MOVING-HEAD
DISC OPERATING SYSTEM

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PREFACE

MOVING-HEAD DISC OPERATING SYSTEM is the programmer's guide for the Hewlett-Packard Moving-Head Disc Operating System (DOS-M). DOS-M is a batch processing system that executes complete jobs with little or no operator intervention. For a full understanding of DOS-M the reader should be familiar with one of the Hewlett-Packard programming languages, as presented in the *FORTRAN* (02116-9015), *FORTRAN IV* (5951-1321), *ALGOL* (02116-9072) and *ASSEMBLER* (02116-9014) programmer's reference manuals and should refer to the appropriate modules of the *SOFTWARE OPERATING PROCEDURES*.

The Introduction of this manual explains the software and hardware elements of the system. Section I presents the system organization, while Sections II and III cover the complete set of batch and keyboard directives and program calls to the system. All facets of DOS-M programming -- FORTRAN, ALGOL, Assembler, Loader, DEBUG, and Library -- are presented in Section IV. Section V assembles all the necessary information on input/output, including the planning of I/O drivers. Section VI describes use of the Extended File Management Package. The appendices provide tables, summaries, and sample job decks.

NEW AND CHANGED INFORMATION

This new edition reflects changes to DOS-M necessary to accommodate a new disc driver (HP 2883), the FORTRAN IV Compiler, and the Extended File Management Package. System installation has been removed from this manual and placed in the *SOFTWARE OPERATING PROCEDURES*.

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INTRODUCTION

In the Moving-Head Disc Operating System (DOS-M), software modules are stored permanently on the disc for high-speed batch processing, eliminating slow and inefficient paper tape loading. Input can be set up and executed in serial order to automatically edit, translate, load and execute a set of source programs written in HP FORTRAN (an extension of ASA BASIC FORTRAN), HP ALGOL, HP FORTRAN IV, or HP Assembly Language. A variety of files can be stored, edited, listed, dumped and used as input to programs.

FEATURES OF DOS-M

DOS-M contains the following highlights and features:

- Keyboard and batch processing modes,
- Software programming aids: FORTRAN Compiler, Assembler, Relocating Loader, Relocatable Library, Debug Routine, Source File Editor, and ALGOL.
- Jobs executed in a queue with minimal operator intervention,
- Symbolic disc files, with relative addressing,
- Centralized and device-independent I/O processing,
- Modular structure,
- Custom configuration to optimize available memory and I/O,
- Cyclic error checking on disc read & write operations,
- Exchangeable discs packs, and
- Optional search of the entire system for file names.

With additional core memory, DOS-M also provides:

- Extended Files (8K more)

MINIMUM HARDWARE

The minimum hardware requirements for the Moving Head Disc Operating System are:

1. Computer, 8,192 words of memory, Central Interrupt Processor, DMA, halt on memory parity error.
2. HP 2870 Moving-Head Disc Drive with fixed disc and removable cartridge or HP 2883 Disc File (requires greater than 8,192 words of memory) with one removable pack.
3. System Input Device: Teleprinter (HP 2752).
4. Batch I/O Device: Second Teleprinter (HP 2754).

In place of the HP 2754B teleprinter, the user can select one of the following combinations instead for batch operations:

Batch List Device	Batch Input Device	Batch Punch Device
HP 2752A Teleprinter	Punched Tape Reader	Punch Unit
HP 2752A Teleprinter	Mark Sense Card Reader	Punch Unit
Line Printer	Punched Tape Reader	Punch Unit
Line Printer	Mark Sense Card Reader	Punch Unit

The following hardware options are available:

1. Time Base Generator (provides accounting times).
2. Extended Arithmetic Unit (EAU): provides hardware multiply, divide, etc. for user programs. (DOS-M software contains no EAU instructions.)
3. Additional memory: 12,288, 16,384, or 32,768 words.
4. Additional I/O channels: extenders are available.
5. Memory Protect. (Without memory protect, user programs can destroy DOS-M.)
6. Photoreader.
7. Paper Tape Punch.
8. Line Printer

9. Mark Sense Card Reader.

10. HP 3030 Magnetic Tape Unit (requires 2116 DMA).

11. Additional Disc Drives. (Maximum is four on HP 2870 and two on HP 2883.)

12. Plotter

DOS-M SOFTWARE MODULES

DOS-M consists of the following programs:

DOS-M Supervisor and sub-modules
DOS-M Assembler
DOS-M FORTRAN Compiler
DOS-M Relocating Loader
DOS-M Moving-Head Disc Driver or Pack Disc Driver (DVR31)
DOS-M Special Teleprinter Driver (DVR 05)
DOS-M DSGEN (the system generator)

In addition, the following programs can be included when DOS-M is generated:

RTE/DOS FORTRAN IV Compiler (8K version and 16K version)
RTE/DOS ALGOL Compiler (16K memory required)
RTE/DOS Relocatable Library (EAU or Non-EAU)
RTE/DOS FORTRAN IV Library (extended precision arithmetic)
DOS I/O Drivers (either core- or disc-resident):

- Teleprinter (DVR ØØ)
- Photoreader (DVR Ø1)
- Tape Punch (DVR Ø2)
- Line Printer (DVR 12)
- Mark Sense Card Reader (DVR 15) (uses DMA)
- 3030 Magnetic Tape (DVR 22) (uses 2116 DMA only)
- Plotter (DVR 1Ø)

Extended File Management Package (16K required).

DOS-M Supervisor

The DOS-M supervisory software consists of a monitor (DISCM) that is partly core-resident and partly (optionally) disc-resident and a disc-resident job processor (JOBPR):

DISCM

Interrupt Processor

Executive Processor

I/O Processor

Executive modules:

$EXØ1 through $EX2Ø

NOTE: Exec modules can be made either core- or disc-resident when DOS-M is generated.

JOBPR

Job Processor

File Manager

NOTE: JOBPR is always made disc-resident when DOS-M is generated. DISCM brings it into core when needed.

SECTION I
SYSTEM ORGANIZATION

An operating system is an organized collection of programs which increases the productivity of a computer by providing common functions for all user programs.

An operating system's function is to aid in the preparation, translation, loading, and execution of programs. This is accomplished by an auxiliary, quick access memory, usually a disc storage unit. The various translators, loaders, and other software are stored permanently on the disc for use only when needed. Since the programmer requests a compiler from the disc instead of loading it by hand from paper tape, the overhead time can be significantly reduced.

DOS-M

The Moving-Head Disc Operating System is composed of user disc files and the DOS-M Supervisor. The Supervisor consists of two parts: a Disc Monitor (DISCM) and a Job Processor (JOBPR). DISCM consists of modules which are either core- or disc-resident and handle I/O transfers, requests from programs, and other supervisory tasks. The disc-resident JOBPR handles operator and programmer directions from the batch or keyboard device.

The Moving-Head Disc Operating System affords speed and convenience. Programs can be input to DOS-M for automatic translation, loading, and execution. For example, simple punched cards carry out load-and-go operations in DOS-M as follows:

a. DOS-M reads the FORTRAN Compiler into core from the disc.

b. The Compiler reads the source program from an external device, such as a card reader, and stores the relocatable binary instructions on the disc.

c. DOS-M reads the Loader into core from the disc.

d. The Loader reads the relocatable binary programs from the disc and stores the converted binary instructions on the disc.

e. DOS-M reads the program in from the disc and runs it.

Directives

The DOS-M Supervisor operates in response to directives input by the programmer or operator. Directives are strings of up to 72 characters that specify tasks to DOS-M. They are entered in one of the two modes of DOS-M operation: keyboard or batch. In keyboard mode, the directives are entered manually from the teleprinter keyboard. In batch mode, directives can be input as punched cards integrated with the source program into a *job deck* or from paper tape with source in card reader.

A job is a related set of user tasks and data. In keyboard mode, the directives (tasks) are entered separately from the job data. In batch mode, they are included in a job deck that can execute without manual intervention. Jobs may be stacked directly upon one another in a queue.

The DOS-M directives are used for the following functions:

- Create, edit, list, dump, and purge user files (relocatable, loader-generated, source and ASCII or binary data).
- Turn on systems programs such as FORTRAN, Assembler, etc.
- Modify the logical organization of the I/O.
- Start and stop a job; type comments; suspend operations.
- Translate, load and execute a user program.
- Dump core or disc memory.
- Resume execution of suspended programs.
- Set the date; abort programs; transfer to batch mode (from keyboard mode or batch mode); return to keyboard mode (from batch mode).
- Check status of user disc tracks.
- Change the subchannel of the user disc.
- Search the various disc subchannels for specified file names.
- Initialize (label) disc.
- Dump a disc to another disc.

DOS-M directives are described in detail in Section II.

EXEC Calls

After being translated and loaded, an executing user program communicates with DOS-M by means of EXEC calls. An EXEC call is a JSB instruction which transfers control to the DOS-M Supervisor.

The EXEC calls perform the following functions:

- I/O read and write operations.
- User file and work area read and write operations.
- I/O control operations (backspace, EOF, etc.),
- Request I/O status.
- Change the subchannel of the user disc.
- Request limits and status of WORK area (temporary disc storage).
- Program completion.
- Program suspension.
- Loading of program segments or main programs.
- Request the time.

Section III describes EXEC calls in detail.

Input/Output

All I/O operations and interrupts are channeled through the DISCM section of the DOS-M Supervisor. DISCM is always core-resident and maintains ultimate control of the computer resources. (See *"Software I/O Structure,"* Section V.)

I/O programming is device-independent. Programs written in FORTRAN, ALGOL, and Assembly Language specify a logical unit number (with a predefined function, such as data input) in I/O statements instead of a particular device. Logical unit numbers are assigned to appropriate devices by the operator, depending upon what is available. Thus, the programmer need not worry about the type of input or output device performing the actual operation. (See *"Logical Unit Numbers,"* Section V.)

SYSTEM ORGANIZATION

Core Layout

When DOS-M is active, the core memory is divided into a user program area and a system area (as shown in Figure 1-1). The Disc Monitor program handles all EXEC calls and, if they are legal, transfers them to the proper module for processing. The I/O drivers handle all actual I/O transfers of information. If some I/O drivers are disc-resident, they are read into core by the supervisor when needed. The user program area provides space for execution of user programs. In addition, large DOS-M software modules, such as the FORTRAN Compiler, Assembler, Relocating Loader, and Job Processor, reside on the disc and execute in the user program area.

If the memory protect option is present, a memory protect boundary is set between the executive area and the user program area. This boundary interrupts whenever a user program attempts to execute an I/O instruction (including a HALT) or to modify the executive area. (Instructions can reference the switch register and overflow register.) Programs to be run in the user area must use EXEC calls for input/output, termination, suspension, and other external processes.

DISC USAGE

HP 2870

The controller for the moving-head disc supports up to four disc drives (one is required). Each drive contains two discs: a fixed disc and a removable cartridge. Each disc is referenced through a subchannel of the controller. Therefore, the controller has eight subchannels (numbered 0 to 7). The channels are assigned as follows:

Disc Drive Numbers	0	1	2	3
Permanent Subchannels	0	2	4	6
Removable Subchannels	1	3	5	7

HP 2883

The controller supports one or two drives. Each drive contains a removable pack of disc surfaces and is divided into 4 subchannels. Therefore, this controller also has up to 8 subchannels. The subchannels are assigned as follows:

Disc drive 0 (subchannels 0, 1, 2, 3)
Disc drive 1 (subchannels 4, 5, 6, 7)

Each subchannel contains 203 tracks. At least three of these tracks must be spares. On the HP 2870, each track contains 24 sectors; on the HP 2883, 115 sectors. (A sector contains 128 16-bit words and is the smallest addressable unit on the disc.) DOS-M normally allows two subchannels to be available to the user: one subchannel contains the system disc and the other contains the user disc (may be the same subchannel as the system disc). The user subchannel can be changed during job or program execution. In addition, an optional system search mode is available to allow searching for user files on any specified subchannels.

The disc storage has four parts:

1. The System Area:
   Executable code created by the system generator and hardware protected; includes DOS-M Supervisor and other system programs.
2. The User Area (optional):
   User file directory and user files (data, object programs, source statements, etc.).
3. The Work Area:
   Temporary storage for the current job.
4. Job Binary Area:
   Temporary storage for relocatable object code generated by the assembler and compilers; this is an area of variable size and starts from the end of the disc.

All four of these areas can reside on the system subchannel. Or the user area can be on a separate subchannel. Only one user area is available to the system at a time. The standard user subchannel is assigned at system generation time; this can be the system disc or another subchannel (removable or permanent disc). The :UD directive and an analogous EXEC call allow the user to temporarily change the user area to another subchannel.

Automatic track switching is provided within each subchannel.

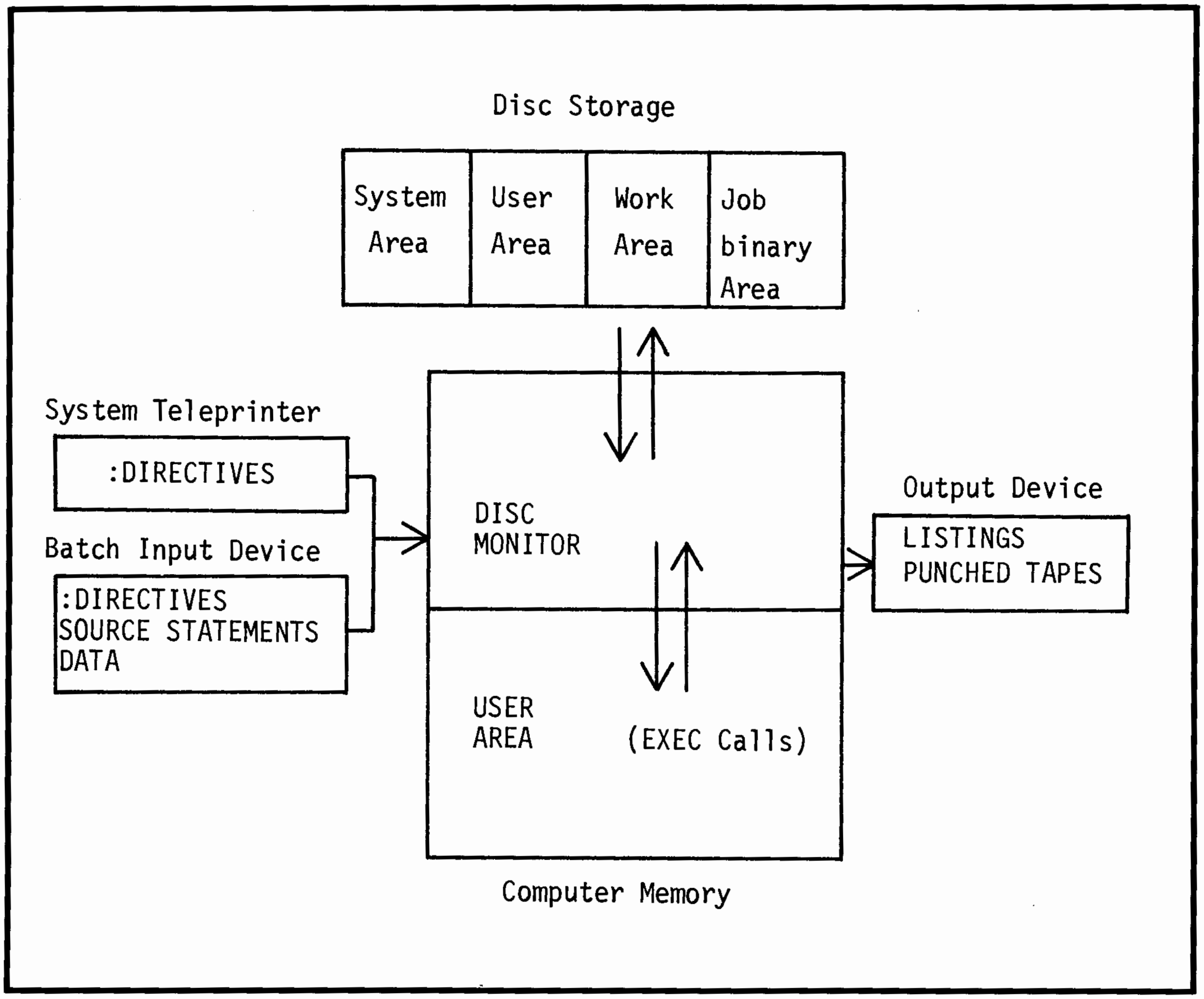


Figure 1-1. Functional Diagram of DOS-M

DOS-M Files

The disc provides quick access and mass storage for user files consisting of source statements, relocatable and loader-generated object programs, and ASCII or binary data. Each file has a name that is used to reference it.

Programs use the work area of the disc for temporary storage. The system area contains files of systems programs, EXEC modules, a system directory, and library subroutines (see *LIST,* Section II).

EXTENDED FILE MANAGEMENT PACKAGE

DOS-M installations with 16K of memory can use the Extended File Management Package (EFMP). This set of optional EXEC modules allows the user program to set aside certain subchannels for a more powerful file structure than that provided by DOS-M. EFMP files allow logical record size (varied under program control), security codes, flexible buffering, sequential reads and writes with a pointer, and detailed status information. In addition, a utility program is available that operates in the user area. It makes these EFMP functions, normally only usable through EXEC calls, usable from the keyboard. For more information on EFMP, see Section VI.

DOS-M Installation

DOS-M is a series of relocatable binary software modules. Since each module is an independent, general purpose program, the hardware and software configuration of each DOS-M is quite flexible. A separate absolute program, DSGEN, accepts the software modules and generates a configured DOS-M following dialogue-type instructions from the user.

Certain DOS-M modules may be either core- or disc-resident. In a minimum 8K core system, all possible modules are disc-resident; but a 16K memory allows more modules to be core-resident for greater efficiency.

An absolute copy of the configured DOS-M is stored on the disc and is protected from alteration by a hardware override switch. A bootstrap program is used to initiate DOS-M from the disc.

SECTION II
DIRECTIVES

Directives are the direct line of communication between the keyboard or batch input device and the Moving-Head Disc Operating System. The operator enters these directives manually through the keyboard or the programmer enters them on punched cards within his job deck. Directives are able to:

- Initiate, suspend, terminate, and abort jobs,
- Switch between keyboard and batch mode,
- Execute, suspend, and resume programs (including compilers, loaders, etc.),
- Print the status of the disc tracks and the I/O tables,
- Create and purge files of source statements, relocatable and loader-generated binary programs, and ASCII or binary data,
- Edit source statement files,
- Set up source files for compilers and assemblers,
- List and dump files, dump disc and core,
- Declare I/O devices up and down,
- Set the date and print comments,
- Change user disc subchannel,
- Dump a copy of a disc onto another subchannel,
- Search specified subchannels for file names,
- Initialize a disc, and
- Turn off an executing program.
- Write an end-of-file on magnetic tape.

Directives may enter DOS-M in two modes: keyboard and batch. In either mode, all directives are listed on the teleprinter. Certain directives are legal in one mode only; other directives are operable in both. In keyboard mode, the operator manually inputs the directives through the teleprinter keyboard. In batch mode, the programmer prepares the directives on punched cards or paper tapes and inputs them along with programs, data, etc, in a complete job.

DIRECTIVES

Directives have the same format, regardless of the mode in which they occur: ":" followed by a directive word (first two characters are significant) and, if necessary, a list of parameters separated by commas (maximum is 15). For example,

```
        :PROG,FTN,99
```

When the sequence of parameters is significant, missing parameters must be represented by commas if the following parameters are to be recognized. The first blank character not preceded by a comma is the end of the directive. Comments may appear after this blank; they are ignored by DOS-M. A "rubout" anywhere in a directive deletes the entire directive, while a "control-A" (striking the "A" key and the "control" key simultaneously) deletes the previous character.

DOS-M has two conventions for notifying the operator that directives may be entered. An asterisk (*) means that DOS-M is waiting for an operator attention directive (see below). An "@" with the bell signals that DOS-M is waiting for further directions. (During some operations, such as editing, there may be perceptible waits while DOS-M processes the directive.)

The operator attains control of DOS-M at any time by striking any system teleprinter key. If the teleprinter is available, DOS-M prints an asterisk (*) on it; if it is busy, DOS-M prints an asterisk as soon as it is free. At this time, the operator may enter any of the following directives (described in detail in this section):

```
        :ABORT
        :DN
        :EQ
        :LU (reports only)
        :TYPE
        :UP
        :OFF
        :PAUSE
```

NOTE: Operator attention is disabled during the completion phase of :EDIT and during :PURGE.

DIRECTIVES

If the operator types any other directives, DOS-M prints the following message and returns to the executing program.

```
        IGNORED
```

Some system conditions restrict allowable directives; e.g., after an I/O ERR NR EQT# *nn*, the system is waiting for an :UP,*nn*, followed by :GO. Under such conditions, otherwise legitimate directives will be IGNORED.

ABORT

Purpose

To terminate the current job before the next JOB or EJOB directive.

Format

```
:ABORT
```

Comments

ABORT carries out all the operations of an EJOB. All I/O devices are cleared. When it returns to the batch device, DOS-M ignores all directives, except TRACKS, OFF, BATCH, or TYPE, until it finds a new JOB directive. An ABORT may be entered through the keyboard, even if DOS-M is in batch mode.

BATCH

Purpose

To switch from keyboard mode to batch mode or to reassign the batch device.

Format

```
:BATCH,logical unit
```

where *logical unit* is the device to be used as the batch input device.

Comments

See "TYPE" in this section for the opposite procedure of returning from batch mode to keyboard mode.

COMMENT

Purpose

To print a message on the system teleprinter.

Format

```
:COMMENT Character String
```

where *Character String* is a message to be printed on the teleprinter.

Comments

The programmer may use the COMMENT directive with the PAUSE directive to relay instructions to the operator about setting up magnetic tapes, etc. A space (but not a comma) is required between the directive word and the comment string.

Examples

```
:COMMENT PLACE MAGTAPE LABELED "INPUT" ON THE M.T. UNIT
:COMMENT PUT "INPUT" PAPERTAPE IN PHOTOREADER
```

DISC-TO-DISC DUMP

Purpose

i. To dump an entire disc onto another subchannel (:DD)

ii. To dump the system area (including system buffer) onto another subchannel (:DD,X)

iii. To dump all or specified files of the user area (optionally assigning some new file names) onto another subchannel (:DD,U...)

Formats

i. :DD

ii. :DD,X

iii. :DD,U[,*file 1*[,(*file A*)],*file 2*[,(*file B*)],...]

where X specifies the system area,

U specifies the user area,

file 1, file 2, ... specify the files to be dumped (the entire user area if no files are specified),

file A, file B, ... specify the optional new names for *file 1, file 2,* etc. (renamed files can be intermixed with unchanged files).

The destination disc must be specified by a :UD directive immediately following the :DD directive. Any other directive will negate the :DD. (For :DD and :DD,X, the directive must be :UD,*,*n* where *n* is not the system disc.)

Comments

When the destination for a :DD,U is a system disc, other than the current system, the user files are dumped in the user area following the system files. This allows the user to dump a system and selected user files to a single disc. (See also :IN.)

The :SS directive does not apply to :DD.

If the files of the source disc cannot completely fit on the destination disc, DOS-M transfers as many whole files as possible and prints

```
TRAC # TOO BIG
```

If DOS-M cannot find some of the files specified to be dump, the messages

```
file
UNDEFINED
```

is printed. This does not effect dumping of the files which are defined.

If a file specified to be dumped has the same name as an existing file on the destination disc, the message

```
file
DUPLICATE FILE-NAME
```

is printed and the file is not dumped. This does not effect dumping of other files.

DOWN

Purpose

To declare an I/O device unavailable for use either before or dur-the execution of a program.

Format

```
:DN,n
```

where *n* is the equipment table entry number for the device to be set down.

Comments

The system teleprinter and the disc (logical units 1,2, and 3) cannot be set down. :UP resets the down condition.

FILE DUMP

Purpose

To dump a user file to a specified peripheral I/O device in a format appropriate to the file content.

Format

:DUMP,*logical unit,file*[,*S1*[,*S2*]]

where *logical unit* is the output device to be used for the dump,
file is the user file to be dumped,
S1 and *S2* are the first and last relative sectors to be dumped.

If *S1* and *S2* are not given, the entire file is dumped. If only *S1* is given, then the file, starting with *S1*, is dumped.

Comments

Files may be dumped on list devices or punch devices. The dump format varies with the type of file and the type of device. See Table 2-1.

Table 2-1

FILE DUMP Formats

File Type	Punch Device	List Device
ASCII data	64 characters/record	64 characters/record
Binary data	64 words/record	8 octal words/line
Rel. binary programs	Relocatable binary records (loadable)	8 octal words/line
Source statements	1 statement/record	1 statement/line

Source statements are packed and do not necessarily start on sector boundaries. Thus, if the *S1* and *S2* parameters are used, dumping begins with the start of the first statement beginning in sector *S1,* and ends with the last statement beginning in sector *S2* (this will probably end in the following sector).

Files in the system area cannot be dumped. Errors occur when *S1* > *S2,* or when either *S1* or *S2* is greater than the length of the file.

Examples

Where L is a source file:

```
        :DUMP,1,L
        A
        BB
        CCC
        DDDD
        EEEEE
        FFFFFF
        GGGGGGG
        @
```

Where SSERH is a binary file:

(On the keyboard:)

```
        :DU,6,SSERH,1,1
        @
```

(On the list device:)

```
ØØ1 ØØØØØØ  Ø62125  Ø72121  114535  Ø1ØØ1Ø  Ø1ØØ75  Ø1Ø156  Ø1Ø1ØØ
    ØØ24ØØ  Ø521ØØ  Ø26Ø14  Ø26Ø36  Ø62ØØ6  Ø42154  Ø72Ø23  114535
    Ø1ØØ25  Ø1ØØ76  Ø1ØØ77  Ø1ØØØ6  Ø1Ø153  114535  Ø1ØØ33  Ø1ØØ76
    Ø1ØØ77  Ø1Ø1Ø1  Ø1Ø117  1Ø25Ø1  ØØ2ØØ2  Ø26Ø56  Ø62ØØ6  Ø72Ø46
    114535  Ø1ØØ5Ø  Ø1Ø123  Ø1ØØ76  Ø1Ø127  Ø1Ø124  Ø1ØØØ6  Ø1Ø122
    114535  Ø1ØØ56  Ø1ØØ76  Ø1ØØ77  Ø1Ø126  Ø1Ø153  Ø36ØØ6  Ø36ØØ6
    Ø36ØØ6  Ø36121  Ø26ØØ3  114535  Ø1ØØ71  Ø1ØØ76  Ø1ØØ77  Ø1Ø1Ø6
    Ø1Ø12Ø  114535  Ø1ØØ74  Ø1ØØ74  ØØØØØ6  ØØØØ22  ØØØØØ2  ØØØØØ1
    ØØØØØØ  Ø2Ø116  Ø47524  Ø2Ø1Ø6  Ø47525  Ø471Ø4  Ø2Ø12Ø  Ø51117
    Ø43522  Ø4Ø515  Ø2Ø1Ø3  Ø47515  Ø5Ø114  Ø42524  Ø425Ø4  ØØØØØ5
    ØØØØ11  ØØØØØØ  ØØØØØØ  ØØØØ16  ØØØØØ2  177746  Ø2ØØ4Ø  Ø2ØØ4Ø
    Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø
    Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø
    Ø2ØØ4Ø  Ø2ØØ4Ø  Ø2ØØ4Ø  ØØØØØ3  177777  Ø2ØØ4Ø  Ø2Ø5Ø1  Ø4Ø44Ø
    Ø2ØØ4Ø  Ø411Ø2  Ø41Ø4Ø  Ø2ØØ4Ø  Ø415Ø3  Ø4144Ø  Ø2ØØ4Ø  Ø421Ø4
    Ø42Ø4Ø  Ø2ØØ4Ø  Ø425Ø5  Ø4244Ø  Ø2ØØ4Ø  Ø431Ø6  Ø43Ø4Ø  Ø2ØØ4Ø
```

EDIT

Purpose

To perform listed edit operations on a user source file.

Format

:EDIT,*file,logical unit*[,*new file*]

where *file* is the name of a source file (follows the :SS condition) to be edited according to an edit list (edit operations plus associated source statements) input on the specified *logical unit*. If *new file* appears, the edited source file is stored in a new file (with the name *new file*) on the same subchannel and the old file is not purged. Otherwise, the edited source file is the updated old file. (Follows :SS in searching for duplicate file names.)

Position one of a source statement must not be a slash (/) or a colon (:). The legal edit operations in an edit list are described under Comments.

Comments

An edit list consists of several edit operations and, optionally, a series of associated source statements (i.e., following REPLACE, INSERT). Edit operations are executed when they are entered. When using the keyboard, the operator must not enter the next operation until the previous one is completed (completion is signaled by "@" output on the keyboard).

All edit operations begin with a slash (/), and only the first character following the slash is required. The rest are ignored up to a comma. If a colon (:) is encountered in column one before the end of the edit list, the job is aborted. In the edit operation formats, the letters *m* and *n* are the sequence numbers of the source statements to be edited, starting with one. Letter *m* signifies the starting statement, and *n* is the ending statements of the operation, inclusive. In all cases, *n* must be greater than or equal to *m*; neither can be less than one, nor greater than the last source statement of the file. The *m* must be greater than the *n* of the previous operation.

