

THE

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THE SCELBI

MONITOR - EDITOR - ASSEMBLER

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I M P O R T A N T N O T I C E

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THE SCELBI MONITOR/EDITOR/ASSEMBLER PROGRAM (MEA)

THE SCELBI MONITOR/EDITOR/ASSEMBLER PROGRAM, ABBREVIATED IN THIS MANUAL AS "MEA," IS A POWERFUL SOFTWARE PACKAGE THAT COMBINES THE FUNCTIONS OF A MONITOR, EDITOR, AND ASSEMBLER IN A RESIDENT, CONVERSATIONAL TYPE ARRANGEMENT. THE PACKAGE IS STANDARDLY SUPPLIED ON PROGRAMMABLE READ ONLY MEMORY ELEMENTS THAT RESIDE ON PAGES 60 THROUGH 77 (OCTAL) FOR USE IN A SCELBI-8B MINICOMPUTER. I/O ROUTINES FOR THE PACKAGE ARE SUPPLIED ON TWO SEPARATE "PROMS." THE STANDARD SCELBI AUDIO TAPE DRIVING PROGRAM RESIDES ON PAGE 77. I/O ROUTINES FOR THE SPECIFIC I/O HARDWARE TO BE USED WITH THE SYSTEM IS PROVIDED ON A PROM ON PAGE 76. TWO STANDARD I/O VERSIONS ARE AVAILABLE. ONE FOR SYSTEMS EQUIPPED WITH THE SCELBI OSCILLOSCOPE ALPHANUMERIC DISPLAY INTERFACE AND SCELBI ASCII KEYBOARD INTERFACE. THE OTHER FOR SYSTEMS USING A MODEL 33 TELETYPE INTERFACED WITH THE SCELBI BIT-SERIAL TTY INTERFACE. OTHER TYPES OF I/O DEVICES CAN BE ACCOMODATED BY SPECIAL ARRANGEMENT AND SUBSTITUTION OF APPROPRIATE I/O ROUTINES PROGRAMMED ONTO A PROM ON PAGE 76.

THIS MANUAL DESCRIBES THE OPERATION OF THE MEA PACKAGE FOR EITHER THE TTY I/O OR THE OSCILLOSCOPE/KEYBOARD I/O. OPERATION WITH OTHER TYPES OF I/O ARRANGEMENTS WOULD BE SIMILAR TO ONE OF THESE STANDARD VERSIONS DISCUSSED IN THIS MANUAL.

STANDARD I/O PORT ASSIGNMENTS

THE MEA PACKAGE IS STANDARDLY SUPPLIED TO OPERATE WITH SCELBI INTERFACES CONNECTED TO THE FOLLOWING I/O PORTS ON THE SCELBI-8B MINICOMPUTER.

AUDIO TAPE INTERFACE: OUTPUT PORT 13 ("OUT3" SOCKET ON REAR OF CHASSIS) AND INPUT PORT 3 ("INP3" SOCKET).

OSCILLOSCOPE INTERFACE: OUTPUT PORTS 10 & 11 ("OUT0" AND "OUT1" SOCKETS).

ASCII KEYBOARD INTERFACE: OUTPUT PORT 12 ("OUT2" SOCKET) AND INPUT PORT 4 ("INP4" SOCKET).

TTY BIT-SERIAL INTERFACE: OUTPUT PORT 16 ("OUT6") AND INPUT PORT 5 ("INP5").

NOTE: THE MEA PACKAGE OPERATES EITHER WITH THE TTY I/O OR THE COMBINATION OF THE ASCII KEYBOARD AND THE OSCILLOSCOPE DISPLAY. IT DOES NOT OPERATE WITH BOTH SIMULTANEOUSLY AS DIFFERENT I/O PROMS ARE REQUIRED ON PAGE 76.

INITIAL INSTALLATION OF THE MEA PROGRAM PACKAGE

THE SCELBI MEA PACKAGE IS NORMALLY SUPPLIED ON A GROUP OF SIXTEEN TYPE 1702A PROMS INSTALLED ON A SCELBI #1109 PROM CARD. THIS CARD WITH THE PROMS INSTALLED SHOULD BE PLUGGED INTO THE REAR-MOST SLOT OF A SCELBI-8B CHASSIS UNIT WHERE IT WILL PICK UP THE MEMORY ADDRESS LINES FOR PAGES 60 - 77. ALWAYS MAKE SURE POWER TO THE UNIT IS TURNED OFF WHEN PLUGGING IN OR REMOVING ANY CARDS IN A SCELBI-8B SYSTEM!

WHEN THE CARD CONTAINING THE MEA PROGRAMMED PROMS HAS BEEN INSTALLED THE POWER TO THE COMPUTER IS TURNED ON AND THE OPERATOR MANUALLY TOGGLES IN THE COMMAND "JMP 000 060" USING THE CONSOLE CONTROL SWITCHES. THE OPERATOR THEN PLACES THE COMPUTER IN THE "RUN" MODE.

MEA MEMORY USAGE MAP

THE MEA PROGRAM PACKAGE REQUIRES A MINIMUM OF 4K OF RAM (READ AND WRITE MEMORY) TO BE AVAILABLE IN THE COMPUTER STARTING AT THE LOWEST ADDRESS (PAGE 00). ADDITIONAL MEMORY BEYOND 4K OF RAM CAN BE USED AS MAY BE SEEN FROM THE FOLLOWING DISCUSSION.

THE ENTIRE MEA PROGRAM ITSELF IS RESIDENT IN THE PROMS ON PAGES 60 THROUGH 77 IN THE STANDARD CONFIGURATION. HOWEVER, VARIOUS PORTIONS OF THE MEA PROGRAM UTILIZE RAM MEMORY TO PERFORM VARIOUS FUNCTIONS. RAM MEMORY USAGE HAS BEEN ASSIGNED AS FOLLOWS:

PAGE 00 LOCATION 000 THROUGH 067 HAVE BEEN LEFT OPEN FOR THE USER AT ALL TIMES. NOTE THAT THIS LEAVES 7 OUT OF THE POSSIBLE 8 SPECIAL "RESTART" (RST) LOCATIONS AVAILABLE TO THE USER.

PAGE 00 LOCATIONS 070 THROUGH 377 ARE USED BY THE MEA AS A GENERAL SCRATCH-PAD AREA. THE USER SHOULD NOT USE THESE LOCATIONS WHEN THE MEA PROGRAM PACKAGE IS BEING UTILIZED.

PAGE 01 LOCATIONS 000 THROUGH 377 ARE USED BY THE MEA AS A CRT BUFFER AREA WHEN THE SCLEBI OSCILLOSCOPE INTERFACE I/O IS BEING UTILIZED. WHEN THE TTY MEA VERSION IS USED, THESE LOCATIONS ARE OPEN TO THE USER.

PAGE 02 LOCATION 000 THROUGH PAGE 07 LOCATION 377 ARE ASSIGNED FOR USE AS A SYMBOL TABLE AREA WHEN THE ASSEMBLER PORTION OF THE MEA PROGRAM IS BEING USED. SYMBOLS ARE STORED DURING AN ASSEMBLY PROCESS BEGINNING AT PAGE 02 LOCATION 000. FOR SHORT PROGRAMS WITH RELATIVELY FEW "SYMBOLS" THE OPERATOR WILL FIND THAT THE UPPER PORTIONS OF THIS ASSIGNED AREA MAY BE USED FOR OTHER PURPOSES. MORE ABOUT THE AMOUNT OF STORAGE USED BY SYMBOLS WILL BE DISCUSSED IN THE SECTION DESCRIBING THE ASSEMBLER PORTION OF THE MEA PROGRAM. SUFFICE IT TO SAY AT THIS POINT, THAT THE ASSIGNED STORAGE AREA WILL ALLOW FOR BETWEEN APPROXIMATELY 170 TO 300 SYMBOLS TO BE STORED DEPENDING ON THE ACTUAL LENGTH OF THE SYMBOLS USED IN AN ASSEMBLY PROCESS. THIS IS PLENTY OF ROOM TO ALLOW FOR QUITE LARGE PROGRAMS TO BE ASSEMBLED AT ONE OPERATION!

PAGE 10 LOCATION 000 THROUGH THE REMAINDER OF AVAILABLE RAM MEMORY IN A SYSTEM IS USED AS A TEXT BUFFER BY THE EDITOR PROGRAM. THE AMOUNT OF ACTUAL RAM MEMORY AVAILABLE IN A SYSTEM IS AUTOMATICALLY DETERMINED BY THE EDITOR PROGRAM AS WILL BE EXPLAINED LATER. THE EDITOR USES THE AVAILABLE RAM MEMORY STARTING AT THE LOWEST POSSIBLE ADDRESS ASSIGNED TO THE TEXT BUFFER (PAGE 10 LOCATION 000). THE AMOUNT OF MEMORY ACTUALLY UTILIZED WILL THUS BE A FUNCTION OF HOW MUCH INFORMATION IS PUT INTO THE TEXT BUFFER. AS WILL BE EXPLAINED LATER, IT IS EASY TO CHECK AND SEE HOW MUCH OF AVAILABLE MEMORY HAS BEEN USED BY THE EDITOR WHEN TEXT IS BEING STORED. THUS, A USER MAY PLAN ON USING PORTIONS OF MEMORY IN THE UPPER REGIONS OF RAM FOR USER DEFINED PURPOSES BY RESTRICTING THE AMOUNT OF TEXT PLACED IN THE TEXT BUFFER AT ANY ONE TIME.

THIS ASSIGNMENT OF RAM USAGE, IT SHOULD BE APPARENT, ALLOWS A USER TREMENDOUS CAPABILITY FOR DEVELOPING SOFTWARE. FOR EXAMPLE, IF A PERSON HAS A SYSTEM WITH 8 K OF RAM, ONE CAN LIMIT USAGE OF THE TEXT BUFFER, TO SAY, 5 K (I.E., PAGES 10 THROUGH 33) AND LEAVE 1 K IN WHICH TO ACTUALLY PLACE A PROGRAM BEING DEVELOPED FOR TESTING AND DEBUGGING. WHEN THE PROGRAM WAS CHECKED OUT, IT COULD BE "RE-ASSEMBLED" INTO IT'S FINAL DESIRED OPERATING LOCATIONS BY SIMPLY CHANGING "ORG" STATEMENT(S) IN THE SOURCE LISTING AND PERFORMING A FINAL ASSEMBLY OPERATION. THIS ENTIRE PROCESS CAN BE DONE USING THE MEA PACKAGE IN A FRACTION OF THE TIME THAT WOULD BE REQUIRED BY CONVENTIONAL METHODS THAT UTILIZE SEPARATE EDITOR AND ASSEMBLER PROGRAMS AND THAT THUS REQUIRE THE CONSTANT RELOADING OF NOT ONLY THE OPERATING PROGRAMS THEMSELVES, BUT ALSO THE SOURCE LISTING BEING WORKED ON.

OPERATING THE MEA MONITOR

THE MONITOR PORTION OF THE MEA PACKAGE PROVIDES A POWERFUL GROUP OF FUNCTIONS THAT AID THE USER IN OPERATING THE COMPUTER SYSTEM AND IN DEVELOPING AND DEBUGGING PROGRAMS.

IT SHOULD BE POINTED OUT THAT THE EASIEST WAY TO REALLY LEARN HOW TO OPERATE THE MEA PACKAGE IS TO PLACE THE PROGRAM IN OPERATION AND SIT DOWN AT THE I/O DEVICE FOR YOUR SYSTEM AND TRY THE VARIOUS FUNCTIONS AS THEY ARE EXPLAINED IN THIS MANUAL. YOU WILL FIND IT A LOT OF FUN AND A PLEASURABLE EXPERIENCE TO OPERATE THIS TYPE OF POWERFUL SOFTWARE PACKAGE. (PARTICULARLY IF YOU HAVE BEEN USED TO WORKING WITH OLD STYLE EDITOR/ASSEMBLER PROGRAMS!) WHILE ALL THE FUNCTIONS OF THE MEA PACKAGE WILL BE PRESENTED IN THIS MANUAL, AND VARIOUS EXAMPLES GIVEN OF THEIR USAGE, IT WOULD NOT BE POSSIBLE TO ILLUSTRATE ALL THE APPLICATIONS OF SUCH A POWERFUL SOFTWARE PACKAGE. THE USER WILL PROBABLY FIND NEW AND INTRIGUING USES FOR VARIOUS PARTS OF THE PACKAGE AS EXPERIENCE IS ACQUIRED.

