RC 70 COMPUTER

OPERATOR'S MANUAL

RC

RECOR

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ERROR MESSAGE SUMMARY

Error Message	Program	Meaning
C901	All	Object program checksum error has been detected. Restart is required
C903	General Loader	Program exceeds memory size
C904	Assembler	Symbol table is full
	General Loader	Program has been loaded, but BSS area exceeds memory size
C907	General Loader and FORTRAN IV Loader	Object program has short forward reference (assembly language) larger than 255. Index register holds location of instruction in error; B-register holds operand address. Press START to continue loading
C909	Redebug	Start trace, single cycle
C910	All	Source tape checksum error has been detected. Press START to continue
C921	General Loader	General Loader program checksum error has been detected
C942	FORTRAN IV Loader	End of core image dump; press START to begin program execution
C944	Tape Edit	Control statement sequence number error has been detected. Press START and re-enter correct control statement
C955	All	Power shutdown has occurred. Repeat preceding activity from beginning
C960	FORTRAN IV Loader and Runtime	Memory overflow has been detected
C961	FORTRAN IV Loader	Common area error has been detected. Correct error
C962	FORTRAN IV Loader	Undefined subprogram has been detected
C963	FORTRAN IV Loader	Illegal tape is in system input
C964	FORTRAN IV Loader	Doubly defined subprogram has been detected
C970	FORTRAN IV Runtime	Illegal character in FORMAT reference has been detected, or required character in FORMAT reference has been omitted
C971	FORTRAN IV Runtime	Data input of illegal character has been detected
C972	FORTRAN IV Runtime	Format error has been detected: left or right parenthesis counts do not match, or maximum allowable parenthesis nesting has been exceeded
C973	FORTRAN IV Runtime	Data input, representing floating-point number, exceeds maximum machine range
C974	FORTRAN IV Runtime	Target address not previously defined by an ASSIGN statement has been detected
C975	FORTRAN IV Runtime	Target address undefined in a computed GO TO statement has been detected
C976	FORTRAN IV Runtime	Exponentiation error has been detected in computing A^b, where b is floating-point value and A is negative
C977	FORTRAN IV Runtime	Negative argument to square root function has been detected
C978	FORTRAN IV Runtime	Argument to logarithm function is less than or equal to zero
C979	FORTRAN IV Runtime	Magnitude of argument to exponent function is too large
C980	All	End of system input; press RESET and START to process next input tape. Exception: when loading FORTRAN IV main and subprograms, message indicates end of process; press START to enter FORTRAN IV Library and I/O Editor
C991	FORTRAN IV Loader	Loader program has been loaded. Place main and subprogram tape in system input and press START to process object program tape
C993	Assembler	Five inches of leader have been read without preceding END statement. Press START to continue this assembly; press RESET and START to begin new assembly
C999	All	Program has been successfully loaded. Press START to begin program execution. When using FORTRAN IV Loader, core image can be dumped by setting sense switch 1 up, turning on system punch, and pressing START; then, to begin program execution, push START

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RC 70 COMPUTER

OPERATOR'S MANUAL

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SECTION I
INTRODUCTION

1.1 GENERAL

This manual describes how the user may most efficiently create, correct, and check out his program. The programs that are used to perform these functions are:

- RC 70 General Loader
- RC 70 Tape Edit
- RC 70 Assembler
- RC 70 Redebug
- RC 70 FORTRAN IV programs

These programs, except the RC 70 FORTRAN IV programs, operate in a system that has a minimum of 4096 words of internal core memory and that uses either an ASR-33 or an ASR-35 Teletype as an input/output device. The RC 70 FORTRAN IV programs also use either of these Teletypes as an input/output device; however, the FORTRAN IV programs operate in a system that has a minimum of 8192 words of memory.

The manner in which the General Loader, Tape Edit, Assembler, and Redebug programs are normally used by the operator is shown in figure 1-1. The programs shown are referred to collectively as the RC 70 Program Utility Package.

This manual is intended both as a reference and as an operations guide. Before using the manual, the reader should be familiar with the information contained in the manuals listed below:

Title	Publication No.
RC 70 Computer Reference Manual	M-5000
RC 70 FORTRAN IV Reference Manual	M-5003
RC 70 Assembler Reference Manual	M-5002

The following paragraphs provide a brief description of RC 70 Computer programs. However, before these programs are described, hexadecimal notation is discussed.

1.2 HEXADECIMAL NOTATION

The basic 16-bit structure of the computer makes it convenient to use hexadecimal notation to express the

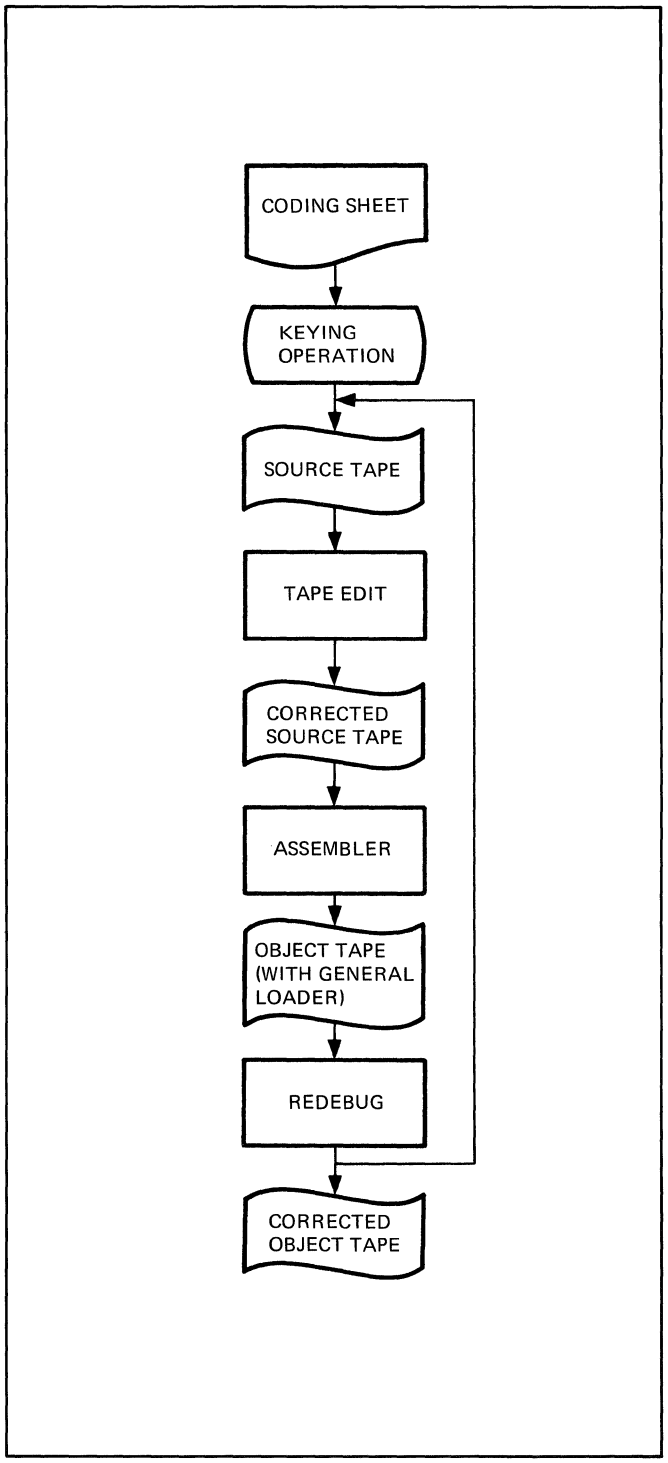


Figure 1-1. Using the Program Utility Package

binary information processed by the computer. Only four hexadecimal digits are needed to express a 16-bit binary number. The following table shows the hexadecimal and binary equivalents for decimal numbers 0 through 15:

Hexadecimal	Binary	Decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

Throughout this manual, hexadecimal notation is represented by a string of hexadecimal digits enclosed in single quotation marks and preceded by the letter X. For example, the hexadecimal notation for the decimal number 79 is written as X'4F'.

1.3 RC 70 GENERAL LOADER

The RC 70 General Loader program may be used to load into the memory of the computer any program assembled by the RC 70 Assembler. It is punched at the beginning of all such program tapes and precedes the main program into the computer memory.

The RC 70 General Loader consists of three loaders: loader A, loader B, and the main loader. Loaders A and B are loaded into the machine's memory using the machine's internal diode bootstrap fill routine. The main loader is loaded by loader B and serves to input the main program.

Loader A, which is optional, determines the computer memory size. Loader B is used to fill the main loader. The main loader inputs the assembled object tapes. It loads reloctable programs not requiring specific linkages to be established at load time. In addition, it recognizes the forward reference control codes and completes the assembly of these forward reference instructions. Operating procedures for the RC 70 General Loader are presented in section III.

1.4 RC 70 TAPE EDIT

The RC 70 Tape Edit program may be used to prepare or modify any statement-formatted, USASCII-coded, punched paper tape, subject to the values of the statement length and control characters described in section IV of this manual. In particular, it is used to facilitate the preparation and modification of source language input tapes for the RC 70 Assembler. Operating procedures for RC 70 Tape Edit are presented in section IV.

1.5 RC 70 ASSEMBLER

The RC 70 Assembler program is a one-pass processor that translates symbolic inputs into machine language. It may be used in conjunction with the RC 70 Tape Edit program and the RC 70 General Loader.

The assembler provides either absolute or relocatable object programs. The allowed character set consists of any legal USASCII-coded character.

The assembler permits the user to write a program using convenient mnemonics for assembler directives and machine instructions. Instructions may have either a long (double word) or a short (single word) format. The assembler converts this symbolic input to machine language, assigns memory locations and addresses as required, and provides messages to alert the user to errors in the program. Operating procedures for the RC 70 Assembler are given in section V.

1.6 RC 70 REDEBUG

The RC 70 Redebug program assists the user in checking out RC 70 Computer programs. Redebug aids the programmer as follows:

- Permits the user to trace the program to a predetermined stopping point and allows the Teletype printer to record the contents of computer registers

- Provides the capability to punch out the contents of memory on paper tape in a format that can be loaded into the machine using the RC 70 General Loader

- Provides the capability to change the contents of any location in memory, as well as changing the contents of computer registers

- Provides the capability to observe the contents of memory and the contents of computer registers

Operating procedures for the RC 70 Redebug program are presented in section VI.

1.7 RC 70 FORTRAN IV PROGRAMS

There are three RC 70 FORTRAN IV programs:

- The FORTRAN IV Compiler

- The FORTRAN IV Loader

- The FORTRAN IV Library and I/O Editor

The manner in which these programs are used during a runtime operation is shown in figure 1-2.

The FORTRAN IV Compiler analyzes FORTRAN IV statements and translates them into object code suitable for execution by the RC 70 Computer. In addition, it provides program listings, a memory map, an extensive set of program diagnostics, and on-line correction capability.

The FORTRAN IV Loader program loads FORTRAN IV and assembly language object programs into the memory of the RC 70 Computer.

The FORTRAN IV Library contains all intrinsic and basic external subroutines listed in the United States of America Standards Institute (USASI) standard. The I/O Editor performs input and output formatting.

Operating procedures for the RC 70 FORTRAN IV programs are presented in section VII.

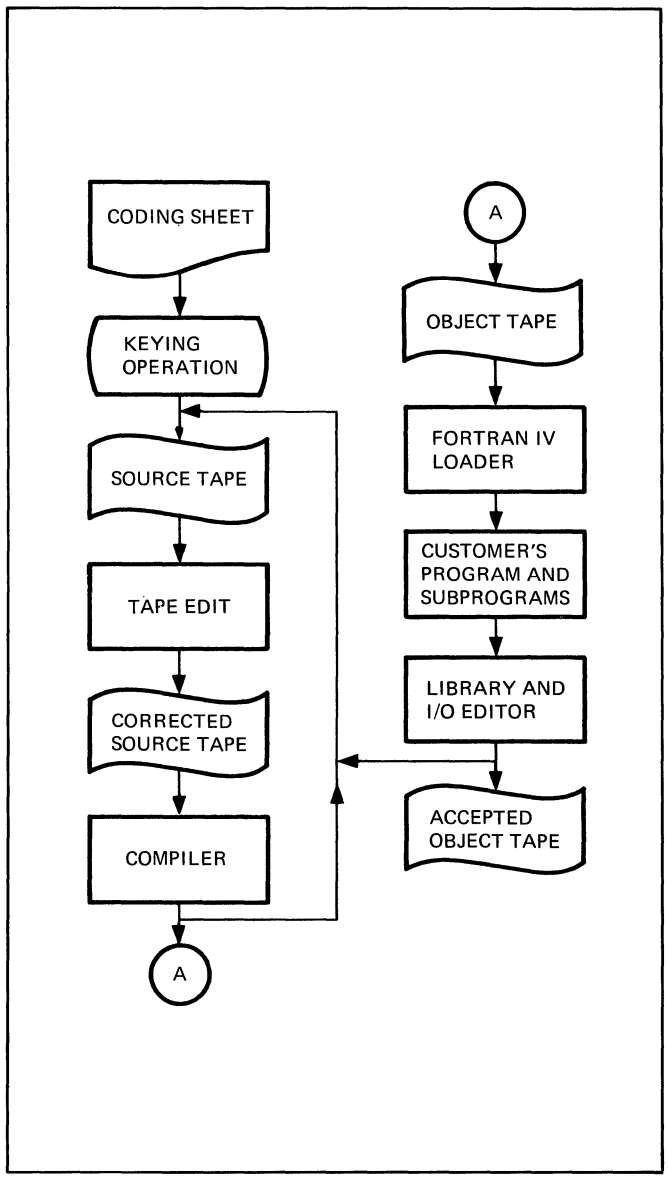


Figure 1-2. Using the FORTRAN IV Programs

SECTION II
OPERATION

2.1 GENERAL DESCRIPTION

This section consists of two parts. The first part describes all controls and indicators on the RC 70 Computer processor control panel and on the Teletype. Tables list each component and its function.