All edit operations are listed on the system teleprinter as they are executed.

EDIT OPERATIONS

The following operation causes source statements *m* through *n*, inclusive, to be deleted from the file.

```
/DELETE,m[,n]
```

If only *m* is specified, only that one statement will be deleted.

By means of an edit operation, the source statements *m* through *n* can be replaced by one or more source statements following /REPLACE in the edit list.

```
/REPLACE,m[,n]
```

Again, if *n* is absent, only *m* is replaced.

The format for the INSERT operation is:

```
/INSERT,m
```

The source statements which follow /INSERT in the edit list are inserted in the file after statement *m*.

In the END operation,

```
/END
```

the edit directive is terminated and DOS-M returns to its previous mode for further directives.

Examples

If a file named SOURC contains:

```
Statement 1      ASMB,R,B,L
Statement 2            NAM START
Statement 3      A     EQU 3Ø
Statement 4      B     EQU 2Ø
Statement 5      START NOP
Statement 6            LDA A
Statement 7            END
```

and the EDIT directive is:

```
:EDIT,SOURC,5
```

and the edit list, which follows :EDIT on the batch device, is:

```
/R,3
A     EQU 1ØØ
B     NOP
/D,4
/I,6
      STA B
/E
```

then the new file equals:

```
Statement 1      ASMB,R,B,L
Statement 2            NAM START
Statement 3      A     EQU 1ØØ
Statement 4      B     NOP
Statement 5      START NOP
Statement 6            LDA A
Statement 7            STA B
Statement 8            END
```

END-OF-FILE

Purpose

To write an end-of-file mark a magnetic tape.

Format

```
:EF[,lu]
```

where *lu* is the logical unit number of the desired magnetic tape (default is 8).

EJOB

Purpose

To terminate the current job normally and return to keyboard mode.

Format

```
                    :EJOB
```

Comments

EJOB condenses all user discs by eliminating spaces left by non-permanent programs. (:EJOB follows the :SS condition.) EJOB outputs a message recording the total job and execution time, tnen returns to keyboard mode. (See STORE directive and *Relocating Loader*, Section IV.) All directives except TRACKS, OFF, or BATCH are ignored until the next JOB directive.

EJOB resets logical units 1 through 9 and resets the :SS condition. EJOB resets the user disc assignment to the standard subchannel unless the standard is not ready or a new cartridge has been inserted (with a different label and without a :UD directive).

When the EJOB directive occurs, a message is printed, similar to that of JOB, giving the total run time of the job and total execution time (if a time-base generator is present). For example,

```
      END JOB START RUN = ØØØ7 MIN. 52.6 SEC. EXEC = ØØØ1 MIN. 21.Ø SEC.
  or
      END JOB START (No TBG)
```

This message is printed on the system teleprinter and on the standard list device.

EQUIPMENT

Purpose

To list one or all entries in the equipment table.

Format

:EQ[,*n*]

where *n*, if present, indicates the one entry to be listed. If *n* is absent, the entire equipment table is listed.

Comments

Each entry is output in the following format:

EQT *nn* CH *vv* DVR*mm* *d* *r* U*u* S*s*

where *nn* is the decimal number of the entry,

vv is the octal channel number of the device,

DVR*mm* is the I/O driver number for the device,

d specifies DMA if equal to D, no DMA if Ø,

r specifies core-resident if equal to R, disc-resident if Ø,

u is one decimal digit used for subchannel addressing,

s is the availability status of the device:

Ø for not busy, and available,

1 for disabled (down),

2 for busy,

Example

```
:EQ
EQT Ø1 CH 1Ø DVR31 D R UØ SØ
EQT Ø2 CH 12 DVR22 D Ø UØ SØ
EQT Ø3 CH 14 DVRØ5 Ø R UØ SØ
EQT Ø4 CH 15 DVRØ1 Ø Ø UØ SØ
EQT Ø5 CH 16 DVRØ2 Ø Ø UØ SØ
EQT Ø6 CH 17 DVR12 Ø Ø UØ SØ
EQT Ø7 CH 21 DVR15 D Ø UØ SØ
@
```

SPECIFY SOURCE FILE

Purpose

To specify the user source file to be used as input by the assembler and compilers. (Follows the :SS condition.)

Format

```
:JFILE,file
```

where *file* is the name of a TYPE-S file on any active subchannel.

Comments

If logical unit 2 is specified as the input device when the compiler or assembler is turned on (using :PROG) and a :JFILE has been defined, then the compiler or assembler reads the source statements from the :JFILE.

Only one program can be translated from a file; any statements beyond the end of the source program will be ignored. The JFILE assignment is only changed at the end of the current job or by another JFILE directive.

It is highly recommended that the :JFILE directive immediately precede the corresponding :PROG directive.

JOB

Purpose

To initiate a user job and assign it a name for accounting purposes.

Format

:JOB[,*name*]

where *name* is a string of up to five characters (starting with an alphabetic character) which identifies the job.

Comments

When DOS-M processes the JOB directive, it prints an accounting message on the system teleprinter and the list device recording the job's *name* (as specified in the JOB directive), the date (as specified in the DATE directive) and the current time (if a time base generator is present):

JOB *name date* TIME = *xxxx* MIN. *xx.x* SECS.

or

JOB *name date* (if no time-base generator)

For example,

```
     :JOB,START
     JOB START MON 6.16.9     TIME = ØØ13 MIN 41.6 SEC.
  or
     JOB START MON 6.16.9
```

If an EJOB directive has not been encountered, JOB also acts as the EJOB for the previous job. In this case, all actions of the EJOB are carried out, except for returning to keyboard mode from batch mode, before starting the new job.

Only the first two characters of JOB are significant. DOS-M skips everything up to the comma.

LIST

Purpose

To list file information recorded in the user or system directories. To list and number the contents of a source file sequentially statement-by-statement.

Format

(System) :LIST,X,*logical unit*[,*file*$_1$,...] (Unaffected by :SS)

(User) :LIST,U,*logical unit*[,*file*$_1$,...]
(Lists the specified directory entries from all the subchannels defined by :SS.)

where X specifies the system area directory, and
U specifies a user area directory,
logical unit specifies the list device, and
file$_1$,... names the entries to be listed (if none is specified, the entire directory is listed).

(Source) :LIST,S,*logical unit, file*[,*m*[,*n*]] (follows :SS)

where *file* names the source file to be listed on the *logical unit* specified.
m and *n*, if present, specify the first and last statements to be listed. If *n* is absent, then all statements from *m* on are listed. If neither appear, then the entire field is listed. The restrictions for *m* and *n* are the same as those for the EDIT directive.

Comments

DIRECTORY LISTING OUTPUT

The first line is a heading, identifying the information that follows:

NAME TYPE SCTRS DISC ORG PROG LIMITS B.P.LIMITS ENTRY LIBR. P-B

SUBCHAN = *n* (This is printed when :LIST switches to the next subchannel under :SS.)

The following lines are then printed:

name type sctrs trk sec lower_p upper_p lower_b upper_b *entry libr p-b*

where *name* identifies the file,

type tells what kind of file *name* is,

AD = ASCII data
BD = binary data
RB = relocatable binary program

User File Only

SS = source statements

DR = disc resident I/O driver
LB = library
SR = system core-resident program

System File Only

XS = supervisor module
UM = user main program
US = user program segment

Either File

sctrs is the number of sectors in the file,

trk is the track origin of the file,

sec is the starting sector of the file within the track specified.

The information below does not appear for types AD, BD, LB, RB and SS.

lower_p is the lower limit (octal) of the program,

upper_p is the upper limit (octal) of the program,

lower_b is the lower limit (octal) of the program base page links,

upper_b is the upper limit (octal) of the program base page links,

entry is the absolute octal address where execution begins,

libr is the beginning absolute octal address of the first library routine included in the program, and

p-b is equal to T if the file is temporary and will be purged by :EJOB unless stored by :ST,P.

If the requested file does not exist, a message appears,

file UNDEFINED

SOURCE LISTING FORMAT

Each source statement is preceded by a four-digit decimal sequence number. If the requested file is not a source file, a three-line message appears,

```
file
ILLEGAL
RE-ENTER STATEMENT ON TTY
```

The list is terminated by the message

```
**** LIST END ****
```

Examples

(On the keyboard:)

```
:LI,U,6
@
```

(On the list device:)

```
NAME TYPE SCTRS DISC ORG PROG LIMITS   B.P. LIMITS   ENTRY   LIBR. PB
SUBCHAN=4
EX9    SS ØØØ8Ø  TØØ1 ØØØ
EXM    RB ØØØ63  TØØ4 ØØ8
BBB    SS ØØØØ1  TØØ6 Ø23
SRCH   RB ØØØØ3  TØØ7 ØØØ
SSERH UM ØØØØ2  TØØ7 ØØ3 1ØØØØ 1Ø271   ØØ713  ØØ713  1ØØØØ  1Ø271  T
ASCII AD ØØ2ØØ  TØØ7 ØØ5
BINRY BD ØØ3ØØ  TØ15 Ø13
```

NOTE: T on the "PB" column means that the entry is temporary.

(On the keyboard:)

```
:ST,P      (To make all temporary files permanent.)
@
:LI,U,6
@
```

(On the list device:)

```
NAME TYPE SCTRS DISC ORG PROG LIMITS   B.P.LIMITS    ENTRY LIBR. PB
SUBCHAN=4
EX9   SS ØØØ8Ø  TØØ1 ØØ0
EXM   RB ØØØ63  TØØ4 ØØ8
BBB   SS ØØØØ1  TØØ6 Ø23
SRCH  RB ØØØØ3  TØØ7 ØØØ
SSERH UM ØØØØ2  TØØ7 ØØ3 1ØØØØ 1Ø271   ØØ713 ØØ713   1ØØØØ 1Ø271
ASCII AD ØØ2ØØ  TØØ7 ØØ5
BINRY BD ØØ3ØØ  TØ15 Ø13
```

NOTE: "PB" no longer equals "T."

(On the keyboard:)

```
:LI,S,6,EX19,926,936

@
```

(On the list device:)

```
Ø926  ASMB,L,R,X,C,N,B
Ø927        HED DUMMY $LIBR AND $LIBX FOR RTS SIMULATION ON DOS
Ø928        NAM DUMRX,6
Ø929        ENT $LIBR,$LIBX
Ø93Ø        SPC 2
Ø931  *     CALLING SEQUENCES: ENTRY         TERMINATION
Ø932  *
Ø933  *
Ø934  *     PRIVILEGED .       JSB $LIBR     JSB $LIBX
Ø935  *                        NOP           DEF (PROGRAM ENTRY POINT)
Ø936  *
      **** LIST END ****
```

LOGICAL UNIT

Purpose

To assign logical unit numbers (4 through 63) for a job or to list the device reference table (logical unit assignments).

Format

:LU[,n_1[,n_2]]

where n_1 and n_2, if both present, assign the device recorded in equipment table entry n_2 to logical unit number n_1 (both are decimal numbers). If only n_1 is present, then the equipment table entry number (see *EQUIPMENT* directive) assigned to logical unit number n_1 is output. If no parameters appear, the entire device reference table is printed.

Comments

Assignments made by :LU for logical units 4 through 9 are only valid during the current job. Assignments for 10 and above remain after EJOB. At the beginning of each new job, the device reference table for the first nine logical units is reset to the assignments given when the system was configured. This insures a standard I/O organization for all users.

Example

```
:LU
LUØ1 EQTØ3
LUØ2 EQTØ1
LUØ3 EQTØ1
LUØ4 EQTØ5
LUØ5 EQTØ4
LUØ6 EQTØ6
LUØ7 EQTØ7
LUØ8 EQTØ2
@
```

PAUSE

Purpose

To interrupt the current job and return to the keyboard for operator action.

Format

```
:PAUSE
```

Comments

PAUSE may be entered through the keyboard even when DOS-M is in batch mode. PAUSE suspends the current job until the operator inputs a GO directive. During this time the operator may mount magnetic tapes or prepare I/O devices. (A series of COMMENT directives or a remark in the PAUSE directive itself can be used to tell the operator what to do during the PAUSE.)

The GO directive returns DOS-M to the job in the previous mode.

PROGRAM DUMP

Purpose

To request that a user program be dumped when it completes execution. Two directives are provided: PDUMP for dumping on a normal completion, and ADUMP for dumping when the program aborts.

Format

```
:PDUMP[,FWA[,LWA]][,B][,L]
:ADUMP[,FWA[,LWA]][,B][,L]
```

where *FWA* is the first word address, relative to the program origin,

B means dump the base page linkage area of the program, and,

L means dump the library subroutines used by the program.

FWA and *LWA* are octal numbers that specify the limits of the program being dumped.

If *LWA* is missing, the entire program, starting with *FWA*, is dumped.

B alone dumps all the main program, plus base page linkages, but not the library routines.

L alone dumps only the library routines.

If no parameters are given, everything is dumped

Comments

The dump directives, PDUMP and ADUMP, must precede the RUN or PROG request in a job. They implicitly refer to the next program to be executed. DOS sets a flag when it encounters either PDUMP or ADUMP, then checks the flag the next time a program is executed. Only one of the requests will be honored, depending upon whether the program runs normally or is aborted. These flags are cleared when a program terminates. Any parameter following L is ignored. If *FWA* is greater than *LWA*, a message is printed.

```
LIMIT ERROR
RE-ENTER STATEMENT ON TTY
```

The main program and library subroutines are dumped eight octal words per line, along with the octal starting address for that line. For example,

adr_8	*wd-1*	*wd-2*	*wd-3*	*wd-4*	*wd-5*	*wd-6*	*wd-7*	*wd-8*
ad_8+10_8	*wd-1*	*wd-2*	*wd-3*	*wd-4*	*wd-5*	*wd-6*	*wd-7*	*wd-8*

If present, the base page dump follows the main program and library. Base page linkages exist for page boundary crossings and subroutines. For each line, the starting address appears first, followed by four pairs of octal numbers. The first number of each pair records the content of the base page word (an address elsewhere in core). The second number of each pair records the contents of the address specified by the first item. If the first item is the address of a subroutine, then the second item contains the last address from which the subroutine was called. For example,

	pair-1		*pair-2*		*pair-3*		*pair-4*	
adr	*item-1*	*item-2*	*item-1*	*item-2*	*item-1*	*item-2*	*item-1*	*item-2*
$adr+4_8$	*item-1*	*item-2*	*item-1*	*item-2*	*item-1*	*item-2*	*item-1*	*item-2*

NOTE: *:OFF before a program executes clears the dump flags*
:OFF during program execution causes an abort dump.
:OFF during a dump terminates the dump.

Example

```
                    :ADUMP,Ø15,B        (Set up dump flag)
                    :RUN,PRG9,6         (Run program)
                    LU    Ø1214Ø
                    ABRT  Ø1214Ø        (Program aborted)
                    (Page Eject)
```

(Main program dump)

```
12ØØØ  16ØØØ1  ØØ2ØØ2  13Ø573  17Ø574  ØØ6ØØ4  16ØØØ1  ØØ2ØØ3  Ø26Ø12
12Ø1Ø  13Ø575  17Ø576  ØØ6ØØ4  16ØØØ1  17Ø577  ØØ6ØØ4  16ØØØ1  17Ø6ØØ
```

(Page Eject)

(Base page dump)

```
ØØ57Ø  Ø1Ø137  ØØ2Ø45  Ø1Ø711  ØØ3237  Ø1Ø763  ØØ2Ø45  Ø17Ø14  ØØØ3ØØ
ØØ574  Ø17641  ØØØØØØ  Ø17Ø15  ØØØ4ØØ  Ø17641  ØØØ4Ø6  Ø176Ø1  ØØØØØØ
ØØ6ØØ  Ø1765Ø  ØØØØØØ  Ø17615  ØØØØØØ  Ø17664  ØØØØØØ  Ø17662  ØØØ573
ØØ6Ø4  Ø17637  ØØØ573  Ø17571  1772Ø5  Ø17563  ØØ12Ø4  Ø17714  Ø17715
ØØ61Ø  Ø17562  Ø21121  Ø17534  Ø21122  Ø17536  Ø21122  Ø17633  16Ø656
ØØ614  Ø17544  Ø37626  Ø17546  Ø37626  Ø17673  ØØØØØØ  Ø176Ø5  ØØØØ4Ø
```

PROG

Purpose

To turn on (i.e., load from the disc and begin executing) a program from the system area or programs from the user file which were generated through the DOS-M Relocating Loader. (Follows the :SS condition in searching for the program.)

Format

:PROG,*name*[,P_1,P_2....P_5]

where *name* denotes a system program, such as FTN for the DOS-M FORTRAN Compiler, ASMB for the DOS-M Assembler, LOADR for the DOS-M Relocating Loader, or ALGOL for the RTE/DOS ALGOL Compiler. A user program is specified via the file name assigned in the DOS-M Relocating Loader.

P_1 through P_5 are optional parameters which DOS-M transfers to the program named. P_1 through P_5 must be positive integers less than 32767. The program must retrieve the parameters immediately. This procedure is described under :GO.

Comment

Consult Section IV for the parameters required by FTN, FTN IV, ASMB, ALGOL, and LOADR. Additional programs may be added at system generation time if desired.

NOTE: User programs can be run using :PROG. This may be useful when the program needs parameters. DOS-M first searches the user files for the program, then the system files.

Examples

```
:PROG,FTN,2,99
:PROG,ASMB,2,6,4
```

PURGE

Purpose

To remove a user file from the user file area.

Format

:PURGE[,*file*$_1$,*file*$_2$,...]

where *file*$_1$,*file*$_2$,... (up to 15 file names or 72 characters per directive) designate files in the user area. These are purged from the user area. If a file cannot be found, a message is printed on the keyboard:

FILE UNDEFINED

If no file names are given, all temporary files are purged.

Comments

Purge follows the :SS condition. After the files are purged from the disc, the remaining user area files are repacked for efficiency. If the end of the user area moves below a track boundary during the purge, the work area becomes a track larger. As each file is purged, DOS-M prints its name on the teleprinter.

IMPORTANT NOTE: Operator attention is disabled during :PURGE.

Example

```
ORIGINAL CONTENTS OF USER FILE:   F1,F2,F3,F4, FLONG, and F5 (at least)
                    DIRECTIVE:    :PURGE,FLONG,F1,F2,D3,D7,F3,F4,F5
                       OUTPUT:    FLONG
                                  F1
                                  F2
                                  D3 UNDEFINED
                                  D7 UNDEFINED
                                  F3
                                  F4
                                  F5
```

The fastest way to purge all files of a single disc is to use :IN,*.

RUN

Purpose

To run a user program. (Follows the :SS condition.)

Format

```
:RUN,name[,time][,N]
```

where *name* is a user file containing the desired program,

time is an integer specifying the maximum number of minutes the program may run (set to five minutes if not specified). DOS-M ignores *time* if a time-base generator is not present.

N, if present, tells DOS-M to allow the program to continue running even if it makes EXEC calls with illegal request codes.

Comments

Programs which have been relocated during the current job but not stored (see STORE directive) permanently in a user file, may be run using this directive. If the program executes longer than the time limit, the current job is aborted and DOS-M scans to the next JOB directive.

If N is not present in the RUN directive, the current job will be aborted by any illegal request codes. The N option is provided so that programs can be written and tested on DOS-M ultimately to execute with other HP software which does not have the same request codes. (See Appendix C, *RELATION TO OTHER SOFTWARE.)*

Example

```
:RUN,ROUT,15
```

executes program ROUT up to fifteen minutes not allowing illegal request codes.

SECTOR DUMP

Purpose

To dump any specified sector or sectors of the current user disc on the standard list device in either ASCII or octal format.

Format

```
:SA,track,sector[,number]     (ASCII)
:SO,track,sector[,number]     (Octal)
```

where *track* and *sector* give the starting disc address for the dump, and

number gives the number of sectors to be dumped. If *number* is absent, only one sector is dumped. All three parameters are decimal numbers.

Comments

The ASCII dump format (:SA) is 64 characters per record. The octal dump format (:SO) is eight octal numbers per line. Two ASCII characters equal one computer word (also represented by one octal number). Although :SA dumps 64 characters per record, these do not necessarily appear on one line since the binary numbers are converted to ASCII characters, some of which might be linefeeds or returns.

Example

(On the keyboard:)

```
:SO,Ø,1
@
```

(On the list device:)

```
ØØ1 ØØØØØØ  Ø67767  Ø1757Ø  Ø67744  Ø77743  Ø17613  Ø17613  Ø17613
    Ø17613  Ø6412Ø  ØØ7ØØ4  Ø7731Ø  Ø64117  Ø44Ø55  16ØØØ1  Ø44Ø51
    Ø1ØØ72  Ø73773  Ø53774  Ø77761  Ø53775  Ø77762  Ø773Ø4  Ø44Ø56
    16ØØØ1  ØØ1727  Ø13733  Ø733Ø5  Ø5ØØ6Ø  Ø2746Ø  Ø53763  Ø27445
    Ø673Ø4  Ø44Ø66  Ø3731Ø  Ø27415  Ø275Ø5  Ø44Ø52  16ØØØ1  Ø23773
    Ø33774  17ØØØ1  Ø63773  Ø733Ø2  ØØ2ØØ4  Ø733Ø3  Ø63774  Ø73773
    Ø673Ø4  16ØØØ1  Ø73766  164ØØØ  Ø1757Ø  Ø633Ø5  Ø5ØØ6Ø  Ø2744Ø
    ØØ6ØØ4  16ØØØ1  Ø33773  17ØØØ1  ØØ6ØØ4  Ø6373Ø  17ØØØ1  ØØ6ØØ4
    ØØ3ØØ4  17ØØØ1  Ø673Ø4  Ø77311  Ø2744Ø  Ø6Ø154  ØØ1722  Ø13765
    Ø33774  ØØ1727  ØØ1723  Ø7Ø154  Ø63761  Ø673Ø2  Ø176Ø6  Ø63762
    Ø673Ø3  Ø176Ø6  ØØ24ØØ  Ø67774  Ø176Ø6  Ø63311  Ø67775  Ø176Ø6
    Ø67761  ØØ6ØØ3  Ø2754Ø  Ø44Ø55  16ØØØ1  Ø23774  Ø333Ø2  17ØØØ1
    Ø67762  ØØ6ØØ3  Ø27546  Ø23775  Ø333Ø3  17ØØØ1  Ø63776  ØØ12ØØ
    Ø67777  ØØ6ØØ3  ØØ2ØØ4  Ø64155  Ø7Ø155  Ø54175  Ø7Ø175  ØØ64ØØ
    Ø5Ø175  Ø64115  Ø742ØØ  Ø4774Ø  Ø74157  Ø64175  Ø74161  124ØØ3
    ØØØØØØ  Ø57766  12757Ø  Ø37766  163766  ØØ2Ø21  Ø27571  Ø13764
```

SYSTEM SEARCH

(Optional Directive)

Purpose

To specify a list of disc subchannels to be searched for file names; the :SS condition applies to all EXEC calls and directives that require a file search. (No check is made for existing duplicate file names during searches; the first file found is used.)

Format

:SS

All active subchannels are searched, starting with the current user subchannel, then continuing from the highest to the lowest number.

:SS,n_1,n_2,n_3....

Where n_1,n_2...are subchannel numbers. The current user subchannel is searched first, then the subchannels specified, starting with the lowest number.

:SS,99

Only the current user subchannel is searched. This is the default condition. Every job starts out in this condition.

Comments

The :SS directive can only be used if it was specifically allowed during system generation. If the operator answers YES to the question

```
ALLOW :SS?
```

then :SS directives will be allowed. Otherwise, they are not, and any :SS directive will cause the following message:

```
BAD CONTROL STATE.
```

If a file search results in the file being found, the current user subchannel is changed to the subchannel containing the file. If the file was not found, the current user subchannel is restored to its previous assignment. The LIST, U directive is an exception: this directive does not stop after it finds the file; it continues to look for duplicate entries. When the LIST search is complete, the user subchannel is always restored.

However, if a search is interrupted before completion, the current user disc may be on any subchannel. (This should be checked with a :UD directive.)

More than one :SS can occur during a job. The job starts in :SS,99 condition until a different :SS directive is issued. Each :SS directive remains in effect until another is issued. :SS directives do not apply to file searches initiated by the Relocating Loader or to disc dumps initiated by the :DD directive.

Whenever the user subchannel assignment is changed (except by a running program), the system prints a message:

```
SUBCHAN = n
```

STORE

Purpose

To create a user file on the disc and assign it a name. The STORE directive can create relocatable object program files (type-R), loader-generated object program files (type-P), source statement files (type-S), ASCII data files (type-A), and binary data files (type-B). (Follows :SS in checking for duplicate file names.)

Format

The format varies according to what type file is being created. See Comments below for details:

TYPE-R	:STORE,R,*file*[,*logical unit*]
TYPE-P	:STORE,P[,$name_1$,$name_2$,...]
TYPE-S	:STORE,S,*file*,*logical unit*
TYPE-A	:STORE,A,*file*,*sectors*
TYPE-B	:STORE,B,*file*,*sectors*

NOTE: The "Control @" should not be used in file names.

Comments

TYPE - R FILES

The directive format is:

:STORE,R,*file*[,*logical unit*]

where *file* is a name consisting of five characters or less.

A user file is created under this name, and relocatable binary programs are read into it from the logical unit specified or from the *job binary area* of the work tracks if none is specified. The *job binary area* remains as it was before the STORE directive. (See Section IV, *DOS-M FORTRAN* and *DOS-M ASSEMBLY LANGUAGE*.)

If DOS-M comes to an end-of-tape, it asks:

```
    DONE?
```

If there are more tapes, the operator places the next tape in the reader and replies NO; otherwise, he answers YES.

The user should not assign any file names that will be used as program names as this will make loading impossible. The file may be input to the DOS-M Relocating Loader for relocation into an executable program. (See Section IV, *DOS-M RELOCATING LOADER*.)

Examples

```
    :STORE,R,RINE
```

(Stores all of the relocatable programs from the job binary area into the file RINE created for that purpose.)

```
    :STORE,R,JUGG,5
```

(Stores relocatable programs from logical unit 5, the standard input device, into the file JUGG.)

TYPE - P FILES

The directive format is:

:STORE,P[,*name*$_1$,*name*$_2$,....]

where *name*$_1$,*name*$_2$ ... are programs that the DOS-M Relocating Loader had relocated into executable format during the current job. Up to 14 programs per directive are allowed. If none are specified, all programs loaded during the current job are stored. DOS-M finds these temporary programs in the user file and converts them to permanent user files; the program name automatically becomes the file name.

Programs loaded during the current job but not stored as files (as shown above) may be executed normally (RUN or PROG directive) and appear in the user directory (LIST directive). At the end of a job, however, they are purged from the directory unless they have been converted to user files by a STORE,P directive.

Examples

```
:STORE,P
```

(Changes all programs loaded during the current job using the Relocating Loader into permanent user files.)

```
:STORE,P,ARITH,MATH,TRIG,ALGEB
```

(Searches for the programs listed and makes them permanent user files.)

TYPE - S FILES

The directive format is:

```
:STORE,S,file,logical unit
```

where *file* is the name of the user file to be filled with source statements from the *logical unit* specified. *File* must not duplicate a name already present in the user or system files. The source statement input must be terminated by a double colon (::). If the :: is omitted, DOS-M stores the succeeding data on the disc as if it were source statements.

If DOS comes to an end-of-tape before finding the ::, it asks

```
DONE?
```

If there are more tapes, the operator replies NO: otherwise, he answers YES.

When DOS-M completes the STORE, it prints

```
nnnn LINES
```

where *nnnn* is the number of statements stored.

Example

```
:STORE,S,SOURC,5
```

(Reads source statements from the standard input device and stores them in a new file SOURC.)

TYPE - A and TYPE - B FILES

The directive format is:

```
:STORE,type,file,sectors
```

where *type* is either A (for ASCII character data) or B (for binary data), and *file* is the name assigned to a file containing the number of *sectors* requested. These requests are made prior to executing a program to reserve a file area; no data is involved. The program may store and retrieve data from the file through a call to EXEC.

It is the programmer's responsibility to store the right kind of data in the file. The EXEC call must specify the file name and the relative sector within the file. DOS-M checks that the file name exists and contains the sector specified.

Example

```
:STORE,A,ASCII,2Ø
```

(Creates a file name ASCII,20 sectors in length. A sector equals 128 words.)

TRACKS

Purpose

To print the next available track on the current user disc.

Format

```
:TRACKS
```

Comments

The number of the first track beyond the end of the current user area, followed by the number of faulty tracks that have been replaced by spares.

Tracks are replaced by spares when parity errors occur on read or write.