AMONG OTHER FUNCTIONS, THE MONITOR PORTION OF THE MEA CONTAINS THE OVER ALL CONTROL ROUTINE OR "COMMAND INTERPRETER" FOR THE MEA PACKAGE. ALL COMMANDS, WHETHER TO OPERATE THE MONITOR ITSELF, THE EDITOR, OR THE ASSEMBLER, PASS THROUGH THE MONITOR PORTION. WHENEVER A FUNCTION HAS BEEN COMPLETED, CONTROL RETURNS TO THE MONITOR. WHENEVER THE MONITOR IS READY FOR A COMMAND FROM THE OPERATOR, THE CHARACTER ">" WILL BE PRINTED OR DISPLAYED.

WHEN THE MEA PROGRAM IS FIRST STARTED (AFTER, FOR INSTANCE, POWER TURN ON AND EXECUTION OF A "JMP 000 060" VIA THE CONSOLE SWITCHES) THE "READY" (>) WILL BE DISPLAYED. IF A TELETYPE IS BEING USED AS AN I/O DEVICE, THE ">" CHARACTER WILL BE PRECEDED BY A CARRIAGE-RETURN AND LINE-FEED COMBINATION (ABBREVIATED "CR/LF" IN THIS MANUAL). IF A CRT IS BEING USED AS A DISPLAY DEVICE, THE ">" WILL APPEAR IN THE UPPER LEFT HAND CORNER OF THE SCREEN.

NOTE: IF THE SCALBI OSCILLOSCOPE DISPLAY UNIT IS BEING UTILIZED THE OPERATOR SHOULD ADJUST THE INTENSITY OF THE DISPLAY WHEN THE PROGRAM IS FIRST STARTED SO THAT THE ">" CHARACTER IS CLEARLY DISPLAYED WHILE THE BACKGROUND "STARBURST PATTERN" IS EFFECTIVELY "BLANKED OUT." (THE BACKGROUND STARBURST PATTERN GENERATED BY THE MEA PACKAGE CONSIST OF FIVE LINES, EACH LINE CONSISTING OF TWENTY CHARACTER POSITIONS, IF THE INTENSITY OF THE DISPLAY IS NOT ADJUSTED PROPERLY THIS PATTERN CAN SHOW UP AS FIVE LINES WHICH APPEAR TO CONTAIN TWENTY "BOXES" WITH LINES

INSIDE THE BOXES. USER'S OF THE SCLEBI OSCILLOSCOPE INTERFACE SHOULD REFER TO APPROPRIATE OPERATING INSTRUCTIONS FOR INITIALLY INSTALLING AND ADJUSTING THE OSCILLOSCOPE DISPLAY SYSTEM.)

COMMANDS TO THE MEA PACKAGE ARE ENTERED VIA THE INPUT I/O DEVICE. (TTY KEYBOARD OR ASCII KEYBOARD IN THE STANDARD VERSIONS.) EACH TYPE OF COMMAND HAS A UNIQUE CHARACTER FOLLOWED BY ONE OR MORE CHARACTERS - LETTERS AND/OR NUMBERS THAT FULLY DEFINE THE COMMAND FUNCTION. WHEN IN THE MONITOR COMMAND MODE (AS DISTINCT FROM THE EDITOR COMMAND MODE WHICH WILL BE DETAILED LATER), ALL COMMANDS ARE EXECUTED BY TYPING A COMBINATION OF THE INPUT "CONTROL KEY" AND THE LETTER "L" SIMULTANEOUSLY. THIS COMBINATION "CONTROL L" WILL BE ABBREVIATED THROUGH OUT THIS MANUAL AS "CTRL/L."

THE TYPES OF COMMANDS THAT ARE CONSIDERED TO MAKE UP THE MONITOR PORTION OF THE MEA PACKAGE ARE SUMMARIZED AS FOLLOWS. A DETAILED DISCUSSION OF EACH COMMAND WILL FOLLOW THE INITIAL SUMMARY.

"M" FOR "MODIFY" FOLLOWED BY AN OCTAL ADDRESS ALLOWS THE OPERATOR TO EXAMINE, AND IF DESIRED TO MODIFY THE CONTENTS OF ANY RAM LOCATION IN MEMORY.

"F" FOLLOWED BY A STARTING OCTAL ADDRESS AND A FINAL ADDRESS RESULTS IN A MEMORY DUMP OF THE REQUESTED LOCATIONS BEING PERFORMED.

"X" FOLLOWED BY THE LETTERS A-E, H, L OR F, RESULTS IN THE CONTENTS OF "VIRTUAL" CPU REGISTERS OR THE CPU FLAG STATUS TO BE DISPLAYED. AFTER DISPLAY, THE CONTENTS OF THE VIRTUAL CPU REGISTERS (BUT NOT THE FLAG STATUS!) CAN BE ALTERED. THE "VIRTUAL" CPU REGISTERS AND FLAG STATUS REFLECT THE ACTUAL CONTENTS OF THE ASSOCIATED CPU REGISTERS AT THE TIME A "BREAKPOINT" WAS ENCOUNTERED OR THE DESIRED CONTENTS OF THE CPU REGISTERS AT THE TIME A "GO TO" MONITOR COMMAND IS ISSUED.

"B" FOR "BREAKPOINT" FOLLOWED BY THE NUMBER "1" OR "2" AND AN OCTAL ADDRESS RESULTS IN A BREAKPOINT BEING ESTABLISHED AT THE SPECIFIED ADDRESS. A TYPE "1" BREAKPOINT WILL RESULT IN THE STATUS OF THE CPU REGISTERS "A, B AND C" PLUS THE CPU'S FLAG STATUS BEING SAVED IN THE "VIRTUAL" REGISTERS AT THE TIME THE BREAKPOINT IS ENCOUNTERED. A TYPE "2" BREAKPOINT RESULTS IN THE "D, E, H AND L" CPU REGISTERS PLUS THE CPU'S FLAG STATUS BEING SAVED WHEN THE BREAKPOINT IS ENCOUNTERED.

"G" FOR "GO TO" FOLLOWED BY THE NUMBER "1" OR "2" AND AN OCTAL ADDRESS RESULTS IN THE COMPUTER JUMPING TO THE SPECIFIED ADDRESS WITH THE CPU REGISTERS SET TO CONTAIN THE VALUES STORED IN THE "VIRTUAL" REGISTER LOCATIONS. A TYPE "1" GO TO COMMAND WILL ALLOW THE CONTENTS OF THE "A, B AND C" CPU REGISTERS TO BE DEFINED AT THE START OF OPERATIONS. A TYPE "2" COMMAND SETS UP THE "D, E, H AND L" REGISTERS PRIOR TO THE START OF OPERATIONS AT THE SPECIFIED "GO TO" ADDRESS.

"R" FOR "READ" FROM THE TAPE UNIT, ALLOWS THE OPERATOR TO ACTIVATE A SCLEBI TAPE INTERFACE SYSTEM AND READ IN A MAGNETIC TAPE USING THE STANDARD SCLEBI TAPE ROUTINES SUPPLIED AS PART OF THE MEA PACKAGE. THIS TAPE ROUTINE WILL AUTOMATICALLY LOAD DATA INTO MEMORY LOCATIONS IN ACCORDANCE WITH ADDRESSING INFORMATION THAT IS CONTAINED ON THE TAPE.

IN ADDITION TO THE MONITOR COMMANDS JUST LISTED, IT IS POSSIBLE TO WRITE FILES TO THE TAPE UNIT USING A COMBINATION OF THE "X" COMMANDS AND A "GO TO" COMMAND.

THE MONITOR "MODIFY" COMMAND

THE MONITOR "MODIFY" COMMAND IS INITIATED BY TYPING IN THE "M" COMMAND IN THE FOLLOWING FORMAT:

M PPP LLL (CTRL/L)

WHERE "PPP" IS THE PAGE ADDRESS AND "LLL" IS THE LOW ADDRESS (IN OCTAL) OF THE RAM MEMORY ADDRESS WHERE ONE DESIRES TO BEGIN EXAMINING AND/OR MODIFYING THE CONTENTS OF MEMORY LOCATIONS. THE OPERATOR SHOULD NOTE THAT A SPACE SHOULD BE INSERTED BETWEEN THE "M" AND THE PAGE ADDRESS AS WELL AS BETWEEN THE PAGE ADDRESS AND THE LOW ADDRESS WHEN ENTERING THE COMMAND STRING.

WHEN THE OPERATOR DEPRESSES THE "CTRL/L" COMBINATION TO EXECUTE THE "M" COMMAND, THE FOLLOWING WILL OCCUR. EITHER THE TELETYPE OR THE OSCILLOSCOPE DISPLAY UNIT WILL PRESENT THE INFORMATION:

PPP LLL XXX:

SHOWING THE ADDRESS OF THE MEMORY LOCATION AND THE CONTENTS OF THE LOCATION. THE PROGRAM WILL THEN WAIT FOR THE OPERATOR TO SELECT EITHER A "MODIFY" OPTION, OR TO TAKE THE OPTION OF NOT MODIFYING THE CURRENT LOCATION BEING DISPLAYED BUT TO EXAMINE THE NEXT OPTION, OR TO TERMINATE THE "M" SEQUENCE. TO ELECT TO MODIFY THE CONTENTS OF THE MEMORY LOCATION BEING DISPLAYED, THE OPERATOR SIMPLY TYPES IN THE DESIRED OCTAL CONTENTS IMMEDIATELY FOLLOWING THE ":" SIGN AND THEN DEPRESSES THE SPACE BAR. THE NUMBER ENTERED WILL BECOME THE NEW VALUE FOR THE MEMORY LOCATION AND THE PROGRAM WILL PROCEED TO DISPLAY THE ADDRESS AND CONTENTS OF THE NEXT SEQUENTIAL MEMORY LOCATION.

IF THE OPERATOR DOES NOT WISH TO MODIFY THE CONTENTS OF A LOCATION, BUT DOES DESIRE TO EXAMINE THE CONTENTS OF THE NEXT MEMORY LOCATION, THEN IT IS ONLY NECESSARY TO DEPRESS THE KEYBOARD SPACE BAR. THE PROGRAM WILL PROCEED TO DISPLAY THE ADDRESS AND CONTENTS OF THE NEXT MEMORY LOCATION.

IF THE OPERATOR DESIRES TO TERMINATE THE "MODIFY" PROCESS, THEN THE "CR" KEY IS DEPRESSED AND THE PROGRAM WILL RETURN TO THE MONITOR COMMAND MODE AND DISPLAY THE ">" MONITOR "READY" CHARACTER.

IT IS IMPORTANT TO NOTE THAT WHEN ELECTING TO MODIFY A MEMORY LOCATION, THE SPACE BAR MUST BE DEPRESSED AFTER ENTERING THE OCTAL NUMBER THAT IS TO BE THE NEW VALUE IN THE MEMORY LOCATION! THIS WILL CAUSE THE NEW VALUE TO BE PLACED IN THE MEMORY LOCATION AND AUTOMATICALLY CAUSE THE NEXT LOCATION IN MEMORY TO BE DISPLAYED. HITTING THE "CR" KEY IMMEDIATELY AFTER ENTERING A NEW VALUE FOR A MEMORY LOCATION WILL CAUSE THE PROGRAM TO RETURN TO THE MONITOR AND WILL NOT RESULT IN THE VALUE BEING PLACED IN MEMORY! THIS FORMAT ALLOWS THE OPERATOR TO ELECT NOT TO CHANGE A MEMORY LOCATION EVEN AFTER HAVING TYPED IN A VALUE. IF, HOWEVER, THE RULE IS NOT REMEMBERED, THE OPERATOR MAY INADVERTENTLY FAIL TO INSERT DESIRED CHANGES.