The second part provides procedures that the operator must be familiar with before he can successfully operate the computer.

2.2 CONTROLS AND INDICATORS

2.3 PROCESSOR CONTROL PANEL

The switches and indicators that are used for controlling and monitoring the internal operations of the computer are located on the processor control panel. The placement of each switch and indicator on the panel is shown in figure 2-1. Table 2-1 lists the function of each of these components.

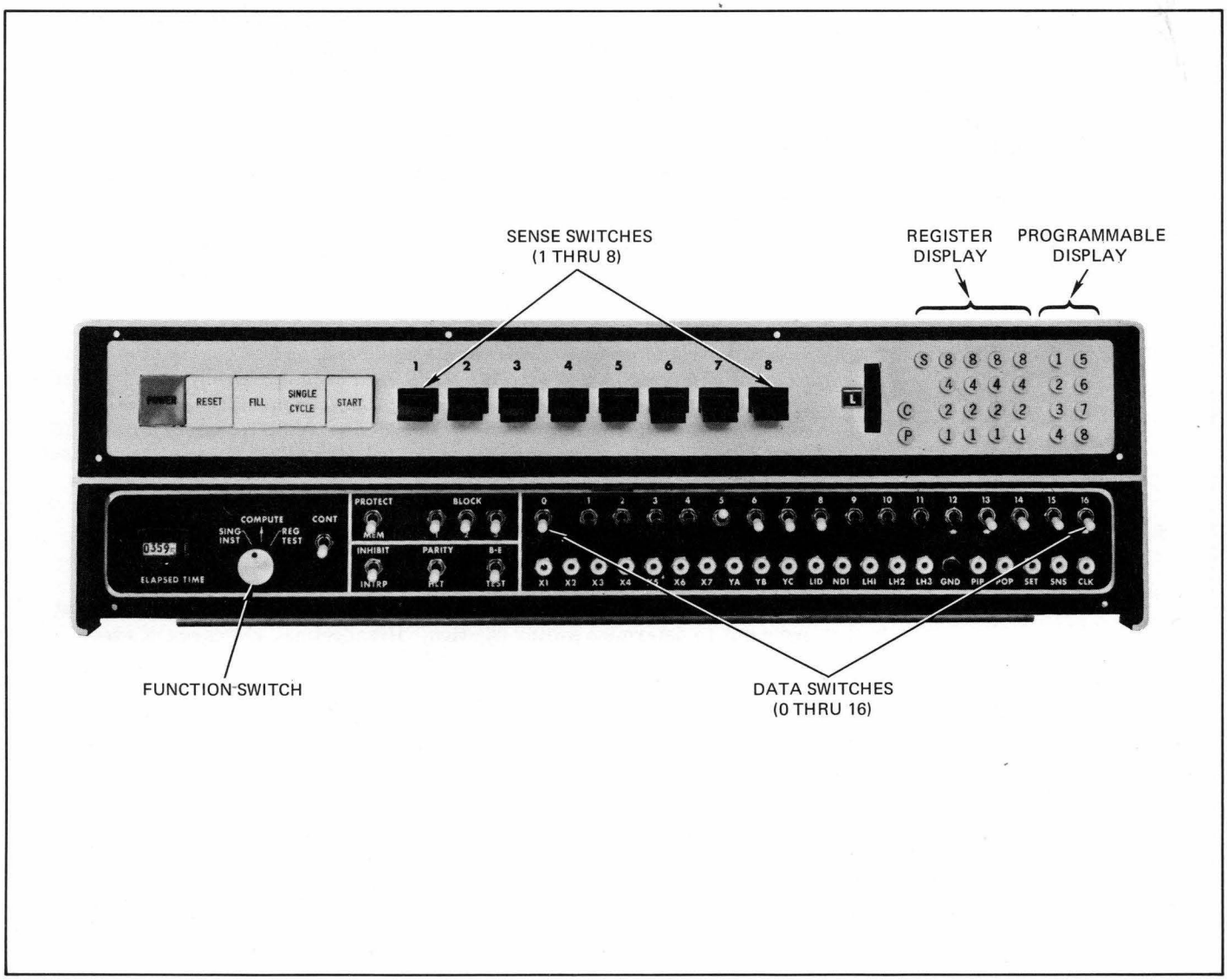


Figure 2-1. Processor Control Panel

Table 2-1. Processor Controls and Indicators

Control or Indicator	Function
POWER	Applies 115V ac power to processor power supply. Indicator lights when power is applied
RESET	Places processor in idle mode and sets up initial operating conditions: a. Processor enters idle mode at end of current memory cycle. b. Contents of data switches 1 through 16 are loaded into L-register. c. Contents of P-register are set to X'01'. All processor controls and indicators are operative in idle mode. Processor remains in idle mode until START switch is pressed or an interrupt becomes active
FILL	Activates execution of 21-instruction fill routine from diode memory. Fill routine loads core memory from I/O device with address X'12'. Loading continues until program is loaded or until RESET or SINGLE CYCLE switch is pressed. FILL switch is operative only in idle mode
SINGLE CYCLE	Enables START switch to step processor through stored program one instruction at a time. Pressing START switch after pressing SINGLE CYCLE switch causes processor to leave idle mode, execute one complete instruction, and return to idle mode again. Pressing SINGLE CYCLE switch while processor is in compute mode returns processor to idle mode after completely executing instruction currently in progress. Indicator lights to indicate that single cycle operation is in effect
START	Controls instruction execution. Pressing START switch causes processor to leave idle mode, enter compute mode, and begin executing stored program. If single cycle operation is not in effect, processor continuously executes instructions until Halt instruction is executed or RESET or SINGLE CYCLE switch is pressed. If single cycle operation is in effect, processor executes one complete instruction and returns to idle mode
Sense switches 1 through 8	Used for external control of stored program. Switches are on in upper position and off in lower position. Status of each switch can be tested and copied into KU indicator by Sense instruction with appropriate address. Either Branch Equal or Branch Unequal instruction can then be used to test indicator to determine switch position. Hexadecimal addresses of sense switches are: Switch 1 — Hexadecimal Address 01 Switch 2 — Hexadecimal Address 02 Switch 3 — Hexadecimal Address 03 Switch 4 — Hexadecimal Address 04 Switch 5 — Hexadecimal Address 05 Switch 6 — Hexadecimal Address 06 Switch 7 — Hexadecimal Address 07 Switch 8 — Hexadecimal Address 00

Table 2-1. Processor Controls and Indicators (Cont.)

Control or Indicator	Function
Register select	Selects certain processor registers, indicators, or memory locations for display by register display indicators. It is also used with REG TEST position of function switch to enter data from 16 data switches into selected register. Information selected for display by this switch is meaningful only in idle mode. Switch positions and data selected for display by each position are summarized as follows: Position — Data Displayed XY — States of minor timing flip-flops X1 through X7 and major timing flip-flops YA through YC. These indications are of interest to maintenance personnel. Figure 2-2 shows display assignments for XY PK — Contents of P-register; states of major timing flip-flops KA, KB, and KC; control flip-flop KK; overflow flip-flop KO; sign flip-flop KS; and unequal flip-flop KU; figure 2-2 shows display assignments for PK D — Contents of D-register (working storage register) L — Contents of L-register (holds memory address) I — Contents of I-register (holds current instruction being executed) R — Contents of memory location X'0007' X — Contents of X-register (index register) B — Contents of B-register (lower accumulator) N — Contents of N-register (holds address of next instruction) A1 thru A6 — Contents of memory locations X'0001' through X'0006'
C (Compute)	Lights when processor is operating in compute mode
P (Memory parity)	Lights when memory parity error is detected
Register display S-8-4-2-1	Displays contents of register, flip-flops, or memory location selected by register select switch. Each column of indicators represents four binary digits (one hexadecimal digit). Information displayed is valid only in idle mode
Programmable display 1 through 8	Displays eight most significant bits (B1 through B8) of B-register under program control. Display is turned on by Parallel Output instruction with I/O address X'00'. Each indicator lights if corresponding bit position of B-register contains 1. Information displayed by indicators is lost if power shutdown occurs

Table 2-1. Processor Controls and Indicators (Cont.)

Control or Indicator	Function
Function switch SING INST COMPUTE REG TEST	Used mainly for maintenance and program debugging. Switch must be set to COMPUTE for normal processor operation. Setting switch to SING INST and then pressing START switch causes processor to execute instruction set into data switches 1 through 16 and then return to idle mode. Setting switch to REG TEST causes processor to load data from 16 data switches into register selected by register select switch
CONT (Continuous)	Used mainly for maintenance and troubleshooting. Setting switch to upper position causes processor to begin executing instructions starting with instruction at address set into 16 data switches. After 1 ms, processor halts and waits for 1 ms before resuming execution at starting address. This cycle continues until switch is set to lower position
PROTECT MEM	Used with BLOCK switches to prevent writing into protected areas of memory. Setting switch to upper position prevents writing into area of memory specified by setting of BLOCK switches. Setting switch to lower position disables memory protection
BLOCK 1 through 3	Select area of memory that is protected when PROTECT MEM switch is set to upper position. Areas of memory selected for protection are as follows (0 represents switch down, 1 represents switch up):

Switch Setting	Protected Area (Hexadecimal)	Decimal Address
000	Entire memory	
001	0800 and up	2048
010	1000 and up	4096
011	1800 and up	6144
100	2000 and up	8192
101	2800 and up	10,240
110	3000 and up	12,288
111	3800 and up	14,336

INHIBIT INTRP	Inhibits or permits interrupts. Setting switch to upper position inhibits interrupts. Setting switch to lower position permits interrupts to occur, provided level is armed and enabled
PARITY HLT	Determines whether processor halts when memory parity error is detected. If switch is set to lower position when parity error occurs, P indicator lights but processor continues executing instructions. If switch is in upper position, P indicator lights and processor halts after executing current instruction. RESET and START switches must then be pressed to restart program
B-E TEST	Tests processor power shutdown and restart circuits. Setting switch to upper position causes processor to continuously cycle through power shutdown and restart sequence consisting of 1 ms operation period followed by 7 ms shutdown period. Cycle continues until switch is set to lower position

Table 2-1. Processor Controls and Indicators (Cont.)

Control or Indicator	Function
Data switches 0 through 16	Used to manually enter data, instructions, or address information into processor. Upper position of switches represents binary 1 and lower position, binary 0. Information is entered into processor from data switches in any of following ways: a. Pressing RESET switch loads address setting of data switches into L-register. b. Executing Parallel Input instruction with I/O address X'01' loads data from switches into B-register. c. Setting function switch to SING INST and pressing START switch causes processor to execute instruction set into switches and then return to idle mode. d. Setting function switch to REG TEST loads data from switches into register specified by setting of register select switch.

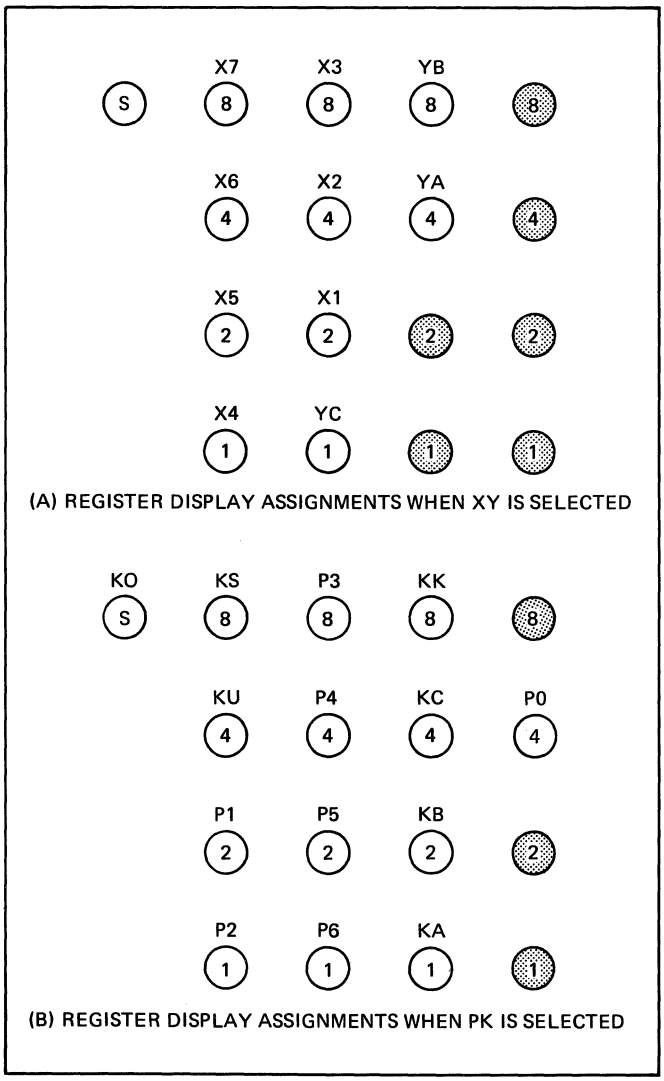


Figure 2-2. Register Display Indicator Assignments for XY and PK

2.4 TELETYPE CONTROLS

The computer may have either an ASR-33 Teletype or an ASR-35 Teletype as an input/output device. Subsequent paragraphs describe the controls of these units.

2.5 Keyboard Controls

The Teletypes have identical keyboard assemblies. Figure 2-3 shows the arrangement of the keyboard. The computer is programmed to accept a total of 69 transmission patterns, one for each character shown in figure 2-4. Also shown in figure 2-4 is the USASCII code generated by each key, as well as the relationship between a keyboard action and a pattern produced on tape.

In addition, there are four control operations that can be performed by pressing either one key or a combination of keys. The keys associated with these operations and the function of each key are listed in table 2-2.