Examples

The following is an example in which no faulty tracks are reported.

```
(INPUT)     :TRACKS
(OUTPUT)    NEXT AVAIL TRACK = ØØ1Ø
            @                         (End of directive processing)
```

In this example, the system reports that 2 tracks have been replaced by spares.

```
(INPUT)     :TRACKS
(OUTPUT)    NEXT AVAIL TRACK = ØØ12
            BAD = 2
            @                           (End of directive processing)
```

In this example, the system reports that there are no more work tracks available.

```
(INPUT)     :TRACKS
(OUTPUT)    NEXT AVAIL TRACK = NONE
            @                           (End of directive processing)
```

TYPE

Purpose

To return from batch mode to keyboard mode.

Format

```
:TYPE
```

Comments

Control is returned to the teleprinter keyboard. TYPE may be entered through the batch device or keyboard device; but when it is entered from the keyboard, DOS-M waits until the current executing program is completed or is aborted before returning to keyboard mode. If TYPE is entered while already in keyboard mode, the directive is ignored.

CHANGE USER DISC

Purpose

To change the subchannel assignment for the user disc.

Format

:UD[,[*label*][,*n*]]

where *label* is a six-character disc label (* for an unlabeled disc).

n is the subchannel.

Comments

Discs are labeled by the :IN directive.

Each form of the :UD directive has a different purpose:

Example	Action

:UD
(without label or subchannel)
	Interrogates the current user disc subchannel and prints its label on the system teleprinter:
	SUBCHAN = *n*
	LBL = *label* (or UNLBL)

:UD,,*n* (no label)	If *n* is labeled, DOS-M prints: LBL = *label* (or UNLBL) No assignment is made.
:UD,*label*,*n*	If *n* is labeled with the specified *label*, DOS-M assigns *n* as the user disc. If *n* is unlabeled or has a different *label*, DOS-M prints: LBL = *label* (or UNLBL) Operator can then reissue :UD,*label*,*n* with the correct label.

Example	Action
:UD,*label* (no subchannel)	DOS-M searches for the *label*, starting with the highest number subchannel (determined at system generation). If *label* is found, DOS-M makes it the user disc and prints: SUBCHAN = *n* If *label* is not found, DOS-M prints: DISC NOT ON SYS
:UD,*,*n*	If *n* is unlabeled, DOS-M assigns *n* as the user disc. If *n* is labeled, DOS-M makes no assignment and prints: LBL = *label*
:UD,*	Assigns the highest number unlabeled disc as the user disc and prints: SUBCHAN = *n* If there are no unlabeled discs, DOS-M prints: DISC NOT ON SYS

If the :UD directive specifies a subchannel with an incorrect system proprietary code (see Appendix A), DOS-M still makes the assignment, and prints:

TSB DISC or ??? DISC

If the :UD directive specifies a subchannel whose system generation code (see Section VI) does not match that of the current system disc, DOS-M still makes the assignment but prints:

DISC GEN CODE *nnnn* NOT SYS GEN CODE *mmmm* ERR POSS

The changes made by :UD are only temporary; the user disc is reset at the end of each job.

NOTE: Before executing a :DD or :DD,X to a TSB or ??? DISC, the disc should be initialized with :IN; otherwise, bad tracks may be reported erroneously.

UP

Purpose

To declare an I/O device ready for use.

Format

:UP,*n*

where *n* is the equipment table entry number corresponding to the device.

Comments

The :UP directive (followed by a :GO) is usually used in response to the following messages from DOS-M:

I/O ERR ET EQT #*n*
I/O ERR NR EQT #*n*
I/O ERR PE EQT #*n*

where ET indicates end of tape,
NR indicates device not ready,
PE indicates parity error, and
n is the equipment entry number.

If you enter the incorrect *n*, DOS-M replies by printing out all the down devices.

NOTE: The directives in the rest of this section pertain to operation in the keyboard mode only.

DATE

Purpose

To set the date and time for accounting purposes whenever DOS-M is started up.

Format

```
:DATE,day[,hour,min]
```

where *day* is any string of ten or less characters (commas not permitted) chosen by the operator (such as 7/1Ø/69,1Ø.JULY.69, etc.);

hour and *min* are the current time in hours and minutes on a 24-hour clock. If not given or time-base generator is not present, they are set to zero.

Comments

The DATE directive is legal only following a start-up procedure. The directive is not accepted any other time.

Examples

```
:DATE,7/1Ø/69,12,23
:DATE,WEDNESDAY,7,45
:DATE,1ØJULY1969
```

GO

Purpose

To resume a program that has been suspended, and optionally, to transfer up to five parameters to that program.

Format

:GO[,P_1,P_2,...P_5]

where P_1 through P_5 are optional parameters and must be decimal values between Ø and 32767.

Comments

When a program suspends itself (see Section III, *PROGRAM SUSPEND EXEC CALL*), it is restarted by a GO directive. Upon return to a suspended program, the initial address of the five parameters is located in the B-register. A FORTRAN program calls the library subroutine RMPAR to transfer the parameters to a specified 5-word array. The first statement after the suspend call, in a FORTRAN program, must be the call to RMPAR. For example,

```
DIMENSION I(5)
CALL RMPAR (I)
```

An assembly language program should use the B-register upon return from the suspend to obtain and save the parameters prior to making any EXEC request or I/O request.

INITIALIZE

Purpose

To label or unlabel the current user disc.

Format

```
:IN,label
```

where *label* is a six-character name to be written on the disc or "*" which means unlabel the disc. (The *label* should not contain a "Control @.")

Comments

If the user disc is already labeled, DOS-M prints:

```
DOS or TSB or ??? LABEL nnnnnn (nnnnnn is existing label)
OK TO PURGE?
```

The operator must respond with

```
YES
```

to actually execute the directive, or

```
NO
```

to leave the disc unchanged.

If the label equals "*", the user files also are purged.

If the current user disc is labeled SYSTEM and is not hardware protected (which means it was created by a :DD,X), the system area is destroyed and any files are moved down to low disc.

NOTE: If the disc labeled SYSTEM is hardware protected, the computer performs a HALT 31 and the new label is not assigned.

Labeling a disc eliminates any old label on the disc but does not eliminate the directory or files on the disc.

Unlabeling a disc also purges the directory.

:IN always changes the system generation code and system proprietary code to that of the current system. :IN can prepare discs for use by DOS-M that were formatted by a diagnostic or other software.

OFF

Purpose

To abort the currently executing user program of system operation without terminating the job.

Format

```
:OFF
```

Comments

:OFF returns the system to keyboard mode.

OFF can be used to terminate undesired lists, edits, disc-to-disc dumps, program loops, loader operations, assemblies, and compilations.

:OFF cancels any pending :DD, :AD, or :PD directives, unless a program is running, in which case, a pending :ADUMP is executed.

SECTION III
EXEC CALLS

Using EXEC calls, which are the line of communication between an executing program and DOS-M, a program is able to:

- Perform input and output operations,
- Request status of I/O devices
- Determine availability of work area tracks,
- Terminate or suspend itself,
- Load its segments,
- Search for file names,
- Obtain the time of day, or
- Change the user disc subchannel.

An EXEC call is a block of words, consisting of an executable instruction and a list of parameters defining the request. The execution of the instruction transfers control to DOS-M. DOS-M then determines the type of request (from the parameter list) and, if it is legally specified, initiates processing of the request. The executable instruction is a jump subroutine (JSB) to EXEC.

In FORTRAN, EXEC calls are coded as CALL statements. In ALGOL, procedure calls are used. In Assembly Language, EXEC calls are coded as a JSB, followed by a series of parameter definitions. For any particular call, the object code generated for the FORTRAN CALL Statement and the ALGOL procedure call is equivalent to the corresponding Assembly Language object code.

This section describes the basic formats of FORTRAN, ALGOL and Assembly Language EXEC calls, then each EXEC call is presented in detail.

FORMAT OF THE ASSEMBLY LANGUAGE CALLING SEQUENCE

The following is a general model of an EXEC call in Assembly Language:

```
        EXT EXEC              (Used to link program to DOS-M)
         .
         .
         .
        JSB EXEC              (Transfer control to DOS-M)
        DEF *+n+1             (Defines point of return from DOS-M, n
                              is number of parameters; may not be an
                              indirect address; must be the location
                              immediately following the last parameter
        DEF P1  )             address)
                 \
         .        }           (Define addresses of parameters which
         .       /            may occur anywhere in program; may be
         .      /             multi-level indirect)
        DEF Pn )
        return point          (Continue execution of program)
         .
         .
         .
         .
         .
         .
         .
     P1 ---
                )
      .          \
      .           }           (Actual parameter values)
      .          /
                )
     Pn ---
```

EXEC CALLS IN ALGOL

In ALGOL, certain conventions must be followed in making EXEC calls. First, since EXEC is external to the program it must be declared a CODE procedure. Second, parameters that are going to be changed must be declared "name" and those that are not to change must be VALUE parameters. Third, when arrays are passed as parameters, the first element of the array (not the name) must be passed as an INTEGER type "name". Fourth, since ALGOL requires that the format of each procedure call be defined, a program must declare a dummy external procedure for each type of EXEC call it makes. (These dummy procedures must be compiled as separate procedures to provide proper Linkage in the Loader.)

ALGOL Example

See Appendix F for an example of an ALGOL program making an EXEC call through an external CODE procedure.

FORMAT OF THE FORTRAN CALLING SEQUENCE

In FORTRAN, the EXEC call consists of a CALL Statement and a series of assignment statements defining the variable parameters of the call:

CALL EXEC (P_1, P_2 .... , P_n)

where P_1 through P_n are either values or variables defined elsewhere in the program. Variables must begin with a letter I through N, since they are integer variables.

Example

```
      CALL EXEC (7)
          or
      IRCDE = 7
      CALL EXEC (IRCDE)
```

Equivalent calling sequence

Some EXEC call functions are handled automatically by the FORTRAN compiler or special subroutines. (Refer to "FORTRAN," Section IV, DOS-M PROGRAMMING, and the specific EXEC calls in this section.)

READ/WRITE

Purpose

To transfer information to or from an external I/O device or the work area of the disc. (DOS-M handles track switching automatically.)

Assembly Language

```
      EXT    EXEC
       :
       :
      JSB    EXEC            (Transfer control to DOS-M)
      DEF    *+5 (or 7)      (Point of return from DOS-M; 7 is
                             for disc request)
      DEF    RCODE           (Request code)
      DEF    CONWD           (Control information)
      DEF    BUFFR           (Buffer location)
      DEF    BUFFL           (Buffer length)
      DEF    DTRAK           (Track number-disc transfer only)
      DEF    DSECT           (Sector number-disc transfer only)
      (return point)         (Continue execution)
       :
RCODE DEC    1 (or 2)        (1=READ, 2=WRITE)
CONWD OCT    conwd           (conwd is described in Comments)
BUFFR BSS    n               (Buffer of n words)
BUFFL DEC    n (or -2n)      (Same n; words (+) or characters (-))
DTRAK DEC    f               (Work area track number, decimal)
DSEC  DEC    g               (Work area sector number, decimal)
```

FORTRAN

I/O transfers to regular devices are programmed by standard FORTRAN READ and WRITE Statements. I/O on the work area of the disc is done with a subroutine BINRY, described in the Comments, or the FORTRAN equivalent of the EXEC call:

```
CALL EXEC (ICODE, ICON, IBUF, IBUFL, ITRAK, ISECT)
```

Comments

READ/WRITE EXEC calls carry out I/O transfers including those on the work area of the disc. (See FILE READ/WRITE EXEC CALL.)

CONWD

The conwd, required in the calling sequence, contains the following fields:

	Ø	Ø	W					K	V	M	LOGICAL UNIT #					
BITS	15	14	13	12	11	1Ø	9	8	7	6	5	4	3	2	1	Ø

Field **Function**

W If 1, tells DOS-M to return to the calling program after starting the I/O transfer. If W = Ø, DOS-M waits until the transfer is complete before returning.

K Used with keyboard input, specifies printing the input as received if K = 1. If K = Ø, "no printing" is specified.

V Used when reading variable length records from punched tape devices in binary format (M = 1, below). If V = Ø, the record length is determined by buffer length. If V = 1, the record length is determined by the word count in the first non-zero character which is read in.

M Determines the mode of data transfer. If M = Ø, transfer is in ASCII character format, and if M = 1, binary format. (Disc is always binary.)

BINRY

User FORTRAN programs call the FORTRAN disc read/write library routine, BINRY, to accomplish I/O in the work area. The user must specify: an array to be used as a buffer, the length of the buffer in words (equal to the number of elements in an integer array, double that for a real array), the disc logical unit, track number, sector number, and offset in words within the sector. (If the offset equals Ø, the transfer begins on the sector boundary. If the offset equals N, then transfer skips N words of the sector before starting). BINRY has two entry points, BREAD and BWRIT, for read and write operations respectively. An example below gives the calling procedure.

```
      DIMENSION  IBUF(1Ø), BUF(2Ø)
      LUN = 2
      ITRK = 12
      ISECT = 63
      IOFF = Ø
      CALL BREAD (BUF, 4Ø, LUN, ITRK, ISECT, IOFF),
   or
      CALL BWRIT (IBUF, 1Ø, LUN, ITRK, ISECT, IOFF)
```

Waiting and No Waiting

If the program requests the *no waiting* option in the *conwd,* it can check for the end of the I/O operation with the I/O STATUS EXEC call. In the Assembly Language calling sequence, the buffer length can be given in words (+) or characters (-). When the transfer is complete, the amount actually transferred can be learned by the same status call. A positive number of words or characters, depending upon which were originally requested, is returned. If the WAIT option is used, DOS-M returns the number of transmitted words or characters to the B register.

NOTE: When doing "no waiting" I/O and attempting to load program segments: 1. Under :RUN DOS-M waits for all I/O to complete before loading the segment; and 2. under :PROG, DOS-M does not wait.

FILE READ/WRITE

Purpose

To transfer information to or from a file on the user disc; the file must be referenced by name. (The :SS condition is followed.)

Assembly Language

```
       EXT EXEC
        :
       JSB EXEC                  (Transfer control to DOS-M)
       DEF *+7                   (Point of return from DOS-M)
       DEF RCODE                 (Request code)
       DEF CONWD                 (Control information)
       DEF BUFFR                 (Buffer location)
       DEF BUFFL                 (Buffer length)
       DEF FNAME                 (File name)
       DEF RSECT                 (Relative sector within file)
       return point              (Continue execution)
        :
RCODE  DEC 14 or 15              (14 = READ, 15 = WRITE)
CONWD  OCT conwd                 (See Comments, READ/WRITE EXEC CALL.)
BUFFR  BSS n                     (Buffer of n words)
BUFFL  DEC n or -2n              (Same n; words (+) or characters (-))
FNAME  ASC 3,xxxxx               (User file name = xxxxx)
RSECT DEC  m                     (Relative sector number )
```

FORTRAN

```
DIMENSION IFILE (3)
IFILE(1) = xxxxxB          (First two characters of file name)
IFILE(2) = xxxxxB          (Second two characters)
IFILE(3) = xxxxxB          (Last character and blank)
IRCD = 14 (or 15)          (Request code)
ICNWD = xxxxxB             (conwd)
DIMENSION IBUF(10)
CALL EXEC (IRCDE, ICNWD, IBUF, 1Ø, IFILE, Ø)
```

Comments

See the Comments under READ/WRITE EXEC CALL for a description of the *conwd* fields needed in the above calling sequences.

To read or write on the first sector of a file, m=Ø; for the last sector, m=number of sectors in the file -1. To determine the size of a file, use the SEARCH FILE NAMES EXEC call.

Any type of file may be read, but only ASCII or binary data files may be written.

If the DOS-M installation is likely to have more than one user disc, the program should use the CHANGE USER DISC EXEC call without a subchannel specified to check whether the correct user disc is currently assigned. Alternatively, the user can use an :SS directive to set up a system search condition for referencing files on many subchannels.

I/O CONTROL

Purpose

To carry out various I/O control operations, such as backspace, write end-of-file, rewind, etc.

Assembly Language

```
         EXT EXEC
          .
          .
          .
         JSB EXEC           (Transfer control to DOS-M)
         DEF *+4(or 3)      (Point of return from DOS-M)
         DEF RCODE          (Request code)
         DEF CONWD          (Control information)
         DEF PARAM          (Optional parameter)
         return point       (Continue execution)
          .
          .
   RCODE DEC 3              (Request code = 3)
   CONWD OCT conwd          (See Comments)
   PARAM DEC n              (Required for some control functions;
                            see Comments)
```

FORTRAN

Use the FORTRAN auxiliary I/O statements or an EXEC calling sequence.

```
IRCDE = 3                   (Request code)
ICNWD = conwd               (See Comments)
IPRAM = x                   (Optional; see Comments)
CALL EXEC (IRCDE, ICNWD, IPRAM)
CALL EXEC (IRCDE, ICNWD)
```

Comments

CONWD

The control word value (*conwd*) has two fields:

	Ø	Ø	W	FUNCTION CODE (see below)							LOGICAL UNIT NUMBER					
BITS	15	14	13	12	11	1Ø	9	8	7	6	5	4	3	2	1	Ø

If W = 1, DOS-M returns to the calling program after starting the control request.

If W = Ø, DOS-M waits until the control request is complete before returning.

Function Code (Octal)	Action
ØØØ	Unused
ØØ1	Write end-of-file (magnetic tape)
ØØ2	Backspace one record (magnetic tape)
ØØ3	Forward space one record (magnetic tape)
ØØ4	Rewind (magnetic tape)
ØØ5	Rewind standby (magnetic tape)
ØØ6	Dynamic status (magnetic tape)
ØØ7	Set end-of-paper tape
Ø1Ø	Generate paper tape leader
Ø11	List output line spacing (PARAM or IPRMA required)
Ø12 : 177	Unused

Function code 11_8, list output line spacing, requires the optional parameter mentioned in the calling sequences. PARAM (or IPRAM) designates the number of lines to be spaced on the specified logical unit. A negative parameter specifies a page eject on a line printer or number of lines to be spaced on the teleprinter. For details of line printer formatting, consult Appendix E.

I/O STATUS

Purpose

To request the status of a particular I/O device, and the amount transmitted in the last operation.

Assembly Language

```
      EXT EXEC
       :
      JSB EXEC            (Transfer control to DOS-M)
      DEF *+5             (Point of return from DOS-M)
      DEF RCODE           (Request code)
      DEF CONWD           (Logical unit)
      DEF STATS           (Status returned)
      DEF TLOG            (Transmission log returned)
      return point        (Continue execution)
       :
RCODE DEC 13              (Request code - 13)
CONWD DEC n               (Logical unit number)
STATS NOP                 (Status returned here)
TLOG NOP                  (Transmission log returned here)
```

FORTRAN

```
      IRCDE = 13          (Request code)
      ICNWD = n           (n is decimal logical unit)
      CALL EXEC (IRCDE, ICNWD, ISTAT, ITLOG)
```

Comments

The status returned in the A-register and in STATS is the hardware status of the device specified by the logical unit. The transmission log in the B-register and in TLOG contains the amount of information which was transferred (a positive number of words or characters depending on which was requested by the call initiating the transfer).

WORK AREA LIMITS

Purpose

To ascertain the first and last tracks of the work area on the system disc and the number of sectors per track.

Assembly Language

```
      EXT EXEC
       :
      JSB EXEC            (Transfer control to DOS-M)
      DEF *+5             (Point of return from DOS-M)
      DEF RCODE           (Request code)
      DEF FTRAK           (First track)
      DEF LTRAK           (Last track)
      DEF SIZE            (Number of sectors/track)
      return point        (Continue execution)
       :
RCODE DEC 17              (Request code = 17
FTRAK NOP                 (Returns first work track number here)
LTRAK NOP                 (Returns last work track number here)
SIZE  NOP                 (Returns number of sectors per track here)
```

FORTRAN

```
      IRCDE = 17          (Request code)
      CALL EXEC (IRCDE, IFTRK, ILTRK, ISIZE)
```

Comments

This call returns the limits of the work area, that area of the system disc which programs use for temporary storage with the READ/WRITE EXEC call.

WORK AREA STATUS

Purpose

To ascertain whether a specified number of consecutive operable tracks exist in the work area of the system disc.

Assembly Language

```
        EXT EXEC
         :
        JSB EXEC         (Transfer control to DOS-M)
        DEF *+5          (Point of return from DOS-M)
        DEF RCODE        (Request code)
        DEF NTRAK        (Number of tracks desired)
        DEF RTACK        (Starting track desired)
        DEF STRAK        (Actual starting track)
        return point     (Continue execution)
         :
RCODE   DEC 16           (Request code = 16)
NTRAK   DEC n            (Consecutive tracks desired)
TRACK   NOP              (Desired track; from LIMITS call)
STRAK   NOP              (Actual starting track available,
                         Ø if n tracks not available)
```

FORTRAN

```
        IRCDE = 16       (Request code)
        ICNWD = n        (Consecutive tracks desired)
        ITRAK = m        (Desired starting track)
        CALL EXEC (IRCDE, ICNWD, ITRAK, ISTRK)
```

Comments

This call is used with the WORK AREA LIMITS EXEC call to establish the nature of the work area. The READ/WRITE EXEC call then transmits information to and from this area, using the track numbers determined by this call. DOS-M handles track switching automatically.

If a read or write is issued to a disc address that does not lie in the WORK AREA, the message

IT *nnnnn*

is printed and the program is terminated.

DOS-M checks whether there are *n* consecutive tracks starting at the track specified. Upon location of tracks, DOS-M returns the starting track number to the program. If DOS-M does not locate *n* consecutive tracks, it returns Ø in TRAK or ITRAK.

PROGRAM COMPLETION

Purpose

To notify DOS-M that the calling program is finished and wishes to terminate.

Assembly Language

```
        EXT EXEC
         :
        JSB EXEC            (Transfer control to DOS-M)
        DEF *+2             (Return point from DOS-M)
        DEF RCODE           (Request code)
        return point
         :
RCODE   DEC 6               (Request code = 6)
```

FORTRAN

The FORTRAN and ALGOL compilers generate a PROGRAM COMPLETION EXEC CALL automatically when they compile an END$ or STOP statement.

PROGRAM SUSPEND

Purpose

To suspend the calling program from execution until restarted by the GO directive.

Assembly Language

```
         EXT EXEC
          :
         JSB EXEC            (Transfer control to DOS-M)
         DEF *+2             (Point of return from DOS-M)
         DEF RCODE           (Request code)
         return point        (Continue execution)
          :
          :
RCODE    DEC 7               (Request Code = 7)
```

FORTRAN

The library subroutine PAUSE, which is automatically called by a PAUSE statement, generates the SUSPEND EXEC call.

Comments

DOS-M prints a message on the system teleprinter when it processes the PROGRAM SUSPEND EXEC call:

name SUSP

When the operator restarts the program with a GO, the B-Register contains the address of a five-word parameter array set by the GO request. (The parameters equal zero if no values have been given.) In a FORTRAN program, the library subroutine RMPAR can load these parameters; however, the call to RMPAR must occur immediately following the SUSPEND EXEC call, as in the following example:

```
DIMENSION I (5)
CALL EXEC (7)          (Suspend)
CALL RMPAR (I)         (Return point; get parameters)
```

PROGRAM SEGMENT LOAD

Purpose

To load a segment of the calling program from the disc into the segment overlay area and transfer execution control to the segment's entry point. (See Section IV, DOS-M PROGRAMMING, for information on segmented programs.) Follows the :SS condition.

Assembly Language

```
       EXT  EXEC
        :
       JSB  EXEC           (Transfer control to DOS-M)
       DEF  *+3 (to 8)     (Determine number of parameters)
       DEF  RCODE          (Request code)
       DEF  SNAME          (Segment name)
       DEF  PRAM1          (First optional parameter)
        :
       DEF  PRAM5          (Fifth optional parameter)
        :
RCODE  DEC  8              (Request code = 8)
SNAME  ASC  3,xxxxx        (xxxxx is the segment name)
PRAM1  ---                 (Up to 5 words of parameter inform-
PRAM5  ---                 ation; passed to segment as parameters
                           are passed to a suspended program.
                           See PROGRAM SUSPEND.)
```

FORTRAN

```
       IRCDE = 8
       DIMENSION INAME (3)
       INAME (1) = xxxxxB       (First two characters)
       INAME (2) = xxxxxB       (Second two)
       INAME (3)   xxxxxB       (Last character)
       CALL EXEC (IRCDE, INAME [,p1...]
```

Comments

In the FORTRAN or ALGOL calling sequence, the name of the segment must be converted from ASCII to octal and stored in the INAME array, two characters per word.

See OVERLAY SEGMENTS and SEGMENTED PROGRAMS, Section IV, for a description of segmented programs.

SEARCH FILE NAME

Purpose

To check whether a specific file name exists in the directory of user or system files. (Follows the :SS condition.)

Assembly Language

```
        EXT EXEC
         :
        JSB EXEC             (Transfer control to DOS-M)
        DEF *+4              (Return address)
        DEF RCODE            (Request code)
        DEF FNAME            (File name)
        DEF NSECT            (Number of sectors)
        return point
         :
RCODE   DEC 18               (Request code = 18)
FNAME   ASC 3,xxxxx          (xxxxx is the file name)
NSECT   NOP                  (Number of sectors returned here;
                             Ø if not found)
```

On return, A-register contains track/sector address of file, and B-register contains the memory address of the track/sector address.

FORTRAN

```
        IRCDE = 18                    (request code)
        DIMENSION INAME (3)           (File name)
        INAME (1) = xxxxxB            (First two characters)
        INAME (2) = xxxxxB            (Next two characters)
        INAME (3) = xxxxxB            (Last character)
        CALL EXEC (IRCDE, INAME, ISECT)
```

TIME REQUEST

Purpose

To request the current time.

Assembly Language

```
        EXT EXEC
         :
        JSB EXEC          (Transfer control to DOS-M)
        DEF *+3           (Point of return from DOS-M)
        DEF RCODE         (Request code)
        DEF ARRAY         (Time value array)
        return point      (Continue execution)
         :
RCODE   DEC 11            (Request code = 11)
ARRAY   BSS 5             (Time value array)
```

FORTRAN

```
        IRCDE = 11
        DIMENSION ITIME (5)
        CALL EXEC (IRCDE, ITIME)
```

Comments

When DOS-M returns, the time value array contains the time on a 24-hour clock:

ARRAY	or ITIME (1)	=	Tens of milliseconds
ARRAY + 1	or ITIME (2)	=	Seconds
ARRAY + 2	or ITIME (3)	=	Minutes
ARRAY + 3	or ITIME (4)	=	Hours
ARRAY + 4	or ITIME (5)	=	Not used, but must be present (always = Ø)

If DOS-M does not contain a time base generator, all values in the time array are set to zero (0).

CHANGE USER DISC

Purpose

To change the subchannel assignment for the user disc.

Assembly Language

```
        EXT EXEC
         .
         .
         .
        JSB EXEC                    (Transfer control to DOS-M)
        DEF *+3 (or 4)              (Point of return from DOS-M)
        DEF RCODE                   (Request code)
        DEF LABEL                   (Disc Label)
        DEF SUBCH                   (Disc Subchannel; optional)
        return point
         .
         .
         .
RCODE   DEC 23                      (Request code = 23)
LABEL   ASC 3, xxxxxx               (Label = xxxxxx)
SUBCH   DEC (Ø to 7)
```

FORTRAN

```
        IRCDE = 23
        DIMENSION LABEL (3)
        LABEL (1) = xx
        LABEL (2) = xx
        LABEL (3) = xx
        ICHNL = M         (Ø through 7)
        CALL EXEC (IRCDE, LABEL, ICHNL)
```

Comments

1. If both the label and subchannel are specified, DOS-M checks whether the subchannel has that label. If it does, the assignment is made and DOS-M returns. If not, DOS-M prints:

```
LBL = name      (name is label on the subchannel)
or UNLBL
UD nnnnn        (nnnnn = address of EXEC call)
xxxxx SUSP      (xxxxx = name of program)
```

   The operator can load a correctly labeled disc on the subchannel and type in

```
:GO
```

   This returns to the *beginning* of the EXEC call (not the normal return point) so that the program can reissue the EXEC call.

   If the operator does not have a properly labeled disc (or the subchannel is a permanent disc), he should use :OFF or :ABORT.

2. If only a label is specified, DOS-M searches for the label, starting with the highest subchannel. If DOS-M finds the label, it makes the assignment.

   If DOS-M cannot find the label, it suspends the program and prints:

```
DISC NOT ON SYS
UD nnnnn
xxxxx SUSP
```

   The operator can then abort the program or load a properly labeled disc and type in:

```
:GO
```

   This returns to the *beginning* of the EXEC call.

3. If the label equals "*" and a subchannel is specified, DOS-M checks whether the subchannel is unlabeled. If it is, DOS-M makes the assignment. If the subchannel is labeled, DOS-M suspends the program and prints:

   ```
   LBL = name
   UD nnnnn
   xxxxx SUSP      (xxxxx is the program)
   ```

   The operator can then abort the program or load an unlabeled disc on the proper channel and type in:

   ```
   :GO
   ```

   This returns to the *beginning* of the EXEC call.

4. If the label equals "*" and a subchannel is *not* given, DOS-M searches for an unlabeled disc, starting with the highest subchannel. DOS-M assigns the first unlabeled disc as the user disc, or if no unlabeled discs are found, it suspends the program and prints.

