OPERATOR'S GUIDE

HEWLETT hp PACKARD

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PREFACE

This Operator's Guide provides clear operating procedures for all computer software used with Hewlett-Packard paper tape, and disc/drum systems. This text has been completely reorganized and includes new software systems since the first edition, January 1968.

The introduction explains the general concept of a computer system and briefly describes Hewlett-Packard computer system(s) and the related software. Binary and octal number systems are explained.

Section I contains descriptions and operating procedures for the three series of Hewlett-Packard computers.

Section II contains information about paper tape and loading that the operator should know before starting operation of a computer system.

Section III explains SIO drivers and configuration of SIO modules.

Section IV contains a brief description of HP ALGOL, HP FORTRAN, HP Assembler followed by operating instructions and a summary of all messages printed while using this software.

Section V contains a brief description of Basic Control System followed by operating instructions and a summary of all messages printed while using this software.

Section VI contains a brief description of HP BASIC followed by operating instructions.

Section VII contains a brief description, operating instructions and a summary of all messages printed while using this software: Punch/Verify, Cross Reference Symbol Table Generator SIO System Dump, and SDUMP.

Section VIII covers the Disc Operating System and the Moving-Head Disc Operating System followed by a summary of all messages printed while using these systems.

Section IX covers the Real-Time Executive System followed by a summary of all messages printed while using this system.

Appendix A is an alphabetized summary of all messages printed during operation of Hewlett-Packard software.

The glossary contains definitions of pertinent computing terms.

An index is provided at the end of this book for easy reference.

NOTE: Information covering the Symbolic Editor, Prepare Tape System and Magnetic Tape System is not included in this book but may be found in, Symbolic Editor, 02116-9016, Prepare Tape System, 02116-91751, and Magnetic Tape System, 02116-91752, manuals respectively.

CONVENTIONS USED IN THIS BOOK

SAMPLE	EXPLANATION
INTERRUPT LINKAGE?	Black, all capitals indicate computer-output information.
Turn on...	Mixed upper and lower case black is used for regular text.
NOTE: When using...	Mixed upper and lower case italics are used for notes and parts of certain systems messages, directives and operator requests.
0/0●0/000/●●●/000/00●	The zeros and slashes illustrate positions in the SWITCH REGISTER for an octal number. The filled zeros indicate switches that are set (on). The blank zeros indicate switches that are zero (off).
:PROG, ALGOL [,*sio*] [,*overlay*][/]	The inclusion of information in brackets is optional.
O	The letter "O"
Ø	Zeros are slashed.
l	The numeral
I	The letter
K	1024 (decimal), 1777 (octal)

CONTENTS

SECTION VIII
DISC OPERATING SYSTEM (cont.)

ILLUSTRATIONS

INTRODUCTION

GENERAL OVERVIEW OF HEWLETT-PACKARD COMPUTER SYSTEMS

A computer is an electronic device that accepts human written information, performs mathematical and logical operations on this information, and returns the results.

Though a computer is instructed by humans, there are other materials needed for its operation. Therefore, the term "computer system" refers to the computer and whatever must be supplied for the computer to operate.

A computer system consists of *hardware* and *software*.

Hardware is the computer itself plus the equipment that handles the information that must go in or out of the computer. These pieces of equipment are called the "peripheral devices."

The computer has four sections.

1. Input/Output - Transfers information and instructions from the peripheral devices to the computer memory or from the computer to the peripheral devices.

2. Memory (core) - The storage area for data and instructions. The smallest core size is four thousand (4K) storage areas. HP computers have core sizes of 4K, 8K, 16K, 24K and 32K.

3. Control - The section that organizes all computer operations.

4. Arithmetic - The section of the computer that adds, subtracts, multiplies, and divides numbers.

Software is the instructions that control computer operation. Groups of instructions make up a program. A program tells the computer to perform certain actions; different kinds of actions are controlled by different programs. All programs are kept on paper tape, magnetic tape or punched cards. (The peripheral devices read these programs from paper tape, magnetic tape or punched cards into the computer.)

Software programs can be divided into four general classes.

1. Translator program - Translates programs from human language into computer (machine) language. There are two types of Translators: Assemblers and Compilers.

2. Executive program - A supervisory program that controls the resources of the system.

3. Utility program - A program that assists computer operation.

4. Application program - Applies the computer to a specific user problem.

Combinations of these programs can be stored within the computer.

HP COMPUTER SYSTEMS

An HP computer system consists of the computer (HP 2114, 2115, 2116) and a system teleprinter. The core memory size is 4K, 8K, 16K, 24K or 32K depending on the computer series and the user's needs. Optional devices can be added to increase input/output operations.

The basic software for the HP computer system includes the FORTRAN Compiler, HP Assembler, Basic Control System and utility routines.

If the user's HP computer system has a magnetic tape unit, Hewlett-Packard furnishes the executive program, Magnetic Tape System.

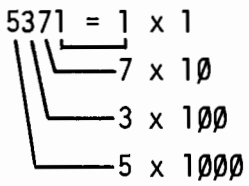
If the user's HP computer system has a disc or drum unit, Hewlett-Packard furnishes the Real-Time Executive and/or the Disc Operating System program.

NUMBER SYSTEMS

The base of a number system is the number of different symbols used in that system. The decimal number system uses ten different numerals -- Ø through 9. The binary number system uses only two numerals -- Ø and 1. The octal number system uses eight different numberals -- Ø through 7.

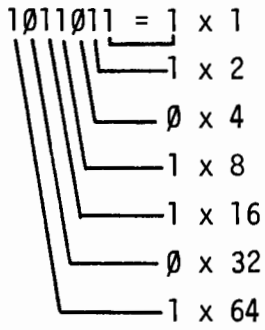
The value of a decimal digit depends on its location in a number -- units, tens, hundreds, thousands, or powers of ten.

For Example:



The value of a binary digit depends on the powers of two -- units, twos, fours, eights, and so on.

For Example:



The value of an octal digit depends on the powers of eight -- units, eight, sixty-four, five hundred twelve and so on.

For Example:

$$155 = 5 \times 8^{0} + 5 \times 8^{1} + 1 \times 8^{2}$$

Three bits (three binary digits) represent the number Ø through 7 in the octal or decimal number systems.

For Example:

Binary	Octal	Decimal
ØØØ	Ø	Ø
ØØ1	1	1
Ø1Ø	2	2
Ø11	3	3
1ØØ	4	4
1Ø1	5	5
11Ø	6	6
111	7	7

To represent numbers higher than 7, three more bits (three binary digits) are required.

For Example:

Binary	Octal	Decimal
ØØ1ØØØ	1Ø	8
ØØ1ØØ1	11	9
ØØ1Ø1Ø	12	1Ø
.	.	.
.	.	.
.	.	.
Ø1ØØØØ	20	16
.	.	.
.	.	.
.	.	.
111111	77	63

When two or more number systems are being considered, it is good practice to use a *subscript number* (a number that identifies the particular number system) to prevent confusion.

For Example:

The binary number $\emptyset\ \emptyset\emptyset\emptyset\ \emptyset\emptyset\emptyset\ \emptyset\emptyset 1\ 1\emptyset 1\ 1\emptyset 1_2$,

the octal number, 155_8,

and the decimal number $1\emptyset 9_8$,

are all the same value.

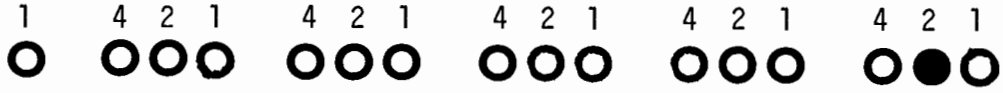
USING THE HEWLETT-PACKARD SWITCH REGISTER

Digital computers use the binary number system. The Hewlett-Packard 2114, 2115, 2116 digital computers work with a computer word containing 16 binary digits or bits.

Since the Hewlett-Packard console register can represent 16 binary digits and an octal digit is three bits, the console register can be divided into five full octal digits and one partial digit (i.e., one bit left over). The 16 register display lights are numbered $\emptyset$ through 15, starting at the right. The fifteenth display light can only be $\emptyset$ or 1.

HOW TO READ THE OCTAL CONTENTS ON THE REGISTER

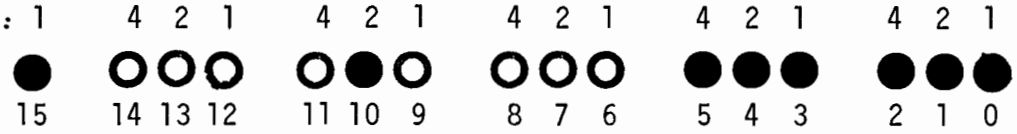
Since each octal number is made up of a series of binary digits, 2_8 appears on the register display lights as:



The binary number is 0000000000000010_2, and the octal equivalent is 000002_8.

Each light on the register display has a "place value" of 1,2, or 4.

To read the octal contents, add the "place values" for each series of three register display lights, for example:

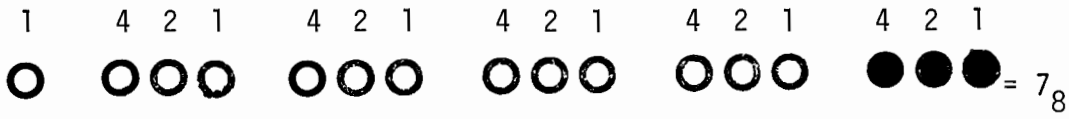


is 102077_8.

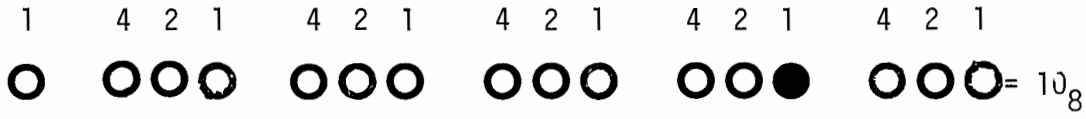
To interpret each digit in 102077_8, add the "place values" (in groups of three), from left to right:

1 is represented by light 15. Since the computer word is 16 bits long, light 15 is the only one in the first octal digit.
0, (the first series of lights) is 0 + 0 + 0.
2, (the second series of lights) is: 0 + 2 + 0.
0, (the third series of lights) is: 0 + 0 + 0.
7, (the fourth series of lights) is: 1 + 2 + 4.
7, (the fifth series of lights) is: 1 + 2 + 4.

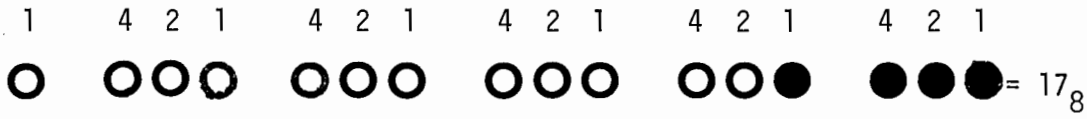
SOME EXAMPLES

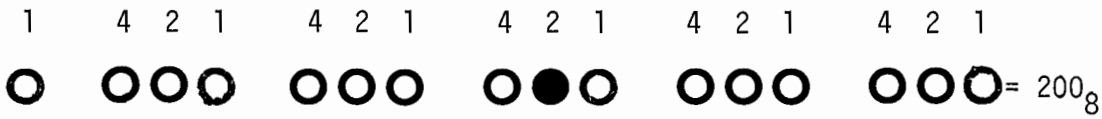


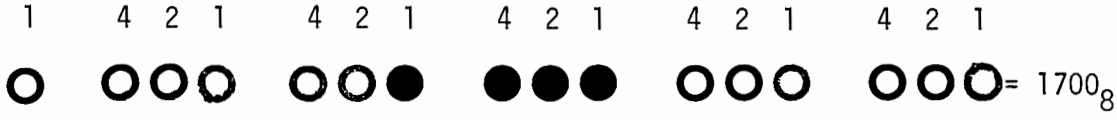
NOTE: 7 is the largest octal digit; there is no 8 or 9 digit.

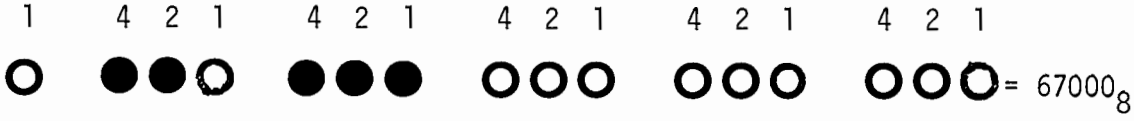


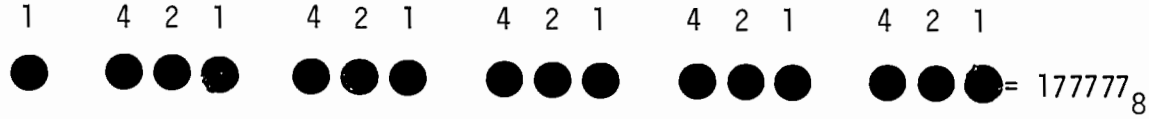
NOTE: 10_8 is a combination of the octal digits 0 and 1.











NOTE: Section I describes how to set octal numbers into the 2114, 2115, 2116 Switch Registers.

THE HEWLETT-PACKARD 2114, 2115, 2116 COMPUTERS

This section familiarizes the operator with the 2114, 2115, 2116 computer series.

Figure 1-1 is a diagram of the 2114, followed by a description of the software, an explanation of the console touch buttons and switches, and display registers.

Figure 1-2 is a diagram of the 2115, followed by a description of the software, and an explanation of the console switches and display registers.

Figure 1-3 is a diagram of the 2116, followed by a description of the software, and an explanation of console switches and display registers.

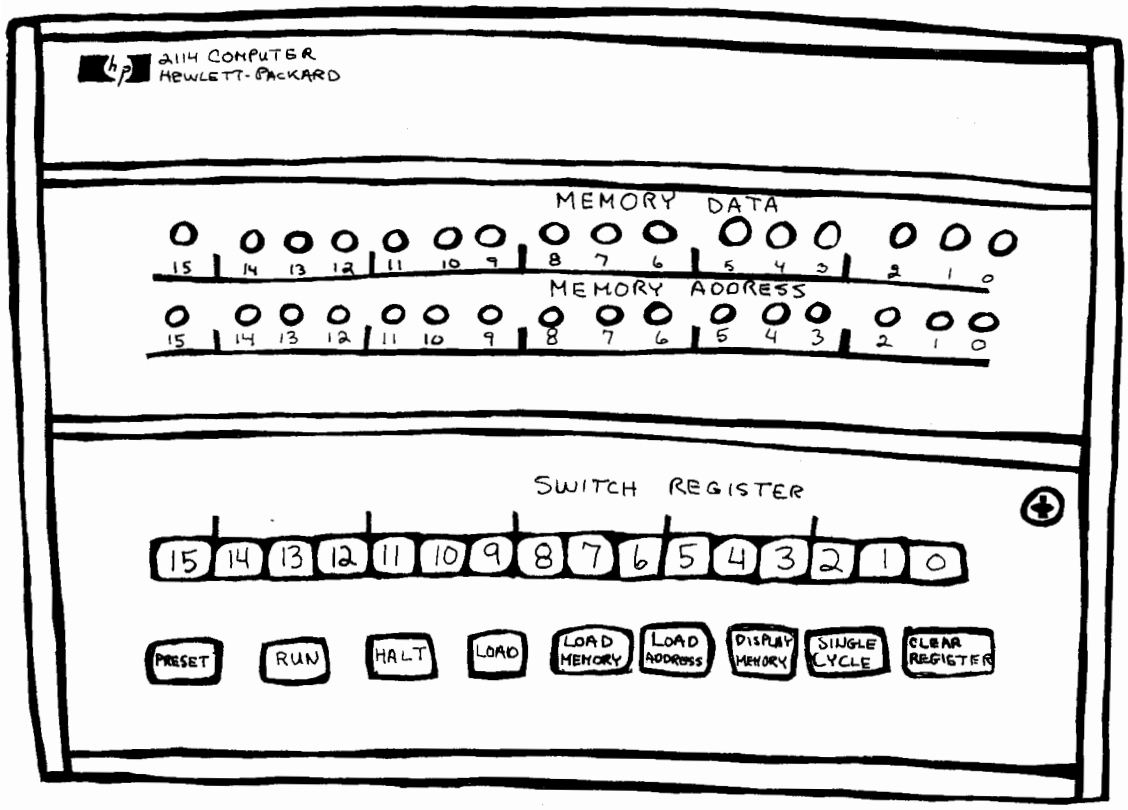


Figure 1-1. Front Panel of the HP 2114 Computer

COMPUTER: HP 2114

MEMORY SIZE: 4K or 8K

SOFTWARE: FORTRAN, Assembler, Basic Control System, FORTRAN Library, Utility Programs and SIO drivers for the devices that are part of the computer system.

For the 2114 with 8K memory size, Hewlett-Packard offers the ALGOL and BASIC Compilers.

SWITCH REGISTER:

A row of 16 illuminated touchbuttons to enable manual entry of data into the computer.

CONSOLE TOUCHBUTTONS:

PRESET	Sets the computer to starting status (clears control flags, turns off interrupt system, etc.); used with the LOAD button to enable the Basic Binary Loader or the Basic Binary Disc Loader to load programs into memory.
RUN	Starts program execution (at memory location specified in MEMORY ADDRESS REGISTER).
HALT	Stops program execution.
LOAD	Used with the PRESET button; enables the Basic Binary Loader or Basic Binary Disc Loader program to load programs into core from punched tape.
LOAD MEMORY	Transfers the contents of the SWITCH REGISTER into the T-REGISTER and then into the memory location specified by the M-REGISTER.

LOAD ADDRESS	Transfers SWITCH REGISTER contents into the MEMORY ADDRESS REGISTER and PROGRAM COUNTER REGISTER.
DISPLAY MEMORY	Displays in the MEMORY DATA REGISTER the contents of the address specified in the MEMORY ADDRESS REGISTER.
SINGLE CYCLE	Moves program through one machine cycle.
CLEAR REGISTER	Clears SWITCH REGISTER to all zeros. (All switches are "OFF.")

CONSOLE REGISTERS:

MEMORY DATA	Shows the numerical information that goes in and out of memory during computer operation.
MEMORY ADDRESS	Holds the address of the memory locations being read or written.

NOTE: All buttons on the front panel are "touch" buttons and are activated only by touching the button with the finger. When the button is lit, the switch is "ON" (set). When the button is not lit, the switch is "OFF" (reset). For this text "press" will be used instead of "touch."

HOW TO PROTECT THE CONTENTS OF A 2114 COMPUTER

If the operator wishes to run a program without unauthorized intervention, use the feature described below:

1. Open the front panel of the 2114.
2. Move the console lock switch (inside the front panel) to the LOCK position.
3. Close the front panel of the 2114. Lock it and remove the key.

This disables all the buttons on the 2114 front panel (so that unauthorized persons cannot tamper with them).

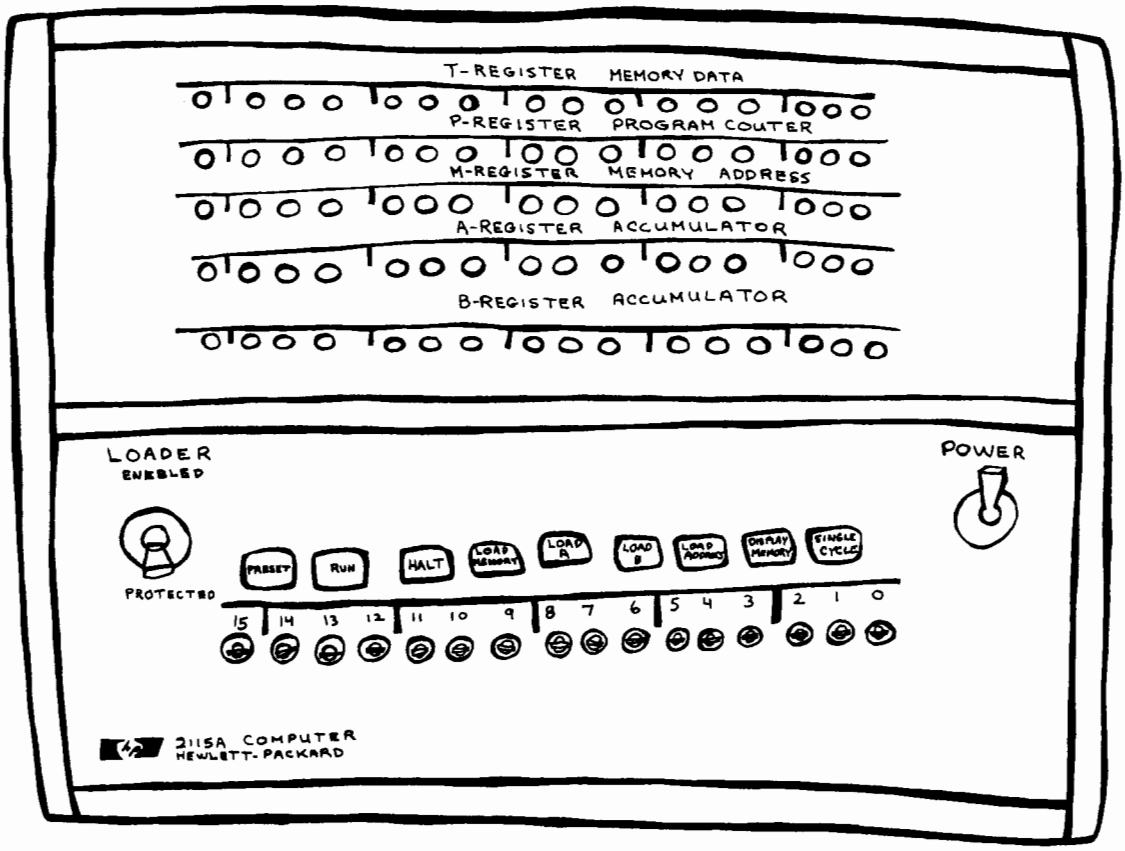


Figure 1-2. Front Panel of HP 2115 Computer

COMPUTER: HP 2115

MEMORY SIZE: 4K expandable to 8K

SOFTWARE: FORTRAN Compiler, HP Assembler, Basic Control System, Symbolic Editor, FORTRAN Library, Debug, Utility Programs, Relocating Loader, and SIO drivers for the devices that are part of the computer system.

For the 2115 with 8K memory size, Hewlett-Packard offers ALGOL and BASIC Compilers.

SWITCH REGISTER:

A row of 16 switches to enable manual entry of data into the computer.

The SWITCH REGISTER bits of the 2115 are turned on by the toggle switches under each number. If the toggle switch is up (set), the bit is "ON." If the toggle switch is down (reset), the bit is "OFF."

The LOADER switch is also operated by a toggle switch. When the toggle switch is up, the LOADER is ENABLED. When the toggle switch is down, the LOADER is PROTECTED.

LOADER ENABLED/PROTECTED

This toggle switch, when set to ENABLED, enables the Basic Binary Loader to load punched tape programs into core.

This toggle switch, when set to PROTECTED, protects the Basic Binary Loader after loading is completed.

CONSOLE BUTTONS:

PRESET	Sets the computer to starting status (clears all control flags, turns off interrupt system, etc.).
RUN	Starts program execution at memory location specified in P-REGISTER.
HALT	Stops program execution.
LOAD MEMORY	Transfers the contents of the SWITCH REGISTER into the T-REGISTER and then into core.
LOAD A	Transfers the contents of the SWITCH REGISTER setting into the A-REGISTER.
LOAD B	Transfers the contents of the SWITCH REGISTER setting into the B-REGISTER.
LOAD ADDRESS	Transfers the SWITCH REGISTER setting to the P-REGISTER and M-REGISTER.
DISPLAY MEMORY	Displays in the T-REGISTER the contents of the address specified in the M-REGISTER.
SINGLE CYCLE	Moves program through one machine cycle.
POWER	Turns computer power on or off.

CONSOLE REGISTERS:

T-REGISTER or MEMORY DATA REGISTER -- Shows the information transferred into or out of memory.

P-REGISTER or PROGRAM COUNTER -- Holds the address of the instruction to be taken from memory.

M-REGISTER or MEMORY ADDRESS -- Holds the address of the memory location being read from or written into.

A-REGISTER or ACCUMULATOR -- Holds the results of arithmetic and logical operation performed by programs. Can be referenced as memory location 0 by assembler instructions.

B-REGISTER or ACCUMULATOR -- Acts in conjunction with or independently of the A-REGISTER to hold the results of arithmetic and logical operations performed by programs. Can be referenced as memory location 1 by assembler instructions.

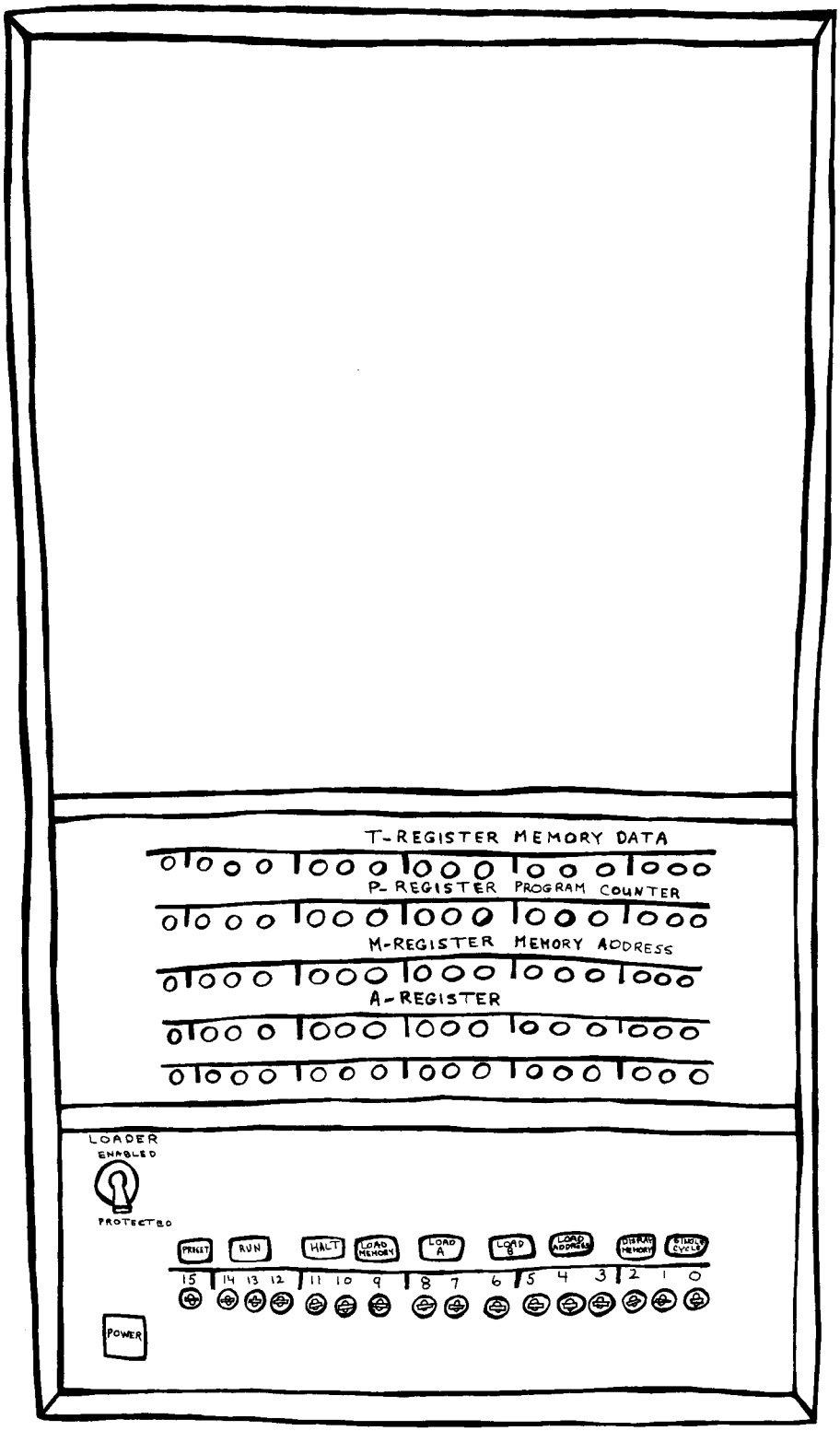


Figure 1-3. Front Panel of the HP 2116 Computer

COMPUTER: HP 2116

MEMORY SIZE: 8K expandable to 32K

SOFTWARE: FORTRAN, ALGOL, BASIC Compiler, Basic Control System, utility routines, Assembler, Debug, FORTRAN Library, Relocating Loader and SIO drivers for the devices that are part of the computer system.

SWITCH REGISTER:

A row of 16 switches to enable manual entry of data into the computer.

The SWITCH REGISTER bits of the 2116 are turned on by the toggle switches under each number. If the toggle switch is up (set), the bit number is "ON." If the toggle switch is down (reset), the bit is "OFF."

The LOADER switch is also operated by a toggle switch. When the toggle switch is up, the LOADER is ENABLED. When the toggle switch is down, the LOADER is PROTECTED.

CONSOLE SWITCHES:

LOADER ENABLED/PROTECTED

This toggle switch, when set to ENABLED, enables the Basic Binary Loader to load punched tape programs into core.

This toggle switch, when set to PROTECTED, protects the Basic Binary Loader after loading is completed.

POWER Turns the computer power on or off.

CONSOLE BUTTONS:

PRESET	Sets the computer to starting status (clears all control flags and turns off interrupt system, etc.).
RUN	Starts program execution at address specified by the P-REGISTER.
HALT	Stops program execution.
LOAD MEMORY	Transfers the contents of the SWITCH REGISTER into the T-REGISTER and then into memory.
LOAD A	Transfers the contents of the SWITCH REGISTER setting into the A-REGISTER.
LOAD B	Transfers the contents of the SWITCH REGISTER setting into the B-REGISTER.
LOAD ADDRESS	Transfers SWITCH REGISTER setting to the P-REGISTER and M-REGISTER.
DISPLAY MEMORY	Displays in the T-REGISTER the contents of the memory location specified in the M-REGISTER.
SINGLE CYCLE	Moves program through one machine cycle.

CONSOLE REGISTERS:

T-REGISTER or MEMORY DATA REGISTER -- Shows the information transferred in or out of memory.

P-REGISTER or PROGRAM COUNTER -- Holds the address of the instruction to be taken from memory.

M-REGISTER or MEMORY ADDRESS -- Holds the address of the memory location being read from or written into.

A-REGISTER or ACCUMULATOR -- Holds the results of arithmetic and logical operation performed by programs. Can be referenced as memory location 0 by assembler instructions.

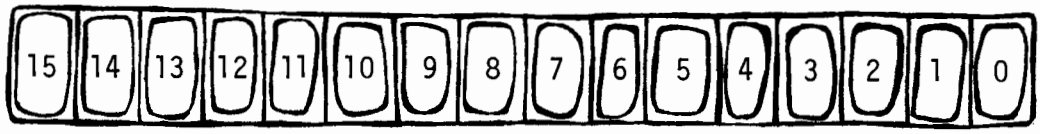
B-REGISTER or ACCUMULATOR -- Acts in conjunction with or independently of the A-REGISTER to hold the results of arithmetic and logical operations performed by programs. Can be referenced as memory location 1 by assembler instructions.

HOW TO SET OCTAL NUMBERS INTO THE 2114 SWITCH REGISTER

1. Press CLEAR REGISTER.
2. Determine which numbers of the SWITCH REGISTER must be set "ON."
3. Press the appropriate SWITCH REGISTER touchbuttons.

For Example:

To put $Ø177ØØ_8$ into the SWITCH REGISTER, press touchbuttons 12,11,1Ø,9,8,7,6.



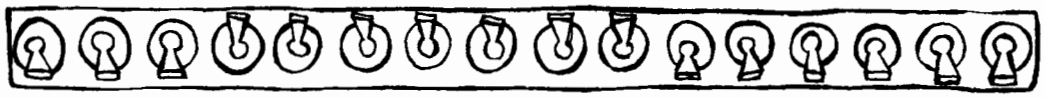
2114 SWITCH REGISTER

HOW TO SET OCTAL NUMBERS INTO THE 2115 OR 2116 SWITCH REGISTER

1. Set all toggle switches "OFF."
2. Determine which toggle switches must be set "ON" to show this octal value.
3. Set the appropriate toggle switches "ON."

For Example:

To put $Ø177ØØ_8$ into the SWITCH REGISTER, set the toggle switches 12,11,1Ø,9 8,7,6 "ON."



2115/2116 SWITCH REGISTER

PRELIMINARY INFORMATION TO KNOW BEFORE OPERATING A COMPUTER SYSTEM

This section gives the operator preliminary information on how to avoid unnecessary problems, how to use paper tape, and how to load the computer using BBL and BBDL.

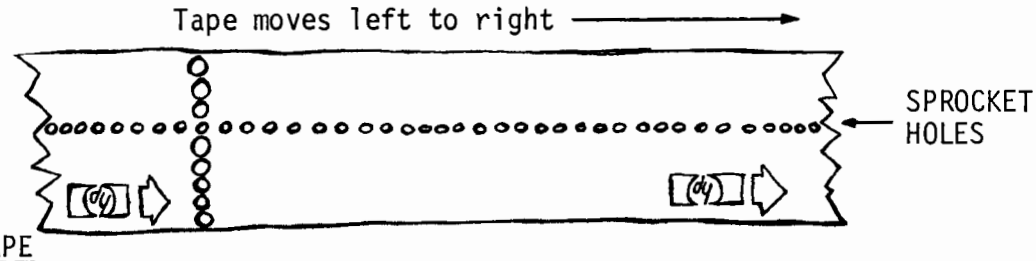
USEFUL INFORMATION

1. Checking all devices before starting eliminates the possibility of finding a device inoperable during computer operation.
2. Turn the teleprinter off when not in use to avoid excessive wear.
3. If the computer stops during operation, check the power source to make sure that the power has not failed. If there has been a general power failure, the computer will restart itself when the power is restored if the hardware option Power Fail Interrupt with Automatic Restart is part of the computer system and if the computer is programmed to restart.
4. The operator's job is easier if:
   a. All input is marked with the programmer's name and given back with all output (also marked) of the computer system.
   b. All paper tapes (source and object) and magnetic tapes are marked and saved.
5. If any unusual halt occurs during an operation, record the contents of the registers; this provides inportant information for the programmer.
6. Magnetic tapes are easily damaged by excessive handling, dust, or such things as donut crumbs. Handle the tape on the shiny side only, never touch more than two feet of the shiny side of the tape when handling a reel of magnetic tape, and always keep tapes in their cases when not in use.
7. Check the magnetic tape for LOAD POINT markers and for a Write Enable Ring (if writing is to be done).

PAPER TAPE

PURPOSE: To record data on paper tape by punching coded groups of holes in the tape.

FORMAT: Eight hole positions for each item of data on the tape. There are three hole positions, then a smaller sprocket hole (which guides the tape as it is being read), then five more hole positions.