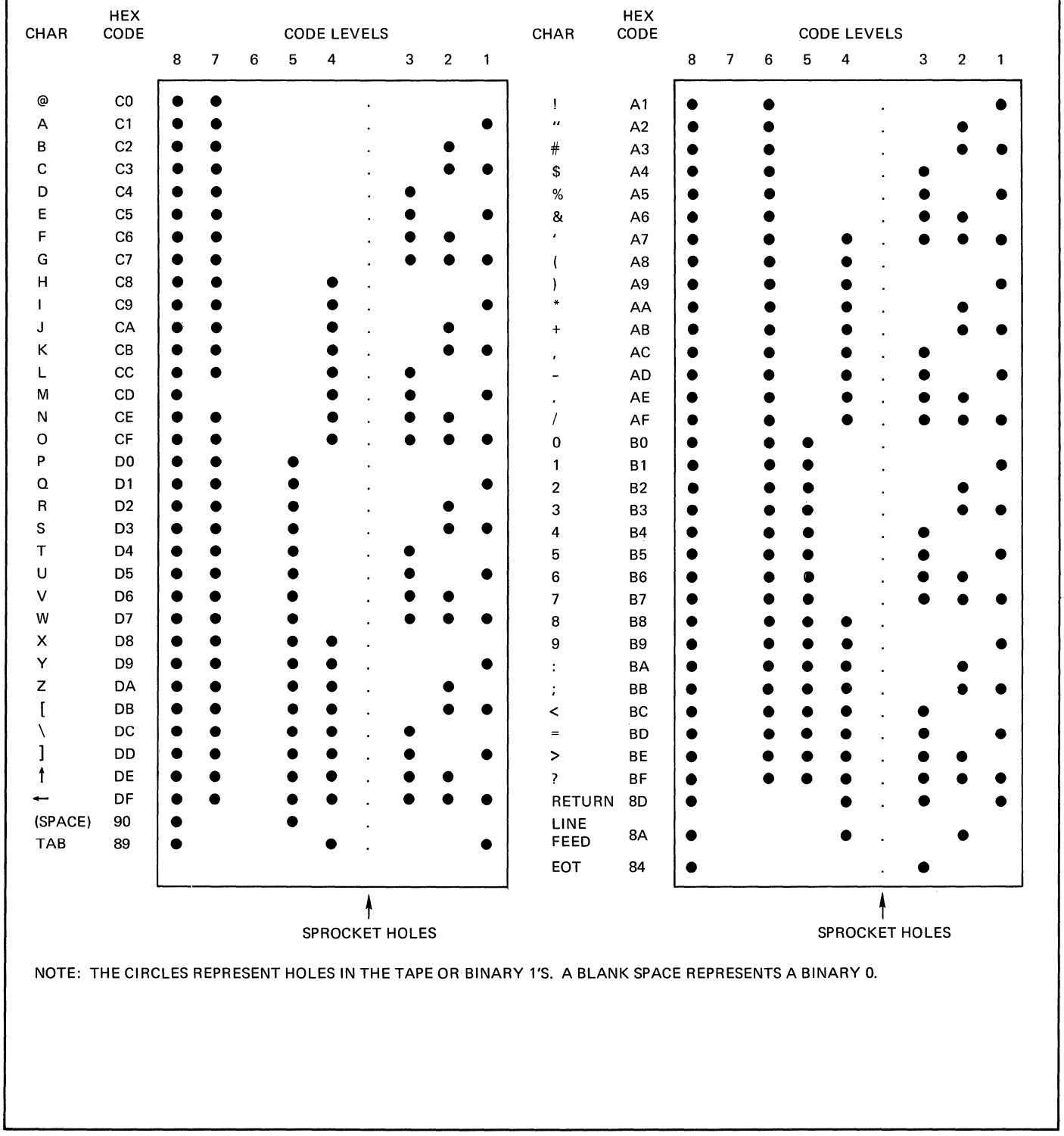
Only the characters shown in figure 2-4 are processed by the RC 70 Character Code Conversion Routine. Other keyboard entries result in a question mark (?) code being substituted in the computer for the keyboard entry.

2.6 ASR-33 Controls

The switches that control the operation of the ASR-33 paper tape reader and paper tape punch, as well as the Teletype's mode of operation, are shown in figure 2-5. Table 2-3 lists each switch and its function.

2.7 ASR-35 Controls

The switches that control the operation of the ASR-35 paper tape reader, paper tape punch, printer, and keyboard, as well as the Teletype's mode of operation, are shown in figure 2-6. Table 2-4 lists each switch and its function.



NOTE: THE CIRCLES REPRESENT HOLES IN THE TAPE OR BINARY 1'S. A BLANK SPACE REPRESENTS A BINARY 0.

Figure 2-4. USASCII Codes

Table 2-2. Keyboard Control Keys

Key	Function
HERE IS	Generates 20 frames (2 inches) of blank tape
RUB OUT	Transmits code of all 1's to processor during on-line mode of operation
FORM	Generates backward slash (\) when SHIFT and FORM keys are pressed. Line is deleted by Teletype Handler when SHIFT-FORM, RETURN, and LINE FEED keys are pressed, in that order
EOT	Indicates end of source tape

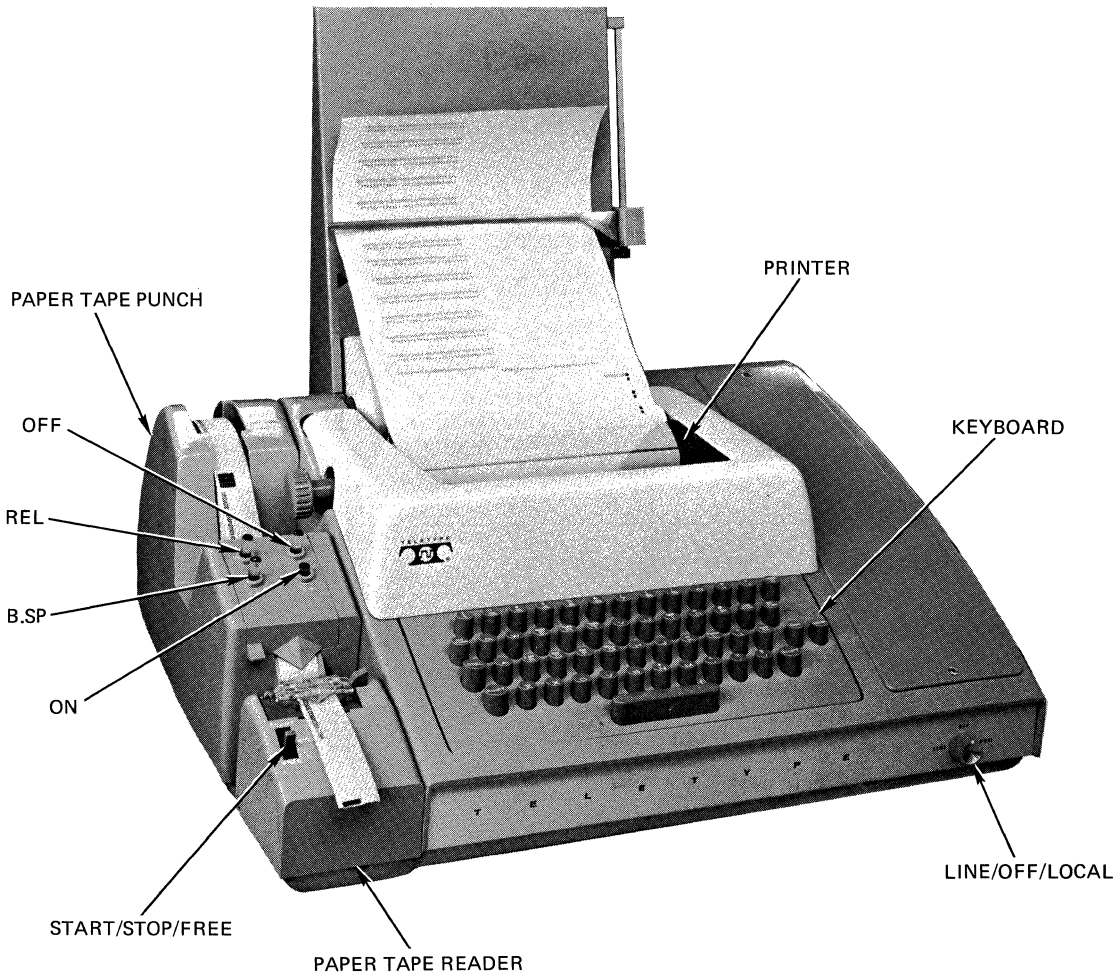


Figure 2-5. ASR-33 Controls

Table 2-3. ASR-33 Teletype Controls

Control	Function
OFF	Turns off paper tape punch
ON	Turns on paper tape punch
REL.	Releases mechanism that permits operator to pull paper tape through paper tape punch without damaging tape
B. SP.	Moves tape in paper tape punch back one space. Control is used with RUB OUT key to delete a character

Table 2-3. ASR-33 Teletype Controls (Cont.)

Control	Function	
	Position	Function
LINE/ OFF/ LOCAL	LINE	Enables ASR-33. Unit is capable of operating under control of processor
	OFF	Disables ASR-33
	LOCAL	Enables ASR-33. Unit is capable of off-line operation
FREE/ STOP/ START	FREE	Permits operator to position paper tape in reader
	STOP	Disables paper tape reader
	START	Enables paper tape reader if LINE/OFF/LOCAL switch is not set to OFF

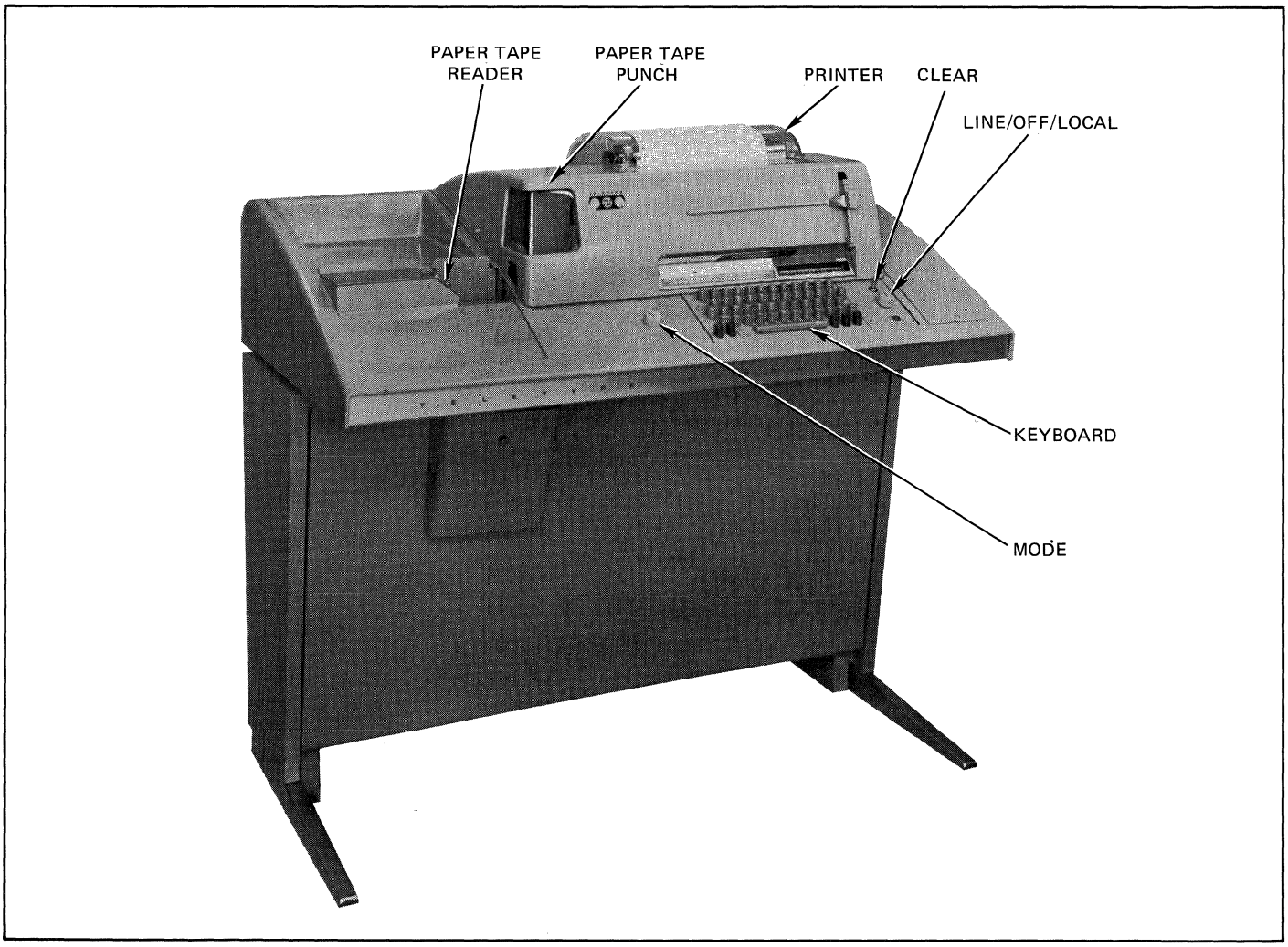


Figure 2-6. ASR-35 Controls

Table 2-4. ASR-35 Teletype Controls

Control	Position	Function
CLEAR	LEFT	Punches leader into tape if MODE switch is set to KT
	CENTER	Off
	RIGHT	Clears Teletype controller
MODE	K	Enables keyboard and printer. Pressing a key transmits character to processor. Printer generates output if processor commands unit to print
	KT	Enables printer, punch, reader, and keyboard
	T	Enables reader, punch, and printer
	TTS	Enables reader
	TTR	Enables punch but not printer
ON LINE/ OFF/LOC	ON LINE	Enables ASR-35. Unit is capable of operating under control of processor
	OFF	Disables ASR-35
	LOC	Enables ASR-35. Punch and printer are capable of off-line operation
FREE/ STOP/ RUN	FREE	Permits operator to position paper tape in reader
	STOP	Disables ASR-35
	RUN	Enables reader if MODE switch is set to any of following positions: KT, T, or TTS

d. Momentarily set the function switch to REG TEST, then to COMPUTE. The information set into the data switches is loaded into the selected register and is displayed by the register display indicators.

e. To restart the program, press the SINGLE CYCLE switch, then the START switch.

