCHR and WRCHR in that software package. This allows current paper tape users to easily upgrade to the FLP-80DOS software.

8-3. RDCHR - READ ONE BYTE

8-4. CALLING SEQUENCE.

```
CALL RDCHR    ;RDCHR Address is specified in Appendix F.
```

8-5. ENTRY PARAMETERS.

```
    E register:
      Bits 0-2 = LUN (0-5).
      Bits 3   = 1 to initialize or open the device.
      Bits 4,5 - reserved.
      Bit 7    = 1 for immediate return.
```

8-6. EXIT PARAMETERS.

A register and D register = byte which was read (ASCII).

E register:

Bit 3 reset after initialization.

Bit 6 = 1 if error occurred on input.

Bit 7 reset if operation was performed.

All other registers are maintained.

8-7. OPERATION. The driver uses LUN 0,2,4 or input. Lun's 1, 3 and 5 are modified to 0,2,4, respectively, within the subroutine. If the initialize bit (3) is set, OPENR request will be performed. Each READ request will return one byte (Byte Format I/O). Upon encountering 04H (EOT), the close request will be performed. Bit 6 will indicate if an I/O error occurred.

8-8. If bit 7 is set upon entry, the device status is read, but no read operation is initiated unless the device is ready. However control is always returned to the caller whether or not the operation was performed. This feature is not available with the disk.

8-9. WRCHR - WRITE ONE BYTE

8-10. CALLING SEQUENCE

```
CALL WRCHR   ;WRCHR Address is specified in Appendix F.
```

8-11. ENTRY PARAMETERS

E register:

Bits 0-2 = LUN (0-5).

Bits 3 = 1 for initialize.

Bits 4,5 - reserved.

Bits 7 = 1 for immediate return.

D register = byte to be output (ASCII).

8-12. EXIT PARAMETERS

A register - changed.

E register:

Bit 3 reset after initialization.

Bit 6 = 1 if error occurred on output.

Bit 7 reset if operation was performed.

All other registers are maintained.

8-13. OPERATION. The driver uses LUN 1,3 or 5 for output. LUN's 0,2, and 4 default to 1,3,5 respectively within the subroutine. If the initialize bit is set, OPENW request will be performed. If the unit is a disk unit and if the file exists, it will be erased and reopened. Each WRITE request outputs one byte (Byte Format I/O). If the byte is 04H (EOT), it will be output and a close request will be performed. Bit 6 indicates if an error occurred. The error number will be in the default vector for the correct LUN.

8-14. If bit 7 is set upon entry, the status port will be read, but no write operation is initiated unless the device is ready. However, control is always returned to the caller whether or not the operation was performed. This feature is not available with the disk.

8-15. DDT OPERATION

8-16. During execution of DDT (debugger) all I/O is directed to the console drivers without using the IOCS facilities. This allows the user to use all of available RAM and facilitates the AIM-80 memory map and operation. This mode can be forced by the programmer by setting location $FF12_H$ to the value 2.

EXAMPLE - See Figure 8-1.

CAUTION: When using RDCHR, the last character of a file, which will be EOT (04_H), must be read in order to properly close the file. When using WRCHR, the last character output must be EOT (04_H) in order to properly close the file.

NOTE The calling addresses for RDCHR and WRCHR will not change in future versions of FLP-80DOS.

```
G8_1 EXAMPLE OF RDCHR & WRCHR        MOSTEK FLP-80 ASSEMBLER V2.0 PAGE 0001
DDR  OBJECT    ST # SOURCE STATEMENT        DATASET = DKO:FIG8D1.

                0002          NAME    FIG8_1
                0003 ;
                0004 ; THIS PROGRAM READS CHARACTERS INTO A BUFFER UNTIL
                0005 ; A CARRIAGE RETURN IS ENCOUNTERED.  THEN THE BUFFER
                0006 ; IS PRINTED OUT ON THE CONSOLE DEVICE.
                0007 ;
                0008 ; THIS PROGRAM MUST BE LINKED WITH 'SYSLNK' IN ORDER
                0009 ; TO RESOLVE THE EXTERNAL REFERENCES.
                0010 ; E.G.:   $LINK FIG8D1,SYSLNK
                0011 ;
                0012 ; EXTERNAL LINKAGES TO SYSTEM ROUTINES
                0013 ;
                0014          GLOBAL  JTASK
                0015          GLOBAL  RDCHR
                0016          GLOBAL  WRCHR
                0017 ;
 0000  212200'  0018          LD      HL,BUF   ;GET BUFFER ADDRESS
 0003  1E00     0019          LD      E,0      ;CONSOLE LOGICAL UNIT NUMBER
                0020 ;
 0005  CDFFFF   0021 LOOP     CALL    RDCHR    ;READ ONE CHARACTER FROM CONSOLE
 0008  77       0022          LD      (HL),A   ;PLACE IT INTO THE BUFFER
 0009  23       0023          INC     HL       ;INCREMENT BUFFER POINTER
 000A  FE0D     0024          CP      0DH      ;CHECK FOR CARRIAGE RETURN
 000C  20F7     0025          JR      NZ,LOOP-$        ;IF NOT, LOOP FOR MORE
                0026 ;
 000E  212200'  0027          LD      HL,BUF   ;REINITIALIZE BUFFER POINTER
 0011  1E01     0028          LD      E,1      ;CONSOLE OUTPUT LUN
                0029 ;
'0013  56       0030 LOOP2    LD      D,(HL)   ;GET CHARACTER FROM BUFFER
'0014  CDFFFF   0031          CALL    WRCHR    ;WRITE IT OUT TO CONSOLE LUN
'0017  23       0032          INC     HL       ;INCREMENT BUFFER POINTER
'0018  7A       0033          LD      A,D      ;GET CHARACTER INTO A-REG
'0019  FE0D     0034          CP      0DH      ;CHECK FOR CARRIAGE RETURN
'001B  20F6     0035          JR      NZ,LOOP2-$       ;IF NOT, LOOP FOR MORE
                0036 ;
'001D  3E01     0037          LD      A,1
'001F  C3FFFF   0038          JP      JTASK    ;ELSE RETURN TO MONITOR
                0039 ;
                0040 ; INPUT/OUTPUT BUFFER
                0041 ;
'>0022          0042 BUF      DEFS    128
'00A2  00       0043          DEFB    0        ;DEFS CANNOT TERMINATE A MODULE
                0044          END


ERRORS=0000
```

SECTION 9

INPUT/OUTPUT CONTROL SYSTEM (IOCS)

9-1. INTRODUCTION

9-2. The Input/Output Control System (IOCS) provides a general purpose means of accessing all types of I/O devices. It makes any differences between devices as transparent as possible to the user. IOCS may be used to access data from a device or write data to a device. This may be achieved in a user program by filling a vector within the user program with information regarding the type of I/O action required and calling IOCS. IOCS not only uses the information contained in the vector, but also returns information to the user in the vector. Several system routines exist to aid the user in working with IOCS and are described in Section 13.

9-3. VECTOR DEFINITION

9-4. IOCS requires that a 48 byte (30H) vector be filled with information regarding the type of I/O action to be performed and where that action is to take place. The vector may be filled within the user program or by using the $ASSIGN command previous to entering the program (see section 2 of this manual). If the $ASSIGN command is used, IOCS fills the vector pointed to by the IY register when an OPEN request is made (see Section 9-15). When a user makes a request to IOCS, the IY register must point to the first address of the vector being used. Bytes 0-29 of the vector are the user interface to IOCS. Bytes 30-39 are reserved for I/O device handler usage. Bytes 40-47 are reserved for IOCS usage. Table 9-1 lists the sections of the vector and assigns a name to each section for easy reference. Each vector name contained in table 9-1 will be discussed in detail. The user may reference the sample program in section 9-71 to see how the vector and IOCS are used.

TABLE 9-1. VECTOR DEFINITION

IELD	#BYTES	OFFSET	NAME	DESCRIPTION	FORM
1	1	*(IY+0)	LUNIT	Logical Unit Number	(Binary)
2	2	*(IY+1)	DVCE	Device Mnemonic	(ASCII)
3	1	*(IY+3)	UNIT	Unit Number	(ASCII)
4	6	*(IY+4)	FNAM	File Name	(ASCII)
5	3	*(IY+10)	FEXT	File Extension	(ASCII)
6	1	*(IY+13)	VERS	File Version	(Binary
7	1	*(IY+14)	USER	User Number	(Binary
8	1	*(IY+15)	RQST	Request Code	(Binary
9	1	*(IY+16)	FMAT	I/O Format	(Binary
10	2	(IY+17)	HADDR	Device Handler Address	(Binary
11	2	*(IY+19)	ERRA	User Specified Error Return Address	(Binary
12	1	*(IY+21)	CFLGS	Control Flags	(Binary
13	1	(IY+22)	SFLGS	Status Flags	(Binary
14	1	(IY+23)	ERRC	Error Code	(Binary
15	1	(IY+24)	PBFFR	Physical Buffer Number	(Binary
16	2	*(IY+25)	UBFFR	User's Buffer Address	(Binary
17	2	*(IY+27)	USIZE	User's Buffer Size	(Binary
18	1	(IY+29)	NREC	Number of Records	(Binary
19	10	(IY+30)	HSCR	Device Handler Scratch	
20	8	(IY+40)	ISCR	IOCS Scratch	

where * appears indicates the parameter is to be set up by the user prior to calling IOCS.

9-5. The following paragraphs describe each field in the IOCS vector.

9-6. LUNIT. The LUNIT field in the vector is the Logical Unit Number. There may be as many as 256 logical units, numbered 0-FF_H. The number stored in the LUNIT field corresponds to the logical unit number used in the Monitor $ASSIGN command (See Section 2). When an OPEN request is made in IOCS, the REDIRECT TABLE is searched for a logical unit number which has been redirected via the $ASSIGN command corresponding to the number stored in the LUNIT field of the vector. LUN FF_H is never redirected. If a match is found, the data found in the REDIRECT TABLE is stored in the user vector and the requested operation is performed. Logical unit numbers 0 - 5 are the default logical units and are assigned by FLP-80DOS at power up and when FLP-80DOS is booted from disk into RAM (See Section 2 of this manual). Vectors for the default logical units already exist in RAM and the user need not set up additional vectors for them. The addresses of the default vectors may be accessed by loading the D-reg. with the default logical unit number and calling GETVEC (see Section 13). These vectors are used by FLP-80DOS utility programs, and they may also be used by user application programs. Lun's 0 and 1 are always assigned to the console input and console output devices respectively. All other LUN's require that memory space be allocated for the 48-byte vector by the program using the LUN.

9-7. Any LUN may be assigned to a device handler by setting up the device information in the vector. (See below). Any LUN (except FF_H) may be redirected to any device by the Monitor $ASSIGN command (See Section 2). LUN FF_H is never redirected: the device information placed in the vector is the information used by IOCS. In addition when LUN 0 and 1 are reassigned in the

Monitor they are closed and reopened immediately to facilitate batch mode operation (See Section 14).

9-8. The same LUN may be used in any number of different vectors. This can facilitate a multi-user system in which several different programs use a LUN with a separate vector for each program. Further, LUN FF_H can be used for any number of different vectors within the same program. The FLP-80DOS Text Editor uses this feature.

NOTE An LUN is redirected to a different device by using the Monitor $ASSIGN command. However, the redirection does not take place until the LUN is opened. (Except for LUN 0 and LUN 1). Section 2 describes this in more detail.

9-9. DVCE. The DVCE field is composed of two ASCII character mnemonic which represents an I/O device. IOCS calls an external routine which searches for the mnemonics in a table. The Mnemonic Lookup Table also contains the corresponding address of the device handler. FLP-80DOS provides an expandable Mnemonic Lookup Table with a number of pre-assigned device mnemonics in it. The list of available FLP-80DOS device mnemoncs is shown in Table 9-2.

TABLE 9-2. FLP-80DOS DEVICE MNEMONICS

MNEMONIC	DESCRIPTION
CP	Line Printer (Centronics compatible)
CR	Card Reader (Documation M200)
DK	Flexible Disk
LP	Line Printer (Data products compatible)
PP	Paper Tape Punch

PR	Paper Tape Reader
TI	Silent 700 digital cassette reader (ADC is required)
TK	Terminal Keyboard
TO	Silent 700 digital cassette write (ADC is required)
TR	Teletype paper tape reader (step control is required)
TT	Teletype Printer or CRT screen, or Silent 700 printer.

9-10. UNIT. The UNIT field specifies one of a number of devices having the mnemonic specified in DVCE. For example if the DVCE was 'DK' (Flexible Disk), the Unit field would specify which disk unit the I/O operation is directed to. The device handler is responsible for decoding and using the UNIT field. In FLP-80DOS, all supplied handlers access one device (UNIT=0) except the Flexible Disk Handler (FDH).

9-11. FNAM. The FNAM (Filename) field is used only when accessing file structured devices. The six (6) ASCII bytes of the filename to be accessed are filled in by the user in the user program previous to calling IOCS or by use of the $ASSIGN command (See Section 2). In FLP-80DOS, the filename starts at the beginning of the field and is padded with blanks.

9-12. FEXT. The FEXT is an extension on a filename. In FLP-80DOS the following system extensions are reserved:

OBJ	ASCII hexadecimal object format
BIN	Binary RAM Image format
CRS	Linker Cross Reference file
TMP	Editor or Assembler temporary file
LST	Assembler listing file

The user may define and use other extensions as required. If the $ASSIGN command was used to enter the filename, the extension defaults to three (3) blanks.

9-13. VERS. The VERS field (version) is another extension on the filename. FLP-80DOS system programs do not support the version number. However, IOCS and the Floppy Disk Handler (FDH) do support it, but it is used for the date implementation in version 2.1 of FLP-80DOS.

9-14. USER. The USER field can be used to further identify a file. FLP-80DOS system programs support the USER field, but they do not support a multi-user environment. OEM users may wish to use this facility to develop a multi-user system. The default user number is one.

9-15. RQST. The RQST field is the request code. This field defines which type of action will be performed by IOCS. How a device handler interfaces to these request codes is described later in this section. The FLP-80DOS Flexible Disk Handler (FDH) supports an extended range of request codes which may be passed to IOCS. These codes are described in Section 10 of this manual.

TABLE 9-3. GENERAL PURPOSE REQUESTS

RQST CODE (HEX)	NAME	DESCRIPTION
00	OPENR	OPEN this unit for READING
01	OPENW	OPEN this unit for WRITING
02	CLOSE	Close this logical unit
03	READ	Read data from this unit
04	WRITE	Write data to this unit
05	REWIND	Go to beginning of input/file
06	INIT	Initialize all units of this device type
07	ERASE	Erase this file

9-16. FMAT. The FMAT field in the vector describes the I/O format selected by the user (high order 4 bits of the FMAT field) as well as the number of physical records to be allocated by the physical buffer allocator when the unit is opened (low order 4 bits (x) of the FMAT field). The user must select the format code best suited for the type of action required and the type of file being used.

TABLE 9-4. FORMAT REQUEST CODES

FMAT CODE (HEX)	TYPE	DESCRIPTION
0X	Byte I/O	Pass single bytes through A-REG.
1X	ASCII Line	Read/Write until carriage return.
2X	Logical Buffer	Read/Write number of bytes specified by USIZE.
3X	Binary ram image	RAM IMAGE to/from disk for binary save or load.

9-17. In all formats except Binary Format, double buffering takes place. That is, when a READ or WRITE request is made, data is placed in a buffer at the top of available RAM (the address of the buffer is determined by the physical buffer allocator). When a READ request is made to IOCS, data is retrieved from the buffer rather than the disk file. When a WRITE request is made, data is placed into the buffer until the buffer is filled before outputting the data to a disk file. IOCS handles all blocking/deblocking functions.

9-18. The size of the buffer used for storing data is controlled by the user in the low order 4 bits (x) of the FMAT field. This number ($0-F_H$) corresponds to the number of physical records to be allocated. For example, if the user selected to read data from a file and selected to store 4 records of data in the buffer, the buffer size would be 496 bytes in length (4 records 124 bytes per record). The user must select the best trade-off for his particular application. If the user chooses a small number of records to be allocated, more memory will be available for user programs in RAM. However, disk access time may be greater. A large number of allocated records will cause disk access time to be reduced but user RAM will be reduced also.

9-19. In Byte I/O Format, a single character may be written to a device. The character to be written is passed to IOCS in the A-register. When reading, the byte read is passed back in the A-register.

9-20. In ASCII Line Format, data may be written to a device or read from a device on a line-at-a-time basis. If reading from a device, UBFFR (IY+25) contains the address (least significant byte first) where the line is to be stored in RAM. If writing to a device, UBFFR contains the address in RAM where the ASCII line to be written begins. Action on each line continues until a carriage return/line feed is encountered. The contents of UBFFR are not destroyed after the request is completed.

9-21. In Logical Buffer Format, the user can control the number of bytes to read or write with the USIZE (IY+27) parameter. To read data from a device, the user should load the UBFFR (IY+25) parameter with the address of the beginning area in RAM where data is to be stored. The USIZE parameter should be filled with the number of bytes to read. IOCS will read data from the device specified, store the data in RAM beginning at the address contained in UBFFR, and continue this operation until the USIZE parameter is satisfied. To write data to a device, the user should load UBFFR with the address of the beginning area in RAM where data is to be written from. IOCS will begin reading data from RAM pointed to by UBFFR and writing the data to a device until the USIZE parameter is satisfied. If writing to a disk file, USIZE must be less than or equal to 'X' times 124, where 'X' is the number of physical records allocated as specified in the FMAT (IY+16) field.

9-22. Binary Format is reserved for binary disk files. When an OPENR (open for reading) request is made, the load address is read from the directory and placed in the UBFFR (IY+25) parameter. UBFFR determines where the contents of the binary file are to be loaded in RAM. The user may alter the address in UBFFR previous to making READ request to IOCS to load the data in a different area in RAM. The binary file will be read and stored in RAM beginning at the address contained in UBFFR and continue until end-of-file is encountered. When an OPENW (open for writing) request is made, the address contained in UBFFR is stored in the directory. The USIZE (IY+27) parameter specifies the number of bytes to be saved. This will be rounded mod-124 in FLP-80DOS. When a WRITE request is made to IOCS, data will be read from RAM beginning at the address contained in UBFFR and stored on a disk file. This action will continue until the USIZE parameter has been satisfied.

9-23. HADDR. The HADDR field is the address of the device handler. This field is filled in by the IOCS when the logical unit is opened. (OPENR or OPENW request).

9-24. ERRA. The ERRA field is a user-specified error return address, least significant byte first. If the field is left zero, then IOCS will return without calling the return address. If bit 4 of CFLGS (See Section 9-28) is set, the system error handler will print a message on the device assigned to default Logical Unit 1.

9-25. CFLGS. The CFLGS field specifies various user specified I/O options as listed in the following table:

BIT #	FLAG DESCRIPTION	NAME
0	"MOUNT"/"DISMOUNT" Upon Open/Close	MOUNT
1	Auto Echo Serial Device	ECHO
2	Immediate Return	IRET
3	Read after Write requested	RDWR
4	Error Print Request	ERRPR
5	Strip Parity	NPAR
6		
7		

9-26. If the MOUNT bit is set in the CFLGS Field, then IOCS will print the following message for OPEN and CLOSE requests:

```
for  OPENR or OPENW
     MOUNT XXY, TYPE C WHEN READY:
for CLOSE
     DISMOUNT XXY, TYPE C WHEN READY:
where XX is device mnemonic
and Y is unit
```

This allows the user to output a message to ensure the device he is trying to access is made ready before execution.

9-27. If the ECHO bit is set, in ASCII line input, each character read in is echoed to the console output device (as specified in default Logical Unit 1). Additional editing is performed on the line (Backspace, Rubout, Control-U, Tab). The following conventions are used:

BACKSPACE (ASCII 08_H) - delete character from the buffer. The cursor movement is backspace, overprint with a blank, and backspace again.

RUBOUT (ASCII $7F_H$) - delete previous character from the buffer. A backslash is printed on either side of the characters which are deleted.

CONTROL-U (ASCII 15_H) - delete line.

TAB (ASCII 09_H) - the tab character is entered into the buffer and the cursor is moved over mod - 8 spaces.

9-28. If the IRET bit is set, then any device handler which supports IRET will return immediately to the caller regardless of the status of the device. The device handler interrogates the device status. If the device is not ready, IRET flag set will be returned to caller. If the device is ready, the I/O operation will be performed and IRET flag reset will be returned to caller. This facility can be used by OEM users in a multitasking environment for handling I/O devices. Immediate Return can be used to check for time out on certain devices.

9-29. If the RDWR bit is set, then those handlers which support this facility will perform a read and verification after write. The FLP-80DOS Floppy Disk Handler (FDH) supports this facility.

9-30. If the ERRPR bit is set, then any error generated by a device handler or IOCS will be printed on the console device by IOCS. Appendix E shows the format of the messages.

9-31. If the NPAR bit is set, then bit 7 of every byte of I/O will be unconditionally reset by IOCS.

9-32. SFLGS. The SFLGS field contains flags used by IOCS to keep track of the status of a logical unit. This field must be cleared (00_H) by user before opening a logical unit.

BIT #	FLAG DESCRIPTION	NAME
0	Unit open	UNOP
1	Unit open for write	UNOPW
2	Unit on	UNON
3	End of File Detected	EOF
4		
5		
6		
7		

9-33. ERRC. The ERRC is a system error code inserted by IOCS or a device handler upon detection of an error. ERRC should be interrogated after each call to IOCS by the application program. Appendix E lists all the error codes for FLP-80DOS.

9-34. PBFFR. The PBFFR field is used by IOCS when assigning a physical buffer for an open logical unit. The user must not change this field.

9-35. UBFFR. The UBFFR (user buffer) field is specified by the user to direct IOCS where to locate the I/O data. This field is left unchanged by IOCS except in I/O Format 3X, in which case it is changed by IOCS to point to the last byte transferred +1. The buffer address is entered least significant byte first. The user should refer to the section regarding the type of format being used.

9-36. USIZE. The USIZE field is the user's buffer size (in bytes), least significant byte first. In I/O Format 2X (LOGICAL BUFFER I/O), the IOCS fills the entire buffer on a read and outputs the entire buffer on a write. If the end of file is reached for format 2X on read operation before the UBFFR is filled, then USIZE is changed by IOCS to the actual number of bytes read. In I/O Format 3X (BINARY RAM IMAGE I/O), the USIZE parameter specifies the number of bytes to be saved (rounded mod-124). The user should refer to the section reqarding the type of format being used.

9-37. NREC. The NREC field tells the device handler the number of physical records to read, write or skip. This field is used by IOCS.

9-38. HSCR. The HSCR field is available to the device handler to use for scratch variables associated with logical unit.

9-39. ISCR. The ISCR is reserved for IOCS to use as scratch variables.

9-40. HOW TO USE IOCS

9-41. When a user wishes to access an I/O device via IOCS, the following procedure should be followed.

9-42. SET UP A VECTOR. The vector should be first initialized to zeros, then appropriate data should be placed into the vector. In FLP-80DOS, the default vectors 0-5 are available for use by an application program but 0 and 1 are reserved for the console device. Recall that the vectors for LUN's 0-5 already exist; their starting addresses are defined via GETVEC (See Section 13). All other LUN's require that the application program provide the vector space (48 bytes). The following fields should be preset by the user program: LUN, DVCE, UNIT, FNAM, FEXT, VERS, and USER, if file structured device is used; RQST, FMAT, ERRA (if used) CFLGS; and UBFFR and USIZE if ASCII Line Format, Logical Buffer Format, or Binary Format is used.

1. SET IY equal to the address of the first byte of the vector.

2. OPEN the device. Insert an OPENR (open for read) or OPENW (open for write) request code into the RQST field of the vector, then call IOCS: CALL JIOCS ;the address of JIOCS is shown in Appendix F.

NOTE: The calling address of IOCS (=JIOCS) will not change in further versions of FLP-80DOS.

3. The READ/WRITE request is placed into the RQST field and IOCS is called once for each I/O operation.

4. CLOSE THE DEVICE. The CLOSE request is placed into the RQST field of the vector and IOCS is called when no more I/O is to be done. FLP-80DOS uses 04_H as end-of-file indicator for ASCII files.

5. After each call to IOCS, the ERRC field should be checked for errors. If it is zero, then no errors were encountered. Some errors are fatal or non-recoverable, such as DISK I/O ERROR. Others are merely indicators, such as END OF FILE.

Idiosyncracies of the Flexible Disk Handler are described in Section 10 this manual.

9-43. DEVICE HANDLER REQUIREMENTS

9-44. Each device handler must begin with a displacement table for each of the supported IOCS requests. If a function is supported, the displacement is added to the table address to determine the handler entry point for a given function. If a function is not supported, then IOCS generates an error code and returns to caller. The following is an example of paper tape device handler.

```
PTAPE     DEFB        3       ; The largest request code supported
          DEFB    PTOPEN-$    ; Displacement for OPENR (RQST 0)
          DEFB        0       ; OPENW is not supported (RQST 1)
          DEFB    PTCLOS-$    ; Displacement for CLOSE (RQST 2)
          DEFB    PTREAD-$    ; Displacement for READ (RQST 3)
PTOPEN                --      ; Initialize Paper Tape RDR
PTCLOS                --      ; Disable Paper Tape Reader
PTREAD                --      ; Read a Byte
                 RET
```

9-45. The first byte of the handler specifies that the largest request supported is 3. Any request code between 0 and 3 must have a zero displacement if it is not supported. When a device handler is opened, it must pass the physical buffer size back to IOCS in the BC register. If the .BIN data type is supported by a device, the handler must generate and/or strip off all non-data bytes such as sync characters and CRC. For devices that do not support REWIND, IOCS will print the following message on the console when REWIND is requested:

"REWIND XXY, ENTER C WHEN READY:"

Where XX is the device mnemonic and Y is the unit number.

NOTE I/O Device Handlers must not destroy the alternate register set or the main set of registers.

9-46. PHYSICAL I/O BUFFERS

9-47. When the user opens a file for use with I/O format 0, 1 or 2 (Byte I/O, ASCII line, or logical record I/O), then IOCS allocates a physical record buffer for the device. When the handler returns control to IOCS after an OPENR or OPENW, the BC register contains the physical record size (in bytes) for the device. IOCS then allocates that number (IF >1) of bytes and assigns a physical buffer number to PBFFR in the vector. IOCS maintains a physical buffer allocation table and can allocate up to 16 concurrent buffers.

9-48. The allocation table contains the start address for each physical buffer wich is shown in following table:

TABLE 9-5. PHYSICAL BUFFER ALLOCATION TABLE

```
BUFFR0   DEFS 2      ; Present location of I/O Buffer #0.
BUFFR1   DEFS 2      ; Present location of I/O Buffer #1.
BUFFR2   DEFS 2      ; Present location of I/O Buffer #2.
BUFFR3   DEFS 2      ; Present location of I/O Buffer #3.
BUFFR4   DEFS 2      ; Present location of I/O Buffer #4.
BUFFR5   DEFS 2      ; Present location of I/O Buffer #5.
BUFFR6   DEFS 2      ; Present location of I/O Buffer #6.
BUFFR7   DEFS 2      ; Present location of I/O Buffer #7.
BUFFR8   DEFS 2      ; Present location of I/O Buffer #8.
BUFFR9   DEFS 2      ; Present location of I/O Buffer #9.
BUFFRA   DEFS 2      ; Present location of I/O Buffer #A.
BUFFRB   DEFS 2      ; Present location of I/O Buffer #B.
BUFFRC   DEFS 2      ; Present location of I/O Buffer #C.
BUFFRD   DEFS 2      ; Present location of I/O Buffer #D.
BUFFRE   DEFS 2      ; Present location of I/O Buffer #E.
BUFFRF   DEFS 2      ; Present location of I/O Buffer #F.
```

9-49. IOCS allocates the first buffer with a buffer number of 0.

This number is placed in the PBFFR field of the VECTOR. The buffer number placed in the vector is FF_H for byte oriented devices (physical buffersize = 1).

9-50. The actual physical buffers contain the number of bytes specified by (BC) after an OPENR or OPENW plus eight bytes for deblocking and de-allocaton as follows:

```
(start of buffer)
DEFS 2  ; Size of Buffer (not including first 8 bytes)
DEFS 2  ; Temporary Buffer Pointer
DEFS 2  ; The physical record size = (BC) after OPENR or OPENW
DEFS 2  ; Last address transferred after a read
```

9-51. When a logical unit which had a physical buffer assigned to it is closed, IOCS de-allocates the buffer space and compresses the buffers, removing any holes in the buffer block.

9-52. SYSTEM INTERRUPT TABLE

9-53. The top 32 bytes in the user RAM space are reserved for the system Interrupt table. The program module DK reserves a 32 byte buffer for this purpose so the end address of OS.BIN [255] can be positioned at the top of RAM (see SYSGEN Section 15). During the system boot sequence the Monitor automatically calculates the top of RAM memory and stores that value in TOR (OFFOOH). The following displacements from TOR have been reserved for system devices.

TOR DISPLACEMENT	DEVICE
5	Operating System Minimal Listener
7	LP:
9	PR:
11	PP:
13	CR:
21-31	Reserved for User Interrupt Devices

9-54. The Open routine within a device handler may use the value in TOR ($FF00_H$) and its designated displacement (see above table) to calculate the position of its interrupt vector. The open routine should place the MSB of the Interrupt vector into the I register and output the LSB to the designated PIO. The open routine should also place the address of the device interrupt service routine into the interrupt vector in the interrupt table. (See Paragraph 9-63).

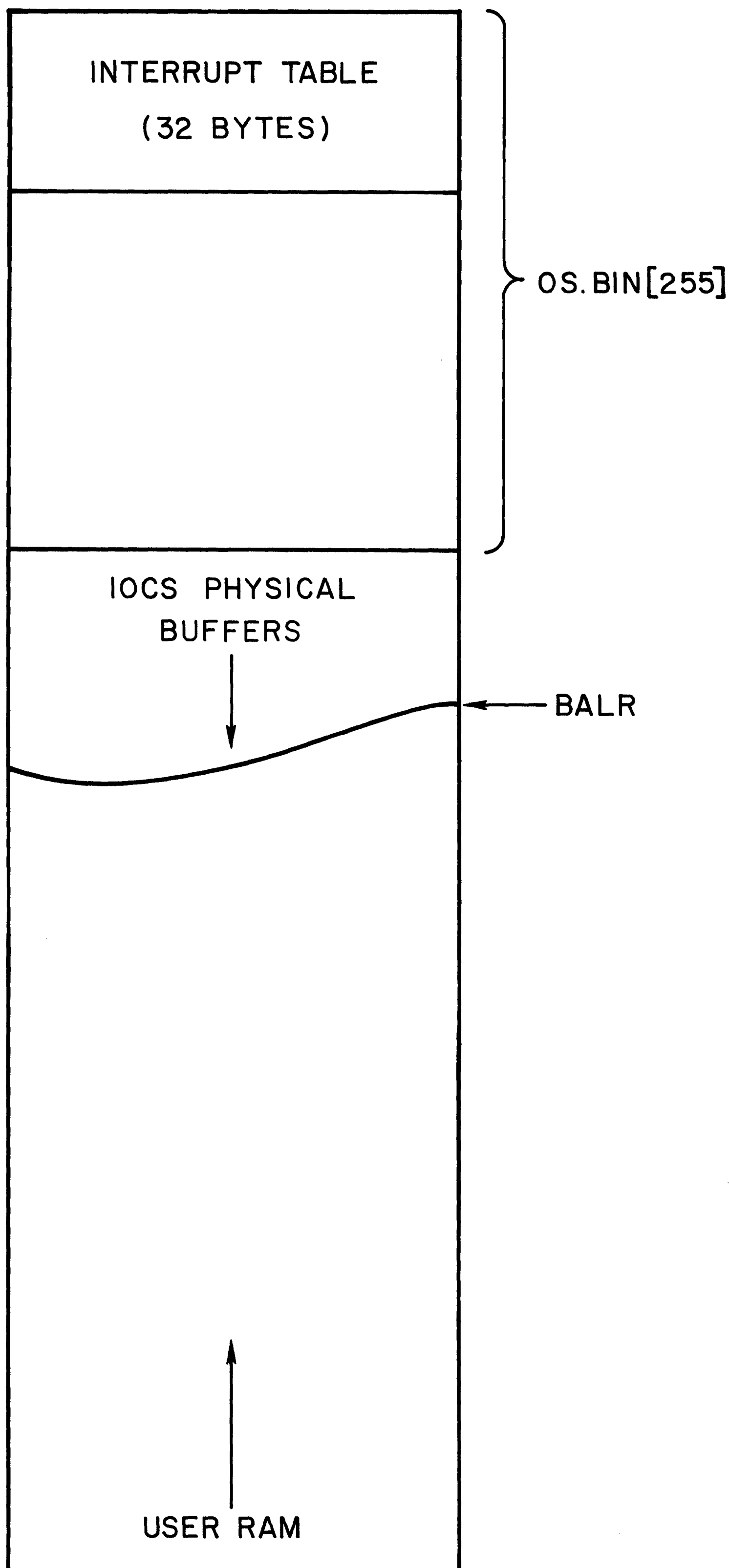
9-55. IOCS MEMORY MAP

9-56. The Default Logical Unit Table, the Logical Unit Redirect table and the IOCS buffer allocation table are included in the program module IOCS. IOCS is an operating system module which is linked into OS.BIN [255] during the SYSGEN procedure (See Section 15). IOCS physical I/O buffers are allocated dynamically downward from the operating system as outlined in figure 9-1.

9-57. The Logical Unit Redirect Table contains the assignment of device handlers to logical unit numbers by the Monitor ASSIGN command. Each item in the table is 15 bytes long. These 15 bytes correspond exactly with the first 15 bytes of the IOCS vector (See Section 9-4). Up to 6 items can be placed into the redirect table. The redirect table is terminated by a logical unit number (1st byte of an item) of FF_H (Recall that this is the Logical Unit Number which cannot be redirected).

9-58. Bottom of Allocated RAM (BALR) is a pointer to the bottom of the system routines less any physical buffers allocated (dynamically) by IOCS. The BALR pointer is maintained in scratchpad locations $FF02\text{-}FF03_H$ and is updated by IOCS as it allocates and de-allocates physical buffers.

FIGURE 9-1. IOCS MEMORY MAP



9-59. WRITING A DEVICE HANDLER

9-60. CHARACTER-ORIENTED DEVICES

9-61. Introduction. Device handlers for character oriented devices are rather straightforward in their design. The paper tape reader for FLP-80DOS is included in Section 12 of this manual. The following discussion examines the design in detail.

9-62. Design Criteria. The handler is to input one character at a time. It will be interrupt driven. Control and I/O will be done via a Z80 PIO, which takes two sequential port addresses (in this case, $D0_H$ for control and $D1_H$ for data). The control port number is contained in a byte in the handler.

9-63. Open Process.

1. Disable interrupts while the Z80 PIO is programmed. The reader is directed to the "Z80 PIO Technical Manual" for details of programming the device.
2. Access the control port number. The least significant bit is used as a ready flag.
3. Access item number in Interrupt Pointer Table (C-reg = 0, the first item).
4. Access the interrupt handler address (RINT).
5. This address is place into the first items of the Interrupt Pointer Table.
6. Program the Z80 PIO for proper operation.
7. Initialize the status bit to zero (not ready).
8. Program the interrupt handler vector into Z80 PIO (LS byte) and into the Z80 I-register (MS byte). Z80 Interrupt Mode 3 is used throughout FLP-80DOS. The reader is referred to the "Z80 CPU Technical Manual" for further discussion.

9. Set up a physical buffer size of one for one byte transfers (BC-reg = 1).
10. Perform first I/O operation to start reader.
11. Enable interrupts and return to caller.

9-64. Close Process. No operation is performed; return to caller.

9-65. Read Process.

1. Access port number and strip off status bit (bit 0).
2. Set up an initial time out of about 250 msec.
3. Enable interrupts.
4. Check the status flag. The status flag is set in the RINT routine when an interrupt occurs.
5. If the status flag is not set (not ready), then check for immediate return. If immediate return is set, then return to the caller (IOCS) without performing any input operation. Otherwise check for time out. If time out occurs, call the system Error Handler(EH) (Described in Section 13) with the time out error code in the A-reg. Then reinitialize the timeout counter and loop on status. Thus the time out error message will be output periodically until the system is reset or the device goes ready.
6. If the status flag is set (device ready, data is available), then read the data from the data port. Reset the status flag and the immediate return flag. Complement the data and return it in the A - register. The complement operation is dependent upon the interface to the device.

9-66. RECORD ORIENTED DEVICES.

9-67. Introduction. Device Handlers which operate on a physical record basis must meet additional requirements for IOCS. The handler must place bytes directly into the IOCS buffer rather than passing them via the A-register. The handler must also properly process multiple record requests by IOCS. An optional Card Reader Driver is shown in Section 12 of this manual. The Card Reader Driver is supplied on the FLP-80DOS diskette in source and relocatable object format, but it is not integrated into the system. The following discussion examines the design in detail.