CORRECTING ERRORS WHEN IN THE MONITOR COMMAND MODE

IF THE OPERATOR MAKES A TYPING MISTAKE WHILE ENTERING A COMMAND SEQUENCE TO THE MONITOR INTERPRETER, THE CURRENT COMMAND CAN BE ERASED BY SIMULTANEOUSLY DEPRESSING THE CONTROL KEY AND THE LETTER "D" KEY. THIS WILL CAUSE THE PROGRAM TO GO BACK TO THE INITIAL "READY" (">" DISPLAYED) CONDITION TO AWAIT A NEW ENTRY.

SHOULD THE OPERATOR INADVERTENTLY ENTER AN INVALID COMMAND OR COMMAND SEQUENCE, THE PROGRAM WILL CAUSE THE LETTER "I" (ILLEGAL COMMAND) TO BE DISPLAYED. TO CLEAR THE DISPLAY AT SUCH A POINT THE OPERATOR MUST DEPRESS THE "CONTROL/D" COMBINATION. THE PROGRAM WILL THEN GO BACK TO THE "READY" CONDITION.

THE MONITOR MEMORY DUMP ("F") COMMAND

THE MONITOR "MEMORY DUMP" COMMAND IS INITIATED BY TYPING IN THE "F" COMMAND IN THE FOLLOWING FORMAT:

```
F PPP LLL,HHH AAA (CTRL/L)
```

WHERE "PPP" AND "LLL" SIGNIFIES THE STARTING ADDRESS (OCTAL) AND "HHH" AND "AAA" INDICATE THE ENDING ADDRESS OF THE BLOCK OF MEMORY THAT ONE DESIRES TO HAVE DISPLAYED. WHEN THE "CTRL/L" COMBINATION IS ISSUED TO EXECUTE THE COMMAND, THE PROGRAM WILL PROCEED TO DISPLAY THE CONTENTS OF THE MEMORY LOCATIONS SPECIFIED. IF A TELETYPE I/O IS IN USE, THE DISPLAY WILL APPEAR IN THE FOLLOWING FORM.

```
PPP LLL  XXX  
PPP+020  XXX  
PPP+040  XXX XXX
```

THAT IS, EACH LINE PRINTED WILL BE PRECEDED BY AN ADDRESS AND THEN 20 (OCTAL) GROUPS OF DIGITS REPRESENTING THE CONTENTS OF SUCCESSIVE MEMORY LOCATIONS. THE TELETYPE WILL CONTINUE TO PRINT THE CONTENTS OF THE MEMORY LOCATIONS REQUESTED UNTIL THE ENDING ADDRESS SPECIFIED IN THE COMMAND SEQUENCE IS REACHED.

IF AN OSCILLOSCOPE DISPLAY SYSTEM IS BEING UTILIZED, THE DISPLAY FORMAT WILL BE DIFFERENT. THE MEMORY DUMP WILL BE SHOWN AS FOLLOWS:

```
>F PPP LLL  
XXX XXX XXX XXX  
XXX XXX XXX XXX  
XXX XXX XXX XXX  
XXX XXX XXX XXX
```

THAT IS, THE FIRST LINE OF THE DISPLAY WILL SHOW THE COMMAND CHARACTER AND THE ADDRESS OF THE START OF THE CURRENT "BLOCK" OF MEMORY BEING DISPLAYED. THE NEXT FOUR LINES SHOW THE CONTENTS OF TWENTY SUCCESSIVE MEMORY LOCATIONS (OCTAL) READING FROM LEFT TO RIGHT. THE "BLOCK" OF 20 (OCTAL) LOCATIONS WILL REMAIN ON THE SCREEN UNTIL THE OPERATOR DEPRESSES THE SPACE BAR ON THE KEYBOARD. DOING SO WILL CAUSE THE "ADDRESS LINE" ON THE DISPLAY TO BE UPDATED AND THE NEXT "BLOCK" OF MEMORY LOCATIONS TO BE DISPLAYED. WHEN THE END OF THE SPECIFIED "DUMP" AREA HAS BEEN REACHED, THE PROGRAM WILL RETURN TO THE COMMAND MODE.

WHEN USING THE CRT DISPLAY, SHOULD THE OPERATOR DECIDE IT IS NOT

NECESSARY TO VIEW ALL THE LOCATIONS ORIGINALLY SPECIFIED IN THE COMMAND SEQUENCE, THE DUMP MAY BE TERMINATED BY DEPRESSING THE "CR" (CARRIAGE-RETURN) KEY ON THE KEYBOARD.

THE MONITOR "VIRTUAL" CPU REGISTER COMMANDS

THE MONITOR "VIRTUAL" CPU REGISTER COMMANDS ARE INITIATED BY TYPING IN ONE OF THE FOLLOWING COMMANDS:

XA (CTRL/L)
XB (CTRL/L)
XC (CTRL/L)
XD (CTRL/L)
XE (CTRL/L)
XH (CTRL/L)
XL (CTRL/L)
XF (CTRL/L)

THE "VIRTUAL" CPU REGISTERS REFLECT THE STATUS OF THE ACTUAL CORRESPONDING CPU REGISTERS AT THE TIME A "BREAKPOINT" WAS ENCOUNTERED, OR THE DESIRED STATUS OF THE CORRESPONDING CPU REGISTERS WHEN A "GO TO" COMMAND IS ISSUED. IF NO BREAKPOINT HAS BEEN ENCOUNTERED (AND THE VIRTUAL REGISTERS HAVE NOT BEEN PREVIOUSLY SET BY THE OPERATOR) THEN THE DATA DISPLAYED SHOULD BE IGNORED AS IT WILL REPRESENT RANDOM DATA THAT IS CREATED WHEN THE COMPUTER SYSTEM IS INITIALLY POWERED UP.

THE CONTENTS OF THE "VIRTUAL" CPU REGISTERS ARE UPDATED IN TWO SECTIONS. THE "A," "B" AND "C" REGISTERS, PLUS THE "F" (FLAG STATUS) ARE UPDATED WHENEVER A TYPE "1" BREAKPOINT (TO BE EXPLAINED LATER) IS ENCOUNTERED DURING PROGRAM OPERATION. THE "D," "E," "H" AND "L" REGISTERS PLUS THE "F" REGISTER ARE UPDATED WHENEVER A TYPE "2" BREAKPOINT IS ENCOUNTERED. SIMILARLY, THE CONTENTS OF THE "A," "B" AND "C" REGISTERS (BUT NOT THE FLAGS) BECOME THE ACTUAL VALUES IN THE CPU REGISTERS WHEN A TYPE "1" "GO TO" COMMAND IS EXECUTED. THE "D," "E," "H" AND "L" VIRTUAL VALUES BECOME THE ACTUAL CPU REGISTER VALUES WHEN A TYPE "2" "GO TO" COMMAND IS ISSUED.

NATURALLY, THE ABILITY TO DETERMINE WHAT THE ACTUAL VALUES WERE IN THE CPU REGISTERS AT ANY GIVEN POINT IN A PROGRAM, OR TO SET THE CPU REGISTERS TO SPECIFIC VALUES BEFORE ENTERING ANY PARTICULAR ROUTINE, SERVES AS A TREMENDOUS AID WHILE TESTING AND DEBUGGING NEWLY DEVELOPED PROGRAMS. THE OPERATOR SHOULD NOTE, THOUGH, THAT NOT ALL OF THE REGISTERS CAN BE SAVED AT A SINGLE BREAKPOINT, NOR SET BY A SINGLE "GO TO" COMMAND. HOWEVER, BY JUDICIOUS USE OF THE APPROPRIATE TYPE "1" AND "2" BREAKPOINT AND "GO TO" COMMANDS, THE OPERATOR WILL HAVE SUFFICIENT CAPABILITY TO ANALYZE PRACTICALLY ANY PROGRAMMING SITUATION.

WHEN A PARTICULAR "X" COMMAND HAS BEEN EXECUTED BY DEPRESSING THE "CTRL/L" COMBINATION, THE OUTPUT DEVICE WILL PROVIDE THE FOLLOWING TYPE OF DISPLAY (REGISTER "A" IS ASSUMED IN THE EXAMPLE):

XA XXX:

SHOWING THE CONTENTS OF THE SELECTED VIRTUAL CPU REGISTER OR FLAG STATUS. FOR ALL BUT THE "XF" COMMAND, THE OPERATOR THEN HAS THE CHOICE OF MODIFYING OR NOT MODIFYING THE CONTENTS OF THE VIRTUAL REGISTER. IF IT IS NOT DESIRED TO MODIFY THE CONTENTS AS DISPLAYED, THE OPERATOR SIMPLY DEPRESSES THE SPACE BAR AND THE PROGRAM RETURNS TO THE MONITOR COMMAND MODE.

IF IT IS DESIRED TO MODIFY THE CONTENTS OF A VIRTUAL REGISTER, THE OPERATOR TYPES IN THE DESIRED OCTAL VALUE AND DEPRESSES THE SPACE BAR.

IF THE OPERATOR SHOULD TYPE IN A NEW OCTAL VALUE AND THEN DECIDE THAT IT IS NOT DESIRABLE TO CHANGE THE ORIGINAL VALUE, THE OPERATOR MAY STRIKE THE "CR" KEY TO RETURN TO THE MONITOR MODE, IN WHICH CASE THE ORIGINAL VALUE WILL REMAIN UNCHANGED.

THE "XF" COMMAND CAUSES THE STATUS OF THE CPU FLAGS (AS THEY WERE WHEN THE LAST BREAKPOINT WAS ENCOUNTERED) TO BE DISPLAYED ACCORDING TO THE FOLLOWING ARRANGEMENT.

THE OCTAL VALUE DISPLAYED ACTUALLY REPRESENTS EIGHT BITS OF INFORMATION WHICH ARE ARRANGED AS FOLLOWS:

B7 B6 B5 B4 B3 B2 B1 B0

THE FOUR FLAGS CONNECTED WITH THE CPU HAVE BEEN ASSIGNED TO THE FOLLOWING POSITIONS IN THE EIGHT BIT GROUP.

B7 = SIGN FLAG
B6 = PARITY FLAG
B3 = ZERO FLAG
B0 = CARRY FLAG

THE FLAG WAS SET IF THE CORRESPONDING BIT POSITION HAS A VALUE OF "1." SINCE THE FLAG STATUS IS DISPLAYED AS AN OCTAL VALUE, THE OPERATOR MUST INTERPRET THE OCTAL CODE DISPLAYED TO DETERMINE THE SETTING OF EACH CPU FLAG. FOR INSTANCE, IF THE VALUE "300" WAS DISPLAYED IT WOULD MEAN THE SIGN AND PARITY FLAGS WERE "SET" AND THE ZERO AND CARRY FLAGS WERE IN THE CLEARED CONDITION. THE VALUE "011" WOULD INDICATE THAT THE SIGN AND PARITY FLAGS WERE IN THE ZERO STATE (FALSE) WHILE THE ZERO AND CARRY FLAGS WERE TRUE (IN THE ONE CONDITION). THE VALUE "201" WOULD BE INTERPRETED TO INDICATE THAT THE SIGN AND CARRY FLAGS WERE SET WHILE THE PARITY AND ZERO FLAGS WERE NOT.