2.11 DISPLAYING REGISTER CONTENTS

The following procedure is used to display the contents of any of the selectable registers:

a. Place the computer in idle mode by pressing the SINGLE CYCLE switch.

b. Set the register select switch to indicate the register whose contents are to be displayed. The register display indicators now display the contents of the selected register.

c. To restart the program, press the SINGLE CYCLE switch, and then press the START switch.

2.12 INTERPRETING ERROR MESSAGES

When an error condition is detected by any of the programs in the RC 70 Program Utility Package or the FORTRAN IV Compiler, the computer halts and the C indicator on the RC 70 control panel goes out. If the register select switch is set to the I (instruction register) position, an error message will be displayed on the RC 70 register display. The meanings of these error messages and the programs to which they apply are summarized in the table presented on the inside of the front cover.

The register display consists of four columns of indicators. Error message numbers are determined by adding the values of indicators that are lit in each column (each column represents four binary digits or one hexadecimal digit). The display is read from left to right. Thus, as shown in figure 2-7, error message C903 is portrayed as follows: Indicators 8 and 4 are

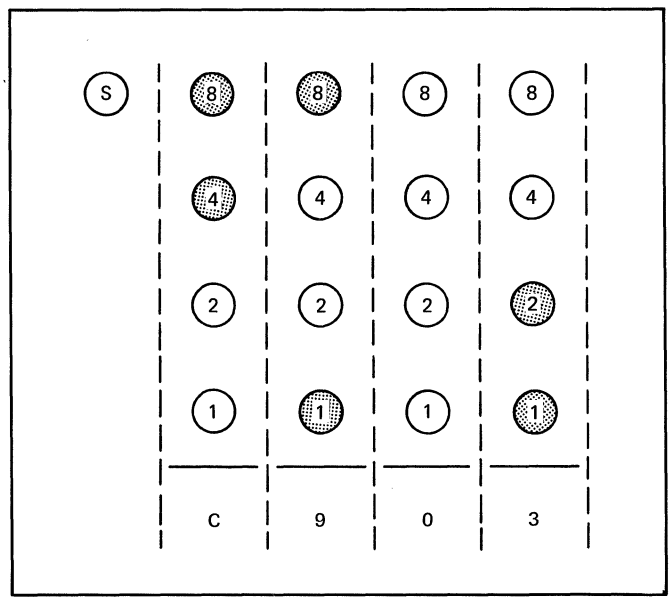


Figure 2-7. Error Message Coding Example

lit in the extreme left column, representing decimal 12 (hexadecimal C); indicators 8 and 1 in the second column represent 9; no indicators lit in the third column represents a zero; and the value of the final column is simply the result of adding 2 and 1.

In addition to the error and halt conditions listed in the table found on the inside front cover of this manual, other halt conditions may be defined for one or more abnormal input or output conditions. Each of these conditions will result in a one or indicator ON condition for a particular bit position of the I-register. The two least significant hexadecimal digits of the I-register are used for this purpose. (The two most significant hexadecimal digits contain the normal halt code X'C9'.) The meanings assigned to the two least significant digits are shown in figure 2-8.

2.13 CHANGING MEMORY CONTENTS

The following procedure is used to change the contents of a location in memory:

a. Loading the X-register.

1. Place the computer in idle mode by pressing the SINGLE CYCLE switch.

2. Set the register select switch to X.

3. Set the memory address into data switches 1 through 16.

4. Set the function switch to REG TEST and then back to COMPUTE. The memory address is now loaded into the index register.

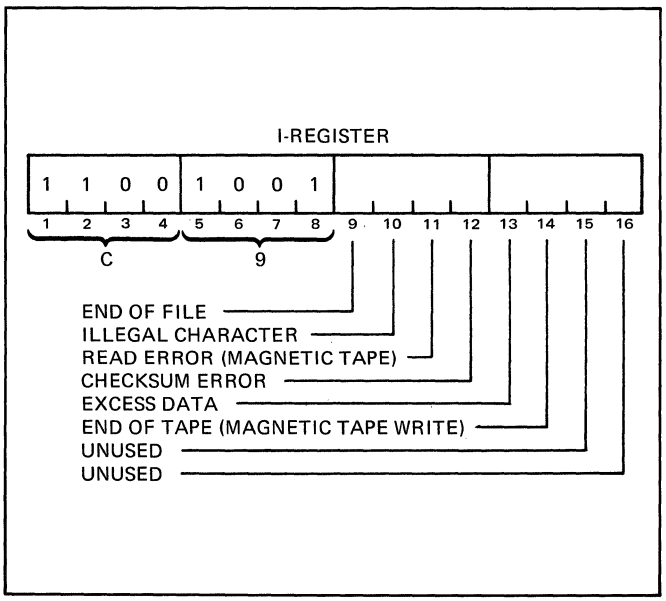


Figure 2-8. I-Register Decoding for I/O Errors

b. Loading the B-register.

1. Set the register select switch to B.

2. Set the data to be stored in memory into data switches 1 through 16.

3. Set the function switch to REG TEST and then back to COMPUTE. The data is now loaded into the B-register.

c. Executing the Store Indexed instruction.

1. Set X'7800' (Store Indexed instruction) into data switches 1 through 16. Verify that the PROTECT MEM switch is off before proceeding with the next step.

2. Set the function switch to SING INST and then press the START switch. The computer now executes the Store instruction to write the data into the selected memory location.

3. To restart the program, reset the function switch to COMPUTE, press the SINGLE CYCLE switch, and then press the START switch.

2.14 DISPLAYING MEMORY CONTENTS

The following procedure is used to display the contents of a location in memory:

a. Loading memory address into X-register.

1. Place the computer in idle mode by pressing the SINGLE CYCLE switch.

b. Loading X-register.

1. Set the register select switch to X.

2. Set the memory address into data switches 1 through 16.

3. Set the function switch to REG TEST and then back to COMPUTE. The memory address is now loaded into the index register.

4. Set the register select switch to B to display the contents of the memory location.

c. Loading selected memory location into accumulator.

1. Set X'3800' (Load instruction) into data switches 1 through 16.

2. Set the function switch to SING INST and then press the START switch. The contents of the selected memory location are now loaded into the accumulator.

3. To restart the program, reset the function switch to COMPUTE, press the SINGLE CYCLE switch, and then press the START switch.

2.15 STEPPING THROUGH A PROGRAM

The following procedure is used to step the processor through a stored program one instruction at a time:

a. Loading the starting address.

1. Place the computer in idle mode by pressing the SINGLE CYCLE switch.

2. Set data switches 1 through 16 to the address of the instruction from which stepping is to start.

3. Press the RESET switch. The address set into the data switches is loaded into the memory address register, and the page register is set to X'0001'.

b. Executing single instructions.

1. Press the START switch. The processor executes one complete instruction and then returns to idle mode.

2. Repeat step b1 sequence through consecutive instructions. Each time the START switch is pressed one complete instruction is executed.

c. Returning to normal program execution.

1. To restart the program, set the starting address into the data switches, press the SINGLE CYCLE switch, press the RESET switch, and then press the START switch.

2.16 REMOVING POWER

To remove power from the computer, press the POWER switch. The POWER indicator should go out to indicate that ac power is off.

2.17 ADDRESSING THE TELETYPE

Each Teletype has an interface card mounted within the unit (figure 2-9). The interface card, also called a controller, has five switches. The switch located to the extreme right is designated switch 0 and represents the most significant bit (MSB) of the address field; the next switch to the left is switch 1 and represents the second MSB; the next switch is switch 2 and represents the third MSB; and so on.

The states of the switches determine the address of the Teletype. If a switch is set to the upper position, it is OFF or a 0. If a switch is placed in the lower position, it is ON or a 1.

For normal Program Utility Package* operation and for all bootstrap filling, the Teletype controller switches are set as follows:

Teletype Used as Fill Device

Switch	Setting
Switch 0	Up (0)
Switch 1	Up (0)
Switch 2	Up (0)
Switch 3	Down (1)
Switch 4	Up (0)

Photoelectric or Other Unit Used as Fill Device

Switch	Setting
Switch 0	Up (0)
Switch 1	Up (0)
Switch 2	Down (1)
Switch 3	Up (0)
Switch 4	Up (0)

For running the RC 70 Diagnostic Program, set the Teletype controller switches as follows:

Switch	Setting
Switch 0	Up (0)
Switch 1	Down (1)
Switch 2	Up (0)
Switch 3	Up (0)
Switch 4	Up (0)

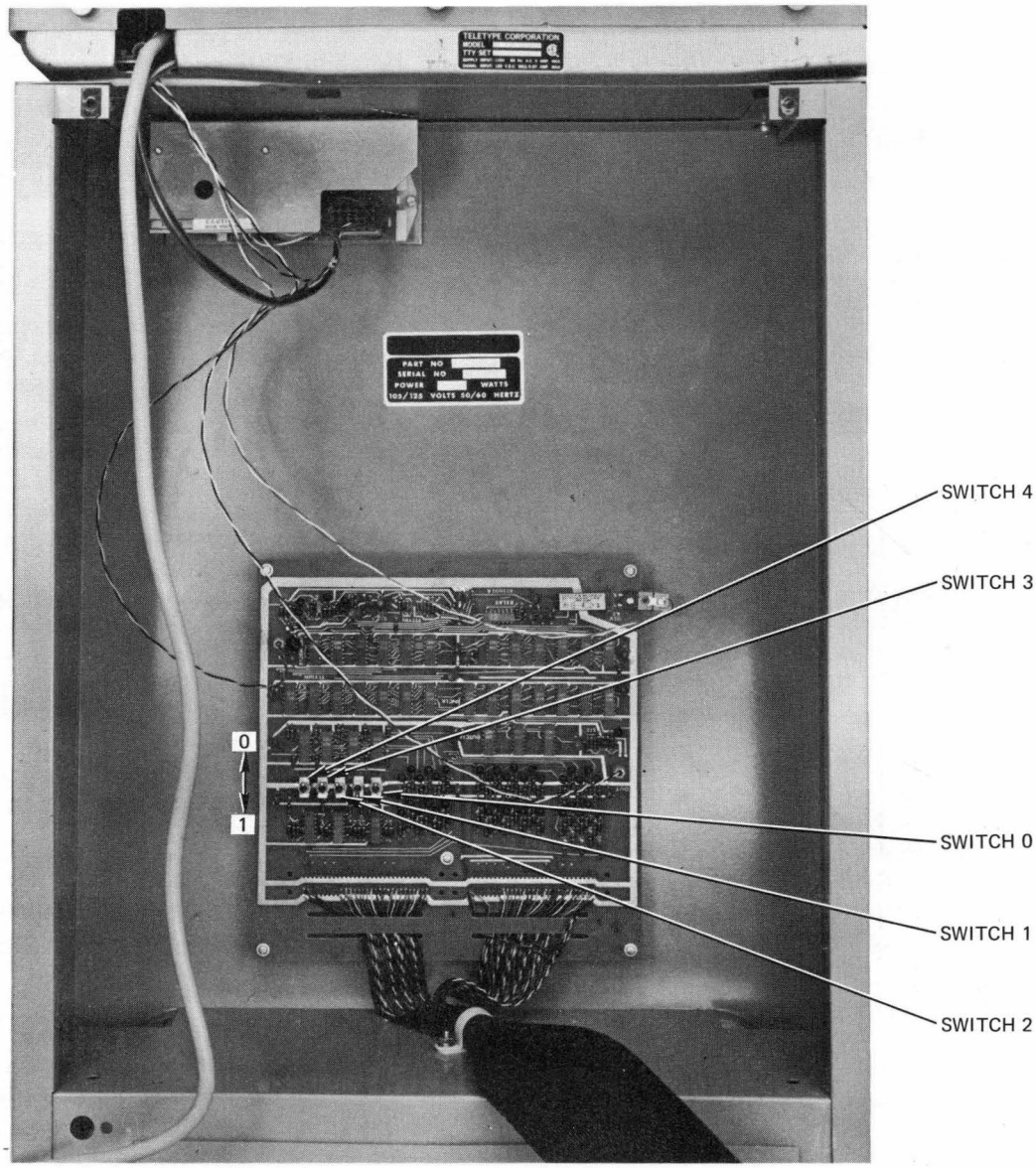
The instructions used to direct the operation of the Teletype unit are SNS, SET, PIP, and POP. The five most significant bits of the eight-bit address field of the instruction must correspond to the settings of switches 0 through 4 to provide an input to or obtain an output from the Teletype.

The instructions used with the Program Utility Package and with all bootstrap filling are listed in table 2-5.

2.18 TELETYPE OPERATING PROCEDURES

The following procedures can be used to operate either an ASR-33 or an ASR-35 Teletype. When a different

*The Program Utility Package consists of the RC 70 Assembler, RC 70 General Loader, RC 70 Tape Edit, and RC 70 Redebug.



NOTE:
SWITCH 0 REPRESENTS THE MOST SIGNIFICANT BIT (MSB) OF THE ADDRESS FIELD;
SWITCH 1 REPRESENTS THE SECOND MOST SIGNIFICANT BIT OF THE ADDRESS FIELD; AND SO ON.

Figure 2-9. Teletype Interface Printed Circuit Card Location

Table 2-5. Teletype Instructions

Instruction*,†	Function
SNS &11	Is the punch ready?
SNS &12	Is the reader ready?
SNS &14	Is the keyboard ready?
SNS &15	Is the printer ready?
SET &10	Start reader.
SET &11	Stop reader.
PIP &12	Parallel input from reader.
PIP &14	Parallel input from keyboard.
POP &11	Parallel output to punch.
POP &15	Parallel output to printer.

*The ampersand sign (&) means hexadecimal.

†Bits 2 or 3 of the least significant digit of the above addresses can be either a 1 or a 0 for the ASR-33. The ASR-33 controller ignores these address bits. Thus SNS &11 is the same as SNS &15 or SNS &17.

control is used by each Teletype to perform a similar function, both controls are referred to in the procedure. The first control mentioned is associated with the ASR-33 Teletype; the second control, which appears in parentheses, is an ASR-35 control. This practice is repeated in other sections of this manual that have Teletype-oriented procedures.