9-68. Design Criteria. The handler is to input one card at a time. The physical buffer size is 80 bytes plus 2 more for carriage return and line feed. Control and I/O will be done via a Z80 PIO which takes 4 sequential port addresses (starting at 69_H in this case). The first port number is taken from a byte in the handler. The handler uses interrupts where each interrupt corresponds to one card column read. Thus, after card pick, the handler must process 80 fast, sequential interrupts. The handler must read as many cards as are requested by IOCS.

9-69. Open Process. Interrupts are disabled. The card reader interrupt handler address (CRDRDR) is placed into the Interrupt Pointer Table. The least significant byte of the interrupt vector is programmed into the Z80 PIO. The most significant byte is loaded into the Z80 I-register (Interrupt Mode 3 is used). The PIO is programmed for handshake (See the Z80 PIO Technical Manual for full details). A physical buffer size of 82 is returned to IOCS via the BC-register.

9-70. Close Process. No operation is performed; return to caller.

9-71. Read Process.

1. The number of records (NREC) being requested by IOCS

is accessed and saved in the handler scratch area (HSCR) of the IOCS vector. Then NREC is set to zero. NREC becomes the counter of the actual number of records (cards) read by the handler.

2. The IOCS physical buffer address is accessed. This is the starting address where the handler is to place data which is read. Recall that this buffer was dynamically allocated by IOCS when the device was opened.
3. The card reader is tested for ready condition. If it is not ready after 4 seconds, then a time out error message is issued. The time out is reprogrammed and loop on status. Note that immediate return is allowed here (IRET bit).
4. When the card reader goes ready, PIO local interrupts are enabled and a card pick is forced. CPU interrupts are enabled.
5. A loop is entered until 80 columns have been read. The interrupt handler (CRDRDR) has the responsibility of reading the data and incrementing the column counter (A-reg).
6. Interrupt Handler. (CRDRDR). The interrupt handler reads data from the PIO ports after each interrupt. One interrupt corresponds to one card column. The data is converted from hollerith image to ASCII via the HOLTAB table. The data is then stored into the physical buffer, pointed to by the DE register. The DE-register is then incremented, as is the column counter (A-register). Return from interrupt is done after reenabling interrupts.
7. After all 80 columns of a card have been read CPU and local PIO interrupts are disabled. The number of records (NREC) is incremented.

8. The first column of the card is accessed in the physical buffer. If the byte is EOT (ASCII 04_H, punch 9-7), then this is the end of file indicator. Upon end of file, the end of file error code is placed in the IOCS vector, the buffer pointer is updated, and return is made to caller.
9. If end of file was not found, then trailing blanks are compressed in the physical buffer. Carriage return and line feed are appended to the card image.
10. The number of records read is checked. If all have been read, then the IOCS buffer pointer is updated and return to caller. Otherwise, another card pick and read is initiated.

```
R    OBJECT     ST # SOURCE STATEMENT        DATASET = DK0:EXAM  .

                     ;
                     ; THIS PROGRAM IS TO DEMONSTRATE SOME OF THE USES
                     ; OF IOCS. THE PROGRAM READS A LINE OF TEXT FROM
                     ; A FILE ON DISK UNIT 0 IN BYTE I/O FORMAT. A COUNTER
                     ; IS KEPT TO IDENTIFY EACH LINE AND IS PLACED AT THE
                     ; BEGINNING OF EACH LINE. THE NEW LINE WITH THE LINE
                     ; NUMBER IS THEN OUTPUT TO ANOTHER FILE ON DISK UNIT
                     ; 0 IN ASCII LINE FORMAT. THE FILE BEING READ IS
                     ; CALLED 'PROGRM.INP'. THE NEW FILE IS CALLED 'PROGRM
                     ; .OUT'. THE USER MAY USE THIS PROGRAM AS A GUIDE TO
                     ; SETTING UP VECTORS AND FOR USING IOCS TO PERFORM
                     ; VARIOUS FUNCTIONS. THE PROGRAM USES GLOBAL REF-
                     ; RENCES AND MUST BE LINKED WITH SYSLNK.OBJ (SHIPPED
                     ; ON THE SYSTEM DISKETTE).
                     ;
                             GLOBAL  JTASK
                             GLOBAL  JIOCS
                             GLOBAL  PTXT
                     ;
                     ; THIS SECTION CLEARS THE INPUT AND OUTPUT VECTORS
                     ;
 00   219A01'        START   LD      HL,INVEC         ;HL -> INPUT VECTOR
 03   119A01'                LD      DE,INVEC
 06   13                     INC     DE               ;DE -> INPUT VEC + 1
 07   AF                     XOR     A
 08   77                     LD      (HL),A           ;LOAD INITIAL 0 IN VECTOR
 09   015F00                 LD      BC,95            ;SET UP LOOP COUNT TO ...
 0C   EDB0                   LDIR                     ;...ZERO BOTH VECTORS.
                     ;
                     ; THIS SECTION STUFFS THE INPUT VECTOR AND PREPARES
                     ; TO OPEN THE INPUT FILE FOR READING.
                     ;
 0E   FD219A01'              LD      IY,INVEC         ;IY -> VECTOR ADDRESS
 12   FD3600FF               LD      (IY+0),0FFH      ;SET LUN = FF
 16   FD360144               LD      (IY+1),'D'       ;SET DEVICE TO DK:
 1A   FD36024B               LD      (IY+2),'K'
 1E   FD360330               LD      (IY+3),'0'       ;SET UNIT TO 0
 22   FD360450               LD      (IY+4),'P'       ;SET FILE NAME TO 'PROGRM'
 26   FD360552               LD      (IY+5),'R'
 2A   FD36064F               LD      (IY+6),'O'
 2E   FD360747               LD      (IY+7),'G'
 032  FD360852               LD      (IY+8),'R'
 036  FD36094D               LD      (IY+9),'M'
 03A  FD360A49               LD      (IY+10),'I'      ;SET EXT TO 'INP'
 03E  FD360B4E               LD      (IY+11),'N'
 042  FD360C50               LD      (IY+12),'P'
 046  FD360D00               LD      (IY+13),0        ;SET VERSION TO 0
 04A  FD360E01               LD      (IY+14),1        ;SET USER # TO 1
 04E  FD360F00               LD      (IY+15),0        ;REQUEST TO OPEN FOR READ
 052  FD361004               LD      (IY+16),4        ;FORMAT TO BYTE I/O, 4 REC
 056  FD361300               LD      (IY+19),0        ;CLEAR ERROR RETURN ADDR
 05A  FD361400               LD      (IY+20),0
 05E  FD361510               LD      (IY+21),10H      ;SET CFLAGS TO PRINT ERRORS
 062  FD361600               LD      (IY+22),0        ;CLEAR STATUS FLAGS
 066  FD361B7C               LD      (IY+27),07CH     ;SET USIZE TO 124 (7CH)
 06A  FD361C00               LD      (IY+28),0
 06E  CDFFFF                 CALL    JIOCS            ;OPEN INPUT FILE
 071  FD7E17                 LD      A,(IY+23)        ;TEST FOR ERRORS
```

```
 ADDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:EXAM

'0074   A7         0059            AND     A
'0075   C23F01'    0060            JP      NZ,ERMSG          ;IF FOUND, PRINT MSG.
                   0061 ;
                   0062 ; THIS SECTION STUFFS THE OUTPUT VECTOR AND PREPARES
                   0063 ; TO OPEN THE OUTPUT FILE FOR WRITE.
'0078   FD21CA01'  0064            LD      IY,OUTVEC         ;IY -> VECTOR ADDRESS
'007C   FD3600FF   0065            LD      (IY+0),0FFH       ;SET LUN = FF
'0080   FD360144   0066            LD      (IY+1),'D'        ;SET DEVICE TO DK:
'0084   FD36024B   0067            LD      (IY+2),'K'
'0088   FD360330   0068            LD      (IY+3),'0'        ;SET UNIT TO 0
'008C   FD360450   0069            LD      (IY+4),'P'        ;SET FILE NAME TO 'PROG
'0090   FD360552   0070            LD      (IY+5),'R'
'0094   FD36064F   0071            LD      (IY+6),'O'
'0098   FD360747   0072            LD      (IY+7),'G'
'009C   FD360852   0073            LD      (IY+8),'R'
'00A0   FD36094D   0074            LD      (IY+9),'M'
'00A4   FD360A4F   0075            LD      (IY+10),'O'       ;SET EXT TO 'OUT'
'00A8   FD360B55   0076            LD      (IY+11),'U'
'00AC   FD360C54   0077            LD      (IY+12),'T'
'00B0   FD360D00   0078            LD      (IY+13),0         ;SET VERSION TO 0
'00B4   FD360E01   0079            LD      (IY+14),1         ;SET USER # TO 1
'00B8   FD360F01   0080            LD      (IY+15),1         ;REQUEST TO OPEN FOR REA
'00BC   FD361014   0081            LD      (IY+16),14H       ;FORMAT=ASCII LINE, 4 RE
'00C0   FD361300   0082            LD      (IY+19),0         ;CLEAR ERROR RETURN ADDR
'00C4   FD361400   0083            LD      (IY+20),0
'00C8   FD361510   0084            LD      (IY+21),10H       ;SET CFLAGS TO PRINT ERR
'00CC   FD361600   0085            LD      (IY+22),0         ;CLEAR STATUS FLAGS
'00D0   FD361B7C   0086            LD      (IY+27),07CH      ;SET USIZE TO 124 (7CH)
'00D4   FD361C00   0087            LD      (IY+28),0
'00D8   CD6F00'    0088            CALL    JIOCS             ;OPEN INPUT FILE
'00DB   FD7E17     0089            LD      A,(IY+23)         ;TEST FOR ERRORS
'00DE   A7         0090            AND     A
'00DF   C23F01'    0091            JP      NZ,ERMSG          ;IF FOUND, PRINT MSG.
                   0092 ;
                   0093 ; THIS SECTION READS DATA FROM THE INPUT FILE,
                   0094 ; ADDS THE LINE # TO THE BEGINNING OF THE LINE,
                   0095 ; AND OUTPUTS THE NEW LINE TO THE OUTPUT FILE.
                   0096 ;
'00E2   FD219A01'  0097 READ       LD      IY,INVEC          ;IY -> INPUT VECTOR
'00E6   FD360F03   0098            LD      (IY+15),3         ;REQUEST FOR READ
'00EA   21FD01'    0099            LD      HL,INBUF          ;HL -> BUFFER
'00ED   CDD900'    0100 INLOOP     CALL    JIOCS             ;READ 1 BYTE FROM FILE
'00F0   57         0101            LD      D,A               ;STORE CHAR IN D REG
'00F1   FD7E17     0102            LD      A,(IY+23)         ;TEST FOR ERROR
'00F4   A7         0103            AND     A
'00F5   C23F01'    0104            JP      NZ,ERMSG
'00F8   7A         0105            LD      A,D               ;RESTORE CHAR IN A
'00F9   FE04       0106            CP      04H               ;TEST FOR END OF FILE
'00FB   CA4701'    0107            JP      Z,EXIT            ;EXIT IF FOUND.
'00FE   77         0108            LD      (HL),A            ;STORE CHAR IN BUFFER
'00FF   23         0109            INC     HL                ;INC BUFFER POINTER
'0100   FE0A       0110            CP      0AH               ;TEST FOR LF
'0102   20E9       0111            JR      NZ,INLOOP-$       ;NO, CONTINUE READING
                   0112 ;
'0104   3A4E02'    0113            LD      A,(LINE)          ;GET CURRENT LINE NUMBER
'0107   3C         0114            INC     A                 ;INC NUMBER
'0108   324E02'    0115            LD      (LINE),A          ;STORE NEW NUMBER
'010B   21FA01'    0116            LD      HL,OUTBUF         ;HL -> OUTPUT BUFFER
```

```
 DDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:EXAM   .

 10E   F5         0117          PUSH    AF
 10F   0F         0118          RRCA                        ;GET UPPER DIGIT OF LINE #
 110   0F         0119          RRCA
 111   0F         0120          RRCA
 112   0F         0121          RRCA
 113   CD7201'    0122          CALL    ASCII               ;CONVERT DIGIT TO ASCII
 116   77         0123          LD      (HL),A              ;STORE ASCII CHAR IN BUFFER
 117   23         0124          INC     HL                  ;INC BUFFER POINTER
 118   F1         0125          POP     AF                  ;GET LOWER DIGIT
 119   CD7201'    0126          CALL    ASCII               ;CONVERT TO ASCII
 11C   77         0127          LD      (HL),A              ;STORE ASCII CHAR IN BUFFER
 11D   23         0128          INC     HL
 11E   3E20       0129          LD      A,' '               ;STORE SPACE AFTER LINE #
 120   77         0130          LD      (HL),A
                  0131 ;
 0121  FD21CA01'  0132          LD      IY,OUTVEC           ;IY -> OUTPUT VECTOR
 0125  21FA01'    0133          LD      HL,OUTBUF
 0128  FD7519     0134          LD      (IY+25),L           ;STORE ADDRESS OF BUFFER...
 012B  FD741A     0135          LD      (IY+26),H           ;...IN UBFFR FOR WRITING.
 012E  FD360F04   0136          LD      (IY+15),04          ;
 0132  FD361500   0137          LD      (IY+21),0           ;TURN OFF ERROR PRINT
 0136  CDEE00'    0138          CALL    JIOCS               ;OUTPUT NEW LINE
 0139  FD7E17     0139          LD      A,(IY+23)           ;TEST FOR ERROR
 013C  A7         0140          AND     A
 013D  28A3       0141          JR      Z,READ-$            ;NO ERROR, GET NEXT LINE
                  0142 ;
                  0143 ; THIS SECTION PRINTS AN ERROR MESSAGE
                  0144 ; AND EXITS AFTER CLOSING THE FILES.
                  0145 ;
 013F  217C01'    0146 ERMSG    LD      HL,MSG              ;HL -> MESSAGE TO PRINT
 0142  1E00       0147          LD      E,0                 ;SET FOR CONSOLE DEVICE
 0144  CDFFFF     0148          CALL    PTXT                ;PRINT MESSAGE
'0147  FD219A01'  0149 EXIT     LD      IY,INVEC            ;IY -> INPUT VECTOR
'014B  FD360F02   0150          LD      (IY+15),2           ;REQUEST TO CLOSE INPUT
'014F  CD3701'    0151          CALL    JIOCS               ;CLOSE FILE
'0152  FD21CA01'  0152          LD      IY,OUTVEC           ;IY -> OUTPUT VECTOR
'0156  217B01'    0153          LD      HL,FILEND
'0159  FD7519     0154          LD      (IY+25),L           ;PREPARE TO WRITE 04H AT..
'015C  FD741A     0155          LD      (IY+26),H           ;...END OF OUTPUT FILE.
'015F  FD360F04   0156          LD      (IY+15),4           ;REQUEST TO WRITE
'0163  CD5001'    0157          CALL    JIOCS               ;OUTPUT 04
'0166  FD360F02   0158          LD      (IY+15),2           ;CLOSE REQUEST
'016A  CD6401'    0159          CALL    JIOCS               ;CLOSE OUPTUT FILE
'016D  3E01       0160          LD      A,1
'016F  CDFFFF     0161          CALL    JTASK               ;RETURN TO MONITOR
                  0162 ;
                  0163 ; ROUTINE TO CONVERT 4 BIT HEX INTO ASCII
                  0164 ;
'0172  E60F       0165 ASCII    AND     0FH
'0174  C690       0166          ADD     A,90H
'0176  27         0167          DAA
'0177  CE40       0168          ADC     A,40H
'0179  27         0169          DAA
'017A  C9         0170          RET
                  0171 ;
'017B  04         0172 FILEND   DEFB    04H
'017C  0D0A       0173 MSG      DEFW    0A0DH
'017E  4552524F   0174          DEFM    'ERROR FOUND DURNG EXECUTION'
```

```
 ADDR   OBJECT      ST # SOURCE STATEMENT          DATASET = DK0:EXAM  .

        5220464F
        554E4420
        4455524E
        47204558
        45435554
        494F4E
'0199   03          0175           DEFB     03H
                    0176 ;
'>019A              0177 INVEC     DEFS     48
'>01CA              0178 OUTVEC    DEFS     48
'>01FA              0179 OUTBUF    DEFS     3
'>01FD              0180 INBUF     DEFS     80
'024D   00          0181           DEFB     0
'024E   00          0182 LINE      DEFB     0
                    0183           END

ERRORS=0000
```

SECTION 10

FLOPPY DISK HANDLER (FDH)

10-1. INTRODUCTION

10-2. All calls for communication with the disk will be through the Floppy Disk Handler. Because a disk is not a character oriented device, all calls will be for a file whose minimum length is 1 record of 124 bytes. By maintaining a directory in the first two tracks of the disk, file operations may take place independent of the physical location of the data on the disk. The Disk Handler System not only provides file reading and writing capability but special pointer manipulation, record deletion and insertion, and directory manipulations such as file creation, renaming, and deletion. The FDH outlined here can serve as a building block for a file maintenance system, a disk based Assembler and Text Editor, BASIC and other high level languages.

10-3. COMMUNICATION

10-4. The FDH can be communicated with by a calling vector (equivalent to the IOCS calling vector-pointed to by IY) which contains all parameter information with each parameter having a fixed displacement from the vector pointer. This vector has been appended to the I/O Control System vector. The purpose of the IOCS is to generalize all calls to the peripheral devices so as to dissolve any device dependence of data structure. However, because the disk is a file oriented device as opposed to being a character oriented device, much additional calling information is required. The required entries into the 48 byte IOCS defined vector are listed as follows.

10-5. DOS RELATED VECTOR PARAMETERS

FIELD	#BYTES	OFFSET	NAME	DESCRIPTION	FORM
3	1	(IY+3)	UNIT	UNIT number	(ASCII)
4	6	(IY+4)	FNAM	Filename	(ASCII)
5	3	(IY+10)	FEXT	File extension	(ASCII)
6	1	(IY+13)	VERS	File Version	(Binary)
7	1	(IY+14)	USER	User number	(Binary)
8	1	(IY+15)	RQST	Request Code	(Binary)
14	1	(IY+23)	ERRC	Error Code	(Binary)
16	2	(IY+25)	UBFFR	User's Buffer Address	(Binary)
18	1	(IY+29)	NREC	Number of records to be transferred	(Binary)
19	1	(IY+30)	SCTR	Current sector pointer	(Binary)
20	1	(IY+31)	TRCK	Current track pointer	(Binary)
21	1	(IY+32)	LSCTR	Last Sector	(Binary)
22	1	(IY+33)	LTRK	Last Track	(Binary)

23	1	(IY+34)	NSCTR	Next Sector	(Binary)
24	1	(IY+35)	NTRK	Next Track	(Binary)

10-6. CALLING CONVENTIONS

10-7. There are three ways for a user to communicate with the Disk System. The user may make calls through the IOCS defined general purpose request codes 0-7H. These request codes are converted to a set of Macros of request codes made up from the complete set of DOS request codes. This permits the disk system to be used as if it were any standard character type device. The second way to communicate is through the complete set of disk request codes. This allows use of more complex but more powerful requests that would be used by sophisticated environments such as the Text Editor. The third communication technique is through direct disk controller commands. See Section 11 for more information.

10-8. GENERAL PURPOSE IOCS DISK MACRO REQUESTS

```
CALLING SEQUENCE - LD     A,0     ;FDH JTASK CODE
                   CALL   JTASK   ;CALL FDH VIA JTASK
```

RQST CODE	NAME	DESCRIPTION
02H	CLOSE	The Close command will store off all linkage information into the directory and update the sector and track maps of the diskette containing the file.
03H	READ	Read Next N Records - Reads the next

RQST CODE	NAME	DESCRIPTION (CONT.)
		N records, where N is in (IY+29), into memory starting at transfer address given (UBFFR). The pointer will be positioned on the last record read and if error exit is required, NREC contains the actual number of records transferred.
04H	WRITE	Insert N Records - Allocates and writes N records from memory starting at the Data Transfer Address, (UBFFR) with the first record written after the current one. The pointer will be left positioned at the last record written.
05H	REWIND	The Rewind command positions the pointer back to the directory entry for the file. All records will now be written before any existing records, or the first record may now be read.
06H	INIT	Initialize - Reads sector and track maps from all disks which are ready and clears active file table of the FDH.
07H	ERASE	Erase File - Writes reformatted directory entry over the entry for the file, de-allocates all re-

RQST CODE	NAME	DESCRIPTION (CONT.)
		cords in the file, removes the active file entry from the table, and rewrites the updated sector map. Any records following one not readable will not be reallocated. The file must be opened before it can be erased.

10-9. COMPLETE DOS REQUEST CODES

REQUEST CODE	DESCRIPTION
18H	Initialize - Reads sector and track maps from all diskettes which are ready and clears active file table of the FDH. This is equivalent to request code 06H.
1CH	Open File - Finds file in directory and creates an entry in the active file table; pointer remains on the directory but the number of records in file is placed in NREC. If file has a BIN extension, UBFFR is set to the binary load address.
1EH	Create File - Creates directory entry for a file and creates entry in active file table. Error is returned if file already exists and the operation is aborted. Pointer is positioned to the directory entry for the file.
20H	Close File - Writes updated directory entry back to the Disk Directory, removes the active file table entry, and rewrites the updated sector map. This is equivalent to request code 02H.
22H	Erase File - Writes reformatted directory entry over the entry for the file, de-allocates all records in the file, removes the active file entry from the table, and rewrites the updated sector map. Any records following one not readable will not be reallocated. This is equivalent to re-

COMPLETE DOS REQUEST CODES (CONT.)

REQUEST CODE	OPERATIONS
	quest code 07H.
24H	Rename File - Takes a second filename and filetype starting in the second parameter vector (IY+48) and verifies that it does not exist or takes error exit. The directory entry for the first filename is replaced by the one for the second. Two contiguous I/O vectors must be defined. The first is a complete 48 byte I/O vector and contains the current name of the file (which must be open). The second contains the new name of the file and may consist of only the first 15 bytes of the standard I/O vector (contains only the new filename).
26H	Rewind File - Repositions the pointer for the file to the directory entry with the next record pointing to the first record to be read by Read Next Record. This is equivalent to request code 05H.
28H	Read Next N Records - Reads the next N records, where N is in (IY+29), into memory starting at transfer address given in (UBFFR). The pointer will be positioned on the last record read and if error exit is required, NREC contains actual number of records transferred. This is equivalent to request code 03H.

COMPLETE DOS REQUEST CODES (CONT.)

REQUEST CODE	OPERATIONS
2AH	Read Current Record - Reads the single current record into memory starting at the transfer address. The pointer will not be moved.
2CH	Read Previous Record - Reads the single record previous to the current one into memory starting at the transfer address given. The pointer will be positioned on this record.
2EH	Skip Forward N Records - Moves pointer N records forward but no data will be transferred.
30H	Skip Backward N Records - Moves the pointer N records backward but no data will be transferred.
32H	Replace (Rewrite) Current Record - Rewrites the single current record from memory starting at the Data Transfer Address. The pointer is not moved.
34H	Insert N Records - Allocates and writes N records from memory starting at the Data Transfer Address, (UBFFR) with the first record coming after the current one. The pointer will be left positioned at the last record written. This is equivalent to request code 04H.
36H	Delete N Records - The current record and the next N-1 records are de-allocated and removed from the file.

FIGURE 10-1. EFFECTS OF FDH COMMANDS

REQUEST	FILENAME, EXT, VERS, USER	NREC	UBFFR	SCTR/TRK
00H OPENR	-	File length	Load Address	Directory
01H OPENW	-	0	-	Directory
02H CLOSE	-	0	-	Unknown
03H READ	-	Number sectors read	(UBFFR) + N * 124	Last sector read
04H WRITE	-	Number sectors written	(UBFFR) + + N * 124	Last sector written
05H REWIND	-	0	-	Directory
06H INIT	-	0	-	Unknown
07H ERASE	-	File length	-	Unknown, File closed
1CH OPEN	-	File length	Load address	Directory
1EH CREATE	-	0	-	Directory
24H RENAME	Moved from vector following this one.	0	-	Directory
2AH RDCURR	-	0	(UBFFR)+124	-
2CH RDPRVR	-	1	(UBFFR)+124	Previous sector
2EH SKIPFWD	-	Number successful skips	-	Last sector read
30H SKIPBKD	-	Number successful skips	-	Last sector read
32H RPCURR	-	0	(UBFFR)+124	-
36H DELETE	-	Number records deleted	-	Previous sector
3CH JUMP	-	0	-	-
3EH DISKID	Disk id (11 characters)	0	-	-
40H STATUS	Sectors available, used and bad (2 bytes each)	0	-	-

3CH	Jump - Go to sector/track defined by SCTR (IY+30) and TRK (IY+31). No data is transferred.
3EH	Read Disk Id - Loads disk name (11 bytes) into filename, extension and version fields of the I/O vector.
40H	Read Status - Loads available, used and bad sector counts into filename field of the vector. 2 bytes each (total of 6 bytes).

10-10. ERROR RETURN

10-11. The error parameter is in (IY+23) and is returned at the end of a DOS operation the contents of (IY+23) is also in the accumulator. A 0 return indicates that no error has occurred. The error return codes are:

ERROR CODE Bits 0-5	INTERPRETATION
01H	Invalid Operation - A request word was specified which is not a valid DOS request.
02H	Duplicate File - An attempt was made to create a directory entry for a file that already exists. Can occur only on create or rename. In the case of OPENW, the file is opened but this error is reported only as a flag.
03H	Active File Table Full - An attempt was made to insert another entry in the active file table when it is full. Can occur only on open or create. A maximum of 7 files may be open at any time.

ERROR CODE	INTERPRETATION
	name.
05H	Directory Full - There is no more space to insert another directory entry.
06H	Write Protect - Diskette is write protected and an attempt has been made to write on it.
08H	File Not Open - An attempt was made to close or perform some record operation on a file which had not been opened. Can occur on any operation except initialize, open, or create.
09H	End of File - An attempt was made to advance the pointer beyond the last record in the file. The error can occur on any read, delete or skip operation. In the case of delete it indicates an attempted delete operation on the directory.
0AH	Disk Error - A disk I/O error occurred during the operation. Data may have been lost. Can occur on any operation except rewind.
0BH	Disk Full - Diskette is full and will not allow the allocation of another record. Can occur only on insert. The number of records successfully transferred is left in NREC. The file must be explictly closed or erased

ERROR CODE	INTERPRETATION
0CH	Pointer Error - The pointers read do not agree with the next or previous record. Can occur on any record operation except rewind. Pointer errors occur because a sector is not readable or because an application program has written on a disk without intializing the handler first, or two diskettes were used with the same Disk ID.
0DH	Directory or map transfer error. A read or write error occurred during operations involving the disk directory or sector and track maps. If operation occurred during a close or erase, directory or maps could be destroyed.
0EH	File Already Open - An attempt was made to open or create a file which is currently active.
0FH	Disk Not Ready - Can occur on any operation when a diskette is not fully inserted and door closed.
10H	Wrong Disk - A file is being accessed on a disk whose ID is different from the one currently in memory. This can occur if disks are changed during operations without initializing. Can occur only on close, open and erase. Error can be avoided by initializing diskette before operations begin.
11H	Non-Existent Disk - A unit number has been specified which is not supported by the FDH. Typically, units DK2 or DK3. See Section 15 for details on how to SYSGEN a system to handle more

than two disk drives.

1AH Beginning Of File - An attempt was made to move the pointer backwards past the beginning of the file. Can occur on read previous record, skip backward, read current record, or rewrite current record.

1BH Invalid drive, track, or sector. Controller has received invalid drive number, or sector and track out of normal range. Can occur on jump or as a result of some fatal FDH error.

1CH Controller not able to locate track during seek, read, or write operation.

1DH Sector not found - Sector address marks not readable.

1EH CRC Operation - incorrect data has been flagged by CRC check during reading.

20H Data lost - hardware problem causing data overrun in reading or writing.

10-12. DIRECTORY

10-13. Associated with each diskette is a 4K block of storage divided into 32 sectors which contain the Directory information: track 0, sector 1-26, track 1, sector 1-6. Each sector contains 6 entries of 20 bytes/entry. Each file name will be entered into the Directory or accessed from the Directory by a hash function for the Filename. This facilitates searches for Directory entries and reduces RAM requirements for the Directory buffer. The format for each Directory entry is the following:

BYTE	CONTENTS
0-5	Filename, left justified, blank filled
6-8	Extension
9	Version - Reserved by Mostek for future use
10	User
11	Key - Reserved by Mostek for future use
12-13	Number of records in file
14	Sector - Location for first record in file
15	Track
16	Sector - Location for last record in file
17	Track
18	LSB - Address for Load Location for Binary File,
19	MSB - or file-date storage if non-Binary File

Each file is composed of one or more records with each record containing trailer information consisting of a forward and backward pointer to locate the next and preceeding records respectively. A null pointer (FFH) is used to indicate no next record or no previous record.

10-14. DISK FORMAT

10-15. Should any of the file structures become disjoint by extended periods of erasing and inserting of new and different length files, the operation of backing up a disk (copying) will optimize the actual file structure on the new disk. The FDH treats the disk as a continuous string of 1964 sectors. Every other sector is written on each track and a 5 sector shift is used between starting sectors of contiguous tracks to allow for head motion. This allows a complete track to be read or written in 2.2 revolutions. The sector allocator looks for the first string of available sectors which is large enough for the file being stored (defined by NREC) when inserts are done.

FIGURE 10-2. FLP-80DOS V2.1 DISKETTE FORMAT

DIRECTORY

Track 0 SCTR 0 thru TRK 1 SCTR 6. Each sector contains 6 20-byte entries. See section 10-13 of FLP-80DOS Manual.

SECTOR MAP

```
   TRK1  SCTR7               thru                 Track 1 Sector B
                       4 byte group
    FORMAT:  1 BYTE

TRACK 0 -                                                   0 0 0
          1      8   9      16   17      24   25,26

              SECTOR NUMBER                                   Last 6
                                                              bits in
                                                              each
                                                              4-byte
                                                              group is
                                                              not used
TRACK 1 -
          1      8   9      16   17      24   25,26
```

EACH SECTOR ON THE DISK IS ASSOCIATED WITH ONE BIT IN THE SECTOR MAP:

BIT = 0 => SECTOR NOT IN USE
BIT = 1 => SECTOR IN USE OR BAD.

```
          .
          .
          .
First
Side

 TRACK 76
          1      8   9      16   17      24

 TRACK 77
Second    .
Side      .
(All Zeros .
for single-sided
Diskette)
 TRACK 153                                                       PHYSICAL
                                                                 TRACK 1
            0 1 0 1    0 1 0 1      0 1 0 1     0 1 0 1   SECTOR B
```

Last 4 bytes of TRK 1 SECTOR B is all "11"s. The "11" pattern is not a required pattern.

NAME OF DISKETTE AND SPACE ALLOCATION

TRACK 1 SECTOR C

First 73 bytes (bytes 0 thru 72) of TRK1 SCTR C are "11'S.

Diskette name is 11 sequential ASCII bytes starting in byte 73.

Available space on disk is number of sectors. Quantity is located in two hex bytes, least significant byte first, in bytes 84 & 85.

Used space is in bytes 86 & 87, same format.

Number of bad sectors is in bytes 88 & 89, same format.

Diskette number is in bytes 90 & 91 (random number given by the system).

The rest of sector C is not used.

DATA (FILES)
Data begins in TRK1 Sector D.

Double sided disk uses same format.

Track 77 is on second side opposite Track 0, Track 153 is on second side opposite track 76.

10-17. SECTOR AND TRACK FORMATS

10-18. The sector map is stored in track-sector location 1-7 through 1-B. Each bit of each byte in the sector map represents one sector. A bit is set for its respective sector if:

1) The sector has been linked into the doubly linked list of the file structure.

or

2) The operating system has tried without success to store information in the sector and has therefore made this sector not available.

The sector map resides in memory along with FDH and is changed when any file is being altered by erasure, deletion, or insertion. The map is stored off when these operations are complete. Bad sector locations will be de-allocated as if they were in use.

10-18. DISKETTE - IDENTIFICATION

10-19. NAME OF DISKETTE AND SPACE ALLOCATION

Diskette identification and space allocation information reside on track 1 sector C. The first 73 bytes of this sector are 11_H -this is not a required pattern. The diskette name is contained in the following sequential bytes (73 through 83). The available space on the diskette (in sectors) is contained in bytes 84 and 85, most significant byte last. The number of used sectors is contained in bytes 86 and 87; the number of bad sectors in bytes 88 and 89. The diskette number is in bytes 90 & 91. This number is randomly assigned at format time. The rest of sector C is not used.

10-20. DATA (FILES)

Data is stored beginning on track 1 sector D. A double-sided disk uses the format described above, except that track 77 is on the opposite side from track 0 and track 153 is on the opposite side from track 76.

SECTION 11

DISK CONTROLLER FIRMWARE (DCF)

11-1. INTRODUCTION

11-2. The Disk Controller Firmware (DCF) interfaces from the Flexible Disk Handler (FDH) to the Mostek FLP-80 Disk Controller Board. Input to the DCF consists of request code, unit number, track number, and sector number. Control of the hardware is exercised via 6 parallel I/O ports which are decoded on the FLP-80 board. A bootstrap sequence is included in the DCF which is used to boot binary files from disk into RAM. Interactive boot and save sequences are also available.

11-3. SOFTWARE CONFIGURATION

11-4. The DCF resides on the SDB-80 in one 2708 PROM located at address $EC00_H$. It is approximately 1K bytes long.

11-5. CONTROLLER OVERVIEW

11-6. The calling address for the DCF is $EC00_H$. All requests are made via the 48-byte IOCS parameter vector. See Section 9 of this manual for a complete definition of the vector. After each request is processed and the operation is completed, return is made to the caller. This is not an interrupt driven program; rather, the operation must be completed before further processing can take place. All I/O to the disk is done via a hardware FIFO. A complete sector (128 bytes) is buffered in the FIFO before transfer from/to the DCF takes place. All registers except the flags are preserved by the DCF. After an operation takes place, the zero flag is set if no error occurred. The zero flag is reset if any errors occurred during the operation. If any error occurred, then bit zero of the vector ERRC parameter is also set. The Unit number is assumed to be in the vector UNIT parameter, the track number in TRK, and the sector number in SCTR. The request code must be in RQST. The unit may be 0-3. The track may be 0-76 for single-sided drives or 0-153 for double sided drives. The type of drive is indicated by bit 0 of port E2H; if set, a double-sided drive is indicated. The sector may be 1-26. The reader is referred to the Disk Drive Controller Hardware Manual for his hardware configuration. A complete software listing of the controller is given in 'DOPS-80 Program Source Listing', MK78589, which is available only to OEM users. The following IOCS vector parameters must be set up; IY must contain the first address of the vector. Numbers enclosed in parenthesis indicate displacement from the beginning of the vector.

UNIT (3)	- disk unit number (either binary or ASCII)
RQST (15)	- request code, described in paragraph 11-7.
UBFFR (25)	- transfer address for data for read or write operation.
SCTR (30)	- sector number
TRK (31)	- track number

The following parameters are returned:

ERRC (23)	- bit 0 set if an error occurred. The error code is saved in location FF09H. Note that bit 0 only is set or reset. The rest of the byte is left unchanged.
SCTR (30)	- not changed
TRK (31)	- not changed

LSCTR (32) - last sector pointer
LTRK (33) - last track pointer
NSCTR (34) - next sector pointer
NTRK (35) - next track pointer

NOTE: $0FF_H$ in LSCTR and LTRK indicate the current record is the first record in the file. $0FF_H$ in NSCTR and NTRK indicate end of file.

11-7. DISK CONTROLLER REQUESTS

11-8. On the following controller operations, request codes are placed in RQST, sector and track into SCTR and TRK, and transfer address into UBFFR. On exit, UBFFR is incremented by 124 if data is transferred. Only one sector is transferred per call.

COMMAND CODE	COMMAND	OPERATION
10H	Status	Returns disk drive status of disk drive not ready, disk drive not safe, disk drive write protected (see 11-9 for status code format).
11H	Read	Transfers a sector of data to host-specified buffer area.
12H	Write	Write a sector of data with address marks and CRC from specified host buffer.
13H	Seek	Positions head to track location specified in TRK.

14H	Restore	Initializes the disk unit and position the head to track 0 (outermost track).
15H	Read ID	Reads next available sector ID and track, and places it into a two byte read ID buffer. Byte 0 is the sector and Byte 1 is the track.
16H	Write Deleted	Identical to write command except that a deleted data address mark replaces regular data address mark.
17H	Format	Formats track specified in TRK to IBM 3740 specification.

NOTE that this formatting operation is not the same as the PIP formatting operation (see section 3). While this format command causes sector address and timing marks to be copied from a user created buffer to the disk being formatted, the PIP format command formats and also builds a file directory on the disk. A 4992 byte buffer is required (pointed to by UBFFR) which contains timing marks and other formatting information. Use of this command is not recommended.