THE STATUS OF THE FLAGS, UNLIKE THE VIRTUAL CPU REGISTERS, CAN NOT BE SET BY THE OPERATOR USING AN "XF" COMMAND. THIS IS BECAUSE THERE ARE MANY COMBINATIONS OF FLAG STATES THAT CANNOT EXIST AT ONE TIME (SUCH AS THE SIGN AND ZERO FLAGS BOTH BEING TRUE). SCREENING OUT THE INVALID COMBINATIONS WOULD TAKE FAR MORE ROOM THAN DESIRABLE IN SUCH A COMPACT PROGRAM AS THE MEA PACKAGE RELATIVE TO THE GENERAL USEFULNESS OF HAVING SUCH CAPABILITY. HOWEVER, THE OPERATOR WHO OCCASSIONALLY DESIRES TO HAVE CERTAIN FLAG CONDITIONS EXIST IS REMINDED THAT IT IS QUITE EASY USING THE FACILITIES OF THE MONITOR, TO DEVELOP SMALL ROUTINES THAT WOULD PUT THE FLAGS INTO DESIRED STATES BEFORE JUMPING TO A PARTICULAR ROUTINE OR CALLING A SUBROUTINE. THE BOOLEAN LOGIC CLASS OF INSTRUCTIONS ARE A PARTICULARLY VALUABLE CLASS OF INSTRUCTIONS TO USE TO ACCOMPLISH FLAG SETTING.

THE MONITOR "BREAKPOINT" COMMANDS

THE MONITOR "BREAKPOINT" COMMANDS ARE INITIATED BY TYPING IN ONE OF THE FOLLOWING COMMANDS:

B1 PPP LLL (CTRL/L)
OR
B2 PPP LLL (CTRL/L)

WHERE "PPP LLL" DESIGNATES THE MEMORY ADDRESS AT WHICH THE BREAKPOINT IS TO BE INSERTED.

N O T I C E

IN CASES WHERE A BREAKPOINT IS TO BE INSERTED IN A MULTI-BYTE INSTRUCTION, SUCH AS "IMMEDIATE," "JUMP" OR "CALL" INSTRUCTIONS, THE ADDRESS INDICATED MUST BE THE ADDRESS OF THE FIRST BYTE IN THE INSTRUCTION!

AS MENTIONED EARLIER IN THE DISCUSSION OF THE "X" MONITOR COMMANDS, THE TWO TYPES OF BREAKPOINT INSTRUCTIONS, "B1" AND "B2," REFER TO THE OPTION OF HAVING THE STATUS OF THE "A," "B" AND "C" CPU REGISTERS (B1) OR THE "D," "E," "H" AND "L" CPU REGISTERS (B2) SAVED IN THE VIRTUAL CPU REGISTER LOCATIONS, ALONG WITH THE FLAG STATUS, AT THE TIME THE BREAKPOINT IS ENCOUNTERED. THUS, THE OPERATOR MAY INSERT A BREAKPOINT IN A PROGRAM BEING TESTED TO ASCERTAIN WHETHER PROGRAM OPERATION IS ACTUALLY REACHING A CERTAIN POINT, OR TO VALIDATE THE STATUS OF THE SELECTED CPU REGISTERS AT GIVEN POINTS WITHIN A PROGRAM UNDER DEVELOPMENT. WHEN THE PROGRAM BEING TESTED REACHES THE ADDRESS AT WHICH A BREAKPOINT HAS BEEN INSERTED, CONTROL WILL REVERT TO THE MEA MONITOR AND THE ORIGINAL INSTRUCTION IN THE PROGRAM WILL BE REPLACED BACK AT THE BREAKPOINT ADDRESS!

C A U T I O N

WHEN UTILIZING THE BREAKPOINT FACILITY THERE ARE SEVERAL CONSIDERATIONS THAT THE OPERATOR MUST KEEP IN MIND:

1. THE PROGRAM BEING TESTED MAY NEVER REACH THE SELECTED BREAKPOINT ADDRESS IN WHICH CASE THE OPERATOR MAY HAVE TO MANUALLY STOP THE PROGRAM AND RESTART THE MEA PACKAGE. IF THIS OCCURS, THE OPERATOR SHOULD USE THE "M" COMMAND TO REMOVE THE "BREAKPOINT" INSTRUCTION FROM THE LOCATION THAT IT WAS INSERTED (WHICH WILL APPEAR AS AN "075" CODE) AND RESTORE THE ORIGINAL INSTRUCTION CODE TO THE PROGRAM UNDER TEST. THE OPERATOR WOULD MOST LIKELY THEN CONTINUE TO "DEBUG" THE PROGRAM BY SELECTING A BREAKPOINT AT SOME OTHER LOCATION.
2. ONLY ONE BREAKPOINT SHOULD BE ESTABLISHED AT ANY ONE TIME. ATTEMPTING TO ESTABLISH MORE THAN ONE BREAKPOINT WILL RESULT IN THE FIRST BREAKPOINT ENCOUNTERED BEING RESTORED WITH THE INSTRUCTION CODE CONTAINED IN THE ORIGINAL PROGRAM AT THE LAST POINT AT WHICH A BREAKPOINT WAS ESTABLISHED. THIS MIGHT NOT BE APPROPRIATE.
3. A TYPE "1" BREAKPOINT SHOULD NOT BE CHANGED TO A TYPE "2" BREAKPOINT (OR VICE-VERSA) UNTIL THE BREAKPOINT HAS ACTUALLY BEEN ENCOUNTERED. ATTEMPTING TO DO SO WILL RESULT IN AN 075 CODE BEING INCORRECTLY RESTORED TO THE ORIGINAL BREAKPOINT.

IT SHOULD BE APPARENT, THAT IF ONE DESIRES TO EXAMINE ALL THE CPU REGISTERS AT A GIVEN POINT IN A PROGRAM'S OPERATION, ONE WILL NEED TO OPERATE THE PROGRAM TWICE - ONCE WITH A "B1" BREAKPOINT ESTABLISHED, AND ONCE WITH A "B2" BREAKPOINT ESTABLISHED AT THE SAME ADDRESS.

SINCE THE "VIRTUAL" CPU REGISTERS ARE ONLY UPDATED WHEN A BREAKPOINT IS REACHED (OR WHEN THE OPERATOR SPECIFICALLY SETS THEM UP) IT IS POSSI-

BLE TO REVIEW THE STATUS OF THE TWO GROUPS OF CPU REGISTERS AT SEVERAL DIFFERENT POINTS IN A PROGRAM. FOR INSTANCE, ONE COULD SET UP A "B1" TYPE BREAKPOINT AT LOCATION "A," HAVE THE BREAKPOINT ENCOUNTERED AND THE ASSOCIATED "A," "B" AND "C" CPU REGISTERS SAVED IN THE VIRTUAL LOCATIONS, THEN INSERT A TYPE "B2" BREAKPOINT AT LOCATION "B," HAVE IT ENCOUNTERED, AND THEN REVIEW THE STATUS OF THE CPU REGISTERS USING THE "X" TYPE COMMANDS. ONE COULD CONTINUE, SAY, TO INSERT AND ENCOUNTER MORE TYPE "B2" BREAKPOINTS WHILE STILL SAVING THE ORIGINAL "A," "B" AND "C" VALUES FOR REVIEW. (PARTICULARLY VALUABLE FOR THOSE THAT HAVE SHORT MEMORIES WHEN WORKING ON DEBUGGING A COMPLEX PROGRAM!)

THE MONITOR "GO TO" COMMANDS

THE MONITOR "GO TO" COMMANDS ARE INITIATED BY TYPING IN ONE OF THE FOLLOWING COMMANDS:

```
G1 PPP LLL (CTRL/L)
OR
G2 PPP LLL (CTRL/L)
```

WHERE "PPP LLL" REPRESENTS THE MEMORY ADDRESS AT WHICH PROGRAM OPERATION IS TO COMMENCE WITH THE "A," "B" AND "C" (G1) OR "D," "E," "H" AND "L" REGISTERS INITIALIZED TO THE VALUES RESIDING IN THE VIRTUAL CPU REGISTER STORAGE LOCATIONS. IN MANY CASES, WHERE THE OPERATOR DOES NOT CARE WHAT THE STATUS OF THE CPU REGISTERS ARE WHEN PROGRAM OPERATION BEGINS, THE SELECTION OF THE "G1" OR "G2" TYPE OF "GO TO" COMMAND IS PURELY ARBITRARY. HOWEVER, WHEN DESIRED, THE OPERATOR MAY SET UP EITHER GROUP OF CPU REGISTERS TO CONTAIN SPECIFIC VALUES (USING THE "X" MONITOR COMMANDS) PRIOR TO EXECUTING THE "GO TO" COMMAND. THOSE VALUES WILL BE PLACED IN THE CPU REGISTERS WHEN THE "GO TO" COMMAND IS EXECUTED AND THE PROGRAM WILL THEN JUMP TO COMMENCE PROGRAMMED OPERATION AT THE ADDRESS SPECIFIED IN THE "GO TO" COMMAND. (NOTE THAT SINCE A BREAKPOINT IS ENCOUNTERED AFTER A "GO TO" COMMAND HAS BEEN EXECUTED, SETTING UP THE DESIRED VALUES IN CPU REGISTERS FOR A "GO TO" COMMAND WILL NOT EFFECT THE BREAKPOINT PROCESS OF "SAVING" THE CONTENTS OF A GROUP OF CPU REGISTERS WHEN A BREAKPOINT IS ENCOUNTERED.)

THE MONITOR TAPE "READ" COMMAND

THE MONITOR TAPE READ COMMAND IS INITIATED BY TYPING IN THE FOLLOWING:

```
R **START TAPE UNIT** (CTRL/L)
```

THIS COMMAND SEQUENCE CAUSES THE TAPE UNIT TO READ IN A PROGRAM AND/OR DATA TO THE SYSTEM USING THE STANDARD SCELBI TAPE INTERFACE AND TAPE FORMAT. THIS FORMAT INCLUDES ADDRESSING INFORMATION ON THE TAPE SO THAT THE DATA IS AUTOMATICALLY LOADED INTO THE CORRECT ADDRESSES. (TAPES MAY BE PREPARED USING THE MONITOR TAPE WRITE FACILITY OR WITH THE MONITOR ASSEMBLER PROGRAM.) WHEN THE TAPE HAS BEEN READ IN CONTROL WILL RETURN TO THE MONITOR. IF A TAPE READ ERROR OCCURS, CONTROL WILL IMMEDIATELY RETURN TO THE MONITOR AND AN "I" WILL BE DISPLAYED. THIS COMMAND ESSENTIALLY CONSIST OF A "CALL" TO THE STANDARD SCELBI TAPE READ PROGRAM CONTAINED ON A PROM ON PAGE 77. USER'S SHOULD REFER TO APPROPRIATE DOCUMENTATION THAT IS SUPPLIED WITH SCELBI TAPE INTERFACES FOR DETAILS AS TO THE OPERATION OF THE INTERFACE AND THE STANDARD SCELBI TAPE READ PROGRAM.

THE MONITOR TAPE WRITE FACILITY

THE USER MAY WRITE A BLOCK OF DATA FROM MEMORY TO A TAPE UNIT VIA A SCLEBI TAPE INTERFACE BY PERFORMING THE FOLLOWING SEQUENCE OF OPERATIONS WITH THE MEA MONITOR:

USING THE "X" COMMANDS SET UP THE FOLLOWING "VIRTUAL" CPU REGISTERS TO CONTAIN THE INDICATED DATA.

1. REGISTER "H" TO THE STARTING PAGE ADDRESS OF THE BLOCK OF DATA THAT IS TO BE TRANSMITTED TO THE TAPE UNIT.
2. REGISTER "L" TO THE STARTING LOCATION ON THE PAGE.
3. REGISTER "D" TO THE ENDING PAGE ADDRESS OF THE BLOCK OF DATA.
4. REGISTER "E" TO THE ENDING LOCATION ON THE PAGE.

(NOTE: D & E MUST BE GREATER THAN H & L.)