   ```
   DISC NOT ON SYS
   UD nnnnn
   xxxxx SUSP
   ```

   The operator can then abort the program or load an unlabeled disc and type in:

   ```
   :GO
   ```

   This returns to the beginning of the EXEC call.

   If the EXEC call specifies a subchannel with an incorrect system proprietary code (see Appendix A), DOS-M still makes the assignment but prints:

   TSB DISC *or* ??? DISC

If the EXEC call specifies a subchannel whose system generation code (see Section VII) does not match that of the system disc, DOS-M still makes the assignment, but prints:

DISC GEN CODE *nnnn* NOT SYS GEN CODE *nnn* ERR POS

The changes made by this EXEC call are only temporary, and will be reset at the end of each job.

If the specified subchannel is not active (physically present), DOS-M aborts the program and prints

UD *nnnnn* (*nnnnn* = address of EXEC call)

MAIN PROGRAM LOAD

Purpose

To load a main program from the disc into core and transfer control to its entry point. Follows the :SS condition.

Assembly Language

```
      EXT   EXEC
       .
       .
      JSB   EXEC          (Transfer control to DOS-M)
      DEF   *+3 (to 8)    (Determine number of parameters)
      DEF   RCODE         (Request code)
      DEF   PNAME         (Program Name)
      DEF   PRAM1         (First optional parameter)
       .
       .
      DEF   PRAM5         (Fifth optional parameter)
       .
       .
RCODE DEC   1Ø
PNAME ASC   3,xxxxx       (Program name)
PRAM1 ---                 (Up to 5 words of parameter information;
                          passed to the program as parameters are
PRAM5 ---                 passed to suspended programs.  See PROGRAM
                          SUSPEND.)
```

FORTRAN

```
      IRCDE = 1Ø
      DIMENSION INAME(3)
      INAME(1) = xxxxxB      (First two characters)
      INAME(2) = xxxxxB      (Next two characters)
      INAME(3) = xxxxxB      (Last character)
      CALL EXEC (IRCDE,INAME [,p1...])
```

SECTION IV
PROGRAMMING

Section IV describes the operating procedures and formatting conventions of the six user programming aids of DOS-M:

- ALGOL Compiler
- FORTRAN Compiler
- FORTRAN IV Compiler
- Assembler
- Relocating Loader
- Relocatable Libraries

Using the EDIT directives, the operator creates and edits files of source programs written in FORTRAN, ALGOL, or Assembly Language. In load-and-go operations the DOS-M FORTRAN Compiler, FORTRAN IV Compiler, ALGOL Compiler and DOS-M Assembler generate relocatable binary code onto temporary disc storage. The DOS-M Relocating Loader can then relocate and merge the code with referenced subroutines of the Relocatable Library. Once loaded, a program is executed by the PROG or RUN directive.

LOAD-AND-GO FACILITY

The Moving Head Disc Operating System provides the facility for "load-and-go" which is defined as compilation or assembly, loading, and execution of a user program without using intervening object paper tapes. To accomplish this, the compiler or assembler generates relocatable object code from source statements and stores it on the disc in the job binary area of the WORK tracks. Then separate directives initiate loading (PROG, LOADR) and execution (RUN, *program*).

DOS-M stores the object code of several programs and associated subroutines on the disc. The Relocating Loader locates them on the disc, and relocates them into executable absolute program units.

DOS-M FORTRAN COMPILERS (Basic FORTRAN and FORTRAN IV)

The DOS-M FORTRAN Compilers operate under control of the DOS-M Supervisor. The compilers reside on the disc and are read into core only when needed.

DOS-M FORTRAN and FORTRAN IV are problem-oriented programming languages. Source programs, accepted from either an input device or a user file, are translated into relocatable object programs, punched on paper tape, and optionally, stored in the job binary area of the disc. The object program can be loaded using the DOS-M Relocating Loader and executed using the RUN or PROG directive.

Compiler Operation

The DOS-M FORTRAN compilers are started by a PROG directive. Before entering the PROG directive, place the source program in the input device, or, if input is from a source file, specify the file with a JFILE directive.

PROG, FTN [4]

```
:PROG,FTN [,p1,p2,p3,p4,99]
:PROG,FTN4[,p1,p2,p3,p4,99]
```

Where

p_1 = logical unit of input device (standard is 5; set to 2 for source file input).

p_2 = logical unit of list device (standard is 6).

p_3 = logical unit of punch device (standard is 4).

p_4 = lines/page on listing (standard is 56).

99 = the job binary parameter. If present, the object program is stored in the job binary area for later loading. Any requested punch output still occurs. (The 99 may occur anywhere in the parameter list, but terminates the list.)

p_1 through p_4 are optional. If not present, the standard operation is assumed. If 99 is not present, then binary is not placed in the job binary area.

MESSAGES TO OPERATOR DURING COMPILATION

This message is printed on the operator console when an end-of-tape occurs on device #*n*:

```
I/O ERR ET EQT #n
```

EQT #*n* is unavailable until the operator declares it up:

```
:UP,n
:GO
```

Compilation continues after the GO. More than one source tape can be compiled into one program by loading the next tape before giving the GO.

At the end of compilation, the following message is printed.

```
$END, FTN[4]
```

If the job binary area (where binary code is stored because of a 99 parameter) overflows, the following message is printed, and compilation continues:

```
JBIN OVF
```

There is no further loading into the job binary area.

The compiler terminates if...

- No JFILE is declared, although logical unit 2 has been given for input. Error E-ØØ19 is printed on the list device. ($END,FTN[4] is not printed.)
- There are not enough work tracks for the compiler. The following message is printed:

  ```
  #TRACKS UNAVAILABLE
  ```

- Colons occur in the first column of a source program entered through the batch device. (Blank cards in the source program are ignored.) The following message is printed.

  IE *nnnnn*

where *nnnnn* is the memory location of the input request.

REFERENCE ON FORTRAN IV

The HP FORTRAN IV language is completely described in *FORTRAN IV Reference Manual,* 5951-1321.

Comments on Basic FORTRAN

FORTRAN CONTROL STATEMENT

Besides the standard options described in the FORTRAN manual, two new compiler options, T and *n*, are available. A "T" lists the symbol table for each program in the compilation. If a "u" follows the address of a variable, that variable is undefined (the program does not assign a value to it). The A option includes this T option. If *n* appears, *n* is a decimal digit (1 through 9) which specifies an error routine. The user must supply an error routine, ERR*n*. If this option does not appear, the standard library error routine, ERRØ, is used. The error routine is called when an error occurs in ALOG, SQRT, .RTOR, SIN, COS, .TROI, EXP, .ITOI or TAN.

PROGRAM STATEMENT

The program statement includes an optional type parameter.

PROGRAM *name* [(*type*)]

where *name* is the name of the program and its main entry point. When the program is executed using a RUN directive, this *name* is used. (It should not equal any file name.)

type is a decimal digit specifying the program type. Only types 3 (main), 5 (segment), and 6 or 7 (library) are significant in DOS-M. The type is set to 3 if not given.

Seven more parameters may be included but they are used only with the Real-Time Executive System. Programs can be compiled on DOS-M to be run under Real-Time.

I/O LOGICAL UNIT NUMBERS

DOS-M FORTRAN function assignments for logical unit numbers are different from regular FORTRAN. (See Section V.)

When preparing input data for the batch device, the user never puts a colon (:) in column one of a record because the colon in first position signifies a directive. DOS-M aborts the job if a directive occurs during data input.

DATA STATEMENT

A new statement, the DATA statement, has been added to DOS-M FORTRAN. DATA sets initial values for variables and array elements. The format of the DATA statement is:

DATA $k_1/d_1/,k_2/,...,k_n/d_n/$

where *k* is a list of variables and array elements separated by commas,

d is a list of constants or signed constants, separated by commas and optionally preceded by *j** (*j* is an integer constant).

The elements of d_i are serially assigned to the elements of k_i. The form *j** means that the constant is assigned *j* times. The k_i and d_i must correspond one-to-one.

Elements of k_i may not be from COMMON.

Arrays must be defined (i.e., DIMENSION) before the DATA statements in which they appear. DATA statements may occur anywhere in a program following the specification statements.

Example,

```
DIMENSION A(3), I(2)
DATA A(1),A(2),A(3)/1.Ø,2.Ø,3.Ø/I(1),I(2)/2*1/
```

EXTERNAL STATEMENT

With the new statement, EXTERNAL, subroutines and functions can be passed as parameters in a subroutine or function call. For example, the routine XYZ can be passed to a subroutine if XYZ is previously declared EXTERNAL. Each program may declare up to five EXTERNAL routines.

The format of the EXTERNAL statement is

EXTERNAL $v_1,v_2,\ldots,v_5$

Where v_1 is the entry point of a function, subroutine
or library program.

EXAMPLE

```
FUNCTION RMX(X,Y,A,B)
RMX=X(A)*Y(B)
END
EXTERNAL XYZ,FL1
Z=Q-RMX(XYZ,FL1,3.56,4.75)
```

ERROR E-ØØ18 means too many EXTERNALS.

Note: If a library routine, such as SIN, is used as an EXTERNAL, the compiler changes the first letter of the entry point to "%". Special versions of the library routines exist with the first character changed to "%".

PAUSE & STOP

PAUSE causes the following message to be printed.

PAUSE *xxxx*

Where *xxxx* is an octal number.

To restart the program, the operator uses a GO directive.

STOP causes the program to terminate after the following message.

STOP *program name xxxx*

Where *xxxx* is an octal number.

OVERLAY SEGMENTS

Segmented user programs may be written in FORTRAN, but certain conventions are required. A segment must be defined as type 5 in the PROGRAM statement. The segment must be initiated using the PROGRAM SEGMENT LOAD EXEC call from main or segment. A dummy call to main must appear in each segment. In this way, the proper linkage is established between the main and its segments.

Chaining of segments is unidirectional. Once a segment is loaded, execution transfers to it. The segment, in turn, may call another segment using an EXEC call, but a segment written in FORTRAN cannot return to the main program. All communication between the main program and segments must be through COMMON. Segments must not contain DATA Statements.

ERRØ LIBRARY ROUTINE

ERRØ, the error print routine referred to under the FORTRAN control statement prints the following message whenever an error occurs in a library routine:

nn xx

Where *nn* is the routine identifier, and
xx is the error type.

The compiler generates calls to ERRØ automatically. If the FORTRAN control statement includes an *n* option, the call will be to ERR*n*, a routine which the user must supply.

REFERENCE ON FORTRAN

For a complete description of the FORTRAN language, read the *FORTRAN* programmer's reference manual (02116-9015).

RTE/DOS ALGOL COMPILER

The RTE/DOS ALGOL Compiler consists of a main program and a data segment. It requires a 16K memory computer and can operate under the control of DOS-M, DOS, or the RTE System. The compiler resides on the disc and is read into core when called for in a :PROG directive. RTE/DOS ALGOL is very similar to the HP ALGOL language described in manual HP 02116-9072. The HP ALGOL compiler implements a language much like ALGOL 60, but it is non-recursive and has I/O capabilities.

Source programs written in DOS-M ALGOL are accepted either from an input device or from a user file and are translated by the ALGOL Compiler into relocatable object programs, punched on paper tape, and optionally, stored in the job binary area of the disc. The object program can be loaded using the DOS-M RELOCATING LOADER and executed using the RUN or PROG directive.

Compiler Operation

The ALGOL Compiler is started by a PROG directive. Before entering the PROG directive place the source program in the input device, or, if the input is from a source file, specify the file with a JFILE directive. The PROG directive for the ALGOL Compiler should take the following form:

PROG,ALGOL

:PROG, ALGOL, p_1,p_2,p_3,p_4,p_5

Where

p_1 = Input unit (=5 if not specified). Input unit = 2 means source input from disc. The source file has to be specified prior to this statement (by "JFILE" control statement).

p_2 = List unit (=6 if not specified).

p_3 = Punch unit (=4 if not specified).

p_4 = Number of lines on a page (=56 if not specified).

p_5 = Load-and-go parameter. To specify load-and-go, set p_5=99. The value of 99 is reserved for the load-and-go parameter. Its appearance in any position (p_1 through p_5) will be interpreted as p_5=99, and it also signals the end of the parameter list.

MESSAGES TO OPERATOR DURING COMPILATION

When the end of a source tape is encountered, the following will be outputed on the system teleprinter:

```
I/O ERR ET EQT #n
```

The compiler will wait until the following messages are entered on the system teleprinter:

```
:UP,n
:GO
```

At the end of the compilation, the following message is output to the system teleprinter:

```
$END, ALGOL
```

If the job binary area (where binary code is stored because of a "99" parameter in the PROG directive) overflows, the following message is output by the system teleprinter and compilation continues:

```
JBIN OVF
```

The compilation will be completed, but there will be no further loading of binary code into the job binary area.

The compiler terminates if...

- No JFILE is declared, although logical unit 2 had been specified as p_1 of the PROG directive. The following message is output:

  ```
  NO SOURCE
  ```

- The first statement of the source file specified by the PROG directive p_1 parameter does not begin with the word HPAL. Or the control statement contains an error. The following message is output:

  ```
  HPAL??
  ```

- A colon occurs in the first position of a source statement line. The following message is output:

  IE *nnnnn*

  where *nnnnn* is the memory location of the input request.

ALGOL Control Statement

The word HPAL is mandatory. Any combination of the following symbols may appear next, separated by commas:

L: produce source program listing

A: produce object code listing

B: produce object tape

P: a procedure only is to be compiled

If no symbols are specified, the program will run but will not produce any output other than diagnostic messages and job binary (if requested). A program name in quotes (the NAM-record name which must be a legitimate identifier without blanks) must follow the symbols. (It should not equal any file name.)

Sense switch control is not used with DOS-M. Two parameters may be specified following the NAM-record name.

> p_1 is a decimal digit between Ø and 9 specifying the name of the error routine to be called if an error occurs in ALOG, SQRT, .RTOR, SIN, COS, .RTOI, EXP, .ITOI, TAN. The name of the error routine is ERR*n*, where $n = p_1$ or $n = Ø$ if p_1 is not specified. ERRØ is supplied in the Relocatable Library, all other error routines must be supplied by the user.
>
> p_2 is a decimal digit specifying the type of the program: 3 for a main program, 5 for a segment, and 6 or 7 for a utility subroutine or procedure. If p_2 is not specified, the type is set to 3 for main programs and to 7 for procedures (P option in the control statement).

EXAMPLE

```
HPAL,L,B,"TEST",1,3
```

ALGOL Segmentation

ALGOL programs can be segmented if certain conventions are followed. A segment must be defined as type 5 in the HPAL statement. The segment must be initiated by using the PROGRAM SEGMENT LOAD EXEC call from the main or another segment.

In order to establish the proper linkage between a main program and its segments, each segment must declare the main a code procedure. For example, if MAIN is the main program, the following must be declared in each segment.

```
PROCEDURE MAIN; CODE:
```

Chaining of segments is undirectional. Once a segment is loaded, execution transfers to it. The segment, in turn, may call another segment using an EXEC call, but a segment written in ALGOL cannot return to the main program.

ALGOL I/O

The HP ALGOL I/O statements should specify the proper logical unit numbers for the DOS-M configuration. (See Section V.)

ALGOL Error Messages

See the manual HP ALGOL (HP 02116-9072) for the meanings of HP ALGOL compilation time and run time error messages.

DOS-M ASSEMBLER

The DOS-M Assembler, a segmented program that executes in the user program area of core, operates under control of DOS-M. The Assembler consists of a main program (ASMB) and six segments (ASMBD, ASMB1, ASMB2, ASMB3, ASMB4, ASMB5), and resides on the disc.

DOS-M Assembly Language, a machine-oriented programming language, is very similar to the HP Extended Assembly Language. Source programs, accepted from either an input device or a user source file on the disc, are translated into absolute or relocatable object programs; absolute code is punched in binary records, suitable for execution only outside of DOS-M. ASMB can store relocatable code in the load-and-go area of the disc for on-line execution, as well as punch it on paper tape. The DOS-M Relocating Loader accepts assembly language relocatable object programs from paper tape, the load-and-go area, and user files.

A source program passes through the input device only once, unless there is insufficient disc storage space. In the latter case, two passes are required.

Assembler Operation

The DOS-M Assembler is started by a PROG directive. However, before entering the PROG directive, the operator must place the source program in the input device. If the source program is on the disc, the operator must first specify the file with a JFILE directive, and set parameter p_1 = logical unit 2 in the PROG directive.

PROG,ASMB

:PROG,ASMB,p_1,p_2,p_3,p_4,*99*

Where

p_1 = logical unit of input device (5 is standard; 2 is used for source file input indicated by a JFILE directive)

p_2 = logical unit of list device (6 is standard)

p_3 = logical unit of punch device (4 is standard)

p_4 = lines/page on listing (56 is standard)

99 = job binary parameter. If present, the object program is stored in the job binary area for later loading. Any requested punching still occurs. The 99, which may follow any parameter in the list, terminates the list.

MESSAGES DURING ASSEMBLY

The messages described in this section are printed at the teleprinter console or in the program listing.

When an end-of-tape occurs on device #*n*, this message appears on the system teleprinter:

I/O ERR ET EQT #*n*

EQT #*n* is unavailable until the operator declares it up and restarts the assembler by means of a GO directive:

:UP,*n*
:GO

Thus, more than one source tape can be assembled into one program. The next tape is loaded each time the input device goes down. The program should be placed in the input device before entering the GO.

The following message on the system teleprinter signifies the end of assembly:

```
$END ASMB
```

If another pass of the source program is required, the message is printed on the system teleprinter at the end of pass one.

```
$END ASMB PASS
```

The operator must replace the program in the input device and type:

```
:GO
```

If an error is found in the Assembler control statement, the following message is printed on the system teleprinter:

```
$END ASMB CS
```

The current assembly stops.

If an end-of-file condition on source input occurs before an END statement is found, the teleprinter signals:

```
$END ASMB XEND
```

The current assembly stops.

If source input for logical unit 2 (disc) is requested, but no file has been declared (see JFILE, Section II), the system teleprinter signals:

```
$END ASMB NPRG
```

If the job binary area, where binary code is stored by a 99 parameter, overflows, assembly continues but the following message is printed on the system teleprinter:

```
JBIN OVF
```

However, no binary code is stored in the job binary area.

The next message is associated with each error diagnostic printed in the program listing during pass 1.

nnn

nnn is the "tape" number on which the error (reported on the next line of the listing) occurred. A program may consist of more than one tape. The tape counter starts with one and increments by one whenever an end-of-tape condition occurs (paper tape) or a blank card is encountered. When the counter increments, the numbering of source statements starts over at one.

Each error diagnostic printed in the program listing during pass 2 of the assembly is associated with a different message:

PG *ppp*

ppp is the page number (in the listing) of the *previous* error diagnostic. PG ØØØ is associated with the first error found in the program.

These messages (#*nnn* and PG *ppp*) occur on a separate line, just above each error diagnostic in the listing.

DOS-M Assembly Language

The DOS-M Assembly Language is equivalent to extended assembly language, as defined in the *ASSEMBLER* programmer's reference manual (02116-9014). A few language changes are required to run under DOS-M; programs must request certain functions, such as I/O, from the executive. These requests are made using the EXEC calls described in Section III.

ASSEMBLER CONTROL STATEMENT

The control statement has the same form as that of regular assembly language; and although only relocatable code can be run under DOS-M, the DOS-M Assembler is able to assemble absolute code if it is specified. Absolute code is never stored in the job binary area. To get absolute code, the control statement must include an "A". The "R", however, is not required for relocatable code. An "X" causes the assembler to generate non-extended arithmetic unit code.

Examples

ASMB,L,B	List and Punch Relocatable Binary
ASMB,R,L,B,X	List and Punch Relocatable, non-EAU Binary.
ASMB,T,L	List and Print Symbol Table.
ASMB,A,B,L	List and Punch Absolute Binary.

ORB STATEMENT

DOS-M Assembly Language does not contain the ORB statement, since information cannot be loaded into the protected base page area by user programs. However, programs can read information from base page using absolute address operands up to 1777_8.

INPUT/OUTPUT

DOS-M has different function assignments for the logical unit numbers. (See Section V.)

When preparing input for the batch device, the programmer must remember to never put a colon (:) in column one of a source statement. DOS-M aborts the current program if a directive (signified by : in column one) occurs during data input.

If present, the memory protect option protects the resident supervisor from alteration and interrupts the execution of a user program under these conditions:

- Any operation that would modify the protected area or jump into it.
- Any I/O instruction, except those referencing the switch register or overflow.
- Any halt instruction.

Memory protect gives control to DOS-M when an interrupt occurs, and DOS-M checks whether it was an EXEC call. If not, the user program is aborted.

NAM STATEMENT

The NAM psuedo-instruction allows up to eight optional parameters. (The last seven parameters are used only by programs to be executed under the Real-Time Executive System.) Only the first parameter is significant in DOS-M. If the first parameter equals 3, the program is a main program; if 5, a program segment; if 6, a library routine; if 7, a subroutine. If the parameter equals another number, the assembler and DSGEN will accept it, but the Relocating Loader will not. (See Section VI for DSGEN program type codes.)

NAM *name* [,*type*]

where *name* is the name of the program (it should not equal any file name), and

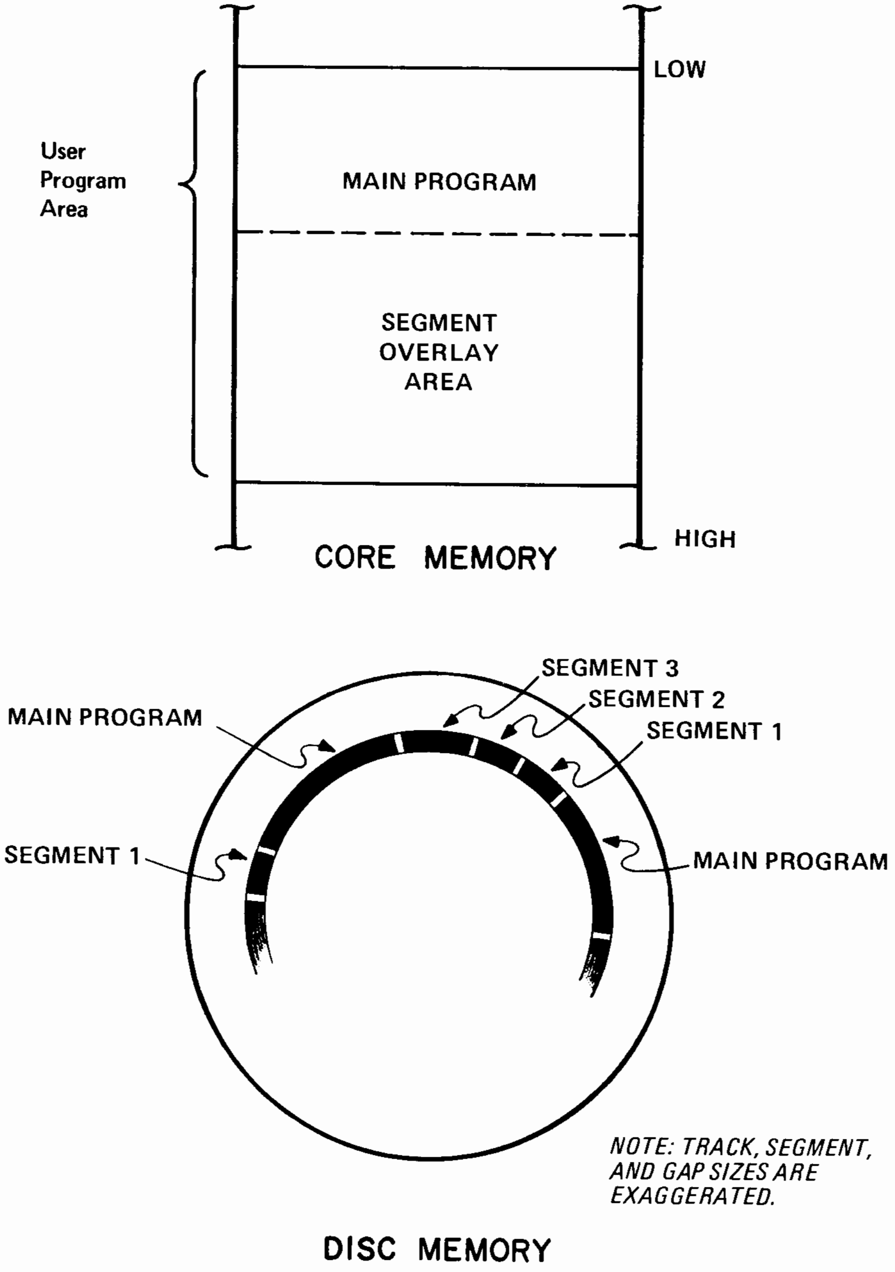
type is the type code.

In addition to the *name* defined by NAM, each program has one or more *entry points* defined by an ENT statement with the exception of the main program. The transfer address on the END statement is sufficient for the main program (type 3). *Name* is used in programmer-to-DOS-M communication, while the *entry points* are program-to-program communication.

Segmented Programs

User programs may be structured into a main program and several segments, as shown in Figure 4-1. The main program begins at the start of the user program area. The area for the segments starts immediately following the last location of the main program. The segments reside on the disc, and are read into core by an EXEC call, when needed. Only one segment may be in core at a time. When a segment is read into core, it overlays the segment previously in core.

The main program must be type 3, and the segments must be type 5. When using DSGEN to configure the system or loading programs with LOADR, the main program must be entered prior to its segments. One external reference from each segment to the main routine is required for DSGEN to link the segments and main programs. Also, each segmented program should use unique external reference symbols. Otherwise, DSGEN or LOADR may link segments and main programs incorrectly.



NOTE: TRACK, SEGMENT, AND GAP SIZES ARE EXAGGERATED.

Figure 4-1. Segmented Programs

Figure 4-2 shows how an executing program may call in any of its segments from the disc using the PROGRAM SEGMENT LOAD EXEC request (1-2). DOS-M locates the segment on the disc (3-4), loads it into core (5) and begins executing it. The segment may call in another of the main program's segments using the same EXEC request (6).

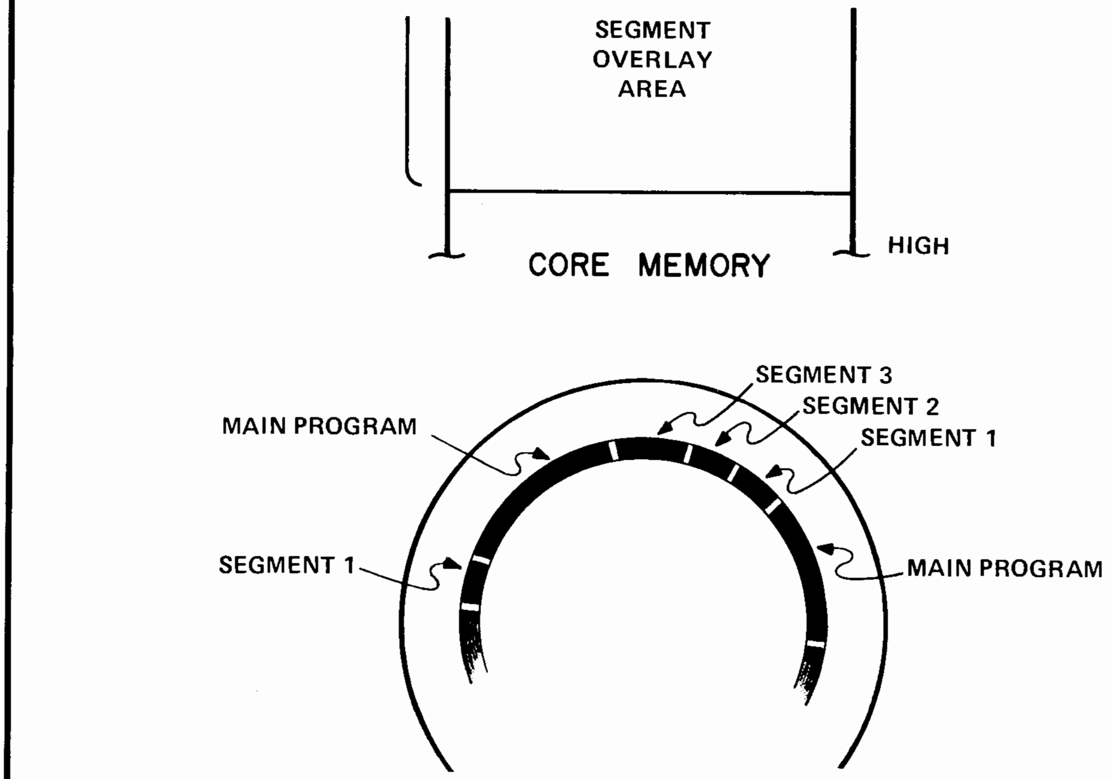


Figure 4-2. Main Calling Segment

Figure 4-3 shows how DOS-M processes the request from the segment (7) by locating the segment on the disc (8-9), loading it into core (10), and beginning execution of it.