USING PAPER TAPE

1. Tape Marking and labels:
   a. Keep a supply of self-adhesive labels in the computer room.
   b. Put an identifying label on the outside end of every tape roll and a corresponding label on the tape box.
   c. Take one tape out of a box at a time.
   d. Keep the boxes closed.
   e. Always rewind and label tape immediately after punching (this helps prevent loading backwards).
2. Check the tape supply. A change in tape color and a computer halt with 102066_8 in the MEMORY DATA REGISTER indicate that a new roll of tape should be installed. If the punching operation is almost finished, press RUN to complete the punching operation.
3. Check for tape defects that can cause errors in tape reading:
   a. Ragged edges on the tape.
   b. Oil on the tape.
   c. Incomplete punching of tape holes.
   d. Lint, dust, chad on the tape.

4. Loading tape into the reader
   a. Make sure the tape is inserted correctly. Paper tape does not feed properly when reversed, but it does feed if it has been inserted upside-down and backwards. When the tape is loaded backwards, neither the program nor the computer will run properly. Correct this situation by reloading the tape properly.
   b. Proper tape position is: from the left with the five-hole side nearest the operator.

5. Tape leader and tape trailer
   a. Tape leader is the uncoded section of tape (sprocket holes only) before the coded information. Tape trailer is the uncoded section of tape after the coded information.
   b. Each tape punched by the tape punch must have a tape leader and tape trailer. Most programs are written so that the computer gives a signal to the tape punch to punch a tape leader and tape trailer. If the program does not produce tape leader and tape trailer, the operator must produce approximately 18 inches of leader and trailer by one of the following methods:

      If the teleprinter only is used for reading and punching tape:
      1. Press the "HERE IS" button on the teleprinter.
      2. Press the "@" button and the "CONTROL" button several times simultaneously.

      If a high-speed tape punch is used, then press the tape leader button on the punch unit.

6. Chad, the paper punched out of the tape by the tape punch, can jam up the tape punch or interfere with reading. Empty the chad box frequently to prevent this.

7. After a tape has been read by the BBL or BBDL, check the front panel of the computer. The HALT button should be lighted and the MEMORY DATA REGISTER should contain $1Ø2Ø77_8$ (●/000/0●0/000/●●●/●●●).

   If the tape has not been properly read, check for tape defects and clean any dust out of the tape reader. Re-thread the tape into the tape reader. If this procedure does not work, consult BBL and BBDL loading procedures in this section.

HOW TO LOAD PAPER TAPE INTO THE TAPE READER

1. Place the tape roll in the tray next to the tape reader, with the five-hole side facing the operator.
2. Thread the tape through the tape reader.

   NOTE: If the tape is not under the wire loop (though the tape may pass through the tape reader), no data will be read into the computer.

3. Check that the tape is not being pinched by the guide block.
4. Set the tape reader to the "READ" position to ready the tape reader for the starting command from the computer.

BBL AND BBDL

The Basic Binary Loader (BBL) and the Basic Binary Disc Loader (BBDL) programs load absolute binary programs into core memory.

Either program, depending on user specifications, is placed into core memory prior to shipment. However, both programs may not exist in the same computer system simultaneously.

BBL and BBDL have identical loading and operating procedures with two exceptions:

a. BBL can verify a program just loaded into core. (Set switch 15 "ON," all others down, and reload the program with BBL.)

b. BBDL can load a program from disc into memory. However, BBDL cannot verify the contents of the program just loaded into core.

NOTE: When using the BBL and BBDL operating procedures remember:

BASIC CONTROL SYSTEM (BCS) uses only BBL, DISC OPERATING SYSTEM (DOS) uses only BBDL, MOVING-HEAD DISC OPERATING SYSTEM (DOS-M) uses only BBL, and REAL-TIME EXECUTIVE (RTE) uses only BBDL.

2114 PAPER TAPE LOADING WITH BBL OR BBDL

1. Be sure the computer has stopped. The HALT button must be lit.
2. Place tape in tape reader and ready the tape reader.
3. Press CLEAR REGISTER.
4. Press PRESET and LOAD simultaneously.
5. When the tape is loaded, the HALT button lights up and the MEMORY DATA REGISTER contains 102077_8 (1/000/010/000/111/111).
6. If the tape does not load properly, check the MEMORY DATA REGISTER for these error halt conditions:

   102055_8 (1/000/010/000/101/101)

   This halt indicates an address error. Check that the proper tape was used; check that the tape was not put in backwards.

   102011_8 (1/000/010/000/001/001)

   This halt indicates a checksum error. Check the tape reader for lint, dust, other particles. Check the tape for lint, dust, chad, ragged edges or turn holes. Back up the tape in the reader to the beginning of the current record (four feed frames) and press RUN.

2115,2116 PAPER TAPE LOADING WITH BBL OR BBDL

1. Be sure the computer is halted. The HALT button must be lit.
2. Place tape in tape reader and ready the tape reader.
3. Set the SWITCH REGISTER to 77700_8 (0/●●●/●●●/●●●/000/000).

   NOTE: If the 2116 has a 24K memory size, set the SWITCH REGISTER to 57700_8 (0/●0●/●●●/●●●/000/000).

4. Press the LOAD ADDRESS button.
5. Set the LOADER switch to ENABLED.
6. Press the PRESET button.
7. Press the RUN button.
8. When the tape is loaded, the computer HALT button lights up and the MEMORY DATA REGISTER contains 102077_8 (●/000/0●0/000/●●●/●●●).
9. Set the LOADER switch to PROTECTED.

   NOTE: If the tape does not load properly, check the MEMORY DATA REGISTER for these error halt conditions:

   102055_8 This halt indicates an address error. Check that the proper tape was used; Check that the tape was not put in backwards.

   102011_8 This halt indicates a checksum error. Check the tape reader for lint, dust, and other particles. Check the tape for lint, dust, chad, ragged edges or torn holes.

HOW TO DETERMINE CONTENTS OF BBL OR BBDL IN MEMORY FOR THE 2114

If there is reason to think the contents of the BBL or BBDL has been partially or completely destroyed, compare the numerical instruction of the BBL or BBDL in a memory location with the corresponding numerical instruction found in the BBL or BBDL listing.

1. The HALT button must be lit on the computer console.
2. Set the SWITCH REGISTER to the Starting Address of the BBL:
   a. If the memory size is 4K, set the SWITCH REGISTER to 007700_8 (0/000/●●●/●●●/000/000).
   b. If the memory size is 8K, set the SWITCH REGISTER TO 017700_8 (0/00●/●●●/●●●/000/000).
3. Press LOAD ADDRESS (the Starting Address is displayed in the MEMORY ADDRESS REGISTER).
4. Open the front panel of the computer. On the inside of the panel are several switches. Move the LOADER ENABLE switch to the left (the "ON" position).
5. Close the front panel.
6. Press DISPLAY MEMORY to display the contents of each location. Compare contents with the BBL or BBDL listings.
7. If there are numerous incorrect instruction words within the first eight instructions words, complete steps 1 through 4 and replace the entire BBL or BBDL using the BBL or BBDL Replacement Procedure.
8. If there are few or no incorrect instruction words within the first eight instruction words, step through the entire 64 locations of the BBL or BBDL, pressing DISPLAY MEMORY to display the next sequential instruction.
9. Note the location of the incorrect instruction words and after stepping through all 64 locations, replace the incorrect instructions following the BBL or BBDL Replacement Procedure.

HOW TO DETERMINE CONTENTS OF BBL OR BBDL IN MEMORY FOR THE 2115, 2116

1. The HALT button must be lit on the computer console.
2. Set the SWITCH REGISTER to the Starting Address of the BBL or BBDL.
   a. Set the SWITCH REGISTER to $77\emptyset\emptyset_8$ (0/■■■/■■■/■■■/000/000).
   b. If the memory size is 24K, set the SWITCH REGISTER to $\emptyset 577\emptyset\emptyset_8$ (0/■0■/■■■/■■■/000/000).
3. Press LOAD ADDRESS.
4. Set the LOADER switch to the ENABLED position.
5. Press DISPLAY MEMORY to display the contents of each location. Compare contents with the BBL or BBDL listings.
   a. If there are numerous incorrect instruction words within the first eight instruction words, complete steps 1-4 and replace the BBL or BBDL following the BBL or BBDL Replacement Procedure.
   b. If there are few or no incorrect instruction words within the first eight instruction words, step through the entire 64 locations of BBL or BBDL, pressing DISPLAY MEMORY to display the next sequential instruction. Note the location of the incorrect instruction(s) and after stepping through all the locations, replace the incorrect instructions following the 2115, 2116 BBL or BBDL Replacement Procedure.

BASIC BINARY LOADER

MEMORY		INSTRUCTION	MEMORY ADDRESS		INSTRUCTION
0x7700	=	107700	0x7740	=	027700
0x7701	=	107700	0x7741	=	102055
0x7702	=	067771	0x7742	=	027700
0x7703	=	006006	0x7743	=	000000
0x7704	=	027710	0x7744	=	017752
0x7705	=	106700	0x7745	=	001727
0x7706	=	102077	0x7746	=	073775
0x7707	=	027700	0x7747	=	017752
0x7710	=	017752	0x7750	=	033775
0x7711	=	002003	0x7751	=	127743
0x7712	=	027703	0x7752	=	000000
0x7713	=	003004	0x7753	=	063771
0x7714	=	073772	0x7754	=	073776
0x7715	=	017752	0x7755	=	002400
0x7716	=	017743	0x7756	=	1027cc
0x7717	=	070001	0x7757	=	001300
0x7720	=	073773	0x7760	=	1031cc
0x7721	=	063773	0x7761	=	1023cc
0x7722	=	000040	0x7762	=	027761
0x7723	=	043774	0x7763	=	1024cc
0x7724	=	002040	0x7764	=	037776
0x7725	=	027741	0x7765	=	027757
0x7726	=	017743	0x7766	=	001222
0x7727	=	044000	0x7767	=	013777
0x7730	=	173773	0x7770	=	127752
0x7731	=	037773	0x7771	=	177765
0x7732	=	037772	0x7772	=	000000
0x7733	=	027721	0x7773	=	000000
0x7734	=	017743	0x7774	=	1n0100
0x7735	=	054000	0x7775	=	000000
0x7736	=	027702	0x7776	=	000000
0x7737	=	102011	0x7777	=	000377

x = 1 for 8K memory, 3(16K), 5(24K), 7(32K)

cc = punched tape reader or teleprinter address

n = 7 for 4K memory, 6(8K), 4(16K), 2(24K), 0(32K)

BASIC BINARY DISC LOADER

MEMORY ADDRESS		INSTRUCTION	MEMORY ADDRESS		INSTRUCTION		
0x7700	=	107700	0x7740	=	102055	x =	1 for 8K memory,
0x7701	=	002401	0x7741	=	027700		3(16K), 5(24K), 7(32K)
0x7702	=	063726	0x7743	=	000000		
0x7703	=	006700	0x7742	=	006600		
0x7704	=	017742	0x7744	=	1037cc	cc =	punched tape reader
0x7705	=	007306	0x7745	=	1023cc		or teleprinter address
0x7706	=	027713	0x7746	=	027745		
0x7707	=	002006	0x7747	=	1064cc		
0x7710	=	027703	0x7750	=	002041		
0x7711	=	102077	0x7751	=	127742		
0x7712	=	027700	0x7752	=	005767		
0x7713	=	077754	0x7753	=	027744		
0x7714	=	017742	0x7754	=	000000		
0x7715	=	017742	0x7755	=	1z0100	z =	7(8K) 4(16K), 2(24K), 0(32K)
0x7716	=	074000	0x7756	=	0200nn	nn =	first disc channel
0x7717	=	077757	0x7757	=	000000		
0x7720	=	067757	0x7760	=	107700		
0x7721	=	047755	0x7761	=	063756		
0x7722	=	002040	0x7762	=	102606		
0x7723	=	027740	0x7763	=	002700		
0x7724	=	017742	0x7764	=	1027qq	qq =	second disc channel
0x7725	=	040001	0x7765	=	001500		
0x7726	=	177757	0x7766	=	102602		
0x7727	=	037757	0x7767	=	063777		
0x7730	=	000040	0x7770	=	102702		
0x7731	=	037754	0x7771	=	102602		
0x7732	=	027720	0x7772	=	103706		
0x7733	=	017742	0x7773	=	1027nn		
0x7734	=	054000	0x7774	=	067776		
0x7735	=	027702	0x7775	=	074077		
0x7736	=	102011	0x7776	=	024077		
0x7737	=	027700	0x7777	=	177700		

HOW TO REPLACE BBL OR BBDL

If the BBL or BBDL has been partially or completely destroyed, use this prodedure:

1. Set the LOADER switch to the ENABLED position.
2. Set the SWITCH REGISTER to the correct memory address (location of the error in BBL or BBDL).
3. Press LOAD ADDRESS.
4. Press DISPLAY MEMORY to verify that the error exists (look at the MEMORY DATA REGISTER).
5. Press LOAD ADDRESS to return to the memory address still set.
6. Set the SWITCH REGISTER to the correct number that should be in that location.
7. Press LOAD MEMORY.
8. Repeat steps 1 through 8 for each correction to be made.
9. Set the LOADER switch to the PROTECTED position.

INPUT/OUTPUT CONFIGURATION

A peripheral device cannot operate without a utility program in core to activate and control that device. Such a program is called an input/output (I/O) driver and is loaded into core from paper tape.

Each device has an identifying octal number called a select code; its driver uses the select code in its instructions to reference the device. The driver is placed in core and when the instructions reference the select code, the computer produces a signal that activates the device.

The process of loading a device driver into core locations and assigning a device to the driver is called configuration.

SIO DRIVERS

SIO means software input/output.

SIO drivers are the minimum working environment for HP Assembler, HP FORTRAN, HP ALGOL, Punch-Verify, Symbolic Editor, Cross-Reference Symbol Table Generator, PTS, SIO System Dump, SDUMP, DSGEN and RTGEN.

These drivers are designed to make efficient use of core. They are not necessarily time-efficient.

There are three sizes of SIO drivers: 4K for use with 4K memory size, 8K for use with 8K memory size, and 16K for use with either 16K, 24K, or 32K memory size. (A 16K SIO environment offers complete flexibility within any environment $\geq$ 16K.)

Before using a computer system, make the device assignments for the SIO drivers. SIO drivers must be configured in the order listed below:

SIO Teleprinter driver
SIO Line Printer driver
SIO Tape Reader driver or SIO Card Reader driver
SIO Tape Punch driver
SIO Magnetic Tape driver or SIO Disc/Drum driver

Always configure the SIO Teleprinter driver first, regardless of other device type assignments.

SIO MODULES

An SIO module consists of one to five configured SIO drivers (always containing the SIO Teleprinter driver) on one roll of tape. Make all the SIO modules appropriate to the system using this procedure:

HOW TO CONFIGURE AN SIO MODULE

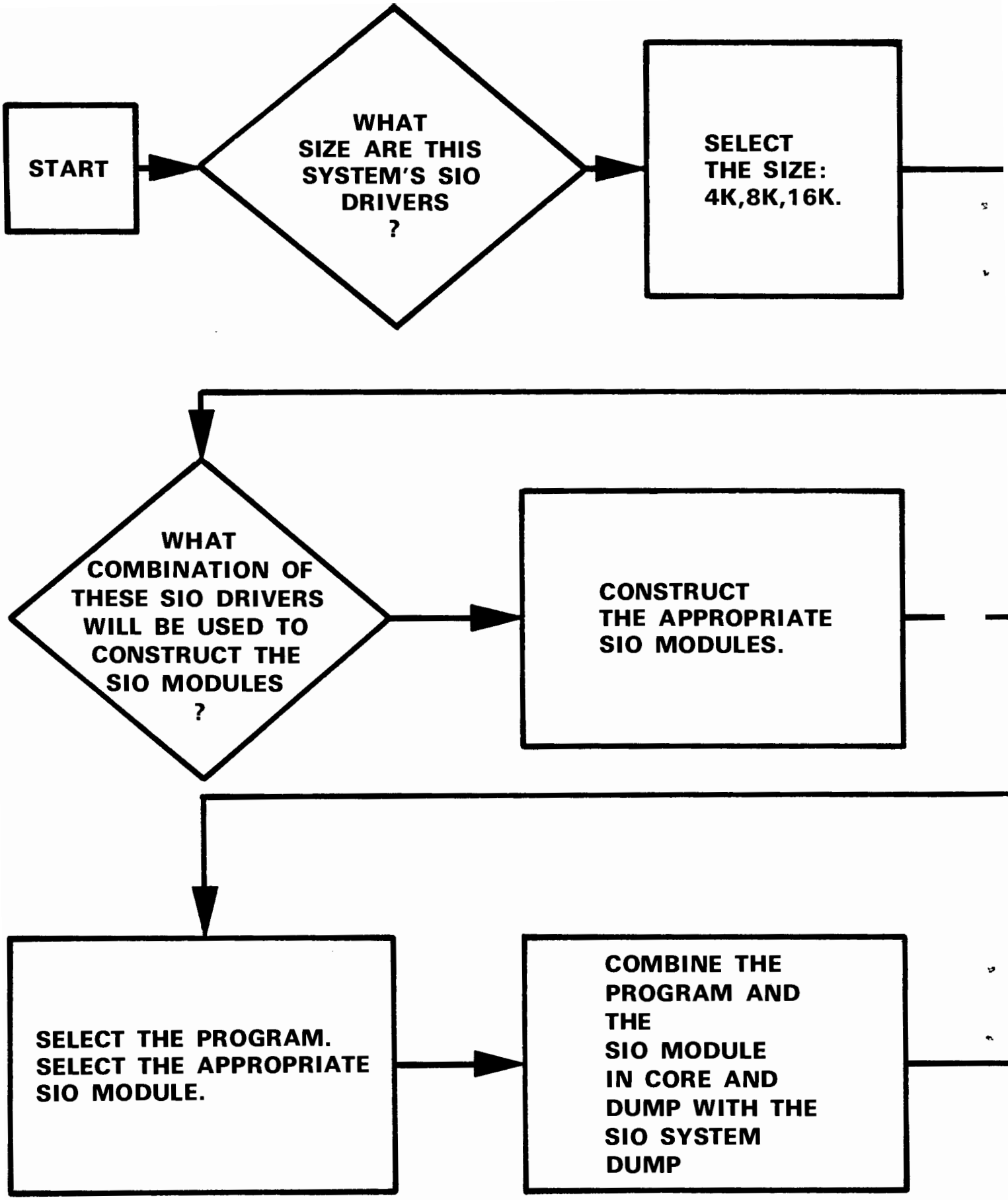
1. Use the BBL or BBDL to load the SIO driver.
2. Set the SWITCH REGISTER to the Starting Address of 2_8 (0/000/000/000/000).
3. Press LOAD ADDRESS.
4. Set the high priority I/O address (select code) of the device whose driver is being configured into switches 5 through Ø. Switches 15 through 6 are "OFF."

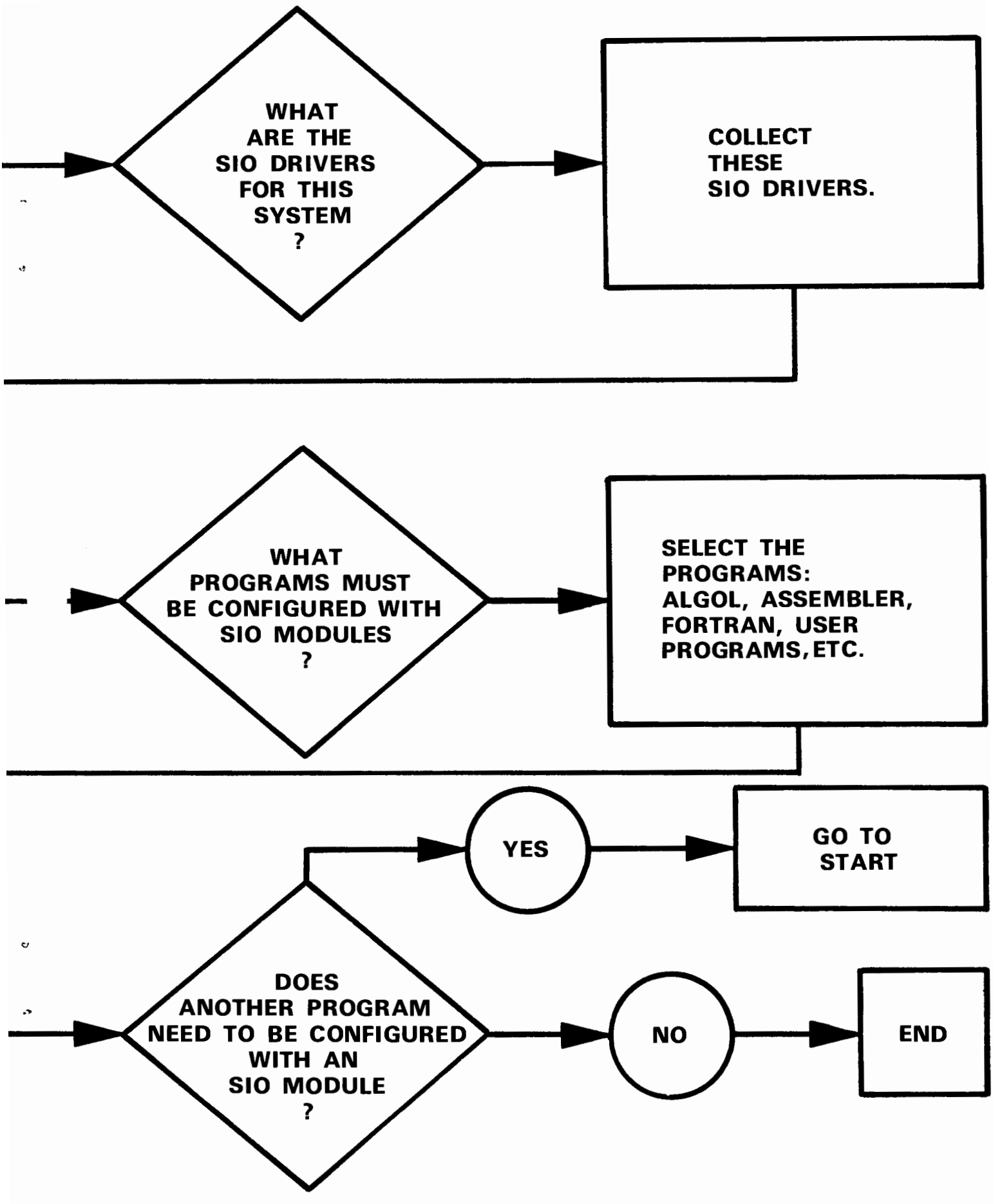
   NOTE: For the SIO Teleprinter driver, set switch 15 on if the teleprinter is a 2754B. Bits 14 through 6 of the SWITCH REGISTER are zero (off).

5. Press PRESET.
6. Press RUN.
7. Repeat steps 1 through 6 for each I/O device driver in this order:

   SIO Teleprinter driver

   Optional
   - SIO Line Printer driver (see Note)
   - SIO Card Reader driver or SIO Tape Reader driver
   - SIO High-Speed Tape Punch driver
   - SIO Magnetic Tape driver or SIO Disc/Drum driver (see Note).


START
WHAT SIZE ARE THIS SYSTEM'S SIO DRIVERS ?
SELECT THE SIZE: 4K,8K,16K.
WHAT COMBINATION OF THESE SIO DRIVERS WILL BE USED TO CONSTRUCT THE SIO MODULES ?
CONSTRUCT THE APPROPRIATE SIO MODULES.
SELECT THE PROGRAM. SELECT THE APPROPRIATE SIO MODULE.
COMBINE THE PROGRAM AND THE SIO MODULE IN CORE AND DUMP WITH THE SIO SYSTEM DUMP


WHAT ARE THE SIO DRIVERS FOR THIS SYSTEM ?
COLLECT THESE SIO DRIVERS.
WHAT PROGRAMS MUST BE CONFIGURED WITH SIO MODULES ?
SELECT THE PROGRAMS: ALGOL, ASSEMBLER, FORTRAN, USER PROGRAMS, ETC.
YES
GO TO START
DOES ANOTHER PROGRAM NEED TO BE CONFIGURED WITH AN SIO MODULE ?
NO
END

NOTE: If the SIO Line Printer driver is loaded, the High-Speed Tape Punch driver must also be loaded in order to punch paper tape output.

SIO Disc/Drum drivers require special device assignment procedures. Refer to "HOW TO ASSIGN AN SIO DISC/DRUM DRIVER" in this section.

8. Load the SIO System Dump with BBL or BBDL.
9. Set the SWITCH REGISTER to the Starting Address of 2_8.
10. Press LOAD ADDRESS.
11. Set all switches "OFF."
12. Turn on the tape punch.
13. Press PRESET.
14. Press RUN.
15. Additional copies of the SIO module can be obtained by pressing RUN.

NOTE: If the operator only wants to load and configure one or more SIO drivers without making a paper tape copy, eliminate steps 8 - 12.

RECOMMENDED SIO PROGRAM CONFIGURATION

After completing the necessary procedures to produce modules configured with one or more drivers, choose one of the programs listed below that are part of the computer system.

Assembler
Extended Assembler
HP FORTRAN
4K FORTRAN
ALGOL
Cross Reference Symbol Table Generator
Symbolic Editor
PTS
SDUMP
Any user program that has properly preset the first word of available memory (105_8)

When any one of these programs is used, it is easier to combine the SIO drivers and the program onto one tape for loading later.

1. Load the program tape with BBL or BBDL.
2. Choose one of the SIO module tapes containing the desired SIO drivers.
3. Load SIO module tape with BBL or BBDL.
4. Load SIO System Dump with BBL or BBDL.
5. Set the SWITCH REGISTER to the Starting Address of 2_8 (0/000/000/000/000/010).
6. Press LOAD ADDRESS.
7. Set all switches "OFF."

8. Set switch 15 "ON" for a tape containing both the program and the drivers.

9. Turn on the tape punch.

10. Press PRESET.

11. Press RUN.

12. Additional copies of the "configured" program can be obtained by pressing RUN.

This tape is a configured SIO program ready for use; i.e., a "configured" Assembler.

SIMULATION OF A MAGNETIC TAPE ENVIRONMENT BY AN SIO DISC/DRUM DRIVER

The SIO Disc/Drum driver simulates a magnetic tape on the disc or drum, enabling a disc to be used instead of a magnetic tape in a magnetic tape environment. This saves time in the generation of the Disc Operating and Real-Time Executive Systems (not the Moving-Head Disc Operating System).

The SIO Disc/Drum driver takes up the same locations in core as the SIO Magnetic Tape drivers; therefore, this driver cannot be used in a Magnetic Tape System.

The programmer supplies the necessary disc/drum information needed to assign the device.

HOW TO CONFIGURE AN SIO DISC/DRUM DRIVER

NOTE: The SIO Disc/Drum Driver must be the last SIO driver loaded with BBL or BBDL.

1. Load the SIO Disc/Drum driver with BBL or BBDL.
2. Set SWITCH REGISTER to 2_8.
3. Press LOAD ADDRESS.
4. Set the select code (high priority) number of the DATA channel into switches 4 through Ø.
5. Set switch 15 "OFF," if there are 9Ø sectors/programming track.
   Set switch 15 "ON," if there are 128 sectors/programming track.
6. Press PRESET.
7. Press RUN.
   The computer halts with $1Ø2ØØ1_8$ (●/000/0●0/000/000/00●) in the MEMORY DATA REGISTER.
8. Set the first octal track address to be made available to the driver into switches 7 through Ø.

9. Set switches 14 through 12 to the logical unit number of the disc.

10. Press RUN.
    The computer halts with 102002_8 (●/000/0●0/000/000/0●0) in the MEMORY DATA REGISTER.

11. Set the last octal track address to be made available to the driver into switches 7 through Ø.

12. Press RUN.

13. a. If the computer halts with 102000_8 (●/000/0●0/000/000/000) in the MEMORY DATA REGISTER, the last track for the current logical unit is less than that of the first track address given. Restart driver configuration with step 4.

    b. If switch 15 was set "ON" in step 8 or 11, the driver terminates configuration.

    NOTE: Configuration of the first logical unit sets the other seven logical units to the same configuration in case of premature termination.

    c. If switch 15 was set "OFF" in step 8 or 11, continue configuration with step 7.

    NOTE: A maximum of eight logical units may be defined.

14. When the computer halts with 102077_8 (●/000/0●0/000/●●●/●●●) in the MEMORY DATA REGISTER, configuration is complete.

    NOTE: The driver may be completely reconfigured again by starting at step 4.

PROGRAMMING LANGUAGES

This section explains how to operate programming languages.

These programming languages are:

- HP ALGOL
- HP Assembler
- HP FORTRAN

HP ALGOL and HP FORTRAN produce relocatable object programs that must be processed by BASIC CONTROL SYSTEM (BCS) for their operation. See Section V for BCS operating instructions.

HP Assembler produces relocatable or absolute object programs. Relocatable object programs must be processed by BASIC CONTROL SYSTEM (BCS) for their operation. See Section V for BCS operating instructions.

LANGUAGE: HP ALGOL

DEFINITION: A high level language used for scientific and computational work. HP ALGOL follows the convention rules defined by the ALGOL 60 Revised Report Communications of the ACM, January, 1963.

ASSOCIATED HARDWARE: 2114, 2115, or 2116 series computer with at least 8K memory; a 2752A or 2754B Teleprinter.

COMMENTS: HP ALGOL requires use of an HP ALGOL Compiler. A compiler is a program that takes each source statement and translates it into machine language. This process is called compilation.

The operation procedures for the HP ALGOL Compiler vary, depending on the system configuration.

With a teleprinter and tape punch only one pass is required; a listing and object binary tape are simultaneously produced.

With a teleprinter, two passes are required. One pass is used to generate the binary output tape, the other to produce the listing. This is most easily done using the "S" option.

NOTE: A pass is one reading of the source program by the Compiler
A three pass operation means that the source program is read by the Compiler three times.

Before beginning operation of the ALGOL Compiler, the operator should be aware of the control statements used by the programmer.

The control statement specifies the output to be produced. The control statement format is HPAL, followed by any or all of the following symbols 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
S: sense switch control

A program name in quotes may follow.

For example:

> The control statement HPAL, B, P, "INVERT" means that a procedure within the program INVERT will be compiled and an object tape will be produced.

If the character "S" is included in the control statement, the B, L, and A options are read by the compiler from the SWITCH REGISTER. Specifications of B, L, and A in the control statements are ignored.

The switches corresponding to the options are:

Switch Up	Control Statement Equivalent
15	B-produce object tape
14	L-produce source listing
13	A-produce object listing

The switches are read at the beginning of each line so that any option may be "turned off" partway through compilation. In general, they should be set at the beginning of compilation and unchanged until the end.

1. Turn the system teleprinter to LINE or ON/LINE.
2. Check that all equipment is operable.
3. a. If the operator does not have a configured ALGOL compiler, follow the procedures: HOW TO CONSTRUCT AN SIO MODULE then RECOMMENDED SIO SYSTEM SETUP PROCEDURE (Section III).

   Load the configured ALGOL tape with BBL or BBDL.

   b. If the operator already has a configured tape, load the configured ALGOL tape with BBL or BBDL.
4. Turn on the tape punch.
5. Turn on the list device.
6. Set the SWITCH REGISTER to the Starting Address of $10\emptyset_8$ (0/000/000/00●/000/000).
7. Press LOAD ADDRESS.
8. If switch options have been specified, set the appropriate switches. Do not turn off switches during operation. (See COMMENTS.)
9. Place the source tape in the input device.
10. Press RUN.

NOTE: If the teleprinter types "HPAL??" and the MEMORY DATA REGISTER contains $10\emptyset2\emptyset77_8$, the control statement is incorrect or has not been read. To restart compilation, place the original or corrected source tape in the input unit and press RUN.

11. If the "L" option is used or "S" option is used with switch 14 up, the source listing is printed on the list unit (includes list of errors).

    If the "L" and "S" options are not used, error messages are listed under the program line where they occur. Only those lines which contain errors are printed.

    If the "B" option is used or "S" option is used with switch 15 up, the relocatable binary tape is punched by the tape punch.

If "B" is used, HPAL is still typed plus:

PROGRAM = XXXXXX BASEPAGE = ... ERRORS = ØØØ

12. Tear off the tape; rewind and label.

13. Turn off the tape punch.

LANGUAGE: Assembler

DEFINITION: An Assembler is a language translation program which converts symbolic source language into numeric machine code.

ASSOCIATED HARDWARE: Assembler -- 2114, 2115, or 2116 series computer with at least 4K memory, 2752A or 2754B Teleprinter

Extended Assembler -- 2114, 2115, or 2116 series computer with at least 8K memory, 2752A or 2754B Teleprinter.

COMMENTS: Assembly language requires use of an Assembler to make the computer translate one assembly language instruction into one machine language instruction. This process of translation is called assembly.

Hewlett-Packard has two Assemblers: the Assembler and the Extended Assembler. The operating procedures for the Assembler and the Extended Assembler depend on the device configuration.

If a 2752A Teleprinter is used without another punch device and the B and L options are specified (see next page), the Assembler or Extended Assembler operates using three passes. Any other device configuration uses a two-pass assembly.

NOTE: A pass is one reading of the source program by the Assembler.
A three pass operation means that the source program is read by the Assembler three times.

Before beginning operation of the Assembler or Extended Assembler the operator should be aware of the purpose of the control statements used by the programmer.

The control statement specifies the output to be produced.

The control statement is composed of "ASMB" followed by one or more of the parameters listed below:

A Absolute output (loaded with BBL or BBDL).

R Relocatable output (loaded with BCS Relocating Loader).

B Binary output, punched according to the A or B parameters.

L List output: A listing is to be produced according to the source language program during pass 2 or pass 3 (if binary output selected) according to the A or R parameter.

T List the symbol table at the end of pass 1.

NOTE: N and Z are parameters which define information pertinent only to the programmer.

For Example:

The control statement ASMB,R,B,L,T means that a symbol table listing is produced at the end of pass 1, a relocatable object tape at the end of pass 2, and a program listing at the end of pass 3.

The control statement may be on the same tape as the source program, or on a separate tape; or it may be entered by the teleprinter keyboard.

ASSEMBLER OR EXTENDED ASSEMBLER OPERATING INSTRUCTIONS

1. Turn the system teleprinter to LINE or ON/LINE.
2. Check that all equipment is operable.
3. a. If the operator does not have a configured Assembler or Extended Assembler, follow the procedures: HOW TO CONFIGURE AN SIO MODULE then RECOMMENDED SIO PROGRAM CONFIGURATION (Section III).

   Load the configured Assembler or Extended Assembler with BBL or BBDL.

   b. For the operator who already has a configured Assembler or Extended Assembler tape, load the tape with BBL or BBDL.

4. If the Assembler control statement is not part of the source program, set the SWITCH REGISTER to the Starting Address of $12Ø_8$ (0/000/000/00●/0●0/000).

   If the control statement is part of the source program, set the SWITCH REGISTER to the Starting Address of $1ØØ_8$ (0/000/000/00●/000/000).

5. Press LOAD ADDRESS.
6. Place the source program in the input device.
7. Set all switches "OFF."
8. If an SIO Magnetic Tape driver is used, set switch 2 "ON" to read the source program from magnetic tape file 3.

   NOTE: Program must have been stored in file 3 by the Editor or a previous assembly.