2.19 Punching Blank Paper Tape

To punch blank paper tape, perform the following procedure:

a. Press the paper tape punch OFF switch. (Set the MODE switch to K.)

b. Set the paper tape reader START/STOP/FREE switch to STOP. (Set the FREE/STOP/RUN switch to STOP.)

c. Set the Teletype LINE/OFF/LOCAL switch to LOCAL. (Set the LINE/OFF/LOCAL switch to LINE.)

d. Press the paper tape punch ON switch. (Set the MODE switch to KT.)

e. Press the HERE IS key on the keyboard several times. (Push the CLEAR switch to the left.) This action feeds the paper tape through the paper tape punch.

f. Press the paper tape punch OFF switch. (Set the MODE switch to K.)

2.20 Positioning Paper in the Printer

To position paper in the printer, perform the following procedure:

a. Set the Teletype LINE/OFF/LOCAL switch to LOCAL.

b. Press the RETURN key on the keyboard.

c. Press the LINE FEED key on the keyboard several times. This action positions the paper on the carriage of the printer.

SECTION III
PROGRAM LOADING

3.1 GENERAL DESCRIPTION

This section describes how to load a program into the computer's memory. Basically, there are two loading procedures. One procedure is used when the RC 70 General Loader is not resident in memory; the other, when it is.

If the General Loader program is not stored in memory, perform the procedure given in paragraph 3.8. This procedure transfers all the information on the object tape into memory.

If the General Loader program is resident in memory, perform the procedure given in paragraph 3.9. This procedure transfers only the object program into memory.

Before either procedure is presented, a typical utility program tape is described.

3.2 UTILITY PROGRAM

A typical utility tape is shown in figure 3-1. It consists of four parts: a visual, General Loader program, object program, and another visual.

3.3 VISUAL

The visual, which appears at the beginning and at the end of the tape, comprises arrows bracketing a catalog number (see figure 3-2). The arrows indicate the direction the tape should move through the paper tape reader. As the tape is processed by the reader, the arrowhead points toward the operator.

3.4 IDENTIFICATION TAG

An identification tag is located at the end of the tape, following the visual. A tag, shown in figure 3-3, provides the program title, the program issue date, and a serial number.

3.5 RC 70 GENERAL LOADER PROGRAM

The General Loader comprises three loaders: loader A, loader B, and the main loader. Loader A determines the computer memory size. Loader B stores the main loader in memory. The main loader loads the assembled object tape.

Refer to figure 3-4. The input format used by the main loader consists of three fields. The introductory field is a 5-frame control field. The first frame in the control field is a control code identifying the field type. The second and third frames contain an address. The last two frames provide a checksum word, which is the binary sum of the first three frames. There are five control codes on tape. These codes, their hexadecimal value, and their functions are listed in table 3-1.

Following the introductory field is a 5-frame block field. The block size is recorded in the first frame. The data

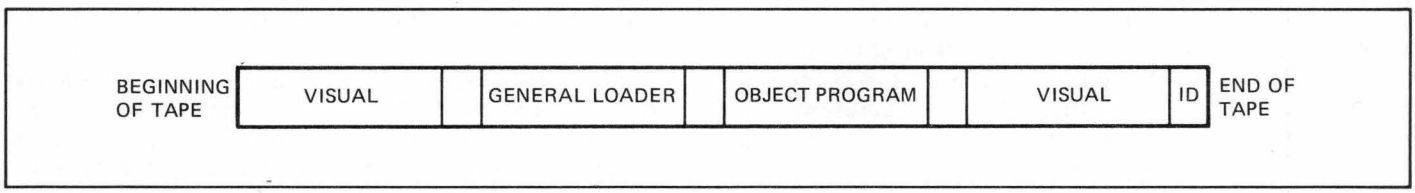


Figure 3-1. Typical Utility Tape Format

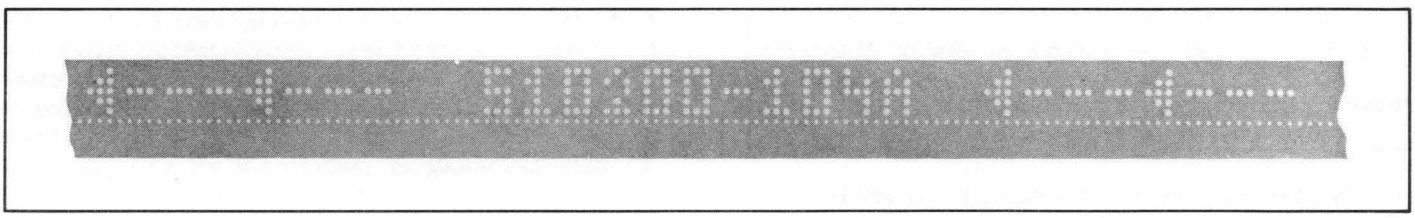


Figure 3-2. Visual

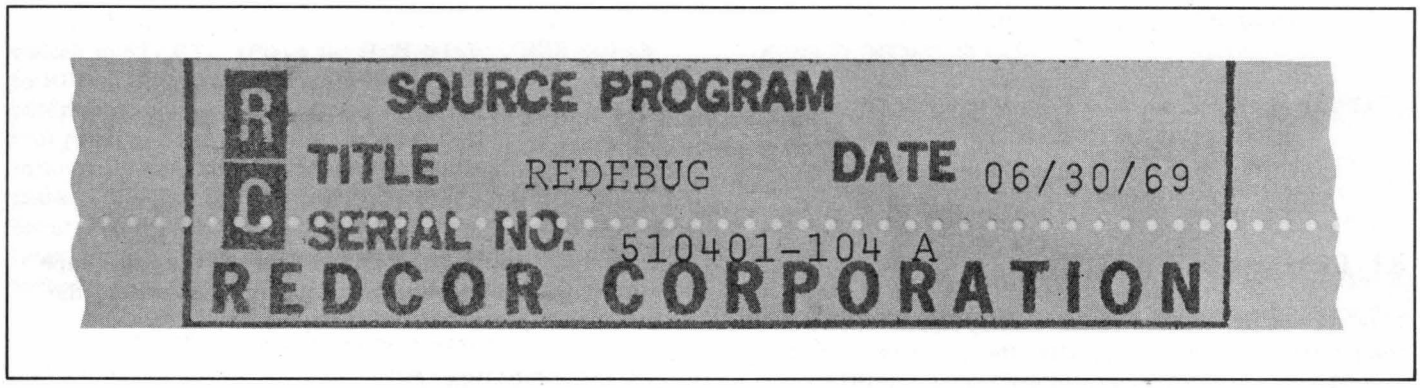


Figure 3-3. Identification Tag

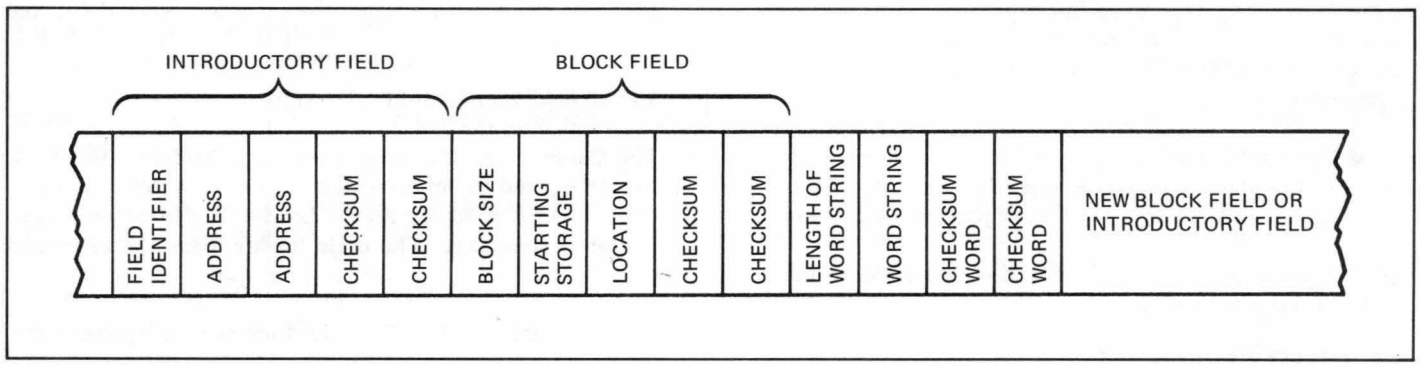


Figure 3-4. Main Loader Format

Table 3-1. Main Loader Control Codes

Control Code	Hexadecimal Value	Function
ORG	90	Beginning address of absolutely located block of data to follow
ROG	88	Beginning offset of block of data to be loaded at location ROLL BOT or starting at this offset if greater than ROLL BOT
END	84	Terminates loading process
LBL	82 or 83	Defines forward reference
LBB	81	Signifies location of forward reference in BSS area only

in this frame may represent a maximum of 127 words. The next two frames provide a modified address offset, establishing the starting storage location for the blocks of data to follow. The last two frames contain a checksum word for the previous three frames.

Following the block field is a word string preceded by a frame. This frame designates the length of the sub-block. Two frames, which contain a checksum word, follow the word string; then either a new block field or a new control field must appear.

3.6 RC 70 GENERAL LOADER ERROR MESSAGES

The General Loader can detect an error in the program tape. If an error is detected, the computer halts, the C indicator on the processor control panel goes out, and an error message is portrayed by the register display. (Paragraph 2.12 explains how to interpret the register display indicators.)

The General Loader can transmit seven error messages to the operator. The error messages are displayed by the register display when the register select switch is set to the I position. Table 3-2 provides a list of the error messages that could occur while loading a program.

3.7 OBJECT PROGRAM

The object program is that portion of the tape prepared by the assembler.

Table 3-2. General Loader Error Messages

Error Message	Meaning
C901	Object program checksum error has been detected. Check tape
C903	Program exceeds memory size
C904	Program has been loaded, but BSS area exceeds memory size
C907	Object program has short forward reference larger than 255. Index register holds location of instruction in error; B-register holds operand address. Press START to continue loading
C921	General Loader Program checksum error has been detected. Check tape
C955	Power shutdown has occurred. Repeat preceding activity from beginning

3.8 LOADING A PROGRAM WITH THE MAIN LOADER NOT RESIDENT IN MEMORY

Loading a new program into the computer is initiated by a fill routine permanently stored in a read-only diode memory inside the processor. When the diode fill routine is executed, it loads a string of instructions, one byte at a time, from the input device into low-order memory (locations X'0028' through X'004F'). The storage location of the first word in the string is selected so that the last word loaded by the fill routine is always stored in location X'004F'. Since locations below X'0028' are reserved for special uses, the maximum number of words that should be loaded by the diode fill routine is 41 (82 bytes). The instruction string read into the computer by the fill routine is normally a bootstrap loader that is used to load the rest of the program into memory.

The input device from which the program is loaded must have X'12' as its I/O address. This address is fixed in the fill routine and cannot be changed. The string of instructions loaded by the fill routine must be headed by one byte containing the one's complement of the number of words to be loaded. This byte is used by the fill routine to determine the storage location of the first word. Normally, the last word stored (location X'004F') is a checksum used to verify correct program loading. When the last word has been loaded by the fill routine, program control is transferred to location X'004E'. This location normally contains a branch instruction to transfer control to the starting address of the bootstrap loader.

To load a standard utility program with the main loader not resident in memory, perform the following procedure:

a. Set the sense switches on the processor control panel to the configuration appropriate for the program about to be loaded.

b. Set the PROTECT MEM switch on the processor control panel to the lower position.

c. Set the INHIBIT INTRP switch on the processor control panel to the lower position.

d. Press the paper tape punch OFF pushbutton switch. (Set the MODE switch to K.)

e. Place the paper tape reader START/STOP/FREE switch to FREE. (Set the RUN/STOP/FREE switch to FREE.)

f. Release the plastic cover (gate) over the reader mechanism.

g. Place the program tape over the plastic sprocket drive.

h. Place the gate in its former position.

i. Position the program tape so that the visual portion of the tape will not be read by the reader.

j. Place the paper tape reader START/STOP/FREE switch to STOP. (Place the RUN/STOP/FREE switch in the STOP position.)

k. Set the Teletype LINE/OFF/LOCAL switch to LINE.

l. Set the register select switch on the processor control panel to I.

m. Press SINGLE CYCLE switch.

n. Press the POWER switch on the processor control panel.

o. Press the RESET switch on the processor control panel.

p. Release SINGLE CYCLE switch.

q. Set the data switches on the processor control panel to the program entry address.

r. Press the HERE IS key on the keyboard. (Press the CLEAR switch.) This action clears the reader.

s. Press the FILL switch on the processor control panel. This action enables the diode bootstrap fill routine.

t. Place the paper tape reader START/STOP/FREE switch to START. (Place the RUN/STOP/FREE switch to RUN.) The program is now being loaded into the computer's memory. The C indicator on the processor control panel goes on, and the register display functions as follows: While the General Loader is being loaded, the pattern displayed by the register display follows a binary count. While the object program is being loaded, the register display shows the address of the locations being loaded.

u. After the program has been stored in memory and the loader program has sensed five inches of blank tape, the reader stops operating. The General Loader now relinquishes program control by branching to the location specified by the contents of location X'0018'.

3.9 LOADING A PROGRAM WITH THE MAIN LOADER RESIDENT IN MEMORY

If the main loader is resident in memory, load the program as follows:

a. Perform steps a through h of the procedure given in paragraph 3.8.

b. Position the program so that the main loader portion of the program will not be read by the reader.

c. Perform steps j through p of the procedure given in paragraph 3.8.

d. Set the data switches on the processor control panel to the main loader program entry address.

e. Press the RESET switch on the processor control panel.

f. Press the HERE IS key on the keyboard. (Press the CLEAR switch to the right.) This action clears the reader.

g. Press the START switch on the processor control panel.

h. Place the paper tape reader START/STOP/FREE switch to START. (Place the RUN/STOP/FREE switch to RUN.) The program is now being loaded into the machine's memory via the main loader. The C indicator on the processor control panel goes on, and the register display shows the address of the locations being loaded.

i. After the program has been stored in memory and the loader program has sensed five inches of blank tape, the reader stops operating. The General Loader now relinquishes program control by branching to the location specified by the contents of location X'0018'.