11-9. DISK CONTROLLER ERROR RETURN CODES

11-10. Upon encountering an error, Bit 0 of the ERRC parameter in the IOCS vector is set. An error code is placed into location $FF09_H$ to indicate the type of error:

BIT	ERROR IF SET
7	Invalid drive, track or sector

6	Disk unit not ready
5	Track seek error
4	Sector not found
3	CRC error
2	Data lost
1	Disk is write protected
0	Attempt to read a deleted sector

The Z flag is set if no error was detected otherwise it is reset.

11-11. LINKED FILE LOADER

11-12. The Linked File Loader is a part of the DCF PROM. It accesses the disk at a given track and sector and loads information from the disk until the last sector in the linked structure is found. The Unit, Track/Sector address and load address are passed via an IOCS vector which is pointed to by the IY-register. 10 retries are performed. The IOCS vector is set up as shown for the DCF, described above. Entry address is EC03H. No request code is required.

11-13. INTERACTIVE BOOT PROCESS

NOTE: This procedure is used only to load programs into areas different than the load address defined in the directory.

11-14. This DCF program allows the user to specify the starting track and sector number of a file to be loaded directly into RAM. All interaction is via the console device. The FLP-80DOS system must be in RAM because IOCS is used. The information from disk is loaded sector by sector. The linked structure on the disk is followed until the last sector in the file is loaded.

To use this process, perform the following command sequence:

$DDT(CR)

.E EC09(CR) - user executes the starting address of the interactive boot process.

LOAD ADR: aaaa(CR) - user enters RAM starting load address (in hexadecimal) for information from the disk. Console interaction at this point is the same as DDT (See Sections 7-12 and 7-18).

UNIT,TRK,SCTR: u,t,s(CR)

- user enters disk unit number (0,1,2,3), starting track number and starting sector number of information to be loaded from disk. All three numbers are entered in hexadecimal.
- after loading is complete, the DDT prompt is issued.

If any errors occurred during the load process, then the following message will be printed on the console:

DSK ERR

If the FLP-80DOS system is not in RAM, then a small section of code which performs the following instructions must be executed to bypass usage of IOCS for console interaction:

```
LD      A,2
LD      (0FF12H),A
JP      EC09H
```

11-15. INTERACTIVE SAVE PROCESS

NOTE This procedure may be used only for modifying the directory or Track/Sector maps. Improper use can destroy files.

11-16. This DCF program allows the user to save a section of RAM on disk as a set of sequential sectors. The doubly linked structure is maintained on disk, but tracks and sectors are not allocated as in the Disk Handler. The sectors are allocated sequentially and without regard to the disk directory. All interaction is via the console device. The FLP-80DOS system must be in RAM because IOCS is used for console I/O. To use this process, perform the following command sequence:

```
$DDT(CR)
.E EC06(CR) - user executes the starting address of the
              interactive save process.
SAVE ADR,#SCTRS: aaaa,bb(CR)
            - user enters the starting address of the
              information to be saved on disk and the
              number of sectors to be saved.  Each sector
              is 124 bytes long, and up to FFH sectors may
              be saved (31744 bytes). Console interaction
              is the same as DDT. The two parameters are
              entered in hexadecimal.
UNIT,TRK,SCTR: u,t,s(CR)
            - user enters disk unit number (0,1,2 or 3),
              starting track number and starting sector
              number for information to be saved on disk.
              Sectors and tracks are allocated sequentially
              increasing.  All three numbers are entered in
              hexadecimal.
.           - after saving is finished, the DDT prompt is
              issued.
```

If any errors occurred during the save process, then the following message will be printed on the console:

```
DSK ERR
```

If the FLP-80DOS system is not in RAM then a small section of code which performs the following instructions must be executed to bypass usage of IOCS for console interaction:

```
LD      A,2
LD      (0FF12H),A      ;SET DEBUG FLAG
JP      0EC06H
```

SECTION 12

I/O HANDLERS

12-1. INTRODUCTION

12-2. This section describes the I/O handlers supplied with FLP-80DOS. In addition, listings of these handlers are included here to aid the user in writing his own handlers for his own devices. The system that is shipped to you contains only TK (keyboard), TT (console output), and CP (Centronics line printer) handlers linked into it. The other handlers are supplied as source and relocatable object modules. In order to use them in your system, you must perform a SYSGEN (System Generation); Hardware configurations are documented in the appropriate system Manual.

12-3. CR - CARD READER

DESCRIPTION - I/O handler. This handler interfaces a Documation M200 Card Reader to the FLP-80 system via two PIO ports. It is callable by IOCS. This is an interrupt driven driver. Immediate return is supported.

OPERATION -

OPEN. Interrupts are disabled. The address of the card reader interrupt handler is entered into the FLP-80 Interrupt Handler Address Table. The interrupt handler address is also programmed in to Port A control. Port A is then programmed for mode 2, and local interrupts are disable. The least significant byte of the interrupt handler address is also programmed into Port B control. Port B is then programmed. Finally, the BC register is set to physical record size of 82 (80 card columns plus carriage return and line feed). Interrupts are re-enabled.

CLOSE. No operation is performed in the handler.

READ. Initialize. The number of physical records to be read (NREC) is recorded, then zeroed. The assigned buffer area is noted. The card reader is checked to see if it is ready. Initial time out is 4 seconds. Immediate return is supported at this point. Additional time out counts are 20 seconds each. When the reader goes ready, a card pick is initiated.

Card Input. Each column of data on the card causes an interrupt which is monitored by 'CRDRDR'. The interrupts are counted by the A - register until 80 interrupts are registered. During reading, conversion of the card EBCDIC data is done in 'CRDRDR' via table 'HOLTAB'.

Card Massaging. After the card has been read into the IOCS buffer, interrupts are disabled in the CPU and locally. If an EOT (ASCII 04_H) exists in column 1 of the last card, an end-of-file sequence is initiated (discussed below). Trailing blanks on the card are compressed. A carriage return and line feed are appended to the resultant card image. NREC is incremented and checked to see if all cards requested were read. If not, another card is read. Otherwise, the IOCS buffer pointer is updated to the byte following the last card image and the subroutine returns to caller.

End-of-file. Upon end-of-file (04_H in card column 1), the EOF error code (9) is placed in the 'ERRC' parameter of the vector. The IOCS buffer pointer is updated and return is made to caller.

12-4. CP-CENTRONICS LINE PRINTER

DESCRIPTION - I/O handler. This handler interfaces to any Centronics line printer. Immediate return is not supported. I/O timeout is checked. Tab (09_H) and form feed (OCH) are decoded and the appropriate horizontal and vertical spacing is done.

OPERATION -

OPEN The ports are initialized, the horizontal and vertical counters are initialized, and a physical record size of one is returned.

CLOSE A form feed is a issued to eject the paper from the printer at the end of an operation. The form feed is translated into a series of line feeds as described below.

WRITE The character to be written is checked. IF it is a tab, then it is translated to spaces mod-8. If it is a line feed then the vertical counter is incremented. If it is a form feed, then the page is ejected by issuing a series of line feeds. Users with form feed option may wish to delete this function. If it is a carriage return, then the horizontal counter is initialized. The line width is checked to truncate each line to 'LWIDTH' characters. Status is checked. If not ready, then the timeout is checked. If time out has occurred, then an error message is output and a new time out is set up. If ready, the character is output with the appropriate interface signals.

12-5. LP-DATA PRODUCTS LINE PRINTER

DESCRIPTION - I/O handler. This handler interfaces to any Data Products line printer. The handler is interrupt driven ; one character at a time is output. Immediate return is supported. I/O timeout is checked.

OPERATION -

OPEN - The port is initialized. The line printer interrupt handler address is stored in the IOCS Interrupt Address Table. The vector address is programmed to the PIO. The tab count is initialized. A physical record size of one is returned.

CLOSE - No action.

WRITE - An initial 3 second time out is set up. The ready bit of the status (bit 0 of LPST) is checked. Immediate return is supported. If the device does not go ready, an error message is issued and the timeout is reprogrammed to 20 seconds. When the device goes ready, the ready bit is reset and the character is checked. If the character is not a tab, then it is output to the device. If the character is a tab then, it is expanded into spaces mod-8.

12-6. PR - PAPER TAPE READER

DESCRIPTION - I/O handler. This handler interfaces a paper tape reader to FLP-80DOS via a PIO port. This handler is called by IOCS. It is interrupt driven. One character at a time is input. Immediate return is supported. I/O timeout is checked.

OPERATION -

OPEN. The port is initialized. The paper tape reader interrupt handler address is stored in the IOCS interrupt handler address table. The first read Operation is initiated. A physical record size of 1 is returned to IOCS.

CLOSE. No action is performed.

READ. Upon reception of an interrupt, Bit 0 of 'PRST' is set to indicate that the reader is ready with another character.

An initial timeout of 250 msec is programmed. The status flag located in the LS bit of address PRST is checked. If it is set, then an interrupt has occurred. This indicates that a character is ready. The character is read and complemented and return is made to caller.

12-7. PP-PAPER TAPE PUNCH

DESCRIPTION - I/O handler. This handler interfaces a paper tape punch to FLP-80DOS. It is interrupt driven and immediate return is supported. One character at a time is output. I/O timeout is checked. The operation of this handler is similar to LP -Data Products Line Printer handler except that tabs are not expanded.

12-8. TI-SILENT 700 CASSETTE INPUT

DESCRIPTION - I/O handler. This handler interfaces a Silent 700 digital cassette for input to FLP-80DOS via the serial ASCII port. Thus, the Silent 700 is also the system terminal. The handler is not interrupt driven and immediate return is not supported. This handler will read tapes recorded in LINE or CONTINUOUS mode. The handler is compatible with other MOSTEK Systems.

HARDWARE - ADC option is required (this is a Texas Instruments field-installable option). The handler will work if RDC is installed, but not all functions of the RDC option will be used. The option to allow printing on the Silent 700 printer must be enabled. This handler will work for 300 or 1200 baud rate.

OPERATION -

OPEN. - Buffer count and null count are initialized to zero. The "Minimal Listener" is disabled to prevent false triggering of the "Debugger Escape". A physical record size of one is returned to caller.

CLOSE. - A DC3 (13_H) character is issued to the Silent 700 to assure that the tape transport is turned off. The buffer count is reinitialized and the "Minimal Listener" is reenabled.

READ. - The read function reads one record from the cassette tape into a buffer and deblocks that buffer one byte at a time. When the buffer is empty, another record is read. End of record is defined by DC3 (13_H). End of file on the tape is defined by EOT (04_H), a sequence or 127 nulls, or a time out condition greater than 2 seconds.

12-9. TK-KEYBOARD

DESCRIPTION - I/O handler. This handler interfaces the terminal keyboard for input to the FLP-80DOS via the serial ASCII port. This handler is called by IOCS. It is not interrupt driven. One character at a time is input. Immediate return is supported. I/O timeout is not checked.

HARDWARE - Any serial terminal with ASCII keyboard. Allowed baud rates are 110, 300, 600, 1200, 2400, 4800 and 9600. RS-232 and 20mA current loop interfaces are supported.

OPERATION -

OPEN - A physical record size of 1 is returned to IOCS.

CLOSE - No action is performed.

READ - If a character was entered via the "Minimal Listener", it is taken as the keyed-in character. Otherwise the Status of the UART is checked. Immediate return is supported. When the UART goes ready, a character is read. Parity bit is cleared and the Minimal Listener holding register is cleared. If the Minimal Listener is enabled, then a test is made for CNTL-C (Debugger Escape) or CNTL-X (reboot). A positive test branches to the appropriate routine. If the Minimal Listener is not enabled, then return is made to caller.

12-10. TT - CONSOLE OUTPUT

DESCRIPTION - I/O handler. This handler is used for all output to the console device. It will support the following terminals depending on the baud rate.

BAUD RATE	TERMINAL TYPE
110	Teletype or CRT
300	Silent 700 or CRT
600	CRT
1200	Silent 700 or CRT
2400-9600	CRT

Tabs are expanded by the handler, and an automatic carriage return/line feed is issued when the right side of the screen is reached. Immediate return is not supported.

HARDWARE - Any terminal with RS-232 or 20mA current loop interface.

OPERATION -

OPEN - A physical record size of one byte is returned.

CLOSE - No action.

WRITE - The character to be output is checked. If it is a tab (ASCII 09_H), then the required number of spaces to position the print head or cursor mod-8 is output. If the character is a backspace, then the position counter is decremented and the backspace is output. For any character other than a carriage return ($0D_H$) or form feed ($0C_H$), the width of the current line is checked. If the cursor is at the right side of the screen specified by 'LWIDTH'), then a carriage return and line feed are output. The position counter is then updated and the UART status is checked. When ready, the character is output to the device. If the device is a TTY or Silent 700, then a form feed ($0C_H$) is translated to 6 line feeds to prevent uncontrolled paper scrolling. If the baud rate is 1200 baud for a Silent 700, then a 32 msec delay is executed after each character output. If the character is a carriage return and the baud rate is 300 or 1200, then an extra 210 msec delay is executed to allow full return of the print head. After each carriage return to output (0DH) the keyboard status byte, (TKST) in the scratchpad, in checked and if it contains a space (020H) then it is cleared and checked again in a loop until the next space is input from TK for release to continue output. This allows pausing the listing of a file to the console device by pressing the space bar once, and continuing the listing by pressing the space bar once again.

12-11. TO - SILENT 700 CASSETTE OUTPUT

DESCRIPTION - I/O handler. This handler interfaces a Silent 700 digital cassette for output to the FLP-80DOS system via the serial port. Thus, the Silent 700 is also the system terminal. This handler is not interrupt driven. Immediate return is not supported. This handler will record tapes in LINE or CONTINUOUS mode. It is compatible with other MOSTEK products.

HARDWARE - See description for 'TI'.

OPERATION -

OPEN - A buffer pointer is initialized and a physical record size of one of returned to caller.

CLOSE - A DC4 (14_H) is issued to the Silent 700 to assure that the tape transport is off.

WRITE - Characters are blocked into a buffer one at a time until an end of record is encountered. An end of record is defined as a line feed character. When the end of record is encountered, the buffer is output to the device. The record format is: data, CR, LF, DC3, RUBOUT. If an end of file (EOT=04_H) is to be output, then any bytes in the buffer are output. Then the EOT is output followed by a carriage return ($0D_H$) to terminate LINE mode. A series of null characters is written to the device to assure that this last record is written to the tape in CONTINUOUS mode.

12-12. TR - TELETYPE PAPER TAPE READER

DESCRIPTION - I/O handler. This handler interfaces a teletype paper tape reader to FLP-80DS via the serial I/O port. This handler is called by IOCS. It is not interrupt driven. One character at a time is output. Immediate return is not supported. I/O time out is 250 milliseconds and returns to caller.

HARDWARE - Reader step control is required on the teletype.

OPERATION -

OPEN - The 'Minimal Listener' is turned off. A physical record size of 1 is returned to IOCS.

CLOSE - The 'Minimal Listener' is turned on and returns to caller.

WRITE - The reader is turned on. The UART is checked. A timeout of 250 milliseconds is initiated. If the UART does not go ready, return is made to caller. Otherwise, the reader is turned off the the character is read via TKREAD.

```
                                 NAME    CLP
                          ;*****************************************
                          ;* TITLE: CENTRONIX LINE PRINTER DRIVER *
                          ;*                                      *
                          ;* ID:    CLP    VERSION  2.0   6/15/78 *
                          ;*                                      *
                          ;* PROGRAMMERS: M. FREEMAN              *
                          ;*              JOHN BATES              *
                          ;*****************************************
                          ;
                          ; THIS IS THE INTERFACE FOR PRINTERS WHICH REQUIRE
                          ; A PULSE INSTEAD OF AN EDGE FOR DATA TRANSFER. FOR
                          ; EACH CHARACTER TRANSFERED, A 7.6 US. PULSE WILL
                          ; BE SENT 16.4 US. AFTER DATA IS SENT TO THE PRINTER.
                          ; BUSY IS USED TO INDICATE THAT THE BUFFER IS FULL
                          ; OR A RETURN OR LINE FEED HAS BEEN SENT.
                          ; 100 US./CHAR IS THE FASTEST RATE THAT THE DRIVER
                          ; CAN OUTPUT DATA.
                          ;
                          ; BOTH BITS 4 AND 5 MUST BE LOW FROM THE PRINTER
                          ; FOR DATA TO BE TRANSFERED. THE 7402 ON PORT
                          ; D2 INVERTS THE DATA, THEREFORE BOTH BITS MUST
                          ; BE HIGH IN THE ACC AFTER THE INPUT INSTRUCTION.
                          ; AFTER SCANNING FOR 1 SEC IF BOTH BITS ARE NOT HIGH
                          ; A TIMEOUT MESSAGE WILL BE PRINTED BY THE DRIVER.
                          ;
                          ; BESIDES THE NORMAL PRINTABLE ASCII CHARACTERS, THIS
                          ; DRIVER RESPONDS TO 2 ASCII CONTROL CHARACTERS. THESE
                          ; CONTROL CHARACTERS ARE DECODED BY THE DRIVER AND ARE
                          ; TRANSLATED CHARACTERS WHICH EVERY PRINTER CAN USE.
                          ; THEN ARE:    TAB (09H) AND FORM FEED (0CH).
                          ;
                                 GLOBAL  CP
                                 GLOBAL  EH
>0000                     LPCSTB EQU     0        ; STROBE FOR CENTRONICS TYPE
>0004                     LPPE   EQU     4        ; PAPER EMPTY
>0005                     LPBSY  EQU     5        ; PRINTER BUSY
>00D0                     LPDP   EQU     0D0H     ;DATA PORT
>00D1                     LPDC   EQU     0D1H     ;CONTROL PORT
>00D2                     LPSP   EQU     0D2H     ;STROBE/BUSY PORT
>00D3                     LPSC   EQU     0D3H     ;STROBE/BUSY CONTROL PORT
>0007                     TIMOUT EQU     07       ;TIMEOUT ERROR CODE
>0042                     PAGE   EQU     66       ;PAGE LENGTH
>0050                     LWIDTH EQU     80       ;MAXIMUM LINE WIDTH
                          ;
'0000   04                CP     DEFB    4                  ;MAX REQUEST
'0001   00                       DEFB    0                  ;OPENR
'0002   06                       DEFB    LPOPEN-$
'0003   30                       DEFB    LPCLOS-$
'0004   00                       DEFB    0                  ;READ
'0005   35                       DEFB    LPWRIT-$           ;WRITE
'0006   00                HCNTR  DEFB    0                  ; COLUMN COUNTER
'0007   01                VCNTR  DEFB    1                  ;LINE COUNTER
                          ;
'0008   3E0F              LPOPEN LD      A,0FH              ;PORT A MODE 0
'000A   D3D1                     OUT     (LPDC),A
'000C   3ECF                     LD      A,0CFH             ;PORT B MODE 3
'000E   D3D3                     OUT     (LPSC),A
```

```
'0010  3EF0       0060          LD      A,0F0H          ;HIGH HALF FOR INPUTS
'0012  D3D3       0061          OUT     (LPSC),A
'0014  3E03       0062          LD      A,3             ;DISABLE INTPS
'0016  D3D1       0063          OUT     (LPDC),A
'0018  3E11       0064          LD      A,11H           ; SELECT WITH DC1
'001A  D3D0       0065          OUT     (LPDP),A
'001C  DBD2       0066          IN      A,(LPSP)        ; RESET LP CSTROBE
'001E  CBC7       0067          SET     LPCSTB,A
'0020  0602       0068          LD      B,2
'0022  D3D2       0069 LPOPN1   OUT     (LPSP),A
'0024  EE01       0070          XOR     1               ; 2**LPCSTB
'0026  10FA       0071          DJNZ    LPOPN1-$
'0028  AF         0072          XOR     A
'0029  320600'    0073          LD      (HCNTR),A
'002C  320700'    0074          LD      (VCNTR),A
'002F  010100     0075          LD      BC,1            ;PHYSICAL RECORD SIZE =
'0032  C9         0076          RET
                  0077 ;
'0033  3E0D       0078 LPCLOS   LD      A,0DH           ;OUTPUT CARRIAGE RETURN
'0035  CD3A00'    0079          CALL    LPWRIT
'0038  3E0C       0080          LD      A,0CH           ;OUTPUT FORM FEED
                  0081 ;
                  0082 ;
'003A  FE09       0083 LPWRIT   CP      9               ; TAB?
'003C  2015       0084          JR      NZ,LP2A-$       ; NO
'003E  C5         0085          PUSH    BC              ; YES
'003F  3A0600'    0086          LD      A,(HCNTR)
'0042  47         0087          LD      B,A
'0043  E6F8       0088          AND     0F8H
'0045  C608       0089          ADD     A,8             ; NEXT TAB LOC
'0047  0E20       0090          LD      C,'             ; SPACE OUT
'0049  90         0091 LP3A     SUB     B               ; # SPACES
'004A  47         0092          LD      B,A
'004B  79         0093 LP3      LD      A,C             ; OUTPUT SPACE
'004C  CD6200'    0094          CALL    LP2
'004F  10FA       0095          DJNZ    LP3-$
'0051  C1         0096          POP     BC
'0052  C9         0097          RET
'0053  FE0C       0098 LP2A     CP      0CH             ; FORM FEED?
'0055  200B       0099          JR      NZ,LP2-$        ;NOTE: THIS LOGIC GENER
'0057  C5         0100          PUSH    BC              ;TO EJECT PAGE. IF LINE
'0058  3A0700'    0101          LD      A,(VCNTR)       ;HARDWARE SUPPORTS A FO
'005B  47         0102          LD      B,A             ;THIS LOGIC SHOULD BE O
'005C  3E42       0103          LD      A,PAGE
'005E  0E0A       0104          LD      C,0AH
'0060  18E7       0105          JR      LP3A-$          ; LINE FEED OUT
                  0106 ;
'0062  F5         0107 LP2      PUSH    AF              ;SAVE CHARACTER
'0063  FE0A       0108          CP      0AH             ;LINE FEED ?
'0065  200E       0109          JR      NZ,LP5-$
'0067  3A0700'    0110          LD      A,(VCNTR)       ;IF CHAR IS LINE FEED
'006A  3C         0111          INC     A               ;THEN UPDATE VERTICLE
'006B  FE42       0112          CP      PAGE            ;COUNTER AND RESET
'006D  2001       0113          JR      NZ,LP4-$        ;TO ZERO AFTER MAX PAGE
'006F  AF         0114          XOR     A               ;LENGTH HAS BEEN REACHE
'0070  320700'    0115 LP4      LD      (VCNTR),A
'0073  1813       0116          JR      LP20-$
                  0117 ;
```

```
)075   FE0D       0118 LP5      CP       0DH              ;IF CARRAGE RET
)077   3E00       0119          LD       A,0              ;ZERO HORIZONTAL CTR.
)079   280A       0120          JR       Z,LP10-$
                  0121 ;
)07B   3A0600'    0122 LP6      LD       A,(HCNTR)        ;FETCH HORIZONTAL CTR
)07E   FE50       0123          CP       LWIDTH
)080   2002       0124          JR       NZ,LP8-$         ;IF MAX LINE WIDTH
)082   F1         0125          POP      AF               ;IS REACHED THEN RETURN.
)083   C9         0126          RET
)084   3C         0127 LP8      INC      A
)085   320600'    0128 LP10     LD       (HCNTR),A        ;UPDATE HORIZONTAL CTR
                  0129 ;
0088   C5         0130 LP20     PUSH     BC               ;SAVE BC
0089   01C409     0131          LD       BC,2500          ;2.5 SECOND DELAY COUNT
008C   C5         0132 LP22     PUSH     BC
008D   062F       0133          LD       B,47             ;MSEC COUNTER
                  0134 ;
008F   DBD2       0135 LP24     IN       A,(LPSP)         ;EXIT TO PRINT CHARACTER
0091   E630       0136          AND      030H             ;IF BOTH STATUS BITS 4 & 5
0093   FE30       0137          CP       030H             ;ARE SET INDICATING PAPER
0095   2813       0138          JR       Z,LP30-$         ;IS NOT EMPTY AND PRINTER
0097   0B         0139          DEC      BC               ;IS NOT BUSY
0098   10F5       0140          DJNZ     LP24-$           ;LOOP FOR 1 MSEC
                  0141 ;
009A   C1         0142          POP      BC
009B   0B         0143          DEC      BC               ;DECREMENT COUNT
009C   78         0144          LD       A,B
009D   B1         0145          OR       C
009E   20EC       0146          JR       NZ,LP22-$
                  0147 ;
'00A0  3E07       0148          LD       A,TIMOUT         ;PRINT TIMEOUT ERROR
'00A2  CDFFFF     0149          CALL     EH
'00A5  01204E     0150          LD       BC,20000                 ;NEW TIME OUT
'00A8  18E2       0151          JR       LP22-$
                  0152 ;
'00AA  C1         0153 LP30     POP      BC               ;ADJUST STACK
'00AB  C1         0154          POP      BC               ;RESTORE BC
'00AC  F1         0155          POP      AF               ;GET CHAR
'00AD  D3D0       0156          OUT      (LPDP),A         ;OUTPUT CHAR
'00AF  F5         0157          PUSH     AF               ;SAVE CHAR
'00B0  DBD2       0158          IN       A,(LPSP)
'00B2  CB87       0159          RES      LPCSTB,A         ;RESET STROBE
'00B4  D3D2       0160          OUT      (LPSP),A         ;GENERATING PULSE.
'00B6  CBC7       0161          SET      LPCSTB,A
'00B8  D3D2       0162          OUT      (LPSP),A
'00BA  F1         0163          POP      AF               ;RESTORE CHAR
'00BB  C9         0164          RET
                  0165 ;
                  0166          END

ERRORS=0000
```

```
 ADDR   OBJECT      ST # SOURCE STATEMENT            DATASET = DK0:LPD    .SRC

                    0002            NAME     LPDATA
                    0003 ;
                    0004 ; DATA PRODUCTS LINE PRINTER HANDLER
                    0005 ;
                    0006            GLOBAL   LP
                    0007            GLOBAL   EH
                    0008 ;
 >FF00              0009 TOR        EQU      0FF00H
 >0002              0010 IRET       EQU      2
 >0015              0011 CFLGS      EQU      21
 >0007              0012 TIMOUT     EQU      7
                    0013 ;
                    0014 ;
'>0000              0015 LP         EQU      $
'0000   04          0016            DEFB     4          ;MAX RQST
'0001   00          0017            DEFB     0
'0002   05          0018            DEFB     LPOPEN-$
'0003   3C          0019            DEFB     LPCLOS-$
'0004   00          0020            DEFB     0
'0005   3B          0021            DEFB     LPWRIT-$
                    0022 ;
'0006   AA          0023 LPST       DEFB     0AAH
 >0007              0024 LPDIS      EQU      7          ;VECTOR DISPLACEMENT FROM TOR
                    0025 ;
'0007   F3          0026 LPOPEN     DI                  ;OPEN DEVICE
'0008   2A00FF      0027            LD       HL,(TOR)        ;ACCESS INTERRUPT TABLE
'000B   110700      0028            LD       DE,LPDIS
'000E   B7          0029            OR       A
'000F   ED52        0030            SBC      HL,DE
'0011   E5          0031            PUSH     HL         ;SAVE VECTOR ADDR
'0012   11A500'     0032            LD       DE,LINT ;GET INTERRUPT HANDLER ADDRESS
'0015   73          0033            LD       (HL),E  ;SAVE IN VECTOR
'0016   23          0034            INC      HL
'0017   72          0035            LD       (HL),D
'0018   D1          0036            POP      DE         ;GET VECTOR ADDRESS
'0019   210600'     0037            LD       HL,LPST ;HL -> STATUS BYTE
'001C   CBC6        0038            SET      0,(HL)  ;SET READY BIT
'001E   4E          0039            LD       C,(HL)  ;GET PORT FOR CONTROL
'001F   3E0F        0040            LD       A,0FH   ;OUTPUT CONTROL
'0021   ED79        0041            OUT      (C),A
'0023   ED59        0042            OUT      (C),E   ;OUTPUT VECTOR LSBYTE
'0025   3E83        0043            LD       A,83H
'0027   ED79        0044            OUT      (C),A
'0029   7A          0045            LD       A,D     ;SET UP VECTOR MSBYTE
'002A   ED47        0046            LD       I,A
'002C   3E0C        0047            LD       A,0CH   ;OUTPUT FORM FEED TO INITIALIZE
'002E   CD4000'     0048            CALL     LPWRIT
'0031   3E0D        0049            LD       A,0DH   ;AND A CR
'0033   CD4000'     0050            CALL     LPWRIT
'0036   3E08        0051            LD       A,8     ;INITIALIZE TAB COUNT
'0038   32AF00'     0052            LD       (CNT),A
'003B   010100      0053            LD       BC,1
'003E   FB          0054            EI                  ;ENABLE
'003F   C9          0055 LPCLOS     RET                 ;RETURN TO CALLER
                    0056 ;
                    0057 ;
'0040   E5          0058 LPWRIT     PUSH     HL         ;SAVE REGS
'0041   C5          0059            PUSH     BC
```

```
 ADDR  OBJECT     ST # SOURCE STATEMENT         DATASET = DK0:LPD    .SRC

'0042  F5         0060            PUSH    AF        ;SAVE BYTE TO OUTPUT
'0043  210600'    0061            LD      HL,LPST ;HL -> STATUS BYTE
'0046  01B80B     0062            LD      BC,3000 ;3 SECOND TIME OUT
'0049  C5         0063 LPA        PUSH    BC        ;SAVE
'004A  0629       0064            LD      B,41      ;MSEC COUNTER
'004C  FB         0065 LPL        EI                ;ENABLE INTPS
'004D  CB46       0066            BIT     0,(HL)  ;CHECK FOR READY
'004F  201D       0067            JR      NZ,LPR-$          ;YES, SKIP OUT
'0051  FDCB1556   0068            BIT     IRET,(IY+CFLGS) ;CHECK IMMED RETURN
'0055  2012       0069            JR      NZ,LPI-$          ;YES, SKIP OUT
'0057  10F3       0070            DJNZ    LPL-$   ;LOOP FOR TIMEOUT
'0059  C1         0071            POP     BC
'005A  0B         0072            DEC     BC        ;DECREMENT COUNT
'005B  78         0073            LD      A,B
'005C  B1         0074            OR      C
'005D  20EA       0075            JR      NZ,LPA-$          ;LOOP FOR TIMEOUT
                  0076 ;
'005F  3E07       0077            LD      A,TIMOUT          ;TIME OUT ERROR
'0061  CDFFFF     0078            CALL    EH        ;OUTPUT IT
'0064  01204E     0079            LD      BC,20000          ;NEW TIMEOUT
'0067  18E0       0080            JR      LPA-$
                  0081 ;
'0069  C1         0082 LPI        POP     BC
'006A  F1         0083            POP     AF
'006B  C1         0084            POP     BC
'006C  E1         0085            POP     HL
'006D  C9         0086            RET
                  0087 ;
'006E  C1         0088 LPR        POP     BC        ;RESTORE STACK
'006F  F1         0089            POP     AF        ;GET BYTE
'0070  CB86       0090            RES     0,(HL)  ;RESET READY BIT
'0072  4E         0091            LD      C,(HL)  ;GET DATA PORT NBR
'0073  FE09       0092            CP      9         ;IS THIS A TAB CHARACTER?
'0075  2016       0093            JR      NZ,LPR2-$         ;NO, SKIP
'0077  3E20       0094            LD      A,' '     ;IF TAB OUTPUT A BLANK
'0079  ED79       0095            OUT     (C),A
'007B  3AAF00'    0096            LD      A,(CNT) ;DECREMENT COUNT
'007E  FE08       0097            CP      8         ;CHECK IF AT END OF TAB SPACE
'0080  2819       0098            JR      Z,LPR4-$          ;IF SO, SKIP OUT
'0082  3D         0099            DEC     A         ;UNTIL IT TURNS TO ZERO
'0083  32AF00'    0100            LD      (CNT),A
'0086  3E09       0101            LD      A,9       ;REINITIALIZE CHARACTER=TAB
'0088  F5         0102            PUSH    AF
'0089  20BE       0103            JR      NZ,LPA-$          ;IF NOT DONE, OUTPUT MORE
'008B  180C       0104            JR      LPR3-$  ;ELSE REINIT TAB COUNTER
                  0105 ;
'008D  ED79       0106 LPR2       OUT     (C),A     ;OUTPUT NON-TAB CHARACTER
'008F  FE0D       0107            CP      0DH       ;IF CARRIAGE RETURN
'0091  2806       0108            JR      Z,LPR3-$          ;GO REINIT TAB COUNTER
'0093  3AAF00'    0109            LD      A,(CNT) ;DECREMENT COUNTER
'0096  3D         0110            DEC     A
'0097  2002       0111            JR      NZ,LPR4-$         ;IF NOT ZERO, SKIP
                  0112 ;******************NOTE: DESTROYS A-REG
'0099  3E08       0113 LPR3       LD      A,8       ;REINIT TAB COUNTER
'009B  32AF00'    0114 LPR4       LD      (CNT),A ;SET TAB COUNTER
'009E  FDCB1596   0115            RES     IRET,(IY+CFLGS) ;RESET IMMED RETURN
'00A2  C1         0116            POP     BC
'00A3  E1         0117            POP     HL
```

```
'00A4  C9         0118            RET                 ;RETURN TO CALLER
                  0119 ;
                  0120 ;
'00A5  E5         0121 LINT       PUSH     HL         ;LINE PRINTER INTERRUPT HANDLER
'00A6  210600'    0122            LD       HL,LPST
'00A9  CBC6       0123            SET      0,(HL)     ;SET READY BIT
'00AB  E1         0124            POP      HL
'00AC  FB         0125            EI
'00AD  ED4D       0126            RETI
                  0127 ;
'00AF  00         0128 CNT        DEFB     0          ;TAB COUNTER

ERRORS=0000
```

```
                    0002        NAME    CR
                    0003 ;TITLE: CARD READER DRIVER FOR FLP-80
                    0004 *
                    0005 *ID: ZCR80 V2.0 27MAY78
                    0006 *
                    0007 *TYPE: SUBROUTINE
                    0008 *
                    0009 *SYSTEM: AID-80F WITH FLP-80DOS
                    0010 *
                    0011 *DESCRIPTION: THIS DRIVER INTERFACES A DOCUMATION
                    0012 * M200 CARD READER TO THE AID-80F VIA TWO
                    0013 * PIO PORTS.  REQUIRES FLP-80DOS.
                    0014 *
                    0015 *STACK USAGE: MAX 10 ENTRIES
                    0016 *
                    0017 *CALLED ROUTINES: EH
                    0018 *
                    0019 *PROGRAMMER: D. LEITCH
                    0020 ;          P. FORMANIAK
                    0021 *
                    0022 ;
                    0023 ; EXTERNAL SYMBOLS
                    0024 ;
                    0025        GLOBAL  EH
                    0026 ;
                    0027 ; SCRATCHPAD EQUATES
>FF00               0028 TOR    EQU     0FF00H
                    0029 ;
                    0030 ; IOCS VECTOR EQUATES
                    0031 ;
>0019               0032 UBFFR  EQU     25      ;USER BUFFER OFFSET IN VECTOR
>0015               0033 CFLGS  EQU     21
>0017               0034 ERRC   EQU     23
>001E               0035 HSCR   EQU     30
>0002               0036 IRET   EQU     2
>001D               0037 NREC   EQU     29
                    0038 ;
                    0039 ; LOCAL EQUATES
                    0040 ;
>0004               0041 EOT    EQU     4       ;EOT CHARACTER
>0007               0042 TIMOUT EQU     7       ;TIMOUT ERROR NUMBER
>0009               0043 EOFERR EQU     9       ;END OF FILE ERROR NUMBER
                    0044 ;
                    0045        GLOBAL  CR
'>0000              0046 CR     EQU     $
'0000   03          0047        DEFB    3       ;MAX REQUEST
'0001   05          0048        DEFB    CROPEN-$        ;OPEN FOR READ
'0002   00          0049        DEFB    0       ;OPEN FOR WRITE
'0003   D3          0050        DEFB    CRCLOS-$        ;CLOSE
'0004   3F          0051        DEFB    CRREAD-$        ;READ
                    0052 ;
'0005   AD          0053 CRPORT DEFB    0ADH    ;PORT FOR CARD READER
>000D               0054 CRDIS  EQU     0DH     ;INTP VECTOR DISPLACEMENT FROM TO
                    0055 ;
'0006   F3          0056 CROPEN DI              ;OPEN CARD READER
'0007   2A00FF      0057        LD      HL,(TOR)        ;GET VECTOR ADDRESS
'000A   110D00      0058        LD      DE,CRDIS        ;OFFSET OF VECTOR FROM TO
'000D   B7          0059        OR      A
```

```
'000E  ED52       0060             SBC     HL,DE
'0010  11D700'    0061             LD      DE,CRDRDR       ;GET INTP HANDLER ADDRES
'0013  73         0062             LD      (HL),E  ;SAVE INTO VECTOR
'0014  23         0063             INC     HL
'0015  72         0064             LD      (HL),D
'0016  2B         0065             DEC     HL      ;GET VECTOR ADDR
'0017  3A0500'    0066             LD      A,(CRPORT)      ;GET CARD READER POPRT
'001A  4F         0067             LD      C,A
'001B  ED69       0068             OUT     (C),L   ;LSBYTE OF VECTOR TO PORT
'001D  7C         0069             LD      A,H     ;MSBYTE OF VECTOR INTO I-REG
'001E  ED47       0070             LD      I,A
'0020  3E8F       0071             LD      A,8FH   ;SET MODE =2
'0022  ED79       0072             OUT     (C),A
'0024  3E03       0073             LD      A,03H   ;DISABLE A INTERRUPTS
'0026  ED79       0074             OUT     (C),A
'0028  0C         0075             INC     C       ;ADJUST TO B CNTL
'0029  0C         0076             INC     C
'002A  ED69       0077             OUT     (C),L   ;LSBYTE OF VECTOR
'002C  3ECF       0078             LD      A,0CFH  ;SET MODE =3
'002E  ED79       0079             OUT     (C),A
'0030  3EFF       0080             LD      A,0FFH  ;ALL I/O LINES=INPUT
'0032  ED79       0081             OUT     (C),A
'0034  3E17       0082             LD      A,17H   ;DISABLE B INTERRUPTS
'0036  ED79       0083             OUT     (C),A
'0038  3EFF       0084             LD      A,0FFH  ;NO I/O LINES=INTERRUPT
'003A  ED79       0085             OUT     (C),A
'003C  015200     0086             LD      BC,82   ;SET BUFFER LENGTH
'003F  ED5E       0087             IM      2
'0041  FB         0088             EI
'0042  C9         0089             RET
                  0090 ;
                  0091 ;
'>0043            0092 CRREAD      EQU     $
'0043  E5         0093             PUSH    HL
'0044  D5         0094             PUSH    DE
'0045  C5         0095             PUSH    BC
'0046  FD7E1D     0096             LD      A,(IY+NREC)     ;GET NBR OF CARDS TO REA
'0049  FD771E     0097             LD      (IY+HSCR),A     ;SAVE IN HANDLER SCRATCH
'004C  FD361D00   0098             LD      (IY+NREC),0     ;ZERO NBR OF CARDS READ
'0050  FD5E19     0099             LD      E,(IY+UBFFR)    ;SET UP BUFFER POINTER
'0053  FD561A     0100             LD      D,(IY+UBFFR+1)
                  0101 ;
'0056  3A0500'    0102 CRLOOP      LD      A,(CRPORT)      ;GET CARD READER PORT
'0059  4F         0103             LD      C,A
'005A  0C         0104             INC     C       ;ADJUST TO PORT B DATA
'005B  21A00F     0105             LD      HL,4000 ;INITIAL TIME OUT IN MSEC
'005E  0626       0106 CRDYL       LD      B,38    ;ONE MSEC COUNTER
'0060  ED78       0107 CRDY0       IN      A,(C)   ;TEST READY BIT
'0062  CB5F       0108             BIT     3,A
'0064  281C       0109             JR      Z,CRGO-$        ;IF READY, SKIP OUT
'0066  FDCB1556   0110             BIT     IRET,(IY+CFLGS) ;CHECK FOR IMMEDIATE RETU
'006A  2011       0111             JR      NZ,ZRET-$       ;RETURN ZERO IF SO
'006C  10F2       0112             DJNZ    CRDY0-$ ;LOOP FOR ONE MSEC COUNT
'006E  2B         0113             DEC     HL      ;DECREMENT TIME OUT COUNTER
'006F  7C         0114             LD      A,H
'0070  B5         0115             OR      L       ;CHECK FOR ZERO
'0071  20EB       0116             JR      NZ,CRDYL-$      ;IF NOT DONE, LOOP FOR MC
                  0117 ; TIMEOUT ERROR. OUTPUT THE ERROR TO CONSOLE.  THEN LOOP
```