9. If the line printer is the list device, set switch 3 "ON" to avoid truncating output to 72 characters.

10. Press PRESET.

11. Press RUN.

12. If the Starting Address of $12Ø_8$ was used in step 4, type the control statement on the teleprinter keyboard, following it with carriage return and linefeed.

    The teleprinter prints out a symbol table listing at the end of pass 1, if requested.

    The computer halts with $1Ø2Ø11_8$ (●/000/0●0/000/00●/00●) in the MEMORY DATA REGISTER to indicate pass 1 is completed.

13. To suppress the leader and trailer that the Assembler or Extended Assembler automatically provides, set switch Ø "ON."

14. Replace the source program in the input device.

15. Turn on the tape punch.

16. Press RUN.

    The teleprinter prints out a program listing if requested.
    The tape punch punches out a relocatable or absolute binary tape if requested.

17. Tear off the tape; rewind and label.

18. Turn off the tape punch.

THREE PASS ASSEMBLER OR EXTENDED ASSEMBLER OPERATING INSTRUCTIONS

1. Repeat steps 1 through 13 of the ASSEMBLER OR EXTENDED ASSEMBLER OPERATING INSTRUCTIONS.
2. Turn on the tape punch.
3. Replace the source program in the input device.
4. To prevent diagnostic messages from being punched on the tape, set switch 15 "ON."
5. Press RUN.

   A relocatable or absolute binary tape is punched. Do not remove this tape.
6. When the computer halts with $10\emptyset55_8$ (●/000/0●0/000/●0●/●0●) in the MEMORY DATA REGISTER:

   a. Turn the tape punch off.

   b. Press RUN.

   The diagnostic message or messages are listed.
7. When the computer halts with $10\emptyset55_8$ in the MEMORY DATA REGISTER:

   a. Turn the tape punch on.

   b. Press RUN.

   More binary output is punched.
8. Repeat steps 6 and 7 each time a diagnostic message is printed. Pass 2 is completed when the MEMORY DATA REGISTER contains $10\emptyset33_8$ (●/000/0●0/000/0●●/0●●).

   Tear off the tape; rewind and label.
9. Set switch 15 "OFF."
10. Place the source program in the tape reader.
11. Press RUN.

    The teleprinter prints out a program listing.

LANGUAGE: HP FORTRAN

DEFINITION: A high-level language following the American Standard Basic FORTRAN specifications, with additions.

ASSOCIATED HARDWARE: 2114, 2115, or 2116 series computer with at least 4K memory size, a 2752A or 2754B Teleprinter.

COMMENTS: HP FORTRAN requires use of a FORTRAN Compiler. A compiler is a program that takes a source program and translates it into machine language. This process is called compilation. The operating instructions for HP FORTRAN depend on the compiler used.

A 4K computer must use the 4K FORTRAN Compiler.

The 4K FORTRAN Compiler is composed of four tapes labeled 4K FORTRAN pass 1, 4K FORTRAN pass 2, 4K FORTRAN pass 3, and 4K FORTRAN pass 4.

The FORTRAN Compiler is used with a minimum of 8K core memory and is composed of two tapes labeled FORTRAN pass1, and FORTRAN pass 2.

Before beginning operation of the 4K FORTRAN Compiler or the FORTRAN Compiler, the operator should be aware of the purpose of the control statement used by the programmer in the source program.

The control statement specifies the output to be produced and is composed of "FTN", followed by one or more of the parameters listed below:

B Binary output; a program is to be punched in relocatable format suitable for loading by the Basic Control System Loader.

L List output: A listing of the source program is to be produced during pass 1.

A Assembly listing: A listing of the object program in assembly level language is to be produced in the last pass.

T Symbol Table only: A listing of the symbol table only is produced. If both T and A are specified, only the last used will be decisive.

NOTE: When using the 4K FORTRAN Compiler, a control statement may be on the same tape as the source program or on a separate tape.

When using the FORTRAN Compiler, the control statement may be on the same tape as the source program, on a separate tape, or it may be entered by the teleprinter keyboard.

1. Turn the system teleprinter to LINE or ON/LINE.
2. Check that all equipment is operable.
3. a. If the operator does not have a configured 4K FORTRAN pass 1, follow the procedures: HOW TO CONFIGURE AN SIO MODULE then RECOMMENDED SIO PROGRAM CONFIGURATION (Section III).

   Load the configured 4K FORTRAN pass 1 with BBL or BBDL.

   b. If the operator already has a configured 4K FORTRAN pass 1, load this tape with BBL or BBDL.

   NOTE: Only 4K FORTRAN pass 1 is configured.

4. Set the SWITCH REGISTER to the Starting Address of $10\emptyset_8$ (0/000/000/00●/000/000).
5. Press LOAD ADDRESS.
6. Place the source tape in the input device.
7. Turn on the tape punch.
8. Press PRESET.
9. Press RUN.
   The first intermediate binary tape is punched.
   The computer halts with $102\emptyset77_8$ (●/000/0●0/000/●●●/●●●) in the MEMORY DATA REGISTER.

   NOTE: If the computer halts with $10\emptyset2\emptyset2_8$ (●/000/0●0/000/000/0●0) in the MEMORY DATA REGISTER, more source input is required.

10. Tear off the first intermediate binary tape; rewind and label.
11. Load the 4K FORTRAN pass 2 tape with BBL or BBDL.
12. Place the first intermediate binary tape in the input device.

13. Set the SWITCH REGISTER to the Starting Address of 100_8.

14. Press LOAD ADDRESS.

15. Press RUN.
    A second intermediate binary tape is punched.

16. Tear off the second intermediate binary tape; rewind and label.

17. Load the 4K FORTRAN pass 3 tape with BBL or BBDL.

18. Place the second intermediate binary tape in the input device.

19. Set the SWITCH REGISTER to 100_8.

20. Press LOAD ADDRESS.

21. Press RUN.

22. A third intermediate binary tape is punched.

23. Tear off the third intermediate binary tape; rewind and label.

24. Load the 4K FORTRAN pass 4 with BBL or BBDL.

25. Place the third intermediate binary tape in the input device.

26. Set the SWITCH REGISTER to the Starting Address of 100_8.

27. Press LOAD ADDRESS.

28. Press RUN.
    A binary tape is punched, if it was requested in the control statement.
    Tear off the tape; rewind and label.

    a. If the MEMORY DATA REGISTER contains 102077_8, the compilation is complete. If a listing was requested, it is on the list output device.

    b. If the MEMORY DATA REGISTER contains 102001_8 (●/000/0●0/000/000/00●), an assembly listing or symbol table listing must be produced by placing the third intermediate binary tape in the input device, and pressing RUN. The list output device produces an assembly or symbol table listing.

1. Turn the system teleprinter to LINE or ON/LINE.
2. Check that all equipment is operable.
3. a. If the operator does not have a configured FORTRAN pass 1, follow the procedures: HOW TO CONFIGURE AN SIO MODULE then RECOMMENDED SIO PROGRAM CONFIGURATION (Section III).

   Load the configured FORTRAN Compiler with BBL or BBDL.

   b. If the operator already has configured FORTRAN pass 1, load this tape with BBL or BBDL.

   NOTE: Only FORTRAN pass 1 is configured.

4. a. If the control statement is on the source program, set the SWITCH REGISTER to the Starting Address of $10\emptyset_8$ (0/000/000/00●/000/000).

   b. If the control statement is not on the source program, set the SWITCH REGISTER to the Starting Address of $5\emptyset_8$ (0/000/000/000/●0●/000).
5. Press LOAD ADDRESS.
6. Place the source program in the input device.
7. Turn on the tape punch.
8. Press PRESET.
9. Press RUN.

   The computer waits for the control statement to be typed in from the teleprinter if the Starting Address was at $5\emptyset_8$.
10. Type the control statement specified by the programmer.
11. The first intermediate binary tape is punched. The computer halts with $102\emptyset77_8$ (●/000/0●0/000/●●●/●●●) in the MEMORY DATA REGISTER.

    NOTE: If the computer halts with $102\emptyset57_8$ (●/000/0●0/000/●0●/●●●) in the MEMORY DATA REGISTER, more source input is required.

12. Tear off the first intermediate binary tape; rewind and label.

13. Load the FORTRAN pass 2 tape with BBL or BBDL.

14. Place the first intermediate binary tape in the input device.

15. Set the SWITCH REGISTER to the Starting Address of 100_8.

16. Press LOAD ADDRESS.

17. Press RUN.
    A binary tape is punched, if it was requested in the control statement.

18. Tear off the tape; rewind and label.

    a. If the MEMORY DATA REGISTER contains 102077_8, the compilation is complete. If a listing was requested, it is on the list device.

    b. If the MEMORY DATA REGISTER contains 102001_8, an assembly listing or symbol table listing must be produced by placing the first intermediate binary tape in the input device and pressing RUN. The list output device produces an assembly or symbol table listing.

ASSEMBLER / FORTRAN MESSAGE TABLE

During the operation of HP ALGOL, HP Assembler and HP FORTRAN, certain error reports or system messages are typed by the system teleprinter or indicated by the contents of the MEMORY DATA REGISTER. These messages are listed alphabetically, then by number, including where they originated, what they mean, and what action the operator should take. If the corrective action is beyond the responsibility of the particular operator, refer to the programmer.

Message	Source	Memory Data Register	Meaning	Action
CS	Assembler		Control statement error: illegal parameter in control statement.	Return program to programmer.
DD	Assembler		Doubly defined symbol name defined in the symbol table appears more than once.	Return program to programmer.
EN	Assembler		Program error.	
EN 0000 <symbol>	Assembler		Program error.	Place next tape in input device. Press RUN.
*EQR	FORTRAN	Unit Number	End of input tape on the teleprinter or; tape supply is low.	Place next tape in input device or: replace tape supply.
*FMT	FORTRAN	ØØØØØ1	FORMAT error.	Irrecoverable error. Return to programmer.

Message	Source	Memory Data Register	Meaning	Action
*FMT	FORTRAN	ØØØØØ2	FORMAT error.	Irrecoverable error. Return to programmer.
*FMT	FORTRAN	ØØØØØ3	FORMAT error.	Irrecoverable error. Return to programmer.
*FMT	FORTRAN	ØØØØØ4	Illegal character on number in program.	Verify data.
*FMT	FORTRAN	ØØØØØ5	A number is in illegal form in program.	Verify data.
IF	Assembler		Illegal instruction in program.	Return program to programmer.
IL	Assembler		Illegal instruction in program.	Return program to programmer.
M	Assembler		Illegal operand.	Return program to programmer.
NO	Assembler		No origin definition.	Return program to programmer.
OP	Assembler		Illegal op code.	Return program to programmer.
OV	Assembler		Numeric operand overflow.	Return program to programmer.
R?	Assembler		Attempt being made to assemble a relocatable program following the assembly of an absolute program.	Reload the Assembler.

Message	Source	Memory Data Register	Meaning	Action
SO	Assembler		There are more symbols defined in the program than the symbol table can handle.	Return program to programmer.
SY	Assembler		Illegal symbol or too many control statements.	Return program to programmer.
UN	Assembler		Undefined symbol	Return to programmer
	FORTRAN	102000	Memory overflow: the program is too large.	Irrecoverable error; program must be revised.
	Assembler, FORTRAN	102001	End of binary object tape output, start of assembly listing.	If only one output device, place intermediate binary output from previous pass in Standard Input unit and press RUN.
	Assembler, FORTRAN	102002	End of source tape. (4K compiler)	Place next input tape in reader.

Message	Source	Memory Data Register	Meaning	Action
	FORTRAN	102007	For all passes except first, unrecognizable record on intermediate binary tape: 1. Punch error on previous pass. 2. Wrong tape supplied as input for pass.	If punch error, restart with Pass 1. If wrong tape, restart current pass: 1. Load FORTRAN pass. 2. Set the SWITCH REGISTER to the Starting Address of 100_8 (0/000/000/000/000/000). 3. Press LOAD ADDRESS. 4. Place previous intermediate binary tape in input device. 5. Press RUN.
	FORTRAN	102010	External symbol table overflow: the number of symbols exceeds 255.	Irrecoverable error; program must be revised.
	ALGOL, Assembler, FORTRAN	102011	Checksum error on intermediate tape, indicates probable punch error.	Attempt to reread record (binary records are seperated by 4 feed frames). Otherwise, restart with pass 1.
			If a magnetic tape is used for intermediate, indicates a magnetic tape parity error or write not enabled.	(irrecoverable)

Message	Source	Memory Data Register	Meaning	Action
	FORTRAN	1Ø2Ø27	A magnetic tape read error has occurred during pass 2.	Restart pass 2.
	ALGOL, Assembler, FORTRAN	1Ø2Ø57	End of source tape.	Place next input tape in reader.
	ALGOL Assembler, FORTRAN	1Ø2Ø66	Tape supply low on 2753A Tape Punch.	Load new tape and press RUN.
	ALGOL, Assembler, FORTRAN	1Ø2Ø77	Normal end of pass or compilation.	Proceed as indicated in the particular operating procedure

FORTRAN MESSAGE TABLE

Errors detected in the FORTRAN source program are indicated by a numeric code inserted before or after the statement in the list output.

The format is as follows:

E-eeee: ssss + nnnn

where eeeee is the error code diagnostic code shown below.

ssss is the statement label of the statement in which the error was detected. If unlabelled, ØØØØ is typed.

nnnn is the ordinal number of the erroneous statement following the last labelled statement.

Source	Code	Meaning
FORTRAN	ØØØ1	Statement label error.
FORTRAN	ØØØ2	Unrecognized statement.
FORTRAN	ØØØ3	There is an unequal number of left and right parenthesis in a statement.
FORTRAN	ØØØ4	Illegal character or format.
FORTRAN	ØØØ5	An arithmetic expression contains adjacent arithmetic operators.

Source	Code	Meaning
FORTRAN	ØØØ6	A variable name is used both as a simple variable and subscripted variable.
FORTRAN	ØØØ7	Doubly defined variable.
FORTRAN	ØØØ8	Invalid parameter list
FORTRAN	ØØØ9	Invalid arithmetic expression.
FORTRAN	ØØ1Ø	Mixed mode expression: integer constants or variables appear in an arithmetic expression with real constants or variables.
FORTRAN	ØØ11	Invalid subscript.
FORTRAN	ØØ12	Invalid constant.
FORTRAN	ØØ13	Invalid EQUIVALENCE statement.
FORTRAN	ØØ14	Table overflow: too many variables and statement labels appear in the program.
FORTRAN	ØØ15	Invalid DO loop.
FORTRAN	ØØ16	Statement function name is doubly defined.

ALGOL MESSAGE TABLE

Errors detected in the source program are indicated by a code number and an (↑) below the symbol which caused the error. There is no operator action to be taken with ALGOL messages unless the operator is a programmer.

Error Code	Meaning
1	More than two characters used in an ASCII constant
2	@ not followed by an octal digit
3	Octal constant greater than 177777
4	Two decimal points in one number
5	Non-integer following apostrophe
6	Label declared but not defined in program
7	Number required but not present
8	Missing END
1Ø	Undefined identifier
11	Illegal symbol
12	Procedure designator must be followed by left parenthesis
13	Parameter types disagree
14	Name parameter may not be an expression
15	Parameter must be followed by a comma or right parenthesis
16	Too many parameters
17	Too few parameters
18	Array variable not followed by a left bracket
19	Subscript must be followed by a comma or right bracket
2Ø	Missing THEN
21	Missing ELSE
22	Illegal Assignment
23	Missing Right Parenthesis
24	Proper procedure not legal in arithmetic expression
25	Primary may not begin with this type quantity
26	Too many subscripts

Error Code	Meaning
27	Too few subscripts
28	Variable required
4Ø	Too many external symbols
41	Declarative following statement
42	No parameters declared after left parenthesis
43	REAL, INTEGER, or BOOLEAN illegal with this declaration
44	Doubly defined identifier or reserved word found
45	Illegal symbol in declaration
46	Statement started with illegal symbol
47	Label not followed by colon
48	Label is previously defined
49	Semicolon expected as terminator
5Ø	Left arrow or := expected in SWITCH declaration
51	Label entry expected in SWITCH declaration
52	Real number assigned to integer
53	Constant expected following left arrow or :=
54	Left arrow or := expected in EQUATE declaration
55	Left bracket expected in array declaration
56	Integer expected in array dimension
57	Colon expected in array dimension
58	Upper bound less than lower bound in array
59	Right bracket expected at end of array dimensions
6Ø	Too many values for array initialization
61	Array size excessive (set to 2Ø47)
62	Constant expected in array initialization
63	Too many parameters for procedure
64	Right parenthesis expected at end of procedure parameter list
65	Procedure parameter descriptor missing
66	VALUE parameter for procedure not in list
67	Illegal TYPE found in procedure declaration

ALGOL MESSAGE TABLE

Error Code	Meaning
68	Illegal description in procedure declaratives
69	Identifier not listed as procedure parameter
7Ø	No type FOR variable in procedure parameter list
71	Semicolon found in a format declaration
72	Left parenthesis expected after I/O declaration name
73	Right parenthesis expected after I/O name parameters
74	Undefined label reference
75	Switch identifier not followed by a left bracket
76	Missing right bracket in switch designator
77	THEN missing in IF statement
78	DO missing in WHILE statement
79	FOR variable must be of type INTEGER
8Ø	FOR variable must be followed by an assign symbol
81	STEP symbol missing in FOR clause
82	UNTIL symbol missing in FOR clause or DO statement
83	DO symbol missing in FOR clause
84	Parenthesis expected in READ/WRITE statement
85	Comma expected in READ/WRITE statement
86	Free field format (*) illegal with WRITE
87	Unmatched [in I/O statement list
88	Missing BEGIN in case statement
89	Missing END in case statement
1ØØ	Program must start with BEGIN, REAL, INTEGER, or PROCEDURE. Computer halts with $1Ø2Ø77_8$ in the MEMORY DATA REGISTER.
999	Table areas have overflowed, program halts with $1Ø2Ø77_8$ in the MEMORY DATA REGISTER.

BASIC CONTROL SYSTEM

This section explains how to create and operate the Basic Control System.

PURPOSE: To provide efficient loading and input/output control capability for relocatable object programs produced by the HP Assembler, HP FORTRAN, and HP ALGOL.

NOTE: ALGOL programs and the Program Library stored on magnetic tape require the BCS Relocating Loader.

ASSOCIATED HARDWARE: 2114 series computer with 4K memory (4K Relocating Loader) or 2114, 2115, and 2116 series computer with at least 8K memory (BCS Relocating Loader), 2752A or 2754B Teleprinter.

HOW TO CREATE BCS:

1. Collect these tapes:

   Prepare Control System (PCS)
   BCS Relocating Loader
   Input Output Control (IOC)
   BCS Drivers

2. Complete the PCS CONFIGURATION DIAGRAM.
3. Complete the PCS CONFIGURATION WORKSHEET.
4. Use PCS to create a configured BCS tape.

The PCS CONFIGURATION DIAGRAM is helpful in planning input/output configuration and ensuring correct entry of input/output information during system configuration time.

HOW TO FILL OUT A PCS CONFIGURATION DIAGRAM

Figure 5-1 is a blank PCS CONFIGURATION DIAGRAM. Each item is explained below, then Figure 5-2 illustrates a completed worksheet.

FIRST WORD OF AVAILABLE MEMORY (FWAM)

The next number after the highest numbered linkage location used ($11\emptyset_8$ for MTS). Enter this number after "FWAM_____".

LAST WORD OF AVAILABLE MEMORY (LWAM)

Determined by the core size as follows:

Memory Size	LWAM
4K	7677
8K	17677
16K	37677
24K	57677
32K	77677

Enter this number after "LWAM_____".

DRIVER IDENTIFICATION

Each driver has an identifying number which specifies the type device it runs. For instance, the BCS Teleprinter Driver is named "D.ØØ."

ØØ to Ø7 Paper Tape Devices
- ØØ Teleprinter
- Ø1 Tape Reader
- Ø2 Tape Punch

1Ø to 17 Unit Record Devices
- 1Ø Calcomp Plotter
- 12 Line Printer
- 15 Mark Sense Card Reader (uses DMA)

2Ø to 37 Magnetic Tape/Mass Storage Devices
- 22 3Ø3Ø Magnetic Tape (uses two channel DMA)
- 23 797Ø Magnetic Tape
- 3Ø Disc or Drum

4Ø to 77 Instruments

NOTE: Mass storage devices require two entries of the Driver Identification number. (See SAMPLE PCS CONFIGURATION DIAGRAM.)

In the spaces marked I/O INTERFACE CARD, write the name of the device in the appropriate slot. If the Teleprinter Interface Board is plugged into Interrupt Location 1Ø, for example, Driver Identification Number ØØ is written in the box above Interrupt Location Number 1Ø.

INTERRUPT LOCATION

The select code of the device specified by the user during the time that I/O device cards are plugged into the computer.

PCS CONFIGURATION WORKSHEET

This worksheet contains the information that appears on the system teleprinter during PCS configuration and instructions to complete this worksheet. Use the PCS CONFIGURATION DIAGRAM when following the instructions.

HS INP? ____ Write the select code number of the input device.
HS PUN? ____ Write the select code number of the punch device.
FWA MEM? ___ Write the octal number of the first word of available memory.
LWA MEM? ___ Write the octal number of the last word of available memory.
EQT? _____
_____
_____
_____
_____
_____
_____
_____
_____ To construct the Equipment Table entries:

1. Find the first device entry for the Equipment Table and write the high priority Interrupt Location (select code) for that device followed by a comma, the letter "D", and a period.

NOTE: For mass storage devices enter the higher priority (lower number) Interrupt Location (select code).

If the user's computer system includes a magnetic tape unit, the operator must specify if the file protect mode or file unprotected mode is to be used.

2. Find the Driver Identification Number above the Interrupt Location entry in the PCS diagram. Write the number after "D."

NOTE: To specify the file protect mode for a mass storage device, enter D,U1 after completing step 2.

To specify the file unprotected mode, enter D, after completing step 2.

EXAMPLE:

11,D.ØØ
13,D.Ø1
21,D.22,D,U1
21,D.22,D
24,D.Ø2

SQT?

To construct the entries for the Standard Equipment Table for each function listed below:

1. Find the device that performs the function listed under Standard Unit Table.
2. Write the Equipment Table number of the device used to perform the function, in the same column as it is listed.

-KYBD?_____
-TTY?_____
-LIB?_____
-PUNCH?_____
-INPUT?_____
-LIST?_____

DMA?_____If one DMA channel is to be used, write 6.
If two DMA channels are to be used, write 6,7.
If no DMA channels are to be used, write Ø.

INTERRUPT LINKAGE?_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

To construct the Interrupt Linkage Table entries:

1. Find the first device listed in the Equipment Table and write its high priority interrupt location (select code), then write a comma.

2. Following the comma, write the linkage location for the device followed by a comma and the letter "I" and a period.

   NOTE: For mass storage devices:

   Make another entry using the low priority interrupt location (select code) followed by a comma. Then enter the linkage location number located under the select code (in the PCS Configuration Diagram). Write a comma, then "C", followed by a period and the device identification number.

3. Following "I" period write the Driver Identification number.

4. Repeat steps 1 through 3 for each device in the computer system.

EXAMPLE:

11,25,I.ØØ
13,26,I.Ø1
21,27,I.22
22,36,C.22
24,31,I.Ø2

HOW TO PREPARE BCS

1. Complete PCS Worksheet.
2. Set the teleprinter to LINE or ON/LINE.
3. Check that all equipment is operable.
4. Load the PCS tape with BBL or BBDL.
5. Set the SWITCH REGISTER to the Starting Address of 2000_8 (0/000/000/000/000/000).
6. Press LOAD ADDRESS.
7. Set all switches "OFF."
8. Set switches 5 through Ø to the select code for the teleprinter.
9. Press PRESET.
10. Press RUN. (PCS immediately types first message.)
11. Set all switches "OFF."

    NOTE: Remember to push the return and linefeed keys after each reply.

12. HS INPT?
    Type the select code of the high-speed input unit. (Type Ø if TTY is used.)
13. HS PUN?
    Type the select code of the high-speed punch. (Type Ø if TTY is used.)
14. FWA MEM?
    Type the octal address of the first word of available memory.
15. LWA MEM?
    Type the octal address of the last word of available memory.
    (Do not prefix this address with zeros or an error results.)
16. *LOAD
    The computer halts.
    Load each BCS driver by placing the tape in the reader and pressing RUN.

    NOTE: Load the BCS Magnetic Tape driver first, if appropriate.

The computer halts after loading each driver.
PCS types the driver name as it loads each driver tape.

17. After all BCS drivers have been loaded, load the Input/Output Control (IOC) tape by placing it in the reader and pressing RUN.
IOC

xxxx yyyy

NOTE: Where xxxx yyyy is the memory bounds printed by PCS.

After IOC is loaded, the computer types:
*TABLE ENTRY
EQT? The computer halts.

18. Press RUN.

19. Type the Equipment Table entries as entered in the PCS CONFIGURATION WORKSHEET. (Do not forget to type *return linefeed* after each line.) Terminate these entries by typing /E *return linefeed*.
After /E *return linefeed*, the computer immediately types:

20. SQT?
-KYBD?
Type the Equipment Table entry for keyboard input.

21. -TTY?
Type the Equipment Table entry for the teleprinter.

22. -LIB?
Type the Equipment Table entry for the library input unit.

23. -PUNCH?
Type the Equipment Table entry for the punch unit.

24. -INPUT?
Type the Equipment Table entry for the input unit.

25. -LIST?
Type the Equipment Table entry for the list unit.

26. DMA?
Type the DMA entry.
The computer halts after typing *LOAD.

27. Load the Relocating Loader tape by putting it in the reader and pressing RUN. PCS loads the tape and responds with the memory boundaries of the Loader:

    LOADR

    xxxxx yyyyy

    PCS then types:
    INTERRUPT LINKAGE? and halts.

28. Press RUN.

29. Type the Interrupt Table entries from the PCS CONFIGURATION WORKSHEET. Terminate the table by typing /E *return linefeed*.

30. At this point, PCS either types out:
    NO UNDEFINED SYMBOLS
    or the message UNDEFINED SYMBOLS followed by a list of entry points of system subroutines which have been referenced but not loaded. User may restart PCS at the beginning and load the missing subroutines or he may press RUN and continue the current configuration procedure.

31. BCS entry points loaded thus far are typed out on the teleprinter, ending with the system linkage area boundaries:
    *SYSTEM LINK
    xxxxx yyyyy

32. The computer halts.

33. Turn on the tape punch.

34. Press RUN.

35. A configured BCS tape is punched and when it is finished, the message: *BCS ABSOLUTE OUTPUT is typed.

36. The computer halts.

37. For additional copies of the configured BCS tape, set switch 15 ON and press RUN.

38. To terminate the PCS program, set all switches OFF and press RUN. Computer halts after typing *END.

1. Collect these tapes:

   Configured BCS
   User's relocatable object tape(s)
   BCS Relocatable Library (EAU) or BCS Relocatable Library (non-EAU)
   BCS FORTRAN IV Library (if desired)

   NOTE: Other libraries may be used in place of the BCS Relocatable Library. These tapes would be supplied by the programmer.

2. Load the configured BCS tape with BBL or BBDL.

3. Set the SWITCH REGISTER to the Starting Address of 2_8 (0/000/000/000/000/020).

4. Press LOAD ADDRESS.

5. Set switch 1 "OFF."

6. There are several options:

   a. To bypass the memory allocation listing during the first load operation, set switch 15 "ON," otherwise it will be listed.

   b. To punch an absolute binary tape of the programs, set switch 14 "ON" for the entire procedure; turn on the tape punch.

   c. To perform listing and punching operations with a 2754B Teleprinter operating through 12531B (parallel transfer) interface kit, set switch 13 "ON" to eliminate halts before and after each line to be printed. Set the teleprinter selector switch to "KT." Switch 14 must be set "ON."

   NOTE: With the exception of step "c", when the absolute binary output option is selected and the teleprinter is used both as list and punch device, the Loader halts before and after each line is printed to avoid punching the line and altering the binary output (see PCS/BCS MESSAGES).

7. Place the user relocatable object tape in the tape reader.

8. Press PRESET.

9. Press RUN.
   If the absolute option was specified, a tape is simultaneously punched.

10. *LOAD
    There are several options:

    a. To load the next user relocatable object tape, go to step 11.

    b. If all programs have been loaded, go to step 12.

    c. To terminate loading operation, go to step 13.

    d. If all user relocatable object tapes have been loaded, go to step 14.

11. a. Set switches 2-Ø "OFF."

    b. Place the user relocatable object tape in the tape reader.

    c. To bypass the memory allocation listing, set switch 15 "ON." otherwise it will be listed.

    d. Press RUN.

    e. Repeat step 11 until all desired user relocatable object tapes have been loaded. Then proceed to step 15.

    NOTE: All of the user's relocatable object tapes must be loaded before any library can be loaded.

12. a. Set switch Ø "ON."

    b. Press RUN.

    c. If there are no undefined external symbols, this message is printed:
    *LST
    Go to step 15.

d. If there are undefined external symbols, this message is printed:
*UNDEFINED SYMBOLS <symbols>
*LOAD
More programs must be loaded containing matching entry points; i.e., another program library tape.

e. Place the program library tape in the tape reader. (The FORTRAN IV Library tape must be loaded before the standard library.)

f. Set switch 2 "ON."

g. Press RUN.

h. Repeat step 12.

13. a. Set switch 1 "ON."

b. Press RUN.
This forces execution even though undefined external symbols have not been matched. Now go to step 15.

14. a. Set switch 2 "ON."

b. To bypass the memory allocation listing of the library routine, set switch 15 "ON," otherwise it will be listed.

c. Place the library tape in the tape reader.

d. Press RUN.
If the absolute option was specified, the tape is simultaneously punched.
If there are no undefined external symbols this message is printed:
*LST
The computer halts.

e. Set switch 2 "OFF."

f. Go to step 15.

g. If there are undefined external symbols, this message is printed:
*UNDEFINED EXTERNAL <symbol>
*LOAD
The computer halts.

h. More programs must be loaded containing matching entry points; i.e., another program library.

i. Repeat step 14.

15. The BCS Relocating Loader is ready to print the Loader Symbol Table (LST), common bounds, and linkage area bounds.
There are several options:

a. To bypass a listing of these items, set switch 15 "ON," otherwise they will be listed.
Press RUN.

b. If the 2754B Teleprinter is used to list and punch the absolute tape, set the selector switch to "T" (this enables the tape punch unit).
Press RUN.

16. *RUN

The computer halts.

a. If absolute binary output has not been selected, the program goes into execution.

b. If absolute binary output has been selected; this message is printed:
*END
The computer halts.
Go to step 17.

17. a. Turn off the tape punch.

b. Tear off the tape; rewind and label.

c. Load the absolute binary tape with BBL or BBDL.

d. Set the SWITCH REGISTER to the Starting Address of 2_8 (0/000/000/000/000/010).

e. Press LOAD ADDRESS.

f. Press RUN.
The program executes.

PCS/BCS MESSAGE TABLE

During the operation of PCS and BCS, certain error reports or system messages are typed by the system teleprinter or indicated by the contents of the MEMORY DATA REGISTER. These messages are listed alphabetically, then by number, including where they originated, what they mean, and what action the operator should take. If the corrective action is beyond the responsibility of the particular operator, refer to the programmer.

Message	Source	Memory Data Register	Meaning	Action
*BCS ABSOLUTE	PCS		PCS is ready to punch absolute output tape.	Turn on the tape punch. Press RUN. *NOTE: If the system teleprinter is a 2752A, set the selector switch to "T" before pressing RUN. This allows both printing and punching.*
DMA?	PCS		Request for DMA channel numbers.	If no DMA channels, type Ø. If one DMA channel, type 6. If two DMA channels, type 6,7.

Message	Source	Memory Data Register	Meaning	Action
*END	BCS		The absolute binary output has been selected and the punched tape is complete.	To execute the program: 1. Load binary tape using BBL or BBDL. 2. Set the SWITCH REGISTER to the Starting Address 2_8(0/000/000/000/000/000). 3. Press LOAD ADDRESS. 4. Press RUN.
*EOT	PCS		End-of-Tape	Place next tape in tape reader and press RUN to continue loading.
*ERROR	PCS		A non-numeric parameter or illegal numeric parameter has been entered as a reply.	Retype the entire entry correctly.
FWA MEM?	PCS		Request for first word of available memory.	Type the address of the first word of available memory.

Message	Source	Memory Data Register	Meaning	Action
HS INP?	PCS		Request for the tape reader select code.	Type the tape reader select code. If the tape reader is not available, type Ø.
HS PUN?	PCS		Request for the tape punch select code	Type the tape punch select code. If the tape punch is not available, type Ø.
-INPUT?	PCS		Request for EQT unit-reference number of device serving as the input device	Type the number.
INTERRUPT LINKAGE?	PCS		Request for interrupt information	Press RUN. For each I/O device, type: a_1,a_2,I.ee a_1-interrupt location address a_2-location containing absolute address of Interrupt Processor entry point I.ee entry point name: ee = ØØ Teleprinter = Ø1 Tape Reader = Ø2 Tape Punch = 1Ø Calcomp Plotter

Message	Source	Memory Data Register	Meaning	Action
				ee = 12 Line Printer = 15 Mark Sense Card Reader = 21 HP 2020, then type C.21 = 22 HP 3030, then type C.22 = 23 HP 7970 MT Unit To terminate linkage input type /E.
I/O DRIVER? D.ee	PCS		A driver has been named in the EQT parameter entry but has not been loaded.	1. If the driver is to be loaded with user's program load time, type an explanation mark (!). The name is added to the loader's LST. 2. If the driver should have been loaded or if a character other than 1 is typed, rerun PCS.

Message	Source	Memory Data Register	Meaning	Action
-KYBD?	PCS		Request for EQT unit-reference number of device serving as the keyboard input device.	Type the number.
-LIB?	PCS		Request for EQT unit-reference number of the device serving as the input device for the Program Library.	Type the number.
-LIST?	PCS		Request for EQT unit-reference number of the device serving as the list output device.	Type the number
*LOAD	BCS		End-of-Tape condition on standard input device.	See step 10 of the procedure HOW TO USE BCS (this section).
*LOAD	PCS		PCS is reguesting the first or next BCS module.	Place BCS tape in the punched tape reader. Press RUN.
*LST	BCS		The Loader is ready to print the LST, common bounds, and linkage area bounds.	See step 11 of the procedure, HOW TO USE BCS (this section). *NOTE: If the user's computer system is using a 2754B Teleprinter for listing and punching, set the selector switch to "T" (enables the punch unit) before pressing RUN.*

Message	Source	Memory Data Register	Meaning	Action
*LØ1	BCS PCS		Checksum error	To reread record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ2	BCS PCS		Illegal record read: The last record read was not recognized as a valid relocatable record tape.	To reread record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ3	BCS PCS		Memory overflow: The length of BCS exceeds available memory.	Return program to programmer.
*LØ4	BCS PCS		System linkage area overflow in Base Page.	Return program to programmer.
*LØ5	BCS PCS		Loader symbol table overflow: The number of EXT/ENT symbols exceeds available memory.	Return program to programmer.
*LØ6	BCS		Common block error: The length of the common block in the current program is greater than the length of the first common block allocated.	Return program to programmer.