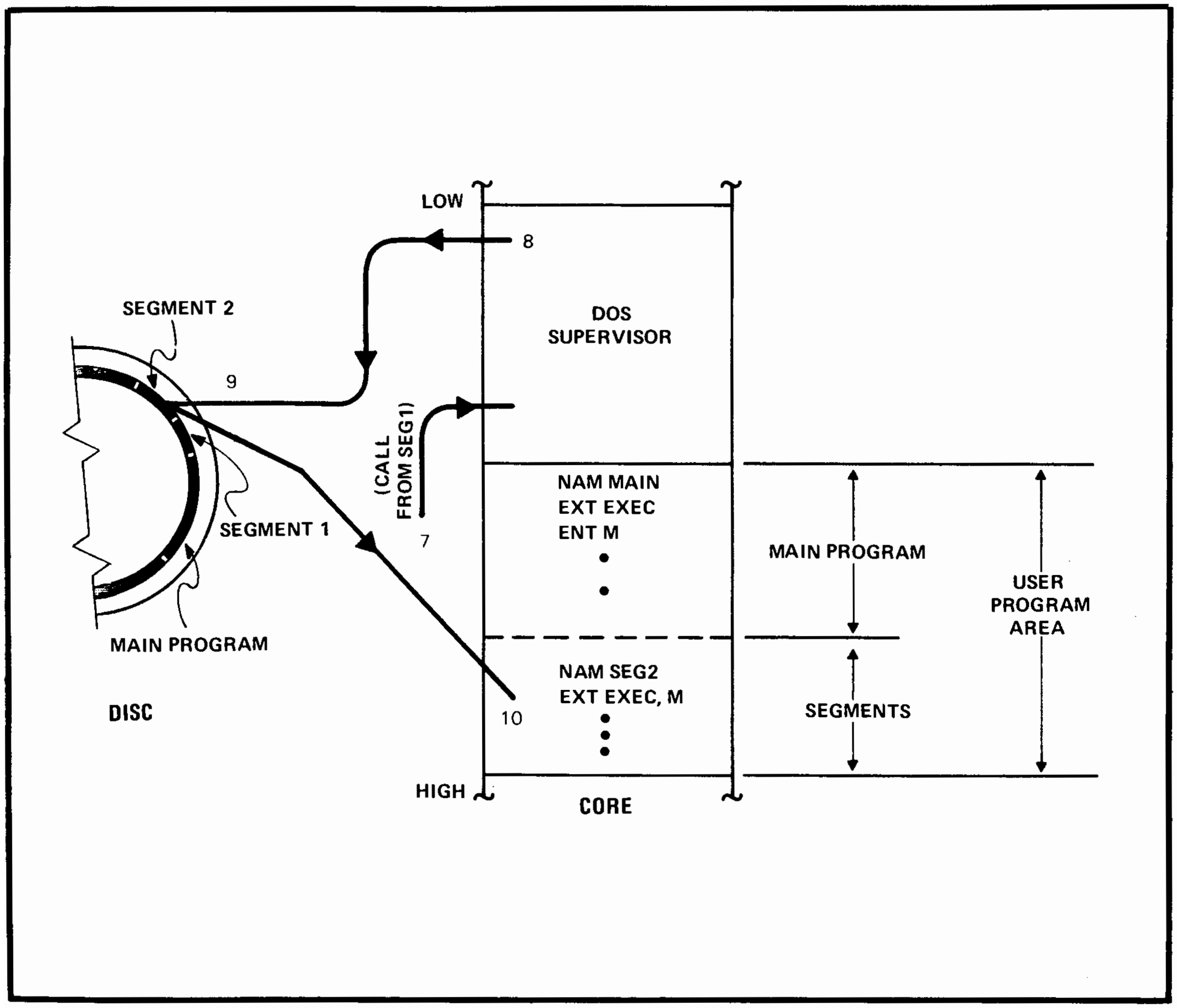


Figure 4-3. Segment Calling Segment

When a main program and segment are currently residing in core, they operate as a single program. Jumps from a segment to a main program (or vice versa) can be programmed by declaring an external symbol and referencing it via a JMP or JSB instruction. (See Figure 4-4.) A matching entry symbol must be defined as the destination in the other program. DSGEN associates the main programs and segments, replacing the symbolic linkage with actual absolute addresses (i.e., a jump into a segment is executed as a jump to a specific address). The programmer should be sure that the correct segment is in core before any JMP instructions are executed.

Reference on Assembly Language

Consult the *ASSEMBLER* programmer's reference manual (02116-9014) for a full description of assembly language.

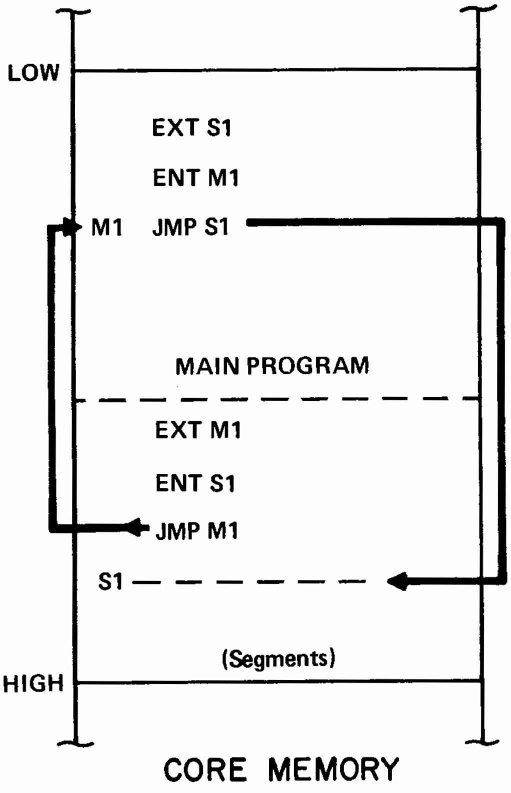


Figure 4-4. Main-to-Segment Jumps

DOS-M RELOCATING LOADER

The DOS-M Relocating Loader accepts relocatable object programs which have been translated by the DOS-M Assembler, RTE/DOS ALGOL Compiler or DOS-M FORTRAN Compiler. It generates an executable core image of each such program on the disc. The relocatable programs may enter the loader as

- Job binary area programs translated during the current job,
- User files,
- Punched tapes, magnetic tapes, or
- Subroutines from the disc-resident Relocatable Library.

Each main program is relocated to the start of the user area and linked to its external references, such as library routines. Segments will overlay the area following the main program and its subroutines. Programs may run under control of the DEBUG library routine. The main program, plus its subroutines and its longest segment, can be as large as the user area. With a RUN or PROG directive, the program is called by name from the disc and executed, or the program is stored as a permanent user file to be run during a later job. If the JBIN is used, the loader may be executed only once during each job, so all load-and-go assemblies or compilations must be done prior to calling the loader.

Starting the Loader

The DOS-M Relocating Loader is initiated by a PROG directive from the batch or keyboard device.

PROG,LOADR

Format

:PROG,LOADR[,P_1,P_2,P_3,P_4,P_5]

P_1 determines the relocatable object program input combination:

P_1 = Ø for loading from jbin and relocatable library.

= 2 for loading from jbin, user files, and relocatable library.

= *n* for loading from jbin, user files, relocatable library and paper tape, or magnetic tape (logical unit *n*).

P_2 = list device logical unit.

P_3 = Ø for no DEBUG, ≠ Ø for DEBUG.

P_4 = Ø for list of program load map, ≠ Ø for none.

P_5 = Ø for list of entry point addresses, ≠ Ø for none.

If values P_1,...P_5 are not set, P_1=Ø, P_2=6, P_3=P_4=P_5=Ø.

Comments

Selecting the DEBUG option causes DEBUG to be appended to each main program and segment. The loader sets the primary entry point of each to DEBUG, rather than the user routine. When the program is run, DEBUG takes control of the program's execution and seeks instructions from the keyboard.

RELOCATABLE FILES

A list of relocatable file names follows the PROG directive (unless P_1 equals Ø). In batch mode, the list starts on the next record and stops at "/E". In keyboard mode, the loader prints

```
ENTER FILE NAME(S) OR /E
```

then waits for input. After each list of files is entered, the message repeats until a /E is entered. In batch mode the list of files follows the PROG directive on the batch input device.

file-name 1, file-name 2,..,/E

The file list is a series of records containing file names separated by commas, ending with a "/E." All programs in each file are loaded unless a particular subset of the file is specified:

file-name (prog 1, prog 2...)

Only the programs specified within the parenthesis are loaded from the *file-name*. The file list is simply a "/E" if no files are to be loaded. (The search for these files is made only on the current user disc; the loader is unaffected by :SS.)

Operating the Loader

SCANNING THE PROGRAMS

The loader scans the relocatable binary programs and maintains two tables--one of program names, and another of entry points and externals. Since mains are matched with segments during the scan, each main program must occur before the associated segments. Programs from tape are stored on the work tracks as they are read in.

If the job binary area contains any programs, it is scanned first. User files given in the file list (if any) are scanned for entries and externals.

If paper tape input is requested, the following messages are printed,

```
LOAD TAPE
LOADR SUSP
@
```

The loader suspends. The operator places a tape in the input device and types

```
:GO
```

When an end-of-tape condition occurs, three messages are printed on the system teleprinter:

```
I/O ERR ET EQT# nn  (paper tape only -- not magnetic tape)
LOAD TAPE
LOADR SUSP
@
```

The operator places the next tape in the input device, enters :UP,_n_, and :GO to read the next tape. Enter :GO,1 to indicate that all tapes have been read in.

Matching Entries with Externals

After matching all possible entry points and external references in the user programs, the loader scans the Relocatable Library (disc-resident) looking for entry points to match the undefined external references. If undefined external references still exist,

```
UNDEFINED EXTS
```

is printed and the external references are listed, one per line.

To load additional programs from paper tape, the operator types:

```
    :GO,Ø[,n]
```

where *n* is the logical unit number of the input device, if different from P_1 of the PROG,LOADR directive.

To continue without fulfilling external references, the operator types:

```
    :GO,1
```

To specify a file name from the keyboard, the following directive is typed:

```
    :GO,2
```

RELOCATION

The main and segment names become user file names once the programs are loaded. To ensure unique file names, the loader compares all program and segment names against the names of previous system and user files (current user disc only). If duplicate names occur, an error message is printed and loading stops.

The loader converts each main program into an absolute core image, stores it on the disc, places the name in the user directory where it remains during the current job, and lists the program address map and entry points, if requested. After each main program, any associated segments are loaded in the same way. When the loader is completely finished, the following message is printed:

```
    LOADR COMPLETE
```

During the current job, the absolute core images appear in the user file area (see LIST directive, Section II) and can be executed by name (see RUN and PROG directives). At the end of the job, however, they disappear from the file area, unless they are made permanent files by means of the STORE, P directive.

If no programs are entered, the loader prints the following messages and terminates:

```
NO PROGRAMS LOADED.
LOADR COMPLETE
```

DEBUG Library Subroutine

RTE/DOS DEBUG, a subroutine of the Relocatable Library, allows programmers to check for logical errors during execution. If the P_3 parameter of the PROG, LOADR directive equals 1, the loader combines DEBUG with the user program being loaded. The primary entry point (the location where execution begins) is set to DEBUG. Therefore, when the program is executed with a RUN directive, DEBUG takes control and prints the message:

```
BEGIN 'DEBUG' OPERATION
```

The programmer now enters any legal debug operation. DEBUG ignores illegal requests and prints a message:

```
ENTRY ERROR
```

DEBUG OPERATIONS

B,*A*	Instruction breakpoint at address *A*. (NOTE: if *A* = JSB EXEC, a memory protect violation occurs.)
D,A,N_1[,N_2]	ASCII dump of core address N_1 or from N_1 to N_2.
D,B,N_1[,N_2]	Binary dump of core address N_1 or from N_1 to N_2.
M,*A*	Sets absolute base of relocatable program unit.
R,*A*	Execute user program starting at *A*. Execute starting at next location in user program (used after a breakpoint or to initiate the program at the transfer point in the user program).
S,A_1,D_1	Set D_1 in location A_1.
S,A_1,D_1,D_n	Set D_1 to D_n in successive memory locations beginning at location A_1.
W,A,D_1	Set A-Register to D_1.
W,B,D_2	Set B-Register to D_2.
W,E,D_3	Set E-Register (Ø=off, non-zero=on).
W,O,D_4	Set Overflow (Ø=off, non-zero=on).
X,*A*	Clear breakpoint at address *A*.
A	Abort Debug operation.

Loader Example

In the following example, DOS-M is in keyboard mode.

```
:PROG,LOADR,5,6,Ø,Ø,Ø        Paper tape input is specified.
ENTER FILE NAME(S)OR/E       No files are specified.
/E
LOAD TAPE                    Place paper tape in input device.
LOADR SUSP
@:GO                         Return to loader.
I/O ERR ET EQT # Ø3          End of tape.
LOAD TAPE                    Put in next tape.
LOADR SUSP
@:UP,3                       Declare input device ready.
@:GO
I/O ERR ET EQT # Ø3
LOAD TAPE
LOADR SUSP
@:UP,3
@:GO
I/O ERR ET EQT # Ø3
LOAD TAPE
LOADR SUSP
@:UP,3
@:GO                         Repeat tape loading process 4 times.
I/O ERR ET EQT # Ø3
LOAD TAPE
LOADR SUSP
@:UP,3
@:GO
I/O ERR ET EQT # Ø3
LOAD TAPE
LOADR SUSP
@:UP,3
@:GO,1                       No more paper tapes.
```

RELOCATING LOADER

```
NAME/ENTRY          ADDR

QA1                 12ØØØ       Main program, starting address.
  *QA1              12Ø76       Main program, entry point.
  QA1A              122ØØ
   *QA1A            122Ø1
  QA1B              12262
   *QA1B            12263
  QA1C              12336
   *QA1C            12337
  QA1D              12364
   *QA1D            12365
  FRMTR             12431
   *.D10.           14612
   *.BIO.           14665
   *.IOI.           145Ø7
   *.IOR.           14462       Subroutine starting addresses and entry
   *.IAR.           14546       points.  Asterisk signifies entry point.
   *.RAR.           14522
   *.DTA.           1471Ø
  .ENTR             15162
  *.ENTR            15162
  .FLUN             1523Ø
  *.FLUN            1523Ø
  .PACK             15243
   *.PACK           15243
  FLOAT             1535Ø
   *FLOAT           1535Ø
  IFIX              15355
   *IFIX            15355
LOADR COMPLETE                  End of Loading.
```

Loader Error Messages

During its operation the loader may print one of the following error messages on the keyboard:

Message	Error Messages
LØ1	Checksum error on tape
LØ2	Illegal record
LØ3	Memory overflow
LØ4	Base page overflow
LØ5	Symbol table overflow
LØ6	Duplicate main or segment name (may be caused by attempting to run the loader twice in one job)
LØ7	Duplicate entry point
LØ8	No main or segment transfer address
LØ9	Record out of sequence
L1Ø	Insufficient directory or work area space
L11	Program name table overflow
L12	User file specified cannot be found
L13	Program name duplication
L14	Non-zero base page length
L15	Segment occurred before main
L16	Program overlay (illegal ORG)
L17	Illegal library record.

The loader aborts (programmer must start over) on each of these conditions and prints a message.

```
LOADR TERMINATED
```

THE RELOCATABLE LIBRARIES

There are two libraries, or collections of relocatable subroutines that can be used by DOS-M: the RTE/DOS Relocatable Library (EAU or Non-EAU versions) and the RTE/DOS FORTRAN IV Library. These libraries contain mathematical routines such as SIN and COS, and utility routines such as BINRY, etc. A program signifies its need for a subroutine by means of an "external reference." External references are generated by EXT statements in assembly language, by CALL statements and the compiler in FORTRAN, and by CODE procedures and the compiler in ALGOL.

When the system is generated, several combinations of libraries are possible. Every system should contain an RTE/DOS Relocatable Library: either an EAU version or a non-EAU version, depending on the computer hardware. This library does not contain a formatter, but the FORTRAN IV Library contains a formatter that handles extended precision numbers. If extended precision arithmetic is not needed, a separate RTE/DOS Basic FORTRAN Formatter is available to take the place of the FORTRAN IV Library.

All of these libraries and the subroutines they contain are documented in the *Relocatable Subroutines* manual (02116-9032).

SECTION V
INPUT/OUTPUT

In the Moving-Head Disc Operating System, centralized control and logical referencing of I/O operations effect simple, device-independent programming. Each I/O device is interfaced to the computer through one or more I/O channels which are linked by hardware to corresponding core locations for interrupt processing. By means of several user-defined I/O tables, multiple-device drivers, and program EXEC calls, DOS-M relieves the programmer of most I/O problems.

SOFTWARE I/O STRUCTURE

An Equipment Table records each device's I/O channels, driver entry points, DMA requirements, and location on disc if disc-resident. A Device Reference Table (logical unit table) assigns an equipment table number to each of its entries, thus allowing the programmer to reference changeable logical units instead of fixed physical units.

An Interrupt Table relates each channel to an entry in the Equipment Table.

A driver is responsible for initiating and continuing operations on all devices of an equivalent type.

The programmer requests I/O by means of an EXEC call in which he specifies only the logical unit, control information, buffer location, buffer length, and type of operation.

The Equipment Table

The Equipment Table (EQT) has an entry for each device recognized by DOS-M (these entries are established by the user when DOS-M is generated). The EQT entries reside in the permanent core-resident part of the system and have this format:

<table>
<tr><th>WORD</th><th colspan="16">CONTENTS</th><th></th></tr>
<tr><td>1</td><td colspan="16">Driver "Initiation" Section Address</td><td></td></tr>
<tr><td>2</td><td colspan="16">Driver "Continuation" Section Address</td><td></td></tr>
<tr><td>3</td><td>D</td><td>R</td><td colspan="5"></td><td colspan="3">Unit #</td><td colspan="6">Channel #</td><td></td></tr>
<tr><td>4</td><td colspan="2">Av</td><td colspan="6">Equipment Type Code</td><td colspan="8">Status</td><td></td></tr>
<tr><td>5</td><td colspan="16">(saved for driver use)</td><td></td></tr>
<tr><td>6</td><td colspan="16">(saved for driver use)</td><td></td></tr>
<tr><td>7</td><td colspan="16">Request Return Address</td><td></td></tr>
<tr><td>8</td><td colspan="16">Request Code</td><td></td></tr>
<tr><td>9</td><td colspan="16">Current I/O Request Control Word</td><td></td></tr>
<tr><td>10</td><td colspan="16">Request Buffer Address</td><td></td></tr>
<tr><td>11</td><td colspan="16">Request Buffer Length</td><td></td></tr>
<tr><td>12</td><td colspan="16">Temporary or Disc Track #</td><td></td></tr>
<tr><td>13</td><td colspan="16">Temporary or Starting Sector #</td><td></td></tr>
<tr><td>14</td><td colspan="16">Temporary Storage for Driver</td><td></td></tr>
<tr><td>15</td><td colspan="16">Upper Memory Address of Main Driver Area</td><td rowspan="3">Ø's if core-resident</td></tr>
<tr><td>16</td><td colspan="16">Upper Memory Address of Driver Linkage Area</td></tr>
<tr><td>17</td><td colspan="8">Starting Track #</td><td colspan="8">Starting Sector #</td></tr>
<tr><td>BITS</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>1Ø</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>Ø</td><td></td></tr>
</table>

D = 1 if DMA channel required.

R = 1 if driver type is core-resident.

Unit # May be used for sub-channel addressing.

Channel # I/O select code for device (lower number if multiboard interface.)

Av = Ø - Unit not busy and available
1 - Unit disabled (down)
2 - Unit busy

Status - Actual or simulated unit status at end of operation.

Equipment Type Code - Identifies type of device and associated software driver. Assigned equipment type codes in octal are:

ØØ-Ø7	Paper Tape Devices
ØØ	Teleprinter
Ø1	Punched Tape Reader
Ø2	High Speed Punch
Ø5	Teletype (System)
1Ø-17	Unit Record Devices
1Ø	Reserved for Plotter
12	Line Printer
15	Mark Sense Card Reader
2Ø-37	Magnetic Tape/Mass Storage and other devices capable of both input and output
22	3030 Magnetic Tape
31	Moving-Head Disc

For equipment type codes Ø1 through 17, odd numbers indicate input devices and even numbers indicate output devices (except Ø5, which is both input and output).

When DOS-M initiates or continues an I/O operation, it places the address of the EQT entry for the device into the base page communication area (see Appendix A) before calling the driver routine.

Logical Unit Numbers

Logical unit numbers from $1_{1\emptyset}$ to $63_{1\emptyset}$ provide logical addressing of the physical devices defined in the EQT. These numbers are maintained in the Device Reference Table (DRT or logical unit table), which is created by the System Generator (DSGEN) and can be modified by the LU directive.

Each one-word entry in the DRT contains the EQT entry number of the device assigned to the logical unit. DOS-M has the following function assignments for logical unit numbers.

	Logical Unit Number	Function
Restored after each :JOB.	1	System Teleprinter
	2	User Mass Storage
	3	System Mass Storage
	4	Standard Punch Device
	5	Standard Input Device
	6	Standard List Device
	7	Unassigned
	8	Recommended for magnetic tape
	9	Can be assigned to any device by user
	1Ø	
	:	
	$63_{1\emptyset}$	

The user determines the number of logical units when the system is generated. At the beginning of each JOB, logical units 1 through 9 are restored to the values set by DSGEN (System Generator), whereas 1Ø through 63 are restored only on a start-up from the disc.

Executing programs use logical unit numbers to specify the type of device for I/O transfers. In an I/O EXEC call, the program simply specifies a logical unit number and does not need to know which actual device or which I/O channel handles the transfer.

The Interrupt Table

The interrupt table contains an entry, established at system generation time, for each I/O channel in the computer which can cause an interrupt. The entry contains the address of the EQT entry for the device on the channel.

The interrupt locations in core contain a jump subroutine to $CIC which is the central interrupt control routine which examines the interrupt table to decide what action to take. On a power failure interrupt, DOS-M halts.

Input/Output Drivers

The I/O driver routines, either core-or disc-resident, handle the actual transfer of information between the computer and external devices. When a transfer is initiated, DOS-M places the EQT entry addresses into the base page communication area and jumps to the driver entry point. The driver configures itself for the particular channel (in this way the same driver can handle several devices of the same type on many channels), initiates the transfer and returns to DOS-M. When an interrupt occurs on the channel, indicating continuation or completion of the transfer, DOS-M again transfers control to the driver. DOS-M contains only two drivers: the Moving-Head Disc Driver (DVR31) and the System Teleprinter Driver (DVRØ5). However, these drivers of the Disc Operating System (DOS, fixed-head disc/drum) are fully compatible with DOS-M:

DVRØØ	-	Teleprinter
DVRØ1	-	Photo-reader
DVRØ2	-	High speed punch
DVR1Ø	-	Plotter
DVR12	-	Line Printer
DVR15	-	Mark Sense Card Reader
DVR22	-	3030 Magnetic Tape
DVR23	-	7970 Magnetic Tape

The driver name consists of the letters "DVR" added to the equipment type code. In addition, the programmer can write drivers for special devices, following the guidelines in this section. The driver is only responsible for updating the status field in the EQT entry; DOS-M handles the availability field.

System I/O

DOS-M itself initiates many I/O transfers. It reads in directives from the batch or keyboard device and transfers modules in from the disc. These functions are accomplished by $SYIO, a routine within the DOS-M Supervisor, which calls the appropriate driver routine.

User Program I/O

The user program initiates an I/O transfer by means of an EXEC call--a "JSB EXEC" as described in Section III. The supervisor recognizes the EXEC call as an I/O request and sends it along to the I/O supervisor EXEC MODULE ($EX18) which determines if the driver for the requested device is core-resident. If not, the driver is read into core from the disc.

$EX18 places the address of the EQT entry in the base page communication area (see Appendix A, *TABLES*) and transfers control to the driver. The driver configures itself to I/O operation on the appropriate channel, initiates the transfer and returns to $EX18. DOS-M either returns to the executing user program or waits until the I/O transfer is complete as requested by the program.

Interrupt Processing

When an interrupt occurs on the computer, control is transferred to the instruction in the interrupt location corresponding to the device. Each interrupt location (memory locations 4_8 through 37_8) contains a "JSB $CIC" instruction. $CIC, the central interrupt control routine of DOS-M, then performs the following:

a. Disables interrupt system

b. Saves registers, point of program suspension

c. Clears interrupt flag

d. Determines the type of interrupt

    1) If power fail, halts

    2) If memory protect, goes to EXEC (goes directly to EXEC if no memory protect)

    3) If time base, goes to CLOCK routine (if installed)

    4) If not a legal I/O channel, returns to suspension point

    5) If legal I/O channel, puts EQT entry addresses in base page communication address and transfers to driver continuation address

e. Upon return from the I/O driver, turns on interrupt system, restores registers, and returns to the point of suspension.

PLANNING I/O DRIVERS

Before attempting to program an I/O driver, the programmer should be thoroughly familiar with Hewlett-Packard computer hardware I/O organization, interface kits, computer I/O instructions and Direct Memory Access (DMA).

An I/O driver, operating under control of the Input/Output Control ($EX18) and Central Interrupt Control ($CIC) modules of DOS-M, is responsible for all data transfer between an I/O device and the computer. The device equipment table (EQT) entry contains the parameters of the transfer, and the base page communication area contains the number of the allocated DMA channel, if required.

An I/O driver includes two relocatable, closed subroutines, -- the Initiation Section and the Completion Section. If *nn* is the octal equipment type code of the device, I.*nn* and C.*nn* are the entry point names of the two sections and DVR*nn* is the driver name.

Initiation Section

The I/O control module ($EX18) calls the initiation section directly when an I/O transfer is initiated. Locations EQT1 through EQT17 of the base page communication area contain the addresses of the appropriate EQT entry. CHAN in base page contains the number of the DMA channel assigned to the device, if needed. This section is entered by a jump subroutine to the entry point, I.*nn*. On entry, the A-register contains the select code (channel number) of the device (bits Ø through 5 of EQT entry word 3). The driver returns to $EX18 by an indirect jump through I.*nn*.

Before transferring to I.*nn*, DOS-M places the request parameters from the user program's EXEC call into words 7 through 13 of the EQT entry. Word 9, CONWD, is modified to contain the request code in bits Ø through 5 in place of the logical unit. See the EQT entry diagram and Section III, ***READ/WRITE EXEC CALL,*** for details of the parameters.

Once initiated, the driver can use words 10 through 14 of the EQT entry in any way, but words, 1, 2, 3, 7, 8, 9, 15, 16 and 17 must not be altered. The driver updates the status field in word 4, if appropriate, but the rest of word 4 must not be altered.

FUNCTIONS OF THE INITIATION SECTION

The initiation section of the driver operates with the interrupt system disabled. The initiation section is responsible for those functions (as flow-charted in Figure 5-1):

1. Rejects the request and proceeds to step 5 if:
   - the device is inoperable, or
   - the request code, or other or the parameters is illegal.
2. Configures all I/O instructions in the driver to include the select code of the device (or DMA channel). (Does not apply to DVRØ5 and 2870 DVR31.)
3. Initializes DMA, if appropriate.

NOTE: *The Initiation Section must save the DMA channel number (found in CHAN) in the EQT entry, since it is not set on entry to the Continuation Section.*

4. Initializes software flags and activates the device. All variable information pertinent to the transmission must be saved in the EQT entry because the driver may be called for another device before the first operation is complete.
5. Returns to $EX18 with the A-register set to indicate initiation or rejection and the cause of the reject:

   If A = Ø, then the operation was initiated.

   If A ≠ Ø, then the operation was rejected with A set as:

   1 - read or write illegal for device,

   2 - control request illegal or undefined,

   3 - equipment malfunction or not ready,

   4 - immediate completion (for control requests).

   6 - driver cannot handle a control request so the system is instructed to wait.