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)DR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:CR     .SRC

                 0118 ; UNTIL DEVICE GOES READY.
)73   3E07       0119            LD      A,TIMOUT         ;TIME OUT ERROR NBR
)75   CDFFFF     0120            CALL    EH       ;OUTPUT THE ERROR
)78   21204E     0121            LD      HL,20000         ;20 SECOND TIMEOUT FROM HER
)7B   18E1       0122            JR      CRDYL-$ ;AND LOOP FOR MORE
                 0123 ;
)7D   97         0124 ZRET       SUB     A        ;RETURN ZERO TO CALLER
)7E   C1         0125            POP     BC
07F   D1         0126            POP     DE
080   E1         0127            POP     HL
081   C9         0128            RET
                 0129 ;
082   0D         0130 CRGO       DEC     C        ;ADJUST TO A CNTL
083   3E83       0131            LD      A,83H    ;ENABLE INTERRUPTS
085   ED79       0132            OUT     (C),A
087   AF         0133            XOR     A        ;CLEAR A
088   0D         0134            DEC     C        ;ADJUST TO A DATA
089   ED79       0135            OUT     (C),A    ;FORCE A PICK
08B   C5         0136            PUSH    BC       ;SAVE BC
08C   FB         0137            EI
008D             0138 CBZY1      EQU     $        ;GO READ THE CARD VIA INTPS
08D   FE50       0139            CP      80       ;A=80 => FINISHED
08F   20FC       0140            JR      NZ,CBZY1-$
091   F3         0141            DI
092   C1         0142            POP     BC       ;RESTORE BC
093   0D         0143            DEC     C        ;ADJUST TO A CNTL
094   3E03       0144            LD      A,3      ;DISABLE I/O INTERRUPTS
096   ED79       0145            OUT     (C),A
                 0146 ;
                 0147 ; CHECK FOR EOT (04H) IN COLUMN 1
                 0148 ;
098   D5         0149            PUSH    DE       ;DE INTO HL
099   E1         0150            POP     HL
09A   C5         0151            PUSH    BC       ;SAVE BC-REG
09B   FD341D     0152            INC     (IY+NREC)        ;INCREMENT NBR OF CARDS REA
09E   015000     0153            LD      BC,80    ;ACCESS FIRST CHARACTER OF CARD
0A1   B7         0154            OR      A
0A2   ED42       0155            SBC     HL,BC
0A4   7E         0156            LD      A,(HL)   ;GET CHARACTER IN COLUMN 1
0A5   C1         0157            POP     BC
0A6   FE04       0158            CP      EOT      ;CHECK FOR END OF FILE INDICATOR
0A8   2006       0159            JR      NZ,NEOT-$        ;NOT EOT, SKIP
0AA   FD361709   0160            LD      (IY+ERRC),EOFERR        ;SET UP END OF FILE
0AE   1817       0161            JR      CREOT-$ ;AND SKIP OUT
                 0162 ;
                 0163 ; NOT EOT, COMPRESS TRAILING BLANKS ON CARD
                 0164 ;
0B0   1B         0165 NEOT       DEC     DE       ;DECREMENT POINTER
0B1   1A         0166            LD      A,(DE)   ;GET CHARACTER
0B2   FE20       0167            CP      20H      ;BLANK?
0B4   28FA       0168            JR      Z,NEOT-$         ;YES, KEEP COMPRESSING
0B6   13         0169            INC     DE       ;CORRECT POINTER
                 0170 ;
0B7   EB         0171            EX      DE,HL    ;HL -> END OF CARD BUFFER
0B8   360D       0172            LD      (HL),0DH         ;STUFF A CR
0BA   23         0173            INC     HL
0BB   360A       0174            LD      (HL),0AH
0BD   23         0175            INC     HL
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'00BE   EB         0176          EX      DE,HL   ;DE -> CARD BUFFER
'00BF   FD7E1D     0177          LD      A,(IY+NREC)      ;CHECK FOR ALL CARDS RE
'00C2   FD961E     0178          SUB     (IY+HSCR)        ;THAT WERE REQUESTED
'00C5   208F       0179          JR      NZ,CRLOOP-$      ;NOT DONE, LOOP FOR NEX
                   0180 ;
'00C7   FD7319     0181 CREOT    LD      (IY+UBFFR),E     ;UPDATE BUFFER POINTER
'00CA   FD721A     0182          LD      (IY+UBFFR+1),D
'00CD   C1         0183          POP     BC       ;RESTORE BC REG
'00CE   D1         0184          POP     DE
'00CF   E1         0185          POP     HL
'00D0   FDCB1596   0186          RES     IRET,(IY+CFLGS) ;RESET IMMEDIATE RETURN
'00D4   FB         0187          EI
'00D5   C9         0188          RET
                   0189 ;
                   0190 ;
'00D6   C9         0191 CRCLOSE RET              ;CLOSE
                   0192 ;
                   0193 ;
'00D7   F5         0194 CRDRDR   PUSH    AF       ;SAVE AF AND BC
'00D8   0607       0195          LD      B,7
'00DA   3A0500'    0196          LD      A,(CRPORT)       ;GET CARD READER PORT
'00DD   4F         0197          LD      C,A
'00DE   0D         0198          DEC     C        ;ADJUST TO A DATA
'00DF   ED78       0199          IN      A,(C)    ;INPUT A DATA
'00E1   2F         0200          CPL              ;COM DATA FROM A
'00E2   6F         0201          LD      L,A      ;SAVE A DATA
'00E3   0C         0202          INC     C        ;ADJUST TO B DATA
'00E4   0C         0203          INC     C
'00E5   ED78       0204          IN      A,(C)    ;B DATA
'00E7   E6F0       0205          AND     0F0H     ;MASK OFF LS 4BITS
'00E9   CB7D       0206          BIT     7,L      ;MOVE BIT 7 FROM A
'00EB   2802       0207          JR      Z,CRD1-$         ; TO BIT3 OF B
'00ED   F608       0208          OR      8
'00EF   CBBD       0209 CRD1     RES     7,L      ;BIT 7 OF A=0
'00F1   CB25       0210 CRD2     SLA     L        ;COUNT LOWER FIELD PUNCHES
'00F3   FAF800'    0211          JP      M,CRD3
'00F6   10F9       0212          DJNZ    CRD2-$
                   0213 ;
'00F8   80         0214 CRD3     ADD     A,B      ;LS 3 BITS OF DISPLACE-
'00F9   4F         0215          LD      C,A      ; MENT ADDED IN
'00FA   0600       0216          LD      B,0      ;BC=TOTAL DISPLACEMENT
'00FC   210801'    0217          LD      HL,HOLTAB        ;HL=HOLLERITH TABLE
'00FF   09         0218          ADD     HL,BC    ;GET ADDRESS OF CHAR
'0100   7E         0219          LD      A,(HL)   ;GET CHARACTER
'0101   12         0220          LD      (DE),A   ;STORE INTO BUFFER
'0102   13         0221          INC     DE       ;INCR PTR
'0103   F1         0222          POP     AF
'0104   3C         0223          INC     A        ;COUNT INTERRUPTS
'0105   FB         0224          EI
'0106   ED4D       0225          RETI
                   0226 ;
                   0227 ;
'0108   20         0228 HOLTAB   DEFB    ' '      ;BLANK
'0109   31         0229          DEFB    '1'      ;1
'010A   32         0230          DEFB    '2'      ;2
'010B   33         0231          DEFB    '3'      ;3
'010C   34         0232          DEFB    '4'      ;4
'010D   35         0233          DEFB    '5'      ;5
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'010E  36          0234          DEFB     '6'       ;6
'010F  37          0235          DEFB     '7'       ;7
'0110  38          0236          DEFB     '8'       ;8
'0111  60          0237          DEFB     60H       ;8-1        BACK QUOTE
'0112  3A          0238          DEFB     ':'       ;8-2
'0113  23          0239          DEFB     '#'       ;8-3
'0114  40          0240          DEFB     '¶['      ;8-4
'0115  27          0241          DEFB     27H       ;8-5
'0116  3D          0242          DEFB     '='       ;8-6
'0117  22          0243          DEFB     '"'       ;8-7
'0118  39          0244          DEFB     '9'       ;9
'0119  00          0245          DEFB     0         ;9-1
'011A  16          0246          DEFB     16H       ;9-2
'011B  00          0247          DEFB     0         ;9-3
'011C  00          0248          DEFB     0         ;9-4
'011D  00          0249          DEFB     0         ;9-5
'011E  00          0250          DEFB     0         ;9-6
'011F  04          0251          DEFB     04H       ;9-7
'0120  00          0252          DEFB     0         ;9-8
'0121  00          0253          DEFB     0         ;9-8-1
'0122  00          0254          DEFB     0         ;9-8-2
'0123  00          0255          DEFB     0         ;9-8-3
'0124  14          0256          DEFB     14H       ;9-8-4
'0125  15          0257          DEFB     15H       ;9-8-5
'0126  00          0258          DEFB     0         ;9-8-6
'0127  1A          0259          DEFB     1AH       ;9-8-7
'0128  30          0260          DEFB     '0'       ;0
'0129  2F          0261          DEFB     '/'       ;0-1
'012A  53          0262          DEFB     'S'       ;
'012B  54          0263          DEFB     'T'       ;0-3
'012C  55          0264          DEFB     'U'       ;0-4
'012D  56          0265          DEFB     'V'       ;0-5
'012E  57          0266          DEFB     'W'       ;0-6
'012F  58          0267          DEFB     'X'       ;0-7
'0130  59          0268          DEFB     'Y'       ;0-8
'0131  00          0269          DEFB     0         ;0-8-1
'0132  5D          0270          DEFB     5DH       ;0-8-2
'0133  2C          0271          DEFB     ','       ;0-8-3
'0134  25          0272          DEFB     '%'       ;0-8-4
'0135  5F          0273          DEFB     5FH       ;0-8-5
'0136  3E          0274          DEFB     '>'       ;0-8-6
'0137  3F          0275          DEFB     '?'       ;0-8-7
'0138  5A          0276          DEFB     'Z'       ;0-9
'0139  00          0277          DEFB     0         ;0-9-1
'013A  00          0278          DEFB     0         ;0-9-2
'013B  00          0279          DEFB     0         ;0-9-3
'013C  00          0280          DEFB     0         ;0-90-4
'013D  0A          0281          DEFB     0AH       ;0-9-5
'013E  17          0282          DEFB     017H      ;0-9-6
'013F  1B          0283          DEFB     1BH       ;0-9-7
'0140  00          0284          DEFB     0         ;0-9-8
'0141  00          0285          DEFB     0         ;0-9-8-1
'0142  00          0286          DEFB     0         ;0-9-8-2
'0143  00          0287          DEFB     0         ;0-90-8-3
'0144  00          0288          DEFB     0         ;0-9-8-4
'0145  05          0289          DEFB     05H       ;0-9-8-5
'0146  06          0290          DEFB     06H       ;0-9-8-6
'0147  07          0291          DEFB     07H       ;0-9-8-7
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'0148   2D         0292          DEFB     '-'       ;11
'0149   4A         0293          DEFB     'J'       ;11-1
'014A   4B         0294          DEFB     'K'       ;11-2
'014B   4C         0295          DEFB     'L'       ;11-3
'014C   4D         0296          DEFB     'M'       ;11-4
'014D   4E         0297          DEFB     'N'       ;11-5
'014E   4F         0298          DEFB     'O'       ;11-6
'014F   50         0299          DEFB     'P'       ;11-7
'0150   51         0300          DEFB     'Q'       ;11-8
'0151   00         0301          DEFB     0         ;11-8-1
'0152   21         0302          DEFB     '!'       ;11-8-2
'0153   24         0303          DEFB     '$'       ;11-8-3
'0154   2A         0304          DEFB     '*'       ;11-8-4
'0155   29         0305          DEFB     ')'       ;11-8-5
'0156   3B         0306          DEFB     ';'       ;11-8-6
'0157   5C         0307          DEFB     5CH       ;11-8-7
'0158   52         0308          DEFB     'R'       ;11-9
'0159   11         0309          DEFB     11H       ;11-9-1
'015A   12         0310          DEFB     12H       ;11-9-2
'015B   13         0311          DEFB     13H       ;11-9-3
'015C   00         0312          DEFB     0         ;11-9-4
'015D   00         0313          DEFB     0         ;11-9-5
'015E   08         0314          DEFB     08H       ;11-9-6
'015F   00         0315          DEFB     0         ;11-9-7
'0160   18         0316          DEFB     18H       ;11-9-8
'0161   13         0317          DEFB     19        ;11-9-8-1
'0162   00         0318          DEFB     0         ;11-9-8-2
'0163   00         0319          DEFB     0         ;11-9-8-3
'0164   1C         0320          DEFB     1CH       ;11-9-8-4
'0165   1D         0321          DEFB     1DH       ;11-9-8-5
'0166   1E         0322          DEFB     1EH       ;11-9-8-6
'0167   1F         0323          DEFB     1FH       ;11-9-8-7
'0168   7D         0324          DEFB     7DH       ;11-0
'0169   7E         0325          DEFB     7EH       ;11-0-1
'016A   73         0326          DEFB     73H       ;11-0-2
'016B   74         0327          DEFB     74H       ;11-0-3
'016C   75         0328          DEFB     75H       ;11-0-4
'016D   76         0329          DEFB     76H       ;11-0-5
'016E   77         0330          DEFB     77H       ;11-0-6
'016F   78         0331          DEFB     78H       ;11-0-7
'0170   79         0332          DEFB     79H       ;11-0-8
'0171   00         0333          DEFB     0         ;11-0-8-1
'0172   00         0334          DEFB     0         ;11-0-8-2
'0173   00         0335          DEFB     0         ;11-0-8-3
'0174   00         0336          DEFB     0         ;11-0-8-4
'0175   00         0337          DEFB     0         ;11-0-8-5
'0176   00         0338          DEFB     0         ;11-0-8-6
'0177   00         0339          DEFB     0         ;11-0-8-7
'0178   7A         0340          DEFB     7AH       ;11-0-9
'0179   00         0341          DEFB     0         ;11-0-9-1
'017A   00         0342          DEFB     0         ;11-0-9-2
'017B   00         0343          DEFB     0         ;11-0-9-3
'017C   00         0344          DEFB     0         ;11-0-9-4
'017D   00         0345          DEFB     0         ;11-0-9-5
'017E   00         0346          DEFB     0         ;11-0-9-6
'017F   00         0347          DEFB     0         ;11-9-0-7
'0180   00         0348          DEFB     0         ;11-0-9-8
'0181   00         0349          DEFB     0         ;11-0-9-8-1
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'0182  00          0350          DEFB     0         ;11-0-9-8-2
'0183  00          0351          DEFB     0         ;11-0-9-8-3
'0184  00          0352          DEFB     0         ;11-0-9-8-4
'0185  00          0353          DEFB     0         ;11-0-9-8-5
'0186  00          0354          DEFB     0         ;11-0-9-8-6
'0187  00          0355          DEFB     0         ;11-0-9-8-7
'0188  26          0356          DEFB     26H       ;12
'0189  41          0357          DEFB     'A'       ;12-1
'018A  42          0358          DEFB     'B'       ;12-2
'018B  43          0359          DEFB     'C'       ;12-3
'018C  44          0360          DEFB     'D'       ;12-4
'018D  45          0361          DEFB     'E'       ;12-5
'018E  46          0362          DEFB     'F'       ;12-6
'018F  47          0363          DEFB     'G'       ;12-7
'0190  48          0364          DEFB     'H'       ;12-8
'0191  00          0365          DEFB     0         ;12-8-1
'0192  5B          0366          DEFB     5BH       ;12-8-2
'0193  2E          0367          DEFB     '.'       ;12-8-3
'0194  3C          0368          DEFB     '<'       ;12-8-4
'0195  28          0369          DEFB     '('       ;12-8-5
'0196  2B          0370          DEFB     '+'       ;12-8-6
'0197  5E          0371          DEFB     5EH       ;12-8-7
'0198  49          0372          DEFB     'I'       ;12-9-
'0199  01          0373          DEFB     01H       ;12-9-1
'019A  02          0374          DEFB     02H       ;12-9-2
'019B  03          0375          DEFB     03H       ;12-9-3
'019C  00          0376          DEFB     0         ;12-9-4
'019D  09          0377          DEFB     09H       ;12-9-5
'019E  00          0378          DEFB     0         ;12-9-6
'019F  7F          0379          DEFB     7FH       ;12-9-7
'01A0  00          0380          DEFB     0         ;12-98
'01A1  00          0381          DEFB     0         ;12-9-8-1
'01A2  00          0382          DEFB     0         ;12-9-8-2
'01A3  0B          0383          DEFB     0BH       ;12-9-8-3
'01A4  0C          0384          DEFB     0CH       ;12-9-8-4
'01A5  0D          0385          DEFB     0DH       ;12-9-8-5
'01A6  0E          0386          DEFB     0EH       ;12-9-8-6
'01A7  0F          0387          DEFB     0FH       ;12-9-8-7
'01A8  7B          0388          DEFB     7BH       ;12-0
'01A9  61          0389          DEFB     61H       ;12-0-1
'01AA  62          0390          DEFB     62H       ;12-0-2
'01AB  63          0391          DEFB     63H       ;12-0-3
'01AC  64          0392          DEFB     64H       ;12-0-4
'01AD  65          0393          DEFB     65H       ;12-0-5
'01AE  66          0394          DEFB     66H       ;12-0-6
'01AF  67          0395          DEFB     67H       ;12-0-7
'01B0  68          0396          DEFB     68H       ;12-0-8
'01B1  00          0397          DEFB     0         ;12-0-8-1
'01B2  00          0398          DEFB     0         ;12-0-8-2
'01B3  00          0399          DEFB     0         ;12-0-8-3
'01B4  00          0400          DEFB     0         ;12-0-8-4
'01B5  00          0401          DEFB     0         ;12-0-8-5
'01B6  00          0402          DEFB     0         ;12-0-806
'01B7  00          0403          DEFB     0         ;12-0-8-7
'01B8  69          0404          DEFB     69H       ;12-0-9
'01B9  00          0405          DEFB     0         ;12-0-9-1
'01BA  00          0406          DEFB     0         ;12-0-9-2
'01BB  00          0407          DEFB     0         ;12-0-9-3
```

```
'01BC  00       0408          DEFB     0        ;12-0-9-4
'01BD  00       0409          DEFB     0        ;12-0-9-5
'01BE  00       0410          DEFB     0        ;12-0-9-6
'01BF  00       0411          DEFB     0        ;12-0-9-7
'01C0  00       0412          DEFB     0        ;12-0-9-8
'01C1  00       0413          DEFB     0        ;12-0-9-8-1
'01C2  00       0414          DEFB     0        ;12-0-9-8-2
'01C3  00       0415          DEFB     0        ;12-0-9-8-3
'01C4  00       0416          DEFB     0        ;12-0-9-8-4
'01C5  00       0417          DEFB     0        ;12-0-9-8-5
'01C6  00       0418          DEFB     0        ;12-0-9-8-6
'01C7  00       0419          DEFB     0        ;12-0-9-8-7
'01C8  7C       0420          DEFB     7CH      ;12-11
'01C9  6A       0421          DEFB     6AH      ;12-11-1
'01CA  6B       0422          DEFB     6BH      ;12-11-2
'01CB  6C       0423          DEFB     6CH      ;12-11-3
'01CC  6D       0424          DEFB     6DH      ;12-11-4
'01CD  6E       0425          DEFB     6EH      ;12-11-5
'01CE  6F       0426          DEFB     6FH      ;12-11-6
'01CF  70       0427          DEFB     70H      ;12-11-7
'01D0  71       0428          DEFB     71H      ;12-11-8
'01D1  00       0429          DEFB     0        ;12-11-8-1
'01D2  00       0430          DEFB     0        ;12-11-8-2
'01D3  00       0431          DEFB     0        ;12-11-8-3
'01D4  00       0432          DEFB     0        ;12-11-8-4
'01D5  00       0433          DEFB     0        ;12-11-8-5
'01D6  00       0434          DEFB     0        ;12-11-8-6
'01D7  00       0435          DEFB     0        ;12-11-8-7
'01D8  72       0436          DEFB     72H      ;12-11-9
'01D9  00       0437          DEFB     0        ;12-11-9-1
'01DA  00       0438          DEFB     0        ;12-11-9-2
'01DB  00       0439          DEFB     0        ;12-11-9-3
'01DC  00       0440          DEFB     0        ;12-11-9-4
'01DD  00       0441          DEFB     0        ;12-11-9-5
'01DE  00       0442          DEFB     0        ;12-11-9-6
'01DF  00       0443          DEFB     0        ;12-11-9-7
'01E0  00       0444          DEFB     0        ;12-11-9-8
'01E1  10       0445          DEFB     10H      ;12-11-9-8-1
'01E2  00       0446          DEFB     0
'01E3  00       0447          DEFB     0
'01E4  00       0448          DEFB     0
'01E5  00       0449          DEFB     0
'01E6  00       0450          DEFB     0
'01E7  00       0451          DEFB     0
'01E8  00       0452          DEFB     0
'01E9  00       0453          DEFB     0
'01EA  00       0454          DEFB     0
'01EB  00       0455          DEFB     0
'01EC  00       0456          DEFB     0
'01ED  00       0457          DEFB     0
'01EE  00       0458          DEFB     0
'01EF  00       0459          DEFB     0
'01F0  00       0460          DEFB     0
'01F1  00       0461          DEFB     0
'01F2  00       0462          DEFB     0
'01F3  00       0463          DEFB     0
'01F4  00       0464          DEFB     0
'01F5  00       0465          DEFB     0
```

```
 ADDR   OBJECT     ST # SOURCE STATEMENT         DATASET = DK0:CR     .SRC

'01F6   00         0466         DEFB     0
'01F7   00         0467         DEFB     0
'01F8   00         0468         DEFB     0
'01F9   00         0469         DEFB     0
'01FA   00         0470         DEFB     0
'01FB   00         0471         DEFB     0
'01FC   00         0472         DEFB     0
'01FD   00         0473         DEFB     0
'01FE   00         0474         DEFB     0
'01FF   00         0475         DEFB     0
'0200   00         0476         DEFB     0
'0201   00         0477         DEFB     0
'0202   00         0478         DEFB     0
'0203   00         0479         DEFB     0
'0204   00         0480         DEFB     0
'0205   00         0481         DEFB     0
'0206   00         0482         DEFB     0
'0207   00         0483         DEFB     0
'0208   00         0484         DEFB     0
'0209   00         0485         DEFB     0
                   0486         END

ERRORS=0000
```

```
                   0002          NAME    PP
                   0003 ;
                   0004 ; PAPER TAPE PUNCH DRIVER FOR FLP-80DOS V2.0
                   0005 ;
                   0006          GLOBAL  PP
                   0007          GLOBAL  EH
                   0008 ;
 >FF00             0009 TOR      EQU     0FF00H
 >0002             0010 IRET     EQU     2
 >0015             0011 CFLGS    EQU     21
 >0007             0012 TIMOUT   EQU     7
                   0013 ;
                   0014 ;
'>0000             0015 PP       EQU     $
'0000  04          0016          DEFB    4        ;MAX RQST
'0001  00          0017          DEFB    0
'0002  05          0018          DEFB    PPOPEN-$
'0003  2D          0019          DEFB    PPCLOS-$
'0004  00          0020          DEFB    0
'0005  2C          0021          DEFB    PPWRIT-$
                   0022 ;
'0006  AA          0023 PPST     DEFB    0AAH     ;PAPER TAPE PUNCH PORT
 >000B             0024 PPDIS    EQU     0BH      ;OFFSET FROM TOR FOR VECTOR
                   0025 ;
'0007  F3          0026 PPOPEN   DI               ;OPEN DEVICE
'0008  2A00FF      0027          LD      HL,(TOR)         ;ACCESS INTERRUPT TABLE
'000B  110B00      0028          LD      DE,PPDIS         ;VECTOR OFFSET FROM TOR
'000E  B7          0029          OR      A
'000F  ED52        0030          SBC     HL,DE
'0011  E5          0031          PUSH    HL
'0012  116D00'     0032          LD      DE,PINT ;DE -> INTERRUPT HANDLER
'0015  73          0033          LD      (HL),E  ;SAVE VECTOR ADDRESS
'0016  23          0034          INC     HL
'0017  72          0035          LD      (HL),D
'0018  D1          0036          POP     DE      ;DE = VECTOR ADDRESS
'0019  210600'     0037          LD      HL,PPST ;HL -> STATUS BYTE
'001C  CBC6        0038          SET     0,(HL)  ;SET READY BIT
'001E  4E          0039          LD      C,(HL)  ;GET PORT FOR CONTROL
'001F  3E0F        0040          LD      A,0FH   ;OUTPUT CONTROL
'0021  ED79        0041          OUT     (C),A
'0023  ED59        0042          OUT     (C),E   ;OUTPUT INTP VECTOR LSBYTE
'0025  3E83        0043          LD      A,83H   ;OUTPUT CONTROL
'0027  ED79        0044          OUT     (C),A
'0029  7A          0045          LD      A,D     ;SET VECTOR MSBYTE
'002A  ED47        0046          LD      I,A
'002C  010100      0047          LD      BC,1    ;PHYSICAL RECORD SIZE
'002F  FB          0048          EI
'0030  C9          0049 PPCLOSE RET              ;RETURN TO CALLER
                   0050 ;
                   0051 ;
'0031  E5          0052 PPWRIT   PUSH    HL
'0032  C5          0053          PUSH    BC
'0033  F5          0054          PUSH    AF      ;SAVE BYTE TO OUTPUT
'0034  210600'     0055          LD      HL,PPST ;HL -> STATUS BYTE
'0037  01D007      0056          LD      BC,2000 ;2000 MSEC TIME OUT COUNT
'003A  C5          0057 PPA      PUSH    BC
'003B  0629        0058          LD      B,41    ;MSEC COUNTER
'003D  FB          0059 PPL      EI              ;ENABLE INTPS
```

```
'003E   CB46      0060          BIT     0,(HL)  ;CHECK FOR READY
'0040   201D      0061          JR      NZ,PPR-$          ;YES, SKIP
'0042   FDCB1556  0062          BIT     IRET,(IY+CFLGS) ;CHECK IMMED RETURN
'0046   2012      0063          JR      NZ,PPI-$          ;YES, SKIP OUT
'0048   10F3      0064          DJNZ    PPL-$   ;LOOP FOR TIMEOUT
'004A   C1        0065          POP     BC
'004B   0B        0066          DEC     BC      ;DECREMENT COUNT
'004C   78        0067          LD      A,B
'004D   B1        0068          OR      C
'004E   20EA      0069          JR      NZ,PPA-$          ;LOOP FOR TIMEOUT
'0050   3E07      0070          LD      A,TIMOUT          ;TIMEOUT ERROR MESSAGE
'0052   CDFFFF    0071          CALL    EH      ;OUTPUT THE MESSAGE
'0055   01204E    0072          LD      BC,20000          ;NEW TIMEOUT
'0058   18E0      0073          JR      PPA-$   ;LOOP AGAIN
                  0074 ;
'005A   C1        0075 PPI      POP     BC      ;RESTORE STACK
'005B   F1        0076          POP     AF      ;RESTORE BYTE
'005C   C1        0077          POP     BC      ;RESTORE REGS
'005D   E1        0078          POP     HL
'005E   C9        0079          RET             ;RETURN TO CALLER
                  0080 ;
'005F   C1        0081 PPR      POP     BC      ;RESTORE STACK
'0060   F1        0082          POP     AF      ;GET BYTE
'0061   CB86      0083          RES     0,(HL)  ;RESET READY BIT
'0063   4E        0084          LD      C,(HL)  ;GET PORT NUMBER
'0064   ED79      0085          OUT     (C),A   ;OUTPUT DATA TO PP
'0066   FDCB1596  0086          RES     IRET,(IY+CFLGS) ;RESET IMMED RETURN BIT
'006A   C1        0087          POP     BC      ;RESTORE REGS
'006B   E1        0088          POP     HL
'006C   C9        0089          RET             ;RETURN TO CALLER
                  0090 ;
                  0091 ;
'006D   E5        0092 PINT     PUSH    HL      ;PAPER TAPE PUNCH INTP HANDLER
'006E   210600'   0093          LD      HL,PPST
'0071   CBC6      0094          SET     0,(HL)
'0073   E1        0095          POP     HL
'0074   FB        0096          EI
'0075   ED4D      0097          RETI

ERRORS=0000
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```
 ADDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:PR     .SRC