Message	Source	Memory Data Register	Meaning	Action
*LØ7	BCS PCS		Duplicate entry points: An entry point in the current program matches a previously declared entry point.	Return program to programmer.
*LØ8	BCS		No transfer address: The initial starting location was not present in any of the programs which were loaded.	To enter the Starting Address, set the absolute value in the SWITCH REGISTER. Press LOAD A. Press RUN.
*LØ9	BCS		Record out of sequence: A NAM record was encountered before the previous program was terminated with an END record.	Return program to programmer.
LWA MEM?	PCS		Request for the last word of available memory.	Type address of the last word used of available memory.
-PUNCH?	PCS		Request for EQT unit-reference number of the device serving as punch output device.	Type the number.
*RUN	BCS		All programs are loaded and ready for execution.	Check that all input/output devices are ready for operation. Press RUN.

Message	Source	Memory Data Register	Meaning	Action
SQT? -KYBD?	PCS		Request for EQT unit-reference number of the device serving as keyboard input device.	Type the number.
*TABLE	PCS		Request for EQT entry information.	Press RUN. For each input/output device, type the appropriate information in the following format: nn,D.ee,[,D][,Uu] nn=channel number D.ee=driver name where: D =device uses a DMA channel ee=ØØ Teleprinter =Ø1 Tape Reader =Ø2 Tape Punch =1Ø Calcomp Plotter =12 Line Printer =15 Mark Sense Card Reader =21 HP 2Ø2Ø MT unit =22 HP 3Ø3Ø MT unit =23 HP 797Ø MT unit

Message	Source	Memory Data Register	Meaning	Action
				Uu=physical unit number (Ø-7) To terminate EQT entry information, type /E
-TTY?	PCS		Request for EQT unit-reference number of the device serving as teleprinter output.	Type the number.
UN	PCS		Undefined symbol.	Return to programmer
*UNDEFINED SYMBOL <symbol>	PCS		An entry point in a BCS module cannot be located.	1. To enter the symbol in the Loader Symbol Table, press RUN. 2. If the subroutine should have been loaded, rerun PCS.
*UN NAME	PCS		The name I.ee is not defined as an entry point in any I/O driver previously loaded.	1. If the driver name was typed incorrectly, retype the entire entry correctly. 2. If the driver is to be loaded with the user's program at object program load

Message	Source	Memory Data Register	Meaning	Action
				time, type an explanation mark (!). The name is added to the Loader's LST. 3. If the driver should have been loaded, rerun PCS.
	BCS, PCS	102055	A line is about to be printed on the teleprinter.	Turn punch unit OFF. Press RUN.
	PCS	102056	A line has been printed while the teleprinter punch unit was off.	Turn punch unit on. Press RUN.
	PCS BCS	102066	Tape supply low on tape punch which is producing absolute binary output. Trailer follows last valid output.	Place new reel of tape in unit. Press RUN. Leader is produced.
	PCS	102077	BCS tape is punched.	To produce additional copies, set switch 15 "ON."

HP BASIC

This section explains how to use HP BASIC.

DEFINITION: Beginners All-Purpose Symbolic Instruction Code is a high-level language used by beginners in the software field for easy communication with the computer. HP BASIC is a combination of simple English and Algebra.

ASSOCIATED HARDWARE: 2114, 2115, or 2116 series computer with at least 8K memory; a 2752A or 2754B Teleprinter.

COMMENTS: Using HP BASIC consists of two prodedures.

a. Configuring a HP BASIC System for the user's HP computer system.

b. Loading the configured HP BASIC system tape.

The operator should be familiar with these tapes:

a.	Prepare BASIC System (PBS)	This tape contains driver programs for the teleprinter, punched tape reader, high-speed tape punch and the necessary instructions to assign the drivers and create a table of system linkages.
b.	BASIC	This tape is the unassigned BASIC interpreter program.
c.	User-subroutines	These are user-written tapes written according to rules given in the *HP BASIC* manual (02116-9077). Their use is optional and specified by the user.

HOW TO CONFIGURE HP BASIC

NOTE: The loading sequence described below is not restartable. If an operating mistake is made or the tapes do not load properly, begin at Step 4.

1. Decide what is going to be on the configured HP BASIC System Tape. There are three choices:

    a. HP BASIC System Tape containing:
    I/O Drivers, BASIC, User-subroutines

    b. HP BASIC System Tape containing:
    I/O Drivers, BASIC

    c. HP BASIC System Tape containing:
    Only I/O Drivers

2. Gather the appropriate tapes.

3. Turn the system teleprinter to LINE or ON/LINE.

4. Check for proper operation of all other equipment.

5. Press the HALT button on the computer.

6. To produce an HP BASIC SYSTEM tape containing I/O Driver, BASIC, and user-subroutines:

    a. Load the PBS tape with BBL or BBDL.

    b. Load the BASIC tape with BBL or BBDL.

    c. Load the desired user-subroutines with BBL or BBDL.

    d. Go to Step 9.

7. To produce an HP BASIC SYSTEM tape containing I/O Drivers and BASIC:

    a. Load the PBS tape with BBL or BBDL.

    b. Load the BASIC tape with BBL or BBDL.

    c. Go to Step 9.

8. To produce an HP BASIC SYSTEM tape containing only I/O Drivers:

   a. Load the PBS tape with BBL or BBDL.

   b. Go to Step 9.

9. Set the SWITCH REGISTER to the Starting Address of 100_8 (0/000/000/001/000/000).

10. Press LOAD ADDRESS.

11. Set the switches 5-Ø to the select code of the teleprinter.

12. Press RUN.

13. PHOTOREADER I/O ADDRESS?

   a. If a tape reader is being used, type its select code. Press the RETURN key.

   b. If a tape reader is <u>not</u> being used, press only the RETURN key.

14. PUNCH I/O ADDRESS?

   a. If a high-speed punch is being used, type its select code. Press the RETURN key.

   b. If a high-speed tape punch is <u>not</u> being used, press only the RETURN key.

15. SYSTEM DUMP I/O ADDRESS?

   a. If a high-speed tape punch is being used, type its select code. Press the RETURN key. Turn on the high-speed tape punch.

   b. If a high-speed tape punch is <u>not</u> being used, press the RETURN key. Turn on the punch output device.

16. CORE SIZE?

   Type the core memory size of the HP computer system being used (8, 16, 24 or 32). Press the RETURN key.

   NOTE: 8K memory can be indicated by pressing only the RETURN key.

17. The tape punch punches a configured HP BASIC tape.
   Tear off the tape; rewind and label.

18. To punch another copy of the configured HP BASIC tape, press RUN.

HOW TO LOAD THE CONFIGURED HP BASIC SYSTEM TAPE

1. Set the teleprinter to LINE or ON/LINE.
2. Check that all other equipment is operable.
3. Load the configured HP BASIC system tape with BBL or BBDL.
4. If the configured HP BASIC system tape contains I/O Drivers, BASIC, and user-subroutines:
   a. Load the configured HP BASIC tape with BBL or BBDL.
   b. Set the SWITCH REGISTER to the Starting Address of 100_8 (0/000/000/001/000/000).
   c. Press LOAD ADDRESS.
   d. Press RUN.

      READY

      HP BASIC is now ready for use.
5. If the configured HP BASIC system tape contains I/O Drivers and BASIC:
   a. Load the configured HP BASIC system tape with BBL or BBDL.
   b. If user-subroutines are now to be included, load them using BBL or BBDL.
   c. Set the SWITCH REGISTER to the Starting Address 100_8.
   d. Press LOAD ADDRESS.
   e. Press RUN.

      READY

      HP BASIC is now ready for use.
6. If the configured HP BASIC system tape contains only I/O Device Drivers:
   a. Load the configured HP BASIC system tape with BBL or BBDL.
   b. Load the BASIC tape with BBL or BBDL.
   c. If user-subroutines are now to be included, load them using BBL or BBDL.

6. (Continued)

   d. Set the SWITCH REGISTER to the Starting Address 100_8.

   e. Press LOAD ADDRESS.

   f. Press RUN.

      READY

      HP BASIC is now ready for use.

SUPPORTING SOFTWARE

This section explains how to operate the Hewlett-Packard Supporting Software.

The supporting software is:

Punch/Verify

Cross Reference Symbol Table Generator

SIO System Dump

SDUMP

PROGRAM: PUNCH/VERIFY

PURPOSE: The Punch/Verify Routine is used to punch a copy of any punched tape or to verify the contents of a copy. Each feed-frame in the master tape is used, regardless of the content.

ASSOCIATED HARDWARE: This routine may be used on an HP 2114, HP 2115, or HP 2116 computer with an HP 2737 or HP 2748 or HP 2758 Tape Reader and an HP 2753 High-Speed Tape Punch.

NOTE: The tape punch is not required for tape copy verifying, only for copy punching.

The Punch/Verify Routine does not require the use of a separate driver routine for the tape reader and the tape punch; the necessary instructions are included within Punch/Verify Routine.

COMMENTS: To punch a copy of a master tape, the Punch/Verify Routine alternately reads 30 feed-frames (tape characters) then punches a copy of those 30 frames. Thus, any size master tape may be copied without limitation.

To verify a tape copy, the Punch/Verify Routine first stores the entire master tape contents in available core memory. Because the Routine is originally coded for an HP computer with an 8K memory, its basic capacity is up to 15,752 feed-frames (tape characters including blanks). However, the user may change one word in the Routine after it has been loaded into memory, to adjust its capacity to match the computer available memory. Refer to the following list for memory sizes and Punch/Verify Routine capacities:

Memory Size	Capacity	Memory Size	Capacity
4K	7,560	20K	40,328
8K	15,752	24K	48,520
12K	23,944	28K	56,712
16K	32,136	32K	64,904

OPERATING INSTRUCTIONS FOR THE PUNCH/VERIFY ROUTINE

Load the Punch/Verify Routine

1. Use the Basic Binary Loader to load the Punch/Verify Routine into core.
2. If the computer memory size is 8K, skip this step. Otherwise, modify the routine for the memory size by performing the following steps:
   a. LOAD ADDRESS 364_8.
   b. LOAD MEMORY one of the following values, according to the memory size to be used:

Memory Size	Value
4K	7700_8
12K	27700_8
16K	37700_8
20K	47700_8
24K	57700_8
28K	67700_8
32K	77700_8

3. Proceed to either HOW TO COPY A TAPE or HOW TO VERIFY A TAPE.

How to Punch a Tape

1. Load the Punch/Verify Routine.
2. Use the pushbutton on the High-Speed Tape Punch to punch a length of tape leader on the copy tape.
3. LOAD ADDRESS 100_8.
4. Press PRESET then press RUN. The computer halts with 102001_8 (0/000/000/000/000/000) in the MEMORY DATA Register.
5. Set SWITCH REGISTER bits 5-0 to the select code of the tape reader.
6. Press RUN. The computer halts with 102002_8 (●/000/0●0/000/000/0●0) in MEMORY DATA.
7. Set SWITCH REGISTER bits 5-0 to the select code of the High-Speed Tape Punch.
8. Place the master tape to be copied in the tape reader and ready that reader.
9. Press RUN. The master tape is read until 30 feed-frames (tape characters) have been read. Then the routine punches an exact copy of those 30 frames. The routine's next action depends on the content of the 30 frames:

   Action 1 - If any one or more of the 30 frames had any code punched, the routine begins to read another 30 frames then punch a copy.

   Action 2 - If none of the 30 frames had any code punched, the routine halts with 102002_8 in the MEMORY DATA Register.

10. When the routine halts with 102002_8 in MEMORY DATA, examine the master tape to see if the end has been reached.
11. If the end of the master tape has <u>not</u> been reached, return to step 9.
12. If the end of the master tape has been reached, remove the master tape from the tape reader then use the pushbutton on the High-Speed Tape Punch to punch a length of tape trailer on the copy tape.

HOW TO VERIFY A TAPE

1. If a tape copy was just punched, skip this step. Otherwise, perform the Load the *Punch/Verify Routine* procedure.
2. LOAD ADDRESS 200_8.
3. Press PRESET then press RUN. The computer halts with 102001_8 in the MEMORY DATA Register.
4. Set SWITCH REGISTER bits 5-0 to the select code of the tape reader.
5. Place the master tape in the tape reader and ready that reader. Perform this step even if the *Punch a Tape Copy* procedure was just used.
6. Press RUN. The master tape is read until the computer halts with $1020xx_8$ in MEMORY DATA

   NOTE: If the entire master tape is read but the computer does not halt, the master tape did not have a long enough trailer (at least 60 blank feed-frames). Press HALT, place at least 8" of blank (feed-frames only) tape in the reader, ready the reader, and press RUN.

7. If the MEMORY DATA is 102077_8 (●/000/0●0/000/●●●/●●●), the master tape is too long for the available memory size (see *Operational Characteristics* and *Load the Punch/Verify Routine* step 2). Skip to step 17.
8. If the MEMORY DATA is 102001_8, examine the master tape. If the end of the master tape has <u>not</u> been read, return to step 6. If the end of the master tape has been read, remove the master tape from the reader.
9. Place the tape copy in the reader and ready the reader. If this is a <u>continuation</u> of verification from a long master tape (see steps 7 and 17), refer to step 17-b-2 for proper positioning of the tape copy.
10. Set SWITCH REGISTER bit 15 ON.
11. Press RUN. The tape copy is read until the computer halts with $1020xx_8$ in MEMORY DATA.

12. If the MEMORY DATA is 102002_8, verfication is complete. To begin verification of another copy of the same master tape, return to step 9. Or, to continue verification of a long master tape (see steps 7 and 17), return to step 17-b-2.

13. If the MEMORY DATA is 102055_8 (●/000/0●0/000/●0●/●0●), verification found an error. The 16-bits (two feed-frames [tape characters]) just read from the tape copy are displayed in the A-Register.

    To compare the two characters from the copy tape with the corresponding location on the mater tape:

    A. For an HP 2114 computer:
        1. Write down the contents of the MEMORY ADDRESS Register for future reference.
        2. Press CLEAR REGISTER.
        3. Press LOAD ADDRESS
        4. Press DISPLAY MEMORY. The contents of the A-register is displayed in the MEMORY DATA Register. Write down the contents of MEMORY DATA.

        To look at the corresponding 16 bits on the master tape:
        5. LOAD ADDRESS 153_8.
        6. Press SINGLE CYCLE <u>three</u> times. The A-register now contains the 16 bits from the master tape. To display the A-register on the 2114 front panal, follow steps 13-a-2 through 13-a-4 and compare that value with the one written earlier.

    B. For an HP 2115 or 2116 computer:
        1. Record the contents of the MEMORY ADDRESS Register and the A-register on a piece of paper.
        2. LOAD ADDRESS 153_8.
        3. Press SINGLE CYCLE <u>three</u> times. The A-register contains the 16 bits stored on the master tape. Compare this value with the A-register value previously recorded.

14. To resume verification of the current tape copy, LOAD ADDRESS the value recorded from the MEMORY ADDRESS Register after the 102055 halt (step 13) then return to step 10.

15. To terminate verification of the current tape copy and start verification of another tape copy of the same master tape, LOAD ADDRESS 221_8 then return to step 9.

16. To verify a tape copy of another master tape, set SWITCH REGISTER bit 15 off then return to step 5.

17. If the master tape is too long (see step 7), two methods are available to process the master tape:

    A. Use a computer with a larger memory, or

    B. Perform the following steps:

        1. Carefully mark the master tape in the tape reader so that it can be removed then put back in the reader later at the exact point. Then perform steps 9 through 12 and, when needed, steps 13 through 15.

        2. When the tape copy stops with 102002_8 in MEMORY DATA, carefully mark it in the reader so that it can be removed from the reader then put back in the reader later at the exact point.

        3. Place the master tape back into the reader at the exact point marked in step 17-2-a, set SWITCH REGISTER bit 15 off, ready the reader, then return to step 6.

NOTE: Step 7 and this step 17 may be used as often as necessary to complete the verification.

PROGRAM: CROSS REFERENCE SYMBOL TABLE GENERATOR

PURPOSE: To process an Assembler source program and print a cross referenced list (in alphabetic order) of all symblols in the program.

ASSOCIATED HARDWARE: 2114, 2115, and 2116 series computer with 4K memory size, or 2116 series with 8K memory size, 2752A or 2754B teleprinter.

COMMENTS:

Each symbol is followed by:

a. The four digit sequence number of the statement in which the symbol was defined.

b. The sequence numbers of all statements referring to the symbol.

If the source program is contained on more than one tape, the tape number (determined by the order in which the tapes are submitted to the generator program) follows the statement sequence number and is separated by a slash.

The tape number is not printed for the first tape.

CROSS REFERENCE SYMBOL TABLE GENERATOR OPERATING INSTRUCTIONS

1. Set the system teleprinter to LINE or ON/LINE.
2. Check that all equipment is operable.
3. If a Cross Reference Symbol Table Generator is not available, follow HOW TO CONFIGURE AN SIO MODULE and then RECOMMENDED SIO PROGRAM CONFIGURATION (Section III). Load the configured Cross Reference Symbol Table Generator using the BBL or the BBDL.
4. Set the SWITCH REGISTER to the starting address of $10\emptyset_8$ (0/000/000/00●/000/000).
5. Press LOAD ADDRESS.
6. Set all SWITCH REGISTER switches OFF.
7. If the entire symbol table is to be printed in only one pass (using one or more source tapes for one program) continue with step 8.

   If only part of the symbol table is to be listed by using the character RANGE option, skip step 8 and continue with step 9.
8. COMPLETE SYMBOL TABLE

   a. Load the source tape in the reader.

   b. Press PRESET.

   c. Press RUN.

   d. The Generator reads the tape.

      If the tape does not contain an END statement (signifying that another tape must be loaded) the computer halts with 102057_8 (●/000/0●0/000/●0●/●●●) in the MEMORY DATA REGISTER. Process the remaining source tapes by returning to the beginning of step 8.

      If the tape contains an END statement (signifying the end for the program) then the Generator prints out the entire symbol table on the teleprinter and halts with 102077_8 in the MEMORY DATA REGISTER.

e. To restart the Generator return to step 6 above.

9. CHARACTER RANGE OPTION

a. Load the source tape in the reader.

b. Set bit 15 of the SWITCH REGISTER on.

c. Press PRESET.

d. Press RUN.

e. The Generator types:
**ENTER CHARACTER RANGE

f. Specify the range of characters for the group of labels to be listed by the Generator.

EXAMPLE: If labels starting with the letters A or B only are to be listed, type AB *return* *linefeed* on the teleprinter.

If labels starting with the letter E only are to be listed, type EE *return* *linefeed* on the teleprinter.

g. The source tape is read immediately after the character range is typed on the teleprinter.

If the tape does not contain an END statement (signifying that one or more additional tapes must be read) then the computer halts with 102057_8 in the MEMORY DATA REGISTER.

Load the next source tape into the reader and press RUN.

When the last tape (containing an END statement to signify the end of the source program) is read, the Generator prints out the symbol table according to the character range specified on the teleprinter and halts with 102077_8 in the MEMORY DATA REGISTER.

If no labels exist in the character range specified, the Generator types "E" and halts with 102077_8 in the MEMORY DATA REGISTER.

h. To restart the Generator, return to step 6 above.

CROSS REFERENCE SYMBOL TABLE GENERATOR MESSAGES

During operation of the Cross Reference Symbol Table Generator the following messages may be printed.

Message	Meaning	Action
DD symbol	A doubly defined symbol has been encountered. (The computer does not halt.)	The programmer must correct the source program after completion of the Cross Reference Symbol Table Generator.
TABLE OVERFLOW	The combined number of symbols and references to them exceeds the capacity of the routine.	Irrecoverable error. If the Table is necessary, the source program must be revised.

PROGRAM: SIO SYSTEM DUMP

PURPOSE: An independent utility program that saves configuration time by either:

a. Preparing a single binary tape copy of one to five SIO drivers whose device assignments have been made, or

b. Preparing a single binary tape copy of the standard software program being used (i.e., FORTRAN, Assembler, ALGOL, etc.) and of one to five SIO drivers whose device assignments have been made.

Any change in the select code for a device or devices means that the copy of the configured drivers cannot be used. A new copy must be made using SIO System Dump.

COMMENTS: Always load and assign the drivers or load the SIO module last. Load the standard software program first.

Load only one standard software program.
To prepare a tape of SIO driver(s), refer to HOW TO CONFIGURE AN SIO MODULE (Section III).

To prepare a tape containing SIO driver(s) and a standard software program, refer to RECOMMENDED SIO PROGRAM CONFIGURATION (Section III).

PROGRAM: SDUMP

PURPOSE: To eliminate lengthy DOS, or RTE configuration time by creating copies of all or selected parts of disc-based systems on punched tape or magnetic tape. SDUMP is also able to transfer this information back onto disc or drum.

HOW TO USE SDUMP:

1. Load SDUMP with BBL or BBDL.
2. Determine the method of storage; i.e., either paper tape or magnetic tape. (For magnetic tape, make sure the tape drive is on AUTO.)
   a. For paper tape storage use:
      SIO Teleprinter driver.
      SIO Tape Reader driver.
      SIO Tape Punch driver.
   b. For magnetic tape storage use:
      SIO Teleprinter driver.
      SIO Magnetic Tape driver.
3. Load the appropriate SIO drivers with BBL or BBDL.
4. Set SWITCH REGISTER to Starting Address of 100_8 (0/000/000/000/000/000).
5. Press LOAD ADDRESS.
6. Press RUN.
7. SDUMP types:
   DUMP = D, T [-S] [,T[-S]]
   VERIFY = V
   LOAD = L
   TERMINATE = T
8. Respond to the SDUMP request according to the purpose of the user:
   a. To dump all or part of the user's DOS, use the "DUMP" request. Type "D", followed by the track number, a comma (,) and the sector number.

NOTE: Use the track and sector numbers recorded from the A-REGISTER at the completion of the Disc Loading Phase of DSGEN or RTGEN.

To dump part of the user's DOS or RTE, the programmer must supply the track and sector numbers.

b. To verify the contents of the dump: Type V.

c. To load from paper or magnetic tape: Type L.

d. To terminate use of SDUMP: Type T.

9. After SDUMP has executed a D, L or V command, it types: "COMMAND:". The user may issue another V, L or D order, or terminate use by typing T.

SDUMP ERROR MESSAGES

The following messages may be printed on the teleprinter by SDUMP:

Statement	Action
STATEMENT ERROR	Retype input statement in correct format.
EOT	The end of the input tape being read has been reached; either load the next tape or go on to the next phase.
CHANGE INPUT TAPE, HIT RUN	Two full tracks have been dumped onto paper tape; perform the requested action.
TURN OFF DISC PROTECT, HIT RUN	Set the DISC TRACK PROTECT Switch off, then press RUN.
DISC INPUT ERROR	Disc Error Diagnostic, for a Parity, Decode or Abort status after 10 retrys. Input sequence repeated on restart.
DISC WRITE ABORT	Disc Error Diagnostic, for an Abort status after a write attempt. Sequence is repeated if restarted.
TRACK *nnn* (8) SECTOR *mmm* (8)	Identification information for the Disc Error Diagnostic messages described above. *nnn* is the octal track number and *mmm* is the octal sector number where the error occurred.
TAPE/DISC VERIFY ERROR	Disc and tape records do not agree. Disc record is rewritten on restart.

TAPE CHECKSUM ERROR	The checksum in the tape record does not match the sum computed by SDUMP. Current record is ignored if restarted.
MT ERROR - READ PARITY MT ERROR - EOT, RESTART	Magnetic Tape Errors. Error recovery procedures are completed by driver. Restart to retry sequence.

DISC OPERATING SYSTEMS

DOS uses batch processing and file access techniques in a disc/drum environment.

Batch processing is automatic compiling, loading and executing user programs with a minimum of operator attention.

File accessing is storing, editing, listing, dumping or using a variety of files as input to programs. Files are a logical division of disc storage based on the quantity and type of information recorded.

A disc/drum environment is disc or drum used for storing large amounts of information. Storing information on a disc or drum involves magnetically sensitive storage areas defined in tracks and sectors. A track is a location area of information, and a sector is a smaller area within a track. Because both devices have similar storage methods, descriptions applying to fixed-head disc apply to drum as well (unless otherwise stated).

The DOS is controlled by the DOS Supervisor. The DOS Supervisor operates in response to directives (instructions) typed by the operator or read from the batch device.

DOS processes user jobs composed of data and directives. Directives control the data contained in the job and what the job does.

Directives are entered in either keyboard or batch mode with this general format:

> A colon ":", followed by a directive word (the first two letters are the only letters that must be present, e.g., :BA,1) followed by a list of parameters which are separated by commas.

In the keyboard mode of operation the operator types the directives through the system teleprinter keyboard.

In the batch mode of operation, the programmer prepares the directives on punched cards, paper tape, or magnetic tape for each job; thus jobs can be entered from the same input device without operator intervention.

To get the attention of DOS while DOS is running, strike any key of the system teleprinter. The computer responds with an asterisk (*), as soon as the system teleprinter is free.

The asterisk (*) indicates that DOS will accept one of the following directives:

:TYPE
:ABORT
:DN
:UP
:EQ
:LU

All other directives are ignored.

NOTE: Do not use the ABORT directive during PURGE or after typing /E after an EDIT.

To eliminate a previously typed character in a directive, press the "control" and "A" keys simultaneously.

To eliminate a directive, press the "rubout key" anywhere in the directive.

To terminate batch mode, use the :TYPE directive.

To enter batch mode, use the :BATCH,*n* directive.

HARDWARE

HP 2116 computer with 8K memory
Direct Memory Access
Extended Arithmetic Unit
Memory Parity Check with Interrupt
Time Base Generator
Memory Protect Check
Disc or Drum Mass Storage Unit
HP 2752A System Teleprinter
HP 2754B Teleprinter for Batch I/O
Punch and List Device

In place of the HP 2754B Teleprinter, the user may select other combinations of I/O devices for batch operations. For example:

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

SOFTWARE

These binary tapes are supplied to the DOS user:

DOS SYSTEM GENERATOR
DOS CORE-RESIDENT SYSTEM
DOS DISC-RESIDENT EXECUTIVE MODULES
DOS JOB PROCESSOR/FILE MANAGER
DOS RELOCATING LOADER
DOS ASSEMBLER MAIN CONTROL
DOS ASSEMBLER SEGMENT D
DOS ASSEMBLER SEGMENT 1
DOS ASSEMBLER SEGMENT 2
DOS ASSEMBLER SEGMENT 3

DOS ASSEMBLER SEGMENT 4
DOS ASSEMBLER SEGMENT 5
DOS FORTRAN MAIN CONTROL
DOS FORTRAN PASS 1
DOS FORTRAN PASS 2
DOS FORTRAN PASS 3
DOS FORTRAN PASS 4
RTE/DOS RELOCATABLE LIBRARY (EAU)
RTE/DOS FORTRAN IV LIBRARY or RTE/DOS FORMATTER
DOS DISC/DRUM DRIVER
SYSTEM DUMP
PREPARE TAPE SYSTEM

NOTE: RTE/DOS ALGOL (MAIN CONTROL) and RTE/DOS ALGOL (SEGMENT 1) tapes are available for users with 16K or more core memory.

These are the DOS drivers that can be supplied to the user:

	DVR ØØ	Teleprinter
DVR Ø1 to	DVR Ø7	Paper Tape Devices
	DVR Ø1	Tape Reader
	DVR Ø2	Tape Punch
DVR 1Ø to	DVR 17	Unit Record Devices
	DVR 1Ø	Calcomp Plotter
	DVR 12	Line Printer
	DVR 15	Mark Sense Card Reader (uses DMA)
DVR 2Ø to	DVR 37	Magnetic Tape/Mass Storage
	DVR 22	3030 Magnetic Tape (uses two channel DMA)
	DVR 3Ø	Disc or Drum Devices
DVR 4Ø to	DVR 77	Instruments

The appropriate SIO drivers are supplied (SIO teleprinter driver is always furnished) according to the user's hardware configuration.

GENERATING DOS

DOS generation consists of five steps:

System Preparation	The operator checks that all devices are operable in the HP computer system and loads the necessary SIO drivers and DSGEN.
Initialization Phase	Establishes disc size, type, system hardware information.
Program Input Phase	System and user programs are copied onto disc.
Parameter Input Phase	With the exception of the main programs and program segments, the operator can modify the type, priority, or execution intervals of any of the programs entered during the program input phase.
Disc Loading Phase	All tables are constructed and the absolute system is created on the disc or drum.

DOS CONFIGURATION WORKSHEET

This worksheet shows the information typed by the system teleprinter during DOS generation. Fill out the worksheet according to the formats specified to expedite the configuration procedure.

SYS DISC CHNL?_____	Write the octal select code (interrupt location) of the system disc device.
#SECTORS/TRACK?_____	Write the number of sectors per track of the system disc. (Check the appropriate hardware document. Disc units are usually 90, drums 128.)
SYSTEM DISC SIZE?_____	Write the number (decimal) of tracks on the system disc or drum.
#PROTECTED TRACKS?_____	Write (in decimal) the number of hardware protected tracks.
FIRST SYSTEM TRACK?_____	Write the decimal number of the first track on disc available to the system. (The first track is number Ø.)
FIRST SYSTEM SECTOR?_____	Write the system starting sector in decimal. Record this response and the previous one if SDUMP is to be used later to make a copy of the system.
AUX DISC CHNL?_____	Write the octal select code (interrupt location) of the auxiliary mass storage device. If none exists, write Ø.
AUX DISC SIZE?_____	Write the decimal number of tracks on the auxiliary disc/drum. (DSGEN asks for this only if the previous response was not zero.)

TIME BASE GEN CHNL?_____	Write the octal select code (interrupt location) of the time base generator.
LWA MEM?_____	Respond according to the chart below: 8K = 17677 16K = 37677 24K = 57677 32K = 77677
PRGM INPT?_____	Enter the abbreviation found in the table below for the device used for program input. PT = Paper Tape TY = Teleprinter MT = Magnetic Tape DF = Disc File
LIBR INPT?_____	Type the abbreviation for the input unit used to enter the relocatable library programs.
PRAM INPT?_____	Type the abbreviation for the input unit used to enter parameters describing the relocatable programs. (PT or TY.)
_____ _____ _____ _____	The parameter input stage gives the user an opportunity to specify where system, user or library programs will reside (disc or core). If no parameters are listed, then all programs are loaded on the disc.
	The format of these optional entries is as follows: *name, type* *name* is the name of the program

type is defined as follows:

- Ø - System Core - Resident
- 1 - System Disc - Resident Exec Modules
- 3 - User Disc - Resident Main
- 4 - Disc - Resident I/O Driver
- 5 - User Segment
- 6,7 - Library
- >7 - Program Deleted From The System

Most common usage is:
Changing from Type 1 to Type Ø.
Changing from Type 4 to Type 1.
Deleting programs from the system.

#SYSTEM LINKS?_____

(The more core-resident modules, the more links are required.) $1ØØ_{1Ø}$ is the minimum response.

#USER LINKS?_____

Respond with a decimal number. FORTRAN alone requires 3ØØ linkages.

EQUIPMENT TABLE ENTRY?_____
_____
_____
_____
_____

The operator responds with a series of one line entries as follows:

XX, DVRnn [,D] [,R] [,U]

XX = select code (interrupt location) of the device listed.

DVRnn is the name of the driver where nn is the Equipment Type.

D means that DMA is required.

R means that the driver is core-resident.

U is the physical subchannel number.

DEVICE REFERENCE TABLE?_____

_____

_____

_____

_____

_____

_____

(logical unit 1 = system teleprinter, 2 = mass storage, etc.)

User assigns the logical unit numbers to the appropriate device listed in the Equipment Table.

EXAMPLE:

DSGEN types: 1 = EQT#?

User responds X, where X is the order in which the teleprinter driver was listed in the Equipment Table. (If the teleprinter was listed first, then the correct response is 1, if second, then respond 2, etc.)

INTERRUPT TABLE?_____

_____

_____

_____

_____

_____

User responds with all of the select codes (interrupt locations) which may interrupt, in ascending order and in this format:

X, Y

X = the interrupt location between 10_8 and 37_8 inclusive (must be in ascending order).

Y = the order in which the interrupt location was listed in the Equipment Table.

FWA USER?_____

The first word address of the user program area is greater than or equal to the last word address (LWA) of the system. DSGEN reports LWA (plus one) with the message:

LWA SYS *xxxxx*.

CONTENTS OF A-REGISTER_____

This message is not typed on the system teleprinter. If the user intends to use SDUMP to create a paper or magnetic tape copy of the DOS system, the contents of the A-REGISTER at the end of the Disc Loading Phase must be recorded. A-REGISTER bits 15-8 show this last track on the disc used, and bits 7-0 show the last sector used.

HOW TO GENERATE THE DISC OPERATING SYSTEM

1. Complete the DOS CONFIGURATION WORKSHEET.
2. Turn on all equipment.
   The System Preparation Phase begins.
3. Set the system teleprinter to LINE or ON/LINE.
4. Set the DISC PROTECT switch down (enables the disc to be written on).
5. Gather the appropriate SIO driver tapes for the devices.
   Follow the procedure HOW TO CONFIGURE AN SIO MODULE (Section III).
6. Load the DOS SYSTEM GENERATOR with BBDL.
7. Set the SWITCH REGISTER to the Starting Address of $10\emptyset_8$.
8. Press PRESET.
9. Press RUN.
10. SYS DISC CHNL?
    Type the low number octal select code (interrupt location) of the disc unit.
11. #SECTORS/TRACK?
    Type the decimal number of sectors per track (disc units usually 90, drum units usually 128; if mixed, use the lower number).*
    *(Consult the hardware manual for the appropriate device.)
12. SYS DISC SIZE?
    Type the decimal number of tracks contained on the disc.
13. #PROTECTED TRACKS?
    Type the decimal number of hardware protected tracks.
14. FIRST SYSTEM TRACK?
    Type the decimal number of the first track available to the computer system.
15. FIRST SYSTEM SECTOR?
    Type the starting system sector decimal number. (If the first track number was zero in step 11, then the sector number must be greater than 2.

16. AUX DISC CHNL?
    Type Ø if there is no auxiliary mass storage device or type its octal select code (interrupt location).

17. AUX DISC SIZE?
    Type the decimal number of tracks of the mass storage device. (This message is not typed if the response to the previous message was zero.)

18. TIME BASE GEN CHNL?
    Type the octal select code (interrupt location) of the Time Base Generator.

19. LWA MEM?
    Type the last word of available memory (octal).

20. PRGM INPT?
    Type the abbreviation (see NOTE below) for the input unit used for relocatable program modules.

    NOTE: PT = Paper Tape
    TY = Teleprinter
    MT = Magnetic Tape
    DF = Disc File

21. LIBR INPT?
    Type the abbreviation for the input unit used to enter the relocatable library programs.

22. PRAM INPT?
    Type the abbreviation for the input unit used to enter the parameters describing the relocatable programs. (Enter PT or TY.)
    The computer halts.