EXECUTE THE FOLLOWING MONITOR COMMAND SEQUENCE:

```
G2 063 357 **START TAPE UNIT** (CTRL/L)
```

WHEN THE BLOCK OF DATA HAS BEEN WRITTEN TO THE TAPE UNIT CONTROL WILL RETURN TO THE MONITOR. (THE OPERATOR SHOULD THEN MANUALLY STOP THE TAPE MECHANISM.)

THE MONITOR TAPE READ AND WRITE FACILITIES ARE PRIMARILY INTENDED AS OPERATING AIDS FOR GENERAL PURPOSE APPLICATIONS. THERE ARE OTHER TAPE READ AND WRITE CAPABILITIES OF THE MEA PACKAGE ASSOCIATED WITH THE "EDITOR" AND "ASSEMBLER" PORTIONS THAT WILL BE DISCUSSED IN THOSE SECTIONS. THE USER MAY NOTE, THAT THE ABOVE GENERAL PURPOSE WRITE CAPABILITY CONSIST OF LITTLE MORE THAN SETTING UP THE APPROPRIATE CPU REGISTERS AND THEN USING THE STANDARD SCLEBI TAPE WRITE ROUTINE UNDER THE AUSPICES OF THE MONITOR FACILITY. AGAIN, USERS ARE REFERRED TO THE RELEVANT DOCUMENTATION SUPPLIED WITH THE SCLEBI TAPE INTERFACE FOR PERTINENT DETAILS OF THE TAPE WRITE OPERATION.

OPERATING THE MEA EDITOR

THE EDITOR PORTION OF THE MEA PACKAGE IS A "LINE FORMATTED" EDITOR PROGRAM. THAT IS, LINES OF TEXT MAY BE INSERTED INTO A MEMORY BUFFER AND MAY BE REFERENCED BY THE OPERATOR TO ENABLE CORRECTIONS, ADDITIONS OR DELETIONS TO BE MADE TO INFORMATION IN THE TEXT BUFFER. THE TEXT BUFFER IS SIMPLY AN AREA IN MEMORY THAT STARTS ON PAGE 10 AND CONSUMES AS MUCH MEMORY AS NECESSARY FOR THE INFORMATION TO BE STORED (OR UNTIL ALL AVAILABLE RAM MEMORY HAS BEEN UTILIZED).

AS EACH "LINE" OF INFORMATION IS ENTERED BY THE OPERATOR IT IS ASSIGNED A REFERENCE NUMBER THAT ALLOWS THE OPERATOR TO REFER TO THAT SPECIFIC LINE WHENEVER DESIRED. IN THIS EDITOR PROGRAM, LINE NUMBERS ARE ASSIGNED USING AN OCTAL NUMBERING SYSTEM. THE OCTAL NUMBERING SYSTEM USED CONSIST OF TWO GROUPS OF THREE OCTAL DIGITS WITH THE ALLOWABLE RANGE BEING FROM 000 001 TO THE LIMITS OF MEMORY. THE SYSTEM COULD BE CONSIDERED TO BE EXACTLY THE SAME FORMAT AS THAT USED WHEN ADDRESSING MEMORY LOCATIONS WHERE THE FIRST GROUP OF DIGITS REPRESENTS A HIGH AD-

DRESS AND THE SECOND GROUP A LOW ADDRESS EXCEPT THAT THE NUMBERS NOW REFER TO "LINES" IN THE TEXT BUFFER INSTEAD OF MEMORY LOCATIONS. NOTE THAT THE SECOND GROUP OF DIGITS IS LIMITED TO 377. THUS, LINE NUMBER 000 377 IN THIS FORMAT IS FOLLOWED BY LINE NUMBER 001 000. THE LINE NUMBERING FORMAT WAS CHOSEN TO CONSERVE MEMORY SPACE IN THE EDITOR CONTROL ROUTINES. WITH A LITTLE EXPERIENCE THE OPERATOR WILL FIND THE FORMAT QUITE COMFORTABLE TO WORK WITH - BUT AT FIRST THE OPERATOR WILL HAVE TO BECOME ACCUSTOMED TO THE NECESSITY FOR ENTERING ANY LINE NUMBER AS TWO GROUPS OF DIGITS. IT IS NOT NECESSARY TO ENTER LEADING ZEROS WHEN SPECIFYING A LINE NUMBER. THUS, LINE NUMBER ONE COULD BE ENTERED AS: 000 001 OR 0 1. (A SPACE MUST ALWAYS BE INSERTED BETWEEN THE LOW AND HIGH PARTS OF THE LINE NUMBER - AND - THE HIGH PORTION IS ALWAYS INSERTED AS THE FIRST GROUP OF DIGIT(S).

A SUMMARY OF THE TYPES OF COMMANDS AVAILABLE TO MANIPULATE INFORMATION IN THE TEXT BUFFER USING THE MEA EDITOR IS SHOWN NEXT. A DETAILED DISCUSSION OF EACH TYPE OF COMMAND WILL BE PRESENTED FOLLOWING THE SUMMARY.

- KILL (K) REMOVE ALL TEXT FROM THE TEXT BUFFER.
- APPEND (A) APPEND INFORMATION TO THE TEXT BUFFER.
- LIST (L) LIST INFORMATION IN THE TEXT BUFFER.
- DELETE (D) DELETE LINE(S) FROM THE TEXT BUFFER.
- INSERT (I) INSERT LINE(S) OF TEXT INTO THE TEXT BUFFER.
- CHANGE (C) CHANGE LINE(S) IN THE TEXT BUFFER.
- SEARCH (S) SEARCH A LINE FOR A SPECIFIC CHARACTER.
- READ TAPE (E) READ FROM MAG-TAPE INTO TEXT BUFFER.
- WRITE TAPE (W) WRITE FROM TEXT BUFFER TO MAG-TAPE.

THE EDITOR "KILL" (K) COMMAND

THE EDITOR KILL COMMAND IS EXECUTED BY ENTERING THE FOLLOWING SEQUENCE ON THE INPUT DEVICE:

K (CTRL/L)

THIS COMMAND EFFECTIVELY "CLEARS OUT" THE TEXT BUFFER BY RESETTING THE EDITOR'S POINTERS AND COUNTERS SO THAT THE TEXT BUFFER AREA IS READY TO ACCEPT COMPLETELY NEW INFORMATION. THE COMMAND SHOULD ALWAYS BE USED WHEN ONE IS FIRST STARTING TO ENTER INFORMATION INTO THE TEXT BUFFER FOLLOWING POWER TURN ON OF THE COMPUTER. THIS IS BECAUSE THE "KILL" COMMAND CONTAINS A SPECIAL ROUTINE THAT "SIZES UP" THE AMOUNT OF RAM MEMORY AVAILABLE IN THE SYSTEM AND SAVES THE VALUE IT DETERMINES SO THAT IT CAN NOTIFY THE OPERATOR IF AN ATTEMPT IS MADE TO ENTER MORE INFORMATION INTO THE TEXT BUFFER THAN CAN BE STORED IN THE AVAILABLE RAM MEMORY.

FOLLOWING EXECUTION OF THE KILL COMMAND THE PROGRAM RETURNS TO THE STANDARD MONITOR COMMAND MODE AND DISPLAYS THE ">" SIGN.

THE EDITOR "APPEND" (A) COMMAND

THE EDITOR APPEND COMMAND IS ISSUED BY ENTERING THE FOLLOWING SEQUENCE ON THE INPUT DEVICE:

A (CTRL/L)

THE "APPEND" COMMAND ALLOWS INFORMATION TO BE APPENDED (ADDED TO THE TEXT BUFFER) STARTING WITH THE NEXT AVAILABLE LINE NUMBER - THAT IS AT THE END OF ANY CURRENT INFORMATION IN THE TEXT BUFFER.

IF A TELETYPE I/O IS BEING USED, A "CR/LF" COMBINATION WILL BE ISSUED IMMEDIATELY FOLLOWING THE EXECUTION OF THE "APPEND" COMMAND AND THE OPERATOR MAY PROCEED TO TYPE IN LINES OF TEXT. WHEN THE TELETYPE I/O IS BEING USED, EACH LINE OF TEXT MAY BE UP TO 72 CHARACTERS IN LENGTH. A LINE OF TEXT WHEN IN THE "EDITOR MODE" (AS DISTINCT FROM WHEN IN THE MONITOR COMMAND MODE) IS TERMINATED BY DEPRESSING THE CARRIAGE RETURN KEY (NOT THE "CTRL/L" COMBINATION)! WHENEVER THE CARRIAGE RETURN KEY IS DEPRESSED IN THE EDITOR MODE A COMBINATION OF A CARRIAGE RETURN AND A LINE FEED WILL BE ISSUED TO THE TELETYPE. THE OPERATOR MAY THEN PROCEED TO ENTER ANOTHER LINE OF TEXT IMMEDIATELY FOLLOWING THE LINE JUST ENTERED WHEN IN THE APPEND MODE.

IF AN OSCILLOSCOPE DISPLAY IS BEING USED, THE OPERATOR WILL OBSERVE THAT THE CHARACTER "A" WILL REMAIN DISPLAYED ON THE FIRST LINE OF THE CRT SCREEN. INFORMATION TYPED IN TO BE APPENDED TO THE TEXT BUFFER WILL BE DISPLAYED ON THE SECOND LINE OF THE CRT. THIS TECHNIQUE IS USED FOR THE CRT DISPLAY SO THAT THE OPERATOR WILL BE REMINDED OF THE TYPE OF OPERATION BEING PERFORMED BY THE EDITOR PROGRAM. WHEN THE OSCILLOSCOPE DISPLAY SYSTEM IS BEING USED, THE OPERATOR SHOULD LIMIT THE NUMBER OF CHARACTERS IN A LINE OF TEXT TO A MAXIMUM OF TWENTY (DECIMAL). WHENEVER THE CARRIAGE RETURN IS DEPRESSED WITH A CRT SYSTEM, THE "TEXT LINE" (LINE TWO ON THE SCREEN) WILL BE ERASED AND THE OPERATOR MAY PROCEED TO ENTER THE NEXT LINE OF TEXT IF DESIRED.

WHEN AN OPERATOR IS PLACING TEXT INTO THE TEXT BUFFER, SUCH AS WHEN IN THE APPEND MODE, INFORMATION TYPED IN WILL BE PLACED IN THE TEXT BUFFER WHEN A CARRIAGE RETURN IS EXECUTED. PRIOR TO THAT TIME, THE OPERATOR MAY DESIRE TO MAKE CORRECTIONS TO THE CURRENT LINE OF TEXT. THERE ARE SEVERAL ERROR CORRECTING OPTIONS AVAILABLE TO THE USER.

STRIKING THE "RUB OUT" KEY ON THE KEYBOARD SERVES TO ERASE PREVIOUS CHARACTERS IN A LINE. ONE CHARACTER IMMEDIATELY TO THE LEFT EACH TIME THE "RUB OUT" KEY IS DEPRESSED. WHEN A TELETYPE IS BEING USED, A "\ " SIGN WILL BE PRINTED EACH TIME THE "RUB OUT" KEY IS DEPRESSED TO INDICATE AN ERASURE. WHEN THE CRT IS USED, THE CHARACTER(S) WILL BE ERASED FROM THE SCREEN AS THE "RUB OUT" KEY IS DEPRESSED.

IF THE OPERATOR DESIRES TO ERASE THE CURRENT LINE OF TEXT BEING ENTERED, THEN THE "CTRL/S" COMBINATION MAY BE USED. IF A TELETYPE IS BEING USED THE "CTRL/S" WILL RESULT IN A CARRIAGE RETURN/LINE FEED COMBINATION BEING ISSUED TO SIGNIFY THE ERASURE. IF A CRT SYSTEM IS IN USE THE "CTRL/S" WILL RESULT IN THE TEXT LINE BEING ERASED FROM THE DISPLAY.