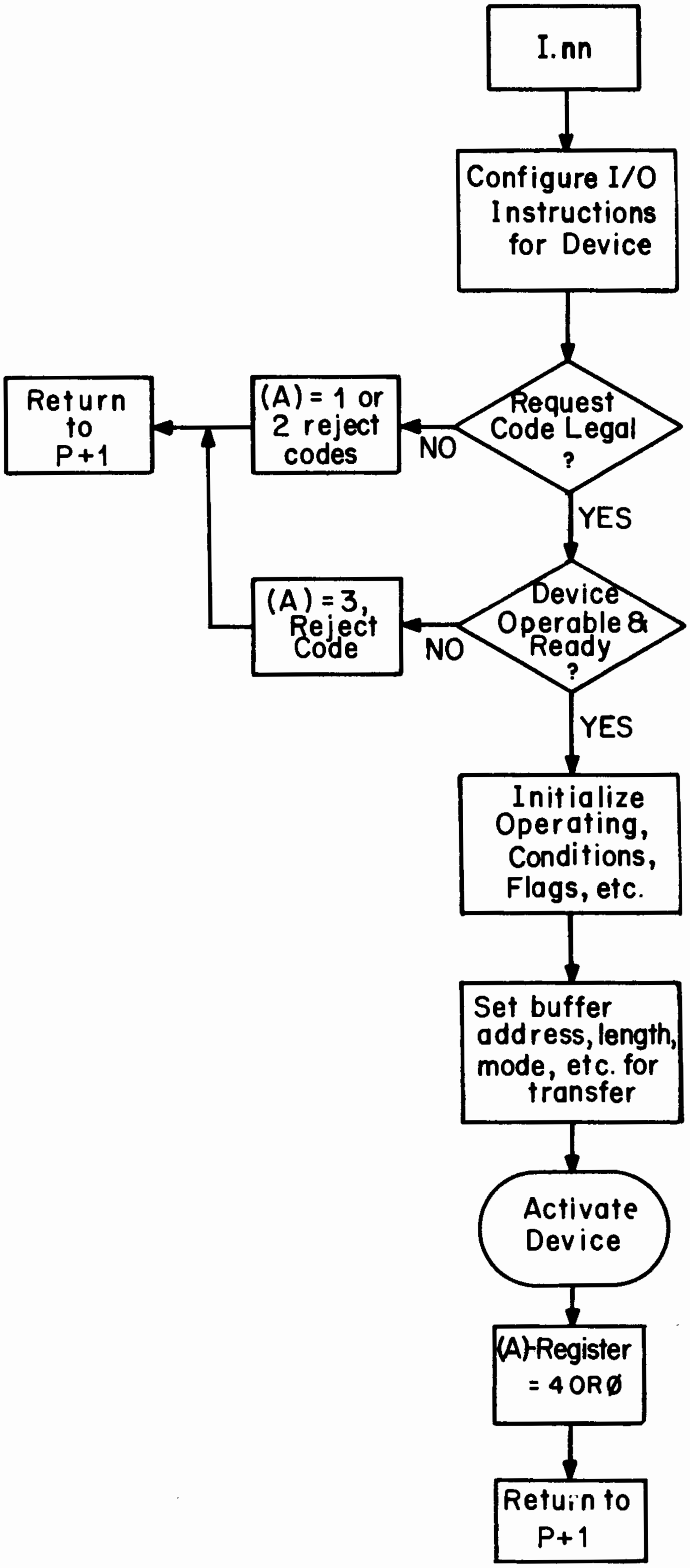

I.nn
Configure I/O Instructions for Device
Request Code Legal ?
NO
(A) = 1 or 2 reject codes
Return to P+1
YES
Device Operable & Ready ?
NO
(A) = 3, Reject Code
YES
Initialize Operating, Conditions, Flags, etc.
Set buffer address, length, mode, etc. for transfer
Activate Device
(A)-Register = 4 OR Ø
Return to P+1

Figure 5-1. I/O Driver Initiation Section

Completion Section

DOS-M calls the completion section of the driver whenever an interrupt is recognized on a device associated with the driver. Before calling the driver, $CIC sets the EQT entry addresses in base page, sets the interrupt source code (select code) in the A-register, and clears the I/O interface or DMA flag. The interrupt system is disabled. The calling sequence for the completion section is:

Location	Action
	Set A-register equal to interrupt source code
(P)	JSB C.*nn*
(P+1)	Completion return from C.*nn*
(P+2)	Continuation return from C.*nn*

The point of return from C.*nn* to $CIC indicates whether the transfer is continuing or has been completed (in which case, end-of-operation status is returned also).

The completion section of the driver is responsible for the functions below (as flow-charted in Figure 5-2):

1. The driver configures all I/O instructions in the Completion Section to reference the interrupting device, and then proceeds to step 2.
2. If both DMA and device completion interrupts are expected and the device interrupt is significant, the DMA interrupt is ignored by returning to $CIC in a continuation return.
3. Performs the input or output of the next data item if the device is driven under program control. If the transfer is not completed, the driver proceeds to step 6.

4. If the driver detects a transmission error, it can re-initiate the transfer and attempt a retransmission. A counter for the number of retry attempts can be kept in the Equipment Table. The return to $CIC must be (P+2) as in step 6.

5. At the end of a successful transfer or after completing the retry procedure, the following information must be set before returning to $CIC at (P+1):

   a. Set the actual or simulated device status into bits Ø through 7 of EQT word 4.

   b. Set the number of transmitted words or characters (depending on which the user requested) to the B-register.

   c. Set the A-register to indicate successful or unsuccessful completion.

      Ø = successful completion,
      1 = device malfunction or not ready,
      2 = end-of-tape (information),
      3 = transmission parity error.

6. Clears the device and DMA control on end-of-operation, or sets the device and DMA for the next transfer or retry. Returns to $CIC at:

   (P+1) - completion, with the A- and B-registers set as in step 5.

   (P+2) - continuation; the registers are not significant.

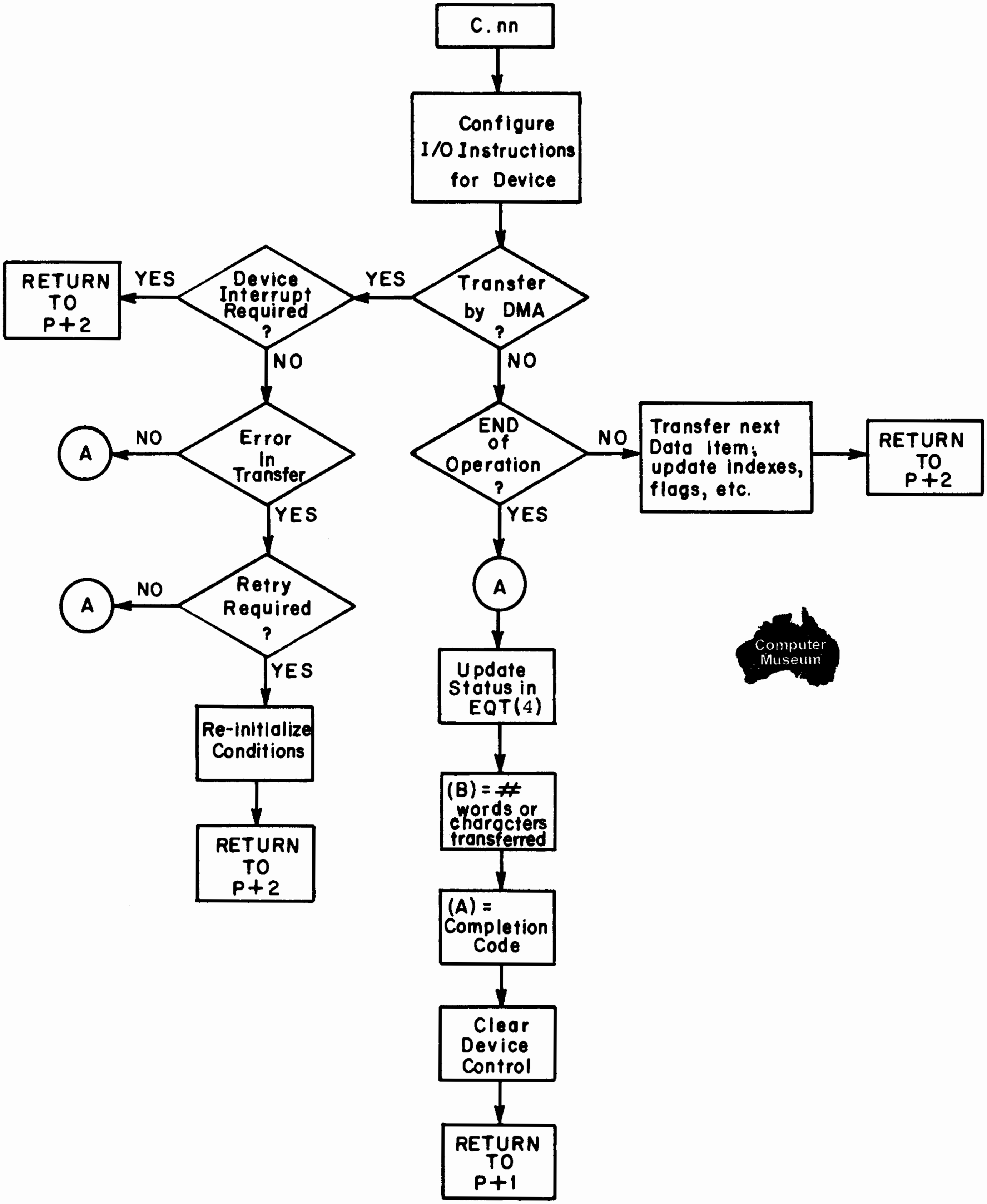


Figure 5-2. I/O Driver Completion Section

LINE PRINTER FORMATTING

When a user program makes a READ/WRITE EXEC call to the line printer (HP 2778A or HP 2778A-01), the line printer driver DVR12 interprets the first character in the line as a carriage control character and prints it as a space.* The control characters have the following meanings:

Character	Meaning
blank	Single space (print on every line),
Ø	Double space (print on every other line),
1	Eject page,
*	Suppress space (overprint next line),
others	Single space.

Each printed line is followed by an automatic single space unless suppressed by the control character asterisk (*). Double spacing requires an additional single space prior to printing the next line. If the last line of a page is printed and the following line contains a "1", then a completely blank page occurs. Goes to start of a line at the top of new page

When a user program makes an EXEC call for I/O CONTROL with the function bits in the CONWD (or the ICONWD) set to $Ø11_8$ (see Section III), the optional parameter PARAM (or IPRAM) word defines the format action to be performed by the Line Printer:

Parameter Word (Dec)	Meaning
<Ø	Page Eject;
Ø	Suppress space only the next print operation only;
1 to 55	Space 1 to 55 lines, ignoring page boundaries;
56 to 63	Use carriage control channel equal to the word - 55;
64	Set automatic page eject mode;
65	Clear automatic page eject mode.

*DVR12 checks for certain program names (ALGOL, FTN, ASMB, LOADR, JOBPR); for these programs it prints the first character of each line and generates a single space.

CARRIAGE CONTROL CHANNELS

If the parameter word is 56 to 63, the printer spaces using the standard carriage control channels, which have the following meanings:

Channel 1	Single space with automatic page eject.
Channel 2	Skip to next even line with automatic page eject.
Channel 3	Skip to next triple line with automatic page eject.
Channel 4	Skip to next 1/2 page boundary.
Channel 5	Skip to next 1/4 page boundary.
Channel 6	Skip to next 1/6 page boundary.
Channel 7	Skip to bottom of the page.
Channel 8	Skip to top of next page.

AUTOMATIC PAGE EJECT

During non-automatic page eject mode, if the parameter word is equal to 56, then it is interpreted as equal to 1. Automatic page eject mode applies only to single space operations.

MAGNETIC TAPE USAGE

Input/output transfers to and from a HP 3Ø3Ø magnetic tape unit can be programmed using the standard READ/WRITE EXEC call. (See Section III.) When specifying the data buffer length, the programmer must know that a buffer length of zero (Ø) causes the driver to take no action on a write or an ASCII read. Only the amount of data that fits within the buffer is transmitted to the user on read. A zero (Ø) buffer length on binary read causes a forward skip one record.

In the I/O STATUS EXEC call, bits 7-Ø of the second status word contain the status of the magnetic tape unit. The bits have the following meaning when they are set (i.e., equal to one):

BIT	MEANING
7	End-of-file record encountered while reading, forward spacing, or backward spacing.
6	Start-of-tape marker sensed.
5	End-of-tape marker sensed.
4	Timing error on last read/write operation.
3	I/O request rejected by magnetic tape unit.
2	No write enable ring, or the tape unit is rewinding.
1	Parity error on last read/write operation.
Ø	Tape unit busy, or in local mode.

The status bits are stored in the EQT entry; they are updated everytime the driver is called. A dynamic status request is processed as soon as the magnetic tape EQT entry is available (availability bits equal to ØØ), and returns the actual status of the device (obtained from the driver) to the calling program in the A-register and to the EQT entry.

Buffers of any length are allowed for the 7970. Buffers of less than 6 words for the 3030 are padded out to six words.

1. For binary writes they are padded with binary zeros.
2. For ASCII they are padded with ASCII Blanks.

The maximum buffer length is 16,384 words.

ERROR RECOVERY PROCEDURES

On a read parity error, the driver rereads the record three times before setting the parity error status bit and returning to the calling program. The final read attempt is transmitted to the program buffer.

On a write parity error, the driver continues to retry the write until one of these two conditions occurs:

a) The record is successfully written, or

b) The end-of-tape is encountered.

On a write without the write enable ring, the magnetic tape unit is made unavailable (magnetic tape not ready). DOS-M prints a message:

```
I/O ERR NR EQT#n
```

and waits for the operator to correct the unit and enter :GO.

At the end-of-tape there are only two legal forward motion requests:

a) Write end-of-file, or

b) Read record.

All other forward motion requests (write, forward space) cause the unit to be made unavailable. In addition, only one of the legal motion requests may be made after an end-of-tape. Backward motion requests clear the end-of-tape status.

SECTION VI
EXTENDED FILE MANAGEMENT PACKAGE

The Extended File Management Package (EFMP) extends the file handling capabilities of DOS-M by allowing the user to create and use files with different record lengths, security codes, and other conveniences. EFMP consists of a series of additional EXEC modules and a utility program; it maintains a file structure that operates within, and in addition to, the standard DOS-M file structure.

ENVIRONMENT

EFMP functions in the DOS-M environment, but requires a computer with at least 16K memory. It is implemented through a set of EXEC modules which are incorporated into DOS-M at system generation time; the EXEC modules are invoked using the familiar EXEC call mechanism.

FUNCTIONS AND STRUCTURE

The EFMP modules themselves allow any program executing in the user area to Create/Destroy, Open/Close, Read/Write, Reset, Repack, Copy, and Post files on the moving-head disc. Also, EFMP makes available detailed status information on all files and packs known to it. EFMP may be accessed conversationally from the keyboard by using UTIL, a utility program that executes in the user area.

DOS-M Files vs. EFMP Files

DOS-M maintains files that are referenced by five-character names and relative sector numbers. The user can access these files in either a keyboard mode (via directives) or in a programming mode (via EXEC calls). In keyboard mode, the user creates a file with the :STORE directive and operates on that file with directives such as :EDIT, :DUMP, etc. In programming mode, the DOS-M files are accessed by EXEC calls such as FILE READ/WRITE and SEARCH FILE NAME.

In addition to the file structure, DOS-M maintains a subchannel (or user disc) identification scheme. User discs are first formatted either during system generation or by a special function of the system generator. These functions format the hardware tracks and set up information such as the Label Presence Code and System Proprietary Code. After a disc pack is formatted, the :INITIALIZE directive is used to set up labels (six-character codes), change labels, and purge old discs.

EFMP operates within this file structure of DOS-M to set up and maintain additional - but distinctly different - files. Selected discs within DOS-M are turned over to EFMP exclusively. The user must identify them with a pack number of the form PN*xxx*, where *xxx* is a decimal integer. The procedure for doing this is described under *SET UP*. Within a pack, EFMP creates files of its own that are not known to DOS-M. They are identified by a fixed length name, contain a grouping of specified length records, and have a security code. Since only the DOS-M files can be created and accessed by directives, all EFMP files must be used through the EFMP EXEC calls or the UTIL program. EFMP files are limited in size only by the requirement that they fit within one subchannel or pack. To avoid confusion, all references to files within this section will mean EFMP files, not DOS-M files, unless specifically stated otherwise.

EFMP Buffers and Tables

To provide maximum flexibility in core size and speed of file accessing, EFMP allows the user to define (at execution time) the size and location of the tables and buffers required in core by EFMP. Two areas are defined by the user and provided in his program space:

1. Opened File Table
2. Temporary Record Buffers

The Opened File Table contains all information necessary for EFMP to identify and access files belonging to the user. The minimum size of the Opened File Table is one sector (128 words) and allows approximately seven files to be opened concurrently.

EFMP uses the Temporary Record Buffers as an intermediate storage area between the disc and the user's record buffer. The user defines the number of Temporary Record Buffers and the size of each. There must be at least one buffer and it must be at least two sectors (256 words) long. Particular files and buffers can be linked to increase the access speed of files. The effect of varying the number and size of these buffers cannot be predicted exactly and must be determined empirically by trial and error.

> *NOTE:* Since these tables and buffers exist in the user area and are not protected, extreme caution must be taken not to modify them in any way.

Logical Read vs. Physical Read

A logical read occurs each time the user requests a record from a file. At that time EFMP checks the appropriate Temporary Record Buffer to determine if the requested record is already in core. If in core, the record is transferred to the user's record buffer without actually physically reading the disc. If the record is not present in core, the necessary disc transfers are performed (physical reads--and writes, if necessary) to bring the record into core. If the Temporary Record Buffer is larger than the record size, several records are brought into core at once.

Logical Write vs. Physical Write

A logical write occurs each time a user requests that a record be written to a file. At that time, EFMP determines if that record is present in the Temporary Record Buffer; if it is, EFMP simply transfers the data in the user's record buffer to the Temporary Record Buffer and flags it as "must be written." Each succeeding read or write is treated in the same manner until a logical record transfer occurs for which the record is not in core, or until the last record in the Temporary Record Buffer is logically written. In these cases, the EFMP must physically write (post) the records in the Temporary Record Buffer (i.e., post them) on the disc.

If the record is not present in core on a write request, EFMP locates the record on the disc and transfers it physically into the Temporary Record Buffer. The data to be written is then transferred from the user buffer to the Temporary Record buffer and flagged as "must be written." The read before write is necessary because records do not necessarily fall on sector boundaries in the disc. If a CLOSE or POST request occurs, all buffers flagged are written to the disc.

Update-Writes vs. Append-Writes

The purpose of an update-write is to change the contents of an existing record; the purpose of append-write is to add new records onto the end of a file. EFMP writes a record as an update-write whenever the record specified exists in a previously accessed section of a file.

EFMP writes a record as an append-write whenever the record specified is beyond the previously accessed section of a file. In this case, EFMP automatically inserts zeros into all records (if any) between the highest record previously written and the new record.

SET UP

There are several prerequisites for EFMP. First, the EFMP EXEC modules must be included in DOS-M when the system is generated. Second, when DOS-M is running, the user must prepare EFMP disc packs from formatted DOS-M packs or cartridges.

The mechanism for creating EFMP packs is as follows:

a. Insert a formatted pack into the disc drive.

b. Make the subchannel of this pack the User Disc using the :UD directive.

c. Label the pack (if unlabeled) using the :IN directive.

d. Set up a DOS-M file which uses the entire pack (i.e., perform a :STORE,B directive.)

The directive format for this function is:

```
:STORE,B,PNxxx,sectors
```

where *xxx* is a unique decimal number,
PN*xxx* is the unique pack number, and
sectors is the number of sectors available on the
pack = 199 * (# sectors/track);
(4776 on a fully utilized HP 2870 or 22885
on a fully utilized HP 2883).

NOTE: EFMP changes the file from Type B to Type A during processing.

EFMP EXEC CALLS

The method of communication between a user program and EFMP is through the standard DOS-M EXEC call format. One DOS-M request code--24-- is reserved for EFMP requests. This, combined with an EFMP function number, determines what action EFMP is requested to take.

Only the Assembly Language calling sequences are given for these EXEC calls. The methods for converting these calling sequences to FORTRAN or ALGOL are described in Section III.

DEFINE

Purpose

To define, before any other EFMP calls are made, the number of 16-bit words within the user program to be used by the EFMP for its internal buffers and tables.

Assembly Language

```
        JSB  EXEC
        DEF  *+9          Return Address
        DEF  RCODE        Request Code
        DEF  EFMPF        EFMP Function Number
        DEF  OPNTB        Opened-File Table Address
        DEF  OPNSZ        Opened-File Table Size
        DEF  TRBUF        Temp. Record Buffer Address
        DEF  NOTRB        No. of Temp. Record Buffers
        DEF  TRBSZ        Temp. Record Buffer Size
        DEF  ERRNO        Error Number
        return            Continue Execution
          .
          .
RCODE   DEF  24
EFMPF   DEC 1
OPNTB   BSS  n            (Opened-File Table.  n is the size.)
OPNSZ   DEC  n            Size of Opened-File Table (in 16-bit
                          words).  See Comment 1.
TRBUF   BSS  M            Beginning of Temp. Record Buffers.
                          See Comment 2.
NOTRB   DEC  p            No. of Temp. Record Buffers.
                          See Comment 2.
TRBSZ   DEC  q            Size of each Temp. Record Buffer
                          (in sectors).
ERRNO   BSS  1            Return point for error codes.
                          See GENERAL ERRORS.
```

Comments

1. The size of the Opened-File Table (*n*) can be calculated by this formula:

   n = 3*(NOTRB)+16*(Max. No. of Files to be OPENed)

   The minimum size of this table is one sector (128 words). This allows approximately seven files to be OPENed concurrently.

2. There must be at least one temporary record buffer and it must be at least two sectors long (256 words). There may, however, be more buffers and they may be more than two sectors in size. All of the space for these buffers must be allocated starting at the location TRBUF. Increasing the number of buffers allows disc efficiency to be increased by assigning a buffer exclusively to one file. Increasing the size of each buffer increases the speed of disc accessing by allowing more than one sector to be transferred per disc access.

   The total size of the Temp. Record Buffers (*m*) can be calculated by the following formula:

   m = NOTRB * TRBSZ * 128 (The minimum value for TRBSZ is 2.)

3. All the tables and buffers are fixed by DEFINE until the end of a program, or another DEFINE. Each time a DEFINE occurs, all information contained in tables and buffers is lost, all pointers are reset, and EFMP assumes a fresh start. At the end of each program, DOS-M calls EFMP to perform a POST on any records flagged as "must be written."

CREATE

Purpose

To set up a directory on disc with all of the information necessary to create a file that can be accessed at a later time.

Assembly Language

```
       JSB   EXEC
       DEF   *+9            Return Address
       DEF   RCODE          Request Code
       DEF   EFMPF          EFMP Function Number
       DEF   FNAME          File Name
       DEF   PAKNO          Pack Number
       DEF   FLGTH          File Length (in records)
       DEF   RLGTH          Record Length (in words)
       DEF   SCODE          Security Code and User Status
       DEF   ERRNO          Error Number
       return               Continue Execution
         .
         .
         .
RCODE  DEC   24
EFMPF  DEC   2
FNAME  ASC   3,xxxxx        xxxxx is the name to be applied to the
                            file.  (First two characters cannot be
                            zero or 1774ØØ8.)
PAKNO  DEC   p              p is the pack number.  See Comments.
FLGTH  DEC   q              q is the number of records in the file;
                            (1 ≤ q ≤ 32,767)
RLGTH  DEC   r              r is the number of words in a record;
                            (1 ≤ r ≤ 32,767) and r must be less
                            than or equal to 1/2 the size of the
                            Temp. Record Buffer.
```

CREATE EXEC CALL (cont.)

SCODE	OCT	*s*	*s* is any 16-bit combination to be checked by EFMP during OPEN and DESTROY.
(SCODE +1)	OCT	*t*	*t* is any 16-bit combination of status information desired by the user (referred to as USTAT elsewhere).
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

Comments

If PAKNO is a number between 1 and 999 it indicates the EFMP pack on which the file is to be created. When EFMP creates a file, it reserves the necessary area on the disc after the last previous file generated. No attempt is made to search for an area between files. If PAKNO is equal to -1, the file is to be created on any pack that is available.

If PAKNO equals zero, the file is placed on the work area of the disc and no area will be reserved in the EFMP packs. When such a temporary file is created, the only directory information that is maintained is in the Opened-File Table. A disc-based directory is not maintained. Also, since the directory information is established in core during the CREATE function, the OPEN function is not required. The only reason for using an OPEN call for a temporary file is to assign it to a specific Temporary Record Buffer or to change the starting record number to a value other than 1. If no OPEN call is given, the first Temporary Record Buffer is used.

When the work area is used for temporary files, EFMP reserves this whole area and identifies it as PNØØØ. In order to keep PNØØØ from using the entire work area, the user must enter a STORE,B,PNØØØ directive for the system disc with the desired number of sectors. When EFMP has terminated, the user should PURGE the file PNØØØ from the work area

DESTROY

Purpose

To eliminate the directory information for a particular file from core and the disc. The user must specify the correct security code for the file. The disc area is repacked only for temporary files. To repack the EFMP subchannels, use the REPACK EFMP call.

Assembly Language

```
       JSB   EXEC
       DEF   *+7        Return Address
       DEF   RCODE      Request Code
       DEF   EFMPF      EFMP Function Code
       DEF   FNAME      File Name
       DEF   PAKNO      Pack Number
       DEF   SCODE      Security Code
       DEF   ERRNO      Error Number
       return           Continue Execution
        .
        .
RCODE  DEC   24
EFMPF  DEC   3
FNAME  ASC   3,xxxx
PAKNO  DEC   n          If n = Ø, then FNAME refers to a temporary
                        file.  If n ≥ 1 and n ≤ 999, then FNAME
                        is to be located on this pack number.
                        If n = -1, then EFMP searches all of its
                        packs until it finds a file that matches
                        FNAME.
SCODE  OCT   s          s is the security code for the file
                        established by the CREATE EFMP Call.
                        Security code ignored on temporary
                        files.
ERRNO  BSS   1          Return point for error codes.  See
                        GENERAL ERRORS.
```

OPEN

Purpose

To make a previously CREATED file accessible by extracting the necessary file information from the disc directories and placing it in core. The number of files that can be OPENED at any one time is limited by the size of the Opened File Table (see DEFINE).

Assembly Language

```
        JSB   EXEC
        DEF   *+9          Return Address
        DEF   RCODE        Request Code
        DEF   EFMPF        EFMP Function Code
        DEF   FNAME        File Name
        DEF   PAKNO        Pack Number
        DEF   RCDNO        Record Number
        DEF   SCODE        Security Code
        DEF   BUFNO        Buffer Number
        DEF   ERRNO        Error Number
        return             Continue Execution
         :
RCODE   DEC   24
EFMPF   DEC   4
FNAME   ASC   3,xxxxx
PAKNO   DEC   n            If n = Ø, the file is a temporary file
                           on the work area.  If n is between 1
                           and 999, EFMP looks for FNAME on the
                           appropriate pack.  If n = -1, EFMP
                           searches all available packs for the
                           requested file.
```

OPEN EXEC CALL (cont.)

RCDNO DEC *r* — If *r* = Ø, EFMP sets the next record to be accessed (for sequential READS or WRITES) to the highest record previously accessed + 1. Otherwise, *r* can be any number between 1 and the maximum record number contained in the file. This allows sequential access to be initialized at any record.

SCODE OCT *s* — *s* is the security code established by the CREATE call. It must match.

BUFNO DEC *b* — *b* must be a number between 1 and the maximum number of Temp. Record Buffers available. For any other number, EFMP uses 1.

ERRNO BSS 1 — Return point for error codes. See *GENERAL ERRORS*.

CLOSE

Purpose

To remove information about a particular file from the core-based Opened-File Table. This allows an additional file to be OPENED. Also, CLOSE updates the user status information (USTAT) and the highest record accessed on the disc.

Assembly Language

```
        JSB  EXEC
        DEF  *+6          Return Address
        DEF  RCODE        Request Code
        DEF  EFMPF        EFMP Function Number
        DEF  FNAME        File Name
        DEF  USTAT        User Status
        DEF  ERRNO        Error Number
        return            Continue Execution
         :
RCODE   DEC  24
EFMPF   DEC  5
FNAME   ASC  3,xxxxx
USTAT   OCT  u            User status information (any 16-bit
                          combination) to be written into the
                          disc directory for the file.
ERRNO   BSS  1            Return point for error codes.
                          See GENERAL ERRORS.
```

Comments

If a CLOSE is requested for a temporary file, the directory information in the Opened-File Table is deleted and the work area is automatically repacked. If a file has been COPIED to the work area, the user status (USTAT) and highest record assessed are not updated on the original copy of the file.

READ

Purpose

To retrieve a specified record (random access) or the next record (sequential access) from a file that has previously been OPENED and WRITTEN.

Assembly Language

```
       JSB EXEC
       DEF  *+7            Return Address
       DEF  RCODE          Request Code
       DEF  EFMPF          EFMP Function Code
       DEF  FNAME          File Name
       DEF  RCDNO          Record Number
       DEF  BUFFR          Buffer for Data
       DEF  ERRNO          Error Number
       return              Continue Execution
        :
RCODE  DEC  24
EFMPF  DEC  6
FNAME  ASC  3,xxxxx
RCDNO  DEC  n              n is a record number between 1 and
                           32,767.  For sequential access and
                           backspacing, see Comment.
BUFFR  BSS  m              m is the length of the buffer in
                           words.  It must be at least the
                           record length.
ERRNO  BSS  1              Return point for error codes.
                           See GENERAL ERRORS.
```

Comments

If RCDNO = Ø, a sequential READ or WRITE is implied. This feature provides the program with the next record available relative to the last READ or WRITE performed (or OPEN operation). If RCDNO is a negative number, it specifies a backspace, relative to the current record (last record accessed plus 1), before the READ or WRITE. If an attempt is made to backspace the record number indicator to a value less than one, the EFMP issues an error and terminates the READ or WRITE. Unless needed, care should be taken so as not to backspace the record number indicator beyond the range of records held in the Temporary Record Buffer at that time, since this will initiate a posting operation and a physical disc access.