                   0002            NAME    PR
                   0003 ;
                   0004 ; PAPER TAPE READER DRIVER FOR FLP-80DOS V2.0
                   0005 ;
                   0006            GLOBAL  PR
                   0007            GLOBAL  EH
                   0008 ;
 >0007             0009 TIMOUT     EQU     7
 >FF00             0010 TOR        EQU     0FF00H
 >0002             0011 IRET       EQU     2
 >0015             0012 CFLGS      EQU     21
                   0013 ;
                   0014 ;
'>0000             0015 PR         EQU     $
'0000   03         0016            DEFB    3         ;MAX REQST
'0001   05         0017            DEFB    PROPEN-$
'0002   00         0018            DEFB    0         ;OPENW
'0003   31         0019            DEFB    PRCLOS-$
'0004   31         0020            DEFB    PRREAD-$
                   0021 ;
'0005   A8         0022 PRST       DEFB    0A8H      ;READER PORT NUMBER
 >0009             0023 PRDIS      EQU     09        ;VECTOR OFFSET FROM TOR
                   0024 ;
                   0025 ;
'0006   F3         0026 PROPEN     DI                ;DISABLE INTPS
'0007   2A00FF     0027            LD      HL,(TOR)          ;ACCESS INTERRUPT TABLE
'000A   110900     0028            LD      DE,PRDIS
'000D   B7         0029            OR      A
'000E   ED52       0030            SBC     HL,DE     ;ACCESS START OF TABLE
'0010   E5         0031            PUSH    HL        ;SAVE IT
'0011   116F00'    0032            LD      DE,RINT ;PR INTERRUPT IS FIRST ENTRY
'0014   73         0033            LD      (HL),E    ;SAVE HANDLER ADDRESS
'0015   23         0034            INC     HL        ;IN INTP TABLE
'0016   72         0035            LD      (HL),D
'0017   D1         0036            POP     DE        ;DE = VECTOR ADDRESS
'0018   210500'    0037            LD      HL,PRST ;HL = STATUS BYTE
'001B   CBC6       0038            SET     0,(HL)    ;SET FOR CONTROL
'001D   4E         0039            LD      C,(HL)    ;GET PORT NUMBER
'001E   3E4F       0040            LD      A,4FH     ;OUTPUT CONTROL
'0020   ED79       0041            OUT     (C),A
'0022   ED59       0042            OUT     (C),E     ;OUTPUT VECTOR LSBYTE
'0024   3E83       0043            LD      A,83H     ;OUTPUT CONTROL
'0026   ED79       0044            OUT     (C),A
'0028   7A         0045            LD      A,D       ;SET UP VECTOR MSBYTE
'0029   ED47       0046            LD      I,A
'002B   CB86       0047            RES     0,(HL)    ;INIT STATUS BIT
'002D   4E         0048            LD      C,(HL)    ;GET PORT
'002E   ED70       0049            IN      F,(C)     ;READ PORT TO INITIALIZE OPERATIC
'0030   010100     0050            LD      BC,1      ;PHYSICAL RECORD SIZE= 1 BYTE
'0033   FB         0051            EI                ;ENABLE INTPS
'0034   C9         0052 PRCLOS     RET               ;RETURN TO CALLER
                   0053 ;
                   0054 ;
'0035   E5         0055 PRREAD     PUSH    HL
'0036   C5         0056            PUSH    BC
'0037   210500'    0057            LD      HL,PRST ;HL -> STATUS BYTE
'003A   01FA00     0058            LD      BC,250    ;TIMEOUT = 250 MSEC
'003D   C5         0059 PRA        PUSH    BC        ;SAVE
```

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 ADDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:PR     .SRC

'003E   0629       0060           LD      B,41     ;MSEC COUNTER
'0040   FB         0061 PRL       EI               ;ENABLE INTPS
'0041   CB46       0062           BIT     0,(HL)   ;CHECK IF READY
'0043   2018       0063           JR      NZ,PRR-$         ;YES, SKIP
'0045   FDCB1556   0064           BIT     IRET,(IY+CFLGS) ;CHECK FOR IMMED RETURN
'0049   2020       0065           JR      NZ,PRI-$         ;IF SO, SKIP OUT
'004B   10F3       0066           DJNZ    PRL-$    ;LOOP FOR TIMEOUT
'004D   C1         0067           POP     BC
'004E   0B         0068           DEC     BC       ;DECREMENT COUNTER
'004F   78         0069           LD      A,B      ;CHECK COUNT
'0050   B1         0070           OR      C
'0051   20EA       0071           JR      NZ,PRA-$
'0053   3E07       0072           LD      A,TIMOUT         ;TIME OUT ERROR CODE
'0055   CDFFFF     0073           CALL    EH
'0058   01204E     0074           LD      BC,20000         ;NEW TIME OUT COUNT
'005B   18E0       0075           JR      PRA-$
                   0076 ;
'005D   C1         0077 PRR       POP     BC
'005E   CB86       0078           RES     0,(HL)   ;ZERO DATA AVAILABLE FLAG
'0060   4E         0079           LD      C,(HL)   ;GET PORT FOR DATA
'0061   ED78       0080           IN      A,(C)    ;GET DATA
'0063   2F         0081           CPL              ;COMPLEMENT THE DATA
'0064   FDCB1596   0082           RES     IRET,(IY+CFLGS) ;RESET IMMED RETURN
'0068   C1         0083           POP     BC
'0069   E1         0084           POP     HL
'006A   C9         0085           RET              ;RETURN TO CALLER
                   0086 ;
'006B   C1         0087 PRI       POP     BC
'006C   C1         0088           POP     BC
'006D   E1         0089           POP     HL
'006E   C9         0090           RET              ;RETURN TO CALLER
                   0091 ;
                   0092 ;
'006F   E5         0093 RINT      PUSH    HL       ;READER INTERRUPT HANDLER
'0070   210500'    0094           LD      HL,PRST
'0073   CBC6       0095           SET     0,(HL)   ;SET READY BIT
'0075   E1         0096           POP     HL
'0076   FB         0097           EI
'0077   ED4D       0098           RETI

ERRORS=0000
```

```
 ADDR   OBJECT      ST # SOURCE STATEMENT          DATASET = DK0:STI    .SRC

                    0002           NAME    TI
                    0003 ;
                    0004 ; SILENT 700 TAPE INPUT HANDLER FOR FLP-80DOS V2.0
                    0005 ; COMPATIBLE WITH PREVIOUS SYSTEMS
                    0006 ;
                    0007           GLOBAL  MINDIS
                    0008           GLOBAL  MINEN
                    0009           GLOBAL  TI
                    0010 ;
 >001E              0011 HSCR      EQU     30
 >0011              0012 DC1       EQU     11H
 >0013              0013 DC3       EQU     13H
                    0014 ;
'>0000              0015 TI        EQU     $
'0000  03           0016           DEFB    3
'0001  04           0017           DEFB    TIOPEN-$
'0002  00           0018           DEFB    0
'0003  FD           0019           DEFB    TICLOS-$
'0004  10           0020           DEFB    TIREAD-$
                    0021 ;
                    0022 ;
'0005  FD361E00     0023 TIOPEN    LD      (IY+HSCR),0      ;ZERO BUFFER COUNTER
'0009  FD362000     0024           LD      (IY+HSCR+2),0    ;ZERO NULL COUNTER
'000D  CDFFFF       0025           CALL    MINDIS  ;DISABLE MINIMAL LISTENER
'0010  010100       0026           LD      BC,1    ;PHYSICAL RECORD SIZE
'0013  C9           0027           RET
                    0028 ;
'0014  E5           0029 TIREAD    PUSH    HL
'0015  C5           0030           PUSH    BC
'0016  FD7E1E       0031           LD      A,(IY+HSCR)      ;GET BUFFER COUNT
'0019  A7           0032           AND     A       ;CHECK IT
'001A  2051         0033           JR      NZ,TIB-$         ;IF NOT ZERO, SKIP
                    0034 ;
                    0035 ; READ A RECORD FROM TAPE INTO THE BUFFER
                    0036 ;
'001C  3E11         0037           LD      A,DC1   ;START THE TRANSPORT
'001E  CD0D01'      0038           CALL    S700P
'0021  218000'      0039           LD      HL,TIBUF         ;HL -> BUFFER
'0024  01D007       0040 TI1       LD      BC,2000 ;2 SECOND TIMEOUT
'0027  C5           0041 TI1A      PUSH    BC
'0028  0630         0042           LD      B,48    ;MSEC COUNT
'002A  DBDD         0043 TI2       IN      A,(0DDH)         ;CHECK THE UART STATUS
'002C  CB77         0044           BIT     6,A
'002E  200A         0045           JR      NZ,TI3-$         ;IF READY, SKIP
'0030  10F8         0046           DJNZ    TI2-$   ;LOOP FOR MSECOND
'0032  C1           0047           POP     BC
'0033  0B           0048           DEC     BC      ;DECREMENT BC COUNTER
'0034  78           0049           LD      A,B     ;CHECK TIMEOUT COUNTER
'0035  B1           0050           OR      C
'0036  20EF         0051           JR      NZ,TI1A-$        ; IF NOT TIMEOUT,LOOP
'0038  1811         0052           JR      TI3A-$  ;ELSE FAKE AN END OF FILE
                    0053 ;
'003A  C1           0054 TI3       POP     BC
'003B  DBDC         0055           IN      A,(0DCH)         ;GET DATA BYTE
'003D  E67F         0056           AND     7FH     ;REMOVE PARITY
'003F  200E         0057           JR      NZ,TI4-$         ;IF NOT NULL, SKIP
                    0058 ; NULL FOUND, COUNT IT.  IF UP TO 127 NULLS,
                    0059 ; FORCE EOT = 04H.
```

```
 ADDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:STI    .SRC

'0041   FD3420     0060             INC      (IY+HSCR+2)      ;INCR NULL COUNTER
'0044   FD7E20     0061             LD       A,(IY+HSCR+2)    ;GET NULL COUNTER
'0047   FE7F       0062             CP       127      ;CHECK IT FOR MAX
'0049   38D9       0063             JR       C,TI1-$ ;IF NOT TOO BIG, JUST IGNORE
'004B   3E04       0064 TI3A        LD       A,4      ;ELSE FORCE EOT
'004D   180C       0065             JR       TI4A-$   ;AND GET OUT
                   0066 ;
'004F   FD362000   0067 TI4         LD       (IY+HSCR+2),0    ;REINIT NULL COUNTER
'0053   FE7F       0068             CP       7FH      ;IGNORE RUBOUT
'0055   28CD       0069             JR       Z,TI1-$
'0057   FE13       0070             CP       DC3      ;CHECK FOR END OF RECORD
'0059   2809       0071             JR       Z,TI5-$ ;YES, SKIP
'005B   77         0072 TI4A        LD       (HL),A   ;ELSE STUFF THE BUFFER
'005C   FD341E     0073             INC      (IY+HSCR)        ;INCREMENT COUNTER
'005F   23         0074             INC      HL       ;INCREMENT BUFFER POINTER
'0060   FE04       0075             CP       4        ;CHECK FOR END OF FILE
'0062   20C0       0076             JR       NZ,TI1-$         ;NO, LOOP FOR MORE
                   0077 ;
'0064   3E13       0078 TI5         LD       A,DC3    ;TURN OFF TRANSPORT
'0066   CD0D01'    0079             CALL     S700P
'0069   FD361F00   0080             LD       (IY+HSCR+1),0    ;ZERO BUFFER POINTER
                   0081 ;
                   0082 ; DEBLOCK THE BUFFER
                   0083 ;
'006D   FD4E1F     0084 TIB         LD       C,(IY+HSCR+1)    ;GET BUFFER POINTER
'0070   0600       0085             LD       B,0
'0072   218000'    0086             LD       HL,TIBUF         ;HL -> BUFFER
'0075   09         0087             ADD      HL,BC    ;GET BUFFER ADDRESS
'0076   7E         0088             LD       A,(HL)   ;GET RETURNED CHARACTER
'0077   FD341F     0089             INC      (IY+HSCR+1)      ;INCREMENT BUFFER POINTE
'007A   FD351E     0090             DEC      (IY+HSCR)        ;DECREMENT COUNTER
'007D   C1         0091             POP      BC
'007E   E1         0092             POP      HL       ;RESTORE REGS
'007F   C9         0093             RET               ;RETURN TO CALLER
                   0094 ;
'>0080             0095 TIBUF       DEFS     128
                   0096 ;
'0100   3E13       0097 TICLOS      LD       A,DC3    ;ASSURE TRANSPORT IS OFF
'0102   CD0D01'    0098             CALL     S700P
'0105   FD361E00   0099             LD       (IY+HSCR),0      ;ZERO BUFFER COUNTER
'0109   CDFFFF     0100             CALL     MINEN    ;REENABLE MINIMAL LISTENER
'010C   C9         0101             RET
                   0102 ;
'010D   F5         0103 S700P       PUSH     AF       ;OUTPUT CHARACTER
'010E   DBDD       0104 S700R       IN       A,(0DDH)         ;CHECK UART STATUS
'0110   CB7F       0105             BIT      7,A
'0112   28FA       0106             JR       Z,S700R-$        ;IF NOT READY, LOOP
'0114   F1         0107             POP      AF       ;GET BYTE
'0115   D3DC       0108             OUT      (0DCH),A         ;OUTPUT IT
'0117   C9         0109             RET
                   0110 ;


ERRORS=0000
```

```
 ADDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DKO:TK     .SRC

                   0002          NAME    TK
                   0003 ;****************************************
                   0004 ;*                                      *
                   0005 ;*       KEYBOARD INPUT DRIVER AND      *
                   0006 ;*       MINIMAL LISTNER SERVICE ROUTINE.*
                   0007 ;*                                      *
                   0008 ;*       ID: TK                         *
                   0009 ;*                                      *
                   0010 ;*       PROGRAMMER: JOHN BATES         *
                   0011 ;*                   M. FREEMAN         *
                   0012 ;*       DATE: 6/1/78                   *
                   0013 ;****************************************
                   0014 ;        INTERNAL GLOBAL VARIABLES
                   0015 ;
                   0016          GLOBAL  TK
                   0017          GLOBAL  MINLIS
                   0018 ;
                   0019 ;        EXTERNAL GLOBAL VARIABLES
                   0020 ;
                   0021          GLOBAL  ENTRY   ;DDT-80 BREAK PT ENTRY
                   0022          GLOBAL  REBOOT  ;SYSTEM REBOOT ADDRESS
                   0023 ;
                   0024 ;        SYSTEM VARIABLES
                   0025 ;
 >00D9             0026 CTC1     EQU     0D9H
 >0015             0027 CFLGS    EQU     21
 >0002             0028 IRET     EQU     2
 >FF25             0029 TKST     EQU     0FF25H
 >FF24             0030 MINFLG   EQU     0FF24H
 >FF06             0031 COUNT    EQU     0FF06H
 >FF13             0032 LONG     EQU     0FF13H
 >00DD             0033 UCTL     EQU     0DDH    ;UART CONTROL PORT
 >00DC             0034 UDATA    EQU     0DCH
 >0003             0035 ETX      EQU     03
 >0018             0036 CAN      EQU     18H
                   0037 ;********************************
                   0038 ;*       TK INPUT DRIVER        *
                   0039 ;********************************
'>0000             0040 TK       EQU     $
'0000   03         0041          DEFB    3        ;MAX REQUEST
'0001   04         0042          DEFB    TKOPEN-$ ;OPENR
'0002   00         0043          DEFB    0        ;OPENW
'0003   09         0044          DEFB    TKCLOS-$ ;CLOSE
'0004   09         0045          DEFB    TKREAD-$ ;READ
                   0046 ;
'>0005             0047 TKOPEN   EQU     $
'0005   3E03       0048          LD      A,3              ; TURN ON CTS
'0007   D3DE       0049 TK01     OUT     (0DEH),A
'0009   010100     0050          LD      BC,1     ;PHYS REC SIZE
'000C   C9         0051 TKCLOS   RET              ;RETURN TO CALLER
                   0052 ;
                   0053 ;
'>000D             0054 TKREAD   EQU     $
'000D   3A25FF     0055 TTI      LD      A,(TKST)         ; FROM ESCAPE TEST
'0010   B7         0056          OR      A                ; IF NZ
'0011   2010       0057          JR      NZ,TTID1A-$
'0013   DBDD       0058 TTID0    IN      A,(0DDH)         ;CHECK UART STATUS
'0015   CB77       0059          BIT     6,A
```

```
'0017   2008        0060             JR      NZ,TTID1-$        ;READY, SKIP
'0019   FDCB1556    0061             BIT     IRET,(IY+CFLGS) ;IMMED RETURN?
'001D   28EE        0062             JR      Z,TTI-$           ;NO, LOOP
'001F   BF          0063             CP      A
'0020   C9          0064             RET              ; YES, EXIT
                    0065 ;
'>0021              0066 TTID1       EQU     $
'0021   DBDC        0067             IN      A,(0DCH)          ;GET DATA
'0023   FDCB1596    0068 TTID1A      RES     IRET,(IY+CFLGS) ;CLEAR IMMED RET BIT
'0027   CBBF        0069             RES     7,A               ;CLEAR PARITY
'0029   F5          0070             PUSH    AF
'002A   AF          0071             XOR     A
'002B   3225FF      0072             LD      (TKST),A          ; CLEAR HOLD REG.
'002E   3A24FF      0073             LD      A,(MINFLG)        ;MINIMAL LISTNER ENABLE
'0031   B7          0074             OR      A
'0032   2002        0075             JR      NZ,TT1D1B-$       ;IF YES, TEST FOR TRAPS
'0034   F1          0076             POP     AF
'0035   C9          0077             RET
'0036   F1          0078 TT1D1B      POP     AF
'0037   FE18        0079             CP      CAN
'0039   280E        0080             JR      Z,TTICAN-$
'003B   FE03        0081             CP      ETX
'003D   C0          0082             RET     NZ                ;NORMAL DATA
'003E   3E01        0083             LD      A,1               ;EXIT TO DDT
'0040   3213FF      0084             LD      (LONG),A
'0043   3206FF      0085             LD      (COUNT),A
'0046   C3FFFF      0086             JP      ENTRY             ;JUMP TO DDT BREAK PT
'0049   3E01        0087 TTICAN      LD      A,1
'004B   D3D9        0088             OUT     (0D9H),A          ;KILL MIN. LIST.
'004D   C3FFFF      0089             JP      REBOOT
                    0090 ;*******************************************
                    0091 ;*                                        *
                    0092 ;*          MINIMAL LISTNER INTERRUPT     *
                    0093 ;*          SERVICE ROUTINE               *
                    0094 ;*                                        *
                    0095 ;*****************************************
'0050   F5          0096 MINLIS      PUSH    AF                ;SAVE CHARACTER
'0051   DBDD        0097             IN  A,(UCTL)              ;DATA READY ?
'0053   CB77        0098             BIT     6,A
'0055   281F        0099             JR      Z,MLIS1-$
'0057   DBDC        0100             IN  A,(UDATA)             ;GET A CHAR
'0059   E67F        0101             AND     7FH
'005B   FE18        0102             CP      CAN               ;CNTL X ?
'005D   281B        0103             JR      Z,MLIS3-$
'005F   FE03        0104             CP      ETX               ;CNTL C
'0061   2010        0105             JR  NZ,MLIS2-$            ;EXIT
'0063   3E01        0106             LD      A,1
'0065   3206FF      0107             LD  (COUNT),A
'0068   3213FF      0108             LD  (LONG),A
'006B   F1          0109             POP     AF                ;GOTO DDT
'006C   E5          0110             PUSH    HL
'006D   214700'     0111             LD      HL,ENTRY;CTL C TRAP TO DDT
'0070   E3          0112 MLIS4       EX      (SP),HL
'0071   1804        0113             JR      MLIS0-$
'0073   3225FF      0114 MLIS2       LD      (TKST),A          ;SAVE FOR BACKGROUND
'0076   F1          0115 MLIS1       POP     AF                ;SAVE AF
'0077   FB          0116 MLIS0       EI
'0078   ED4D        0117             RETI                      ;EXIT
```

```
\DDR  OBJECT    ST # SOURCE STATEMENT         DATASET = DK0:TK     .SRC

)07A  3E01      0118 MLIS3    LD      A,1
)07C  D3D9      0119          OUT     (CTC1),A       ;TURN OFF MINIMAL LISTNER
)07E  214E00'   0120          LD      HL,REBOOT              ;CTL X TRAP TO BOO]
)081  18ED      0121          JR      MLIS4-$
                0122 ;
                0123          END

RRORS=0000
```

```
                   0002        NAME    TO
                   0003 ;
                   0004 ; SILENT 700 TAPE OUTPUT HANDLER
                   0005 ; COMPATIBLE WITH PREVIOUS SYSTEMS
                   0006 ; FOR FLP-80DOS V2.0
                   0007 ;
                   0008        GLOBAL  TO
                   0009 ;
>001E              0010 HSCR   EQU     30
>0011              0011 DC1    EQU     11H
>0012              0012 DC2    EQU     12H
>0013              0013 DC3    EQU     13H
>0014              0014 DC4    EQU     14H
                   0015 ;
                   0016 ;
>0000              0017 TO     EQU     $
0000   04          0018        DEFB    4
0001   00          0019        DEFB    0
0002   04          0020        DEFB    TOOPEN-$
0003   6D          0021        DEFB    TOCLOS-$
'0004  00          0022        DEFB    0
'0005  09          0023        DEFB    TOWRIT-$
                   0024 ;
                   0025 ;
'0006  FD361E00    0026 TOOPEN LD      (IY+HSCR),0     ;ZERO POINTER
'000A  010100      0027        LD      BC,1    ;PHYS RECORD SIZE
'000D  C9          0028        RET             ;RETURN TO CALLER
                   0029 ;
                   0030 ;
'000E  C5          0031 TOWRIT PUSH    BC
'000F  E5          0032        PUSH    HL
'0010  FD4E1E      0033        LD      C,(IY+HSCR)     ;GET BUFFER COUNT
'0013  0600        0034        LD      B,0
'0015  217A00'     0035        LD      HL,TOBUF        ;HL -> BLOCKING BUFFER
'0018  09          0036        ADD     HL,BC   ;GET TO POINT IN BUFFER
'0019  77          0037        LD      (HL),A  ;PUT CHAR INTO BUFFER
'001A  FD341E      0038        INC     (IY+HSCR)       ;INCREMENT POINTER
'001D  FE0A        0039        CP      0AH     ;CHECK FOR LF
'001F  2804        0040        JR      Z,TOB-$ ;YES, SKIP OUT
'0021  FE04        0041        CP      4       ;CHECK FOR END OF FILE
'0023  2048        0042        JR      NZ,TO5-$
                   0043 ;
                   0044 ; WRITE OUT BUFFER TO DEVICE
                   0045 ;
'0025  3E12        0046 TOB    LD      A,DC2   ;START RECORD OPERATION
'0027  CDFA00'     0047        CALL    S700P
'002A  217A00'     0048        LD      HL,TOBUF        ;HL -> BUFFER
                   0049 ;
'002D  7E          0050 TO2    LD      A,(HL)  ;GET CHARACTER FROM BUFFER
'002E  23          0051        INC     HL
'002F  FE7F        0052        CP      7FH     ;IGNORE RUBOUT
'0031  28FA        0053        JR      Z,TO2-$
'0033  FE11        0054        CP      DC1     ;IGNORE DC1 - DC4
'0035  3804        0055        JR      C,TO3-$
'0037  FE15        0056        CP      DC4+1
'0039  38F2        0057        JR      C,TO2-$
                   0058 ;
'003B  CDFA00'     0059 TO3    CALL    S700P   ;OUTPUT THE CHARACTER
```

```
'003E   FE04       0060         CP      4        ;CHECK FOR END OF FILE
'0040   200F       0061         JR      NZ,TO3A-$        ;NO, SKIP
                   0062 ; OUTPUT 86 NULLS TO FLUSH BUFFER TO
                   0063 ; TERMINATE CONTINUOUS MODE
'0042   0656       0064         LD      B,86
'0044   AF         0065 TO3L    XOR     A
'0045   CDFA00'    0066         CALL    S700P
'0048   10FA       0067         DJNZ    TO3L-$
                   0068 ; OUTPUT A CARRIAGE RETURN AFTER THE EOT
'004A   3E0D       0069         LD      A,0DH    ;FOR LINE MODE TERMINATION
'004C   CDFA00'    0070         CALL    S700P
'004F   1804       0071         JR      TO4-$    ;AND SKIP OUT
                   0072 ;
'0051   FE0A       0073 TO3A    CP      0AH      ;CHECK FOR LF
'0053   20D8       0074         JR      NZ,TO2-$         ;IF NOT, LOOP FOR MORE
                   0075 ;
'0055   3E13       0076 TO4     LD      A,DC3    ;OUTPUT CONTROL CHARACTERS
'0057   CDFA00'    0077         CALL    S700P    ;AT END OF RECORD
'005A   3E7F       0078         LD      A,7FH
'005C   CDFA00'    0079         CALL    S700P
'005F   3E14       0080         LD      A,DC4
'0061   CDFA00'    0081         CALL    S700P
'0064   3E7F       0082         LD      A,7FH
'0066   CDFA00'    0083         CALL    S700P
'0069   FD361E00   0084         LD      (IY+HSCR),0      ;REINIT BUFFER POINTER
'006D   E1         0085 TO5     POP     HL
'006E   C1         0086         POP     BC
'006F   C9         0087         RET              ;RETURN TO CALLER
                   0088 ;
                   0089 ;
'0070   3E14       0090 TOCLOS  LD      A,DC4    ;ASSURE TAPE IS OFF
'0072   CDFA00'    0091         CALL    S700P
'0075   FD361E00   0092         LD      (IY+HSCR),0      ;REINIT POINTER
'0079   C9         0093         RET
                   0094 ;
'>007A             0095 TOBUF   DEFS    128
                   0096 ;
'00FA   F5         0097 S700P   PUSH    AF       ;SAVE BYTE
'00FB   DBDD       0098 S700R   IN      A,(0DDH)         ;CHECK UART STATUS
'00FD   CB7F       0099         BIT     7,A
'00FF   28FA       0100         JR      Z,S700R-$
'0101   F1         0101         POP     AF       ;OUTPUT THE BYTE
'0102   D3DC       0102         OUT     (0DCH),A
'0104   C9         0103         RET
                   0104 ;


ERRORS=0000
```

```
TR      COPYRIGHT 1978 MOSTEK CORP       MOSTEK FLP-80 ASSEMBLER V2.0 PAGE 0001
 ADDR   OBJECT     ST # SOURCE STATEMENT         DATASET = DK0:TR     .SRC

                   0002         NAME    TR
                   0003 ;*********************************************************
                   0004 ;*      TITLE: DRIVER FOR TELETYPE TAPE READER   *
                   0005 ;*                                               *
                   0006 ;*      ID:  PR    VERSION 2.0                   *
                   0007 ;*                                               *
                   0008 ;*      PROGRAMMER: JOHN BATES                   *
                   0009 ;*                                               *
                   0010 ;*      DATE: 6/20/78                            *
                   0011 ;*********************************************************
                   0012 ;
                   0013 ;        SYSTEM EQUATES
                   0014 ;
 >0011             0015 DC1     EQU     11H
 >0012             0016 DC2     EQU     12H
 >0013             0017 DC3     EQU     13H
 >0014             0018 DC4     EQU     14H
 >0017             0019 ERRC    EQU     23        ;ERROR CODE OFFSET
 >0015             0020 CFLGS   EQU     21
 >0007             0021 TIMOUT  EQU     7         ;TIME OUT ERROR CODE
 >1A40             0022 MS250   EQU     6720
 >0002             0023 IRET    EQU     2
                   0024         GLOBAL  MINDIS
                   0025         GLOBAL  MINEN
                   0026         GLOBAL  TR
                   0027 ;
                   0028 ;
'>0000             0029 TR      EQU     $
'0000   03         0030         DEFB    3         ;MAX REQUEST
'0001   04         0031         DEFB    TROPEN-$ ;OPENR
'0002   00         0032         DEFB    0         ;OPENW
'0003   09         0033         DEFB    TRCLOS-$ ;CLOSE
'0004   0C         0034         DEFB    TRREAD-$ ;READ
                   0035 ;
                   0036 ;
'>0005             0037 TROPEN  EQU     $
'0005   CDFFFF     0038         CALL    MINDIS            ;DISABLE MINIMAL LISTNER
'0008   010100     0039         LD      BC,1      ;PHYSICAL RECORD SIZE=1
'000B   C9         0040         RET
                   0041 ;
'000C   CDFFFF     0042 TRCLOS  CALL    MINEN             ;ENABLE MINIMAL LISTNER
'000F   C9         0043         RET
                   0044 ;
                   0045 ;
                   0046 ;
'0010   C5         0047 TRREAD  PUSH    BC        ;SAVE BC-REG
'0011   3E07       0048         LD      A,7       ;TURN ON READER
'0013   D3DE       0049         OUT     (0DEH),A
                   0050 ;
'0015   01401A     0051         LD      BC,MS250 ;TIME OUT
'0018   DBDE       0052 TRD1    IN      A,(0DEH)          ; TEST FOR START OF CHAR
'001A   CB7F       0053         BIT     7,A
'001C   200B       0054         JR      NZ,TRD2-$         ; GOT IT
'001E   0B         0055         DEC     BC
'001F   78         0056         LD      A,B
'0020   B1         0057         OR      C
'0021   20F5       0058         JR      NZ,TRD1-$
'0023   FD361707   0059         LD      (IY+ERRC),TIMOUT ;TIMEOUT ERROR
```

```
 ADDR   OBJECT     ST # SOURCE STATEMENT         DATASET = DKO:TR    .SRC

'0027   C1         0060            POP     BC       ; ERROR OUT
'0028   C9         0061            RET
                   0062 ;
'0029   3E03       0063 TRD2       LD      A,3               ;TURN OFF READER
'002B   D3DE       0064            OUT     (ODEH),A
'002D   C1         0065            POP     BC
'002E   180B       0066            JR      TKREAD-$          ;GET CHAR
                   0067 ;
'0030   F5         0068 TTWRIT     PUSH    AF                ;SAVE CHAR
'0031   DBDD       0069 TTODO      IN      A,(ODDH)          ;CHECK UART STATUS
'0033   CB7F       0070            BIT     7,A
'0035   28FA       0071            JR      Z,TTODO-$         ;IF NOT READY, LOOP
'0037   F1         0072 TTOD1      POP     AF                ;RESTORE CHARACTER
'0038   D3DC       0073            OUT     (ODCH),A          ;OUTPUT IT
'003A   C9         0074            RET
                   0075 ;
'003B   DBDD       0076 TKREAD     IN      A,(ODDH)          ;CHECK UART STATUS
'003D   CB77       0077            BIT     6,A
'003F   2008       0078            JR      NZ,TTID1-$        ;READ, SKIP
'0041   FDCB1556   0079            BIT     IRET,(IY+CFLGS) ;IMMED RETURN?
'0045   28F4       0080            JR      Z,TKREAD-$        ;NO, LOOP
'0047   BF         0081            CP      A
'0048   C9         0082            RET                       ;YRES, EXIT
                   0083 ;
'0049   DBDC       0084 TTID1      IN      A,(ODCH)          ;GET DATA
'004B   FDCB1596   0085 TTID1A     RES     IRET,(IY+CFLGS) ;CLEAR IMMED RET BIT
'004F   CBBF       0086            RES     7,A               ;CLEAR PARITY
'0051   C9         0087            RET
                   0088 ;
                   0089            END

ERRORS=0000
```

```
TT      COPYRIGHT 1977 MOSTEK CORP        MOSTEK FLP-80 ASSEMBLER V2.0 PAGE 0001
 ADDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:TT     .SRC

                   0002          NAME    TT
                   0003 ;***********************************************
                   0004 ;*      TERMINAL OUTPUT DRIVER                 *
                   0005 ;*      (CRT,S700 OR TELETYPE)                 *
                   0006 ;*                                             *
                   0007 ;*      ID: TT  VERSION 2.0                    *
                   0008 ;*                                             *
                   0009 ;*      PROGRAMMER: JOHN BATES                 *
                   0010 ;*                                             *
                   0011 ;*      DATE:   6/16/78                        *
                   0012 ;***********************************************
                   0013 ;
                   0014 ;
                   0015          GLOBAL  TT
'>0000             0016 TT       EQU     $
                   0017 ;
                   0018 ; TELETYPE, S700  OR CRT DRIVER
                   0019 ;
'0000   04         0020          DEFB    4        ;MAX REQUEST
'0001   00         0021          DEFB    0        ;OPENR
'0002   05         0022          DEFB    TTOPEN-$ ;OPENW
'0003   07         0023          DEFB    TTCLOS-$ ;CLOSE
'0004   00         0024          DEFB    0        ;READ
'0005   06         0025          DEFB    WRITE-$ ;WRITE
                   0026 ;
 >FFE0             0027 BRATE    EQU     0FFE0H   ;BAUD RATE VARIABE
 >0050             0028 LWIDTH   EQU     80       ;TERMINAL LINE WIDTH
'0006   00         0029 HCTR     DEFB    0        ;HORIZONTAL COLUMN COUNTER
                   0030 ;
                   0031 ;
'0007   010100     0032 TTOPEN   LD      BC,1     ;PHYSICAL RECORD SIZE = 1
'000A   C9         0033 TTCLOS   RET
                   0034 ;
                   0035 ;
'000B   FE09       0036 WRITE    CP      9                ;CHAR = TAB ?
'000D   2015       0037          JR      NZ,WRITE1-$
'000F   C5         0038          PUSH    BC
'0010   3A0600'    0039          LD      A,(HCTR)         ;IF TAB THEN FETCH HCTR
'0013   47         0040          LD      B,A
'0014   E6F8       0041          AND     0F8H
'0016   C608       0042          ADD     A,8              ;FIND NEXT TAB LOC
'0018   0E20       0043          LD      C,' '            ;SPACE OUT
'001A   90         0044          SUB     B                ;NUMBER OF SPACES
'001B   47         0045          LD      B,A
'001C   79         0046 TT6      LD      A,C
'001D   CD2400'    0047          CALL    WRITE1           ;OUTPUT SPACE
'0020   10FA       0048          DJNZ    TT6-$
'0022   C1         0049          POP     BC
'0023   C9         0050          RET
                   0051 ;
'0024   F5         0052 WRITE1   PUSH    AF               ;SAVE CHARACTER
'0025   FE08       0053          CP      8        ;DECREMENT CHARACTER COUNTER FOR
'0027   2009       0054          JR      NZ,TT6A-$        ;BACKSPACE = 08H
'0029   3A0600'    0055          LD      A,(HCTR)
'002C   3D         0056          DEC     A
'002D   320600'    0057          LD      (HCTR),A
'0030   181D       0058          JR      TT20-$
                   0059 ;
```

```
 ADDR   OBJECT     ST # SOURCE STATEMENT            DATASET = DK0:TT     .SRC

'0032   FE0D       0060 TT6A     CP       0DH                 ;DO NOT INCREMENT HCTR
'0034   3819       0061          JR       C,TT20-$            ;FOR LF=0A OR FF=0C.
'0036   2811       0062          JR       Z,TT14-$            ;IF CHAR=CR CLEAR HCTR
'0038   3A0600'    0063          LD       A,(HCTR)
'003B   FE50       0064          CP       LWIDTH              ;END OF LINE REACHED ?
'003D   200C       0065          JR       NZ,TT16-$           ;IF NOT INCRFEMENT HCTR
'003F   3E0D       0066          LD       A,0DH               ;IF END OF LNE IS
'0041   CD2400'    0067          CALL     WRITE1              ;REACHED THEN AUTOMATICA
'0044   3E0A       0068          LD       A,0AH               ;OUTPUT A CR AND LF.
'0046   CD2400'    0069          CALL     WRITE1
'0049   3EFF       0070 TT14     LD       A,0FFH              ;RESET HCTR TO ZERO
'004B   3C         0071 TT16     INC      A
'004C   320600'    0072          LD       (HCTR),A
'004F   3AE0FF     0073 TT20     LD       A,(BRATE)
'0052   FE10       0074          CP       010H                ;600 BAUD ?
'0054   2804       0075          JR       Z,CRT-$
'0056   FE08       0076          CP       08H                 ;110, 300, 1200 BAUD ?
'0058   300F       0077          JR       NC,TTFF-$
                   0078 ;
                   0079 ;        DRIVER FOR CRT (BAUD RATES 600 AND 2400 AND GREA
                   0080 ;
'005A   F1         0081 CRT      POP      AF                  ;RESTORE CHAR
                   0082 ;
'005B   FE04       0083 TTWRIT   CP       04                  ;IGNORE 04
'005D   C8         0084          RET      Z
'005E   F5         0085          PUSH     AF                  ;SAVE CHAR
'005F   DBDD       0086 TT100    IN       A,(0DDH)            ;CHECK UART STATUS
'0061   CB7F       0087          BIT      7,A
'0063   28FA       0088          JR       Z,TT100-$           ;IF NOT READY, LOOP
'0065   F1         0089          POP      AF                  ;RESTORE CHAR
'0066   D3DC       0090          OUT      (0DCH),A            ;OUTPUT IT
'0068   C9         0091          RET
                   0092 ;
                   0093 ;
                   0094 ;        DRIVER FOR S700 (300 AND 1200 BAUD) AND TELETYPE
                   0095 ;
'0069   F1         0096 TTFF     POP      AF                  ;RESTORE CHARACTER
'006A   FE0C       0097          CP       0CH                 ;FORM FEED ?
'006C   200B       0098          JR       NZ,STWRIT-$
'006E   C5         0099          PUSH     BC
'006F   0605       0100          LD       B,5                 ;IF FORM FEED THEN OUTPU
'0071   3E0A       0101          LD       A,0AH               ;6 LINE FEEDS
'0073   CD7900'    0102 ST0      CALL     STWRIT
'0076   10FB       0103          DJNZ     ST0-$
'0078   C1         0104          POP      BC                  ;RESTORE BC
                   0105 ;
'0079   F5         0106 STWRIT   PUSH     AF                  ;SAVE CHAR
'007A   CD5B00'    0107          CALL     TTWRIT              ;OUTPUT CHARACTER
'007D   3AE0FF     0108          LD       A,(BRATE)
'0080   FE57       0109          CP       57H                 ;110 BAUD ?
'0082   280C       0110          JR       Z,TTRET-$
'0084   FE08       0111          CP       08H                 ;1200 BAUD ?
'0086   CC9200'    0112          CALL     Z,DEL32             ;DELAY 32 MSEC IF 1200 B.
'0089   F1         0113          POP      AF                  ;RESTORE CHAR
'008A   FE0D       0114          CP       0DH
'008C   CC9700'    0115          CALL     Z,DEL210            ;DELAY 210 MSEC IF CHAR=(
'008F   C9         0116          RET
'0090   F1         0117 TTRET    POP      AF                  ;RESTORE CHAR
```

```
'      COPYRIGHT 1977 MOSTEK CORP        MOSTEK FLP-80 ASSEMBLER V2.0 PAGE 0003
.DDR   OBJECT     ST # SOURCE STATEMENT          DATASET = DKO:TT     .SRC

)091   C9         0118          RET
                  0119 ;
)092   C5         0120 DEL32    PUSH    BC                 ;DELAY 32 MSEC
)093   0E20       0121          LD      C,32
)095   1803       0122          JR      DELAY-$
)097   C5         0123 DEL210   PUSH    BC                 ;DELAY 210 MSEC
)098   0ED2       0124          LD      C,210
)09A   06BF       0125 DELAY    LD      B,191
)09C   10FE       0126 DEL1     DJNZ    DEL1-$             ;1 MSEC DELAY
)09E   0D         0127          DEC     C
)09F   20F9       0128          JR      NZ,DELAY-$
)0A1   C1         0129          POP     BC
)0A2   C9         0130          RET
                  0131 ;
                  0132          END

RRORS=0000
```

SECTION 13

SYSTEM ROUTINES

13-1. INTRODUCTION

13-2. Many subroutines in FLP-80DOS are accessable to the user. The following pages describe these routines, which fall into two major categories: PROM resident routines and RAM resident routines (within the RAM portion of the operating system).

13-3. PROM RESIDENT ROUTINES

13-4. Since the routines located in PROM reside at fixed addresses, they may be called directly. The usual method of calling one of these routines is to declare the name of that routine as a GLOBAL symbol. The routine may then be called just as if it resided within the calling program. To actually resolve the calling address of the routine, the file SYSLNK.OBJ must be included when linking the program.

13-5. Example. Suppose that the System Error Handler (EH) is to be called with an error number held in variable "ERRCOD."

```
        GLOBAL      EH              ;SYSTEM ERROR HANDLER
        .
        .
        .
ERROR   LD          A,(ERRCOD)      ;GET ERROR CODE
        CALL        EH              ;
        .
        .
        .
```

When the program is linked, SYSLNK.OBJ would be included.
$<u>LINK PROG,SYSLNK TO PROG(CR)</u>

13-6. RAM RESIDENT ROUTINES

13-7. User callable system subroutines that reside within the RAM-based portion of the operating sytem may not be accessed in the same manner as the PROM resident routines. With the SYSGEN Feature in FLP-80DOS, the user is given the option to position the operating system at any location in RAM. This positioning causes the addresses of the callable routines within the operating system to change depending on where the current operating system was positioned during the SYSGEN procedure (See Section 15).