IF THE OPERATOR SHOULD ATTEMPT TO ENTER A LINE THAT WOULD RESULT IN THE TEXT BUFFER BECOMING OVER-FILLED, THE LINE WILL NOT BE ACCEPTED WHEN THE CARRIAGE RETURN IS DEPRESSED AND THE STANDARD MONITOR ERROR INDICATOR ("B") WILL BE DISPLAYED. THE OPERATOR MAY THEN RETURN TO THE MONITOR MODE BY ISSUING A "CTRL/D" COMBINATION.

WHEN THE OPERATOR DESIRES TO TERMINATE APPENDING INFORMATION TO THE TEXT BUFFER, THE "CTRL/D" COMBINATION IS USED. THIS SHOULD NORMALLY BE DONE AFTER A CARRIAGE RETURN HAS BEEN ISSUED TO APPEND THE CURRENT LINE TO THE TEXT BUFFER. IF A "CTRL/D" IS ISSUED WHILE A LINE IS BEING ENTERED (BUT BEFORE A CARRIAGE RETURN WAS GIVEN) THE PROGRAM WILL RETURN TO THE MONITOR MODE BUT THE PARTIAL LINE WILL NOT BE APPENDED TO THE TEXT BUFFER. (OF COURSE, THIS IS ANOTHER WAY TO "ERASE" A LINE BEING ENTERED IF ONE DOES NOT DESIRE TO CONTINUE APPENDING TEXT AFTER THE ERASING OPERATION!)

THE EDITOR "LIST" (L) COMMAND

THE EDITOR "LIST" COMMAND MAY BE ISSUED IN SEVERAL FORMATS AS ILLUSTRATED NEXT.

L (CTRL/L)

L HHH LLL (CTRL/L)

L HHH LLL,MMM NNN (CTRL/L)

THE FIRST FORMAT IS USED WHEN A "LISTING" OF THE ENTIRE CONTENTS OF THE TEXT BUFFER IS DESIRED. IF A TELETYPE I/O IS BEING UTILIZED, THE COMMAND WILL RESULT IN THE ENTIRE CONTENTS OF THE INFORMATION IN THE TEXT BUFFER BEING PRINTED ON THE TELETYPE.

IF THE OSCILLOSCOPE DISPLAY IS BEING USED, THE FIRST LINE ON THE DISPLAY WILL SHOW THE "L" (LIST) COMMAND AND THE NEXT FOUR LINES WILL DISPLAY FOUR LINES OF INFORMATION IN THE TEXT BUFFER. THIS DATA WILL BE DISPLAYED UNTIL THE OPERATOR STRIKES THE KEYBOARD "SPACE" BAR. AT THAT TIME, LINE ONE OF THE DISPLAY WILL CONTINUE TO SHOW THE "L" COMMAND PLUS THE LINE NUMBER OF THE TOP LINE OF THE NEXT GROUP OF FOUR LINES BEING DISPLAYED. USING THIS MANNER, THE OPERATOR MAY CONTROL THE LISTING OF THE TEXT BUFFER ON THE CRT DISPLAY. IF, WHEN USING THE CRT (BUT NOT WHEN USING THE TELETYPE) AN OPERATOR DESIRES TO TERMINATE THE LISTING PROCESS BEFORE ACTUALLY REACHING THE END OF THE INFORMATION IN THE TEXT BUFFER, THE OPERATOR MAY SIMPLY DEPRESS THE CARRIAGE RETURN KEY INSTEAD OF THE SPACE BAR. DOING SO WILL IMMEDIATELY RETURN THE PROGRAM TO THE MONITOR COMMAND MODE. WHEN THE END OF THE INFORMATION IN THE TEXT BUFFER HAS BEEN REACHED, THE PROGRAM RETURNS TO THE MONITOR COMMAND MODE AT THE NEXT DEPRESSION OF THE SPACE BAR. (OR, WHEN THE TELETYPE PRINTER HAS FINISHED TYPING THE CONTENTS OF THE BUFFER.)

IF IT IS DESIRED TO SIMPLY LIST ONE LINE IN THE TEXT BUFFER, THE SECOND FORMAT SHOWN ABOVE IS UTILIZED. THAT IS, THE OPERATOR ENTERS THE "L" COMMAND PLUS THE OCTAL LINE NUMBER (IN THE FORMAT DESCRIBED EARLIER) INDICATING THE LINE THAT IT IS DESIRED TO HAVE DISPLAYED. UPON EXECUTION OF THIS COMMAND THE TELETYPE OR CRT WILL DISPLAY THE DESIRED LINE OF INFORMATION.

TO "LIST" A GROUP OF LINES, THE THIRD FORMAT SHOWN ABOVE IS UTILIZED. THAT IS, THE STARTING LINE NUMBER, AND ENDING LINE NUMBER OF THE LINES TO BE DISPLAYED IS ENTERED BY THE OPERATOR. THE DESIRED LINES WILL THEN BE DISPLAYED IN A MANNER SIMILAR TO THAT DESCRIBED FOR THE GENERAL "LIST" COMMAND DISCUSSED ABOVE.

NOTE: BE CAREFUL WHEN COUNTING LINES IN THE TEXT BUFFER TO USE OCTAL NOTATION, I.E., COUNTING 1, 2, ... 6, 7, 10, 11 ... 17, 20 ETC., AND NOT TO SLIP AND ATTEMPT TO USE DECIMAL NOTATION!

THE EDITOR "DELETE" (D) COMMAND

THE EDITOR "DELETE" COMMAND MAY BE GIVEN IN ONE OF TWO FORMS:

D HHH LLL (CTRL/L)

D HHH LLL,MMM NNN (CTRL/L)

THE FIRST FORM IS USED TO DELETE A SINGLE LINE IN THE TEXT BUFFER. THE SECOND FORM WILL DELETE A GROUP OF LINES FROM THE TEXT BUFFER.

WHEN THE DELETE COMMAND IS UTILIZED, THE EDITOR WILL AUTOMATICALLY ASSIGN NEW LINE NUMBERS TO ALL THE LINES AFTER THE DELETED LINE(S) SO THAT THE BUFFER IS EFFECTIVELY "SHORTENED" BY THE NUMBER OF LINES DELETED. THUS, IF LINE "N" IS DELETED, THE FORMER LINE "N+1" IS SHIFTED DOWN TO BECOME LINE "N" AND ALL HIGHER NUMBERED LINES ARE SIMILARLY SHIFTED DOWN IN THE TEXT BUFFER.

THE EDITOR "INSERT" (I) COMMAND

THE EDITOR "INSERT" COMMAND IS GIVEN IN THE FOLLOWING FORM.

I HHH LLL (CTRL/L)

THE "INSERT" COMMAND ALLOWS ONE TO INSERT LINE(S) OF TEXT IMMEDIATELY BEFORE THE LINE NUMBER SPECIFIED IN THE COMMAND. MORE THAN ONE LINE MAY BE INSERTED IF DESIRED.

IF A TELETYPE I/O IS IN USE, EXECUTION OF THE "INSERT" COMMAND WILL RESULT IN A CARRIAGE RETURN/LINE FEED BEING ISSUED. THE OPERATOR MAY THEN PROCEED TO INSERT LINE(S) OF TEXT USING THE SAME PROCEDURES AS WHEN APPENDING INFORMATION EXCEPT NOW ALL LINES WILL BE INSERTED IMMEDIATELY BEFORE THE SPECIFIED LINE NUMBER. THE OPERATOR MAY USE THE "ROB OUT," "CTRL/S" AND "CTRL/D" FUNCTIONS TO MAKE CORRECTIONS IF DESIRED. EACH LINE TO BE INSERTED IS TERMINATED BY A CARRIAGE RETURN. RETURN TO THE MONITOR COMMAND MODE IS ACCOMPLISHED BY THE "CTRL/D" COMBINATION.

AS EACH LINE OF TEXT IS INSERTED, THE EDITOR PROGRAM WILL AUTOMATICALLY ASSIGN NEW LINE NUMBERS TO ALL THE REMAINING LINES IN THE TEXT BUFFER. THUS, IF A LINE IS INSERTED IN FRONT OF LINE "N," THE NEW LINE BECOMES LINE NUMBER "N" AND THE FORMER LINE "N" BECOMES LINE "N+1" ETC.

WHEN THE OSCILLOSCOPE DISPLAY SYSTEM IS BEING USED, THE OPERATOR WILL NOTE THAT THE "I" COMMAND ALONG WITH THE SPECIFIED LINE NUMBER WILL REMAIN DISPLAYED ON LINE ONE. LINE NUMBER TWO OF THE DISPLAY WILL SHOW THE NEW LINE BEING INSERTED. IF MORE THAN ONE LINE IS INSERTED AT A TIME, THE CRT WILL UPDATE THE LINE NUMBER AS EACH NEW LINE IS INSERTED.

THE EDITOR "CHANGE" (C) COMMAND

THE EDITOR "CHANGE" COMMAND MAY TAKE ONE OF TWO FORMS:

C HHH LLL (CTRL/L)

C HHH LLL,MMM NNN (CTRL/L)

THE FIRST FORM IS FOR THE CASE WHEN ONE SINGLE LINE IS TO BE ALTERED. THE "CHANGE" COMMAND ESSENTIALLY ERASES THE SPECIFIED LINE AND ALLOWS THE OPERATOR TO TYPE IN A NEW LINE IN IT'S PLACE. HOWEVER, THE COMMAND WILL ALSO ALLOW THE OPERATOR TO EFFECTIVELY INSERT ADDITIONAL LINES IF DESIRED IMMEDIATELY FOLLOWING THE LINE THAT IS CHANGED. THIS IS ACCOMPLISHED BY SIMPLY ENTERING ADDITIONAL LINES BEFORE RETURNING TO THE COMMAND MODE.

THE SECOND FORM ALLOWS A GROUP OF LINES TO BE CHANGED AT ONE TIME. THIS COMMAND EFFECTIVELY ERASES THE SPECIFIED LINES AND THEN ENABLES THE OPERATOR TO INSERT NEW LINES IN THEIR PLACES. THIS IS POINTED OUT BECAUSE OF THE OPERATOR SPECIFIES A "CHANGE" COMMAND FOR A GROUP OF THREE LINES AND THEN ONLY ENTERS TWO LINES, THE THIRD LINE WILL BE EFFECTIVELY ERASED FROM THE TEXT BUFFER.

INPUTTING NEW TEXT USING THE "CHANGE" COMMAND IS SIMILAR TO THAT DESCRIBED WHEN USING THE "INSERT" COMMAND FOR BOTH TELETYPE AND CRT I/O DEVICES.

THE EDITOR "SEARCH" (S) COMMAND

THE EDITOR "SEARCH" COMMAND IS INITIATED BY TYPING IN THE SEQUENCE:

S HHH LLL (CTPL/L)

THE "SEARCH" COMMAND ALLOWS THE OPERATOR TO "SEARCH" THE SPECIFIED LINE FOR A SPECIFIC CHARACTER. WHEN THAT CHARACTER IS "FOUND" THE OPERATOR MAY THEN PROCEED TO MAKE ALTERATIONS IN THE LINE.

WHEN THE COMMAND IS EXECUTED BY ISSUING THE "CTPL/L" COMBINATION, THE PROGRAM WILL WAIT FOR THE OPERATOR TO ENTER A "CHARACTER" FROM THE KEYBOARD. (NOTE: THE "SEARCH" CHARACTER WILL NOT BE DISPLAYED WHEN IT IS INITIALLY ENTERED!) THE PROGRAM WILL THEN PROCEED TO DISPLAY THE CONTENTS OF THE SPECIFIED LINE UNTIL THE "SEARCH CHARACTER" IS LOCATED. AT THAT POINT, THE OPERATOR HAS SEVERAL OPTIONS THAT WILL BE DESCRIBED SHORTLY. IF THE "SEARCH CHARACTER" IS NOT LOCATED ON THE SPECIFIED LINE, THE PROGRAM WILL RETURN TO THE MONITOR COMMAND MODE. (NOTE: IF A CRT IS IN USE THE "SEARCH" FOR A NON-EXISTANT CHARACTER WILL PROCEED SO RAPIDLY THAT THE OPERATOR WILL NOT SEE THE LINE BEING DISPLAYED AND THE PROGRAM WILL APPEAR TO INSTANTANEOUSLY RETURN TO THE MONITOR COMMAND MODE.)