23. The Program Input Phase starts.

24. For each program on the following page:
    a. Place the tape in the tape reader.
    b. Set the SWITCH REGISTER to $ØØ_8$ if loading from the program input device, or $1Ø_8$ if loading from the library input device (if different).
    c. Press RUN.

DOS CORE-RESIDENT SYSTEM
DOS DISC-RESIDENT EXECUTIVE MODULES
DOS ASSEMBLER MAIN CONTROL
DOS ASSEMBLER SEGMENT D
DOS ASSEMBLER SEGMENT 1
DOS ASSEMBLER SEGMENT 2
DOS ASSEMBLER SEGMENT 3
DOS ASSEMBLER SEGMENT 4
DOS ASSEMBLER SEGMENT 5
DOS FORTRAN MAIN CONTROL
DOS FORTRAN PASS 1
DOS FORTRAN PASS 2
DOS FORTRAN PASS 3
DOS FORTRAN PASS 4
DOS RELOCATING LOADER
RTE/DOS RELOCATABLE LIBRARY (EAU)
FORTRAN IV or BASIC FORMATTER
DOS I/O DRIVERS: DVRØØ = Teleprinter, DVRØ1 = Tape Reader,
DVR3Ø = Disc and any other drivers for the user's I/O devices.
DOS JOB PROCESSOR/FILE MANAGER

25. Now take each user program to be made a permanent part of DOS:
    a. Place the tape in the tape reader.
    b. Set the SWITCH REGISTER to $ØØ_8$ if loading from the program input device, or $1Ø_8$ if loading from the library input device (if different).
    c. Press RUN.
26. When all programs have been loaded, set switch Ø "ON." Press RUN.
27. If there are no undefined externals in the programs loaded, this message is printed:
    NO UNDEF EXTS
    If there are undefined externals, this message is printed:
    UNDEF EXTS
    The undefined external references in the programs loaded are printed one per line. The computer halts after they are all listed.

28. If more program tapes must be loaded:
    a. Place the tape in the tape reader.
    b. Set the SWITCH REGISTER to $ØØ_8$ (Input Unit) or $1Ø_8$ (Library Unit).
    c. Press RUN.
    d. Repeat steps a-c until all desired tapes have been loaded.
29. After all programs have been loaded, set switch Ø ON.
30. Press RUN.
31. ENTER PROG PARAMETERS
    Type the program parameters as indicated on the DOS CONFIGURATION WORKSHEET.

    When all parameters have been entered, close the Parameter Input Phase by typing /E. The Disc Loading Phase starts.
32. #SYSTEM LINKS?
    Type the number of system linkages. ($1ØØ_{1Ø}$ is the minimum response.)
33. #USER LINKS?
    Type the number of user linkages required on base page. ($3ØØ_{1Ø}$ is the minimum response.)
34. EQUIPMENT TABLE ENTRY?
    Type the Equipment Table numbers in a series of one line entries. Terminate the Equipment Table entries by typing /E.
35. INTERRUPT TABLE
    Type the Interrupt Table entries in ascending numerical order from the DOS CONFIGURATION WORKSHEET. Terminate the Interrupt Table entries by typing /E.
36. DSGEN
    Types a list of the contents of disc resident EXEC SUPERVISOR MODULE and disc-resident I/O drivers followed by the last word address of the system.

37. FWA USER?

Type an octal address that is equal or greater than the last word address of the system (above).

38. DSGEN

Types a memory map of user system programs. DSGEN then loads the disc with programs, types *SYSTEM STORED ON DISC and halts with the last track and last sector used, displayed in the A-REGISTER.

Record the contents of the A-REGISTER. The program SDUMP cannot be used without this information.

A-REGISTER bits 15-8 contain the last track number.

A-REGISTER bits 7-0 contain the last sector number.

The track and sector numbers are located as shown below:

A-REGISTER

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Last Track								Last Sector							

39. Set the DISC PROTECT Switch "UP" to protect the information written on the disc. (See the appropriate manual for the disc device.) DOS can now be loaded.

40. SDUMP

To eliminate configuring DOS again, the operator can create copies by using SDUMP. This program is discussed in Section VII.

ERROR MESSAGES

The following messages are printed on the teleprinter only during configuration and loading of DOS:

Message	Meaning	Action
Messages During Initialization and Input Phase		
ERRØ1	Invalid response to initialization request.	Request is repeated. Enter valid reply.
ERRØ2	Checksum error on program input.	Computer halts; reposition tape to beginning of record and press RUN to reread.
ERRØ3	Record out of sequence.	Same as ERRØ2.
ERRØ4	Illegal record type.	Same as ERRØ2.
ERRØ5*name*	Duplicate entry point.	Revise program by reloading the entry points (the current entry point replaces the previous entry point).
ERRØ6	Invalid base page length (must be zero).	Base page area is ignored, but memory protect error will occur if program is executed.
ERRØ7	Program name or entry point table overflow of available memory.	Irrecoverable error. Revise or delete programs.
ERRØ8*name*	Duplicate program name.	The current program replaces the previous program.
Messages During the Parameter Phase		
ERRØ9	Parameter name error (no such program).	Enter valid parameter statement.
ERR1Ø	Parameter type error.	Same as ERRØ9.

Message	Meaning	Action
General Messages		
ERR13	User segment precedes user main program.	Irrecoverable.
ERR15	More than 63 subprograms called by a main program.	Revise main program (subsequent calls to subprograms are ignored).
ERR16	Base page linkage overflow.	Diagnostic printed for each word required. Revise order and composition of program loading to reduce linkage requirements.
ERR17	Current disc address exceeds number of available tracks.	Irrecoverable error.
ERR18	Memory overflow (absolute code exceeds LWA memory).	Diagnostic printed for each word required (absolute code is generated beyond LWA). Revise program.
ERR19	Program overlay (current word of absolute code has identical location to previous).	Current word is ignored (the address is printed).
ERR2Ø	Binary DBL record overflow of internal table.	Records overlay previous DBL records (diagnostic printed for each overflow record). Revise program.
ERR21	Module containing entry point $CIC not loaded.	Irrecoverable error.

Message	Meaning	Action
ERR22	Read parity/decode disc error. A-REGISTER bits 8-14 show track number; bits Ø-7 show sector number.	After ten attempts to read or write the disc sector, the computer halts. To try ten more times, press RUN.
ERR23	EQT not entered for disc-resident I/O module.	Restart at $4ØØØ_8$.

Messages During I/O Table Entry

ERR24	Invalid channel number.	Enter valid EQT statement.
ERR25	Invalid driver name or no driver entry points.	Same as ERR24.
ERR26	Invalid or duplicate D,R,U operands.	Same as ERR24.
ERR27	Invalid logical unit no.	Enter valid DRT statement.
ERR28	Invalid channel number.	Enter valid INT statement.
ERR29	Channel number decreasing.	Same as ERR28.
ERR31	Invalid EQT number.	Same as ERR28.
ERR35	Base page interrupt locations overflow into linkage area.	Restart Disc Loading Phase.
ERR36	Invalid number of characters in final operand.	Same as ERR28.

SUMMARY OF DIRECTIVES

DIRECTIVE	DESCRIPTION
:ABORT	Terminate the current job.
:ADUMP[,*FWA*[,*LWA*]][,B][,L]	Dump a program if it aborts.
:BATCH,*n*	Switch from keyboard to batch mode.
:COMMENT *string*	Print a message.
:DATE,*day*[,*hour*,*min*]	Set the date and time.
:DN,*n*	Declare an I/O device down.
:DUMP,*log.unit*,*file*[,S_1[,S_2]]	Dump a user file.
:EDIT,*file*,*log.unit*[,*new*]	Edit a source statement file.
:EJOB	Terminate the current batch and/or job normally.
:EQ[,*n*]	List the equipment table.
:GO[,P_1,P_2...P_5]	Restart a suspended program.
:JFILE,*file*	Specify a source file for the assembler or compiler.
:JOB[,*name*]	Initiate a user job.
:LIST,S,*log.unit*,*file*[,*m*[,*n*]]	List a source statement file.
:LIST,U,*log.unit*[,$file_1$,...]	List the user directory.
:LIST,X,*log.unit*[,$file_1$,...]	List the system directory.
:LU[,n_1[,n_2]]	Assign or list logical units.
:PAUSE	Interrupt the current job.
: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.

DIRECTIVE	DESCRIPTION
:RUN,*name*[,*time*][,N]	To run a user program.
:SA,*track*,*sector*[,*number*]	Dump disc in ASCII.
:SO,*track*,*sector*[,*number*]	Dump disc in octal.
: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 loader generated programs.
:STORE,R,*file*[,*log.unit*]	Create a relocatable file.
:STORE,S,*file*,*log.unit*	Create a source statement file.
:TRACKS[,T_1,T_2...]	Print or set disc track status.
:TYPE	Return to batch from keyboard mode.
:UP,*n*	Declare an I/O device up.

HOW TO LOAD DOS

1. Set the SWITCH REGISTER to $Ø7776Ø_8$ (0/■■■/■■■/■■■/■■0/000).
2. Press LOAD ADDRESS.
3. Set the LOADER switch to ENABLED.
4. Press PRESET.
5. Press RUN.
6. Set the LOADER switch to PROTECTED after the computer halts with $1Ø2Ø77_8$ in the T-REGISTER.
7. Set SWITCH REGISTER bit Ø ON.
8. Press RUN.
9. When DOS is loaded it types:
   #INPUT FR=FRESH: CO-CONTINUATION
   a. If no user files are currently saved on the disc, type FR.
   b. If user files currently exist on disc or have been loaded by SDUMP, type CO.
10. DOS then types:
    INPUT:DATE,XXXXXXXX,H,M
    Type a DATE directive.

NOTE: The only directives that can be used after the DATE directive are TRACKS, BATCH and JOB. All other directives are ignored by DOS.

After typing a JOB directive, any other directives may be used.

MOVING-HEAD DISC OPERATING SYSTEM

The Moving-Head Disc Operating System (DOS-M) uses batch processing and file access techniques in a disc environment.

Batch processing is automatic compiling, loading, and executing user programs with a minimum of operator attention.

File accessing is storing, editing, listing, dumping or using a variety of files as input to programs.

A disc environment is up to four (one is required) moving-head disc drives used for storage of large amounts of information. Each disc drive has two discs (one permanent and one removable cartridge) and uses two subchannels, one for each disc.

Storing information on a disc involves magnetically sensitive areas defined in tracks and sectors. A track is a location area of information, and a sector is a smaller area within a track. (Also the smallest addressable unit on a disc.) A disc contains 203 tracks, each divided into twenty-four 128-word sectors. At least three tracks on a disc are reserved as spares, to be used when bad tracks are detected.

DOS-M operations are controlled by the DOS Supervisor. The DOS-M Supervisor operates in response to directives (instructions) typed by the operator or read from the batch device.

DOS-M processes user jobs composed of data and directives. Directives control:

The data contained in the job and
What the job does.

Directives are entered in either keyboard or batch mode with this general format:

> A colon ":" followed by a directive word (the first two letters are the only letters that must be present, e.g., :BA,1) followed by a list of parameters which are separated by commas.

In the keyboard mode of operation, the operator types the directives through the system teleprinter keyboard.

In the batch mode of operation, the programmer prepares the directives on punched cards, paper tape, or magnetic tape for each job; thus jobs can be entered from the same input device without operator intervention.

To get the attention of DOS-M while DOS-M is running, strike any key of the system teleprinter. The computer responds with an asterisk (*), as soon as the system teleprinter is free.

The asterisk (*) indicates that DOS-M will accept one of the following directives:

:TYPE
:ABORT
:DN
:UP
:EQ
:LU
:OFF

All other directives are ignored.

NOTE: Do not use the OFF or ABORT directives during a PURGE or after typing /E following an EDIT.

To eliminate a previously typed character in a directive, press the "control" and "A" keys simultaneously.

To eliminate a directive, press the "rubout" key anywhere in the directive.

To terminate the batch mode, use the: TYPE directive.

To enter batch mode, use the :BATCH,*n* directive.

HARDWARE

HP 2114 or HP 2116 computer with 8K memory
Direct Memory Access
Halt on Memory Parity
Central Interrupt Processor
HP 2870A Moving-Head Disc Drive
HP 2752A System Teleprinter
HP 2754B Teleprinter for Batch I/O

In place of the HP 2754B Teleprinter, the user may select other combinations of I/O devices for batch operations. For example:

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

SOFTWARE

HP Disc Operating System (DOS) user programs can run under DOS-M without modification. These binary tapes are supplied to the DOS-M user:

DOS-M SYSTEM GENERATOR
DOS-M CORE-RESIDENT SYSTEM
DOS-M DISC-RESIDENT EXECUTIVE MODULES
DOS-M JOB PROCESSOR/FILE MANAGER
DOS-M BOOTSTRAP LOADER
DOS-M RELOCATING LOADER
DOS-M ASSEMBLER MAIN CONTROL
DOS-M ASSEMBLER SEGMENT 0
DOS-M ASSEMBLER SEGMENT 1
DOS-M ASSEMBLER SEGMENT 2
DOS-M ASSEMBLER SEGMENT 3

DOS-M ASSEMBLER SEGMENT 4
DOS-M ASSEMBLER SEGMENT 5
DOS-M FORTRAN MAIN CONTROL
DOS-M FORTRAN PASS 1
DOS-M FORTRAN PASS 2
DOS-M FORTRAN PASS 3
DOS-M FORTRAN PASS 4
RTE/DOS FORTRAN IV LIBRARY OR RTE/DOS BASIC FORMATTER
RTE/DOS RELOCATABLE LIBRARY (EAU OR NON-EAU)
DOS-M MOVING-HEAD DISC DRIVER (DVR31)
DOS-M SYSTEM TELEPRINTER DRIVER (DVRØ5)

NOTE: RTE/DOS ALGOL (MAIN CONTROL) and RTE/DOS ALGOL (SEGMENT 1) tapes are available for users with 16K or more core memory.

For other I/O devices, DOS drivers are used and are compatible with DOS-M without modification. Those currently available include:

DVRØØ Teleprinter
DVRØ1 Tape Reader
DVRØ2 Tape Punch
DVR1Ø Calcomp Plotter
DVR12 Line Printer
DVR15 Mark Sense Card Reader (uses DMA)
DVR22 3030 Magnetic Tape Driver

ALGOL is available for >8K users.

The appropriate SIO driver tapes (the SIO Teleprinter driver is always furnished) are supplied according to the user's hardware configuration.

DOS-M generation consists of four steps:

Initialization Phase	Establishes hardware configuration for DOS-M.
Program Input Phase	System and user relocatable programs are copied onto the disc.
Parameter Input Phase	Parameters to change EXEC modules and/or drivers from disc to core-resident may be entered. (The programs' NAM records are set for a minimum core system.) DISCM, DVR31 (moving-head disc driver) and DVRØ5 (teleprinter driver) must be core-resident.
Disc Loading Phase	DSGEN requests the number base page linkages to be allocated, then begins loading programs onto the disc. Systems programs (i.e., the modules of DOS-M), are loaded first, after which DSGEN requests information for the equipment table, device reference table (logical unit table), and interrupt table and proceeds to load the rest of programs onto the disc.

DOS-M CONFIGURATION WORKSHEET

This worksheet shows the information typed by the system teleprinter during DOS-M generation. Fill out the worksheet according to the formats specified to expedite the configuration process.

SYS GEN CODE?_____	Assign a number from one to four decimal digits for identification purposes.
SYS DISC CHNL?_____	Write the octal select code (interrupt location) of the system disc.
#SECTORS/TRACK?_____	Enter the decimal number of sectors contained on each track of the disc. Consult the appropriate hardware manual.
SYSTEM DISC SIZE?_____	Consult the disc hardware manual and enter the decimal number of tracks contained on the disc.
#DRIVES?_____	The number of disc drives on the system may be from one to four inclusive.
FIRST SYSTEM TRACK?_____	Enter the decimal first track number available to the system.
FIRST SYSTEM SECTOR?_____	Enter the decimal first sector number available to the system.
SYS DISC SUBCHNL?_____	Subchannels are numbered from Ø to 7_8. Write the subchannel number of the system disc.
USER DISC SUBCHNL?_____	This number may be the same as the system disc or different if a separate disc is available.
TIME BASE GEN CHNL?_____	Enter the select code (interrupt location) of the Time Base Generator.

IS 2114?_____	Type YES if the computer is an HP 2114; otherwise, type NO.
LWA MEM?_____	Respond according to the chart below: 4K = 7677 8K = 17677 16K = 37677 24K = 57677 32K = 77677
ALLOW :SS?_____	Enter YES if the system is to allow the system search optional directive; otherwise, enter NO.
PRGM INPT?_____	Write the abbreviation from the table below to specify the program input device: PT = Paper Tape MT = Magnetic Tape TY = Teleprinter
LIBR INPT?_____	Write the abbreviation of the library input device, (PT,MT,TY).
PRAM INPT?_____	Write the abbreviation of the device used to enter program parameters.
ENTER PROG PARAMETERS?_____ _____ _____ _____ _____ _____	Program parameters are specified in the following format: *name, type* *type* is the program type code, defined as follows: Ø - System Core - Resident 1 - System Disc - Resident EXEC Modules 3 - User Disc - Resident Main 4 - Disc - Resident I/O Driver 5 - User Segment 6,7 - Library >7 - Program Deleted From The System

If no parameters are specified, most of the system is loaded on the disc (with the exception of DVRØØ).

#SYSTEM LINKS?_____

Respond with a decimal number. The more core-resident modules, the more links are needed. 1ØØ is the minimum response.

#USER LINKS?_____

32Ø (decimal) is the minimum response since the Loader needs 32Ø.

NOTE: If the total of the above two responses overflows base page (>677$_{10}$), the two questions are repeated.

*EQUIPMENT TABLE ENTRY?_____

_____

_____

_____

_____

Type one EQT entry per line in this format:

XX, DVRnn [,D] [,R] [,U]

XX = the high priority select code of the device.

DVRnn is the driver name (nn is the equipment type code).

D, if present, means DMA is required.

R, if present, means that the driver is defined as type Ø (core-resident).

U, if present, is the physical subchannel number.

*DEVICE REFERENCE TABLE?_____

_____

_____

_____

_____

Write the EQT number (the order in which the device entries were made in the Equipment Table) of the device which is to perform the desired standard function.

*INTERRUPT TABLE?_____

_____

_____

_____

Write each interrupt location (select code) that may interrupt, in ascending order, in the following format:

X, Y

X is the select code (the high number if the device is two-channel) between 10_8 and 37_8 inclusive.

Y is the decimal EQT number associated with that select code.

FWA USER?_____

Respond with a number greater than the last word address of the system reported by DSGEN.

HOW TO GENERATE DOS-M

1. Complete the DOS-M Configuration Worksheet.
2. Turn on all equipment.
3. Set the system teleprinter to LINE.
4. Turn on the disc protect override switch (located in the lower right-hand corner of the controller).
5. For the disc drive, press POWER; place a cartridge in the slot; press LOAD; wait for the READY light to come on.
6. Load a configured DSGEN with BBL.
   (See HOW TO CONFIGURE DSGEN.)
7. Set the SWITCH REGISTER to the Starting Address of 100_8
   (0/000/000/000/000/000).
8. Press LOAD ADDRESS.
9. Press RUN.
   The Initialization Phase begins.
10. SYS GEN CODE?
    Type the decimal system generation code (written in the label field of the system disc for identification).
11. SYS DISC CHNL?
    Type the lower numbered octal channel number (select code) of the disc controller.
12. #SECTORS/TRACK?
    Type the number of sectors per physical track on the disc. This is half the number of sectors per logical or software track (usually 12).
13. SYSTEM DISC SIZE?
    Type the number of tracks on the system disc, less than or equal to 200. A response of 200 leaves three tracks as spares. A response less than 200 leaves extra tracks as spares.

14. #DRIVES?
    Type the number of drives on the system, between 1 and 4 inclusive.

15. FIRST SYSTEM TRACK?
    Type the decimal number of the first track on the system disc which is available to DOS-M.

16. FIRST SYSTEM SECTOR?
    Type the decimal number of the first sector available to DOS-M (the system area cannot begin before track Ø, sector 3).

17. SYS DISC SUBCHNL?
    Type the subchannel number of the system disc (between Ø and 7).

18. USER DISC SUBCHNL?
    Type the subchannel number of the default user disc (between Ø and 7). This number may be the same as the system disc.

19. TIME BASE GEN CHNL?
    Type the I/O channel (select code) of the Time Base Generator; an octal number or Ø if the Time Base Generator is not present.

20. Is 2114?
    Type YES if the computer is a 2114; type NO if not.

21. LWA MEM?
    Type the last word of available core memory in octal.

22. ALLOW :SS?
    Type YES if :SS directives are to be allowed in the system; type NO if not.

23. PRGM INPT?
    Type the abbreviation (See NOTE below) for the input used for relocatable program modules.

    NOTE: PT = Paper Tape
    TY = Teleprinter
    MT = Magnetic Tape

24. LIBR INPT?
    Type the abbreviation for the input unit used to enter relocatable library programs.

25. PRAM INPT?

    Type the abbreviation for the input unit used to enter the parameters describing the relocatable programs.

    Enter PT or TY.

    The disc clears tracks and after about 1Ø seconds the computer halts.

26. The Program Input Phase begins.

27. For each program listed below:

    a. Place the tape in the tape reader.

    b. Set all switches "OFF" for the Program Input Device or set switch 1 "ON" for the Library Input Unit.

    c. Press RUN.

    d. The computer halts at the end of each tape successfully read with $1Ø2Ø77_8$ in MEMORY DATA REGISTER and types *EOT on the teleprinter.

Recommended order of input:

DOS-M CORE-RESIDENT SYSTEM (DISCM)

NOTE: DISCM must be the first module loaded.

DOS-M DISC-RESIDENT EXEC MODULES ($EXØ1 thru $EX2Ø)
DOS-M I/O DRIVERS DVRØ5, DVRØ1,...etc.)
DOS-M JOB PROCESSOR/FILE MANAGER (JOBPR)
DOS-M RELOCATING LOADER (LOADR)
DOS-M ASSEMBLER MAIN CONTROL
DOS-M ASSEMBLER SEGMENT 1
DOS-M ASSEMBLER SEGMENT 2
DOS-M ASSEMBLER SEGMENT 3
DOS-M ASSEMBLER SEGMENT 4
DOS-M ASSEMBLER SEGMENT 5

DOS-M FORTRAN MAIN CONTROL
DOS-M FORTRAN PASS 1
DOS-M FORTRAN PASS 2
DOS-M FORTRAN PASS 3
DOS-M FORTRAN PASS 4
RTE/DOS-M RELOCATABLE PROGRAM LIBRARY (EAU or NON-EAU)

Any relocatable user programs to be made a permanent part of DOS-M.

NOTE: If the FORTRAN IV Library is to be included in an 8K System, certain rules must be followed:

1. *The system must be generated without any compilers or assembler.*
2. *A magnetic tape driver cannot be used with DSGEN.*
3. *The compilers and assembler must be loaded into the system during operation (using the loader).*

28. There are now several options:

    a. Additional programs can be input from the same device by repeating a,b, and c of step 27.

    b. Input can be switched to the other input device; set all switches to "OFF" (for Program Input Unit), or set switch 1 "ON" (for Library Input Unit).

29. To terminate the Program Input Phase:

    a. Set switch Ø "ON."

    b. Press RUN.

30. If there are no undefined externals, this message is printed on the system teleprinter:

    NO UNDEF EXTS

    If there are undefined externals, this message is printed:

    UNDEF EXTS

The externals are listed one per line and the computer halts.

External references are satisfied by locating more programs.

If more programs are to be loaded:

a. Set all switches "OFF" (for Program Input Unit) or set switch 1 "ON" (for Library Input Unit).

b. Press RUN.

If the externals are to be left unsatisfied:

a. Set the switch Ø "ON."

b. Press RUN.

The Parameter Input Phase begins with the teleprinter message:

ENTER PROG PARAMETERS

31. During the Parameter Input Phase, the operator can change some disc-resident modules to core-resident modules.

NOTE: If an I/O driver is changed from disc-resident (Type 4) to core-resident (Type Ø), the associate EQT entry must include the R (resident) parameter.

Since DVRØØ is a DOS driver (rather than DOS-M), it is distributed as core-resident. If the system contains DVRØ5, then DVRØØ should be changed to disc-resident.)

Each parameter record is of this general form:

name, type

where *name* is the name of the program

type is the program type code;

- Ø - System core-resident
- 1 - System disc-resident Exec modules
- 3 - User disc-resident main
- 4 - Disc-resident I/O driver
- 5 - User segment
- 6,7 - Library
- >7 - Program deleted from the system

Exec modules and drivers that are used frequently may be changed from disc to core-resident. The functions of the Exec modules are:

Module Name		Function
$EXØ1	-	Disc Work Tracks Status
$EXØ2	-	Disc Work Track Limits
$EXØ3	-	Program Completion
$EXØ4	-	Program Suspension
$EXØ5	-	Program Segment Load
$EXØ6	-	User File Name Search
$EXØ7	-	Current Time Processor
$EXØ8	-	Real-Time Disc Allocation.
$EXØ9	-	Execution Time :EQ Processor
$EX1Ø	-	Load and Execute Program
$EX11	-	System File Name Search
$EX12	-	System Startup
$EX13	-	Error Message Processor
$EX14	-	Execution Time, :UP, :DN, :LU Processor
$EX15	-	Abort and Post Mortem Dump
$EX16	-	:GO Parameter Processor
$EX17	-	:UD Processor
$EX18	-	User I/O Requests
$EX19	-	:IN Processor
$EX20	-	Disc Parity Error Processor

When Exec modules are made core-resident, certain associated subroutines must also be changed to be core-resident. Several Exec modules use $ADDR:

$EXØ1
$EXØ2
$EXØ6
$EXØ7
$EXØ8

The following Exec modules use $LBL:

$EX17
$EX19

The following Exec modules use $SRCH:

$EXØ5
$EXØ6
$EX11

These Exec modules use ASCII:

$EXØ4
$EXØ9
$EX13
$EX14
$EX15
$EX2Ø

32. To end the Parameter Input Phase and continue on to the Disc Loading Phase, type: /E (instead of a parameter record).

NOTE: If the user wishes the entry points for all main programs to be given, now set switch 15 "ON."

33. Before entering the Disc Loading Phase, two questions are asked:

#SYSTEM LINKS?

Type the estimated number decimal of system linkages required in base page.

NOTE: The more modules that are core-resident, the more links are needed; 1ØØ should be the minimum response.

34. USER LINKS?

Type the estimated decimal number of user linkages required in base page.

NOTE: Since the loader requires approximately 32Ø linkages, 32Ø should be the minimum number entered.

If the system requires more linkages than the number assigned by the operator, it takes them away from the user linkage area.

If the total of the two responses overflows base page (i.e., is greater than $577_{1Ø}$), the questions are repeated.

The Disc Loading Phase begins.

35. Loading of the absolute, resident supervisor begins after the establishment of the user and system linkage areas. As each program is loaded, a memory map is printed, giving the starting locations and, if switch 15 is "ON," the entry points for all main programs and subroutines. Subroutines are indented two spaces, and entry point addresses are preceded by an asterisk.

36. Three I/O tables are now generated: the Equipment Table, the Device Reference Table, (Logical Unit Table), and the Interrupt Table.

*EQUIPMENT TABLE ENTRY?

Respond with a series of one line EQT entries, which are assigned EQT numbers sequentially from one as they are entered. The EQT entry relates the EQT number to an I/O channel and driver, in this format:

*n*1, DVR*nn* [,D][,R][,U]

where *n*1 is the I/O channel (lower number if multi-board),
DVR*nn* is the driver name (*nn* is the equipment type code),
D, if present, means DMA channel required,
R, if present, means driver is core-resident (must be type Ø),
U, is the physical subchannel number.

37. Terminate the Equipment Table entries by typing:

```
/E
```

For Example:

```
*EQUIPMENT TABLE ENTRY
1Ø,DVR31,D,R          (EQT entry #1 = disc)
12,DVR22,D            (EQT entry #2 = magnetic tape)
14,DVRØ5,R            (EQT entry #3 = system teleprinter)
15,DVRØ1              (EQT entry #4 = photoreader)
16,DVRØ2              (EQT entry #5 = Tape punch)
17,DVR12              (EQT entry #6 = line printer)
/E                    (End of Table)
```

38. *DEVICE REFERENCE TABLE?

n=EQT#?

n=EQT? is printed for each logical unit number. Enter an EQT entry number (*m*) appropriate to standard definition of *n*. Numbers above may be assigned any EQT entry desired.

Terminate the Device Reference Table entries by typing:

```
/E
```

For Example:

```
*DEVICE REFERENCE TABLE
1 = EQT#?
Answer:  3 (System teleprinter on channel (select code) 14, EQT#3)
2 = EQT#?
Answer:  1 (User disc on channel (select code) 1Ø, EQT#1)
3 = EQT#?
Answer:  1 (System disc on channel (select code) 1Ø, EQT#1)
4 = EQT#?
Answer:  5 (Standard punch unit on channel 16, EQT#5)
5 = EQT#?
Answer:  4 (Standard input unit on channel 15, EQT#4)
6 = EQT#?
Answer:  6 (Standard list unit on channel 17, EQT#6)
7 = EQT#?
Answer:  2 (Standard unit defined by user, EQT#2)
8 = EQT#?
Answer:  /E (End of Table).
```

39. *INTERRUPT TABLE?

Respond with an entry for each I/O location which may interrupt, in ascending order, and in this format.

*n*1, *n*2,

where *n*1 is the octal channel number (higher numbered channel for 3Ø3Ø magnetic tape and 287Ø moving-head disc) between $1Ø_8$ and 37_8 inclusive

*n*2 is a decimal EQT entry number

Terminate the Interrupt Table entries by typing:

/E

For Example:

```
*INTERRUPT TABLE
 11,1   (Channel 11 linked to EQT #1)
 13,2   (Channel 13 linked to EQT #2)
 14,3   (Channel 14 linked to EQT #3)
 15,4   (Channel 15 linked to EQT #4)
 16,5   (Channel 16 linked to EQT #5)
 17,6   (Channel 17 linked to EQT #6)
 /E     (End of Table)
```

NOTE: The EQT numbers need not appear in numerical order. This order is determined by referring back to the Equipment Table. The octal channel numbers, however, must be in ascending sequence.

40. The last address (plus 1) of the supervisor is typed:

LWA SYS *xxxxx*

then:

FWA USER?

Type the first word address octal of the user program area greater than *xxxxx*.

NOTE: In an 8K computer, this response must be less than or equal to $72ØØ_8$.

(This option is provided so that user programs can start on a page boundary, if desired.)

DSGEN proceeds to load all user main programs and segments onto the disc with memory map listings as described for system programs. When system generation is complete, this message is typed:

*SYSTEM STORED ON DISC

The last track used is in bits 15 through 8 of the A-REGISTER, and the last sector used is bits 7 through Ø of the A-REGISTER.

The disc protect override switch should be turned off.

41. During any of the phases, DSGEN can restart that phase if any error occurs.

Set the SWITCH REGISTER to the Starting Address of $1ØØ_8$ (0/000/000/00●/000/000).

Press LOAD ADDRESS.

Press RUN.

ERROR MESSAGES

See DOS Error Messages in this section for messages printed during DOS-M generation.

HOW TO INITIATE DOS-M

1. Load a configured Bootstrap with BBL. (See HOW TO CONFIGURE A DOS-M BOOTSTRAP.)
2. Set the SWITCH REGISTER to the Starting Address of 100_8 (0/000/000/000/000/000).
3. Press LOAD ADDRESS.
4. Set switches 2 through Ø equal to the octal subchannel of the system disc. (If this subchannel is not the same as the subchannel that was specified when the system was generated, the new subchannel overrides the old.)
5. Press PRESET.
6. Press RUN.
7. INPUT:DATE,*xxxxxxxxxx*[,H,M]
   Type a DATE directive (See SUMMARY OF DIRECTIVES.)

NOTE: The only directives that can be used after the DATE directive are TRACKS, BATCH and JOB. All other directives are ignored by DOS-M. After typing a JOB directive, any other directives may be used.

HOW TO CONFIGURE A DOS-M BOOTSTRAP

1. Load the SIO Tape Punch Driver or the SIO Teleprinter Driver with BBL.
2. Set the SWITCH REGISTER to the Starting Address of $10\emptyset\emptyset_8$ (0/000/000/00●/000/000).
3. Press LOAD ADDRESS.
4. Set switches 5 through Ø equal to the octal select code of the device.
5. Press RUN.
6. Load Bootstrap with BBDL.
7. Set switch 1 "ON."
8. Press LOAD ADDRESS.
9. Set switches 5 through Ø equal to the octal select code of the disc controller.
10. Set switch 15 "ON" to punch a configured Bootstrap.
11. Press RUN.
    After Bootstrap punches the tape, it halts with $10\emptyset2\emptyset77_8$ (●/000/0●0/000/●●●/●●●) in the MEMORY DATA REGISTER.
12. Press RUN for another copy.

NOTE: If the computer halts with $10\emptyset2\emptyset11_8$ (●/000/0●0/000/00●/00●) in the MEMORY DATA REGISTER, a disc error has occurred. The disc status is in the A-Register.

FORMATTING USER DISCS

Any time a new disc is added or an old system disc is reused as a user disc, DSGEN must be used to format a new user disc or cartridge. Formatting a disc results in an unlabelled user disc ready for use in DOS-M.

> *NOTE: Formatting does not have to be done for the system disc because DSGEN will format it during system generation.*

The formatting process involves:

- Assigning a system generation code.
- Reading every sector
- Clearing any existing user directory
- Clearing any protected or disabled sectors, etc.

HOW TO FORMAT DISCS

1. Turn on all equipment.
2. For the disc drive:
    a. Press POWER.
    b. Place a cartridge in the slot.
    c. Press LOAD.
    d. Wait for the READY light to come on.
3. Turn ON the disc protect override switch. (This switch is located in the lower right hand corner of the controller.)
4. Load a configured DSGEN tape with BBL. (See HOW TO CONFIGURE DSGEN.)
5. Set the SWITCH REGISTER to the Starting Address of 100_8 (0/000/000/000/000/000).
6. Press LOAD ADDRESS.
7. Set switch 15 "ON."
8. Press PRESET.
9. Press RUN.
10. SYS GEN CODE?
    Type the decimal number to be written on the disc label.
11. SYS DISC CHNL?
    Type the octal select code (lower numbered) of the disc controller.
12. #SECTORS/TRACK
    Type the decimal number of sectors per hardware track on the disc. (This is half the number of sectors on a software track, usually 12.)
13. USER DISC SUBCHANNEL?
    Type the subchannel number (between 0 and 7 inclusive) of the user disc to be formatted.

14. If the disc protect override switch is not turned on, this message is typed:

    TURN ON DISC PROTECT OVERRIDE

    Turn on the disc protect override switch.

    Press RUN.

15. DSGEN carries out formatting on the specified subchannel and halts with $10200 7_8$ (●/000/0●0/000/000/●●●) in the MEMORY DATA REGISTER.

16. There are now two operator choices:

    a. To format a new disc (check that switch 15 is still "ON") press RUN. DSGEN repeats from step 12.

    b. To proceed to system generation, set switch 15 "OFF."