13-8. This problem is solved in the following manner. A routine called JTASK is located in scratchpad RAM and has a fixed address. JTASK contains a mechanism for locating all RAM resident callable routines. Each of these routines has been assigned a number which is placed into register A just prior to calling JTASK. JTASK then jumps to the appropriate routine (all other calling parameters are as described for that routine later in this secttion). These codes are listed below. Individual routines not reserved for system use are described in greater detail later in this section.

Code	Routine
0	FDH (Floppy Disk Handler). Described in Section 10.
1	MRENT (Monitor Reentry Point).
2	IOCS RDC (Read Character), reserved for system use.
3	IOCS WRC (Write Character), reserved for system use.

4	PVECT (Print Vector Contents).
5	GETLIN (Get Line Into Monitor Command Buffer). Reserved for system use.
6	CSIPAR (Parse Dataset Specifications Into Vector).
7	CSISYN (Check Syntax of Dataset Specifications).
8	ASTCHK (Check For Asterisk In I/O Vector).
9	GETHL (Get Line From Console Into Buffer).
10	GETVEC (Get Address of Default LUN Buffer).
11	SEARCH (Get Directory entry for a given file).

13-9. The following is an example of the calling sequence used to access these RAM resident routines.

```
       .
       .
       .
       GLOBAL  JTASK    ;SYSTEM LINKAGE ROUTINE
GETVEC EQU     10       ;GETVEC JTASK CODE
MRENT  EQU     1        ;MRENT JTASK CODE
       .
       .
       .
       LD      D,1      ;CONSOLE OUTPUT LUN
       LD      A,GETVEC ;GETVEC JTASK CODE
       CALL    JTASK    ;CALL GETVEC
       .
       .
       .
       LD      A,MRENT  ;MRENT JTASK CODE
       JP      JTASK    ;JP MRENT
                        ;END OF PROGRAM
                        ;SO DON'T CALL
       END              ;JTASK-JUST JUMP
```

13-10. ASBIN - CONVERT ASCII DIGIT TO BINARY - PROM RESIDENT

DESCRIPTION - Convert ASCII representation of a hex digit to binary. No error checking is done, so the binary "equivalent" of any ASCII character can be found using ASBIN.

ENTRY PARAMETERS - A - reg contains the ASCII character to be converted (8-bits).

Normal Conversion:

INPUT	OUTPUT
31	00000001B
32	00000010B
.	
.	
.	
39	00001001B
41	00001010B
42	00001011B
43	00001100B
44	00001101B
45	00001110B
46	00001111B

EXIT PARAMETERS - A - reg contains the corresponding binary value of the ASCII character.

CALLING SEQUENCE - CALL ASBIN

EXAMPLE - GLOBAL ASBIN

```
LD    A,'A'  ;CONVERT ASCII 'A' TO
CALL  ASBIN   ;BINARY
;A = 00001010B = A_H
```

13-11. ASTCHK - ASTERISK CHECK
- RAM RESIDENT
- JTASK CODE 8

DESCRIPTION - This routine checks for asterisk (*) in an IOCS vector. If an asterisk is found in the device code, filename, extension, or user identification code, then zero flag is set. This routine is called after a CSI routine.

ENTRY PARAMETERS - IY reg points to start of an IOCS vector to be checked.

EXIT PARAMETER -

Z flag = 1 if asterisk found in string.
Z flag = 0 if no asterisk found in string.

CALLING SEQUENCE - LD A,8
CALL JTASK

EXAMPLE -

```
        GLOBAL  JTASK
        LD      IY,VECTOR       ;IY = VECTOR ADDRESS
        LD      A,8             ;ASTCHK JTASK CODE
        CALL    JTASK
        JP      Z,ASTFND        ;IF ASTERISK, JUMP
; NO ASTERISKS FOUND - CONTINUE
```

13-12. CRLF - OUTPUT CARRIAGE RETURN AND LINE FEED - PROM RESIDENT

DESCRIPTION - Output a carriage return (ODH) and line feed (OAH).

ENTRY PARAMETERS - E - reg. designates LUN as in WRCHR (see Section 8).

EXIT PARAMETERS - A - reg is destroyed.
D - reg contains line feed (OAH).

CALLING SEQUENCE - CALL CRLF

EXAMPLE -

```
GLOBAL  CRLF
LD      E,1     ;CONSOLE OUT LUN
CALL    CRLF    ;OUTPUT CARRIAGE RETURN
                ;AND LINE FEED TO
                ;CONSOLE
```

13-13. CSI - COMMAND STRING INTERPRETER
- RAM RESIDENT
- JTASK CODES 6 (CSIPAR) AND 7 (CSISYN)

DESCRIPTION - The Command String Interpreter is a system routine which reads command strings containing dataset specifications. CSI is used extensively by FLP-80DOS system programs (MONITOR, PIP, ASM, etc.) but is also available for use in application programs. CSI assumes that the HL register points to a command string containing datasets which is terminated by a carriage return. A dataset (See paragraph 1-21) is defined as follows:

DEV:FILENAME.EXT[UIC]

The command string interpreter contains the following subroutines.

NAME	FUNCTION
CSISYN	Checks the syntax of a command string containing datasets.
CSIPAR	Parses a single dataset and places dataset specifications in I/O vector.

13-14. CSISYN - JTASK CODE 7

CALLING SEQUENCE - LD A,7
CALL JTASK

```
CALLING SEQUENCE - LD    A,7
                   CALL  JTASK
```

ENTRY PARAMETERS

1. HL points to the first character or a blank preceding the first character of the dataset portion of the command string. The end of the string must be terminated by a carriage return.

EXIT PARAMETERS

1. REGISTER A
   0 - Indicates Valid Dataset Specifications (no Syntax Errors). Zero flag is set.
   2 - Invalid Dataset Specifications (Syntax Error). Zero flag is cleared.
2. Other Registers Modified: None

13-15. CSIPAR - JTASK CODE 6

```
CALLING SEQUENCE - LD    A,6
                   CALL  JTASK
```

EXIT PARAMETERS

1. HL points to the first character or a blank preceding the first character of the dataset portion of the command string.
2. IY points to I/O vector.

13-14. On Exit From CSIPAR

1. REGISTER A
   - 0 - Indicates Dataset Found and Parsed. Zero flag is set.
   - 1 - Dataset Not Found. End of line (carriage return) was encountered. Zero flag is cleared.
   - 2 - Syntax Error (Note CSIPAR does partial but not complete syntax check. For complete check call CSISYN). Zero flag is cleared.
2. REGISTER C

   Register C contains the character that terminates the dataset.

DATASET TERMINATOR	C REGISTER ON EXIT
,	','
CARRIAGE RETURN	0DH
TO	'T'
>	'T'

NOTE: > is equivalent to TO.

3. HL REGISTER

   If a valid dataset is found (A=0) then HL points to the next character after the dataset.

4. I/O Vector

   If a dataset is found, then the device, filename, extension and user number are placed in the I/O vector (See para. 9-3). The following default conditions are assumed if the dataset element is not specified.

ELEMENT	DEFAULT NAME
Device	2 blanks
Unit No.	0
Filename	6 blanks
Extension	3 blanks
User Code	1

5. REGISTER D'

   1 - If user number was entered.

   0 - If user number was not entered.

6. Other Registers Modified: A'

EXAMPLE - Upon entry to a program from the Monitor, the DE-register points to the rest of the command buffer after the program name. For example, the command:

$MYPROG DK1:FILE1(CR)

loads and executes the file 'MYPROG.BIN'. Upon entry to MYPROG, the DE-register points to the blank after 'MYPROG' in the command line. To syntax check and parse the dataset specification into its I/O vector, the following sequence of code may be used.

```
        GLOBAL      JTASK
CSIPAR  EQU         6
CSISYN  EQU         7
```

```
MYPROG  PUSH    DE        ;MOVE POINTER
        POP     HL        ;TO HL
        LD      A,CSISYN  ;CHECK SYNTAX
        CALL    JTASK     ;OF DATASET
        JP      NZ,ERR    ;IF SYNTAX ERROR, SKIP
        LD      IY,VECT   ;GET VECTOR ADDRESS
        LD      A,CSIPAR  ;PARSE DATASET
        CALL    JTASK     ;INTO VECTOR
        JP      NZ,ERR    ;IF ERROR, SKIP
        .
        .
        .
```

13-16. RENTRY - DDT-80 RE-ENTRY
- PROM RESIDENT

DESCRIPTION - Entry address to DDT. This address should be jumped to, not called. DDT will print a carriage return, line feed, and a period (.) prompt. The user register map is not saved when jumping to RENTRY. DDT is then ready to accept a command.

13-17. ECHO - INPUT AND ECHO A CHARACTER - PROM RESIDENT

DESCRIPTION - Read and write a character through the same LUN pair. Input LUN is 0, 2, or 4. Output LUN is 1, 3, or 5. Valid LUN pairs are (0,1), (2,3), (4,5).

ENTRY PARAMETERS -

E - reg designates the LUN as in RDCHR and WRCHR. Immediate return is not valid when calling ECHO.

EXIT PARAMETERS -

A - reg is destroyed

D - reg contains the character read and printed

CALLING SEQUENCE - CALL ECHO

EXAMPLE -

```
GLOBAL    ECHO
LD        E,0      ;READ AND WRITE
                   ;CHARACTER TO
CALL      ECHO     ;CONSOLE
```

13-18. EH - SYSTEM ERROR HANDLER
- PROM RESIDENT

DESCRIPTION - Print error message in the following format:

***** ERROR nn (message) (dataset specification)

where nn is the error code in hexadecimal, the message is obtained from a lookup table within EH, and the dataset is the one defined by IY.

FLP-80DOS all I/O error messages (numbers $1\text{-}1F_H$) are cataloged in EH. If an error code not associated with a message is input, then the output is:

***** ERROR nn

Output is directed via the DDT console output handler (thus bypassing IOCS).

Error messages for FLP-80DOS are shown in Appendix E.

ENTRY PARAMETERS -

A - reg = error code (8 bits). If A = 1 through $1F_H$ then the standard message format will be output.

IY - reg = vector address containing a dataset specification of the dataset for which the error occurred.

EXIT PARAMETERS -

All registers remain unchanged.

CALLING SEQUENCE - CALL EH

EXAMPLE -

```
      GLOBAL    EH
      GLOBAL    JIOCS
      GLOBAL    JTASK

      LD        IY,VECTOR          ;IY = VECTOR ADDRESS
      LD        (IY+RQST),OPENR    ;OPEN READ REQUEST
      CALL      JIOCS              ;OPEN THE FILE
      LO        A,(IY+ERRC)        ;GET ERROR CODE
      AND       A                  ;CHECK FOR ERRORS
      JR        Z,CONT-$           ;IF NONE, SKIP
      CALL      EH                 ;ELSE PRINT ERROR
      LD        A,1                ;MRENT CODE
      JP        JTASK              ;RETURN TO MONITOR
CONT ----------
```

13-19. GETHL - GET LINE FROM THE CONSOLE DEVICE
- RAM RESIDENT
- JTASK CODE 9

DESCRIPTION - GETHL inputs a line of data from the console device into the buffer pointed to by HL. All line editing functions are active: tab, backspace, rubout, and line delete (CNTL-U). Return is made to caller upon carriage return.

ENTRY PARAMETERS - HL-reg pair points to input buffer. D - reg contains reprompt character for line delete function (see above). This character is displayed on the console whenever a line is deleted via CNTL-U.

EXIT PARAMETERS - Data is placed into buffer. All registers are saved.

CALLING SEQUENCE -

```
        LD      A,9
        CALL    JTASK
```

EXAMPLE -

```
        GLOBAL  JTASK
        LD      HL,INBUF     ;INPUT BUFFER POINTER
        LD      D,"$"        ;REPROMPT CHARACTER
        LD      A,9          ;GETHL CODE
        CALL    JTASK
        .
        .
        .
INBUF   DEFS    160          ;MAXIMUM  SIZE  =  160
                              BYTES
```

13-20. GETVEC - GET DEFAULT VECTOR ADDRESS
- RAM RESIDENT
- JTASK CODE 10

DESCRIPTION - This routine calculates the default vector address for LUN's 0-5.

ENTRY PARAMETERS -

D-reg contains default vector number (0 through 5).

EXIT PARAMETERS -

IY reg points to start of IOCS default vector address. Carry bit set if A - reg > 5 upon entry, otherwise carry is reset.

CALLING SEQUENCE -

```
        LD      A,10
        CALL    JTASK
```

EXAMPLE -

```
        GLOBAL  JTASK
        LD      D,0    ;GET VECTOR ADDRESS
        LD      A,10   ;FOR LUN 0
        CALL    JTASK
; IY points to default vector for LUN 0
```

13-21. MINDIS - DISABLE MINIMAL LISTENER - PROM RESIDENT

DESCRIPTION - This subroutine turns off the minimal listener function to disable Console Escape (control-X) and Debugger Escape (control-C).

ENTRY PARAMETERS - None

EXIT PARAMETERS - None

CALLING SEQUENCE - CALL MINDIS

13-22. MINEN - ENABLE MINIMAL LISTENER - PROM RESIDENT

DESCRIPTION - This subroutine turns on the Minimal Listener function to enable Console Escape (control-X) and Debugger Escape (control-C).

ENTRY PARAMETERS - None

EXIT PARAMETERS - None

CALLING SEQUENCE - CALL MINEN

13-23. MRENT - MONITOR RE-ENTRY
- RAM RESIDENT
- JTASK CODE 1

DESCRIPTION - This is the normal re-entry address to the Monitor. Program exits should return to the Monitor via a jump to this address if the system software has not been overlayed.

CALLING SEQUENCE -

```
LD      A,1
JP      JTASK
```

13-24. PACC - PRINT ASCII CONTENTS OF THE ACCUMULATOR - PROM RESIDENT

DESCRIPTION - Print the contents of the A - register in ASCII equivalent.

ENTRY PARAMETERS -

E - reg designates LUN as for WRCHR (see Section 8). Immediate return is not valid when calling PACC.

A - reg contains the binary equivalent of the 2 hexadecimal digits to be printed in ASCII.

EXIT PARAMETERS -

E - reg used as in WRCHR.

A - reg is destroyed.

CALLING SEQUENCE - CALL PACC

EXAMPLE -

```
        LD    A,25H       ;A=25
        LD    E,1         ;SELECT CONSOLE LUN
        CALL  PACC        ;PRINT THE
                          ;CHARACTERS
                          ;'25' ON CONSOLE
                          : DEVICE
```

13-25. PTXT - PRINT TEXT STRING - PROM RESIDENT

DESCRIPTION - Print a text string. The string terminates with ETX (03_H), which is not output.

ENTRY PARAMETERS -

E - reg designates LUN as in WRCHR (see Section 8). Immediate return is not valid when calling PTXT.

HL - reg pair contains the beginning address where the text string is stored in memory. The text string must terminate with ETX (03_H).

EXIT PARAMETERS -

A - reg is destroyed

D - reg contains ETX (03_H)

HL - reg pair contains address in memory where the ETX terminator is stored.

CALLING SEQUENCE - CALL PTXT

EXAMPLE -

```
        LD      HL,MSG      ;GET MESSAGE ADDRESS

        LD      E,1         ;SELECT CONSOLE LUN
        CALL    PTXT        ;PRINT MESSAGE
        .
        .
        .
MSG     DEFM       'THIS IS A MESSAGE'
        DEFB       3        ;ETX
```

13-26. PVECT - PRINT VECTOR DATASET - PROM RESIDENT

DESCRIPTION - This routine prints out a dataset specification from an IOCS vector on the device specified by the console output LUN (LUN1).

ENTRY PARAMETERS -
IY reg points to start of IOCS vector.

EXIT PARAMETERS - None.

CALLING SEQUENCE - CALL PVECT

EXAMPLE -
```
LD      IY,VECTOR       ;IY POINTS TO
CALL    PVECT           ;START OF VECTOR
```

13-27. REBOOT - SYSTEM REBOOT SEQUENCE - PROM RESIDENT

DESCRIPTION - Reboot System. This is the beginning of the initialization sequence <u>after</u> the terminal baud rate is determined. The system software is booted in RAM from OS.BIN[255] and the Monitor prompt ($) is issued to the console.

This location should be jumped to, not called. It is the entry point for Monitor Escape (CNTL-X).

CALLING SEQUENCE - JP REBOOT

13-28. SCAN - INTERACTIVE SCAN - PROM RESIDENT

DESCRIPTION - This routine is the interactive scan routine used in DDT. It can be called to return up to 3 parameters from the user terminal in the interactive mode described for DDT. The hexadecimal operands are converted from ASCII into 16-bit binary. Up to 3 operands may be entered, separated by commas or blanks. If more than three operands are entered, then the third operand is updated to the last one entered.

ENTRY PARAMETERS - None.

EXIT PARAMETERS -

OPFLG = $FF1A_H$ - number of a operands entered, 0,1,2, or 3.

OPR1 = $FF14_H$ - first operand (16 bits).

OPR2 = $FF16_H$ - second operand (16 bits).

OPR3 = $FF18_H$ - third operand (16 bits).

NXTCHR = FF1B - last character processed by the SCAN routine.

CALLING SEQUENCE - CALL SCAN

13-29. SEARCH - FIND DIRECTORY ENTRY OF A FILE
- RAM RESIDENT
- JTASK CODE 11

DESCRIPTION - This routine finds the directory entry for the file specified in the IOCS vector.

ENTRY PARAMETERS -

IY reg points to the file vector.

EXIT PARAMETERS -

DE reg has the directory address
C reg has the unit number
The Z flag is set if found
The NZ flag is set if not found.

CALLING SEQUENCE -

```
LD   A,11
CALL JTASK
```

EXAMPLE -

```
GLOBAL JTASK
LD   IY, VINP     ;POINT TO VECTOR
LD   A,11
CALL JTASK
```

13-30. SPACE - OUTPUT A SPACE
- PROM RESIDENT

DESCRIPTION - Output a blank (20_H).

ENTRY PARAMETERS -

E - reg designates LUN as in WRCHR.

EXIT PARAMETERS -

A - reg is destroyed.

B - reg contains blank (20_H).

CALLING SEQUENCE - CALL SPACE

EXAMPLE -

```
        LD      E,1       ;CONSOLE LUN
        CALL    SPACE     ;OUTPUT A SPACE
```

13-31. SRCHR, SRCHU - SEARCH MNEMONIC TABLES - PROM RESIDENT

DESCRIPTION - Search resident mnemonic table (SRCHR) or search user mnemonic table (SRCHU) for a match. The resident menmonic table contains the user registers and their save locations accessed by DDT. This table exists in PROM. The user mnemonic table contains the device handlers and their addresses. The user mnemonic table in part of the SYSGEN FILE (RAM resident).

ENTRY PARAMETERS -

HL - reg pair points to 2 character mnemonic to be searched for. The first character goes into L, the second goes into H.

EXIT PARAMETERS -

Zero flag reset if no match.
Zero flag set if match found and HL reg pair equals 16 bit address associated with the mnemonic.

CALLING SEQUENCE - CALL SRCHR
CALL SRCHU

EXAMPLE -

```
LD    H,'P'      ;GET ADDRESS OF
LD    L,'L'      ;LP = HANDLER
CALL  SRCHU      ;HL = ADDRESS OF
                 ;HANDLER ON EXIT
```

SECTION 14

BATCH MODE OPERATION

14-1. INTRODUCTION

14-2. FLP-80DOS directly supports batch mode operation in configurations with more than 16K of RAM. In batch mode operation, all commands are entered via a batch input device. The batch input device is specified by the dataset assigned to logical unit 0 and may be any input device such as a card reader, paper tape reader, or a disk file. All responses by the system to the batch input device may be directed to any other output dataset. In batch mode operation, all input from an input dataset corresponds exactly to what the user would normally type in via the terminal keyboard. There is no difference between commands entered via the console or in batch mode. Batch mode operation can be applied to all programs in FLP-80DOS, except DDT, the debugger. Insert mode in the Editor also cannot be activated in batch mode from a disk file. User programs which interface to the console device via IOCS may also be used directly in batch mode operation.

14-3. PRINCIPLES OF OPERATION

14-4. The key to batch mode operation in FLP-80DOS is the system's ability to reassign the console channels (Logical Unit Numbers 0 and 1). LUN 0 is used for all console input. LUN 1 is used for all console output. These LUN's may be reassigned to any other dataset via the Monitor ASSIGN command. When the Monitor makes an assignment of a dataset to LUN 0 or 1, the Monitor automatically closes the currently assigned dataset. Then it opens the new dataset. This operation is different from the other LUN assignments in which the Monitor does not automatically open the new dataset.

14-5. When an assignment is made to LUN 0 (Console In), the assigned dataset referred to as the batch input device is opened and input is automatically started by the Monitor. Commands input from the dataset are called the Batch Command Sequence (BCS), and they control the system operation. Reassignment back to the original user terminal is then the responsibility of the batch command sequence from the dataset.

14-6. When an assignment is made to LUN 1 (Console Out), the new dataset is opened and all output which would normally appear on the user terminal is directed to the new dataset. Such an assignment, if it is to be done, should be done by the first statement of a batch command sequence (BCS).

14-7. BATCH COMMAND SEQUENCE SYNTAX

14-8. The syntax of a batch command sequence (BCS) is exactly like the user input from the terminal. In this manual, all user input is underlined. Each line of input in a BCS is terminated with a carriage return. A BCS can be built on a disk file by using the FLP-80DOS Text Editor. If a card reader is interfaced to the system, the BCS can be on cards.

14-9. If the console output is to be directed to a non-console dataset, the assignment should be the first record of the BCS:

```
ASSIGN 1,LP:
```

14-10. The last record of the BCS should be assignment of LUN's 0 and 1 back to the original console datasets:

```
ASSIGN 1,TT:
ASSIGN 0,TK:
```

14-11. During Batch Mode Operation, no initialization of the disk units is performed by the system. This means that diskettes cannot be switched during batch mode. This restriction is necessary because during initialization the disk handler's active file table is cleared. This action would clear the BCS disk file, and further BCS records could not be accessed.

14-12. EXAMPLE 1. Build a BCS on a disk file called "BATCH" which accesses PIP and prints out the directory and status of each disk unit on the line printer. The following commands are entered from the user terminal (interactive mode) to build the BATCH file:

```
$EDIT BATCH(CR)
 FLP-80DOS EDITOR V2.0
 -- > NEW FILE
 -- > INSERT MODE
 0001 < PIP(CR)
 0002 < D TO LP:(CR)
 0003 < S TO LP:(CR)
 0004 < D DK1: TO LP:(CR)
 0005 < S DK1: TO LP:(CR)
 0006 < Q(CR)
 0007 < ASSIGN O,TK:(CR)
 0008 < (CR)
 >Q(CR)
```

To execute the batch file, the following command should be entered:

```
$ASSIGN O, BATCH(CR)
```

The BATCH file will be executed, command by command. The total command sequence will be printed on the terminal. The directory and status listings will be directed to the line printer.

14-13. EXAMPLE 2. Assemble two files in batch mode, directing all printable output to the line printer. The BCS to be built up as a file (named 'BSC1') is:

```
ASSIGN 1, LP:
ASM FILE 1 TO LP:
S
   -this is the "option" input to the Assembler.
ASM FILE2 TO LP:
S
ASSIGN 1,TT:
ASSIGN 0,TK:
```

The BCS is executed by entering the following Monitor command:

$ASSIGN 0,BCS1(CR)

SECTION 15

SYSTEM GENERATION

15-1. INTRODUCTION

15-2. After reset or power up the system boot routine resident in PROM loads the operating system from the file OS.BIN [255] into memory and starts execution at its beginning address. The system generation or SYSGEN procedure can be used to link operating system object modules together to generate a modified OS.BIN [255] if desired. The following parameters are defined during SYSGEN.

1. Operating System starting address.
2. Number of disk drives (1-4)
3. I/O drivers linked into system (E.G., LP,CR and etc.)
4. Default I/O vectors for logical units 2-5

15-3. The standard system as shipped from the factory contains 32K of RAM (see Figure 15-1) and contains the I/O drivers TK:, TT: and CP:. The SYSGEN procedure which may be used to modify the operating system is performed as outlined below and is also illustrated in Figure 15-1. All system object files are on the MOSTEK supplied system disk.

15-4. SYSTEM GENERATION PROCEDURE (SYSGEN)

STEP 1. Place a Version 2.0 system diskette containing the operating system object files in disk unit DKO. Depress reset and the carriage return key to boot up the system . If a change in the number of disk drives to be supported needs to be made, follow the instructions in paragraph 15-15. If the user wishes to change the system device table for purposes of adding a mnemonic for a new I/O driver, he should follow the instructions starting at paragraph 15-10. If modifications to the default logical units are required see paragraph 15-13.

STEP 2. Use the LINKER to create a test operating system file. The Linker A option is used to specify the operating system beginning address .

EXAMPLE:

```
$LINK   MONITOR,IOCS,SYSGEN,CSI,TASK,TK,TT,LPC,DKUNIT,DKTAB,DK,
SYSLNK TO TEST.BIN(CR)
      OPTIONS? A U C(CR)
      ENTER STARTING LINK ADDRESS >5A00(CR)
```

NOTES

1). The user may arbitrarily choose the starting address. The LINKER generates a load map listing the beginning and ending addresses of each module (see Figure 15-1). Step 2 may be repeated a second time in order to position the operating system at the top of the user's RAM space, thereby maximizing the amount of RAM available for the user.

2). When entering the Linker command from the terminal the command line may exceed the maximum terminal line length (usually 80 characters). If this occurs, the terminal output driver will automatically issue a CR and LF to enable continuation of the command on the next line. Since a carriage return input from the keyboard is interpreted by the Linker to be the terminator of the command string, the user should not enter a carriage return until the entire Linker command has been entered. Maximum command line length is 160 characters.

3). The terminal I/O drivers TK and TT must always be linked into the system. Additional I/O drivers (E.,G., LPC) may also be linked into the system.

4). The order in which the system modules are linked must be maintained as shown in the table in paragraph 15-5. The Monitor must be the first module and SYSLNK must be the last module. Additional I/O drivers should be added after the TT driver.

5). The Linker C option may be used to save a copy of the new operating sytem load map (See figure 15-1) and the global cross reference table for future reference. The Cross reference output defaults to the file TEST.CRS unless another output device is specified (See LINKER Section 6).

6). The Linker U option is used to list all of the I/O drivers which are not linked into the new operating system but are in the System Device Table (See Paragaph 15-7). The linker load map specifies all the I/O drivers which have been linked into the system.

STEP 3. Place the diskette on which the new operating system is to be copied into the disk unit DK1. Enter PIP and copy the new operating system to OS.BIN 255 on DK1 as shown below. Other system programs such as PIP,LINK,EDIT and ASM may also be copied to the diskette DK1 should they

they already not be on that diskette.

```
$PIP(CR)
#C TEST.BIN TO DK1:OS.BIN  255  (CR)
#C PIP.BIN,LINK.BIN,EDIT.BIN,ASM.BIN TO DK1:(CR)
```

NOTE: The user may also copy the file TEST.CRS which contains the operating system load map to DK1:OS.CRS[255] which may be listed using PIP.

STEP 4. Move the diskette with the modified OS.BIN 255 operating system from disk unit DK1 to DK0. Depress reset and carriage return on the terminal and verify that the modified operating system responds with sign on message:

MOSTEK FLP-80DOS V2.0

The sign on message should be followed by a $ indicating that the user is in the monitor environment and that the new operating sytem has been created successfully. The environments EDIT,ASM,LINK and PIP may be entered next to verify that all system programs are operational.

This completes the System Generation Procedure.

15-5. OPERATING SYSTEM MODULES

The following is a list of the system object modules in the order in which they must be linked into the operating system during the SYSGEN procedure. (See STEP 2).

	MODULE	DESCRIPTION
1.	MONITOR	System Monitor
2.	IOCS	I/O Control system

3.	SYSGEN	See description on next page
4.	CSI	Command String Interpreter
5.	TASK	Task selector for system subroutines
6.	TK	Terminal Input Driver
7.	TT	Terminal Output Driver
8.	I/O DRIVERS	See description below
9.	DKUNIT	Specifies Number of Disk Units
10.	DKTAB	Table or buffer space for disk drives
11.	DK	Disk handler
12.	SYSLNK	Linkages to system software in PROM (E000-EFFF)

15-6. STANDARD I/O DRIVERS

15-7. The user may link up to a maximum of 12 I/O drivers into his system at one time using the SYSGEN procedure. The following is a list of the standard I/O devices which are in the system device table (See Pargraph 15-9) and are also supplied with the system diskette.

DRIVER	FILE NAME	DESCRIPTION
TT:	TT	Terminal Output Device
TK:	TK	Terminal Keyboard
LP:	LPD	Data Products Line Printer
CP:	LPC	Centronics Line Printer
TR:	TR	Teletype tape reader
CR:	CR	Card Reader
PR:	PP	Paper tape reader
PP:	PR	paper tape punch
TI:	STI	Silent 700 Cassette Tape Input
TO:	STO	Silent 700 Cassette Tape Output

15-8. SYSTEM DEVICE TABLE. The system device table is in the operating system module SYSGEN.OBJ. It contains a mnemonic and a GLOBAL reference for each I/O device. The devices listed in paragraph 15-7 represent the standard System Device Table supplied for FLP-80DOS.

15-9. After system reset or power up the Monitor creates a RAM mnemonic table in scratchpad RAM starting at OFF2FH (See Appendix C). The RAM mnemonic table contains the mnemonics for the I/O devices which are supported by the operating system at execution time. Devices which are not in the RAM mnemonic table will generate the error message UNSUPPORTED DEVICE if an I/O transaction is attempted. In order for a device to be placed in the RAM mnemonic table during the Monitor initialization sequence the following conditions must be met.

1. The mnemonic for the device is in the System Device Table in the program module SYSGEN.OBJ which is linked into the operating system in OS.BIN 255 .
2. The I/O driver itself is linked into the operating system (See STEP 2 in SYSGEN procedure paragraph 15-4).

15-10. ADDING NEW I/O DRIVERS

15-11. A new or modified I/O driver having a mnemonic which is in the system device table (e.g. LP:) may be linked directly into the operating system as outlined in STEP 2 of the SYSGEN procedure. However, if the mnemonic of the new driver is not in the System Device Table (See paragraph 15-7) the table can be modified by the user. Changes to the table are made by editing and assembling the file SYSGEN.SRC. After the System Device Table is modified the user should then link the new I/O driver module into the operating sytem (See STEP 2 of SYSGEN procedure).

15-12. CHANGING THE DEFAULT LOGICAL UNITS

15-13. The default dataset definitions for logical units 2-5 may be changed by the user with the SYSGEN procedure. Changes to the default vectors are made by editing and assembling the file SYSGEN.SRC and then linking the new SYSGEN module into the operating system (see STEP 2 of SYSGEN procedure, paragraph 15-4).

15-14. CHANGING THE NUMBER OF DISK UNITS IN THE SYSTEM

15-15. The variable NMUNIT in the files DKUNIT and DKTAB specifies the number of disk units in the system. NMUNIT is set to 2 for the standard Mostek system. If the user wishes to add additional disk drives (up to 4), NMUNIT should be modified in DKUNIT.SRC and DKTAB.SRC and these modules should be reassembled prior to performing the SYSGEN procedure.

15-16. SYSTEM GENERATION OF A 64K OPERATING SYSTEM

15-17. The hardware modifications to produce a system with 60K total RAM are discussed in the system hardware operations manual. For this configuration, the FLP-80DOS may be split to place most of the operating system below the PROM's (which start at 56K) and part of the operating system above the PROM's (which end at 60K). Here is the procedure to follow.

15-18. Create a module called 'SPACE' with the following instructions on it. Assemble the module.

```
PSECT  ABS
ORG    0EFFFH
NOP
END
```

FIGURE 15-1. SAMPLE SYSTEM GENERATION

```
$LINK MONITO,IOCS,SYSGEN,CSI,TASK,TK,TT,LPC,DKUNIT,DKTAB,DK,
SYSLNK TO TEST
OPTIONS? C U A
ENTER STARTING LINK ADDRESS > 5B35
DK0:MONITO.OBJ[1]
DK0:IOCS  .OBJ[1]
DK0:SYSGEN.OBJ[1]
DK0:CSI   .OBJ[1]
DK0:TASK  .OBJ[1]
DK0:TK    .OBJ[1]
DK0:TT    .OBJ[1]
DK0:LPC   .OBJ[1]
DK0:DKUNIT.OBJ[1]
DK0:DKTAB .OBJ[1]
DK0:DK    .OBJ[1]
DK0:SYSLNK.OBJ[1]
CR     LP     PP     PP    TI
TO     TR
UNDEFINED SYMBOLS 07
PASS 2
DK0:MONITO.OBJ[1]   REL   BEG ADDR 5A8A   END ADDR 6129
DK0:IOCS  .OBJ[1]   REL   BEG ADDR 612A   END ADDR 6AC0
DK0:SYSGEN.OBJ[1]   REL   BEG ADDR 6AC1   END ADDR 6B62
DK0:CSI   .OBJ[1]   REL   BEG ADDR 6B63   END ADDR 6DB4
DK0:TASK  .OBJ[1]   REL   BEG ADDR 6DB5   END ADDR 6E7B
DK0:TK    .OBJ[1]   REL   BEG ADDR 6E7C   END ADDR 6EFE
DK0:TT    .OBJ[1]   REL   BEG ADDR 6EFF   END ADDR 6FB4
DK0:LPC   .OBJ[1]   REL   BEG ADDR 6FB5   END ADDR 7070
DK0:DKUNIT.OBJ[1]   ABS   BEG ADDR 7071   END ADDR 7072
DK0:DKTAB .OBJ[1]   REL   BEG ADDR 7073   END ADDR 76BD
DK0:DK    .OBJ[1]   REL   BEG ADDR 76BE   END ADDR 7FFF
DK0:SYSLNK.OBJ[1]   ABS   BEG ADDR 8000   END ADDR 8000
```

NOTE: The above example is the Linker Load Map resulting from the SYSGEN procedure on a system having 32K of RAM (TOR=7FFF). Since the module SYSLNK is only used by the Linker to resolve global addresses the end address of the module DK is allowed to be the top location of addressable RAM. The end address of DK must not exceed that of the top of RAM. Since additional I/O drivers may be added and module sizes might change in the future, the starting link address should be adjusted during each system generation to correctly position the end address of DK.

15-19. Link the modules of the operating system together with 'SPACE.OBJ'. The constraints are as follows: 1) the lower part of the OS must have an end address below $DFE0_H$; 2) the upper part of the OS will start above 'SPACE' (start address = 0F000H), and it must have an end address below $FF00_H$.

15-20. Figure 15-2 shows an example of how to link a 64K OS. Note that both the centronics and Data Products line printer handlers (LPC and LPD) were linked in this example. The lower part of OS ends with module 'DKTAB' whose end address is belwo $DFE0_H$. The upper part of OS starts with 'CSI' and ends with 'SYSLNK' whose end address is below $FF00_H$.