SECTION IV
RC 70 TAPE EDIT

4.1 GENERAL DESCRIPTION

This section of the manual describes how to use the RC 70 Tape Edit program. Procedures are presented and error messages are explained. In addition, the sense switch options available to the operator are described.

4.2 PROGRAM USAGE

The following procedure permits the operator to perform editing functions on a source tape using RC 70 Tape Edit:

a. Load RC 70 Tape Edit using one of the procedures given in section III. If the loader program is not resident in memory, perform the procedure in paragraph 3.8. If the loader program is stored in memory, perform the procedure in paragraph 3.9.

b. Set the data switches on the processor control panel to X'0019', the program entry address.

c. Place each of the eight sense switches on the processor control panel in the lower position.

d. Press the paper tape punch OFF switch. (Set the MODE switch to K.)

e. To obtain leader, perform the following steps:

1. Set the Teletype LINE/OFF/LOCAL switch to LOCAL. (Set the LINE/OFF/LOCAL switch to LINE.)

2. Press the paper tape punch ON switch. (Set the MODE switch to KT.)

3. Press the HERE IS key on the keyboard several times. (Push the CLEAR switch to the left.) Leader is now being produced by the paper tape punch.

4. Press the paper tape punch OFF switch. (Set the MODE switch to K.)

5. Set the Teletype LINE/OFF/LOCAL switch to LINE.

f. Load the source tape into the paper tape reader.

g. Press the HERE IS key on the keyboard. (Push the CLEAR switch to the right.) This action clears the reader.

h. Press the paper tape punch ON switch. (Set the MODE switch to KT.)

i. Press the RESET switch on the processor control panel.

j. Press the START switch on the processor control panel.

k. The editing functions that can be performed on a source tape and the paragraphs that provide the necessary procedures to perform these functions are listed in table 4-1.

4.3 ADDING A STATEMENT

The following procedure permits the operator to add one or more statements to his program. A summary of this procedure is presented in table 4-1.

a. Type a slash (/), the letter A, and the statement number (s) in the program preceding the statement to be added. Then press RETURN and LINE FEED on the keyboard.

b. The Teletype prints and punches statement s. The register display portrays the number of the last statement processed by the computer.

c. Type one or more new statements. The statement number displayed by the register display does not change.

d. If you have finished editing the tape and want to copy the rest of it, type a slash (/), the letter A, and the numbers 9999. This action processes the remaining portion of the source tape through the reader.

e. If additional editing is required, perform the applicable procedure listed in table 4-1.

4.4 DELETING A STATEMENT

The following procedure permits the operator to delete one or more statements from his program. A summary of this procedure is presented in table 4-1.

a. Type a slash (/), the letter A, the number of the statement to be deleted (n), a comma, and the number of the statement to be deleted again. Then press RETURN and LINE FEED on the keyboard.

b. The Teletype prints and punches up to statement n-1, and the register display shows statement number n-1. Statement n is deleted from the source tape.

Table 4-1. Tape Edit Program Operation Summary

Function	General Input Form*	Meaning	Reference
Adding a statement	/AsCR-LF y	Add new statement y to program, following statement number s	Paragraph 4.3
	/A9999CR-LF	Finished editing; copy remainder of source tape (see checksum function below)	
Deleting a statement	/An,nCR-LF	Delete statement n (register display shows statement n-1)	Paragraph 4.4
	/An_1,n_2CR-LF	Delete all statements from n_1 through n_2	
	/A9999CR-LF	Finished editing; copy remainder of source tape (see checksum function below)	
Editing a comment field	Set SS3		Paragraph 4.5
	/An-1CR-LF	Select statement number preceding statement to be edited (n-1)	
	/CcCR-LF	Change comment field of selected statement to desired comment (c)	
	/CcCR-LF	Not finished; change comment field in consecutive statement to desired comment (c)	
	/A9999CR-LF	Finished editing; copy remainder of source tape (see checksum function below)	
Editing a modifier field	Set SS3		Paragraph 4.6
	/An-1CR-LF	Select statement number preceding statement to be edited (n-1)	
	/MmCR-LF	Change modifier field of selected statement to desired modifier (m)	
	/MmCR-LF	Not finished; change modifier field in consecutive statement to desired modifier (m)	
	/A9999CR-LF	Finished editing; copy remainder of source tape (see checksum function below)	
Checksum	/SCR-LF	Finished editing; punch checksum at end of tape (replaces /A9999 copy command)	Paragraph 4.7

*Underscoring indicates operator input; lack of underscoring indicates computer output.

c. To delete more than one statement, type a slash (/), the letter A, the number of the first statement to be deleted (n_1), a comma, and the number of the last statement to be deleted (n_2). Then press RETURN and LINE FEED on the keyboard.

d. The Teletype prints and punches all statements up to n_1-1. Statements n_1 through n_2 are deleted from the source program.

e. If you have finished editing the tape and want to copy the rest of it, type a slash (/), the letter A, and the numbers 9999. Then press RETURN and LINE FEED on the keyboard. This action processes the remaining portion of the source tape through the reader.

f. If additional editing is required, perform the applicable procedure listed in table 4-1.

4.5 EDITING A COMMENT FIELD

The following procedure permits the operator to edit the comment field of a given assembly language statement. A summary of this procedure is presented in table 4-1.

a. Place sense switch 3 in the upper position.

b. Type a slash (/), the letter A, and the number of the statement that precedes the statement to be edited (n-1). Then press RETURN and LINE FEED on the keyboard.

c. Next, type a slash (/), the letter C, and the desired comment field (c). Then press RETURN and LINE FEED on the keyboard.

d. To modify consecutive statements, repeat step c.

e. If you have finished editing the tape and want to copy the rest of it, type a slash, the letter A, and the numbers 9999. Then press RETURN and LINE FEED on the keyboard. This action processes the remaining portion of the source tape through the reader.

f. If additional editing is required, perform the applicable procedure listed in table 4-1.

4.6 EDITING A MODIFIER FIELD

The following procedure permits the operator to edit the modifier field of a given assembly language statement. A summary of this procedure is presented in table 4-1.

a. Place sense switch 3 in the upper position.

b. Type a slash (/), the letter A, and the number of the statement that precedes the statement to be edited (n-1). Then press RETURN and LINE FEED on the keyboard.

c. Next, type a slash (/), the letter M, and the desired modifier field (m). Then press RETURN and LINE FEED on the keyboard.

d. To modify consecutive statements, repeat step c.

e. If you have finished editing the tape and want to copy the rest of it, type a slash (/), the letter A, and the numbers 9999. Then press RETURN and LINE FEED on the keyboard. This action processes the remaining portion of the source tape through the reader.

f. If additional editing is required, perform the applicable procedure listed in table 4-1.

4.7 CHECKSUM OPERATION

A two-frame sequence consisting of an identifying code and a binary sum of the data contained on the punched tape can be punched at the end of the tape if desired. To do so, type a slash (/), the letter S, and then press RETURN and LINE FEED on the keyboard.

This input can be used in place of

/A9999CR-LF

to signify completion of editing. This two-frame sequence is recognized by the utility program and results in an error halt if the input data checksum does not agree with the punched checksum. Pressing START releases the program from this halt and allows it to complete its task.

4.8 ERROR MESSAGES

When an error is detected by the RC 70 Tape Edit program, the computer halts, the C indicator on the processor control panel goes out, and an error message is shown in the register display. (Paragraph 2.12 explains how to interpret the register display indicators.)

Tape Edit can transmit five error messages to the operator. The error messages can be displayed by the register display when the register select switch on the processor control panel is set to the I position. Table 4-2 provides a list of the error messages that could occur while editing a program.

4.9 PROGRAM OPTIONS

Five sense switch options are available to the operator. Any combination of these options can be used at the same time. When using a given option, place each of the sense switches, except the one being used, in the lower position. The sense switch options are summarized in table 4-3.

Table 4-2. Tape Edit Program Error Messages

Error Message	Meaning
C910	Input tape checksum error has been detected. Check tape. Press START to continue
C944	Control statement sequence number error has been detected. Press START switch on processor control panel and re-enter proper control statements
C955	Power shutdown has occurred. Repeat editing function from beginning
C980	End of file. Press RESET and START to process next source tape
C999	Program has been successfully loaded. Press START if input tape is ready

Table 4-3. Tape Edit Program Options

Sense Switch	Function
1	Suppresses system punch
2	Indicates keyboard echo and system punch are mechanically coupled (ASR-33 only)
3	When TAB is input to computer, spaces, which complete assembly language field, are output
4	Accepts alter tape from system utility No. 1
8	Suppresses system output

SECTION V
RC 70 ASSEMBLER

5.1 GENERAL DESCRIPTION

This section of the manual describes how to use the RC 70 Assembler. A procedure is presented and error messages are explained. In addition, the sense switch options available to the operator are described.

5.2 PROGRAM USAGE

The following procedure permits the operator to assemble a source program using the RC 70 Assembler.

a. Load the RC 70 Assembler using one of the procedures given in section III. If the loader program is not resident in memory, perform the procedure in paragraph 3.8. If the loader program is stored in memory, perform the procedure in paragraph 3.9.

b. Set the data switches on the processor control panel to the program entry address.

c. Place the paper tape with the source program into the paper tape reader.

d. Press the HERE IS key on the keyboard. (Press the CLEAR switch.) This action clears the reader.

e. Press the START switch on the processor control panel. The source tape is processed by the computer, and the program is assembled.

5.3 ERROR MESSAGES

Except for undefined symbol references, error messages are recorded by the printer preceding the statement that is in error. Because the assembler is a one-pass processor, undefined references cannot be determined for global labels until the end of the program, or for local labels until the next global label.

The error message for undefined references is "UNDEFINED REFERENCE AT." This message is followed by one or more locations. The locations refer to the last reference to an undefined symbol. The message is typed at the end of the assembled program for global undefined references, and at the next global label for local undefined references.

Table 5-1 provides a list of error messages that could precede a statement in error.

Error messages can be portrayed by the register display when the register select switch on the RC 70 control panel is set to the I position. (Paragraph 2.12 explains how to interpret the register display indicators.) There are five assembler error messages that can be transmitted to the operator via the register display. Table 5-2 lists these error messages and their meanings.

5.4 PROGRAM OPTIONS

Three sense switch options are available to the operator. When sense switch 1 is in the upper position, punching is suppressed and the assembler produces a listing of the assembled program. When sense switch 2 is in the upper position, system output is suppressed except for error messages. If sense switch 8 is in the upper position, typing is suppressed and the assembler causes the assembled object code to be punched in a format appropriate for the loader program. No meaningful printing occurs during this mode of operation (ASR-33 only).

Table 5-1. Printed Assembler Error Messages

Error Message	Meaning
INDEX ERROR *****	Printed when non-indexable instruction has X in modifier field
DBL DEFINED LBL ERROR *****	Printed when label is defined more than once
UNDEFINED OPERAND ERROR *****	Printed if symbol in operand field of Block Storage Save (BSS), Equivalent (EQU), or Origin (ORG) directive is undefined
FWD REF ERROR *****	Printed if symbol in label field of EQU directive has appeared in operand field of previous instruction
ILLEGAL CHAR ERROR *****	Printed when illegal character appears in any field
ILLEGAL INST ERROR *****	Printed when illegal instruction mnemonic appears in instruction field

Table 5-2. Displayed Assembler Error Messages

Error Message	Meaning
C904	Symbol table is full
C910	Source tape checksum error has been detected. Press START to continue
C955	Power shutdown has occurred. Repeat preceding activity from beginning
C980	End of file. Five inches of leader following END statement have been detected. Press RESET and START to process next input tape
C993	Five inches of leader have been read without preceding END statement. Press START to continue this assembly; press RESET and START to begin new assembly
C999	Computer is now ready to assemble source program

SECTION VI
RC 70 REDEBUG

6.1 GENERAL DESCRIPTION

This section of the manual describes how to use the RC 70 Redebug program. The program has 10 modes of operation. A procedure is given for each mode, describing that mode of operation. In addition, program operations are defined and error messages are explained.

6.2 PROGRAM USAGE

RC 70 Redebug assists the operator in checking out RC 70 Computer programs. It is a relocatable program that resides in 600 locations starting at X'0B00' of the high 4096-word block of the computer's memory. The program is always entered by setting the data switches on the processor control panel to program entry point (X'7B00') and by pressing the RESET and START switches.

Redebug may not be entered by setting the data switches to X'0019'. This location is reserved for the initial branch instruction of the program being checked out. If the program being checked out uses location ROLL TOP* to define the end of a variable-length array or table, Redebug must be entered first to initialize ROLL TOP to be below Redebug before the program being checked out is executed.

If the operator types an incorrect entry, he may correct it by setting the data switches to X'7B00', by pressing the RESET and START switches, and by entering the correct statement via the selected mode of operation.

The following procedure permits the operator to check out his program:

a. Load Redebug using one of the procedures given in section III. If the loader program is not resident in memory, perform the procedure in paragraph 3.8. If the loader program is stored in memory, perform the procedure in paragraph 3.9.

b. Set the data switches on the processor control panel to the program entry address.

c. Load the program to be checked out.

d. Press the RESET switch on the processor control panel.

e. Press the START switch on the processor control panel.

*ROLL TOP is defined as the upper limit of unused core.

f. Redebug has 10 modes of operation. A mode is selected by pressing a particular key on the keyboard. Table 6-1 lists the program's modes of operation, the keyboard key that selects each mode, and the paragraphs where each mode is described. Table 6-2 presents a summary of Redebug program operation.