HOW TO CONFIGURE DSGEN

To use DSGEN, configure DSGEN for the particular input/output arrangement presently residing in memory. There are two ways to configure DSGEN:

1. To configure DSGEN and make a tape copy of the configuration:
    a. Follow HOW TO CONFIGURE AN SIO MODULE, then RECOMMENDED SIO PROGRAM CONFIGURATION (Section III).
    b. Load the configured DSGEN tape with BBL.

2. For the operator who already has a configured tape, load the configured DSGEN tape with BBL.

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.
:COMMENT *string*	Print a message.
:DATE,*day*[,*hour,min*]	Set the date and the time (if time-base is present).
:DD	Dump an entire 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 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.
: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.

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 the user directory.
:LIST,X,*log.unit*[,$file_1$,...]	List 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.
: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).

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 and subchannel information for a user disc.
:UP,*n*	Declare an I/O device up.

During operation of the DOS or DOS-M, certain error reports or system messages may be printed out on the system teleprinter. These messages are listed alphabetically, including where they originated, what they mean, and what action, if any, the operator must take. If these actions are beyond the responsibility of the particular operator, refer to the programmer.

Message	System	Source	Meaning	Action
BAD CONTROL STATE	DOS, DOS-M	JOBPR	Directive just entered is not acceptable in DOS.	Enter correct directive on system teleprinter.
BAD DIRECTORY OR SYSTEM	DOS	JOBPR	Parity error has occurred during read from disc of a system directory, or the system buffer.	Restart. If same message occurs again, call maintenance.
BEGIN'DEBUG' OPERATION	DOS, DOS-M	DEBUG	Any legal DEBUG operations may be entered.	Enter any legal DEBUG operations.
CHECKSUM ERROR	DOS, DOS-M	JOBPR	Checksum error in input to :ST,R,file, LU directive.	Correct tape.
CW*nnnnn*	DOS, DOS-M	DISCM	In a READ/WRITE EXEC call at *nnnnn*, buffer for EXEC call at *nnnnn* is out of memory bounds.	Correct program.
DEVICE #*nn* DOWN	DOS, DOS-M	JOBPR	EQT #*nn* is unavailable (down).	Use the UP,*nn* directive to make the device available (up). (Then use the GO directive if needed.)

Message	System	Source	Meaning	Action
DICTIONARY OVERFLOW				
	DOS, DOS-M	JOBPR	No room is left for entries in the user file dictionary.	Put file on another disc or remove some of the files on the disc.
??? DISC	DOS-M	DISCM	Informs user that user disc was labelled by TSB or other non-DOS systems.	May be made a DOS-M disc by labeling or unlabeling with :IN.
DISC GEN CODE *nnnn* NOT SYS GEN CODE *nnnn* ERR POSS				
	DOS-M	DISCM	Informs the user that the disc being requested was initialized (labeled) by a system with a different system Generation Code.	Generation Code on disc may be updated by labelling or unlabelling with :IN.
DISC INPUT ERROR	DOS	SDUMP	Disc error diagnostic, for a parity, decode, or abort status after 10 retrys. Input sequence repeated on restart.	Call maintenance.
DISC NOT ON SYSTEM				
	DOS-M	DISCM	No disc with the currently requested label can be found on the system.	Mount disc pack with correct label or ready drive containing disc.
DISC TRACK *ttt* ERROR				
	DOS	DISCM	Disc error when attempting to read track *ttt*.	Call maintenance if track is in system area; otherwise, system will continue to function.
DISC WRITE ABORT	DOS	SDUMP	Disc error diagnostic for an abort status after a write attempt. Sequence is repeated if requested.	Call maintenance.

Message	System	Source	Meaning	Action
DONE?	DOS, DOS-M	JOBPR	Thirty feed frames (paper tape) or an end-of-file (magnetic tape) have occurred during input.	Enter YES for end of input; NO for more input.
??? LABEL *xxxxxx* DOS LABEL *xxxxxx* TSB LABEL *xxxxxx*	DOS-M	DISCM	Attempting to label (or unlabel) an already labeled disc pack.	Enter YES to relabel the disc pack or NO to drop the request to relabel the disc pack.
DUPLICATE FILE NAME	DOS, DOS-M	JOBPR	Doubly defined file name found in a :STORE directive (other than STORE,P), or an EDIT directive with a new file name, or on DD,U	Remove file, or rename file.
$END ALGOL	DOS, DOS-M	ALGOL	End of ALGOL compilation	No action required.
$END ASMB	DOS, DOS-M	ASMB	Assembly has completed.	No action required.
$END ASMB CS	DOS, DOS-M	ASMB	Assembly has ended because of an error in the Assembler control statement.	Correct the control statement.
$END ASMB NPRG	DOS, DOS-M	ASMB	Assembly has terminated because no JFILE was found when required.	Define the file using a JFILE directive.
$END ASMB PASS	DOS, DOS-M	ASMB	Another pass of the source program through the input device is required. Printed on the system teleprinter after Pass 1.	Replace the program in the input device and type: :GO.
$END ASMB XEND	DOS, DOS-M	ASMB	Assembly stops. An EOF occurred in the source program before an END statement.	Add an END statement to the program.

Message	System	Source	Meaning	Action
END FILE	DOS, DOS-M	JOBPR	During an "EDIT, (1) the master file ended before completion of editing or (2) a colon occurred in column 1 of a source statement.	Check input to the EDIT program.
$END FTN	DOS DOS-M	FTN	Compilation has completed.	No action required.
END JOB *xxxx* [RUN = *xxxx* MIN. *xx.x* SEC EXEC = *xxxx* MIN. *xx.x* SEC]				
	DOS, DOS-M	JOBPR	End of current job. Total job time and execution time of the job are printed on the system teleprinter and standard list device. The portion of the message in brackets is printed in DOS-M only if a Time Base Generator is part of the system.	Enter next job.
ENTER FILE NAME(S) OR /E				
	DOS, DOS-M	LOADR	Enter list of relocatable program files.	To terminate list of file names, type "/E".
ENTRY ERROR	DOS, DOS-M	DEBUG	DEBUG operation entered was illegal.	Correct entry.
EQT *xx* CH *xx* DVR*xx*	D R U*x* S*x*			
	DOS, DOS-M	JOBPR	Equipment table entry printed by the directive :EQ.	No action required.
EXTRA PARAMETERS				
	DOS, DOS-M	JOBPR	More than 15 parameters in a directive.	Reduce the number of parameters.
FI *nnnnn*	DOS, DOS-M	DISCM	In a FILE READ/WRITE EXEC call, the file requested at *nnnnn* cannot be found. Calling program is aborted.	Check for File name requested at *nnnnn*. If the file *nnnnn* is not present, enter the file *nnnnn*.

Message	System	Source	Meaning	Action
HPAL	DOS, DOS-M	ALGOL	Control statement error.	Correct control statement.
IB *nnnnn*	DOS, DOS-M	DISCM	Illegal buffer address in EXEC call at location *nnnnn*. Program is aborted.	Correct buffer program address.
IE *nnnnn*	DOS, DOS-M	DISCM	If a colon occurs in the first column of input entered through the batch device during a program execution, the program is aborted, and control is given to the JOBPR. *nnnnn* is the memory location of the input request.	Correct program and data deck.
IGNORED	DOS, DOS-M	DISCM	Input from system teleprinter during program execution cannot be processed.	Correct input.
*IGNORED	DOS, DOS-M	JOBPR	All directives following EJOB and before next JOB except BATCH, TYPE, and TRACKS are ignored.	Enter acceptable directive and OFF.
file ILLEGAL	DOS, DOS-M	JOBPR	(1) On a source file LIST directive, the requested file was not a source file. (2) A file name begins with a non-alphabetic character.	(1) Retype LIST directive using source file. (2) Rename the file.
ILLEGAL DIGIT	DOS, DOS-M	JOBPR	(1) In a decimal number, character is other than Ø-9. (2) In an octal number, digit is other than Ø-7.	(1) Enter correct decimal number. (2) Enter correct octal number.

Message	System	Source	Meaning	Action
ILLEGAL PROGRAM RUN LIMITS				
	DOS-M	DISCM	Attempt to run a user main or segment whose user area limits or base page limits will not fit within the limits of the current system.	Recreate user mains or segments on current system using LOADR.
ILLEGAL PROGRAM TYPE				
	DOS, DOS-M	JOBPR	Program requested in a RUN or PROG is not legal.	Enter correct name.
INPUT ERROR	DOS, DOS-M	DISCM	Equipment table entry number of logical unit number in EQ, LU, UP or DN is illegal.	Enter correct equipment table entry number.
INPUT:DATE, XXXXXXXXXX[,H,M,]				
	DOS, DOS-M	DISCM	When system is initiated from the disc, DOS requires a DATE directive. The "HM" is ignored in DOS-M if a Time Base Generator is not in the system.	Enter a DATE directive.
INPUT FR=FRESH; CO=CONTINUATION				
	DOS	DISCM	When system is initiated from the disc, DOS or DOS-M asks whether start-up is fresh (no user files) or continuation (user files on disc).	Enter FR if start-up is fresh. Enter CO if start-up is a continuation.
I/O ERR ET EQT #*mm*				
	DOS, DOS-M	DISCM	End-of-tape on device #*mm*. EQT #*mm* is unavailable.	Install a new tape supply. To make the device available (up) use the UP,*n* directive.

Message	System	Source	Meaning	Action
I/O ERR NR EQT *#mm*	DOS, DOS-M	DISCM	The device *#mm* is not ready.	To make the device available (up) use the UP,*n* directive.
I/O ERR PE EQT *#mm*	DOS, DOS-M	DISCM	Parity error on device *#mm* returns to program return address with A set to status, B set to Ø.	Call maintenance.
I/O ERR {PE / NR} USER DISC	DOS-M	DISCM	A parity error or device not ready occurred when attempting to assign a user disc.	Disc may not be formatted; format it with DSGEN.
IT *nnnnn*	DOS, DOS-M	DISCM	Illegal disc track or sector address in EXEC call from location *nnnnn*. Program is aborted.	Correct the track or sector address in EXEC call.
JBIN OVF	DOS, DOS-M	FTN, ASMB	Overflow of job binary area during assembly or compilation.	Reduce size of job or purge user files.
JBIN TRK BAD	DOS	JOBPR	Parity error when reading a program from the job binary area.	Call maintenance.
JOB ABORTED!	DOS, DOS-M	JOBPR	Current job is aborted.	Correct program and start new job.
JOB *xxxxx ddddddddd*[TIME = *xxxx* MIN. *xx.x* SECS EXEC = *xxxx* MIN. *xx.x* SEC.]	DOS, DOS-M	JOBPR	Message printed at the beginning of each job. The time information is deleted in DOS-M if a Time Base Generator is not included in the system.	Start job.

Message	System	Source	Meaning	Action
LBL = *111111*	DOS-M	DISCM	Disc subchannel referenced is labeled *111111*.	If attempting to change user subchannel, enter UD with correct label.
LIMIT ERROR	DOS, DOS-M	JOBPR	In a directive, source statement numbers out of order (EDIT), dump limits are incompatible in (PDUMP, ADUMP), sector numbers are illegal (DUMP), or beginning source statement is greater than final statement number (EDIT).	Correct directive and re-enter.
xxxx LINES	DOS, DOS-M	JOBPR	Total number of statements stored by a STORE,S directive.	No action required.
****LIST END****	DOS, DOS-M	JOBPR	Terminates list of source statements generated by a LIST directive.	No action required.
LN *nnnn*	DOS, DOS-M	DISCM	Logical unit requested by an EXEC call at *nnnn* is unassigned. Program is aborted.	Reassign logical unit.
LOADR COMPLETED	DOS, DOS-M	LOADR	Loading has completed.	No action required.
LOADR SUSP	DOS, DOS-M	LOADR	Loader has suspended (usually at EOT).	Type :GO,*n* to restart the Loader with proper parameter value.
LOAD TAPE	DOS, DOS-M	LOADR	In conjunction with LOADR SUSP, this message requests that next relocatable tape be loaded before GO	Load the next relocatable tape and enter :GO to read next tape or :GO,*1* to indicate that all tapes are read in.
LOADR TERMINATED	DOS, DOS-M	LOADR	Loader has terminated because of an error.	Check input.

Message	System	Source	Meaning	Action
LU *nnnnn*	DOS, DOS-M	DISCM	Illegal logical unit in EXEC call at *nnnnn*. Program is aborted.	Enter correct logical unit number.
LU*xx* EQT*xx*	DOS, DOS-M	JOBPR	Logical unit table entry; EQT #*xx* is assigned to LU #*xx*.	No action required.
LUN UNASSIGNED	DOS, DOS-M	JOBPR	Logical unit requested in a directive is unassigned.	Assign logical unit number requested in the directive.
LØ1	DOS DOS-M	LOADR	Checksum error on tape.	Return to programmer.
LØ2	DOS, DOS-M	LOADR	Illegal record.	Return to programmer.
LØ3	DOS, DOS-M	LOADR	Memory overflow.	Return to programmer.
LØ4	DOS, DOS-M	LOADR	Base page overflow.	Return to programmer.
LØ5	DOS, DOS-M	LOADR	Symbol table overflow.	Return to programmer.
LØ6	DOS, DOS-M	LOADR	Duplicate main or segment name (may be caused by attempting to run the loader twice in one job).	Return to programmer.
LØ7	DOS, DOS-M	LOADR	Duplicate entry point.	Return to programmer.
LØ8	DOS, DOS-M	LOADR	No main or segment transfer address.	Return to programmer.
LØ9	DOS, DOS-M	LOADR	Record out of sequence.	Return to programmer.
L1Ø	DOS, DOS-M	LOADR	Insufficient directory, work area or user area space.	Return to programmer.
L11	DOS, DOS-M	LOADR	Program name table overflow.	Return to programmer.

Message	System	Source	Meaning	Action
L12	DOS, DOS-M	LOADR	User file specified cannot be found,	Return to programmer.
L13	DOS, DOS-M	LOADR	Program name duplication.	Return to programmer.
L14	DOS, DOS-M	LOADR	Non-zero base page length.	Return to programmer.
L15	DOS, DOS-M	LOADR	Segment occurred before main.	Return to programmer.
L16	DOS, DOS-M	LOADR	Program overlay (illegal ORG).	Return to programmer.
xxxxx MISSING	DOS, DOS-M	DISCM	Segment *xxxxx*, by an EXEC call, is not in system or user directory. Job is aborted.	Correct job.
MISSING PARAMETER	DOS, DOS-M	JOBPR	A parameter is missing in a directive.	Retype the directive correctly.
MP *nnnnn*	DOS, DOS-M	DISCM	Memory protect violation at location *nnnnn*. Program is aborted.	Correct the program.
NAME*IGNORED	DOS, DOS-M	JOBPR	Illegal JOB *name*; non-alphabetic first character.	Retype correct JOB name.
NEXT AVAIL TRACK=*tt* BAD=*nn*	DOS-M	JOBPR	In TRACK directive, *tt* = first track beyond end of current user area; *n* = number of bad tracks. "BAD=*n*" returned only if bad tracks do exist. *tt* = "NONE" if no tracks are available.	No action required
NO BIN END	DOS, DOS-M	JOBPR	No END record detected when storing a relocatable binary program.	Input correct binary program.

Message	System	Source	Meaning	Action
NO PROGRAM LOADED				
	DOS, DOS-M	LOADR	No programs were loaded by the LOADR. Loading terminates.	
NO SOURCE	DOS, DOS-M	ALGOL	Source file from disc not pre-set.	
NO SOURCE	DOS, DOS-M	JOBPR	No source statements following a /R or /I in an EDIT directive. Job is aborted.	Enter source statements after the /R or /I.
NO TRACKS AVAILABLE				
	DOS	JOBPR	No tracks available on disc for writing.	Purge unnecessary file and try again.
NUMBER OVERFLOW	DOS, DOS-M	JOBPR	An integer is too large.	
OR *nnnnn*	DOS, DOS-M	DISCM	I/O operation requested EXEC call at *nnnnn* is rejected. Program is aborted.	Check program.
OVERFLO JBIN	DOS, DOS-M	JOBPR	There is not enough room in the JBIN for storing the relocatable binary output from the assembler or compiler.	
PARAMETER ILLEGAL				
	DOS, DOS-M	JOBPR	A parameter of a directive is illegal.	Re-enter directive.
PARITY ERROR/TRK=*ttt*				
	DOS	JOBPR	Parity error during disc read or write.	Call maintenance.
PARITY ERROR/SC=*m*,TRK=*ttt*,SCTR=*sss*				
	DOS-M	JOBPR	Parity error during disc read or write.	Call maintenance.

Message	System	Source	Meaning	Action
PAUSE *xxxx*	DOS, DOS-M	DISCM	Program has temporarily suspended itself. *xxxx* is an octal number.	Restart program using the GO directive.
RE-ENTER STATEMENT ON TTY				
	DOS, DOS-M	JOBPR	Follows most error messages that do not cause abort.	Type in the correct statement.
RQ *nnnnn*	DOS, DOS-M	DISCM	Illegal request code in EXEC call at *nnnnn*. Program is aborted.	Correct the program.
SPARE TRK OVERFLOW				
	DOS-M	JOBPR	Defective cylinder detected and no spare tracks available for reassignment.	
STOP *xxxxx nnnnn*	DOS, DOS-M	DISCM	Program *xxxxx* has terminated at location *nnnnn*.	No action required.
SUBCHAN=*n*	DOS-M	DISCM JOBPR	Given in response to UD information request or when JOBPR in :SS makes new subchannel assignment.	No action required.
xxxxx SUSP	DOS, DOS-M	DISCM	Program *xxxxx* suspended by EXEC call or PAUSE directive.	Restart program using the GO directive.
TAPE END	DOS-M	JOBPR	EOT flag set on magnetic tape or paper tape device during output via JOBPR directives :DUMP and :LIST or output of a JOB or EJOB statement. If a magnetic tape, it is rewound with standby; if paper tape, a trailer is punched. The JOBPR will then pause to allow new tape to be set up.	Mount a new magnetic tape. Enter :GO to continue the output.

Message	System	Source	Meaning	Action
TM *nnnnn*	DOS, DOS-M	DISCM	Maximum execution time exceeded. The program is currently at *nnnnn* and is aborted.	Increase execution time.
TRAC # TOO BIG	DOS, DOS-M	JOBPR	Track requested is higher than last available disc track (track may be in JBIN area).	Redefine the TRACK request, purge files or, only for DOS-M use different disc.
#TRACKS UNAVAILABLE	DOS, DOS-M	DISCM	There are not enough work tracks for the compiler.	Purge disc of unnecessary files.
TSB DISC	DOS-M	DISCM	Informs user that the user disc was labeled by a non-DOS-M system.	May be made. DOS-M disc by labeling or unlabeling with :IN.
TURN {ON / OFF} DISC PROTECT OVERRIDE SWITCH	DOS-M	DISCM	Follows parity error.	Follow the instruction. Press RUN.
UD *nnnnn*	DOS-M	DISCM	Unable to find user disc requested by EXEC call at *nnnnn*.	Mount required disc and type :GO or terminate program with :AB or :OF.
UNLBL	DOS-M	DISCM	User disc specified in UD is unlabeled.	If trying to change user disc assignment, enter UD,*[,*n*].
file name UNDEFINED	DOS, DOS-M	JOBPR	Undefined file-name in PURGE, LIST, RUN, STORE, or DD, U file name.	Retype correct file name on the system teleprinter.

Message	System	Source	Meaning	Action
UNDEFINED EXTS	DOS, DOS-M	LOADR	Undefined external references exist in programs loaded. The external references are listed one per line.	To load additional programs from paper tape type :GO,Ø[,*n*]. To continue without fulfilling external references type :GO,*1*.
WAIT	DOS	JOBPR	DOS is purging the user files or moving them, sector by sector, because of parity error on read. Printed every 6 seconds.	Wait.
WRONG INPUT	DOS, DOS-M	JOBPR	Relocatable binary input furnished for a source file request or vice-versa.	Put in correct input.
nn xx	DOS, DOS-M	ERRØ	Library routing error code.	
@	DOS, DOS-M	JOBPR/ DISCM	Directives may be entered.	Enter desired directive.
*	DOS, DOS-M	DISCM	Operator attention directives may be entered.	Enter desired directive.
1ST WORK TRACK=*ttt* BAD=				
bbb	DOS	JOBPR	In TRACK directive, *ttt* = available work track; *bbb* = faulty tracks.	Redefine track.

REAL-TIME EXECUTIVE

The Real-Time Executive (RTE) operates in a disc/drum environment (see Glossary) and uses multiprogramming and priorities to schedule both real-time and background programs that can be core- or disc-resident. RTE controls all input/output and interrupt processing, except for special privileged interrupt, which can circumvent RTE for extra-quick response.

HARDWARE

HP 2116 computer with 16K memory
Direct Memory Access
Extended Arithmetic Unit
Memory Protect
Disc or Drum Storage Unit
Time Base Generator
HP 2752A or 2754B teleprinter

Background translation and execution require additional input, list, and output power which an extra 2752A can supply.

SOFTWARE

These binary tapes are supplied to the RTE user:

REAL-TIME GENERATOR
REAL-TIME SCHEDULER
REAL-TIME EXECUTIVE CONTROL
REAL-TIME I/O CONTROL
REAL-TIME EDITOR
REAL-TIME ASSEMBLER MAIN CONTROL
REAL-TIME ASSEMBLER SEGMENT D
REAL-TIME ASSEMBLER SEGMENT 1
REAL-TIME ASSEMBLER SEGMENT 2
REAL-TIME ASSEMBLER SEGMENT 3
REAL-TIME ASSEMBLER SEGMENT 4
REAL-TIME ASSEMBLER SEGMENT 5
REAL-TIME FORTRAN MAIN CONTROL
REAL-TIME FORTRAN PASS 1
REAL-TIME FORTRAN PASS 2
REAL-TIME FORTRAN PASS 3
REAL-TIME FORTRAN PASS 4
REAL-TIME RELOCATING LOADER

RTE/DOS RELOCATABLE LIBRARY (EAU)
RTE/DOS FORTRAN IV LIBRARY or
RTE/DOS FORMATTER
SYSTEM DUMP
PREPARE TAPE SYSTEM

NOTE: RTE/DOS ALGOL (MAIN CONTROL) and RTE/DOS ALGOL (SEGMENT 1) tapes may be used only with 24K memory size.

These are the RTE drivers that can be supplied to the user:

DVR ØØ Teleprinter
DVR Ø1 to DVR Ø7 Paper Tape Devices
DVR Ø1 Tape Reader
DVR Ø2 Tape Punch
DVR 1Ø to DVR 17 Unit Record Devices
DVR 1Ø Calcomp Plotter
DVR 12 Line Printer
DVR 15 Mark Sense Card Reader (uses DMA)
DVR 2Ø to DVR 37 Magnetic Tape/Mass Storage Devices
DVR 22 3030 Magnetic Tape (uses two channel DMA)
DVR 3Ø Disc/Drum
DVR 4Ø to DVR 77 Instruments

The appropriate SIO driver tapes (the SIO teleprinter is always furnished) are supplied according to the user's hardware configuration.

GENERATING THE REAL-TIME EXECUTIVE SYSTEM

These are the five stages in RTE generation.

System Preparation	The operator checks that all devices are operable in the HP computer system, loads the necessary SIO driver tapes, and loads the REAL-TIME GENERATOR tape.
Initialization Phase	Establishes disc size, type, and system hardware information.
Program Input Phase	System and user programs are copied onto disc.
Parameter Input Phase	With the exception of the main programs and segments, the operator can modify the type, priority, or execution intervals of any of the programs entered during the Program Input Phase.
Disc Loading Phase	All tables are constructed and the absolute system is created on the disc or drum.

RTE CONFIGURATION WORKSHEET

This worksheet contains the information that appears on the system teleprinter during RTE generation.

DISC CHNL?_____	Type the octal select code (interrupt address) of the system disc device.
SYS DISC SIZE?_____	Enter the number of tracks on the system disc (decimal).
NO. PROTECTED?_____	RTGEN asks for the number of hardware protected tracks (decimal).
#SECTORS/TRACK?_____	Write the number of sectors per track on the system disc device.
AUX DISC SIZE?_____	If no auxiliary disc exists, type Ø. Otherwise, type the number of tracks (decimal) on the auxiliary disc.
TBG CHNL?_____	Enter the octal select code (interrupt location) of the Time Base Generator.
PRIV. INT. CARD ADDR?_____	Enter the octal select code (interrupt location) of the Privileged Interrupt Card (all devices in channels below the card become privileged). Enter zero if the card is not used.
SWAPPING?_____	Enter YES if swapping of real-time disc-resident programs in and out of core is included. Otherwise enter NO.
LWA MEM?_____	Respond with the Last Word Address (octal) of available memory according to the memory size of the computer. 8K = 1776Ø 16K = 3776Ø 24K = 5776Ø 32K = 7776Ø

PRGM INPT?_____

Enter the abbreviation from the table below of the device used to load program tapes:
PT = Paper Tape
MT = Magnetic Tape
TY = Teleprinter

LIBR INPT?_____

Enter the abbreviation of the device used to load the library routines.

PRAM INPT?_____

Enter the abbreviation of the device used to load program parameters (PT or TY).

PARAMETERS_____
_____
_____
_____

Parameter input allows the user to change disc-resident modules to core-resident and modify priority or execution intervals according to the form:
name, type [,*priority*][,*execution interval*]

name is the name of the program.
type is the program type code.
priority is the program priority from 1 to 99, with 1 the highest.
execution interval is a list of six parameters specifying the times the program should be scheduled for execution, once it is turned on.

#OF BLANK SEGMENTS?_____

Respond with a one or two digit decimal number of Blank ID Segments used for on-line loading of background programs by the Relocating Loader.

FWA BP LINKAGE?_____

Respond with an octal number just above the linkage location address.

*EQUIPMENT TABLE ENTRY_____

_____

_____

_____

Write a series of one-line EQT entries which are assigned numbers sequentially from one as they are entered. The format is as follows:

XX, DVRnn [,D] [,B] [,U]

XX is the select code (lower number if two) of the device.

DVRnn is the driver name (nn is the equipment type code).

D, if present, means DMA is required.

B, if present, means automatic output buffering required.

U is the physical subchannel number.

*DEVICE REFERENCE TABLE

For each logical unit number, RTGEN prints:
n = EQT#?
where n is a decimal integer starting with one.

Operator responds with an EQT entry number appropriate to the standard definition of n.

*INTERRUPT TABLE_____

_____

_____

_____

_____

Write each select code which may interrupt (in ascending order) followed by an option in this format:

XX, *option*

XX = select code (interrupt location)

Option = one of four ways of handling the interrupt.

EQT,Y relates channel X to EQT entry number Y.

PRG,*name* causes program called name to be scheduled upon interrupt.

ENT,*entry* causes control to be passed to the entry point of a user written system program upon interrupt.

ABS,XXXXXX places an absolute octal value in the interrupt location

CHANGE FWA SYS AV MEM?_____

If user wishes to change the first word address of available system memory (to make room in the linkage area for more disc-resident programs) he responds with a number greater than the FWA SYS MEM reported by RTGEN earlier. Type zero for no change.

BG BOUNDARY?_____

The first address of the Background Area shows area used for I/O buffering. Operator responds with an octal address.

PRAM INPT?_____

Write the abbreviation of the device used to enter program parameters.

ENTER PROG PARAMETERS_____

_____

_____

_____

_____

_____

Program parameters are specified in the following format:

name, type

type is the program type code;

Ø - System core-resident
1 - System disc-resident EXEC modules
3 - User disc-resident main
4 - Disc-resident I/O driver
5 - User segment
6,7 - Library
>7 - Program deleted from the system.

If no parameters are specified, most of the system is loaded on the disc (with the exception of DVRØØ).

1. Complete the RTE CONFIGURATION WORKSHEET.
2. Turn on all equipment.
   The System Preparation Phase begins.
3. Set the system teleprinter to LINE.
4. Set the DISC PROTECT switch DOWN (enables the disc to be written on).
5. Load the REAL-TIME GENERATOR (RTGEN) with BBDL.
6. Load and assign the appropriate SIO drivers. (See HOW TO CONFIGURE AN SIO MODULE, Section III.)

   NOTE: If the relocatable programs are on magnetic tape or disc file, the file must be created by the Prepare Tape System and the SIO magnetic tape or disc/drum driver.

7. Set the SWITCH REGISTER to the Starting Address of $10\emptyset_8$ (0/000/000/00●/000/000).
8. Press LOAD ADDRESS.
9. Press RUN.
   The Initialization Phase begins.
10. DISC CHNL?
    Type the interrupt location (select code) of the system disc or drum unit (higher priority (lower number) if multi-card).
11. SYS DISC SIZE?
    Type the decimal number of tracks of the system disc or drum unit.
12. NO. PROTECTED?
    Type the decimal number of hardware protected tracks.
13. #SECTORS/TRACK?
    Type the decimal number of sectors per track. (Disc units are usually 90; drums, 128.)
14. AUX DISC SIZE?
    Type the number of tracks of the auxiliary disc or drum. If there is no auxiliary mass storage, type Ø.
15. This question is asked if the response to the last query was not zero: #SECTORS/TRACK?
    Type the decimal number of sectors per track of the auxiliary mass storage device.
16. TBG CHNL?
    Type the select code (interrupt address) of the Time Base Generator.

17. PRIV. INT. CARD ADDR?

    Type the select code (interrupt address) of the privileged interrupt card (if present). If the privileged interrupt card is not used, type Ø.

18. SWAPPING?

    If the swapping option is included in the RTE System, type YES. If the swapping option is not to be included in the RTE System, type NO.

19. LWA MEM?

    For 16K, type 37677.

    For 24K, type 57677.

    For 32K, type 77677.

20. PRGM INPT?

    Type the abbreviation (see NOTE below) for the input used to enter relocatable program modules.

    NOTE: PT = Paper Tape
    TY = Teleprinter
    MT = Magnetic Tape
    DF = Disc File

21. LIBR INPT?

    Type the abbreviation for the input unit being used to enter relocatable library programs.

22. PRAM INPT?

    Type the abbreviation for the input unit being used to enter the parameters describing the relocatable programs. (TY or PT)

23. The computer halts.

24. Select either input device (see steps 20 and 21) specified during the Initialization Phase:

    a. To select the Program Input Unit, set all SWITCH REGISTER switches "OFF."

    b. To select the Library Input Unit, set switch 1 "ON."

25. Load the tapes listed below as follows;

    a. Set SWITCH REGISTER for the desired input device as specified in step 24.

    b. Press RUN.

    REAL-TIME I/O CONTROL

    REAL-TIME EXECUTIVE CONTROL

    REAL-TIME SCHEDULER

Appropriate Driver tapes
REAL-TIME EDITOR
REAL-TIME ASSEMBLER MAIN CONTROL
REAL-TIME ASSEMBLER SEGMENT D
REAL-TIME ASSEMBLER SEGMENT 1
REAL-TIME ASSEMBLER SEGMENT 2
REAL-TIME ASSEMBLER SEGMENT 3
REAL-TIME ASSEMBLER SEGMENT 4
REAL-TIME ASSEMBLER SEGMENT 5
REAL-TIME FORTRAN MAIN CONTROL
REAL-TIME FORTRAN PASS 1
REAL-TIME FORTRAN PASS 2
REAL-TIME FORTRAN PASS 3
REAL-TIME FORTRAN PASS 4
REAL-TIME RELOCATING LOADER
RTE/DOS RELOCATABLE LIBRARY (EAU)
RTE/DOS FORTRAN IV LIBRARY or RTE/DOS FORMATTER

26. The programmer may now request that switches 3-5 be set to a non-zero value when loading a particular program. Set switches 3-5 "OFF" after loading the program. Now load any user programs to be made a permanent part of RTE, repeating the same loading procedure.

    NOTE: These programs can be input from the same device or changed to the other input device (by setting all switches "OFF" or switch 1 "ON").

27. When all programs have been loaded, stop the Program Input Phase by setting switch Ø "ON." Press RUN twice (the first "RUN" prints any undefined external references). The Parameter Input Phase starts.
28. PARAMETERS
    Type the parameters supplied by the programmer, one per line. To terminate parameter entries, type /E.
29. #OF BLANK ID SEGMENTS?
    Type the decimal number supplied by the programmer.
30. FWA BP LINKAGE?
    Type the octal number just above the locations necessary for interrupt linkages.

The Disc Loading Phase starts.

RTGEN prints a memory map giving the starting locations of each program loaded. (If switch 15 is "ON," RTGEN also prints the entry points for all main programs and subroutines. Subroutines are indented two spaces.)

31. *EQUIPMENT TABLE ENTRY
    Type the Equipment Table information from the RTE CONFIGURATION WORKSHEET. Terminate these Equipment Table Entries by typing /E.
32. *DEVICE REFERENCE TABLE
    Type the Device Reference Table information from the RTE CONFIGURATION WORKSHEET. Terminate these entries by typing /E.
33. *INTERRUPT TABLE
    Type the Interrupt Table information from the RTE CONFIGURATION WORKSHEET.
    Terminate these entries by typing /E.
34. FWA SY MEM*nnnnn*
    (where *nnnnn* is the first word address of the system available memory.)
    CHANGE FWA SY AV MEM?
    If the user wishes to increase the size of the real-time disc resident area, type an octal number greater than *nnnnn*. If there is no change, type Ø.
35. BG BOUNDARY?
    Type the octal number address supplied by the programmer. This message is typed after the background resident and disc-resident programs have been loaded.
36. SYSTEM STORED ON DISC
37. LAST SYS DISC ADDR: TRK *nn* SEC *mmm(8)*
    where *nn* is the octal track number.
    mmm is the octal sector number.
    If the RTE System is going to be dumped onto tape for backup protection using SDUMP, record these numbers.

NOTE: During any of the Initialization, Program Input, Parameter Input or Disc Loading Phases, RTGEN can restart any phase if an error occurs if the operator:

a. Sets the SWITCH REGISTER to the starting address of $10\emptyset_8$ (0/000/000/00●/000/000).

b. Presses LOAD ADDRESS, then RUN.

In addition, the Parameter Input Phase can be restarted at $4\emptyset\emptyset\emptyset_8$ and the Disc Loading Phase at $6\emptyset\emptyset\emptyset_8$.

38. To eliminate configuring RTE again, the operator can create copies by using SDUMP. This program is discussed in Section VII.

The following messages may be printed on the system teleprinter during RTGEN generation. If these actions are beyond the responsibility of the particular operator, refer to the programmer.

Message	Meaning	Action
Messages During Initialization and Input Phase		
ERR Ø1	Invalid response to initialization request.	Message is repeated. Enter valid reply.
ERR Ø2	Checksum error on program input.	Computer halts; reposition tape to beginning of record and press RUN to reread.
ERR Ø3	Record out of sequence.	Same as ERR Ø2.
ERR Ø4	Illegal record type.	Same as ERR Ø2.
ERR Ø5 *name*	Duplicate entry point.	Revise program by relabeling the entry points (the current entry point replaces the previous entry point).
ERR Ø6	Invalid base page length (must be zero).	Base page area is ignored, but memory protect error will occur if program is executed.
ERR Ø7	Program Name or Entry Point Table overflow of available memory.	Irrecoverable error. Revise or delete programs.
ERR Ø8 *name*	Duplicate program name.	The current program replaces the previous program.
Messages During the Parameter Phase		
ERR Ø9	Parameter name error (no such program).	Enter valid parameter statement.
ERR 1Ø	Parameter type error.	Same as ERR Ø9.
ERR 11	Parameter priority error.	Same as ERR Ø9.
ERR 12	Execution interval error.	Same as ERR Ø9.