WRITE

Purpose

To write into a specified record (random access) or into the next record (sequential access) of a file that has previously been OPENED.

Assembly Language

```
       JSB   EXEC
       DEF   *+7          Return Address
       DEF   RCODE        Request Code
       DEF   EFMPF        EFMP Function Number
       DEF   FNAME        File Name
       DEF   RCDNO        Record Number
       DEF   BUFFR        Buffer for Data
       DEF   ERRNO        Error Number
       return             Continue Execution
         :
RCODE  DEC   24
EFMPF  DEC   8
FNAME  ASC   3,xxxxx
RCDNO  DEC   n            Same as for the READ EXEC CALL.
BUFFR  BSS   m            Same as for READ.
ERRNO  BSS   1            Return point for error codes.
                          See GENERAL ERRORS.
```

RESET

Purpose

To reset the highest record accessed pointer for a file to a lower value. The information beyond the pointer is lost. The file must be OPEN before it can be RESET. (PAKNO below provides an additional check.)

Assembly Language

```
         JSB   EXEC
         DEF   *+7
         DEF   RCODE          Request Code
         DEF   EFMPF          EFMP Function Code
         DEF   FNAME          File Name
         DEF   PAKNO          Pack Number
         DEF   RCDNO          Record Number
         DEF   ERRNO          Error Number
         return               Continue Execution
           :
RCODE    DEC   24
EFMPF    DEC   9
FNAME    ASC   3,xxxxx
PAKNO    DEC   n              If n = Ø, EFMP searches the work area to
                              find the desired file name.  If n is a
                              number between 1 and 999, EFMP searches
                              pack number PNn to find the desired file
                              name.  If n = -1, EFMP searches all packs.
RCDNO    DEC   m              m is a number between Ø and 32,767
                              to which the highest record accessed
                              pointer will be set.  m must be
                              lower than the current value.

ERRNO    BSS   1              Return point for error codes.
                              See GENERAL ERRORS.
```

STATUS

Purpose

To allow the user program access to various types of status information relative to EFMP. Several separate status functions (identified by unique Status Function Numbers) are provided; all have basically the same form of calling sequence, but they vary in the parameters used.

Assembly Language

```
JSB  EXEC
DEF  *+9        Return Address
DEF  RCODE      Request Code
DEF  EFMPF      EFMP Function Code
DEF  FSTAT      Status Function Number
DEF  FNAME      File Name
DEF  PAKNO      Pack Number
DEF  DUMMY      Not Used
DEF  STATB      Status Buffer
DEF  ERRNO      Error Number
return          Continue Execution
 :
```

NOTE: Above is the general format for Status EFMP calls. The use and meaning of each parameter in the calling sequence varies from status call to status call. The parameters for each call are given separately below. Common to all status functions are:

```
RCODE  DEC  24
EFMPF  DEC  10
DUMMY  BSS  1
```

STATUS

STATUS FUNCTION NUMBER 1

Purpose

To provide the user with all information, except the security code, contained in the directory for a file.

Parameters

FSTAT	DEC	1	
FNAME	ASC	3,*xxxxx*	
PAKNO	DEC	*m*	If *m* = Ø, EFMP searches the work area for the requested file. If *m* is between 1 and 999, EFMP searches the pack of that number. For *m* = -1, EFMP searches all available packs for the requested file.
STATB	BSS	1Ø	The pack number is returned in the first word if PAKNO = -1. The remaining nine words will receive the directory status information in the same format as the directory itself. (See *EFMP File Disc Directory.)*
ERRNO	BSS	1	Return point for error code. See *GENERAL ERRORS*.

STATUS

STATUS FUNCTION NUMBER 2

Purpose

To determine if a file is OPEN.

Parameters

FSTAT	DEC	2	
FNAME	ASC	3,*xxxxx*	
PAKNO	OCT	Ø	Not used.
STATB	BSS	2	The first word returns the pack number if the file is OPEN. The second word returns a value of Ø if the file is OPEN or 1 if the file is not open.
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

STATUS

STATUS FUNCTION NUMBER 3

Purpose

To check the security code of a file.

Parameters

FSTAT	DEC	3	
FNAME	ASC	3,*xxxxx*	
PAKNO	DEC	*m*	Same as Function Number 1.
STATB	BSS	3	The first word returns the pack number if appropriate. The second word is used by the user program to give the security code to be checked. The third word returns Ø if the code checks or 1 if it does not check.
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

STATUS

STATUS FUNCTION NUMBER 4

Purpose

To determine the number of available full sectors left between the highest record accessed in a file and the end of the file.

Parameters

FSTAT	DEC	4	
FNAME	ASC	3,*xxxxx*	
PAKNO	DEC	*m*	Same as Function Number 1.
STATB	BSS	2	The first word returns the pack number if appropriate. The second word returns the number of sectors available.
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

STATUS

STATUS FUNCTION NUMBER 5

Purpose

To determine the number of available sectors left between the last file in a pack and the end of the pack.

Parameters

FSTAT	DEC	5	
FNAME	OCT	Ø	Not used.
PAKNO	DEC	*m*	Same as Function Number 1, but cannot equal -1.
STATB	BSS	2	The first word must be present, but is not used. The second word returns the number of sectors available.
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

STATUS

STATUS FUNCTION NUMBER 6

Purpose

To obtain the name of the *n*th file on a pack where *n* is an integer between 1 and the maximum number of files on a pack.

Parameters

FSTAT	DEC	6	
FNAME	BSS	3	Return point for file name or all zeroes if no file is present.
PAKNO	DEC	*m*	*m* is a number between 1 and 999.
STATB	DEC	*n*	*n* indicates the *n*th file.
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

STATUS

STATUS FUNCTION NUMBER 7

Purpose

To request all pack numbers currently available to EFMP.

Parameters

FSTAT	DEC	7	
FNAME	OCT	Ø	Not used.
PAKNO	OCT	Ø	Not used.
STATB	BSS	7	Return point for pack numbers. They are presented in ascending order of subchannel number. The list is terminated by a zero.
ERRNO	BSS	1	Return point for error codes. See *GENERAL ERRORS*.

Example

Information returned in buffer.

STATB	2ØØ	
	1Ø	
	762	
	Ø	(terminates list)

STATB	5	
	1Ø	
	2	
	9ØØ	
	213	
	22	
	6	(list terminates by being complete)

Order of pack numbers does not imply specific subchannel numbers.

REPACK (PURGE)

Purpose

To repack the existing files on a pack(s), removing empty spaces left when files have been destroyed.

Assembly Language

```
       JSB  EXEC
       DEF  *+5
       DEF  RCODE         Request Code
       DEF  EFMPF         EFMP Function Code
       DEF  PAKNO         Pack Number
       DEF  ERRNO         Error Number
       return             Continue Execution
        :
RCODE  DEC  24
EFMPF  DEC  11
PAKNO  DEC  n             For n between 1 and 999, only the speci-
                          fied pack is repacked.  For n = -1, all
                          the packs available to EFMP are repacked.
ERRNO  BSS  1             Return point for error codes.
                          See GENERAL ERRORS.
```

CAUTION: If the EFMP disc directory contains a large number of files and the sizes of the Temporary Record Buffers are small, repacking may require considerable time. Therefore, REPACK should be performed when sufficient time is available. Under no circumstances should an ABORT be performed during a REPACK.

COPY

Purpose

To transfer a copy of an opened file and its directory from an EFMP pack to the work area of DOS-M, from a pack to another pack, or from the work area to a pack.

Assembly Language

```
         JSB   EXEC
         DEF   *+6
         DEF   RCODE        Request Code
         DEF   EFMPF        EFMP Function Code
         DEF   FNAME        File Name
         DEF   PAKNO        Pack Number
         DEF   ERRNO        Error Number
         return             Continue Execution
           :
RCODE    DEF   24
EFMPF    DEC   12
FNAME    ASC   3,xxxxx      See Comment 1.
PAKNO    DEC   n            If n = Ø, EFMP copies the file onto the
                            work area.  If n is between 1 and 999,
                            EFMP copies the file onto the specified
                            pack.  If n is between -1 and -999, EFMP
                            copies the file from the work area to a
                            pack specified by the 1Ø's complement
                            of n.  See Comment 2.
ERRNO    BSS   1            Return point for error codes.
                            See GENERAL ERRORS.
```

Comments

1. Remember that a file must be OPENED before it can be COPIED. This is necessary to determine from which pack to copy the file. When a file has been copied *to* the work area, all READS and WRITES referencing that file use the work area version until the file is CLOSED. (Files copied *from* the work area to a pack continue to use the work area version for READS and WRITES.) Temporary copies of files do not have security codes. Therefore, files copied from the work area to a pack have a security code of Ø. When a file is copied from pack to pack, the original security code is retained. See *CLOSE* for further notes on Work Area files.

2. If there is already a file with the same name in the destination pack directory, an error code is returned and the COPY is aborted. In this case, the user can first DESTROY the name in the destination pack, and then perform the COPY again.

3. When COPYING from a pack to a pack not on the drive (and only a single removable pack is available), EFMP automatically requests that the user continually swap packs until the entire file has been COPIED. EFMP prints out a message and halts the computer with 1Ø2Ø76 in the T-Register:

   ```
   INSERT DESTINATION [SOURCE] PACK AND PRESS RUN.
   ```

   After the user inserts the appropriate pack and presses RUN, a check is made to determine if the proper pack has been entered. If EFMP cannot find the correct pack, the message is repeated. To allow the user an orderly exit in case the correct pack is not available, the following question is asked after each question:

   ```
   ENTER C OR T
   ```

   where C means to continue COPYING, and
   T means to terminate the COPY and return to the program.

4. Care <u>must</u> be taken to insert the original pack (if it has been removed during the COPY function) into its original subchannel.

CHANGE FILE NAME

Purpose

To change a file name. (File need not be OPEN.)

Assembly Language

```
       JSB   EXEC
       DEF   *+7
       DEF   RCODE        Request Code
       DEF   EFMPF        EFMP Function Code
       DEF   FNAME        File Name
       DEF   PAKNO        Pack Number
       DEF   SCODE        Security Code
       DEF   ERRNO        Error Number
       return             Continue Execution
        :
RCODE  DEC   24
EFMPF  DEC   13
FNAME  ASC   3,xxxxx      Current file name.
       ASC   3,zzzzz      New file name.
PAKNO  DEC   n            n = Ø, indicates that the file is on the
                          work area.  If n is between 1 and 999,
                          n indicates the pack containing the file.
                          If n = -1, EFMP searches all available
                          packs for the current file name.
SCODE  OCT   m            Security code.  See CREATE.
ERRNO  BSS   1            Return point for error codes.
                          See GENERAL ERRORS.
```

POST

Purpose

To physically write on the disc all buffers that have been flagged as "must be written" in the Temporary Record Buffer. (That is, convert all outstanding logical WRITE's into physical WRITE's.)

Assembly Language

```
       JSB  EXEC
       DEF  *+4
       DEF  RCODE          Request Code
       DEF  EFMPF          EFMP Function Code
       DEF  ERRNO          Error Number
       return              Continue Execution
        .
        .
RCODE  DEC  24
EFMPF  DEC  14
ERRNO  BSS  1              Return point for error codes.
                           See GENERAL ERRORS.
```

Comments

The POST operation updates the highest record accessed pointer in the disc directories, but not the user status word (USTAT).

UTIL PROGRAM--CONVERSATIONAL USE OF EFMP

UTIL is a program that allows access to most of the EFMP functions through the keyboard; it accepts commands or directives from the operator and converts these into EFMP calling sequences. When EFMP has processed the call, UTIL reports back a successful operation or an error given by EFMP.

Functions

The following EFMP functions are provided by UTIL:

1. CREATE
2. DESTROY
3. OPEN
4. CLOSE
5. STATUS (all functions)
6. REPACK
7. COPY
8. CHANGE FILE NAME
9. POST
10. RESET

When initiated, UTIL makes a DEFINE call to establish a Temporary Record Buffer of four sectors and an Opened File Table of one sector. In addition, UTIL provides one other function--BRIEF--that allows the operator to increase or decrease the amount of disc storage reserved for a file.

NOTE: UTIL requires the FORTRAN IV version of the Formatter program to operate properly.

:PROG, UTIL

Purpose

To initiate execution of the UTIL program.

Format

```
:PROG, UTIL,n
```

where *n* = Ø to print a list of commands or
n ≠ Ø to skip printing the list.

List of commands message:

```
/CRE,FNAME,PAKNO,FLGTH,RLGTH,SCODE,USTAT
/DES,FNAME,PAKNO,SCODE
/OPE,FNAME,PAKNO,RCDNO,SCODE
/CLO,FNAME,USTAT
/RES,FNAME,PAKNO,RCDNO
/STA,DF,FNAME,PAKNO
/STA,FO,FNAME
/STA,SC,FNAME,PAKNO,SCODE
/STA,LR,FNAME,PAKNO
/STA,LF,PAKNO
/STA,NF,PAKNO,STATB
/STA,AP
/REP,PAKNO
/COP,FNAME,PAKNO
/CHA,FNAM1,FNAM2,PAKNO,SCODE
/POS
/BRI,FNAME,SCODE
/END
```

(All parameters are decimal.)

UTIL begins by printing a message to indicate that it is ready for a directive:

```
UTIL READY
```

After it processes the directive, UTIL prints out the results of the operation (where appropriate) or any error codes that may have been returned by EFMP. (See *GENERAL ERRORS*.) When it is ready for another directive, UTIL prints UTIL READY. If an incorrect directive is entered, UTIL prints

```
ILLEGAL OPERATION
UTIL READY
```

UTIL is terminated by typing in the command /END.

UTIL prints any error messages on the system terminal; normal output is printed on the list device.

CREATE COMMAND

Purpose

To create a new file (i.e., to invoke the CREATE function of EFMP).

Format

/CRE, *FNAME, PAKNO, FLGTH, RLGTH, SCODE, USTAT*

See *CREATE EFMP CALL* for explanation of parameters.

Example

```
/CRE, DATA, 42, 2Ø, 126, 3901, 1
       ↑     ↑    ↑    ↑     ↑    ↑
      file   |    |  record  |   user
      name   |    |  length  |  status
             |    |          |
           pack   |       security
          number  |         code
                  |
                file
               length
```

Example print-out:

```
FILE  CØ      CREATED
THE FILE IS ON PACK#      12Ø
THE FILE LENGTH IS      8 RECORDS
THE RECORD LENGTH IS      8 WORDS
THE SECURITY CODE IS      Ø
THE USER STATUS WORD IS      Ø
```

DESTROY COMMAND

Purpose

To destroy a file by eliminating its directory entry (i.e., to invoke the DESTROY EFMP function).

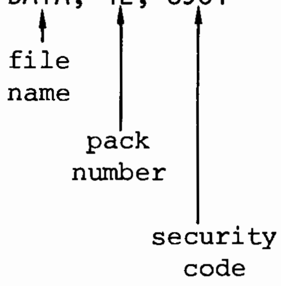
Format

```
/DES, FNAME, PAKNO, SCODE
```

See *DESTROY EFMP CALL* for explanation of parameters.

Example

```
/DES, DATA, 42, 3901
```



Example print-out:

```
FILE  CØ     DESTROYED
```

OPEN COMMAND

Purpose

To OPEN a previously CREATED file (i.e., to invoke the OPEN function of EFMP).

Format

/OPE, *FNAME, PAKNO, RCDNO, SCODE*

See *OPEN EFMP CALL* for explanation of parameters.

Example

```
/OPE, DATA, 42, 1, 3901
        ↑     ↑   ↑   ↑
       file   |   | security
       name   |   |   code
              |   |
            pack  |
          number  |
                  |
               record
               number
```

Example print-out:

```
FILE  LOB7Ø  OPENED
THE FILE IS ON PACK#     12Ø
THE RECORD # IS     1
THE SECURITY CODE IS     Ø
```

CLOSE COMMAND

Purpose

To CLOSE a previously OPENED file (i.e., to invoke the CLOSE function of EFMP).

Format

```
/CLO, FNAME, USTAT
```

See *CLOSE EFMP CALL* for explanation of parameters.

Example

```
/CLO, DATA, 2
        ↑   ↑
      file  |
      name  |
            |
          user
         status
```

Example print-out:

```
FILE LOB7Ø   CLOSED
THE USER STATUS WORD IS     Ø
```

RESET COMMAND

Purpose

To reset the highest record number accessed for a file (i.e., to invoke the RESET function of EFMP).

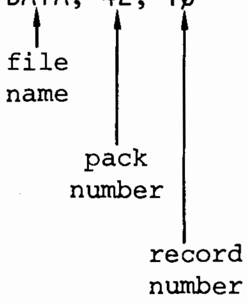
Format

```
/RES, FNAME, PAKNO, RCDNO
```

See *RESET EFMP CALL* for explanation of the parameters.

Example

```
/RES, DATA, 42, 1Ø
```



Example print-out:

```
FILE  LOB7Ø  RESET
THE FILE IS ON PACK#     12Ø
THE RECORD # IS      Ø
```

STATUS-1 COMMAND

Purpose

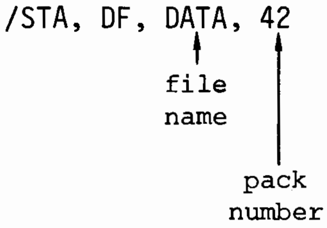
To print out directory information about a file (i.e., to invoke STATUS function number 1 of EFMP).

Format

```
/STA, DF, FNAME, PAKNO, RCDNO
```

See *STATUS EFMP CALL, STATUS FUNCTION NUMBER 1* for explanation of the parameters and results.

Example



```
/STA, DF, DATA, 42
```

Example print-out:

```
FILE  LOB7Ø  STATUS
THE FILE IS ON PACK#    12Ø
STARTING TRACK # IS      6
STARTING SECTOR # IS      9
THE FILE LENGTH IS    12 RECORDS
THE RECORD LENGTH IS   128 WORDS
THE USER STATUS WORD IS     Ø
HIGHEST RECORD # ACCESSED IS       Ø
```

STATUS-2 COMMAND

Purpose

To determine if a file is OPEN (i.e., to invoke STATUS function number 2 of EFMP).

Format

```
/STA, FO, FNAME
```

See *STATUS FUNCTION NUMBER 2* for explanation of the parameters and results.

Example

```
/STA, FO, DATA
            ↑
          file
          name
```

Example print-out:

```
FILE LOB7Ø   STATUS
FILE IS [NOT] OPEN
```

STATUS-3 COMMAND

Purpose

To check the security code of a file (i.e., to invoke STATUS function number 3 of EFMP).

Format

```
/STA, SC, FNAME, PAKNO, SCODE
```

See *STATUS FUNCTION NUMBER 3* for explanation of parameters and results.

Example

```
/STA, SC, DATA, 42, 3904
            ↑    ↑    ↑
          file   |    |
          name   |    |
                 |    |
               pack   |
              number  |
                      |
                  security code
                  to be checked
```

Example print-out:

```
FILE  LOB7Ø  STATUS
THE FILE IS ON PACK#    12Ø
THE SECURITY CODE IS     Ø
CODE CHECKS [DOES NOT CHECK]
```

STATUS-4 COMMAND

Purpose

To determine the number of available full sectors left between the highest record accessed in a file and the end of the file (i.e., to invoke STATUS function number 4 of EFMP).

Format

```
/STA, LR, FNAME, PAKNO
```

See *STATUS FUNCTION NUMBER 4* for explanation of parameters and results.

Example

```
/STA, LR, DATA, 42
             ↑    ↑
           file   |
           name   |
                  |
                pack
               number
```

Example print-out:

```
FILE  LOB7Ø  STATUS
THE FILE IS ON PACK#    12Ø
# OF AVAILABLE SECTORS IS      12
```

STATUS-5 COMMAND

Purpose

To determine the number of available sectors left between the last file in a pack and the end of the pack (i.e., to invoke STATUS function number 5 of EFMP).

Format

```
/STA, LF, PAKNO
```

See *STATUS FUNCTION NUMBER 5* for explanation of parameters and results.

Example

```
/STA, LF, 42
           ↑
          pack
         number
```

Example print-out:

```
FOR PACK#    12Ø
# OF AVAILABLE SECTORS IS  461Ø
```

STATUS-6 COMMAND

Purpose

To obtain the name of the *n*th file on a pack where *n* is an integer between 1 and the maximum number of files on a pack (i.e., to invoke STATUS function number 6 of EFMP).

Format

```
/STA, NF, PAKNO, STATB
```

See *STATUS FUNCTION NUMBER 6* for explanation of parameters and results.

Example

```
/STA, NF, 42, 9
          ↑   ↑
        pack  |
      number  |
              |
            file
           number
```

Example print-out:

```
FILE   LOB7Ø   STATUS
THE FILE IS ON PACK#     12Ø
FILE #      1 IN THE DIRECTORY
```

STATUS-7 COMMAND

Purpose

To request all available pack numbers (i.e., to invoke STATUS function number 7 of EFMP).

Format

```
/STA, AP
```

Example print-out:

```
PACK #    12Ø IS AVAILABLE
```

REPACK COMMAND

Purpose

To repack existing packs (i.e., to invoke the REPACK EXEC CALL function of EFMP).

Format

```
/REP, PAKNO
```

See *REPACK (or purge) EFMP CALL* for explanation of parameters.

Example

```
/REP, 42   (repacks pack 42)
/REP, -1   (repacks all packs)
```

Example print-out:

```
ALL PACKS AVAILABLE REPACKED
            or
PACK # 12Ø REPACKED
```

COPY COMMAND

Purpose

To copy a file (i.e., to invoke the COPY function of EFMP).

Format

```
/COP, FNAME, PAKNO
```

See *COPY EFMP CALL* for explanation of parameters and messages.

Example

```
/COP, DATA, 45
       ↑     ↑
      file   |
             |
        destination
           pack
```

Example print-out:

```
FILE  LOB7Ø  COPIED
THE FILE IS TEMPORARY IN WORK AREA

FILE  LOB7Ø  COPIED
THE FILE IS ON PACK#    12Ø
```

CHANGE COMMAND

Purpose

To change the name of a file (i.e., to invoke the CHANGE FILE NAME function of EFMP).

Format

/CHA, *FNAM1, FNAM2, PAKNO, SCODE*

FNAM1 is the current file name; FNAM2 is the new file name.

See *CHANGE FILE NAME EFMP CALL* for explanation of other parameters.

Example

```
/CHA, DATA, STUFF, 42, 3901
        ↑      ↑
       old     |
       name    |
               |
              new
              name
```

Example print-out:

```
FILE LOB7Ø  OLD FILE
FILE XXXXX  NEW FILE
THE FILE IS ON PACK#    12Ø
THE SECURITY CODE IS     Ø
```

POST COMMAND

Purpose

To post files (i.e., to invoke the POST function of EFMP).

Format

```
/POS
```

Example print-out:

```
ALL FILES POSTED
```

BRIEF COMMAND

Purpose

To increase or decrease the amount of disc storage reserved for a file.

Format

```
/BRI, FNAME, SCODE
```

FNAME is the name of the file, and
SCODE is the security code of the file.

BRIEF first prints the status of the file:

```
AVAILABLE RECS. = m       RECORDS USED = r
NEW RECORD COUNT?
```

The user types in either:

/E to terminate the command and prepare UTIL for more commands,
or
n to change the available record count to *n*.

BRIEF stores the contents of *FNAME* on the Work Area, destroys the current file, purges the pack, and CREATES and OPENS a new file. The contents of *FNAME* are transferred from the Work Area to the new file and BRIEF prints out a message:

```
AVAILABLE RECS. = n       RECORDS USED = r
```

BRIEF terminates.

Comment

BRIEF creates and uses a temporary file named "^^^^^^" (all blanks).

END COMMAND

Purpose

To terminate the operation of the UTIL program.

Format

```
/END
```

GENERAL ERRORS

These error numbers are returned to the user program (in ERRNO) by the EFMP.

Error No.	Description
0	No errors.
1	Invalid EFMP function number.
2	Duplicate File Name.
3	File Name not in directory.
4	File too long for this pack.
5	Invalid record length.
6	Pack number not available (or Name not in directory if a search was made on all available pack directories).
7	Invalid Security Code.
8	A Temporary File must be "OPENED" with a CREATE function. An OPEN function can only change the Temporary Record Buffer number or the starting record number for a Temporary File.
9	Buffer area specified in Exec call is not valid.
10	Invalid Record Number.
11	File not open.
12	DEFINE not previously executed.
13	Backspaced beyond "start-of-file."
14	No pack space available.
15	Invalid pack number.
16	During a pack search, a pack was found where the entire space was not allocated to PN*xxx*.
17	Work area space not sufficient
18	No "Open" table space available.
19	Invalid Temporary Record Buffer Number.
20	Invalid number of Executive call parameters.
21	End-of-File.
22	COPY terminated.
23	Invalid argument(s).
24	Maximum number of files exceeded.
25	File already OPEN.
26	Record size larger than one-half of a TRB.

The error numbers are also returned in the A-Register.

EFMP FILE DISC DIRECTORY

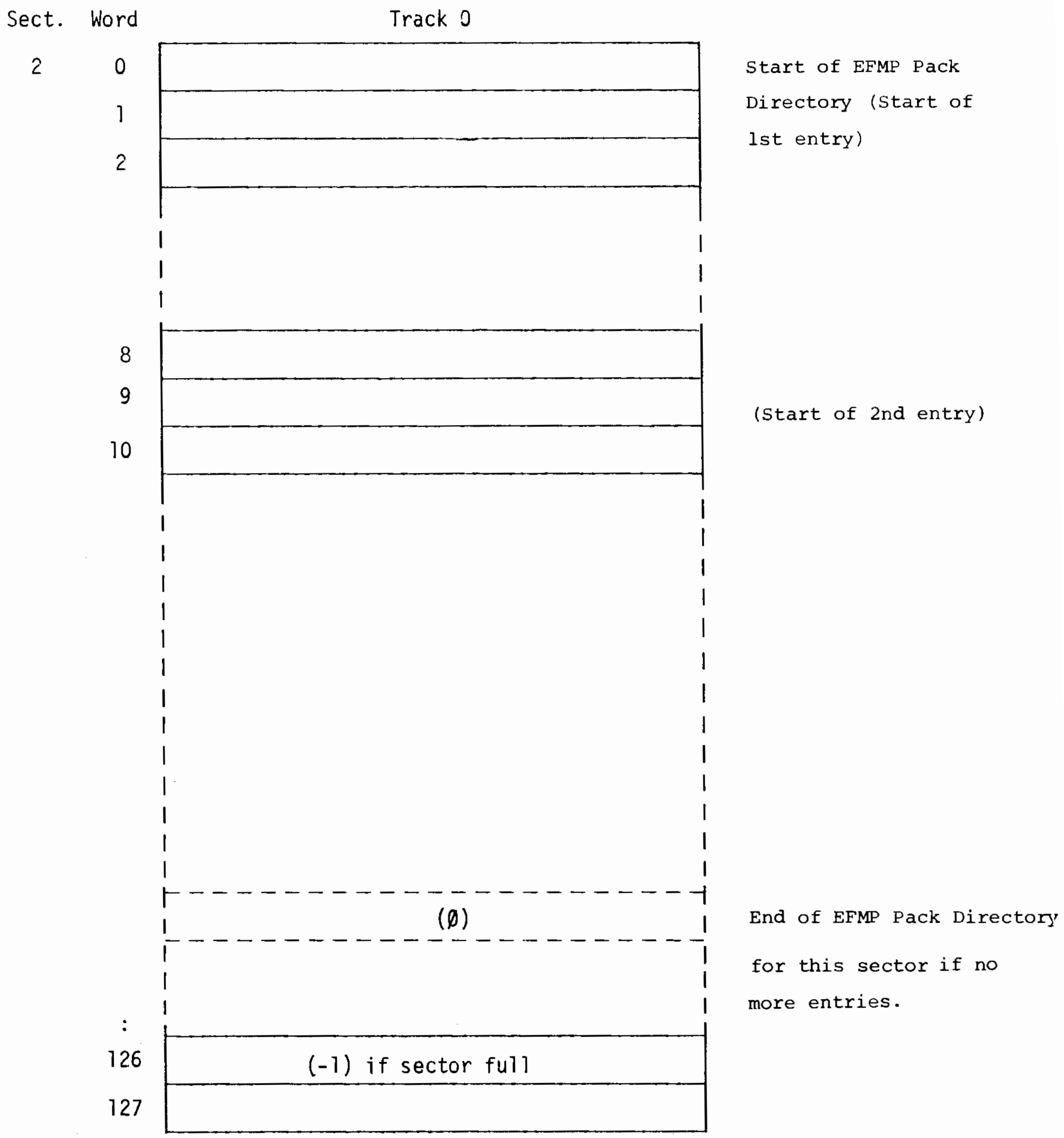
Word	Contents	
	15 8	7 0 Bit
0	1st Char.	2nd Char.
1	3rd Char.	4th Char.
2	5th Char.	Not Used
3	Starting Trk. No.	Starting Sect. No.
4	File Length (In Records)	
5	Record Length (In Words)	
6	Security Code	
7	User Supplied Status	
8	Highest Record Number Accessed	

Figure 6-1. EFMP File Disc Directory Format

Sect.	Word	15	Track 0	0	Bit
0	0	"LB"			
	1	"DO" OR "TS"			
	2	SYS.GEN.CODE			
	3	1st Char.	2nd Char.		(*) or Six Char. Disc Label
	4	3rd Char.	4th Char.		
	5	5th Char.	6th Char.		
	:				
	31	CHECKSUM,0-30,($\overline{\text{XOR}}$)			
	:				
	64	NEXT AVAIL. TK & SECT.			(200$_{10}$, Ø)
	65	NO. BAD TRACKS			
	66	NEXT AVAIL. SPARE TRACK			
	:				
	127	USED BY DOS-M			
1	0	P	N		PNxxx, where the x's
	1	x_1	x_2		are no's. bet 0 & 9.
	2	x_3	P	ENTRY TYPE	PNxxx is the pack number.
	3	TRACK	SECTOR		← (1,0) (In ASCII).
	4	FILE LENGTH			← (199*24)$_{10}$ = 4776$_{10}$ for HP 2870 (199*115)$_{10}$ = 22885$_{10}$ for HP 2883
	5	- 0 -			
	6				
	7				
	8				Reserved for possible EFMP use
	9				
	:				
	127	TRACK/SECT. OF NEXT AVAIL. FILE AREA			

Words 0 through 127 on sector 0 and words 0 through 5 on sector 1 represent the DOS-M format. See Appendix A for further details.