6.3 FETCH MODE

The Fetch mode permits the operator to record or to change the contents of a location in memory. To accomplish either or both of these functions, perform the following procedure:

a. Type the letter F, the hexadecimal address of the location to be read or changed, and a period.

b. The computer issues a carriage return and line feed command, and the printer records the hexadecimal address and the contents of that location.

c. To change the contents of a cell, type the new entry, and end the entry with either a period or a comma.

Table 6-1. Selecting a Redebug Mode

Key	Mode	Procedure
F	Fetch	Paragraph 6.3
B	Display B-Register	Paragraph 6.4
X	Display Index Register	Paragraph 6.5
R	Display Roll-Arrow Register	Paragraph 6.6
K	Display Status Indicators and Page Register	Paragraph 6.7
I	Initialize a Block of Storage	Paragraph 6.8
S	Search	Paragraph 6.9
D	Dump Program	Paragraph 6.10
G	Go To	Paragraph 6.11
T	Trace	Paragraph 6.12

d. If the entry is terminated with a comma, the computer generates a carriage return and line feed command, and the printer records the next location in memory and the contents of that location. The contents of the new memory location can be changed by repeating step c of this procedure.

e. If the entry is followed by a period, the Fetch mode is terminated. At this time, the computer executes a carriage return and line feed command and waits for the operator to request a mode of operation.

Note

Except for the Display Status Indicators and Page Register mode (paragraph 6.7), all Redebug modes that require a hexadecimal input do not require leading zeros to be entered. If more than four digits are entered, only the last four are used.

6.4 DISPLAY B-REGISTER MODE

The following procedure describes the Display B-Register mode:

a. Type the letter B.

b. The printer records the contents of the B-register.

c. If the contents of the B-register are not to be changed, type a period; if they are to be changed, type a new value followed by a period.

6.5 DISPLAY INDEX REGISTER MODE

The following procedure describes the Display Index Register mode:

a. Type the letter X.

b. The printer records the contents of the index register.

c. If the contents of the index register are not to be changed, type a period; if they are to be changed, type a new value followed by a period.

6.6 DISPLAY ROLL-ARROW REGISTER MODE

The following procedure describes the Display Roll-Arrow Register mode:

Note

When Redebug is loaded into memory, the roll-arrow register (memory location 7) is initialized to X'YBEC' and location ROLL TOP is initialized to X'YBEB'. (The Y represents one less than the number of memory modules in the computer.) When using Trace (paragraph 6.12), the roll table of the program being checked out must have an additional five words set aside for the Redebug program.

a. Type the letter R.

b. The printer records the contents of the roll-arrow register.

c. If the contents of the roll-arrow register are not to be changed, type a period; if they are to be changed, type a new value followed by a period.

6.7 DISPLAY STATUS INDICATORS AND PAGE REGISTER MODE

The following procedure describes the Display Status Indicators and Page Register mode:

a. Type the letter K.

b. The printer records the states of the status indicators and the contents of the page register as follows:

1. The printer types an O for the Overflow indicator (KO), an S for the Sign indicator (KS), a U for the Unequal indicator (KU), and a P for the page register.

2. Each letter, except P, is followed by a 1 or a 0 enclosed in parentheses. The 1 indicates that the indicator (flip-flop) is set, or ON; the 0 indicates that the flip-flop is reset, or OFF. The P is followed by two hexadecimal digits enclosed in parentheses. This printout specifies the contents of the page register.

c. To maintain the current states of the status indicators and the contents of the page register, type a period.

d. To change the states of the indicators or the contents of the page register, type five entries: one for each indicator and two for the page register. Type the status of the items that are not going to be changed plus the desired changes. Each entry is defined below.

1. The first hexadecimal digit must be a 1 or a 0 and controls the state of the KO indicator. A 1 sets the KO indicator and a 0 resets it.

2. The second and third hexadecimal digits control the states of the KS and KU indicators, respectively.

3. The last two hexadecimal digits are used to change the contents of the page register.

e. After typing the five hexadecimal digits, type a period to complete the entry.

6.8 INITIALIZE BLOCK OF STORAGE MODE

The Initialize Block of Storage mode sets each location in a specified block of memory to the same fixed constant. The following procedure describes this mode of operation:

a. Type the letter I, the memory address of the first word in the block of memory, and a comma.

b. Type the address of the last word in the block of memory, a comma, the hexadecimal value of the fixed constant, and a period to complete the entry.

6.9 SEARCH MODE

The Search mode searches a block of memory. The Teletype prints the contents of all the locations within that block of memory that are equal to a specified data word in the positions defined by a mask. The following procedure describes the Search mode:

a. Type the letter S, the memory address of the first location in the block of memory that is to be searched, and a comma.

b. Type the address of the last location in the block of memory to be searched, a comma, and the data word.

c. Type a comma, then the mask.

1. To list every location in the block of memory, regardless of contents, enter a zero mask and a zero data word. For example, to list the contents of every location in memory locations X'0100' through X'0200', type: S100,200,0,0.

2. To list every location in a block of memory that is equal to a particular constant, enter all F's for the mask. For example, to list every occurrence of the number X'1234' between the limits of locations X'0200' and X'0300', type: S200,300,1234,FFFF.

3. To list all the short Store (STB) instructions from locations X'0400' to X'0500', enter the following: S400,500,7000,F000. This sequence is entered because the operation code for the STB instruction is 7, and the short instruction operation code occupies the first four bits of the instruction word.

d. Type a period to complete the entry. The program scans the block of memory, starting with the address of the first location. Each word is read from memory. The program performs a logical And with the mask and compares the result with the data word. If the value of the data word is equal to the value of the mask, the printer records the location and the contents of the memory location.

6.10 DUMP PROGRAM MODE

To punch or dump one or more blocks of memory on paper tape in a format that may be loaded into the computer using either the short or General Loader program, perform the following procedure:

a. Press the paper tape punch OFF switch.

b. Type the letter D, the memory address of the first location in the block of memory, and a comma.

c. Type the memory address of the last location in the block of memory and a period.

d. Press the paper tape ON switch.

e. If this is the first or only block of information to be processed, press the L key on the keyboard. Leader is now being punched before the block of information.

f. If this is not the only block of information to be processed, type N. Leader is not produced by the paper tape punch.

Note

Normally all information entered via the keyboard is echoed back to the printer by the computer. However, the codes for L and N are not printed because they would produce an erroneous tape.

g. After the last block of information has been punched, it is necessary to punch leader. To obtain leader, perform the procedure given in step e of paragraph 4.2.

h. Repeat step a of this procedure.

6.11 GO TO MODE

The Go To mode exits the monitor and transfers control to a specified location in memory. This location is called the start location. The following procedure describes the Go To mode:

a. Type the letter G, the hexadecimal address of the start location, and a period to complete the entry.

b. It is sometimes desirable to use the computer's single cycle mode to go through a program, one instruction at a time. To accomplish this, perform the following procedure:

1. Set the register select switch on the processor control panel to the I position.

2. Type the entry and terminate it with an S, instead of a period.

3. The computer halts and the register display portrays C909. This message indicates the start of tracing.

4. Press the SINGLE CYCLE switch on the processor control panel.

5. Press the START switch on the processor control panel. Control is transferred to the specified location.

6. Press the START switch. The computer executes the first instruction in the operator's program.

7. Repeat step 6 until the program has been checked out.

8. Set the data switches on the processor control panel to X'7B00'.

9. Release the SINGLE CYCLE switch. This action inhibits single cycle operation.

10. Press the RESET switch on the processor control panel.

11. Press the START switch. Control is now returned to the Redebug program.

6.12 TRACE MODE

The Trace mode exits from the monitor, transfers control to any specified location, and designates a stop address. When the program reaches the stop address, control is transferred back to the monitor for operator action.

The following steps describe the Trace mode:

a. Type the letter T, the hexadecimal address of the start location, and a comma.

b. Type the hexadecimal address of the stop location and a period to complete the entry. The program traces to the specified stop address but does not execute the instruction at this address. When the stop address is reached, the Teletype prints the stop address; the contents of the stop address; the contents of the B, index, and page registers; and the states of the status indicators.

c. To continue tracing, type a T, a comma, another stop address, and a period. The program now uses the first stop address as a start address and traces to the next stop address. If this step is repeated, the program will trace from one address to the next. Thus, if the last stop address is not specified as an end address, then the last address is used as a start address.

The stop address is established by Redebug. This program inserts a Branch and Put instruction at the location selected for the stop address and saves the instruction that was in that location. When the last address is reached, control is returned to Redebug. The program then restores the original instruction in the stop location.

d. It is sometimes desirable to use the computer's single cycle mode to trace through a program one instruction at a time. To accomplish this, perform the following procedure:

1. Perform steps b1 through b5 of the procedure in paragraph 6.11.

2. Press the START switch on the processor control panel.

3. Repeat step 2 of this procedure until the program has been checked out. When the stop location is reached, a Branch Back instruction is executed. Control is now returned to Redebug.

e. If the program does not sequence correctly, perform the following recovery procedure:

1. Set the data switches on the processor control panel to X'7B00'.

2. Press the RESET switch on the processor control panel.

3. Press the START switch on the processor control panel. The instruction that was replaced by the Branch and Put instruction is stored again in its proper location in memory.

6.13 PROGRAM OPERATIONS

A summary of each Redebug mode of operation is shown in table 6-2. Table 6-3 defines the characters listed in the General Input Form column of table 6-2.

6.14 ERROR MESSAGES

Error messages can be portrayed on the processor control panel register display if the register select switch is in the I position. (Paragraph 2.12 explains how to interpret the register display indicators.)

There are two Redebug error messages that can be transmitted to the operator via the register display. Table 6-4 lists these error messages and their meanings.

Table 6-2. Redebug Program Operation Summary

Mode	General Input Form*	Meaning	Reference
Fetch	Fa. CR-LFa␣(a)␣ . CR-LF	Fetch and display contents of location a Contents of location a are displayed Period terminates operation	Paragraph 6.3
	Fa. CR-LFa␣(a)␣ y. CR-LF	Fetch and display contents of location a Change contents of location a to equal y. Period terminates operation	
	Fa. CR-LFa␣(a)␣ , CR-LFa+1␣(a+1)␣ y, CR-LFa+2␣(a+2)␣ . CR-LF	Fetch and display contents of location a Display contents of next location, a+1 Change contents of location a+1 to equal y Period terminates operation	
Display B-Register	B (B)␣ . CR-LF	Display contents of B-register Period terminates operation	Paragraph 6.4
	B (B)␣ y. CR-LF	Display contents of B-register Change contents of B-register to equal y	

*Underscoring indicates operator input; lack of underscoring indicates computer output.

Table 6-2. Redebug Program Operation Summary (Cont.)

Mode	General Input Form*	Meaning	Reference
Display Index Register	X (X)␣	Display contents of index register	Paragraph 6.5
	. CR-LF	Period terminates operation	
	X (X)␣	Display contents of index register	
	y. CR-LF	Change contents of index register to equal y. Period terminates operation	
Display Roll-Arrow Register	R (R)␣	Display contents of roll-arrow register	Paragraph 6.6
	. CR-LF	Period terminates operation	
	R (R)␣	Display contents of roll-arrow register	
	y. CR-LF	Change contents of the roll-arrow register to equal y. Period terminates operation	
Display Status Indicators and Page Register	K	Display contents of three status indicators and page register	Paragraph 6.7
	O(O)␣S(S)␣U(U)␣P(P)	Contents of KO, KS, KU indicators and page register are displayed	
	. CR-LF	Period terminates operation	

*Underscoring indicates operator input; lack of underscoring indicates computer output.

Table 6-2. Redebug Program Operation Summary (Cont.)

Mode	General Input Form*	Meaning	Reference
Display Status Indicators and Page Register (Cont.)	K	Display contents of three status indicators and page register	Paragraph 6.7
	O(O)␣S(S)␣U(U)␣P(P)	Contents of KO, KS, KU indicators and page register are displayed	
	aaaaa.	Change contents of status indicators and/or page register to equal aaaaa. Period terminates operation	
	CR-LF		
Initialize Block of Storage	Ia,b,w.	Set contents of memory locations a through b equal to value w. Period terminates operation	Paragraph 6.8
	CR-LF		
Search	Sa,c,w,m.	Search contents of memory between locations a and c for word w with mask m. When value is found, computer outputs location number and contents	Paragraph 6.9
	CR-LF		
	Sa,b,0,0.	List contents of memory from locations a to b	
	CR-LF		
	a␣(a) CR-LF a+1␣(a+1) CR-LF ⋮ b-1␣(b-1) CR-LF b␣(b) CR-LF	Contents of memory from locations a to b are displayed	
Dump Program	Da,b.N	Dump contents of locations a through b onto paper tape in object format with no leader	Paragraph 6.10
	Da,b.L	Dump contents of locations a through b onto paper tape in object format with four inches of leader first	

*Underscoring indicates operator input; lack of underscoring indicates computer output.

Table 6-2. Redebug Program Operation Summary (Cont.)

Mode	General Input Form*	Meaning	Reference
Go To	Ga. CR-LF	Go to location a and start executing instructions in operator's program. Set index register, B-register, and so on to pseudo values	Paragraph 6.11
Trace	Ta,b. CR-LF	Enter program at location a and execute program until location b is reached	Paragraph 6.12
	bØØ(b)ØB(B)ØX(X)ØO (O)ØS(S)ØU(U)ØP(P) CR-LF	When location b is reached, Teletype prints b, contents of b, contents of B-register, index register, states of status indicators, and contents of page register	
	Ta,bS CR-LF	Operation is same as preceding operation, except computer is running in single cycle mode. Therefore, computer halts after instruction is checked out	
	T,c. CR-LF	Continue to trace from last address to location c	

*Underscoring indicates operator input; lack of underscoring indicates computer output.