IF THE "SEARCH CHARACTER" IS LOCATED IN THE SPECIFIED LINE, THE OPERATOR MAY ELECT TO MAKE MODIFICATIONS TO THE LINE USING THE STANDARD TECHNIQUES SUCH AS "RUB OUT" TO EPASE CHARACTERS IN THE LINE. THE OPERATOR MAY THEN PROCEED TO TYPE IN NEW DATA FOR THE REMAINING PORTION OF THE LINE - TERMINATING THE LINE WHERE DESIPED BY ENTERING A CARRIAGE RETURN. OR, THE OPERATOR MAY ELECT TO USE SEVERAL FEATURES AVAILABLE ONLY WHEN OPERATING IN THE EDITOR "SEARCH" MODE.

ONE SUCH FEATURE WHEN IN THE EDITOR "SEARCH" MODE IS THE ABILITY TO LEAVE THE REMAINDER OF THE ORIGINAL LINE ALONE AFTER MAKING CORRECTIONS WHEN THE "SEARCH CHARACTER" IS REACHED. TO ACCOMPLISH THIS, THE OPERATOR SIMPLY TYPES IN A COMBINATION "CTRL/U" FOLLOWED BY A CARRIAGE RETURN. THE PROGRAM WILL RETURN TO THE MONITOR COMMAND MODE. HOWEVER, THE REMAINDER OF THE ORIGINAL LINE WILL BE STORED IN THE TEXT BUFFER. THE RESULT OF THE OPERATION MAY BE CHECKED BY USING AN APPROPRIATE LINE LIST COMMAND.

THE SECOND FEATURE WHEN IN THE EDITOR "SEARCH" MODE IS THE ABILITY TO GO ON TO THE SECOND, OR THIRD, OR "N'TH" APPEARANCE OF THE "SEARCH CHARACTER" IN THE LINE BEING "SEARCHED." THIS IS ACCOMPLISHED BY FIRST DEPRESSING THE "CTRL/T" COMBINATION AND THEN THE "CTRL/L" COMBINATION. THE PROGRAM WILL THEN PROCEED TO DISPLAY THE INFORMATION UNTIL THE NEXT APPEARANCE OF THE "SEARCH CHARACTER." AT THAT POINT, THE OPERATOR AGAIN HAS THE OPTIONS DESCRIBED IN THIS SECTION.

THE EDITOR "TAPE READ" (E) COMMAND

THE EDITOR TAPE READ COMMAND IS INITIATED BY TYPING IN THE FOLLOWING:

E **START TAPE UNIT** (CTRL/L)

THIS COMMAND SEQUENCE CAUSES THE TAPE UNIT TO READ IN INFORMATION TO THE TEXT BUFFER STORAGE AREA. (NOTE: TAPES READ IN USING THIS COMMAND SHOULD BE PREPARED USING THE EDITOR TAPE WRITE (W) COMMAND DESCRIBED IN THE NEXT SECTION.) WHEN THE TAPE HAS BEEN READ IN CONTROL WILL RETURN TO THE MONITOR. IF A TAPE READ ERROR OCCURS, CONTROL WILL IMMEDIATELY RETURN TO THE MONITOR AND AN "I" WILL BE DISPLAYED.

NOTE: THE EDITOR TAPE READ COMMAND (E) MUST BE USED WHEN READING IN TAPES PREPARED BY USING THE EDITOR TAPE WRITE (W) COMMAND (AND NOT THE MONITOR TAPE READ (R) COMMAND!!) AS THE EDITOR TAPE READ ROUTINE SETS UP A SPECIAL GROUP OF EDITOR POINTERS AND COUNTERS AFTER THE TEXT HAS BEEN LOADED INTO THE BUFFER AREA.

ADDITIONALLY, IT SHOULD BE NOTED THAT THE INFORMATION LOADED INTO THE TEXT BUFFER FROM THE MAGNETIC TAPE INTERFACE WILL BE PLACED STARTING AT THE BEGINNING OF THE BUFFER. DATA MAY NOT BE "APPENDED" TO THE BUFFER VIA THE TAPE UNIT.

THE EDITOR "TAPE WRITE" (W) COMMAND

THE EDITOR TAPE WRITE COMMAND IS INITIATED BY TYPING IN THE FOLLOWING:

W **START TAPE UNIT** (CTRL/L)

THE EDITOR TAPE WRITE COMMAND WILL CAUSE THE CONTENTS OF THE TEXT BUFFER TO BE TRANSMITTED TO THE MAGNETIC TAPE UNIT. ADDITIONALLY, THE VALUES OF SEVERAL POINTERS AND COUNTERS USED BY THE EDITOR PROGRAM ARE SENT TO THE TAPE. THIS INFORMATION IS THEN USED WHEN THE TAPE IS READ BACK IN TO INITIALIZE THE EDITOR MANIPULATING ROUTINES TO CORRESPOND WITH THE CONTENTS OF THE TEXT BUFFER. WHEN THE INFORMATION HAS BEEN SENT, CONTROL RETURNS TO THE MONITOR. (THE OPERATOR SHOULD THEN MANUALLY STOP THE TAPE RECORDING UNIT.) THE AMOUNT OF TIME REQUIRED TO WRITE THE CONTENTS OF THE TEXT BUFFER ON THE TAPE WILL BE DEPENDENT ON THE AMOUNT OF INFORMATION STORED IN THE TEXT BUFFER. AS A ROUGH RULE OF THUMB, THE TAPE UNIT REQUIRES ABOUT ONE MINUTE TO RECORD THE DATA IN 1,024 WORDS OF MEMORY.

NOTE: THE OPERATOR MAY ASCERTAIN THE AMOUNT OF MEMORY USED TO STORE TEXT IN THE TEXT BUFFER BY USING THE FOLLOWING MONITOR COMMAND TO EXAMINE THE "END OF BUFFER" POINTER FOR THE EDITOR PROGRAM:

DISPLAYING THE TWO LOCATIONS WILL YIELD THE VALUE OF THE LAST MEMORY LOCATION CURRENTLY IN USE IN THE EDITOR TEXT BUFFER. THE PAGE ADDRESS IS IN LOCATION 161 AND THE LOCATION ON THE PAGE IS IN LOCATION 160. SINCE THE TEXT BUFFER STARTS AT PAGE 10 LOCATION 000 ONE CAN READILY DETERMINE THE ACTUAL AMOUNT OF MEMORY USED BY SUBTRACTING THE STARTING ADDRESS OF THE TEXT BUFFER FROM THE ENDING VALUE OBTAINED BY EXAMINING THE CONTENTS OF LOCATIONS 160 AND 161 ON PAGE 00! (NOTE ACTUAL TEXT IN THE EDITOR TEXT BUFFER IS STORED STARTING AT LOCATION 004 ON PAGE 10 - THE FIRST FOUR LOCATIONS ARE USED FOR HOLDING INFORMATION USED BY THE EDITOR CONTROL PROGRAM. HOWEVER, SINCE THIS SPACE MUST ALWAYS BE AVAILABLE FOR SUCH PURPOSES, IT IS INCLUDED AS PART OF THE TEXT BUFFER STORAGE AREA.)

OPERATING THE MEA ASSEMBLER

THE ASSEMBLER PORTION OF THE MEA PACKAGE IS ESSENTIALLY A TWO PASS ASSEMBLER WITH AN OPTIONAL THIRD PASS FOR OBTAINING A LISTING OF AN ASSEMBLED PROGRAM. THE ASSEMBLER OPERATES DIRECTLY ON TEXT PLACED IN THE TEXT BUFFER BY THE EDITOR PORTION OF THE MEA PROGRAM. THE FIRST PASS OF THE ASSEMBLER IS USED TO CHECK FOR SYNTAX ERRORS AND BUILD UP THE USER DEFINED SYMBOL TABLE. THE SECOND PASS IS USED TO WRITE COMPLETELY ASSEMBLED OBJECT CODE DIRECTLY TO THE MAGNETIC TAPE UNIT. THIS TAPE MAY THEN BE READ BACK INTO MEMORY TO ALLOW OPERATION OF THE ASSEMBLED PROGRAM. THE FORMAT USED TO WRITE THE TAPE ALLOWS THE PREPARED TAPE TO BE AUTOMATICALLY READ BACK INTO THE MEMORY LOCATIONS WHERE THE PROGRAM HAS BEEN ASSEMBLED TO OPERATE IN. AN OPTIONAL THIRD PASS OF THE ASSEMBLER PROGRAM MAY BE USED TO OBTAIN A LISTING OF THE ASSEMBLED PROGRAM. THE LISTING PROVIDES A COMBINATION OF THE ORIGINAL SOURCE CODE ALONG WITH THE ASSEMBLED OBJECT CODE AND THE ADDRESSING INFORMATION FOR EACH BYTE OF ASSEMBLED CODE.

THE FACT THAT THE ASSEMBLER PROGRAM OPERATES DIRECTLY FROM INFORMATION STORED IN THE TEXT BUFFER ENABLES ONE TO DEVELOP PROGRAMS WITH CONSIDERABLE SPEED. FOR INSTANCE, IF SYNTAX ERRORS ARE DETECTED DURING PASS ONE OF THE ASSEMBLER PROGRAM, AN ERROR CODE ALONG WITH THE LINE NUMBER IN THE TEXT BUFFER THAT CONTAINS THE ERROR WILL BE DISPLAYED TO THE OPERATOR. THE OPERATOR MAY THEN IMMEDIATELY USE THE MEA EDITOR TO CORRECT THE ERROR AND PROCEED TO ATTEMPT TO RE-ASSEMBLE THE PROGRAM.

WHEN THERE ARE NO SYNTAX ERRORS IN THE SOURCE LISTING, AS INDICATED BY THE SUCCESSFUL COMPLETION OF PASS ONE OF THE ASSEMBLER, ONE THEN PROCEEDS TO HAVE THE ASSEMBLER WRITE THE ASSEMBLED PROGRAM (WHICH WILL CONSIST OF ADDRESSING INFORMATION AND THE OBJECT OR MACHINE LANGUAGE CODE) ONTO THE TAPE UNIT USING THE SECOND PASS FEATURE OF THE ASSEMBLER. ONE MAY THEN IMMEDIATELY USE THE MEA MONITOR TAPE READ FACILITY TO LOAD THE ASSEMBLED PROGRAM BACK INTO MEMORY (WHICH WILL AUTOMATICALLY LOAD IT INTO THE ADDRESSES IT WAS ASSEMBLED TO OPERATE IN). THEN, ONE MAY UTILIZE THE MONITOR FEATURES TO CHECK OUT AND IF NECESSARY "DEBUG" THE PROGRAM. BY JUDICIOUS USE OF AVAILABLE RAM MEMORY (SUCH AS USING LOCATIONS ABOVE THOSE UTILIZED BY THE TEXT BUFFER FOR THE SPECIFIC SOURCE LISTING BEING ASSEMBLED) ONE MAY ACTUALLY CHECK OUT A PROGRAM WITHOUT DISTURBING THE ORIGINAL SOURCE LISTING CONTAINED IN THE TEXT BUFFER. THEN, SHOULD PROGRAMMING LOGIC ERRORS BE DISCOVERED, ONE MAY INSTANTLY REVISE THE SOURCE LISTING AND THEN OBTAIN A NEW ASSEMBLY WITHOUT EVEN HAVING TO RELOAD THE SOURCE LISTING! (IN CASES WHERE THIS IS NOT POSSIBLE, ONE WOULD, OF COURSE, SAVE A COPY OF THE ORIGINAL SOURCE LISTING ON THE TAPE UNIT USING THE EDITOR TAPE WRITE (W) CAPABILITY DESCRIBED EARLIER. THEN, IF

CORRECTIONS TO THE SOURCE LISTING WERE REQUIRED, ONE WOULD READ THE ORIGINAL LISTING BACK INTO THE TEXT BUFFER USING THE EDITOR READ (E) FACILITY AND UPDATE THE SOURCE AS APPROPRIATE.)