Message	Meaning	Action
General Messages		
ERR 13	BG segment precedes BG main disc-resident program.	Irrecoverable.
ERR 14	Invalid background bounds or illegal response to CHANGE FWA SYS MEM?	Message is repeated. Enter valid reply.
ERR 15	More than 63 subprograms called by a main program.	Revise main program (subsequent calls to subprogram are ignored).
ERR 16	Base page linkage overflow into system communication area.	Diagnostic printed for each word required (communication area is used). Revise order and composition of program loading to reduce linkage requirements.
ERR 17	Current disc address exceeds number of available tracks.	Irrecoverable error.
ERR 18	Memory overflow (absolute code exceeds LWA memory).	Diagnostic printed for each word required (absolute code is generated beyond LWA). Revise program.
ERR 19	Program overlay (current word of absolute code has identical location to previous).	Current word (the address is printed) is ignored.
ERR 20	Binary DBL record overflow of internal table.	Records overlay previous DBL records (diagnostic printed for each overflow record). Revise program.
ERR 21	Module containing entry point $CIC not loaded.	Irrecoverable error.
ERR 22	Read parity/decode disc error. A-register bits 7-14 show track number; bits 0-6 show sector number.	After ten attempts to read or write the disc sector, the computer halts. To try ten more times, press RUN.

Message	Meaning	Action
ERR 23	Invalid FWA BP LINKAGE.	Message repeated; enter valid reply.

Messages During I/O Table Entry

ERR 24	Invalid channel number.	Enter valid EQT statement.
ERR 25	Invalid driver name or no driver entry points.	Same as ERR 24.
ERR 26	Invalid or duplicate D,B,U operands.	Same as ERR 24.
ERR 27	Invalid logical unit no.	Enter valid DRT statement.
ERR 28	Invalid channel number.	Enter valid INT statement.
ERR 29	Channel number decreasing.	Same as ERR 28.
ERR 30	Invalid mnemonic.	Same as ERR 28.
ERR 31	Invalid EQT number.	Same as ERR 28.
ERR 32	Invalid program name.	Same as ERR 28.
ERR 33	Invalid entry point.	Same as ERR 28.
ERR 34	Invalid absolute value.	Same as ERR 28.
ERR 35	Base page interrupt locations overflow into linkage area.	Re-start Disc Loading Phase at FWA BP LINKAGE? request.
ERR 36	Invalid number of characters in final operand.	Same as ERR 28.

General Message

ERR 37 *name*	Invalid declaration of common in system or library programs (*name* is the illegal program).	Revise the program.

LOADING RTE

1. Set the SWITCH REGISTER to 077760_8 (0/000/000/000/000/000).
2. Press LOAD ADDRESS.
3. Set the LOADER switch to ENABLED.
4. Press PRESET.
5. Press RUN.
6. When the computer halts with 102077_8 (0/000/000/000/000/000) in the MEMORY DATA REGISTER, set the LOADER switch to PROTECTED.
7. Set switch 0 "OFF."
8. Press RUN.
   RTE types when loaded:
   *INIT REAL TIME CLOCK
9. Either initialize the clock using the TM operator request, or type any other request. See OPERATOR REQUESTS.

After configuring and loading the RTE System, the operator uses operator requests to perform the following functions:

- Turn programs on and off.
- Suspend and restart programs.
- Examine the status of any program or I/O device.
- Schedule programs to execute at specified times.
- Change the priority of dormant programs.
- Set up load-and-go operations and source files.
- Declare I/O devices available or unavailable.
- Dynamically alter the I/O structure and buffering.
- Eliminate disc-resident programs from the system.
- Initialize the real-time clock and print the time.

The general format of an operator request is:

A two-character request word (e.g., ON, UP etc.); and up to seven parameters separated by commas. (Two commas in a row mean the parameter is zero.) The second parameter field is often a program name.

The request formats include items in italics and items in brackets. The italicized items are symbolic; the bracketed items are optional.

TO ENTER AN OPERATOR REQUEST

1. To gain the attention of RTE, press any key on the system teleprinter.
2. When the computer responds with an asterisk (*), as soon as the system teleprinter is ready, the operator inputs any operator request (e.g., ON, UP, etc.).
3. Each request must terminate with a return and linefeed.
4. To eliminate a request, press the "rubout key" anywhere in the request.
5. To eliminate the previously typed character, press the "control" and "A" keys simultaneously.

SUMMARY OF RTE OPERATOR REQUESTS

REQUEST	DESCRIPTION
ON,*name*[,NOW][*p1,p2,...p5*]	Schedules *name*. NOW means ignore time values.
OF,*name,p*	Terminates *name (p=Ø)*. Purge *name (p=8)*. Abort *name (p>Ø)*.
SS,*name*	Suspend *name*.
GO,*name*[,*p1,p2,...p5*]	Re-schedule suspended *name*.
ST,*name*	Print status of *name*.
IT,*name,R,MPT*[,*HR,MI*,[,*SC*][,*MS*]]	Set time values of *name*.
PR,*name,n*	Set priority of *name=n*.
LG,*n*	Declare *n* L&G tracks or release L&G tracks *(n=Ø)*.
LS,*p1,p2*	Declare disc number *p1*, track number *p2* of source file.
DN,*n*	Set EQT device *n* down.
UP,*n*	Set EQT device *n* up.
LU,*n*[,*m*]	Assign EQT *m* to LU *n*, release *n (m=Ø)*, or print *n* (*m* absent).
EQ,*n*	Print EQT entry *n*.
EQ,*n,p*	Delete *(p=Ø)* or specify *(p=1)* buffering on EQT *n*.
TM,*day,hr,mi,sc*	Specify day of year, and 24 hour time.
TI	Print time.

RTE MESSAGE CODE TABLE

During operation of RTE, certain error reports or system messages may be printed out on the system teleprinter. These messages are listed alphabetically, including what they mean, and what action, if any, the operator must take. If these actions are beyond the responsibility of the particular operator, refer to the programmer.

Message	Meaning	Action
BEGIN 'DEBUG' OPERATION	DEBUG is now controlling program execution.	
CS ERR	Illegal edit command, which is printed.	
/C OVF	Character overflow in edit statement (i.e., >72 characters).	
DISC OVF	Character overflow in edit statement (i.e., >72 characters).	
DRØ1	Insufficient number of parameters.	
DRØ2	Number of tracks is zero, >255, or >zero; illegal or logical unit; or number of tracks to release is zero or negative.	
DRØ3	Attempt to release track assigned to another program.	
DUPLICATE PROG *name*	*name* is printed when a program *name* is already defined in the system for a normal load or a program addition.	The loader changes the name of the current program by replacing the first two characters with "##."

Message	Meaning	Action
$END ASMB	End of Assembly	RTE executes the next scheduled program.
$END ASMB CS	Error in Assembler control statement.	
$END ASMB NPRG	If source input for logical unit 2(disc) is requested but no file has been declared, the teleprinter signals. Assembly stops.	
$END ASMB PASS	Another pass of the source program is required.	Replace program in input device and type: GO, ASMB.
$END ASMB XEND	End-of-file condition occurs before an END statement is found.	Current Assembly stops.
$END FTN	End of FORTRAN compilation.	RTE executes the next scheduled program.
/EDIT:*error message: illegal command*	RTE Editor prints error messages on the system teleprinter in this format.	RTE continues with the Edit File. There is no on-line correction of illegal edit commands.
ENTRY ERROR	Illegal request in DEBUG statement.	
FILE UN	Undefined Symbolic File or Edit File = 2.	Edit terminates.
ILL INT *xx*	Interrupt in on I/O channel, where *xx* is the octal I/O channel number.	RTE clears the interrupt.
INPUT ERROR	An illegal parameter in request.	Enter request again correctly.

Message	Meaning	Action
I/O ERR ET EQT #*n*	End-of-tape on device #*n*.	Install new tape supply. Declare #*n* available using the UP request.
I/O ERR NR EQT #*n*	Device #*n* is not ready.	Ready the device. Declare #*n* available using the UP request.
I/O ERR PE EQT #*n*	Parity error in data transmission from device #*n*.	Examine device.
IOØ1	Not enough parameters.	
IOØ2	Illegal logical unit.	
IOØ3	Logical unit not assigned.	
IOØ4	Illegal user buffer.	
IOØ5	Illegal disc track or sector.	
IOØ6	Reference to protected track, or using load-and-go before assigning load-and-go tracks.	
IOØ7	Illegal read or write.	
IOØ8	Disc transfer longer than track.	
IOØ9	Overflow of load-and-go area.	
LOAD	End-of-tape condition on input unit. Loader is suspended.	Load next program.
/LOADR	Loader is suspended.	
/LOADR: "GO" WITH EDIT PARAMETERS	The loader requires additional information to carry out the on-line modifications.	Check that the hardware disc protect is disabled then reschedule the loader with a GO operator request.

Message	Meaning	Action
/LOADR:*message*	Format of Relocating Loader error message.	1. For recoverable errors (LØ1 and LØ2) reposition tape and type: GO LOADR. 2. Another program can be entered with a GO operator request.
LØ1 "LOADING ABORTED"	Checksum error.	Reposition tape. Type GO,LOADR.
LØ2 "LOADING ABORTED"	Illegal record.	Reposition tape. Type GO, LOADR.
LØ3 "LOADING ABORTED"	Memory overflow.	Return program to programmer.
LØ4 "LOADING ABORTED"	Base page linkage overflow.	Return program to programmer.
LØ5 "LOADING ABORTED"	Symbol table area overflow.	Return program to programmer.
LØ6 "LOADING ABORTED"	Common block error.	Return program to programmer.
LØ7 "LOADING ABORTED"	Duplicate entry points.	Return program to programmer.
LØ8 "LOADING ABORTED"	No main program in program unit.	Another program can be entered with a GO request.
LØ9 "LOADING ABORTED"	Record out of sequence.	Return program to programmer.
L1Ø "LOADING ABORTED"	Error in an operator request.	GO requests can be typed; ON requests cannot.

Message	Meaning	Action
MEM OVERFLOW	Edit File overflows available memory.	RTE prints the command causing the overflow. Edit terminates.
MT ERROR-EOT, RESTART	Magnetic tape errors.	Call maintenance.
**name address*	The entry point listing format for the loader, where *name* is the entry point name and *address* is its absolute location in octal.	Return program to programmer.
name ABORTED	RTE aborts a program where *name* is the *name* of the program aborted.	Return program to programmer.
NO BLANK ID SEGMENTS	Printed when an available (blank) ID segment is not found by the Loader.	The loader calls for program suspension. The operator can delete a program from the system (OF request) or terminate the loader.
NO SUCH PROG	The *name* given is not a main program in the system.	

Message	Meaning	Action
#nnn	*nnn* is the "tape" number where the error (reported on the next line of the listing) occurred. A program can consist of more than one tape. The tape counter starts with one and increments whenever an End-of-tape (paper tape) or a blank card is encountered. When the counter increments, the numbering of source statements starts over at one.	
OP CODE ERROR	Illegal operator request word.	Enter correct request.
PARAM ERR	Illegal edit command.	
PG *ppp*	Error diagnostic where *ppp* is the page number (in the listing) of the previous error diagnostic.	
RQ *name address*	An EXEC call contains an illegal request code; where *name* is the program that made the call and *address* is the location of the illegal call.	Return program to programmer.
/R ERR	Illegal edit command.	Return program to programmer.
SCØ1	Missing parameter.	Return program to programmer.
SCØ2	Illegal parameter.	Return program to programmer.

Message	Meaning	Action
SCØ3	Program cannot be scheduled.	Return program to programmer.
SCØ5	Program given is not defined.	Return program to programmer.
SCØ6	No resolution code in EXECUTION TIME EXEC call.	Return program to programmer.
SEQ ERR	Illegal edit command.	Return program to programmer.
TRAK *nnn* EQT #*uu* S(or U)	Irrecoverable disc read parity error. If user read request (U), then program is abnormally terminated and track is made unavailable for further write operations. If system read request (S), the program transfer terminates.	

ALPHABETIC SUMMARY OF SYSTEM MESSAGES

Appendix A contains all messages generated on the system teleprinter for the Hewlett-Packard software systems covered in this book. The messages are listed alphabetically; along with their origin, meaning, and what response, if any the operator must make. If the corrective action is beyond the responsibility of the operator, refer to the programmer.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
BAD CONTROL STATE	DOS, DOS-M			Directive just entered is not acceptable in DOS.	Enter correct directive in system teleprinter.
BAD DIRECTORY OR SYSTEM	DOS			Parity error has occurred during read from disc of a system directory, or the system buffer.	Restart. If same message occurs again, call maintenance.
*BCS ABSOLUTE	PCS			PCS is ready to punch absolute output tape.	Turn on the tape punch. Press RUN.
BEGIN 'DEBUG' OPERATION	DEBUG			Any legal DEBUG operations may be entered.	Enter any legal DEBUG operations. *NOTE: If the system teleprinter is a 2752A, set the selector switch to "T" before pressing RUN. This allows both printing and punching.*
CHANGE INPUT TAPE, HIT RUN	SDUMP			The end of the input tape begin read has been reached.	Either load the next tape or go on to the next phase.
CHANGE OUTPUT TAPE	SDUMP			Two full tracks have been dumped onto paper tape.	Perform the requested action.
CHECKSUM ERROR	DOS, DOS-M			Checksum error in input to :ST,R, file, LU directive.	Correct program.
CS	Assembler			Control statement error; illegal parameter in control statement.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
CS ERROR	RTE			Illegal edit command, which is printed.	
CW *nnnnn*	DOS, DOS-M			In a READ/WRITE EXEC call at *nnnnn*, buffer for EXEC call at *nnnnn*, is out of memory.	Correct program. Restart.
/C OVF	RTE			Character overflow in edit statement (i.e., greater than 72 characters).	
DD	Assembler			Doubly defined symbol: name defined in the symbol table appears more than once.	
DEVICE #*nn* DOWN	DOS, DOS-M			Logical unit *nn* is unavailable (down).	Use the UP, *nn* directive to make the device available. (Then use the :GO directive if needed.)
DICTIONARY OVERFLOW	DOS, DOS-M			No room is left for entries in the user file dictionary.	Put file on another disc or remove some of the files on the disc.
DISC GEN CODE *nnnn* NOT SYS GEN CODE *nnnn* ERR POSS	DOS-M			Informs the user that the disc being requested was initialized (labeled) by a system with a different system generation code.	Generation code on disc may be updated by labeling or unlabeling using :IN.
??? DISC	DOS-M			Informs user that user disc was labeled by a non-DOS-M system.	May be a DOS-M by labeling or unlabeling with :IN.
DISC INPUT ERROR	SDUMP			Disc error diagnostic, for a parity, decode, or abort status after 10 retrys. Input sequence repeated on restart.	Call maintenance.
DISC GEN CODE *nnnn* NOT SYS GEN CODE *nnnn* ERR POSS	DOS-M			Informs the user that the disc being requested was initialized (labeled) by a system with a different system Generation Code.	Generation Code on disc may be updated by labeling or unlabeling with :IN.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
DISC NOT ON SYSTEM	DOS-M			No disc pack with the currently requested label can be found on the system.	Mount disc pack with correct label or ready drive containing disc.
DISC OVF	RTE			Character overflow in edit statement (i.e., >72 charaters).	
DISC TRACK *ttt* ERROR	DOS			Disc error when attempting to read track *ttt*.	Call maintenance if track is in system area; otherwise, system will continue to function.
DISC WRITE ABORT	SDUMP			Disc error diagnostic for an abort status after a write attempt. Sequence is repeated if requested.	Call maintenance.
DMA?	PCS			Request for DMA channel numbers.	If no DMA channels, type Ø. If one DMA channel, type 6. If two DMA channels, type 6.
DONE?	DOS, DOS-M			Thirty feed frames (paper tape) or an end-of-file (magnetic tape) have occurred during input.	Enter YES for end of input; NO for more input.
DRØ1	RTE			Insufficient numbers of parameters.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
DRØ2	RTE			Number of tracks is zero, >255, or >Ø; illegal or logical unit; or number of tracks to release is zero or negative.	
DRØ3	RTE			Attempt to release track as assigned to another program.	
DUPLICATE FILE NAME	DOS, DOS-M			Doubly defined file name found in a :STORE directive, (other than STORE,P), or an :EDIT directive with a new file name, or on DD,U.	Remove file or rename file
DUPLICATE PROG *name*	RTE			*name* is printed when a program *name* is already defined in the system for a normal load or a program addition.	The loader changes the name of the current program by replacing the first two characters with "##."
/EDIT:*error message: illegal command*	RTE			RTE Editor prints error messages on the system teleprinter in this format.	RTE continues with the Edit File. There is no on-line correction of illegal edit commands.
EN	Assembler			Program error.	Return program to programmer.
ENØØØØ <symbol>	Assembler			Program error.	Place next tape in input device or load new reel of tape. Press RUN.
*END	BCS			The absolute binary output has been selected and the punched tape is complete.	To execute the program: 1. Load binary tape using Basic Binary Loader. 2. Set the SWITCH REGISTER to the Starting Address of 2_8 (0/000/000/000/000/000). 3. Press LOAD ADDRESS. 4. Press RUN.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
$END ALGOL	ALGOL			End of ALGOL compilation	No action required.
$END ASMB	Assembler			Assembly has completed.	No action required.
$END ASMB CS	Assembler			Error in assembler control statement.	Correct the control statement.
$END ASMB NPRG	Assembler			Assembly has terminated because no JFILE was found when required.	Define the file using a JFILE directive.
$END ASMB PASS	Assembler			Another pass of the source program is required.	Replace program in input device and type :GO.
$END ASMB XEND	Assembler			Assembly stops. An EOF occurred in the source program before an END statement.	Add an END statement to the program.
END FILE	DOS, DOS-M			During an :EDIT, (1) the master file ended before completion of editing; or (2) a colon occurred in column 1 of a source statement.	Check the input to the EDIT program.
$END FTN	FORTRAN			End of FORTRAN compilation.	No action required.
END JOB *xxxx* RUN=*xxxxx* MIN. *xx.x* SEC EXEC=*xxxx* MIN. *xx.x* SEC	DOS, DOS-M			End of current job. Total job time and execution time of the job are printed on the system teleprinter and standard list device. The portion of the message in brackets is printed in DOS-M only if a Time Base Generator is part of the system.	Enter next job.
ENTER FILE NAME(S) OR /E	DOS, DOS-M			Enter list of relocatable program files	To terminate list of file names type "/E."
ENTRY ERROR	DEBUG			DEBUG operation entered was illegal.	Correct entry.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
EOT	SDUMP			End of the input tape being read has been reached.	Load the next tape or go on to the next phase of operation.
*EOT	PCS			End-of-tape.	Place next tape in tape reader and press RUN to continue loading.
*EQT	DEBUG			The end of the input tape being read has been reached.	Load the next tape or go on to the next phase of operation.
EQT *xx* CH *xx* DVR*xx* D R U*x* S*x*					
	DOS, DOS-M			Equipment table entry printed by the directive :EQ.	No action required.
*EQT	PCS			End-of-tape.	Place next tape in punched tape reader. Press RUN.
*ERROR	PCS			A non-numeric parameter or illegal numeric parameter has been entered as a reply.	Re-type the entire entry correctly.
EXTRA PARAMETERS					
	DOS, DOS-M			More than 15 parameters in a directive.	Reduce the number of parameters.
FI *nnnnn*	DOS, DOS-M			In a FILE READ/WRITE EXEC call, the file *nnnnn* cannot be found. Calling program is aborted.	Check for file name requested at *nnnnn*. If file *nnnnn* is not present, enter file *nnnnn*.
FILE UN	RTE			Undefined Symbolic File or Edit File = 2.	Edit terminates.
*FMT	FORTRAN		ØØØØØ1	FORMAT error.	Irrecoverable error. Program must be recompiled or rewritten. Return to programmer.
*FMT	FORTRAN		ØØØØØ2	FORMAT error.	Irrecoverable error. Program must be recompiled or rewirtten. Return to programmer.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
*FMT	FORTRAN		ØØØØØ3	FORMAT error.	Irrecoverable error. Program must be recompiled or rewritten. Return to programmer.
*FMT	FORTRAN		ØØØØØ4	Illegal character or number in program	Verify data.
*FMT	FORTRAN		ØØØØØ5	A number is in illegal form in program.	Verify data.
FWA MEM?	PCS			Request for first word of available memory.	Type address of the first word of available memory.
HPAL	ALGOL			Control statement error.	Correct control statement.
HS INP?	PCS			Request for the tape reader select code.	Type the select code of the tape reader. If the tape reader is not available, type Ø.
HS PUN?	PCS			Request for the tape punch select code.	Type the tape punch select code. If the tape punch is not available, type Ø.
IB *nnnnn*	DOS, DOS-M			Illegal buffer address in EXEC call at location *nnnnn*. Program is aborted.	Correct buffer program address.
IC OUF	RTE			Character overflow in edit statement (i.e., more than 72 characters).	
IE *nnnnn*	DOS			If a colon occurs in the first column of a source program entered through the batch device during program execution, the program is aborted, and control is given to JOBPR. *nnnnn* is the memory location of the input request.	Correct program and data deck.
IGNORED	DOS, DOS-M			Input from system teleprinter or batch device during program execution cannot be processed.	Correct input.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
*IGNORED	DOS, DOS-M			All directives following EJOB and before next JOB except BATCH, TYPE and TRACKS are ignored.	Enter acceptable directive and OFF.
IF	Assembler			Illegal instruction in program.	Return program to programmer.
IL	Assembler			Illegal instruction in program.	Return program to programmer.
file ILLEGAL	DOS, DOS-M			1. On a source file LIST directive, the requested file was not a source file. 2. A file name begins with a non-alphabetic character.	1. Retype LIST directive using source file. 2. Rename the file.
ILLEGAL DIGIT	DOS, DOS-M			1. In a decimal number, character is other than Ø-9. 2. In an octal number, digit is other than Ø-7.	1. Enter correct decimal number. 2. Enter correct octal number.
ILLEGAL LUN	DOS, DOS-M			Logical unit requested is equal to zero, greater than number of logical units in the system, not the correct type (i.e., input for output device etc.).	Enter a correct logical unit number.
ILLEGAL PROGRAM RUN LIMITS	DOS-M			Attempt to run a user main or segment whose user area limits or base page limits will not fit within the limits of the current system.	Recreate user mains or segments on current system using LOADR.
ILLEGAL PROGRAM TYPE	DOS-M			Program requested in a RUN or PROG is not legal.	Enter correct name.
ILL INT*xx*	RTE			Interrupt is on I/O channel, where *xx* is the octal I/O channel number.	RTE clears the interrupt.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
INPUT ERROR	DOS, DOS-M			Equipment table entry number of logical unit number in EQ, LU, UP or DN is illegal.	Enter correct equipment table entry number.
INPUT:DATE, *xxxxxxxxxx*[,H,M,]	DOS, DOS-M			When system is initiated from the disc, DOS or DOS-M requires a DATE directive. The "HM" is ignored in DOS-M if a Time Base Generation is not in the system.	Enter a DATE directive.
INPUT ERROR	RTE			An illegal parameter in request.	Enter request again correctly.
INPUT FR=FRESH;CO=CONTINUATION	DOS			When system is initiated from the disc, DOS asks whether start-up is fresh (no user files) or continuation (user files on disc).	Enter FR if start-up is fresh. Enter CO if start-up is a continuation.
-INPUT?	PCS			Request for EQT unit-reference numbers of device serving as the input device.	Type the number.
INTERRUPT LINKAGE?	PCS			Request for interrupt information.	Press RUN and for each I/O device, type: a_1,a_2,I.ee a_1-interrupt location address a_2-location containing absolute address of Interrupt Processor entry point I.ee entry point name: ee = ØØ Teleprinter = Ø1 Tape Reader = Ø2 Tape Punch = 1Ø Calcomp Plotter = 12 Line Printer = 15 Mark Sense Card Reader = 21 HP 2Ø2Ø, then type C.21 (cont. on next page)