Figure 6-2. EFMP Disc Pack Layout (Part 1 of 2)


Sect.
Word
Track 0
2
0
1
2
8
9
10
:
126
127
Start of EFMP Pack Directory (Start of 1st entry)
(Start of 2nd entry)
(Ø)
End of EFMP Pack Directory for this sector if no more entries.
(-1) if sector full

All succeeding sectors follow the same format as sector 2.

End-of-directory is indicated by a zero in the word following the last directory entry.

End-of-sector is indicated by a (-1) in the word following the last entry.

Figure 6-2. EFMP Disc Pack Layout (Part 2 of 2)

APPENDIX A
TABLES

Appendix A contains several useful tables and figures.

DOS-M BASE PAGE CONSTANTS

LOCATION	TYPE	VALUE
4Ø	DEC	-64
41	DEC	-1Ø
42	DEC	-9
43	DEC	-8
44	DEC	-7
45	DEC	-6
46	DEC	-5
47	DEC	-4
5Ø	DEC	-3
51	DEC	-2
52	DEC	-1
53	DEC	Ø
54	DEC	1
55	DEC	2
56	DEC	3
57	DEC	4
6Ø	DEC	5
61	DEC	6
62	DEC	7
63	DEC	8
64	DEC	9
65	DEC	1Ø
66	DEC	17
67	DEC	64
7Ø	OCT	17
71	OCT	37
72	OCT	77

TABLES

LOCATION	TYPE	VALUE
73	OCT	177
74	OCT	377
75	OCT	1774ØØ
76	OCT	3777
77	OCT	1777ØØ

DOS-M BASE PAGE SYSTEM COMMUNICATION AREA

LOCATION	NAME	CONTENTS
1ØØ	UMLWA	Last word address of user available memory
1Ø1	JBINS	Start track/sector of job binary area
1Ø2	JBINC	Current Track/sector of job binary area
1Ø3	TBG	Time base generator I/O channel address
1Ø4-5	CLOCK	Current system clock time
1Ø6-7	CLEX	Execution clock time
11Ø	CXMX	Maximum allowable execution time
111	BATCH	Logical unit # of batch input device
112	SYSTY	Logical unit # of system teletype
113	DUMPS	Abort/Post Mortem dump flag
114	SYSDR	System directory track/sector
115	SYSBF	System buffer track/sector
116	SECTR	Number of sectors/disc track
117	EQTAB	First word address of Equipment Table
12Ø	EQT#	Number of Equipment entries
121	LUTAB	First word address of Logical Unit table
122	LUT#	Number of Logical Unit entries
123	JBUF	Job input buffer address
124	JFILS	Source file starting track/sector
125	JFILC	Source file current track/sector
126-4Ø	RONBF	User area file name information (11 words)
141-53	EXPG	Directory entry for current program (11 words)

LOCATION	NAME	CONTENTS
154	DISCO	Disc I/O channel/last track on disc
155	SYSSC	System subchannel
156	SCCNT	Number of subchannels on system minus 1
157	UDNTS	Next user disc track/sector
16Ø	SYNTS	Next system disc track/sector
161	CUDSC	Current user disc subchannel
162	CRFLG	Current disc request flag: Ø for system, not Ø for user
163	CUDLA	Current user disc last access
164	SDLA	System disc last access
165	CUMID	Computer identification
166-7Ø	DBUFR	System disc triplet parameter buffer
171-73	UBUFR	User disc triplet parameter buffer
174	TSONE	Last track/sector referenced +1
175	GUDSC	Default user disc subchannel
176	SYSCD	System generation code
177	JFLSC	Source file subchannel
2ØØ	DISCL	User label track/sector
2Ø1	INTAB	First word address of interrupt table
2Ø2	INT#	Number of interrupt entries
2Ø3	EQT1	EQT1-EQT17 are addresses of current Equipment Table entry
2Ø4	EQT2	
2Ø5	EQT3	
2Ø6	EQT4	
⋮	⋮	
223	EQT17	
224	RQCNT	Number of request parameters.
225	RQRTN	Current request return address
226	RQP1	RQP1-RQP8 are addresses of current request parameters
⋮	⋮	
235	RQP8	

LOCATION	NAME	CONTENTS
236	NABRT	Illegal request code abort/no abort option
237	XA	A register contents at time of interrupt
24Ø	XB	B register contents at time of interrupt
241	XEO	E and O register contents at time of interrupt
242	XSUSP	Point of suspension at time of interrupt
243	EXLOC	Address of Exec module doublet table
244	EX#	Number of Exec module doublet table entries
245	EXMOD	Exec module # currently in Exec module overlay area
246-47	EXMAN	Exec module low and high main core addresses
25Ø-51	EXBAS	Exec module low and high base page core addresses
252	IODMN	First word address of I/O driver module main area
253	IODBS	First word address of I/O driver module base page area
254	UMFWA	First word address of user main area
255	UBFWA	First word address of user base page area
256	UBLWA	Last word address of user base page area
257	CHAN	Current DMA channel number
26Ø	OPATN	Operator/keyboard attention flag
261	OPFLG	Operator communication flag
262	SWAP	Job processor resident flag
263-65	JOBPM	Job processor disc address/number of words in main
265	JOBPB	Job processor base page number of words
266	EJOBF	End job flag
267	RTRK	Real time simulation track number
27Ø	$BUF	System input/output buffer (128 words)
47Ø	$GOPT	Point of suspension continuation address
471	$IDCD	Input request code check
472	$MDBF	Exec module data buffer

LOCATION	NAME	CONTENTS	
474	TEMP	System temporary (7 word buffer)	
5Ø3	TEMPØ	System temporary	
5Ø4	TEMP1	System temporary	
5Ø5	UTMPØ	User temporary	Available to user
5Ø6	UTMP1	User temporary	
5Ø7	UTMP2	User temporary	
51Ø	TEMP5	System temporary	
511	MSECT	Negative number of sectors/track	
512	VADR	Address of instruction causing memory protect violation	
513	IODMD	Current resident I/O driver module flag	
514	RCODE	Current request code value	
515	SXA	Operator attention restore A register value	
516	SXB	Operator attention restore B register value	
517	SXEO	Operator attention restore E and O register value	
52Ø	SXSUS	Operator attention return address	
521	EFMP	Extended file management package flag	
522	DSCLB	Disc track/sector of relocatable library	
523	DSCL#	Number of relocatable library routines	
524	LSTCH	Last disc referenced	
525	TRAC#	User file table validity flag	
526	XFLG	Entry address for disc not ready	
527	SSFLG	System search flag	
53Ø	CHARC	Batch Input Character Count	
531	TYEQT	System TTY EQT4 Address	

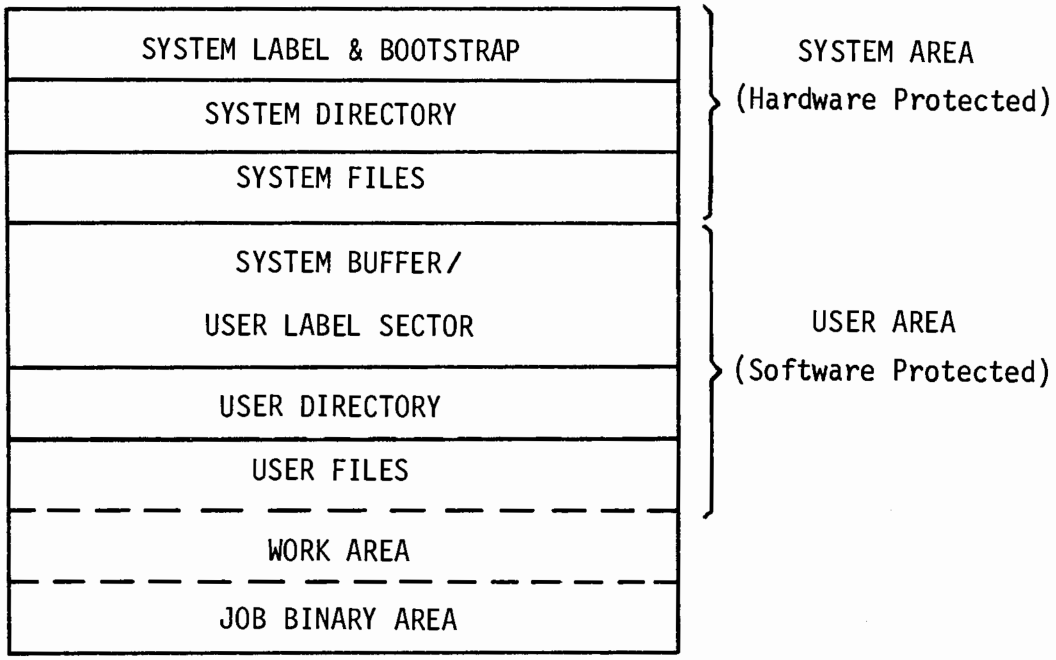


Figure A-1. General Disc Layout

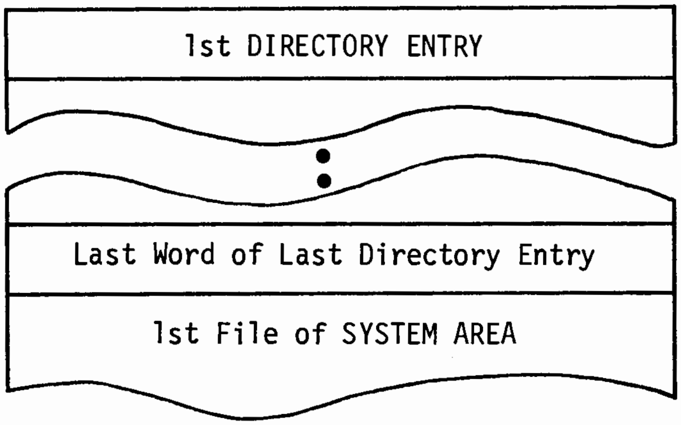


Figure A-2. System Directory Format

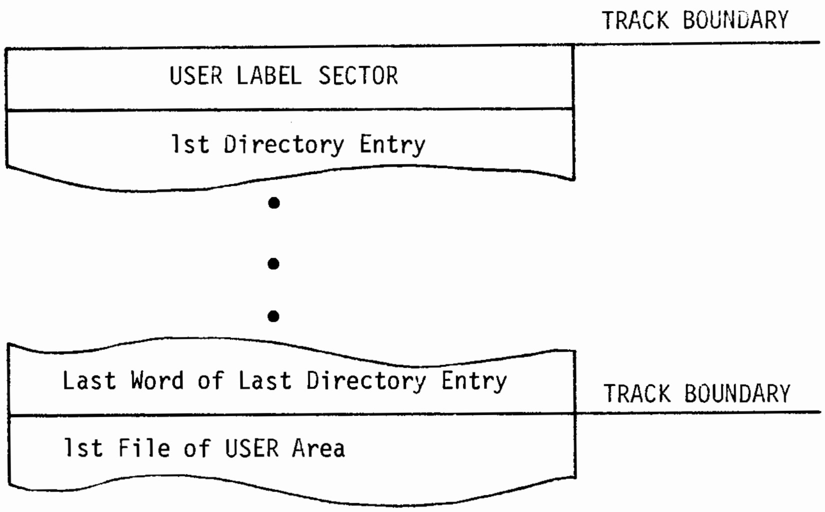


Figure A-3. User Directory Format

Word 1	F	N
Word 2	A	M
Word 3	E	P | Entry Type
Word 4	Track	Sector
Word 5	File Length (in sectors)	
Word 6	FWA Program	
Word 7	LWA Program	
Word 8	FWA Base Page Linkage Area	
Word 9	LWA Base Page Linkage Area	
Word 1Ø	Program Entry Point	
Word 11	FWA of LIB routine section	

For System or Loader Generated Binary Programs Only

The 1st five characters (in Words 1 through 3) contain the File Name

The lower character in Word 3 contains the Type Code and 'P' bit, as shown below.

Figure A-4. Directory Entry Format

TYPE	FILE
Ø	System Resident
1	Disc Resident Executive Supervisor Module
2	Reserved for System
3	User Program, Main
4	Disc Resident Device Driver
5	User Program, Segment
6,7	Library
10_8	Relocatable Binary
11_8	ASCII Source Statements
12_8	Binary Data
13_8	ASCII Data

'P' Bit

Ø = No Action

1 = Purge this entry at the end of the JOB. This bit is set by the LOADER and cleared by a :STORE,P[,*file-name*] request

The last directory entry in each sector is followed by a word containing '-1'. The last entry in the directory is followed by a word containing zero.

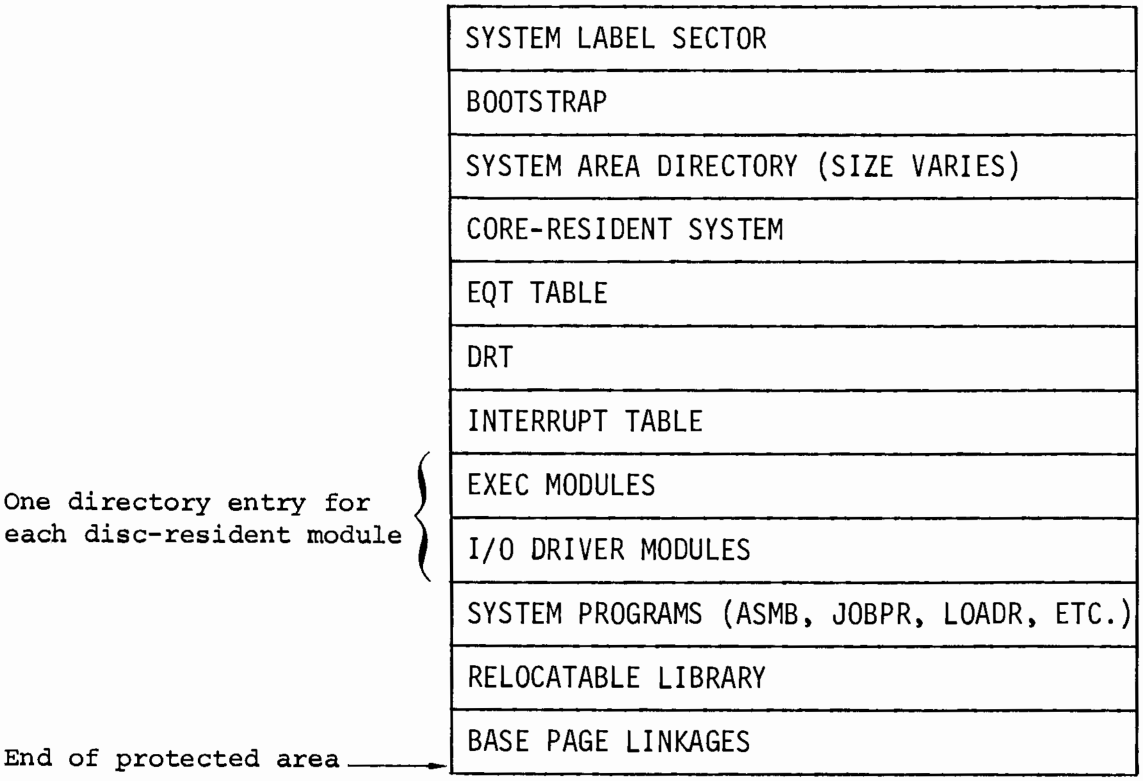


Figure A-5. Disc Layout

DISC LABELS

Sector 0 of track 0 of each disc is used for label information. In addition, if the user area is on the system disc, a label also occurs in Sector 0 of the first track after the system area.

The contents of the label include:

Word 0: Label presence code (ASCII "LB").

Word 1: System Proprietary Code:

1. "DO" for DOS-M
2. "TS" for Time-Shared Basic

Word 2: System generation code assigned at system generation time. The code can be any 4 decimal digits.

Words 3-5: A six-character disc label. If the first character equals * the disc is unlabeled. This label can only be set using :IN (for user areas) or by DSGEN (set to "SYSTEM" for system discs).

Word 31: Checksum of words 0-30.

The first 64 words are reserved for label information. Word 65 contains the next available track and sector. Words 66 and 67 contain the number of bad tracks and the next available spare track.

APPENDIX B
TYPICAL JOB DECKS

ASSEMBLE A PROGRAM AND STORE IN FILE

```
:JOB,ASMBS
:PROG,ASMB,5,6,4,56,99
ASMB,B,L
      NAM TEST,3
       .
       .                        Source Program
       .
      END ENTER
:STORE,R,AFILE
:JOB,NEXT JOB
```

LOAD AND EXECUTE A RELOCATABLE FILE

```
:JOB,LOADE
:PROG,LOADR,2
AFILE,/E
:STORE,P,TEST
:RUN,TEST
1Ø
23
 .
 .                              Data
 .
51
:JOB,NEXT JOB
```

TYPICAL JOB DECKS

STORE, EDIT, COMPILE, LOAD AND RUN A PROGRAM

```
:JOB,EVERY
:STORE,S,SOURC,5
FTN,B,L                   ⎫
      PROGRAM ZOOM        ⎪
      DIM  I(1Ø)          ⎬          Source Program
        .                 ⎪
        .                 ⎪
      ENDS$               ⎭
::
:LIST,S,6,SOURC
:EDIT,SOURC,5
/I,2                ⎫
.                   ⎬                Edit List
.                   ⎪
/E                  ⎭
:JFILE,SOURC
:PROG,FTN,2,6,4,56,99
:PROG,LOADR
:RUN,ZOOM
123.62          ⎫
 .              ⎬                    Data for first run
 .              ⎪
ØØØØ1           ⎭
:RUN,ZOOM
321.5           ⎫
 .              ⎬                    Data for second run
 .              ⎪
Ø.56            ⎭
:JOB,NEXT JOB
```

APPENDIX C
RELATION TO OTHER SOFTWARE

The Hewlett-Packard general-purpose computers can handle other HP software when the Moving-Head Disc Operating System is inactive. Every computer is shipped with the software and documentation appropriate to the system configuration.

Prepare Tape System can be used to store the relocatable modules of DOS-M on a magnetic tape. DSGEN can then read from this magnetic tape to generate a system.

In an attempt to make DOS-M compatible with the Real-Time Executive, DOS-M simulates the Real-Time EXEC requests as follows (See *REAL-TIME SOFTWARE,* 02116-9139):

READ/WRITE	Identical for work area of disc and I/O devices.
I/O CONTROL	Identical
I/O STATUS	Status word 2 returns transmission log instead of Real-Time Equipment Table word 5.
DISC ALLOCATION	Simulates request in work area.
DISC RELEASE	No action; tracks cannot be released.
PROGRAM COMPLETION	Identical
PROGRAM SUSPENSION	Identical
PROGRAM SEGMENT LOAD	Identical
PROGRAM SCHEDULE	Treated as program main load.
CURRENT TIME	Word 5 set to Ø, other words identical.
EXECUTION TIME (TIMER)	Not accepted See N option of RUN request.

APPENDIX D
SUMMARY OF DIRECTIVES

DIRECTIVE	DESCRIPTION
:ABORT	Terminate the current job.
:ADUMP[,*FWA*[,*LWA*][,B],L]	Dump a program if it aborts
:BATCH, *logical unit*	Switch from keyboard to batch mode, or reassign batch device.
:COMMENT *string*	Print a message.
:DATE,*day*[,*hour*,*min*]	Set the date and the time (if time-base is present).
:DD	Dump the entire current disc onto a disc on another subchannel.
:DD,X	Dump the system area only to another disc.
:DD,U[,*file*[,(*name*)],*file*[,(*name*)]...]	Dump all or specified files of the current user disc to another disc, optionally assigning new file names.
:DN,*n*	Declare an I/O device down.
:DUMP,*log.unit*,*file*[,S_1[,S_2]]	Dump all or part of a user file to a peripheral I/O device.
:EDIT,*file log.unit*],*new*]	Edit a source statement file stored on disc, optionally creating a new file.
:EF[,*logical unit*]	Write end-of-file on magnetic tape.
:EJOB	Terminate the current batch and/or job normally.
:EQ[,*n*]	List the equipment table.
:GO[,P_1,P_2...P_5]	Continue processing a suspended program.
:IN,*label*	Label or unlabel ("*") the current user disc.

SUMMARY OF DIRECTIVES

DIRECTIVE	DESCRIPTION
:JFILE,*file*	Specify a source file on the disc for the assembler or compiler.
:JOB[,*name*]	Initiate a user job.
:LIST,S,*log.unit*,*file*[,*m*[,*n*]]	List all or part of a source statement file.
:LIST,U,*log.unit*[,*file*$_1$,...]	List all or part of the user directory.
:LIST,X,*log.unit*[,*file*$_1$,...]	List all or part of the system directory.
:LU[,n_1[,n_2]]	Assign or list logical units.
:OFF	Abort the currently executing program or operation without terminating the job.
:PAUSE	Suspend the current job or program.
:PDUMP[,*FWA*[,*LWA*]][,B][,L]	Dump a program after normal completion.
:PROG,*name*[,p_1,p_2...p_5]	Turn on a system or user program.
:PURGE[,*file*$_1$,*file*$_2$,...]	Delete user files.
:RUN,*name*[,*time*][,N]	Run a user program
:SA,*track*,*sector*[,*number*]	Dump disc In ASCII to standard list device.
:SO,*track*,*sector*[,*number*]	Dump disc in octal to standard list device.
:SS	Set up system search for file names over all subchannels.
:SS,n_1,n_2...	Set up system search for file names over specified subchannels.
:SS,99	Restrict search for file names to current user disc (plus system directory for RUN & PROG).

SUMMARY OF DIRECTIVES

DIRECTIVE	DESCRIPTION
:STORE,A,*file,sectors*	Reserve space for an ASCII data file.
:STORE,B,*file,sectors*	Reserve space for a binary data file
:STORE,P[,name_1, name_2,...]	Store temporary Loader generated programs as permanent files.
:STORE,R,*file* [,*log.unit*]	Store a relocatable file from a peripheral I/O device or from the JBIN area of disc after an assembly or compilation.
:STORE,S,*file*,*log.unit*	Store a source statement file from a peripheral I/O device.
:TRACKS	Print the disc track status of the current user disc.
:TYPE	Return to keyboard mode from batch mode.
:UD[,[*label*][,*n*]]	Change the subchannel assignment for the user disc, or request label & subchannel information for a user disc.
:UP,*n*	Declare an I/O device up.

APPENDIX E
SUMMARY OF EXEC CALLS

Consult Section III for the complete details on each EXEC call.

For each EXEC call, this appendix includes only the parameters (P_1 through P_n)of the assembly language calling sequence.

READ/WRITE: Transfer input or output.

```
RCODE  DEC  1 or 2     1 = read or 2 = write
CONWD  OCT  c          (See Section III for control information.)
BUFFR  BSS  n          (n-word buffer)
BUFFL  DEC  n or -2n   (buffer length, words (+), characters (-).)
DTRAK  DEC  p          (disc track; optional)
DSECT  DEC  q          (disc sector; optional)
```

I/O CONTROL: Carry out control operations.

```
RCODE  DEC  3
CONWD  OCT  c          (See Section III for control information.)
PARAM  DEC  n          (Optional parameter required by some CONWDs.)
```

PROGRAM COMPLETION: Signal end of program.

```
RCODE  DEC  6
```

PROGRAM SUSPEND: Suspend calling program.

```
RCODE  DEC  7
```

SUMMARY OF EXEC CALLS

PROGRAM SEGMENT LOAD: Load segment of calling program.

```
RCODE  DEC  8
SNAME  ASC  3,xxxxx      (xxxxx is segment name)
```

TIME REQUEST: Request the 24-hour time and day.

```
RCODE  DEC  11
ARRAY  BSS  5            (Time values; tens of milliseconds, seconds,
                         minutes, hours, returned in that order.)
```

I/O STATUS: Request device status.

```
RCODE  DEC  13
CONWD  DEC  n            (Logical unit number)
STATS  NOP               (Status returned here)
TLOG   NOP               (Transmission log returned here)
```

FILE READ/WRITE: Read or write a user data file.

```
RCODE  DEC  14 or 15     (14 = read or 15 = write.)
CONWD  OCT  c            (See Section III for control information.)
BUFFR  BSS  n            (Buffer of n words.)
BUFFL  DEC  n or -2n     (Length of buffer in words (+) or
                         characters (-).)
FNAME  ASC  3,xxxxx      (User file name = xxxxx.)
RSECT  DEC  m            (Relative sector within file.)
```

WORK AREA STATUS: Ascertain if *n* contiguous work tracks are available.

```
RCODE  DEC  16
NTRAK  DEC  n            (Number of consecutive tracks desired.)
TRACK  NOP               (Desired first track; from LIMITS call.)
STRAK  NOP               (Actual starting track, or Ø if n not
                         available.)
```

SUMMARY OF EXEC CALLS

WORK AREA LIMITS: Ascertain first and last tracks of work area.

```
RCODE  DEC  17
FTRAK  NOP              (Returns first work track number here.)
LTRAK  NOP              (Returns last work track number here.)
SIZE   NOP              (Returns number of sectors per track here.)
```

SEARCH FILE NAMES: Ascertain if a file name exists in the directory.

```
RCODE  DEC  18
FNAME  ASC  3,xxxxx     (xxxxx is the file name.)
NSECT  NOP              (Number of sectors in file returned here, or
                        Ø if not found.)
```

CHANGE USER DISC: Change the current user disc subchannel.

```
RCODE  DEC  23
LABEL  ASC  3,xxxxx     (Disc label = xxxxx or ASCII 1, * for unlabel.)
SUBCH  DEC (Ø to 7)     (Subchannel number; optional parameter.)
```

MAIN PROGRAM LOAD: Transfer a main program into core.

```
RCODE  DEC  1Ø
PNAME  ASC  3,xxxxx     (Program name)
```

APPENDIX F
ALGOL EXEC CALLS

The program below (DXFER) reads one sector from the work area and writes the information into a different location in the work area. DXFER calls EXEC through the CODE procedure EXECX compiled externally. EXECX is compiled in the program DSKIO, although that program name is irrelevant to the linkage between DXFER and EXECX.

MAIN PROGRAM

```
HPAL,B,L,"DXFER"
BEGIN
  INTEGER ARRAY BUFFER[1:128];
  BOOLEAN READX;
  INTEGER TRACK,SECTOR;
  FORMAT F1("SOURCE TRACK,SECTOR?"),
         F2("DESTINATION TRACK,SECTOR?");
  PROCEDURE EXECX(RD,TRK,SCTR,BFR);
    VALUE RD,TRK,SCTR;
    BOOLEAN RD;
    INTEGER TRK,SCTR,BFR;
    CODE;
 WRITE(1,F1);
 READ(1,*,TRACK,SECTOR);
 READX←TRUE;
 EXECX(READX,TRACK,SECTOR,BUFFR[1]);
 WRITE(1,F2);
 READ(1,*,TRACK,SECTOR);
 READX←FALSE:
 EXECX(READX,TRACK,SECTOR,BUFFR[1]);
END$
```

ALGOL EXEC CALLS

PROCEDURE

```
HPAL,P,B,L,"DSKIO"
PROCEDURE EXECX(RD,TRK,SCTR,BFR);
   VALUE RD,TRK,SCTR;
   BOOLEAN RD;
   INTEGER TRK,SCTR,BFR;
BEGIN
  PROCEDURE EXEC(IO,LU,BFR,BFSZ,TRK,SCTR);
     VALUE IO,LU,BFSZ,TRK,SCTR;
     INTEGER IO,LU,BFR,BFSZ,TRK,SCTR;
     CODE;
  INTEGER REQCD;
  IF RD THEN REQCD←1 ELSE REQCD←2;
  EXEC(REQCD,2,BFR,128,TRK,SCTR);
END;
```

INDEX