FIGURE 15-2 LINKING A 64K OPERATING SYSTEM

```
LINK
MONITOR,IOCS,SYSGEN,TASK,DKUNIT,DKTAB,SPACE,CSI,TK,TT,LPC,LPD,DK,
SYSLNK TO TEST
CUA
C7F7
Y
Y
```

LOAD MAP

```
DK0:MONITO.OBJ[1]     REL     BEG ADDR C7F7     END ADDR CE96
DK0:IOCS  .OBJ[1]     REL     BEG ADDR CE97     END ADDR D82D
DK0:SYSGEN.OBJ[1]     REL     BEG ADDR D82E     END ADDR D8CF1
DK0:TASK  .OBJ[1]     REL     BEG ADDR D8D0     END ADDR D991
DK0:DKUNIT.OBJ[1]     ABS     BEG ADDR D992     END ADDR D992
DK0:DKTAB .OBJ[1]     REL     BEG ADDR DFDE     END ADDR DFDE
DK0:SPACE .OBJ[1]     ABS     BEG ADDR EFFF     END ADDR EFFF
DK0:CSI   .OBJ[1]     REL     BEG ADDR F000     END ADDR F251
DK0:TK    .OBJ[1]     REL     BEG ADDR F252     END ADDR F2D4
DK0:TT    .OBJ[1]     REL     BEG ADDR F2D5     END ADDR F377
DK0:LPC   .OBJ[1]     REL     BEG ADDR F378     END ADDR F433
DK0:LPD   .OBJ[1]     REL     BEG ADDR F434     END ADDR F4E7
DK0:DK    .OBJ[1]     REL     BEG ADDR F4E8     END ADDR FDA3
DK0:SYSLNK.OBJ[1]     ABS     BEG ADDR FDA4     END ADDR FDA4
```

APPENDIX A

Z80 OPCODES

```
                  0002 ; PSEUDO OPS
                  0003 ;
                  0004          NAME    OPCODES
>0000             0005          ORG     0
                  0006          PSECT   REL
                  0007 ;
'0000  AA         0008          DEFB    0AAH
>0001             0009 L2       DEFL    $
>55AA             0010 L2       DEFL    55AAH
'0001  41424344   0011          DEFM    'ABCD'
'>0005            0012 NN       DEFS    2
'0007  BBAA       0013          DEFW    0AABBH
>AABB             0014 L1       EQU     0AABBH
>0005             0015 IND      EQU     5
>0020             0016 N        EQU     20H
>0030             0017 DIS      EQU     30H
                  0018          GLOBAL  NN
                  0019          IF      0
                  0020 ; SHOULD NOT BE ASSEMBLED
                  0021          LD      A,B
                  0022          ENDIF
                  0023          IF      1
                  0024 ; SHOULD BE ASSEMBLED
'0009  78         0025          LD      A,B
                  0026          ENDIF
                  0027 ; TURN LISTING OFF
                  0032 ; LISTING SHOULD BE ON
                  0033 ;
                  0034 ;
                  0035 ;
                  0036 ; Z80 OPCODES
                  0037 ;
'000B  8E         0038          ADC     A,(HL)
'000C  DD8E05     0039          ADC     A,(IX+IND)
'000F  FD8E05     0040          ADC     A,(IY+IND)
'0012  8F         0041          ADC     A,A
'0013  88         0042          ADC     A,B
'0014  89         0043          ADC     A,C
'0015  8A         0044          ADC     A,D
'0016  8B         0045          ADC     A,E
'0017  8C         0046          ADC     A,H
'0018  8D         0047          ADC     A,L
'0019  CE20       0048          ADC     A,N
'001B  ED4A       0049          ADC     HL,BC
'001D  ED5A       0050          ADC     HL,DE
'001F  ED6A       0051          ADC     HL,HL
'0021  ED7A       0052          ADC     HL,SP
                  0053 ;
'0023  86         0054          ADD     A,(HL)
'0024  DD8605     0055          ADD     A,(IX+IND)
'0027  FD8605     0056          ADD     A,(IY+IND)
'002A  87         0057          ADD     A,A
'002B  80         0058          ADD     A,B
'002C  81         0059          ADD     A,C
'002D  82         0060          ADD     A,D
'002E  83         0061          ADD     A,E
'002F  84         0062          ADD     A,H
'0030  85         0063          ADD     A,L
```

```
'0031  C620      0064           ADD     A,N
'0033  09        0065           ADD     HL,BC
'0034  19        0066           ADD     HL,DE
'0035  29        0067           ADD     HL,HL
'0036  39        0068           ADD     HL,SP
'0037  DD09      0069           ADD     IX,BC
'0039  DD19      0070           ADD     IX,DE
'003B  DD29      0071           ADD     IX,IX
'003D  DD39      0072           ADD     IX,SP
'003F  FD09      0073           ADD     IY,BC
'0041  FD19      0074           ADD     IY,DE
'0043  FD29      0075           ADD     IY,IY
'0045  FD39      0076           ADD     IY,SP
                 0077 ;
'0047  A6        0078           AND     (HL)
'0048  DDA605    0079           AND     (IX+IND)
'004B  FDA605    0080           AND     (IY+IND)
'004E  A7        0081           AND     A
'004F  A0        0082           AND     B
'0050  A1        0083           AND     C
'0051  A2        0084           AND     D
'0052  A3        0085           AND     E
'0053  A4        0086           AND     H
'0054  A5        0087           AND     L
'0055  E620      0088           AND     N
                 0089 ;
'0057  CB46      0090           BIT     0,(HL)
'0059  DDCB0546  0091           BIT     0,(IX+IND)
'005D  FDCB0546  0092           BIT     0,(IY+IND)
'0061  CB47      0093           BIT     0,A
'0063  CB40      0094           BIT     0,B
'0065  CB41      0095           BIT     0,C
'0067  CB42      0096           BIT     0,D
'0069  CB43      0097           BIT     0,E
'006B  CB44      0098           BIT     0,H
'006D  CB45      0099           BIT     0,L
                 0100 ;
'006F  CB4E      0101           BIT     1,(HL)
'0071  DDCB054E  0102           BIT     1,(IX+IND)
'0075  FDCB054E  0103           BIT     1,(IY+IND)
'0079  CB4F      0104           BIT     1,A
'007B  CB48      0105           BIT     1,B
'007D  CB49      0106           BIT     1,C
'007F  CB4A      0107           BIT     1,D
'0081  CB4B      0108           BIT     1,E
'0083  CB4C      0109           BIT     1,H
'0085  CB4D      0110           BIT     1,L
                 0111 ;
'0087  CB56      0112           BIT     2,(HL)
'0089  DDCB0556  0113           BIT     2,(IX+IND)
'008D  FDCB0556  0114           BIT     2,(IY+IND)
'0091  CB57      0115           BIT     2,A
'0093  CB50      0116           BIT     2,B
'0095  CB51      0117           BIT     2,C
'0097  CB52      0118           BIT     2,D
'0099  CB53      0119           BIT     2,E
'009B  CB54      0120           BIT     2,H
'009D  CB55      0121           BIT     2,L
```

```
                0122 ;
)09F  CB5E      0123          BIT     3,(HL)
)0A1  DDCB055E  0124          BIT     3,(IX+IND)
)0A5  FDCB055E  0125          BIT     3,(IY+IND)
)0A9  CB5F      0126          BIT     3,A
)0AB  CB58      0127          BIT     3,B
)0AD  CB59      0128          BIT     3,C
)0AF  CB5A      0129          BIT     3,D
)0B1  CB5B      0130          BIT     3,E
)0B3  CB5C      0131          BIT     3,H
)0B5  CB5D      0132          BIT     3,L
                0133 ;
)0B7  CB66      0134          BIT     4,(HL)
)0B9  DDCB0566  0135          BIT     4,(IX+IND)
)0BD  FDCB0566  0136          BIT     4,(IY+IND)
)0C1  CB67      0137          BIT     4,A
)0C3  CB60      0138          BIT     4,B
)0C5  CB61      0139          BIT     4,C
)0C7  CB62      0140          BIT     4,D
)0C9  CB63      0141          BIT     4,E
)0CB  CB64      0142          BIT     4,H
)0CD  CB65      0143          BIT     4,L
                0144 ;
)0CF  CB6E      0145          BIT     5,(HL)
)0D1  DDCB056E  0146          BIT     5,(IX+IND)
)0D5  FDCB056E  0147          BIT     5,(IY+IND)
)0D9  CB6F      0148          BIT     5,A
)0DB  CB68      0149          BIT     5,B
)0DD  CB69      0150          BIT     5,C
)0DF  CB6A      0151          BIT     5,D
)0E1  CB6B      0152          BIT     5,E
)0E3  CB6C      0153          BIT     5,H
)0E5  CB6D      0154          BIT     5,L
                0155 ;
)0E7  CB76      0156          BIT     6,(HL)
)0E9  DDCB0576  0157          BIT     6,(IX+IND)
)0ED  FDCB0576  0158          BIT     6,(IY+IND)
)0F1  CB77      0159          BIT     6,A
)0F3  CB70      0160          BIT     6,B
)0F5  CB71      0161          BIT     6,C
)0F7  CB72      0162          BIT     6,D
)0F9  CB73      0163          BIT     6,E
)0FB  CB74      0164          BIT     6,H
)0FD  CB75      0165          BIT     6,L
                0166 ;
)0FF  CB7E      0167          BIT     7,(HL)
)101  DDCB057E  0168          BIT     7,(IX+IND)
)105  FDCB057E  0169          BIT     7,(IY+IND)
)109  CB7F      0170          BIT     7,A
)10B  CB78      0171          BIT     7,B
)10D  CB79      0172          BIT     7,C
)10F  CB7A      0173          BIT     7,D
)111  CB7B      0174          BIT     7,E
)113  CB7C      0175          BIT     7,H
)115  CB7D      0176          BIT     7,L
                0177 ;
)117  DC0500'   0178          CALL    C,NN
)11A  FC0500'   0179          CALL    M,NN
```

```
 ADDR  OBJECT    ST # SOURCE STATEMENT        DATASET = DK0:OPCODE.

'011D  D40500'   0180          CALL    NC,NN
'0120  CD0500'   0181          CALL    NN
'0123  C40500'   0182          CALL    NZ,NN
'0126  F40500'   0183          CALL    P,NN
'0129  EC0500'   0184          CALL    PE,NN
'012C  E40500'   0185          CALL    PO,NN
'012F  CC0500'   0186          CALL    Z,NN
                 0187 ;
'0132  3F        0188          CCF
                 0189 ;
'0133  BE        0190          CP      (HL)
'0134  DDBE05    0191          CP      (IX+IND)
'0137  FDBE05    0192          CP      (IY+IND)
'013A  BF        0193          CP      A
'013B  B8        0194          CP      B
'013C  B9        0195          CP      C
'013D  BA        0196          CP      D
'013E  BB        0197          CP      E
'013F  BC        0198          CP      H
'0140  BD        0199          CP      L
'0141  FE20      0200          CP      N
                 0201 ;
'0143  EDA9      0202          CPD
'0145  EDB9      0203          CPDR
'0147  EDA1      0204          CPI
'0149  EDB1      0205          CPIR
                 0206 ;
'014B  2F        0207          CPL
                 0208 ;
'014C  27        0209          DAA
                 0210 ;
'014D  35        0211          DEC     (HL)
'014E  DD3505    0212          DEC     (IX+IND)
'0151  FD3505    0213          DEC     (IY+IND)
'0154  3D        0214          DEC     A
'0155  05        0215          DEC     B
'0156  0B        0216          DEC     BC
'0157  0D        0217          DEC     C
'0158  15        0218          DEC     D
'0159  1B        0219          DEC     DE
'015A  1D        0220          DEC     E
'015B  25        0221          DEC     H
'015C  2B        0222          DEC     HL
'015D  DD2B      0223          DEC     IX
'015F  FD2B      0224          DEC     IY
'0161  2D        0225          DEC     L
'0162  3B        0226          DEC     SP
                 0227 ;
'0163  F3        0228          DI
                 0229 ;
'0164  102E      0230          DJNZ    DIS
                 0231 ;
'0166  FB        0232          EI
                 0233 ;
'0167  E3        0234          EX      (SP),HL
'0168  DDE3      0235          EX      (SP),IX
'016A  FDE3      0236          EX      (SP),IY
'016C  08        0237          EX      AF,AF'
```

```
 ADDR  OBJECT    ST # SOURCE STATEMENT         DATASET = DK0:OPCODE.

'016D  EB        0238           EX      DE,HL
'016E  D9        0239           EXX
                 0240 ;
'016F  76        0241           HALT
                 0242 ;
'0170  ED46      0243           IM      0
'0172  ED56      0244           IM      1
'0174  ED5E      0245           IM      2
                 0246 ;
'0176  ED78      0247           IN      A,(C)
'0178  DB20      0248           IN      A,(N)
'017A  ED40      0249           IN      B,(C)
'017C  ED48      0250           IN      C,(C)
'017E  ED50      0251           IN      D,(C)
'0180  ED58      0252           IN      E,(C)
'0182  ED70      0253           IN      F,(C)
'0184  ED60      0254           IN      H,(C)
'0186  ED68      0255           IN      L,(C)
                 0256 ;
'0188  34        0257           INC     (HL)
'0189  FD3405    0258           INC     (IY+IND)
'018C  DD3405    0259           INC     (IX+IND)
'018F  3C        0260           INC     A
'0190  04        0261           INC     B
'0191  03        0262           INC     BC
'0192  0C        0263           INC     C
'0193  14        0264           INC     D
'0194  13        0265           INC     DE
'0195  1C        0266           INC     E
'0196  24        0267           INC     H
'0197  23        0268           INC     HL
'0198  DD23      0269           INC     IX
'019A  FD23      0270           INC     IY
'019C  2C        0271           INC     L
'019D  33        0272           INC     SP
                 0273 ;
'019E  EDAA      0274           IND
'01A0  EDBA      0275           INDR
'01A2  EDA2      0276           INI
'01A4  EDB2      0277           INIR
                 0278 ;
'01A6  E9        0279           JP      (HL)
'01A7  DDE9      0280           JP      (IX)
'01A9  FDE9      0281           JP      (IY)
'01AB  DA0500'   0282           JP      C,NN
'01AE  FA0500'   0283           JP      M,NN
'01B1  D20500'   0284           JP      NC,NN
'01B4  C30500'   0285           JP      NN
'01B7  C20500'   0286           JP      NZ,NN
'01BA  F20500'   0287           JP      P,NN
'01BD  EA0500'   0288           JP      PE,NN
'01C0  E20500'   0289           JP      PO,NN
'01C3  CA0500'   0290           JP      Z,NN
                 0291 ;
'01C6  382E      0292           JR      C,DIS
'01C8  182E      0293           JR      DIS
'01CA  302E      0294           JR      NC,DIS
'01CC  202E      0295           JR      NZ,DIS
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'01CE  282E       0296          JR      Z,DIS
                  0297 ;
'01D0  02         0298          LD      (BC),A
'01D1  12         0299          LD      (DE),A
'01D2  77         0300          LD      (HL),A
'01D3  70         0301          LD      (HL),B
'01D4  71         0302          LD      (HL),C
'01D5  72         0303          LD      (HL),D
'01D6  73         0304          LD      (HL),E
'01D7  74         0305          LD      (HL),H
'01D8  75         0306          LD      (HL),L
'01D9  3620       0307          LD      (HL),N
                  0308 ;
'01DB  DD7705     0309          LD      (IX+IND),A
'01DE  DD7005     0310          LD      (IX+IND),B
'01E1  DD7105     0311          LD      (IX+IND),C
'01E4  DD7205     0312          LD      (IX+IND),D
'01E7  DD7305     0313          LD      (IX+IND),E
'01EA  DD7405     0314          LD      (IX+IND),H
'01ED  DD7505     0315          LD      (IX+IND),L
'01F0  DD360520   0316          LD      (IX+IND),N
                  0317 ;
'01F4  FD7705     0318          LD      (IY+IND),A
'01F7  FD7005     0319          LD      (IY+IND),B
'01FA  FD7105     0320          LD      (IY+IND),C
'01FD  FD7205     0321          LD      (IY+IND),D
'0200  FD7305     0322          LD      (IY+IND),E
'0203  FD7405     0323          LD      (IY+IND),H
'0206  FD7505     0324          LD      (IY+IND),L
'0209  FD360520   0325          LD      (IY+IND),N
                  0326 ;
'020D  320500'    0327          LD      (NN),A
'0210  ED430500'  0328          LD      (NN),BC
'0214  ED530500'  0329          LD      (NN),DE
'0218  220500'    0330          LD      (NN),HL
'021B  DD220500'  0331          LD      (NN),IX
'021F  FD220500'  0332          LD      (NN),IY
'0223  ED730500'  0333          LD      (NN),SP
                  0334 ;
'0227  0A         0335          LD      A,(BC)
'0228  1A         0336          LD      A,(DE)
'0229  7E         0337          LD      A,(HL)
'022A  DD7E05     0338          LD      A,(IX+IND)
'022D  FD7E05     0339          LD      A,(IY+IND)
'0230  3A0500'    0340          LD      A,(NN)
'0233  7F         0341          LD      A,A
'0234  78         0342          LD      A,B
'0235  79         0343          LD      A,C
'0236  7A         0344          LD      A,D
'0237  7B         0345          LD      A,E
'0238  7C         0346          LD      A,H
'0239  ED57       0347          LD      A,I
'023B  7D         0348          LD      A,L
'023C  3E20       0349          LD      A,N
'023E  ED5F       0350          LD      A,R
                  0351 ;
'0240  46         0352          LD      B,(HL)
'0241  DD4605     0353          LD      B,(IX+IND)
```

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ADDR  OBJECT    ST # SOURCE STATEMENT         DATASET = DK0:OPCODE.

0244  FD4605    0354         LD      B,(IY+IND)
0247  47        0355         LD      B,A
0248  40        0356         LD      B,B
0249  41        0357         LD      B,C
024A  42        0358         LD      B,D
024B  43        0359         LD      B,E
024C  44        0360         LD      B,H
024D  45        0361         LD      B,L
024E  0620      0362         LD      B,N
                0363 ;
0250  ED4B0500' 0364         LD      BC,(NN)
0254  010500'   0365         LD      BC,NN
                0366 ;
0257  4E        0367         LD      C,(HL)
0258  DD4E05    0368         LD      C,(IX+IND)
025B  FD4E05    0369         LD      C,(IY+IND)
025E  4F        0370         LD      C,A
025F  48        0371         LD      C,B
0260  49        0372         LD      C,C
0261  4A        0373         LD      C,D
0262  4B        0374         LD      C,E
0263  4C        0375         LD      C,H
0264  4D        0376         LD      C,L
0265  0E20      0377         LD      C,N
                0378 ;
0267  56        0379         LD      D,(HL)
0268  DD5605    0380         LD      D,(IX+IND)
026B  FD5605    0381         LD      D,(IY+IND)
026E  57        0382         LD      D,A
026F  50        0383         LD      D,B
0270  51        0384         LD      D,C
0271  52        0385         LD      D,D
0272  53        0386         LD      D,E
0273  54        0387         LD      D,H
0274  55        0388         LD      D,L
0275  1620      0389         LD      D,N
                0390 ;
0277  ED5B0500' 0391         LD      DE,(NN)
027B  110500'   0392         LD      DE,NN
                0393 ;
027E  5E        0394         LD      E,(HL)
027F  DD5E05    0395         LD      E,(IX+IND)
0282  FD5E05    0396         LD      E,(IY+IND)
0285  5F        0397         LD      E,A
0286  58        0398         LD      E,B
0287  59        0399         LD      E,C
0288  5A        0400         LD      E,D
0289  5B        0401         LD      E,E
028A  5C        0402         LD      E,H
028B  5D        0403         LD      E,L
028C  1E20      0404         LD      E,N
                0405 ;
028E  66        0406         LD      H,(HL)
028F  DD6605    0407         LD      H,(IX+IND)
0292  FD6605    0408         LD      H,(IY+IND)
0295  67        0409         LD      H,A
0296  60        0410         LD      H,B
0297  61        0411         LD      H,C
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'0298  62         0412        LD      H,D
'0299  63         0413        LD      H,E
'029A  64         0414        LD      H,H
'029B  65         0415        LD      H,L
'029C  2620       0416        LD      H,N
                  0417 ;
'029E  2A0500'    0418        LD      HL,(NN)
'02A1  210500'    0419        LD      HL,NN
                  0420 ;
'02A4  ED47       0421        LD      I,A
                  0422 ;
'02A6  DD2A0500'  0423        LD      IX,(NN)
'02AA  DD210500'  0424        LD      IX,NN
                  0425 ;
'02AE  FD2A0500'  0426        LD      IY,(NN)
'02B2  FD210500'  0427        LD      IY,NN
                  0428 ;
'02B6  6E         0429        LD      L,(HL)
'02B7  DD6E05     0430        LD      L,(IX+IND)
'02BA  FD6E05     0431        LD      L,(IY+IND)
'02BD  6F         0432        LD      L,A
'02BE  68         0433        LD      L,B
'02BF  69         0434        LD      L,C
'02C0  6A         0435        LD      L,D
'02C1  6B         0436        LD      L,E
'02C2  6C         0437        LD      L,H
'02C3  6D         0438        LD      L,L
'02C4  2E20       0439        LD      L,N
                  0440 ;
'02C6  ED4F       0441        LD      R,A
                  0442 ;
'02C8  ED7B0500'  0443        LD      SP,(NN)
'02CC  F9         0444        LD      SP,HL
'02CD  DDF9       0445        LD      SP,IX
'02CF  FDF9       0446        LD      SP,IY
'02D1  310500'    0447        LD      SP,NN
                  0448 ;
'02D4  EDA8       0449        LDD
'02D6  EDB8       0450        LDDR
'02D8  EDA0       0451        LDI
'02DA  EDB0       0452        LDIR
                  0453 ;
'02DC  ED44       0454        NEG
                  0455 ;
'02DE  00         0456        NOP
                  0457 ;
'02DF  B6         0458        OR      (HL)
'02E0  DDB605     0459        OR      (IX+IND)
'02E3  FDB605     0460        OR      (IY+IND)
'02E6  B7         0461        OR      A
'02E7  B0         0462        OR      B
'02E8  B1         0463        OR      C
'02E9  B2         0464        OR      D
'02EA  B3         0465        OR      E
'02EB  B4         0466        OR      H
'02EC  B5         0467        OR      L
'02ED  F620       0468        OR      N
                  0469 ;
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ADDR  OBJECT     ST # SOURCE STATEMENT          DATASET = DKO:OPCODE.

02EF  EDBB       0470          OTDR
02F1  EDB3       0471          OTIR
                 0472 ;
02F3  ED79       0473          OUT     (C),A
02F5  ED41       0474          OUT     (C),B
02F7  ED49       0475          OUT     (C),C
02F9  ED51       0476          OUT     (C),D
02FB  ED59       0477          OUT     (C),E
02FD  ED61       0478          OUT     (C),H
02FF  ED69       0479          OUT     (C),L
0301  D320       0480          OUT     (N),A
                 0481 ;
0303  EDAB       0482          OUTD
0305  EDA3       0483          OUTI
                 0484 ;
0307  F1         0485          POP     AF
0308  C1         0486          POP     BC
0309  D1         0487          POP     DE
030A  E1         0488          POP     HL
030B  DDE1       0489          POP     IX
030D  FDE1       0490          POP     IY
030F  F5         0491          PUSH    AF
0310  C5         0492          PUSH    BC
0311  D5         0493          PUSH    DE
0312  E5         0494          PUSH    HL
0313  DDE5       0495          PUSH    IX
0315  FDE5       0496          PUSH    IY
                 0497 ;
0317  CB86       0498          RES     0,(HL)
0319  DDCB0586   0499          RES     0,(IX+IND)
031D  FDCB0586   0500          RES     0,(IY+IND)
0321  CB87       0501          RES     0,A
0323  CB80       0502          RES     0,B
0325  CB81       0503          RES     0,C
0327  CB82       0504          RES     0,D
0329  CB83       0505          RES     0,E
032B  CB84       0506          RES     0,H
032D  CB85       0507          RES     0,L
                 0508 ;
032F  CB8E       0509          RES     1,(HL)
0331  DDCB058E   0510          RES     1,(IX+IND)
0335  FDCB058E   0511          RES     1,(IY+IND)
0339  CB8F       0512          RES     1,A
033B  CB88       0513          RES     1,B
033D  CB89       0514          RES     1,C
033F  CB8A       0515          RES     1,D
0341  CB8B       0516          RES     1,E
0343  CB8C       0517          RES     1,H
0345  CB8D       0518          RES     1,L
                 0519 ;
0347  CB96       0520          RES     2,(HL)
0349  DDCB0596   0521          RES     2,(IX+IND)
034D  FDCB0596   0522          RES     2,(IY+IND)
0351  CB97       0523          RES     2,A
0353  CB90       0524          RES     2,B
0355  CB91       0525          RES     2,C
0357  CB92       0526          RES     2,D
0359  CB93       0527          RES     2,E
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'035B  CB94       0528          RES     2,H
'035D  CB95       0529          RES     2,L
                  0530 ;
'035F  CB9E       0531          RES     3,(HL)
'0361  DDCB059E   0532          RES     3,(IX+IND)
'0365  FDCB059E   0533          RES     3,(IY+IND)
'0369  CB9F       0534          RES     3,A
'036B  CB98       0535          RES     3,B
'036D  CB99       0536          RES     3,C
'036F  CB9A       0537          RES     3,D
'0371  CB9B       0538          RES     3,E
'0373  CB9C       0539          RES     3,H
'0375  CB9D       0540          RES     3,L
                  0541 ;
'0377  CBA6       0542          RES     4,(HL)
'0379  DDCB05A6   0543          RES     4,(IX+IND)
'037D  FDCB05A6   0544          RES     4,(IY+IND)
'0381  CBA7       0545          RES     4,A
'0383  CBA0       0546          RES     4,B
'0385  CBA1       0547          RES     4,C
'0387  CBA2       0548          RES     4,D
'0389  CBA3       0549          RES     4,E
'038B  CBA4       0550          RES     4,H
'038D  CBA5       0551          RES     4,L
                  0552 ;
'038F  CBAE       0553          RES     5,(HL)
'0391  DDCB05AE   0554          RES     5,(IX+IND)
'0395  FDCB05AE   0555          RES     5,(IY+IND)
'0399  CBAF       0556          RES     5,A
'039B  CBA8       0557          RES     5,B
'039D  CBA9       0558          RES     5,C
'039F  CBAA       0559          RES     5,D
'03A1  CBAB       0560          RES     5,E
'03A3  CBAC       0561          RES     5,H
'03A5  CBAD       0562          RES     5,L
                  0563 ;
'03A7  CBB6       0564          RES     6,(HL)
'03A9  DDCB05B6   0565          RES     6,(IX+IND)
'03AD  FDCB05B6   0566          RES     6,(IY+IND)
'03B1  CBB7       0567          RES     6,A
'03B3  CBB0       0568          RES     6,B
'03B5  CBB1       0569          RES     6,C
'03B7  CBB2       0570          RES     6,D
'03B9  CBB3       0571          RES     6,E
'03BB  CBB4       0572          RES     6,H
'03BD  CBB5       0573          RES     6,L
                  0574 ;
'03BF  CBBE       0575          RES     7,(HL)
'03C1  DDCB05BE   0576          RES     7,(IX+IND)
'03C5  FDCB05BE   0577          RES     7,(IY+IND)
'03C9  CBBF       0578          RES     7,A
'03CB  CBB8       0579          RES     7,B
'03CD  CBB9       0580          RES     7,C
'03CF  CBBA       0581          RES     7,D
'03D1  CBBB       0582          RES     7,E
'03D3  CBBC       0583          RES     7,H
'03D5  CBBD       0584          RES     7,L
                  0585 ;
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'03D7  C9          0586            RET
'03D8  D8          0587            RET      C
'03D9  F8          0588            RET      M
'03DA  D0          0589            RET      NC
'03DB  C0          0590            RET      NZ
'03DC  F0          0591            RET      P
'03DD  E8          0592            RET      PE
'03DE  E0          0593            RET      PO
'03DF  C8          0594            RET      Z
                   0595 ;
'03E0  ED4D        0596            RETI
'03E2  ED45        0597            RETN
                   0598 ;
'03E4  CB16        0599            RL       (HL)
'03E6  DDCB0516    0600            RL       (IX+IND)
'03EA  FDCB0516    0601            RL       (IY+IND)
'03EE  CB17        0602            RL       A
'03F0  CB10        0603            RL       B
'03F2  CB11        0604            RL       C
'03F4  CB12        0605            RL       D
'03F6  CB13        0606            RL       E
'03F8  CB14        0607            RL       H
'03FA  CB15        0608            RL       L
                   0609 ;
'03FC  17          0610            RLA
                   0611 ;
'03FD  CB06        0612            RLC      (HL)
'03FF  DDCB0506    0613            RLC      (IX+IND)
'0403  FDCB0506    0614            RLC      (IY+IND)
'0407  CB07        0615            RLC      A
'0409  CB00        0616            RLC      B
'040B  CB01        0617            RLC      C
'040D  CB02        0618            RLC      D
'040F  CB03        0619            RLC      E
'0411  CB04        0620            RLC      H
'0413  CB05        0621            RLC      L
                   0622 ;
'0415  07          0623            RLCA
                   0624 ;
'0416  ED6F        0625            RLD
                   0626 ;
'0418  CB1E        0627            RR       (HL)
'041A  DDCB051E    0628            RR       (IX+IND)
'041E  FDCB051E    0629            RR       (IY+IND)
'0422  CB1F        0630            RR       A
'0424  CB18        0631            RR       B
'0426  CB19        0632            RR       C
'0428  CB1A        0633            RR       D
'042A  CB1B        0634            RR       E
'042C  CB1C        0635            RR       H
'042E  CB1D        0636            RR       L
                   0637 ;
'0430  1F          0638            RRA
                   0639 ;
'0431  CB0E        0640            RRC      (HL)
'0433  DDCB050E    0641            RRC      (IX+IND)
'0437  FDCB050E    0642            RRC      (IY+IND)
'043B  CB0F        0643            RRC      A
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'043D  CB08      0644        RRC    B
'043F  CB09      0645        RRC    C
'0441  CB0A      0646        RRC    D
'0443  CB0B      0647        RRC    E
'0445  CB0C      0648        RRC    H
'0447  CB0D      0649        RRC    L
                 0650 ;
'0449  0F        0651        RRCA
                 0652 ;
'044A  ED67      0653        RRD
                 0654 ;
'044C  C7        0655        RST    0
'044D  CF        0656        RST    08H
'044E  D7        0657        RST    10H
'044F  DF        0658        RST    18H
'0450  E7        0659        RST    20H
'0451  EF        0660        RST    28H
'0452  F7        0661        RST    30H
'0453  FF        0662        RST    38H
                 0663 ;
'0454  9E        0664        SBC    A,(HL)
'0455  DD9E05    0665        SBC    A,(IX+IND)
'0458  FD9E05    0666        SBC    A,(IY+IND)
'045B  9F        0667        SBC    A,A
'045C  98        0668        SBC    A,B
'045D  99        0669        SBC    A,C
'045E  9A        0670        SBC    A,D
'045F  9B        0671        SBC    A,E
'0460  9C        0672        SBC    A,H
'0461  9D        0673        SBC    A,L
'0462  DE20      0674        SBC    A,N
                 0675 ;
'0464  ED42      0676        SBC    HL,BC
'0466  ED52      0677        SBC    HL,DE
'0468  ED62      0678        SBC    HL,HL
'046A  ED72      0679        SBC    HL,SP
                 0680 ;
'046C  37        0681        SCF
                 0682 ;
'046D  CBC6      0683        SET    0,(HL)
'046F  DDCB05C6  0684        SET    0,(IX+IND)
'0473  FDCB05C6  0685        SET    0,(IY+IND)
'0477  CBC7      0686        SET    0,A
'0479  CBC0      0687        SET    0,B
'047B  CBC1      0688        SET    0,C
'047D  CBC2      0689        SET    0,D
'047F  CBC3      0690        SET    0,E
'0481  CBC4      0691        SET    0,H
'0483  CBC5      0692        SET    0,L
                 0693 ;
'0485  CBCE      0694        SET    1,(HL)
'0487  DDCB05CE  0695        SET    1,(IX+IND)
'048B  FDCB05CE  0696        SET    1,(IY+IND)
'048F  CBCF      0697        SET    1,A
'0491  CBC8      0698        SET    1,B
'0493  CBC9      0699        SET    1,C
'0495  CBCA      0700        SET    1,D
'0497  CBCB      0701        SET    1,E
```

```
ADDR  OBJECT     ST # SOURCE STATEMENT          DATASET = DK0:OPCODE.

0499  CBCC       0702          SET      1,H
049B  CBCD       0703          SET      1,L
                 0704 ;
049D  CBD6       0705          SET      2,(HL)
049F  DDCB05D6   0706          SET      2,(IX+IND)
04A3  FDCB05D6   0707          SET      2,(IY+IND)
04A7  CBD7       0708          SET      2,A
04A9  CBD0       0709          SET      2,B
04AB  CBD1       0710          SET      2,C
04AD  CBD2       0711          SET      2,D
04AF  CBD3       0712          SET      2,E
04B1  CBD4       0713          SET      2,H
04B3  CBD5       0714          SET      2,L
                 0715 ;
04B5  CBDE       0716          SET      3,(HL)
04B7  DDCB05DE   0717          SET      3,(IX+IND)
04BB  FDCB05DE   0718          SET      3,(IY+IND)
04BF  CBDF       0719          SET      3,A
04C1  CBD8       0720          SET      3,B
04C3  CBD9       0721          SET      3,C
04C5  CBDA       0722          SET      3,D
04C7  CBDB       0723          SET      3,E
04C9  CBDC       0724          SET      3,H
04CB  CBDD       0725          SET      3,L
                 0726 ;
04CD  CBE6       0727          SET      4,(HL)
04CF  DDCB05E6   0728          SET      4,(IX+IND)
04D3  FDCB05E6   0729          SET      4,(IY+IND)
04D7  CBE7       0730          SET      4,A
04D9  CBE0       0731          SET      4,B
04DB  CBE1       0732          SET      4,C
04DD  CBE2       0733          SET      4,D
04DF  CBE3       0734          SET      4,E
04E1  CBE4       0735          SET      4,H
04E3  CBE5       0736          SET      4,L
                 0737 ;
04E5  CBEE       0738          SET      5,(HL)
04E7  DDCB05EE   0739          SET      5,(IX+IND)
04EB  FDCB05EE   0740          SET      5,(IY+IND)
04EF  CBEF       0741          SET      5,A
04F1  CBE8       0742          SET      5,B
04F3  CBE9       0743          SET      5,C
04F5  CBEA       0744          SET      5,D
04F7  CBEB       0745          SET      5,E
04F9  CBEC       0746          SET      5,H
04FB  CBED       0747          SET      5,L
                 0748 ;
04FD  CBF6       0749          SET      6,(HL)
04FF  DDCB05F6   0750          SET      6,(IX+IND)
0503  FDCB05F6   0751          SET      6,(IY+IND)
0507  CBF7       0752          SET      6,A
0509  CBF0       0753          SET      6,B
050B  CBF1       0754          SET      6,C
050D  CBF2       0755          SET      6,D
050F  CBF3       0756          SET      6,E
0511  CBF4       0757          SET      6,H
0513  CBF5       0758          SET      6,L
                 0759 ;
```

```
 ADDR   OBJECT    ST # SOURCE STATEMENT        DATASET = DK0:OPCODE.

'0515   CBFE      0760            SET     7,(HL)
'0517   DDCB05FE  0761            SET     7,(IX+IND)
'051B   FDCB05FE  0762            SET     7,(IY+IND)
'051F   CBFF      0763            SET     7,A
'0521   CBF8      0764            SET     7,B
'0523   CBF9      0765            SET     7,C
'0525   CBFA      0766            SET     7,D
'0527   CBFB      0767            SET     7,E
'0529   CBFC      0768            SET     7,H
'052B   CBFD      0769            SET     7,L
                  0770 ;
'052D   CB26      0771            SLA     (HL)
'052F   DDCB0526  0772            SLA     (IX+IND)
'0533   FDCB0526  0773            SLA     (IY+IND)
'0537   CB27      0774            SLA     A
'0539   CB20      0775            SLA     B
'053B   CB21      0776            SLA     C
'053D   CB22      0777            SLA     D
'053F   CB23      0778            SLA     E
'0541   CB24      0779            SLA     H
'0543   CB25      0780            SLA     L
                  0781 ;
'0545   CB2E      0782            SRA     (HL)
'0547   DDCB052E  0783            SRA     (IX+IND)
'054B   FDCB052E  0784            SRA     (IY+IND)
'054F   CB2F      0785            SRA     A
'0551   CB28      0786            SRA     B
'0553   CB29      0787            SRA     C
'0555   CB2A      0788            SRA     D
'0557   CB2B      0789            SRA     E
'0559   CB2C      0790            SRA     H
'055B   CB2D      0791            SRA     L
                  0792 ;
'055D   CB3E      0793            SRL     (HL)
'055F   DDCB053E  0794            SRL     (IX+IND)
'0563   FDCB053E  0795            SRL     (IY+IND)
'0567   CB3F      0796            SRL     A
'0569   CB38      0797            SRL     B
'056B   CB39      0798            SRL     C
'056D   CB3A      0799            SRL     D
'056F   CB3B      0800            SRL     E
'0571   CB3C      0801            SRL     H
'0573   CB3D      0802            SRL     L
                  0803 ;
'0575   96        0804            SUB     (HL)
'0576   DD9605    0805            SUB     (IX+IND)
'0579   FD9605    0806            SUB     (IY+IND)
'057C   97        0807            SUB     A
'057D   90        0808            SUB     B
'057E   91        0809            SUB     C
'057F   92        0810            SUB     D
'0580   93        0811            SUB     E
'0581   94        0812            SUB     H
'0582   95        0813            SUB     L
'0583   D620      0814            SUB     N
                  0815 ;
'0585   AE        0816            XOR     (HL)
'0586   DDAE05    0817            XOR     (IX+IND)
```

```
.DDR   OBJECT    ST # SOURCE STATEMENT        DATASET = DK0:OPCODE.