Table 6-3. Redebug Definitions

Character	Example	Meaning
a	Fa.	Lower-case "a" denotes hexadecimal number or cell location
Capital letter	F	Denotes any Redebug control mnemonic
(letter)	a/(a)/	Letter in parentheses denotes contents of designated location or register
CR-LF	CR-LF	Mnemonic that means carriage return and line feed
Underscore	Da,b.N	Characters underlined denote operator inputs
0a	aaaaa.	Leading zeros may not be typed
/	(R)/	Lower-case "b" with slash through it denotes space
y	y.	Lower-case "y" denotes new value to be loaded into specified location
.	y.	Period terminates particular mode operation
/	Fa,/	Slash cancels operation before completion

Table 6-4. Redebug Error Messages

Error Message	Meaning
C909	Start trace, single cycle
C955	Power shutdown has occurred. Repeat preceding activity from beginning

SECTION VII
RC 70 FORTRAN IV PROGRAMS

7.1 GENERAL DESCRIPTION

This section of the manual describes how to use the RC 70 FORTRAN IV programs. Compiler, runtime loader operation, and runtime operation procedures are presented. In addition, Teletype information is given, error messages are described, and program options are explained.

7.2 TELETYPE USAGE

The Teletype records all the information being punched. To obtain a program listing and a binary object tape of the compiled program, two passes over the source tape are required. Switch options control both the listing pass and the punching pass. Subsequent paragraphs describe how both the listing and object tape are produced, as well as how to cancel a partially entered statement.

7.3 PRODUCING A LISTING

The listing pass is normally run with sense switch 1 in the upper position and the other sense switches in the lower position. If errors are to be corrected on-line, sense switch 3 is also placed in the upper position.

When sense switch 1 is in the upper position, the printer records a complete listing of the source statements with sequence numbers. In addition, error messages are listed after any statement in error, and a question mark (?) appears below the character that is in error.

If sense switch 3 is in the upper position and an error is detected, the program waits for operator entry from the keyboard. The operator types in the correct statement. After entering the correct statement, the operator types a blank line by pressing the RETURN and LINE FEED keys on the keyboard.

The compiler program compiles the new statement and then continues to compile the source program. If the new statement is also in error, the printer records the statement with the error message, and again waits for operator input. More than one statement may be inserted in this manner before the blank line is used to terminate the entry mode.

After the END statement has been processed, a memory map is listed. The map provides the relative location of variables, subroutines used, certain memory allocation errors, and label errors.

7.4 PRODUCING A BINARY OBJECT TAPE

The punching pass is normally run with sense switch 8 in the upper position and all the other sense switches in the lower position. If errors are to be corrected on-line, sense switches 2 and 3 are also placed in the upper position. When either of the previously mentioned sense switch configurations is used, a complete binary object tape is punched.

When the paper tape punch is on, the ASR-33 punches the same information that is recorded by the printer. To allow the error statement to be printed, the program marks this output in a special way so that the FORTRAN IV Loader will ignore this portion of the object tape. If the error cannot be corrected, the compilation may be continued by entering a blank statement. If the error can be corrected, the operator enters the correct statement followed by a blank statement.

7.5 CANCELLING PARTIALLY ENTERED STATEMENTS

A partially entered statement may be cancelled by pressing the SHIFT-FORM keys on the keyboard. The Teletype generates the code for the backward slash (\) and transmits it to the computer. After entering the backward slash, the operator presses the RETURN and LINE FEED keys on the keyboard.

To terminate a correction operation, the operator enters a blank statement. During a correction operation, statement numbers cannot be changed. New statement numbers may be introduced, but corrections to statements in error should not include statement numbers. For example:

```
805   GO TO $01
            ?
SYNTAX
      GO TO 401
```

The first line contains the statement in error. The second line directs the operator to the error. The next line specifies the type of error, and the last line is the corrected entry. Note that the statement number (805) is not changed, only the statement.

7.6 COMPILER PROGRAM USAGE

The FORTRAN IV Compiler analyzes FORTRAN IV statements and translates them into object code suitable for execution by the RC 70 Computer. The

following procedure permits the operator to compile a source program using the FORTRAN IV Compiler:

a. Load the FORTRAN IV Compiler using one of the procedures given in section III. If the loader program is not resident in memory, perform the procedure in paragraph 3.8. If the loader program is stored in memory, perform the procedure in paragraph 3.9.

Note

If the computer halts and the register display shows C921 or C901, a checksum error has been detected. Check the tape for a checksum error.

b. After loading the compiler, the computer halts, and the register display shows C999. This message indicates that the program has been loaded successfully and that the source tape can now be processed.

c. Place the source tape into the paper tape reader.

d. Set the data switches on the processor control panel to the program entry address.

e. Set the sense switches on the processor control panel as desired. The options available to the operator are described in paragraph 7.8.

f. Press the RESET switch on the processor control panel.

g. Press the START switch on the processor control panel. The computer reads each statement on the source tape. The statement is examined for tape edit control codes. If the statement is accepted by the compiler as a FORTRAN IV statement, it is scanned and compiled by the program. After each statement is compiled, it is recorded on tape via the paper tape punch.

7.7 COMPILER ERROR MESSAGES

Error messages are recorded by the printer and displayed by the register display. Table 7-1 lists the error messages that can be printed by the Teletype. The messages with an asterisk (*) indicate errors that can be corrected on-line through the keyboard during compilation.

If sense switch 3 on the processor control panel is in the upper position, the computer halts for these corrections. A correction affects only the object tape and the listing, not the source tape. The source tape may be corrected using the RC 70 Tape Edit program (see section IV for editing procedures).

To portray an error message, the register select switch on the processor control panel must be set to the I position. (Paragraph 2.12 explains how to interpret the register display indicators.) Eight FORTRAN IV Compiler error messages can be transmitted to the operator via the register display. Table 7-2 lists the error messages and their meaning.

Table 7-1. Printed Compiler Error Messages

Message	Explanation
SYNTAX*	Syntax error in source program statement
ORDER*	Order error in program
COMPILER OVERFLOW	Insufficient memory to compile program
COMMON OVERFLOW	Overflow of COMMON storage area
MISSING LBL*	Label missing
SUBSCRIPTS	Erroneous subscript
ID CONFLICT*	Mode illegal in this context
DATA CNT*	Data length does not agree with list
BLOCK DATA*	BLOCK DATA must be first statement of subprogram
MODE*	Mode error
ALLOCATION*	Allocation conflict
LABEL ERRORS	Undefined labels and labels of improper DO statements
ALLOCATION ERRORS	List of variables with allocation conflicts
TYPE CONFLICT*	Illegal type assignments

*May be corrected on-line through keyboard during compilation

7.8 COMPILER PROGRAM OPTIONS

Five sense switch options are available to the operator. Different combinations of these switches can be used at the same time. The combination used is a function of the operation being performed. The options available to the operator when using the Teletype during compilation are described in paragraphs 7.3 and 7.4.

Table 7-2. Displayed Compiler Error Messages

Error Message	Meaning
C910	Source tape checksum error has been detected. Correct error
C955	Power shutdown has occurred. Repeat preceding activity from beginning
C980	End of file. Press RESET and START to process next input tape
C999	Compiler program has been loaded successfully. Process source tape

When using the options, place each of the sense switches, except the ones being used, in the lower position. The sense switch options are summarized in table 7-3.

7.9 RUNTIME LOADER OPERATION

To load the required programs and subprograms prior to a runtime operation, perform the following loading procedure:

a. Load the FORTRAN IV Loader into memory, using the paper tape fill procedure. To load the program, perform the procedure in paragraph 3.8.

Table 7-3. Compiler Program Options

Sense Switch	Function
1	When switch is in upper position, system punching is suppressed
2	When switch is in upper position, system output is suppresed, except for errors
3	When switch is in upper position, on-line error corrections can be made
4	When switch is in upper position, object program is listed in hexadecimal code on system output. This output is used for compiler debugging only
8	When switch is in upper position, system output is suppressed

b. After the program is loaded, the computer halts and the register display shows C991. This message indicates that the program has been successfully loaded and that the object tape can now be processed.

c. Place the main program and subprogram object tape into the paper tape reader.

d. Press the START switch on the processor control panel. The main object program is then loaded into memory.

e. After this program is loaded, the computer halts and the register display shows C980. This message indicates that the main object program and subprograms have been loaded successfully and that the FORTRAN IV Library and I/O Editor can now be processed.

f. After the main program and subprograms have been loaded into memory, place the FORTRAN IV Library and I/O Editor into the paper tape reader.

g. Press the START switch. The FORTRAN IV Library and I/O Editor is then loaded into memory. If sense switch 8 is in the lower position, the following occurs:

1. The Teletype prints a subroutine location map.

2. If one or more required subroutines were not loaded, the computer halts and the C962 is shown in the register display. This message indicates that the loading process must be repeated with the missing subroutines included.

3. The subroutine map indicates the names of the missing subroutines by having the word UNDEFINED appear after the name of the missing subroutine.

h. After successfully loading the FORTRAN IV Library and I/O Editor, the computer halts and the register display shows C999. This message indicates that the program is loaded in the computer's memory and that the object program may be executed.

Note

If sense switch 1 is in the upper position and the library has been loaded, a C992 halt will occur. To dump the core image on the system punch, turn on the ASR-33 punch and press START. To reload this core dump, a copy of the General Loader must be attached to the beginning of the dump tape.

7.10 RUNTIME LOADER OPERATION ERROR MESSAGES

While loading the programs specified in the preceding procedure, error messages can be portrayed by the register display. To portray an error message, the register select switch must be in the I position. (Paragraph 2.12 explains how to interpret the register display indicators.)

There are 12 messages that can be transmitted to the operator via the register display. Table 7-4 lists these error messages and their meanings.

Table 7-4. Runtime Loader Operation Error Messages

Error Message	Meaning
C901	Loader checksum error has been detected. Correct error
C907	Short forward reference in assembly language subroutine is larger than 255. Index register holds location of instruction in error, and B-register holds operand address. Press START to continue
C942	End of core image dump; press START to begin program execution
C955	Power shutdown has occurred. Repeat preceding activity from beginning
C960	Memory overflow has been detected
C961	Common area error has been detected. Correct error
C962	Undefined subprogram has been detected
C963	Illegal tape is being used
C964	Doubly defined subprogram has been detected
C980	Main object program and subprograms have been loaded successfully. Press START to process FORTRAN IV Library and I/O Editor tape
C991	FORTRAN IV Loader has been loaded successfully. Press START to process main object program tape
C999	FORTRAN IV Library and I/O Editor has been loaded successfully. Main object program can now be executed. To dump core image, set sense switch 1 up, turn on system punch, and push START; then, to begin program execution, push START

7.11 LOADER PROGRAM OPTIONS

There are two FORTRAN IV Loader program options available to the operator. Sense switches 1 and 8 are used to control the operation of the loader program.

When sense switch 1 is in the upper position, the loaded object program is dumped or punched onto an output tape. If sense switch 8 is in the upper position, the memory map is not printed by the Teletype.

7.12 RUNTIME OPERATION

The following procedure permits the operator to run the main object program and the object subprograms that were loaded into the machine's memory during the runtime loader operation.

a. Perform the runtime loader procedure in paragraph 7.9.

b. To punch or dump the contents of memory onto paper tape, perform the following steps:

1. Before starting the library load (after halt C980), set sense switch 1 to the upper position.

2. When the computer halts (C992) turn on ASR-33 punch and press START switch on the processor control panel.

c. If a dump of the contents of memory is not required, set switch 1 OFF. Place the library tape in the system library unit and press START.

d. When halt C999 is reached, select the Teletype components to be used during the program run. To activate the reader, punch, or printer or any combination of these components, perform the applicable steps of the procedures in paragraphs 2.19 and 2.20.

Note

When the Teletype is not ready for the execution of the main object program, the runtime program waits in a programmed loop for the operator to take the necessary action (that is, perform step d of this procedure).

e. Press the START switch on the processor control panel. The main object program is then executed.

f. To run the main object program again, press the RESET and START switches.

7.13 RUNTIME OPERATION ERROR MESSAGES

Errors detected during runtime operation cause a programmed halt, and the register display portrays an

error message when the register select switch on the processor control panel is set to the I position. (Paragraph 2.12 explains how to interpret the register display indicators.)

Twelve error messages can be transmitted to the operator via the display. Table 7-5 lists these messages and their meanings.

Table 7-5. Runtime Operation Error Messages

Error Message	Meaning
C955	Power shutdown has occurred. Repeat preceding activity from beginning
C960	Memory overflow has been detected
C970	Illegal character in FORMAT reference has been detected, or required character in FORMAT reference has been omitted
C971	Data input of illegal character has been detected
C972	FORMAT error has been detected: left or right parenthesis counts do not match, or maximum allowable parenthesis nesting has been exceeded

Table 7-5. Runtime Operation Error Messages (Cont.)

Error Messages	Meaning
C973	Data input, representing a floating-point number, exceeds maximum machine range
C974	Target address, not previously defined by ASSIGN statement, has been detected
C975	Target address, undefined in computed GO TO statement, has been detected
C976	Exponentiation error has been detected in computing A^b, where b is floating-point value and A is negative
C977	Negative argument to square root function has been detected
C978	Argument to logarithm function is less than or equal to zero
C979	Magnitude of argument to exponent function is too large

SENSE SWITCH SETTINGS SUMMARY

SENSE SWITCH	PROGRAM			
	Tape Edit	Assembler	FORTRAN IV Compiler	FORTRAN IV Loader
1	Suppress system punch	Suppress system punch	Suppress system punch	Enable system punch (core dump)
2	Indicates keyboard echo and system punch are mechanically coupled	Suppress system output except for errors	Suppress system output except for errors	
3	Output spaces to complete Assembler field for TAB inputs		Stop for on-line error corrections	
4	Accept alter tape from system utility No. 1		List object code in hexadecimal on system output	
5				
6				
7				
8	Suppress system output	Suppress system output	Suppress system output	Suppress system output (memory map)

END-OF-FILE CONDITION SUMMARY

Program	Condition
General Loader	Five inches of leader
FORTRAN IV Loader	Five inches of leader
Tape Edit	Five inches of leader
Assembler	Five inches of leader after END statement
FORTRAN IV Compiler	Five inches of leader

Note

End-of-file condition normally produces variable amount of leader on system punch. Operator should extend this leader to more than 15 inches to ensure proper end-of-file processing on subsequent input.