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
INTERRUPT LINKAGE? (cont)					= 22 HP 3Ø3Ø then type C.22 = 21 HP 2Ø2Ø MT unit = 22 HP 3Ø3Ø MT unit Uu = physical unit number (Ø-7) To terminate EQT entry type "/E."
I/O DRIVER? D.ee	PCS			A driver has been named in the EQT parameter entry but has not been loaded.	1. If the driver is to be loaded with user's program at object program load time, type an exclamation mark (!). The name is added to the loaders LST. 2. If the driver should have been loaded or; if a character other than 1 is typed; rerun PCS.
I/O ERR ET EQT #*mm*	DOS, DOS-M			End-of-tape on device #*mm*. EQT #*mm* is unavailable.	Install a new tape supply. To make the device available (up) use the UP,*n* directive.
I/O ERR ET EQT #*n*	RTE			End-of-tape on device #*n*.	Install a new tape supply. Declare #*n* available (up) by using the UP request.
I/O ERR NR EQT #*mm*	DOS, DOS-M			The device #*mm* is not ready.	To make the device available (up) use the UP,*n* directive.
I/O ERR NR EQT #*n*	RTE			Device #*n* is not ready.	Ready the device. Declare #*n* available using the UP request.
I/O ERR PE EQT #*mm*	DOS, DOS-M			Parity error on device #*mm* returns to program with A set to status, B set to Ø.	Call maintenance.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
I/O ERR PE EQT #*n*	RTE			Parity error in data transmission from device #*n*	Call maintenance.
I/O ERR {PE / NR} USER	DISC				
	DOS-M			A parity error or device not ready occurred when attempting to assign a user disc.	Disc may not be formatted; format it with DSGEN.
IOØ1	RTE			Not enough parameters.	
IOØ2	RTE			Illegal logical unit.	
IOØ3	RTE			Logical unit not assigned.	
IOØ4	RTE			Illegal user buffer.	
IOØ5	RTE			Illegal disc track or sector.	
IOØ6	RTE			Reference to a protected track; or using load-and-go before assigning load-and-go tracks.	
IOØ7	RTE			Illegal read or write.	
IOØ8	RTE			Disc transfer longer than track.	
IOØ9	RTE			Overflow of load-and-go area.	Correct the track or sector address in
IT *nnnnn*	DOS, DOS-M			Illegal disc track or sector address in EXEC call from location *nnnnn*. Program is aborted.	EXEC call.
JBIN OVF	DOS, DOS-M			Overflow of job binary area during assembly or compilation.	Reduce size of job or purge user files.
JBIN TRK BAD	DOS			Parity error when reading a program from the job binary area.	Call maintenance.
JOB ABORTED!	DOS, DOS-M			Current job is aborted.	Correct program and start new job.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
JOB *xxxxx ddddddddd*[TIME = *xxxxx* MIN. *xx.x* SECS EXEC = *xxxxx* MIN. *xx.x* SEC]					
	DOS, DOS-M, RTE			Message printed at the beginning of each job. The time information is deleted in DOS-M if a Time Base Generator is not included in the system.	Start job.
-KYBD?	PCS			Request for EQT unit-reference number of device serving as the keyboard input device.	Type the number.
??? LABEL *xxxxxx* DOS LABEL *xxxxxx* TSB LABEL *xxxxxx*				Attempting to label (or unlabel) an already labeled disc pack.	Enter YES to relabel the disc pack or NO to drop the request to relabel the disc pack.
{??? DOS TSB} LABEL *llllll* OK TO PURGE?	DOS-M			Attempting to label an already labeled disc pack.	Enter YES to relabel the disc pack or NO to drop the request to relabel the disc pack.
LBL = *llllll*	DOS-M			Disc subchannel referenced is labeled *llllll*.	If attempting to change user disc subchannel, enter UD with correct label.
-LIB?	PCS			Request for EQT unit-reference number of the device serving as the input device for the Program Library.	Type the number.
LIMIT ERROR	DOS, DOS-M			In a directive, source statement numbers out of order (EDIT), dump limits are incompatible (PDUMP, ADUMP), section numbers are illegal (DUMP), or beginning source statement number is greater than final statement number (EDIT).	Correct directive and re-enter.
*xxxx*LINES	DOS, DOS-M			Total number of statements stored by a STORE,S directive.	No response required.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
-LIST?	PCS			Request for EQT unit-reference number of the device serving as the list output device.	Type the number.
****LIST END***	DOS, DOS-M			Terminates list of source statements generated by a LIST directive.	No action required.
LN *nnnnn*	DOS, DOS-M			Logical unit requested by an EXEC call at *nnnnn* is unassigned. Program is aborted.	Reassign logical unit.
LOAD	RTE			End-of-tape condition on input unit. Loader is suspended.	Load next program.
*LOAD	BCS			End-of-tape condition on Standard Input Device.	See step 10 of the procedure, HOW TO USE BCS, Section V.
*LOAD	PCS			PCS is requesting the first or next BCS module.	Place BCS tape in the punched tape reader. Press RUN.
LOAD TAPE	DOS, DOS-M			In conjunction with LOADR SUSP, this message requests that next relocatable tape be loaded before GO.	Load the next tape relocatable tape and enter :GO to read next tape or :GO,1 to indicate that all tapes are read in.
LOADR COMPLETED	DOS, DOS-M			Loading has completed.	No action required.
LOADR SUSP	DOS, DOS-M			Loader has suspended (usually at EOT).	Type :GO,*n* to restart the Loader with proper parameter value.
LOADR TERMINATED	DOS, DOS-M			Loader has terminated because of an error.	Check input.
/LOADER	RTE			Loader is suspended.	
/LOADR: "GO" WITH EDIT PARAMETERS	RTE			The loader requires additional information to carry out the on-line modifications.	Check that the hardware disc protect is disabled then reschedule the loader with a GO operator request.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
/LOADR:*message*	RTE			Format of Relocating Loader error message.	1. For recoverable errors (LØ1 and LØ2) reposition tape and type: GO LOADR. 2. Another program can be entered with a GO operator request.
*LST	BCS			The Loader is ready to print the LST, common bounds, and linkage area bounds.	See step 11 of the procedure, HOW TO USE BCS, Section V. *NOTE: If the user's computer system is using a 2754B Teleprinter for listing and punching, set the selector switch to "T" before pressing RUN (enables the punch unit).*
LWA MEM?	PCS			Request for the last word of available memory.	Type address of the last word of available memory.
LU *nnnnn*	DOS, DOS-M			Illegal logical unit in EXEC call at *nnnnn*. Program is aborted.	Enter correct logical unit number.
LU*xx* EQT*xx*	DOS, DOS-M			Logical unit table entry; EQT #*xx* is assigned to LU #*xx*.	No action required.
LUN UNASSIGNED	DOS, DOS-M			Logical unit requested in a directive is unassigned.	Assign logical unit number requested in the directive.
*LØ1	BCS, PCS			Checksum error.	To re-read record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
*LØ2	BCS, PCS			Illegal record read. The last record read was not recognized as valid relocatable record type.	To re-read record, reposition tape to beginning of record and press RUN. If computer halts again, tape must be replaced.
*LØ3	BCS, PCS			Memory overflow. The length of BCS exceeds available memory.	Return to programmer.
*LØ4	BCS, PCS			System linkage area overflow in base page.	Return to programmer.
*LØ5	BCS, PCS			Loader symbol table overflow. The number of EXT/ENT symbols exceeds available memory.	Return to programmer.
*LØ6	BCS			The length of the common block in the current program is greater than the length of the first common block allocated.	Return to programmer.
*LØ6	PCS			PCS interprets the program length of BCS to be zero.	Return to programmer.
*LØ7	BCS, PCS			Duplicate entry points. An entry point in the current program matches a previously declared entry point.	Return program to programmer.
*LØ8	BCS			No transfer address. The initial starting location was not present in any of the programs which were loaded.	To enter the Starting Address, set the absolute value in the SWITCH REGISTER. Press LOAD A. Press RUN.
*LØ9	BCS			Record out of sequence. A NAM record was encountered before the previous program was terminated with an END record.	Return program to programmer.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
LØ1 LOADR TERMINATED	DOS, DOS-M			Checksum error on tape.	Return to programmer.
LØ2 LOADR TERMINATED	DOS, DOS-M			Illegal record.	Return to programmer.
LØ3 LOADR TERMINATED	DOS, DOS-M			Memory overflow	Return to programmer.
LØ4 LOADR TERMINATED	DOS, DOS-M			Base page overflow.	Return to programmer.
LØ5 LOADR TERMINATED	DOS, DOS-M			Symbol table overflow.	Return to programmer.
LØ6 LOADR TERMINATED	DOS, DOS-M			Duplicate main or segment name (may be caused by attempting to run the loader twice in one job).	Return to programmer.
LØ7 LOADR TERMINATED	DOS, DOS-M			Duplicate entry point.	Return to programmer.
LØ8 LOADR TERMINATED	DOS, DOS-M			No main or segment transfer address.	Return to programmer.
LØ9 LOADR TERMINATED	DOS, DOS-M			Record out of sequence.	Return to programmer.
L1Ø LOADR TERMINATED	DOS, DOS-M			Insufficient directory, or work area, or user area space.	Return to programmer.
L11 LOADR TERMINATED	DOS, DOS-M			Program name table overflow.	Return to programmer.
L12 LOADR TERMINATED	DOS, DOS-M			User file specified cannot be found.	Return to programmer.
L13 LOADR TERMINATED	DOS, DOS-M			Program name duplication.	Return to programmer.
L14 LOADR TERMINATED	DOS, DOS-M			Non-zero base page length.	Return to programmer.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
L15 LOADR TERMINATED	DOS, DOS-M			Segment occurred before main program.	Return to programmer.
L16 LOADR TERMINATED	DOS, DOS-M			Program overlay (illegal ORG).	Return to programmer.
LØ1 "LOADING ABORTED"	RTE			Checksum error.	Reposition tape. Type: GO, LOADR.
LØ2 "LOADING ABORTED"	RTE			Illegal record.	Same as above.
LØ3 "LOADING ABORTED"	RTE			Memory overflow.	Return to programmer.
LØ4 "LOADING ABORTED"	RTE			Base page linkage overflow.	Return to programmer.
LØ5 "LOADING ABORTED"	RTE			Symbol table area overflow.	Return to programmer.
LØ6 "LOADING ABORTED"	RTE			Common block error.	Return to programmer.
LØ7 "LOADING ABORTED"	RTE			Duplicate entry points.	Return to programmer.
LØ8 "LOADING ABORTED"	RTE			No main program in program unit.	Another program can be entered with a GO request.
LØ9 "LOADING ABORTED"	RTE			Record out of sequence.	Return to programmer.
L1Ø "LOADING ABORTED"	RTE			Error in an operator request.	GO requests can be retyped; ON requests cannot.
M	Assembler			Illegal operand.	Return to programmer.
MEM OVERFLOW	RTE			Edit file overflows available memory.	RTE prints the command causing the overflow. Edit terminates.
xxxxx MISSING	DOS, DOS-M			Segment *xxxxx* by an EXEC call is not in system or user directory. Job is aborted.	Correct job.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
MISSING PARAMETER	DOS, DOS-M			A parameter is missing in a directive.	Retype the directive correctly.
MP *nnnnn*	DOS, DOS-M			Illegal memory protect violation at location *nnnnn*. Program is aborted.	Correct the program.
MT ERROR-READ PARITY	SDUMP			Magnetic tape errors.	Error recovery procedures are completed by a driver. Restart to re-try sequence.
MT ERROR-EQT, RESTART	SDUMP			Magnetic tape errors. Error recovery procedures completed by the driver.	Press REWIND. Press AUTO. If the procedure does not work, call maintenance.
MT ERROR-READ PARITY	SDUMP			Magnetic tape errors. Error recovery procedures completed by the driver.	Press REWIND. Press AUTO. If the procedure does not work, call maintenance.
name ABORTED	RTE			RTE aborts a program where *name* is the name of the program aborted.	
**name address*	RTE			The entry point listing format for the loader, where *name* is the entry point and *address* is its absolute location in octal.	
NAME*IGNORED	DOS, DOS-M			Illegal JOB *name*; non-alphabetic first character.	Retype correct JOB name.
NEXT AVAIL TRACK = *tt* BAD = *nn*	DOS-M			In TRACK directive, *tt* = first track beyond end of current user area; *n* = number of bad tracks. "BAD = *n*" returned only if bad tracks do exist. *tt* = "NONE," if no tracks are available.	No action required.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
#*nnn*	Assembler			*nnn* is the "tape" number where the error (reported on the next line of the listing) occurred. A program can consist of more than one tape. The tape counter starts with one and increments whenever an End-of-tape (paper tape) or a blank card is encountered. When the counter increments, the numbering of source statements starts over at one.	
NO	Assembler			No origin definition.	
NO BIN END	DOS, DOS-M			No END record detected when storing a relocatable binary program.	Input correct binary program.
NO PROGRAM LOADED	DOS, DOS-M			No programs were loaded by the LOADR. Loading terminates.	
NO SOURCE	ALGOL			Source file from disc not preset.	
NO SOURCE	DOS, DOS-M			No source statements following a /R or /I in an EDIT directive. Job is aborted.	Enter source statements after the /R or /I.
NO BLANK ID SEGMENTS	RTE			Printed when an available (blank) ID segment is not found by the loader.	The loader calls for program suspension. The operator can delete a program from the system (OF request) or terminate the loader.
NO SUCH PROG	RTE			The *name* given is not a main program in the system.	
NO TRACKS AVAILABLE	DOS			No tracks available on disc for writing.	Purge unnecessary file(s) and try again.
NUMBER OVERFLOW	DOS, DOS-M			An integer is too large.	Return to programmer.
**NUMERIC INPUT ERROR!	Magnetic Tape			Non-octal value has been typed.	Retype the correct value.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
OP	Assembler			Illegal op code.	Return to programmer.
OP CODE ERROR	RTE			Illegal operator request word.	Enter correct request.
OR *nnnnn*	DOS, DOS-M			I/O operation requested by EXEC call at *nnnnn* is rejected. Program is aborted.	Check program.
OV	Assembler			Numeric operand overflow.	Return to programmer.
OVERFLOW JBIN	DOS, DOS-M			There is not enough room in the JBIN for storing the relocatable binary output from the Assembler or compiler.	Return to programmer.
PARAM ERR	RTE			Illegal edit command.	
PARAMETER ILLEGAL	DOS, DOS-M			A parameter of a directive is illegal.	Re-enter directive.
PARITY ERROR/SC=*n*, TRK=*ttt*, SCTR=*sss*	DOS-M			Parity error during disc read or write.	Call maintenance.
PARITY ERROR/TRK=*ttt*	DOS			Parity error during disc read or write.	Call maintenance.
PAUSE *xxxx*	DOS, DOS-M			Program has temporarily suspended itself. *xxxx* is an octal number.	Restart program using the GO directive.
PG *ppp*	Assembler			Error diagnostic where *ppp* is the page number (in the listing) of the previous error diagnostic.	
-PUNCH?	PCS			Request for EQT unit-reference number of the device serving as the punch output device.	Type the number.
R?	Assembler			Attempt being made to assemble a relocatable program following the assembly of an absolute program.	Reload the Assembler
/R ERR	RTE			Illegal edit command.	
RE-ENTER STATEMENT ON TTY	DOS, DOS-M			Follows most error messages that do not cause abort.	Type in the correct statement.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
RQ *nnnnn*	DOS, DOS-M			Illegal request code in EXEC call at *nnnnn*. Program is aborted.	Correct the program.
RQ *name address*	RTE			An EXEC call contains an illegal request code; where *name* is the program that made the call and *address* is the location that made the illegal call.	Return program to programmer.
*RUN	BCS			All programs are loaded and ready for execution.	Check that all input/output devices are ready for operation. Press RUN.
SCØ1	RTE			Missing parameter.	Return program to programmer.
SCØ2	RTE			Illegal parameter.	Return program to programmer.
SCØ3	RTE			Program cannot be scheduled.	Return program to programmer.
SCØ5	RTE			Program given is not defined.	Return program to programmer.
SCØ6	RTE			No resolution code in EXECUTION TIME EXEC call.	Return program to programmer.
SEQ ERR	RTE			Illegal edit command.	Return program to programmer.
*SET ALL SWITCH REGISTER BITS TO ZERO (Ø)				All switches were not set "OFF."	Set all switches "OFF."
SO	Assembler			There are more symbols defined in the program than the symbol table can handle.	
SPARE TRK OVERFLOW	DOS-M			Defective cylinder detected and no spare tracks available for assignment.	
SQT -KYBD?	PCS			Request for EQT unit-reference number of the device serving as the keyboard input device.	Type the number.
STATEMENT ERROR	SDUMP			Illegal command.	Re-type input statement in correct format.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
STOP *xxxxx nnnnn*	DOS, DOS-M			Program *xxxxx* has terminated at location *nnnnn*.	No action required.
SUBCHAN = *n*	DOS-M			Given in response to :UD information request or when :SS makes new subchannel assignment.	No action required.
xxxxx SUSP	FORTRAN			Program *xxxxx* suspended.	Restart program using the GO directive.
xxxxx SUSP	DOS, DOS-M			Program *xxxxx* suspended by EXEC call or PAUSE directive.	Restart the program using the GO directive.
SY	Assembler			Illegal symbol or too many control statements.	
*TABLE	PCS			Request for EQT entry information.	Press RUN. For each input/output device type the appropriate information in the following format: nn,D.ee,[,D][,Uu] nn = channel number D.ee = driver name where: D = device uses a DMA channel ee = ØØ Teleprinter = Ø1 Tape Reader = Ø2 Tape Punch = 1Ø Calcomp Plotter = 12 Line Printer = 15 Mark Source Card Reader = 21 HP 2Ø2Ø MT unit = 22 HP 3Ø3Ø MT unit = 23 HP 797ØA MT unit
TAPE CHECKSUM ERROR	SDUMP			The checksum in the tape record does not match the sum computed by SDUMP. Current record is ignored if restarted.	1. Backup tape. Press REWIND. Press RUN. 2. Restart ready of tape.
TAPE/DISC VERIFY ERROR	SDUMP			Disc and tape records do not agree. Disc record is rewritten on restart.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
TAPE END	DOS-M			EQT flag set on magnetic tape or paper tape device during output via JOBPR directives :DUMP and :LIST or output of a JOB or EJOB statement. If a magnetic tape, it is rewound with standby, if paper tape, a trailer is punched. The JOBPR will then pause to allow a new tape to be set up.	Mount a new magnetic tape. Enter :GO to continue the output.
TM *nnnnn*	DOS, DOS-M			Maximum execution time exceeded. The program is currently at *nnnnn* and is aborted.	Increase execution time.
TRAC # TOO BIG	DOS, DOS-M			Track requested is higher than last available disc track (track may be in JBIN areas).	Redefine the track request, purge files or DOS-M only use different disc.
TRACK *nnn* (8) SECTOR *mmm* (8)	SDUMP			Identification for the Disc Error Diagnostics messages. *nnn* is the octal track number and *mmm* is the octal sector number where the error occurred.	Save this information. Call for maintenance.
# TRACKS UNAVAILABLE	DOS, DOS-M			There are not enough work tracks for the compiler.	Purge disc of unnecessary files.
TRAK *nnn* EQT#*uu* S(or U)				Irrecoverable disc read parity error. If user read request (U), then program is abnormally terminated and track is made unavailable for further write operations. If system read request (S), the program transfer terminates.	Return to programmer.
TSB DISC	DOS-M			Informs user that the user disc was labeled by a non-DOS-M system.	May be made DOS-M disc by labeling or unlabeling with :IN.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
TURN {ON / OFF} DISC PROTECT OVERRIDE SWITCH	DOS-M			Follows parity error.	Follow the instruction. Press RUN.
-TTY?	PCS			Request for EQT unit-reference number of the device serving as teleprinter output.	Type the number.
TURN OFF DISC PROTECT, HIT RUN	SDUMP			SDUMP instruction.	Set the Disc Protect Switch off. Press RUN.
UD*nnnnn*	DOS-M			Unable to find user disc requested by EXEC call at *nnnnn*.	Mount required disc and type :GO, or terminate program with :AB or :OF.
UN	Assembler, PCS			Undetermined symbol.	Return to programmer.
UNLBL	DOS-M			User disc specified in UD is unlabelled.	If trying to change user disc assignment, enter UD,*[,*n*]
*UN NAME	PCS			The name I.ee is not defined as an entry point in any I/O driver previously loaded.	1. If the driver name was typed incorrectly, retype the entire entry correctly. 2. If the driver is to be loaded with the user's program at object program load time, type an exclamation mark (!). The name is added to the Loader's LST. 3. If the driver should have been loaded, rerun PCS.
file name UNDEFINED	DOS, DOS-M			Undefined file-name in PURGE, LIST, RUN or STORE or DD,u file name.	Retype correct file name on the system teleprinter.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
UNDEFINED EXTS	DOS, DOS-M			Undefined external references exists in programs loaded. The external references are listed, one per line.	To load additional programs from paper tape type :GO, [,n]. To continue without fulfilling external references, type :GO,1.
*UNDEFINED SYMBOL <symbol>	PCS			An entry point in a BCS module cannot be located.	1. To enter the symbol in the Loader Symbol Table, press RUN. 2. If the subroutine should have been loaded, rerun PCS.
UNLBL	DOS-M			User disc specified in UD is unlabelled.	If trying to change user disc assignment, enter UD,*[,*n*].
WAIT	DOS			DOS is purging the user files or moving them, sector by sector, because of parity error on read. Printed every 6 seconds.	Wait.
WRONG INPUT	DOS, DOS-,			Relocatable binary input furnished for a source file request or vice-versa.	Put in correct input.
nn xx	DOS, DOS-M			Library routine error code.	
@	DOS, DOS-M			Directives may be entered.	Enter desired directive.
*	DOS, DOS-M			Operator attention directives may be entered.	Enter desired directive.
1ST WORK TRACT=*ttt* BAD= *bbb*				In TRACK directive, *ttt* = available work track; *bbb*=faulty tracks.	Redefine track.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
NEXT AVAIL TRACK = *tt* BAD=*nn*	DOS-M			In TRACK directive, *tt* = first track beyond end of current user area; *nn* = number of bad tracks. "BAD=*nn*" returned only if bad tracks do exist. *tt* = "NONE" if no tracks are available.	
		BCS	102055	A line is about to be printed on the teleprinter.	Turn the punch unit off. Press RUN.
		BCS	102056	A line has been printed while the teleprinter punch unit was off.	Turn punch unit on. Press RUN.
		BCS	102066	Tape supply low on tape punch which is producing absolute binary output. Trailer follows last valid output.	Place new reel of tape in unit. Press RUN. Leader is produced.
		PCS	102077	BCS tape is punched.	To produce additional copies, set switch 15 "ON." Press RUN.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
	FORTRAN	ØØØ1		Statement label error.	
	FORTRAN	ØØØ2		Unrecognized statement.	
	FORTRAN	ØØØ3		There is an unequal number of left and right parenthesis in a statement.	
	FORTRAN	ØØØ4		Illegal character or format.	
	FORTRAN	ØØØ5		An arithmetic expression contains adjacent arithmetic operators.	
	FORTRAN	ØØØ6		A variable name is used both as a simple variable and subscripted variable.	
	FORTRAN	ØØØ7		Doubly defined variable.	
	FORTRAN	ØØØ8		Invalid parameter list.	
	FORTRAN	ØØØ9		Invalid arithmetic expression.	
	FORTRAN	ØØ1Ø		Mixed mode expression: integer constants or variables appear in an arithmetic expression with real constants or variable.	
	FORTRAN	ØØ11		Invalid subscript.	
	FORTRAN	ØØ12		Invalid constant.	
	FORTRAN	ØØ13		Invalid EQUIVALENCE statement.	
	FORTRAN	ØØ14		Table overflow: too many variables and statement labels appear in the program.	
	FORTRAN	ØØ15		Invalid DO loop.	
	FORTRAN	ØØ16		Statement function name is doubly defined.	
			1Ø2ØØØ	Memory overflow: the program is too large; has too many symbols.	Irrecoverable error; program must be revised.
			1Ø2ØØ1	End of binary object tape output, start of assembly listing.	If only one output device, place intermediate binary output from previous pass in Standard Input unit and press RUN.
			1Ø2ØØ2	End of source tape. (4K compiler)	Place next input tape in reader.

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
			102007	For all passes except first, unrecognizable record on intermediate binary tape: 1. Punch error on previous pass. 2. Wrong tape supplied as input for pass.	If punch error, restart with pass 1. If wrong tape, restart current pass: a. Load FORTRAN pass. b. Set SWITCH REGISTER to 000100_8. c. Press LOAD ADDRESS. d. Place previous intermediate binary tape in input device. e. Press RUN.
			102010	External symbol table overflow: the number of symbols exceeds 255.	Irrecoverable error; program must be revised.
			102011	Checksum error on intermediate tape; indicates probable punch error.	Attempt to reread record (binary records are separated by 4 feed frames). Otherwise, restart with pass 1.
				If a magnetic tape is used for intermediate, indicates MT parity error or write not enabled.	Irrecoverable error.
			102027	A magnetic tape read error has occurred during pass 2.	Restart.
			102057	End of source tape.	Place next input tape in reader.
			102066	Tape supply low on 2753A Tape Punch.	Load new tape and press RUN.
			102077	Normal end of pass or compilation.	Proceed as indicated in above steps.
	ALGOL	1		More than two characters used in an ASCII constant.	
	ALGOL	2		@ not followed by an octal digit.	
	ALGOL	3		Octal constant greater than 177777.	
	ALGOL	4		Two decimal points in one number.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
	ALGOL	5		Non-integer following apostrophe.	
	ALGOL	6		Label declared but not defined in program.	
	ALGOL	7		Number required but not present.	
	ALGOL	8		Missing END.	
	ALGOL	1Ø		Undefined identifier.	
	ALGOL	11		Illegal symbol.	
	ALGOL	12		Procedure designator must be followed by left parenthesis.	
	ALGOL	13		Parameter types disagree.	
	ALGOL	14		Name parameter may not be an expression.	
	ALGOL	15		Parameter must be followed by a comma or right parenthesis.	
	ALGOL	16		Too many parameters.	
	ALGOL	17		Too few parameters.	
	ALGOL	18		Array variable not followed by a left bracket.	
	ALGOL	19		Subscript must be followed by a comma or right bracket.	
	ALGOL	2Ø		Missing THEN.	
	ALGOL	21		Missing ELSE.	
	ALGOL	22		Illegal assignment.	
	ALGOL	23		Missing right parenthesis.	
	ALGOL	24		Proper procedure not legal in arithmetic expression.	
	ALGOL	25		Primary may not begin with this type quantity.	
	ALGOL	26		Too many subscripts.	
	ALGOL	27		Too few subscripts.	
	ALGOL	28		Variable required.	
	ALGOL	4Ø		Too many external symbols.	
	ALGOL	41		Declarative following statement.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
	ALGOL	42		No parameters declared after left parenthesis.	
	ALGOL	43		REAL, INTEGER, or BOOLEAN illegal with this declaration.	
	ALGOL	44		Doubly defined identifier or reserved word found.	
	ALGOL	45		Illegal symbol in declaration.	
	ALGOL	46		Statement started with illegal symbol.	
	ALGOL	47		Label not followed by colon.	
	ALGOL	48		Label is previously defined.	
	ALGOL	49		Semicolon expected as terminator.	
	ALGOL	5Ø		Left arrow or := expected in SWITCH declaration.	
	ALGOL	51		Label entry expected in SWITCH declaration.	
	ALGOL	52		Real number assigned to integer.	
	ALGOL	53		Constant expected following left arrow or :=.	
	ALGOL	54		Left arrow or := expected in EQUATE declaration.	
	ALGOL	55		Left bracket expected in array declaration.	
	ALGOL	56		Integer expected in array dimension.	
	ALGOL	57		Colon expected in array dimension.	
	ALGOL	58		Upper bound less than lower bound in array.	
	ALGOL	59		Right bracket expected at end of array dimensions.	
	ALGOL	6Ø		Too many values for array initialization.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
	ALGOL	61		Array size excessing (set to 2Ø47).	
	ALGOL	62		Constant expected in array initialization.	
	ALGOL	63		Too many parameters for procedure.	
	ALGOL	64		Right parenthesis expected at end of procedure parameter list.	
	ALGOL	65		Procedure parameter descriptor missing.	
	ALGOL	66		VALUE parameter for procedure not in list.	
	ALGOL	67		Illegal TYPE found in procedure declaration.	
	ALGOL	68		Illegal description in procedure declaratives.	
	ALGOL	69		Identifier not listed as procedure parameter.	
	ALGOL	7Ø		No type FOR variable in procedure parameter list.	
	ALGOL	71		Semicolon found in a format declaration.	
	ALGOL	72		Left parenthesis expected after I/O declaration name.	
	ALGOL	73		Right parenthesis expected after I/O name parameters.	
	ALGOL	74		Undefined label reference.	
	ALGOL	75		Switch identifier not followed by a left bracket.	
	ALGOL	76		Missing right bracket in switch designator.	
	ALGOL	77		THEN missing in IF statement.	
	ALGOL	78		DO missing in WHILE statement.	
	ALGOL	79		FOR variable must be of type INTEGER.	

MESSAGE	SOURCE	CODE	MEMORY DATA REGISTER	MEANING	ACTION
	ALGOL	8Ø		FOR variable must be followed by an assign symbol.	
	ALGOL	81		STEP symbol missing in FOR clause.	
	ALGOL	82		UNTIL symbol missing in FOR clause or DO statement.	
	ALGOL	83		DO symbol missing in FOR clause.	
	ALGOL	84		Parenthesis expected in READ/ WRITE statement.	
	ALGOL	85		Comma expected in READ/WRITE statement.	
	ALGOL	86		Free field format (*) illegal with WRITE	
	ALGOL	87		Unmatched [in I/O statement list.	
	ALGOL	88		Missing BEGIN in case statement.	
	ALGOL	89		Missing END in case statement.	
	ALGOL	1ØØ		Program must start with BEGIN, REAL, INTEGER or PROCEDURE.	
	ALGOL	999		Table areas have overflowed, program is discontinued.	

APPENDIX B
HP FORTRAN IV OPERATING INSTRUCTIONS

The HP FORTRAN IV Compiler is available with three operating systems: DOS, DOS-M and RTE. The HP FORTRAN IV operating procedures for these three systems are identical to the FORTRAN procedures described in Sections VII and IX, with the following exceptions: hardware, binary tapes supplied, PROG directive and compiler error diagnostics.

HARDWARE

Compilation under DOS or RTE control requires 16K words of core memory. To execute object programs under DOS control, 8K words of core memory are required. To execute object programs under RTE control, 16K words of core memory are required.

To compile and execute object programs under DOS-M control, 8K words of core memory are required.

> *NOTE: HP FORTRAN IV programs cannot be compiled under BCS control. However, object programs produced by the compiler can be loaded and executed under BCS control if the BCS system includes 8K words of core memory and a HP 2752A teleprinter.*

BINARY TAPES SUPPLIED

The HP FORTRAN IV Compiler consists of a main program and 18 segments supplied to the user on three binary paper tapes.

Binary Tape #1

FTN4 (the main program) and segments FTN40, FTN41, FTN42

Binary Tape #2

Segments FTN43, FTN44, FTN45, FTN46, FTN47, FTN48, FTN49

Binary Tape #3

Segments FTN4A, FTN4B, FTN4C, FTN4D, FTN4E, FTN4F, FTN4G, FTN4H


Computer
Museum

pname = the program name

nn = the diagnostic error number

cc = column number of source line being scanned when error detected.

NOTE: If cc = 01, the error is in the source line preceding the last one printed. If cc = 00, there is an error in an EQUIVALENCE group.

HP FORTRAN IV COMPILER ERROR MESSAGES

Error Code	Meaning	Effect	Action
01	COMPILER CONTROL STATEMENT MISSING There is no FTN or FTN4 directive preceding the FORTRAN IV job	Compilation Terminated	
02	ERROR IN COMPILER CONTROL STATEMENT Incorrect syntax or illegal parameter in FTN or FTN4 directive	Compilation Terminated	
03	SYMBOL TABLE OVERFLOW Insufficient core memory exists for continuing compilation	Compilation Terminated	Reduce number of symbols (constants, variable names and statement numbers) in program and shorten lengths of variable names and statement numbers
04	LABELED COMMON NOT ALLOWED Only unlabeled (blank) COMMON is allowed in HP FORTRAN IV	Statement Terminated	Convert labeled COMMON blocks to blank COMMON
05	NO DISC SOURCE FILE ASSIGNED The logical unit for input of the FORTRAN IV source program is 2, but the address of source file on disc has not been assigned	Compilation Terminated	Precede compilation by a :JFILE (DOS) or LS (RTE) directive to operating system
06	END OF FILE OCCURRED BEFORE "$" Source input file ended before the "$" or END$ statement ending the FORTRAN IV job was encountered	Compilation Terminated	Example: no "$" or END$ statement at end of source file
07	RETURN IN MAIN PROGRAM A RETURN statement occurs in a main program. It is interpreted as a STOP statement	Comment	

Error Code	Meaning	Effect	Action
19	INTEGER CONSTANT REQUIRED	Statement terminated	Examples: A non-dummy integer variable is used in an array declarator or an integer variable is used as a subscript in an EQUIVALENCE group.
20	EMPTY HOLLERITH STRING In an 'nH' specification, n=0.	Statement terminated	
21	NON-OCTAL DIGIT IN OCTAL CONSTANT A digit > 7 occurs in an octal constant.	Warning	Example: 1289B
22	ILLEGAL USAGE OF NAME A variable is used as a subprogram name or an array name is used as a DO statement index variable	Statement terminated	
23	DO TERMINATOR DEFINED PREVIOUS TO DO STATEMENT The terminating statement of a DO loop comes before the DO statement or is the DO statement itself.	Statement terminated	Example: 10 DO 10 I=1,5
24	ILLEGAL CONSTANT A variable name is expected but a constant appears.	Statement terminated	

Error Code	Meaning	Effect	Action
25	ILLEGAL SUBPROGRAM NAME USAGE A subprogram name is used where a variable name or constant is expected.	Statement terminated	Examples: A subprogram name occurs on the left-hand side of an assignment statement. A FUNCTION or statement function name occurs as an operand in an expression but no argument list is given.
26	INTEGER VARIABLE OR CONSTANT REQUIRED Non-integer value is used where an integer quantity is required.	Statement terminated	Examples: A subscript in an EQUIVALENCE group element is a non-integer constant. A READ or WRITE statement has a non-integer logical unit reference.
27	STATEMENT NUMBER PREVIOUSLY DEFINED The same statement number appears on two statements.	Statement terminated	
28	UNEXPECTED CHARACTER Syntax of statement is incorrect.	Statement terminated	
29	ONLY STATEMENT NUMBER ON SOURCE LINE Some source code must appear within the first 72 columns of a numbered statement.	Warning	

Error Code	Meaning	Effect	Action
41	ILLEGAL COMMON BLOCK EXTENSION An EQUIVALENCE group requires the COMMON block base to be altered. Further EQUIVALENCE groups are ignored.	Statement terminated	
42	FUNCTION HAS NO PARAMETERS OR ARRAY HAS EMPTY DECLARATOR LIST A function must have at least one parameter. There is insufficient information to dimension an array name.	Statement terminated	
43	PROGRAM, FUNCTION OR SUBROUTINE NOT FIRST STATEMENT A PROGRAM statement, if present, must come first. A FUNCTION or SUBROUTINE statement is required for subprograms.	Statement terminated	
44	NAME IN CONSTANT LIST IN DATA STATEMENT A constant list in a DATA statement contains a non-constant.	Statement terminated	
45	ILLEGAL EXPONENTIATION Exponentiation is not permitted with data types used.	Statement terminated	
46	FUNCTION NAME UNUSED OR SUBROUTINE NAME USED In a FUNCTION subprogram, the name of the FUNCTION is not defined or a SUBROUTINE name is used within the subroutine.	Warning	

Error Code	Meaning	Effect	Action
47	FORMAT SPECIFICATION NOT AN ARRAY NAME, STATEMENT NUMBER OR * The FORMAT reference in an I/O statement is invalid.	Statement terminated	
48	DO MISSPELLED Keyword DO misspelled.	Comment	Example: DØ
49	IMPROPER USE OF NAME A variable is used as a sub-program name.	Statement terminated	
50	DO STATEMENT IN LOGICAL IF A DO statement is illegal as the "true" branch of a logical IF.	Warning	
51	CONTROL VARIABLE REPEATED IN DO NEST A variable occurs as the index of two DO loops or implied DO's or a combination of these which are nested.	Statement terminated	
52	LOGICAL IF WITHIN LOGICAL IF A logical IF statement is illegal as the "true" branch of another logical IF.	Statement terminated	

Error Code	Meaning	Effect	Action
64	FREE FIELD OUTPUT ILLEGAL An '*' in place of a format designation is illegal in a WRITE statement.	Statement terminated	
65	HOLLERITH COUNT GREATER THAN 2 In an 'nH' specification, n > 2.	Comment	
66	PROGRAM UNIT HAS NO BODY A main program, SUBROUTINE or FUNCTION requires no object program.	Warning	
67	END$ OR $ OCCURS BEFORE END STATEMENT The end of the FORTRAN job was encountered before the END statement terminating the current program unit.	Compilation terminated	Example: END statement contains syntax error or it is missing.
68	EXTERNAL NAME HAS MORE THAN FIVE CHARACTERS The name of a PROGRAM, SUBROUTINE or FUNCTION has more than five characters. The first five characters are used.	Warning	
69	OCTAL STRING IN STOP OR PAUSE STATEMENT IS TOO LONG In the statement STOP n or PAUSE n, n has more than four digits.	Warning	
70	EQUIVALENCE GROUP SYNTAX An EQUIVALENCE group does not start with a left parenthesis. All further groups are ignored.	Statement terminated	

Error Code	Meaning	Effect	Action
71	DUMMY VARIABLE IN DATA LIST Dummy parameters of a subprogram cannot be initialized in a DATA statement.	Statement terminated	
72	COMMON VARIABLE IN DATA LIST Entities of a COMMON block cannot be initialized with a DATA statement.	Statement terminated	
73	MIXED MODE IN DATA STATEMENT A name and its corresponding constant in a DATA statement do not agree in type.	Statement terminated	
74	ILLEGAL USE OF STATEMENT FUNCTION NAME The name of a statement function also occurs in its dummy parameter list.	Warning	
75	RECURSION ILLEGAL The current program unit name has been used in a CALL statement.	Statement terminated	
76	DOUBLY DEFINED DUMMY VARIABLE The same dummy variable name occurs twice in a subprogram or statement function parameter list.	Warning	
77	STATEMENT NUMBER IGNORED A statement number on a specification or DATA statement or on a statement function is ignored.	Warning	

Error Code	Meaning	Effect	Action
78	PROGRAM UNIT HAS NO EXECUTABLE STATEMENTS A program unit has only specification or DATA statements or statement functions.	Warning	
79	FORMAT DOES NOT START WITH LEFT PARENTHESIS	Warning	
80	FORMAT DOES NOT END WITH RIGHT PARENTHESIS	Warning	
81	ILLEGAL EQUIVALENCE GROUP SEPARATOR EQUIVALENCE groups are not separated by a comma or a non-array name has subscripts in an EQUIVALENCE group. All further EQUIVALENCE groups are ignored.	Statement terminated	
82	ILLEGAL USE OF ARRAY NAME IN AN EQUIVALENCE GROUP An array name in an EQUIVALENCE group is not followed by '(', ',' or ')'. All further EQUIVALENCE groups are ignored.	Statement terminated	
83	SUBPROGRAM NAME RETYPED The type declared for a subprogram name within its body does not agree with the type established in the SUBROUTINE or FUNCTION statement.	Warning	

Error Code	Meaning	Effect	Action
84	OBJECT CODE MEMORY OVERFLOW Object program size is greater than 32K.	Compiler terminated	
85	POSSIBLE RECURSION MAY RESULT The use of one of the library names REAL, SNGL, DBLE, CMPLX, FLOAT, CLRIO, IFIX, ERRO or EXEC as the name of a PROGRAM, may produce recursion if the body of the subprogram so named requires an implicit call to one of these names.	Comment	The user is advised to change the name of the subprogram or to make certain that no mixed mode exists in the program and that no library subprogram used requires a call to ERRØ.
86	DUMMY VARIABLE IN STATEMENT FUNCTION CANNOT BE SUBSCRIPTED A dummy variable in a statement function cannot represent an array or a subprogram name.	Warning	Example: ASF(A)=A(1,1)+A(2,2)

GLOSSARY

TERM	MEANING
ABSOLUTE PROGRAM	An object program with a fixed location in core memory for its instructions and data.
ACCESS TIME	The computer time required to locate data and move it to and from storage.
ADDRESS	An identification code used to locate a specific item of data within the storage area of the computer.
ALPHANUMERIC	A term used to indicate a combination of letters, numbers, and special symbols such as punctuation or mathematical notation.
ASCII CODE	American Standard Code for Information Interchange; a special eight-channel paper tape code developed to facilitate data transmission between machines manufactured by different companies.
ASSEMBLE	To prepare a machine language program by translating each symbolic coded instruction into one machine language instruction.
BATCH MODE	Directives are incorporated into the source program and read from the input device that reads the source program. The operator does not enter directives from the keyboard.
BINARY	A number system using the number two as its base (as opposed to decimal which uses the number ten), and only the digits Ø and 1 to express numerical quantities.
BIT	A unit of information capacity of a storage device; abbreviation for binary digit.

TERM	MEANING
COMMAND	The portion of an instruction used to control the operation of a computer.
COMPILE	To produce object code from a program written in a high-level programming language, such as FORTRAN or ALGOL.
COMPUTER	An electronic device that accepts, processes, and returns information according to a program.
CONFIGURE	The process of assigning the device codes to a program.
CONSOLE	The part of a computer that is used for manual control and visual display of data.
CORE MEMORY	The main "dynamic" memory of the computer where the programs, the information processed by the programs, and the results of the processing, are stored.
DATA	Basic elements of information--facts, numbers, letters, symbols--that can be processed by a computer.
DECIMAL	A number system using the number 1Ø as its base, and the digits Ø through 9 to express numerical quantities.
DIGIT	A sign or symbol used to convey a specific quantity of information either by itself or with other digits.
DIRECTIVES	Instructions (in DOS or DOS-M) either contained in the job or input by the operator. Directives control either job data or what the job does.
DISC/DRUM ENVIRONMENT	A disc or drum used for storage of large amounts of information; this involves magnetically sensitive storage areas defined in tracks and sectors.
DRIVER	A program that activates and controls a device.

TERM	MEANING
DUMP	To transfer part or all of the contents from one section of computer storage into another storage section or output device.
EDIT	To modify data by deleting, inserting, or re-arranging.
EXECUTE	To interpret a machine instruction and perform the specified operations.
FILE	An area of core memory or mass storage used for storing program information.
HALT	A temporary stop in processing, indicated by the HALT button light on the front panel of the computer. A halt can be caused by pressing the HALT button or by the computer or program.
INPUT	Information or data transferred from an external medium; i.e., punched cards, paper tape, magnetic tape, disc or drum, into the internal storage of the computer.
INITIALIZE	To set the register to starting values before running a program.
KEYBOARD MODE	The user's directives are entered by the operator at the terminal keyboard.
LOAD-AND-GO	A procedure that compiles the program and executes the created program.
MAGNETIC TAPE	Mylar tape coated with a substance that enables the tape to be magnetized or demagnetized. Information or data is stored on this tape using the magnetically sensitive storage areas.
MEMORY	The area in the computer used to store programs, the information to be processed by the programs, and the results of processing.

TERM	MEANING
MESSAGE	A group of alphanumeric characters, either words or abbreviations, presented to the operator (normally on the system teleprinter) describing error conditions or requesting some operator action.
OBJECT PROGRAMS	Source programs written by programmers must be compiled into machine instructions before they can be run. Programs, such as the ALGOL and FORTRAN Compilers, and the Assembler, accept source programs and produce object programs which consist of machine instructions in either absolute or relocatable format that carry out the operations specified in the source program.
OCTAL	A number system using the number 8 as its base and the digits Ø through 7 to express numerical quantities.
OFF-LINE	Pertains to equipment or devices not in direct communication with the computer.
ON-LINE	Pertains to equipment or devices directly connected to the computer.
OPERATOR	The person who manipulates the computer controls, places information media into the input devices, removes the output, and performs other related functions.
OUTPUT	Information transferred to external storage (such as disc, magnetic tape) or to any device outside the computer.
OVERFLOW	The resulting condition when an arithmetic operation exceeds the capacity of the storage space allotted in a computer.
PARAMETER	A quantity in a subroutine whose value specifies or partially specifies the process to be performed.

TERM	MEANING
PROCESSING	Accepting storing, changing, or delivering information according to a program.
PROGRAM	A sequence of instructions to a computer telling it how to perform a certain task.
RECORD	A group of related facts or fields of information treated as a unit.
RELOCATABLE PROGRAM	An object program with relative, not fixed, memory assignments for instructions and data.
REQUESTS	Instructions input only by an operator that control the RTE System.
RESET	A bit is "OFF" (zero).
ROUTINE, SUBROUTINE	A particular set of computer instructions within a larger program that cause the program to perform a specific function.
SET	A bit is "ON" (one).
SIO MODULE	From one to four SIO drivers whose device assignments have been made and are on one roll of paper tape.
SOURCE PROGRAMS	Source programs are programs written in ALGOL, FORTRAN, and Assembly Language by the programmer. They must be compiled into object programs and relocated (if relocatable) before they can run on the computer.
STORAGE	A device or medium such as disc, drum, magnetic tape, or paper tape or core memory where which information or data may be placed and later retrieved.
SYSTEM	The computer, optional peripheral devices, and the supporting software (programs) to control and operate the system.