)589   FDAE05    0818          XOR      (IY+IND)
)58C   AF        0819          XOR      A
)58D   A8        0820          XOR      B
)58E   A9        0821          XOR      C
)58F   AA        0822          XOR      D
)590   AB        0823          XOR      E
)591   AC        0824          XOR      H
)592   AD        0825          XOR      L
)593   EE20      0826          XOR      N
                 0827 ;
                 0828          END

RRORS=0000
```

APPENDIX B

MOSTEK OBJECT OUTPUT DEFINITION

APPENDIX B

MOSTEK OBJECT OUTPUT DEFINITION

B-1. INTRODUCTION

B-2. Each record of an object module begins with a delimiter (colon or dollar sign) and ends with carriage return and line feed. A colon (:) is used for data records and end of file record. A dollar sign ($) is used for records containing relocation information and linking information. An Intel loader will ignore such information and allow loading of non-relocatable, non-linkable programs. All information is in ASCII. Each record is identified by a "type". The type appears in the 8th and 9th bytes of the record and can take the following values:

- 00 - data record
- 01 - end-of-file
- 02 - internal symbol
- 03 - external symbol
- 04 - relocation information
- 05 - module definition

B-3. DATA RECORD FORMAT (TYPE 00)

Byte 1	Colon (:) delimiter.
2-3	Number of binary bytes of data in this record. The maximum is 32 binary bytes (64 ASCII bytes).
4-5	Most significant byte of the start address of data.
6-7	Least significant byte of start address of data.
8-9	ASCII zeros. This is the "record type" for data.
10-	Data bytes.
Last two bytes	- Checksum of all bytes except the delimiter, carriage return, and line feed. The

	checksum is the negative of the binary sum of all bytes in the record.
CRLF	Carriage return, line feed.

B-4. END-OF-FILE RECORD (TYPE 01)

Byte 1	Colon (:) delimiter.
2-3	ASCII zeros.
4-5	Most significant byte of the transfer address of the program. This transfer address appears as an argument in the 'END' Pseudo-op of a program. It represents the starting execution address of the program.
6-7	Least significant byte of the transfer address.
8-9	Record type 01.
10-11	Checksum.
CRLF	Carriage return, line feed.

B-5. INTERNAL SYMBOL RECORD (TYPE 02)

Byte 1	Dollar sign ($) delimiter.
2-7	Up to 6 ASCII characters of the internal symbol name. The name is left justified, blank filled.
8-9	Record type 02.
10-13	Address of the internal symbol, most significant byte first.
14-15	Binary checksum. Note that the ASCII letters of the symbol are converted to binary before the checksum is calculated. Binary conversion is done without regard to errors.
CRLF	Carriage return, line feed.

B-6. EXTERNAL SYMBOL RECORD (TYPE 03)

Byte 1	Dollar Sign ($) Delimiter.

```
499  CBCC       0702          SET     1,H
49B  CBCD       0703          SET     1,L
                0704 ;
49D  CBD6       0705          SET     2,(HL)
49F  DDCB05D6   0706          SET     2,(IX+IND)
04A3 FDCB05D6   0707          SET     2,(IY+IND)
04A7 CBD7       0708          SET     2,A
04A9 CBD0       0709          SET     2,B
04AB CBD1       0710          SET     2,C
04AD CBD2       0711          SET     2,D
04AF CBD3       0712          SET     2,E
04B1 CBD4       0713          SET     2,H
04B3 CBD5       0714          SET     2,L
                0715 ;
04B5 CBDE       0716          SET     3,(HL)
04B7 DDCB05DE   0717          SET     3,(IX+IND)
04BB FDCB05DE   0718          SET     3,(IY+IND)
04BF CBDF       0719          SET     3,A
04C1 CBD8       0720          SET     3,B
04C3 CBD9       0721          SET     3,C
04C5 CBDA       0722          SET     3,D
04C7 CBDB       0723          SET     3,E
04C9 CBDC       0724          SET     3,H
04CB CBDD       0725          SET     3,L
                0726 ;
04CD CBE6       0727          SET     4,(HL)
04CF DDCB05E6   0728          SET     4,(IX+IND)
04D3 FDCB05E6   0729          SET     4,(IY+IND)
04D7 CBE7       0730          SET     4,A
04D9 CBE0       0731          SET     4,B
04DB CBE1       0732          SET     4,C
04DD CBE2       0733          SET     4,D
04DF CBE3       0734          SET     4,E
04E1 CBE4       0735          SET     4,H
04E3 CBE5       0736          SET     4,L
                0737 ;
04E5 CBEE       0738          SET     5,(HL)
04E7 DDCB05EE   0739          SET     5,(IX+IND)
04EB FDCB05EE   0740          SET     5,(IY+IND)
04EF CBEF       0741          SET     5,A
04F1 CBE8       0742          SET     5,B
04F3 CBE9       0743          SET     5,C
04F5 CBEA       0744          SET     5,D
04F7 CBEB       0745          SET     5,E
04F9 CBEC       0746          SET     5,H
04FB CBED       0747          SET     5,L
                0748 ;
04FD CBF6       0749          SET     6,(HL)
04FF DDCB05F6   0750          SET     6,(IX+IND)
0503 FDCB05F6   0751          SET     6,(IY+IND)
0507 CBF7       0752          SET     6,A
0509 CBF0       0753          SET     6,B
050B CBF1       0754          SET     6,C
050D CBF2       0755          SET     6,D
050F CBF3       0756          SET     6,E
0511 CBF4       0757          SET     6,H
0513 CBF5       0758          SET     6,L
                0759 ;
```

```
'0515  CBFE      0760          SET     7,(HL)
'0517  DDCB05FE  0761          SET     7,(IX+IND)
'051B  FDCB05FE  0762          SET     7,(IY+IND)
'051F  CBFF      0763          SET     7,A
'0521  CBF8      0764          SET     7,B
'0523  CBF9      0765          SET     7,C
'0525  CBFA      0766          SET     7,D
'0527  CBFB      0767          SET     7,E
'0529  CBFC      0768          SET     7,H
'052B  CBFD      0769          SET     7,L
                 0770 ;
'052D  CB26      0771          SLA     (HL)
'052F  DDCB0526  0772          SLA     (IX+IND)
'0533  FDCB0526  0773          SLA     (IY+IND)
'0537  CB27      0774          SLA     A
'0539  CB20      0775          SLA     B
'053B  CB21      0776          SLA     C
'053D  CB22      0777          SLA     D
'053F  CB23      0778          SLA     E
'0541  CB24      0779          SLA     H
'0543  CB25      0780          SLA     L
                 0781 ;
'0545  CB2E      0782          SRA     (HL)
'0547  DDCB052E  0783          SRA     (IX+IND)
'054B  FDCB052E  0784          SRA     (IY+IND)
'054F  CB2F      0785          SRA     A
'0551  CB28      0786          SRA     B
'0553  CB29      0787          SRA     C
'0555  CB2A      0788          SRA     D
'0557  CB2B      0789          SRA     E
'0559  CB2C      0790          SRA     H
'055B  CB2D      0791          SRA     L
                 0792 ;
'055D  CB3E      0793          SRL     (HL)
'055F  DDCB053E  0794          SRL     (IX+IND)
'0563  FDCB053E  0795          SRL     (IY+IND)
'0567  CB3F      0796          SRL     A
'0569  CB38      0797          SRL     B
'056B  CB39      0798          SRL     C
'056D  CB3A      0799          SRL     D
'056F  CB3B      0800          SRL     E
'0571  CB3C      0801          SRL     H
'0573  CB3D      0802          SRL     L
                 0803 ;
'0575  96        0804          SUB     (HL)
'0576  DD9605    0805          SUB     (IX+IND)
'0579  FD9605    0806          SUB     (IY+IND)
'057C  97        0807          SUB     A
'057D  90        0808          SUB     B
'057E  91        0809          SUB     C
'057F  92        0810          SUB     D
'0580  93        0811          SUB     E
'0581  94        0812          SUB     H
'0582  95        0813          SUB     L
'0583  D620      0814          SUB     N
                 0815 ;
'0585  AE        0816          XOR     (HL)
'0586  DDAE05    0817          XOR     (IX+IND)
```

2-7	Up to 6 ASCII characters of the external symbol name. The name is left justified, blank filled.
8-9	Record type 03.
10-13	Last address which uses the external symbol. This is the start of a link list in the object data records which is described below. The most significant byte is first.
14-15	Binary checksum.
CRLF	Carriage return, line feed.

The Assembler outputs the external symbol name and the last address in the program where the symbol is used. The data records which follow contain a link list pointing to all occurrences of that symbol in the object code. This is illustrated in Figure B-1.

1. The external symbol record shows the symbol ('LAB') and the last location in the program which uses the symbol ($212A_H$).
2. The object code at 212AH has a pointer which shows where the previous reference to the external symbol occurred ($200F_H$).
3. This backward reference list continues until a terminator ends the list. This terminator is FFFFH. This method is easy to generate and decode. It has the advantage of reducing the number of bytes of object code needed to define all external references in a program.

B-7. RELOCATING INFORMATION RECORD (TYPE 04)

The addresses in the program which must be relocated are explicitly defined in these records. Up to 16 addresses (64 ASCII characters) may be defined in each record.

Byte 1	Dollar sign ($) delimiter.
2-3	Number of sets of 2 ASCII characters, where 2 sets define an address.

4-7	ASCII zeros.
8-9	Record type 04.
10-	Addresses which must be relocated, most significant byte first.

Last two bytes - Binary checksum.

CRLF	Carriage return, line feed.

B-8. MODULE DEFINITION RECORD (TYPE 05)

This record has the name of the module (defined by the 'NAME' pseudo-op) and a loading flag byte. The flag byte is determined by the 'PSECT' pseudo-op.

Byte 1	Dollar sign ($) delimiter.
2-7	Name of the module, left justified, blank filled.
8-9	Record type 05.
10-11	Flag byte. When converted to binary, the flag byte is defined as follows: Bit 0 = 0 For absolute = 1 For relocatable Bit 1 = 0 For Z80 Data Format (LSB First) = 1 For 3870 Data Format (MSB First)
12-13	Binary checksum.
CRLF	Carriage return, line feed.

FIGURE B-1. EXTERNAL SYMBOL LINK LIST

```
$ LABbbb03212A          defines last reference to
                        external symbol 'LAB'
         .
         .
         .
:        00
:        00
                FFFF          1.
             .
             .          3.
             .
:        00        2.
:        00   200F
```

Object Data

APPENDIX C

SCRATCHPAD MEMORY MAP

APPENDIX C

SCRATCHPAD MEMORY MAP

C-1. INTRODUCTION

C-2. The FLP-80DOS operating system makes extensive use of the 256 x 8 scratchpad memory from $0FF00_H$ to $0FFFF_H$ for system variables. This area is reserved for the operating system and should not be modified by user programs.

C-3. DESCRIPTION OF PARAMETERS

SCRATCHPAD MAP

MEMORY LOCATION	MNEMONIC	DESCRIPTION
FF00-01	TOR	Top of contiguous RAM Memory (calculated by Monitor)
FF02-03	BALR	Bottom of Allocated RAM
FF04-05	CDATE	Current Date
FF06	Count	DDT variables
FF07	CMDSV	Disk Controller Command Save location
FF08	TRK	Disk Controller Variable
FF09	ERSTAT	Disk Controller Error Status Flag
FF0A	SCTR	Disk Controller Variable
FF0B	SCTRSIZE	Disk Controller Variable
FF0C-FF11		Software Break Point Control
FF12	FLAG	Debug Flag
FF13	LONG	Register Map long/short flag

MEMORY LOCATION	MNEMONIC	DESCRIPTION
FF14-FF19	OPR1,OPR2, OPR3	DDT OPERANDS, 124 Byte Buffer for Reset Boot sequence
FF1A	OPFLG	DDT Operand Flag
FF1B	NXCHR	DDT Variable
FF1C	CMD	DDT Variable
FF1D-1E	MAP	DDT Variable
FF1F-20	OFFSET	DDT Offset Address
FF21	EXCTL	DDT Variable
FF22	FSAVE	DDT Variable
FF23	BUSY FLG	IOCS busy flag
FF24	MINFLG	DDT Variable
FF25	TKST	DDT Variable
FF26-28	JTASK	Jump to the routine TASK
FF29-2B	JIOCS	Jump to IOCS
FF2C-2E		Not used. Reserved for future use
FF2F-5F		Ram Mnemonic Table*
FF60-FF8F		Monitor I/O Vector, Reset Boot Vector
FF90-FF98		AIM-80 Flags
FFA9		User Stack Origin
FFAA-FFDF		Monitor and DDT Stack and Breakpoint Area
FFE0	BRATE	Baud Rate Flag
FFE1		Not used. Reserved for future use
FFE2-E3	SPSV	FLP-80 Disk Controller Stack Pointer Save
FFE4-FFFF		DDT User Register Save Area

*The RAM mnemonic table is initialized by the Monitor. It contains device mnemonics for I/O drivers which are linked into the operating system during the System Generation procedure (See Section 15).

APPENDIX D

TESTING/DIAGNOSTICS

APPENDIX D

TESTING/DIAGNOSTICS

D-1. INTRODUCTION

D-2. This Appendix contain a description of Software/Firmware troubleshooting techniques and instructions for using the Disk Diagnostic Utility. For problems in areas other than those listed above, consult the appropriate hardware or software manual.

D-3. SOFWARE/FIRMWARE TROUBLE SHOOTING

D-4. Double check the hardware and associated interfaces. Assure that the FLP-80DOS PROMS are in the correct sockets and that the strapping options are correct. Double check connections from the terminal to the serial port. If you suspect a hardware problem perform the diagnostic tests listed in the hardware manuals.

D-5. POWER UP SEQUENCE WITHOUT DISKETTE

1. Assure that no diskettes are in the drives.
2. Power up the system.
3. Depress " carriage return" on your terminal. The system should print the following:

   DSK ERR

   The dot is the DDT-80 prompt.
4. If the above message was not printed and all hardware appears correct, the problem is probably bad PROM's which should be replaced.

D-6. POWER UP SEQUENCE WITH DISKETTE

1. Assure that no diskettes are in the drives.
2. Power up the system.
3. Place a system diskette in the right hand drive (DK0:).
4. Depress "carriage return" on your terminal.
5. The disk should be accessed.
6. If the disk was not accessed, then a controller or disk controller Firmware problem is indicated. Double check the strapping options on the disk drive board. Then proceed to paragraph D-7, DISK CONTROLLER FIRMWARE TEST.
7. If the sign-on message was printed on the terminal but a disk error was indicated (*****ERROR 0A DISK I/O ERROR), then the diskette is bad and should be replaced.
8. If the following message is displayed on the terminal:

   OS.BIN 255 NOT FOUND

   the operating system binary file is not on the disk in DK0:. The period is the DDT-80 prompt.
9. If the sign-on message and Monitor prompt ('$') appeared on the terminal, proceed to paragraph D-8, MONITOR CHECKOUT.

D-7. DISK CONTROLLER FIRMWARE TEST (only for FLP-80 card. See Hardware manual for other cards).

1. Perform the following sequence.

```
.F 0,7F,AA(CR)
.E EC06(CR)
SAVE ADR, #SCTRS: 0,1(CR)
UNIT,TRK,SCTR: 0,A,1(CR)
```

If a disk error is indicated, then a disk controller problem is indicated for WRITE.

```
.F 0,7F,0(CR)
.E EC09(CR)
LOAD ADR: 0(CR)
UNIT,TRK,SCTR: 0,A,1(CR)
```

.M 0,7F(CR)

Check locations 0-7FH for the pattern AAH. If any discrepancies are found, then failure in the disk controller or disk unit is indicated for READ.

Consult the FLP-80 Operations Manual; MK78560.

D-8. MONITOR CHECKOUT

D-9. A major portion of the system software and hardware can be checked out by performing the following procedure:

```
$DDT
.F 0,FF,AA(CR)
.Q(CR)
$SAVE 0,FF,TEST(CR)
$DDT(CR)
.F 0,FF,0(CR)
.Q(CR)
$GET TEST(CR)
$DDT(CR)
.M 0,FF(CR)
...
```

All of the displayed locations should have AA in them. If not, then the Disk Diagnostic should be executed.

D-10. DISK DIAGNOSTIC UTILITY

D-11. PURPOSE

D-12. The Disk Diagnostic Utility allows the user to perform a battery of tests on the disk controller and individual disk drives.

D-13. USER INTERFACE

D-14. The Disk Diagnostic Utility is executed by the user by entering the following while in the Monitor environment.

$<u>DSKDIA(CR)</u>

D-15. At this point, the program will print a list of available tests and how to call for them. A brief description of the available tests follows.

D-16. DESCRIPTION OF TESTS

1. TEST 20 -- Write and read every sector. This test causes random data to be written to and read from each sector of the diskette in the unit specified. The data is verified as it is read in.
2. TEST 21 -- read every sector. Every sector of the diskette in the unit specified is read. No check of the input data is performed, however format information is checked.
3. TEST 22 -- read ID. This test allows the user to specify a random track and sector address, which the program will then attempt to access.
4. TEST 23 -- random write and read (single drive). Random track and sector addresses are generated and random data is written to the sector at that address. The data is then read and verified.
5. TEST 24 -- random write and read (both drives). This test is the same as the 23 except that both drives are used.
6. TEST 27 -- format diskette. The diskette in the unit specified is formatted in IBM compatible format (Note, this is not to be confused with the PIP format command).
7. TEST 30 -- Memory test. This tests all memory locations from the end of the program to location $7FFF_H$ (32K system).

8. TEST 31 -- fifo test. This test causes writing to and reading from the fifo on the disk controller board.

NOTE -- the removal of disks containing data to be saved from their respective drives is highly recommended immediately after the Disk Diagnostic Utility is loaded. This will prevent accidential overwriting of data during tests 20, 23, 24, and 27.

APPENDIX E

FLP-80DOS ERROR DICTIONARY

APPENDIX E

ERROR MESSAGE/DESCRIPTION

1 INVALID RQST
A request word was specified which is not a valid DOS request.

2 DUPLICATE FILE
An attempt was made to create a directory entry for a file that already exists. Can occur only on create or rename. In the case of OPENW, the file is opened but this error is reported only as a flag.

3 FILE TABLE FULL
An attempt was made to insert another entry in the active file table when it is full. Can occur only on open or create. Up to 7 files can be open at one time.

4 FILE NOT FOUND
The requested file was not found in the directory. Can occur only on open or rename.

5 DIR FULL
There is no more space to insert another directory entry. The directory can have up to 192 entries in it.

6 DISK WRITE PROTECT
Diskette is write protected and an attempt has been made to write on it. Write protection is documented in the Shugart SA800/801 OEM Manual, paragraphs 8.2 and 8.3.

7 I/O TIME OUT
The maximum time allowed for an I/O device to go ready has been exceeded. This is a non-terminating error printed on

the console device by an I/O device handler. In MOSTEK I/O handlers, the message is output every 20 seconds until the I/O device is made ready by the user. The user may terminate the wait loop via RESET or Console Escape (CNTL-C or CNTL-X from the keyboard).

8 FILE NOT OPEN
An attempt was made to close or perform some record operation on a file which had not been opened. Can occur on any operation except initialize, open, or create.

9 READ PAST EOF
An attempt was made to advance the pointer beyond the last record in the file. The error can occur on read next, skip forward, or delete. In the case of delete it points to a null record, with the previous record being the last one.

0A DISK I/O ERR
A disk I/O error occurred during the operation. Data may have been lost. Can occur on any operation except rewind.

0B DISK FULL
Diskette is full and will not allow the allocation of another record. Can occur only on insert.

0C DISK PTR ERR
The pointers read do not agree with the next or previous record. Can occur on any record operation except rewind. Pointer errors occur because a sector is not readable or because an application program has written on a non-initialized disk.

0D DIR MAP ERR
A read or write error occurred during operations involving

the disk directory or sector and track maps. If operation occurred during a close or erase, directory or maps could be destroyed.

0E FILE ALREADY OPEN
An attempt was made to open or create a file which is currently active.

0F DISK NOT READY
Can occur on any operation when a diskette is not fully inserted and ready.

10 INITIALIZE
A file is being closed on a disk whose ID is different from the one currently in memory. This can occur if disks are changed during operations without initializing. Can occur only on close and erase. Recovery is by initializing disks before operations begin (INIT command).

11 BAD UNIT
A unit has been specified other than 0/-3 for any command.

12 INVALID RQST
An invalid request code was passed to IOCS in the IOCS vector. The programmer should assure that each request code is one which is described in Section 9 of this manual and that the code is allowed for the selected device.

13 UNIT ALREADY OPEN
An attempt was made to open the same device more than once. This applies to non-file-structured devices and file structured devices. The user should open a device only once. The device must be closed via a CLOSE request before it can be opened again.

14 UNIT NOT OPEN

An I/O operation was attempted on a device which had not been opened. This applies to non-file-structured devices and file structured devices. The user should assure that any device to be accessed is opened for read or write via an OPENR or OPENW request.

15 UNSUPPORTED DEVICE

An operation was attempted on a device whose two character device name was not recognized by the system. The user should assure that an allowable device name is being used. Alternatively, new device names may be added to the system (See Section 7-29). This error occurs at the IOCS level. Allowed device names are shown in Section 9-12.

16 INVALID FMAT

The format specification (FMAT) in the IOCS vector is invalid. The programmer should assure that a valid format specification is used (See Section 9).

17 ALLOC ERR

This error occurs if the user attempts to open more than 16 files or devices requiring physical buffers at the same time.

18 DE-ALLOC ERR

This error occurs during a CLOSE request if the physical buffer number (PBFFR) in the IOCS vector contained an erroneous number, or if the physical buffer had previously been de-allocated.

19 BAD FILE NAME

An invalid file name was specified. A file name may have up to 6 alphanumeric characters and must start with an alphabetic character.

1A An attempt was made to read from or write into the directory area of the diskette. These operations are not allowed via the FDH, but they are allowed via the Disk Controller Firmware (DCF). Occurrence of this error during normal operation of the software indicates that the diskette has not been initialized or that track and sector pointers on the diskette have been corrupted. The diskette should be reformatted via PIP's FORMAT command.

1B BAD UNIT, TRK, OR SCTR
Controller has received invalid drive number, or sector and track out of normal range.

1C SEEK ERR
Controller not able to locate track during seek, read, or write operation.

1D SCTR NOT FOUND
Sector address marks not readable.

1E CRC ERR
Incorrect data has been flagged by CRC check during reading.

1F DATA LOST
Hardware problem causing data overrun in reading or writing.

20 INVALID DEVICE SPEC
An I/O device was specified in a command which is not al-

lowed in the system. The user should assure that an allowable device mnemonic is being used. See Section 9-12. Alternatively, new mnemonics may be added to the system (See Section 15-6). This error occurs at the system program level and is used in PIP. The Append command, for example, is only supported on the disk device DK.

21 INCOMPATIBLE EXTENSIONS
An attempt was made to perform some PIP command on files whose extensions are not compatible. Specifically, binary files (extension 'BIN') cannot be intermixed with non-binary files. The user should assure that binary file operations are associated only with binary files. The PIP commands Rename and Copy will generate this error if the extensions are incompatible.

22 BINARY EXTENSION NOT ALLOWED
Binary files (extension 'BIN') cannot be appended. This error is generated by the PIP Append command.

23 RESERVED FOR FUTURE USE

24 I/O FILES EQUAL
An input and output file in a PIP copy command were the same file. The user should assure that any file is not used for both input and output in PIP.

25-2B Reserved for future use.

MONITOR ERROR MESSAGES

2C INVALID LUN
The Logical Unit Number (LUN) specified in a Monitor com-

mand was not allowed. LUN's may be 0/-FEH. LUN FFH is reserved for applications in which the LUN is not to be redirected.

2D SAVE TOO LARGE

The amount of memory to be saved as a binary file via the Monitor SAVE command exceeded the maximum allowable, which is 256x124=31744 bytes. The user should assure that the maximum size of the area to be saved does not exceed 31744 bytes.

2E INVALID EXTENSION

A valid extension consists of one to three alphanumeric digits.

2F ASSIGN TABLE FULL

Too many redirects were attempted via the Monitor ASSIGN command. The maximum number of allowed redirects is 6. The user should eliminate some of the redirects via the Monitor CLEAR command.

30 MEMORY FAULT LOC

A memory location was found to be faulty. The address is printed out.

31 CHECKSUM

A checksum error was encountered by the LINKER within an object module. The user should regenerate the object module and then try linking it.

32 GLOBAL DOUBLE DEF

The LINKER generates this error when a global symbol is multiply defined in two different modules.

33-34 RESERVED FOR FUTURE USE

35 MODULE SEQUENCE ERROR
During use of the LINKER, specification of modules to be linked did not match during both passes.

36 NOT ENOUGH MEMORY AVAILABLE
During use of the LINKER, the largest object module to be linked exceeded the available memory.

37-3E Reserved for future use.

ASSEMBLER ERROR MESSAGES

3F BAD RELOCATABLE USAGE
A relocatable value was used in an 8-bit operand. The user should assure that relocatable quantities are used only for 16-bit operand values (addresses), or the PSECT ABS pseudo-op should be used.

40 BAD LABEL
An invalid label was specified. A label may consist of any printable ASCII characters except '( ) * + , - = . / : ; or space. In addition, the first character cannot be a number. A label may start in any column if followed by a colon. It does not require a colon if started in column one.

41 BAD OPCODE
An invalid Z80 opcode or pseudo-op was specified. This error will also occur for a label which starts beyond column 1 and is not followed by a colon.

42 BAD OPERAND

An invalid operand or combination of operands was specified for a given opcode.

43 BAD SYNTAX

The specification of an operand was invalid.

44 UNDEF SYMBOL

A symbol was used in an operand which was not defined in the program, either locally or as an external symbol.

45 MULTIPLE DEF

A symbol was defined more than once in the same program.

46 MULTIPLE PSECT USAGE

A PSECT pseudo-op was used more than once or was defined after the first code producing opcode. The PSECT pseudo-op should be used only once at the beginning of a program.

47 SYMBOL TABLE FULL

The symbol table of the Assembler is full and will accept no more symbols. The user should reduce the number of symbols in his program or break the program up into one or more linkable modules.

48 BAD EXTERNAL USAGE

An external symbol was used in an expression or as the operand of an 'EQU' or 'DEFL' pseudo-op. The user should assure that an external symbol is not used in these situations.

49 MACROS NOT ALLOWED WITH THIS VERSION

The current version of the Assembler does not support macros.

4A UNBALANCED QUOTES

An uneven number of quote characters (') occurred in an operand or operands.

4B LABEL REQUIRED

A label was not used on an 'EQU' or 'DEFL' pseudo-op. Each 'EQU' or 'DEFL' pseudo-op must have a label associated with it.

4C OVERFLOW IN EXPRESSION

In evaluating an expression, the value of the expression exceeded 65536 (0/FFFFH). The user should check the expression for validity. Alternatively, the .RES. operation may be used to ignore the overflow condition and only the least significant 16 bits of the expression will be used.

4D OPERAND OUT OF RANGE

The final value of an operand was found to be out of the range allowed for the given opcode. For example, the valid range of the JR operand is -126 through +129.

4E BAD DIGIT

An invalid digit was found in a number.

4F BAD OPERATOR

An invalid operator was found in an expression.

50 BAD SYMBOL TABLE LIMITS

The available RAM is not sufficient for the Assembler symbol table. The user should assure that 'BALR' (Bottom of Allocated RAM) is correct for his configuration. 'BALR' is defined in locations FF02H and FF03H. All system routines exist above BALR and must not be overwritten. See SYSGEN,

51 INPUT TRUNCATED

The input statement exceeded 80 characters in length. This is the system input limit for all FLP-80DOS Software.

52 MULTIPLE NAME

The 'NAME' pseudo-op was used more than once in the same program. The user should use the NAME pseudo-op only once per source module.

53 The 'INCLUDE' pseudo-op was nested. The user should assure that the 'INCLUDE' pseudo-op is not used in the body of an included module.

54 The expression evaluator stack reached its limit. The user should reduce the complexity of the expression in the statement with caused the errror.

55 The cross reference table became too large. This is a warning message indicating that not all cross references will be output in the cross reference listing.

APPENDIX F

SYSTEM LINKAGES
(SYSLNK)

F-1. INTRODUCTION

F-2. FLP-80DOS system routines are documented in Section 13 of this manual. The linkage addresses for these routines are documented here, and they are set up in a file on the system diskette called SYSLNK. SYSLNK contains linkages for all system routines resident in PROM (E000-EFFF). It also contains the variable JTASK which is the linkage to the RAM resident system routines in the operating system (See Section 13), and the linkage to JIOCS for calls to IOCS.

F-3. Any program using a system routine should declare that routine name as an external global symbol.

EXAMPLE

```
GLOBAL RDCHR
GLOBAL WRCHR
GLOBAL JTASK
```

F-4. When the user program is loaded or linked, the SYSLNK.OBJ file should be linked in with it to resolve these external references.

EXAMPLE

$<u>LINK MYFILE,SYSLNK(CR)</u>

F-5. The source and object files SYSLNK.SRC and SYSLNK.OBJ are both included on FLP-80DOS system diskettes.

```
LNK COPYRIGHT 1978 MOSTEK CORP       MOSTEK FLP-80 ASSEMBLER V2.0 PAGE 0001
DR   OBJECT     ST # SOURCE STATEMENT        DATASET = DKO:SYSLNK.SRC

                0002        NAME    SYSLNK
                0003        PSECT   ABS
                0004 ;**********************************************
                0005 ;*      SYSTEM LINKAGES FOR FLP-80DOS V2.0      *
                0006 ;*                                              *
                0007 ;*      ID: SYSLNK   VERSION 2.0   5/22/78      *
                0008 ;*                                              *
                0009 ;*      PROGRAMMER: JOHN BATES                  *
                0010 ;*                                              *
                0011 ;*      DESCRIPTION:                            *
                0012 ;*      THIS IS AN ABSOLUTE LINK BLOCK FOR      *
                0013 ;*      FLP-80DOS SYSTEM SUBROUTINES.  MOST OF  *
                0014 ;*      THESE ROUTINES ARE RESIDENT IN THE      *
                0015 ;*      SYSTEM FIRMWARE AREA (E000-EFFF).       *
                0016 ;*      ADDITIONAL RAM RESIDENT SYSTEM ROUTINES *
                0017 ;*      IN OS.BIN[255] MAY BE ACCESSED THROUGH  *
                0018 ;*      LINKAGES IN SCRATCH PAD RAM (E.G.TASK). *
                0019 ;*      EACH SYSTEM SUBROUTINE IS IDENTIFIED BY *
                0020 ;*      ITS ASSIGNED NAME AND ITS ASSOCIATED    *
                0021 ;*      STARTING ADDRESS.  THIS SOURCE MODULE   *
                0022 ;*      SHOULD BE ASSEMBLED SO ITS OBJECT MODULE*
                0023 ;*      MAY BE LINKED WITH USER PROGRAMS OR     *
                0024 ;*      SYSTEM PROGRAMS (E.G. PIP).             *
                0025 ;**********************************************
                0026 ;
                0027 ;
                0028 ;
                0029 ;      SYSTEM SUBROUTINES IN FIRMWARE SPACE (E000-EFFF)
                0030 ;
                0031        GLOBAL  AORN
>E56A           0032 AORN   EQU     0E56AH
                0033        GLOBAL  ASBIN
>E583           0034 ASBIN  EQU     0E583H
                0035        GLOBAL  CRLF
>E59C           0036 CRLF   EQU     0E59CH
                0037        GLOBAL  ECHO
>E597           0038 ECHO   EQU     0E597H
                0039        GLOBAL  EH
>E003           0040 EH     EQU     0E003H  ;ERROR HANDLER
                0041        GLOBAL  FATAL
>EC23           0042 FATAL  EQU     0EC23H  ;FATAL ERROR EXIT
                0043        GLOBAL  FLOPPY
>EC00           0044 FLOPPY EQU     0EC00H  ;FLOPPY CONTROLLER
                0045        GLOBAL  LOADER
>EC03           0046 LOADER EQU     0EC03H  ;LINKED FILE LOADER
                0047        GLOBAL  MINDIS
>E3B3           0048 MINDIS EQU     0E3B3H  ;DISABLE MINIMAL LISTNER
                0049        GLOBAL  MINEN
>E534           0050 MINEN  EQU     0E534H  ;ENABLE MINIMAL LISTNER
                0051        GLOBAL  PACC
>E58B           0052 PACC   EQU     0E58BH
                0053        GLOBAL  PADDO
>E61C           0054 PADDO  EQU     0E61CH
                0055        GLOBAL  PASP
>E5AA           0056 PASP   EQU     0E5AAH  ;PRINT ACC AND SPACE
                0057        GLOBAL  PTXT
>E3C7           0058 PTXT   EQU     0E3C7H
                0059        GLOBAL  RDCHR
```

```
 ADDR  OBJECT     ST # SOURCE STATEMENT          DATASET = DKO:SYSLNK.SRC

 >E522            0060 RDCHR   EQU     0E522H
                  0061         GLOBAL  RENTRY
 >E11D            0062 RENTRY  EQU     0E11DH  ;DDT-80 RENTRY POINT
                  0063         GLOBAL  ENTRY
 >E066            0064 ENTRY   EQU     0E066H  ;BREAK PT REENTRY
                  0065         GLOBAL  RUN
 >EFE1            0066 RUN     EQU     0EFE1H  ;EXIT FOR IMPILIED RUN CMD
                  0067         GLOBAL  SCAN
 >E414            0068 SCAN    EQU     0E414H
                  0069         GLOBAL  SPACE
 >E5A5            0070 SPACE   EQU     0E5A5H
                  0071         GLOBAL  SRCHU
 >E547            0072 SRCHU   EQU     0E547H
                  0073         GLOBAL  WRCHR
 >E527            0074 WRCHR   EQU     0E527H
                  0075         GLOBAL  REBOOT
 >E006            0076 REBOOT  EQU     0E006H
                  0077 ;
                  0078 ;       SCRATCH PAD VARIABLES
                  0079 ;
                  0080         GLOBAL  ERSTAT
 >FF09            0081 ERSTAT  EQU     0FF09H  ;ERROR STATUS
                  0082         GLOBAL  JTASK
 >FF26            0083 JTASK   EQU     0FF26H  ;JUMP TO TASK
                  0084         GLOBAL  JIOCS
 >FF29            0085 JIOCS   EQU     0FF29H  ;JUMP TO IOCS
                  0086 ;
                  0087         END

ERRORS=0000
```

APPENDIX G

DISK RECOVERY UTILITY

APPENDIX G

DISK RECOVERY UTILITY

G-1. INTRODUCTION

G-2. The Disk Recovery Utility may be used to recover ASCII text files that are inaccessible to other programs due to some form of error within the file. Typically, the Disk Recovery Utility would be used to recover files that have experienced a pointer error.

G-3. USER INTERFACE

G-4. The file to be recovered must be on the diskette currently in unit DK1:. As its contents are recovered, they are copied to a file on unit DK0: (the file is automatically created by the Disk Recovery Utility).

G-5. The Disk Recovery Utility is invoked by entering the following from the console while in the monitor environment:

```
$DSKREC DK1:sfilename  TO  DK0:dfilename  (CR)
```

G-6. The parameter 'sfilename' is the name of the input (source) file that is to be recovered. The parameter 'dfilename' is the name of the output (destination) file that is to receive the recovered data. This is optional and defaults to the name of the source file.

G-7. After the above is entered by the user, the program attempts to recover the source file. One or more of the following messages may then be printed.

G-8. MESSAGES

G-9. Error messages that may be printed by the Disk Recovery Utility are listed in Appendix E (FLP-80DOS ERROR MESSAGES/-DESCRIPTION)

G-10. The following messages indicates normal termination of the Disk Recovery Utility:

DSKREC> FILE VERIFIED--NO ERRORS

This indicates that the file was recovered and that no errors of any sort were detected.

DSKREC> FILE RECOVERED--POSSIBLE ERRORS

The source file has been partially recovered. An error was detected in the file and therefore some data may have been lost.

G-11. When some form of error is detected in a file being recovered, the Disk Recovery Utility inserts a message into the recovered copy of the file at the point were the error occurred. This message is highly visible and enables the user to quickly locate the area in the recovered file at which data may be garbled and/or lost. This message should be deleted from the recovered copy of the file when the user has verified the data in the area of the message. The message will appear as follows:

```
************************************
* I/O OR POINTER ERROR OCCURRED HERE*
************************************
```

G-12. METHOD OF OPERATION

G-13. The procedure used by the Disk Recovery Utility to recover disk files is descibed below.

G-14. The directory entry for the source (input) file is obtained from the disk file directory. Within this entry the addresses of the first and last sectors in the source file are found. These are copied and saved. At this point the destination file is created on unit DK0:.

G-15. The source file is then read and copied to the destination file sector by sector until either an end of file or error condition is detected. If an end of file condition is detected, the output file is closed and a message is printed on the console indicating that no errors were detected. The program returns control to the Monitor. If an error condition is detected, the program retries the operation 50 times. If the error is still present, the program then writes a message to the destination file that will aid the user in locating the area in the file where data is suspect.

G-16. The program then begins reading sectors backward starting at the last sector in the file (the address was saved previously). No sectors are written to the destination file during this pass. Reading continues until an error condition is detected and 50 retries are performed.

G-17. Sectors are then read forward, beginning at the last sector correctly read (in G-16, above). These sectors are written to the destination file. Reading and copying continues until the end of the source file is detected, at which time a message is printed on the console indicating that errors have been detected. The program then returns control to the Monitor.

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