ASSEMBLER SOURCE LISTING FORMAT

SINCE THE ASSEMBLER PROGRAM OPERATES ON INFORMATION IN THE TEXT BUFFER, THERE IS LITTLE MORE TO OPERATING THE ASSEMBLER THAN MAKING SURE THE SOURCE LISTING IS IN PROPER FORMAT. THE FOLLOWING DISCUSSION DESCRIBES THE FORMAT REQUIRED BY THE ASSEMBLER PROGRAM.

SOURCE FORMAT: THE ASSEMBLER ACCEPTS SOURCE STATEMENTS IN LINE FORMAT. EACH LINE IS CONSIDERED TO CONSIST OF VARIOUS CATEGORIES OF FIELDS WITH EACH FIELD BEING DELIMITED BY A SPACE, OR THE SPECIAL CHARACTERS: COMMA (AFTER AN ADDRESS DEFINING LABEL), OR A SLASH (/) SIGN (WHICH IS USED FOR INDICATING THE BEGINNING OF A "COMMENTS" FIELD).

LINES: IF AN OSCILLOSCOPE DISPLAY IS BEING USED FOR OUTPUT, LINES SHOULD BE LIMITED TO A MAXIMUM OF 20 (DECIMAL) CHARACTERS (IN KEEPING WITH THE DISPLAY CAPABILITY OF THE EDITOR PROGRAM). IF A TELETYPE I/O IS IN USE LINES MAY CONTAIN UP TO 50 CHARACTERS. A LINE IS TERMINATED BY A CARRIAGE RETURN. AS LINES ARE PROCESSED BY THE ASSEMBLER THEY ARE ASSIGNED "REFERENCE LINE NUMBERS" WHICH MAY BE REFERRED TO IN THE EVENT A "DIAGNOSTIC ERROR" OCCURS. LINES ARE NUMBERED USING THE SAME OCTAL NUMBER (TWO GROUPS OF THREE DIGITS) DESCRIBED FOR THE EDITOR PROGRAM. LINES MAY BE STARTED WITH ANY CHARACTER OTHER THAN A COMMA, CARRIAGE RETURN, LINE FEED, OR SPACE.

FIELDS: FIELDS IN A LINE ARE CLASSIFIED BY THEIR SERIAL POSITION WITHIN THE LINE, BY THE CONTENTS OF THE FIELD, AND BY THE CONTENTS OF PROCEEDING FIELDS. A FIELD MAY BE CLASSIFIED AS CONTAINING ONE OF THE FOLLOWING: A LABEL, A MNEMONIC, AN OPERAND, AN ADDRESS, A NAME, AN OCTAL NUMBER (AS AN INSTRUCTION, ADDRESS, OR DATA), OR COMMENTS. EXCEPT FOR MNEMONICS AND OCTAL NUMBERS A FIELD MAY VARY IN LENGTH. (ALL MNEMONICS CONTAIN EXACTLY 3 ALPHABETICAL CHARACTERS. ALL OCTAL NUMBERS MUST BE SPECIFIED AS 3 OCTAL DIGITS IN THE RANGE 000 TO 377.) LABELS AND NAMES MAY VARY IN LENGTH AS THE USER DESIRES. AN ADDITIONAL FIELD CLASSIFICATION IS USED TO DEFINE TWO SPECIAL FUNCTION PSEUDO-OPERATORS. PSEUDO-OPERATORS ARE MNEMONICS THAT ARE INTERPRETED BY THE ASSEMBLER PROGRAM AND DIRECT ITS OPERATION BUT ARE NOT PART OF THE COMPUTER'S STANDARD INSTRUCTION SET.

LABELS: ANY LINE OF SOURCE CODING MAY BE ASSIGNED ONE OR MORE LABEL(S). IF ONLY ONE LABEL IS ASSIGNED TO A LINE IT MUST BE IN THE FIRST FIELD (LEFT JUSTIFIED) OF THE LINE. IF MORE THAN ONE LABEL IS DESIRED ON THE SAME LINE, THE ADDITIONAL LABEL(S) MUST FOLLOW IMMEDIATELY AFTER THE FIRST. A LABEL MAY NOT BE ASSIGNED TO THE RIGHT OF ANY FIELD THAT DOES NOT ITSELF CONTAIN A LABEL. A LABEL MAY BE OF ANY LENGTH FOR PROGRAMMING CONVENIENCE BUT THE ASSEMBLER WILL TRUNCATE THE LABEL AFTER THE FIRST SIX CHARACTERS. (NOTE: LABELS CONSUME SYMBOL STORAGE SPACE IN DIRECT RELATIONSHIP TO THE NUMBER OF CHARACTERS IN THE SYMBOL. SHORTER LABELS THUS ALLOW MORE SYMBOLS TO BE STORED FOR A GIVEN ASSEMBLY OPERATION.) ALL LABELS MUST BE IMMEDIATELY TERMINATED BY THE COMMA (,) SIGN. IN ADDITION, LABELS MUST MEET THE FOLLOWING CONDITIONS:

THE FIRST CHARACTER MUST BE A LETTER OF THE ALPHABET.

THE LABEL MAY NOT CONTAIN CHARACTERS OTHER THAN LETTERS AND NUMBERS.

A NAME USED AS A LABEL MAY ONLY BE ASSIGNED AS A LABEL ONCE IN AN ASSEMBLY. (IT MAY THEN BE REFERENCED AS A "NAME" AS OFTEN AS DESIRED.)

MNEMONICS: ALL MNEMONICS SPECIFIED FOR THE SCELBI-8B MAY BE USED WITH THIS ASSEMBLER WITH THE EXCEPTION OF INPUT/OUTPUT MNEMONICS AND THE RESTART (RST) COMMANDS. (THOSE INSTRUCTIONS MUST BE GIVEN USING THEIR OCTAL CODES AS DESCRIBED SHORTLY.) MNEMONICS MUST CONSIST OF THREE ALPHABETICAL CHARACTERS AND ARE TERMINATED BY A SPACE. CERTAIN MNEMONICS REQUIRE OPERANDS AS DESCRIBED BELOW:

MNEMONICS FOR "IMMEDIATE" INSTRUCTIONS ARE EXPECTED TO BE FOLLOWED BY A TERM SPECIFYING THE CONTENTS OF THE "IMMEDIATE" BYTE. THIS TERM SHOULD BE GIVEN AS AN OCTAL NUMBER IN THE RANGE 000 TO 377. IF NO TERM IS SPECIFIED, OR THE "IMMEDIATE" PORTION OF THE MNEMONIC IS NOT A VALID OCTAL NUMBER, AN ERROR CONDITION WILL OCCUR.

CALL (CAL) OR JUMP (JMP) MNEMONICS AS WELL AS THE VARIOUS CATEGORIES OF CONDITIONAL CALL AND JUMP MNEMONICS SHOULD BE FOLLOWED BY TERM(S) TO INDICATE THE ADDRESS THE INSTRUCTION REFERS TO. THIS IS ACCOMPLISHED BY: 1.) GIVING THE ADDRESS AS TWO GROUPS OF OCTAL NUMBERS (LOW ORDER PORTION FOLLOWED BY PAGE PORTION - AS IT WOULD APPEAR IN MACHINE CODE) OR, 2.) USING A NAME WHICH APPEARS ELSEWHERE IN THE SOURCE CODING FOR THE ASSEMBLY AS A LABEL. WHEN THE NAME OF A LABEL IS GIVEN THE ASSEMBLER WILL INSERT THE ADDRESS OF THE LABEL THAT HAS THE SAME "NAME." IF AN ADDRESS DEFINING "NAME" OR ADDRESS DEFINING OCTAL NUMBERS ARE NOT INCLUDED WITH A JMP OR CAL MNEMONIC, AN ERROR CONDITION WILL OCCUR.

SEVERAL CLASSES OF INSTRUCTIONS WHICH HAVE MNEMONIC REPRESENTATIONS ARE NOT INTERPRETED BY THE MEA ASSEMBLER. THESE CLASSES, THE I/O COMMANDS AND THE RESTART COMMANDS MUST BE GIVEN AS OCTAL NUMBERS. A LISTING OF THE OCTAL NUMBERS FOR THESE INSTRUCTIONS IS PROVIDED FOR READY REFERENCE BELOW.

INSTRUCTION	OCTAL VALUE
INP 0	1 0 1
INP 1	1 0 3
INP 2	1 0 5
INP 3	1 0 7
INP 4	1 1 1
INP 5	1 1 3
OUT 10	1 2 1
OUT 11	1 2 3
OUT 12	1 2 5
OUT 13	1 2 7
OUT 14	1 3 1
OUT 15	1 3 3
OUT 16	1 3 5
OUT 17	1 3 7
RST 0	0 0 5
RST 1	0 1 5
RST 2	0 2 5
RST 3	0 3 5
RST 4	0 4 5
RST 5	0 5 5
RST 6	0 6 5
RST 7	0 7 5

AN OPERAND IS A FIELD THAT COMPLETES CERTAIN CLASSES OF MNEMONICS SUCH AS THE "IMMEDIATE" CLASS OF INSTRUCTIONS.

ADDRESSES ARE FIELDS THAT SPECIFY THE ADDRESS FOR THE CLASS OF INSTRUCTIONS THAT REQUIRE ADDRESS DESIGNATIONS - NOTABLY THE JUMP AND CALL INSTRUCTIONS. ADDRESSES MAY BE FILLED BY ONE FIELD NAMES, OR A TWO FIELD SERIES OF OCTAL DIGITS AS MENTIONED EARLIER.

OCTAL NUMBER FIELDS CONTAIN AN OCTAL NUMBER EXPRESSED AS THREE OCTAL DIGITS. THE OCTAL VALUES MUST BE IN THE RANGE OF 000 TO 377. OCTAL NUMBER FIELDS MAY BE USED TO FILL ALL THE PREVIOUSLY DEFINED TYPES OF FIELDS EXCEPT LABELS AND NAMES. HOWEVER, WHEN OCTAL NUMBERS ARE USED IN PLACE OF MNEMONICS, EACH INSTRUCTION, AND ADDITIONAL OPERANDS OR ADDRESSES SHOULD BE PLACED ON SEPARATE LINES. SOME EXAMPLES OF THE USE OF OCTAL NUMBERS IS GIVEN BELOW.

AN "IMMEDIATE" INSTRUCTION SUCH AS "LAI 246" COULD BE GIVEN TO THE ASSEMBLER USING THE MNEMONIC FORMAT:

LAI 246

BUT WHEN GIVEN USING PURE OCTAL NUMBERS THE FORMAT FOR THE ASSEMBLER WOULD BE:

006
246

SIMILARLY, A "JMP" (JUMP) INSTRUCTION COULD BE GIVEN IN MNEMONIC FORMAT AS:

JMP NEW

WHERE "NEW" IS USED ELSEWHERE IN THE SOURCE CODING AS A LABEL. OR A "JMP" INSTRUCTION COULD BE GIVEN IN THE FORM:

JMP 140 003

WHERE THE MNEMONIC IS FOLLOWED BY AN ACTUAL OCTAL ADDRESS. IF IT WAS DESIRED TO INSERT THE SAME INSTRUCTION USING PURE OCTAL NUMBERS FOR THE ASSEMBLER PROGRAM THE FORMAT WOULD BE:

104
140
003

COMMENT FIELDS ARE FIELDS THAT CONTAIN TEXT COMMENTS FOR THE PROGRAMMER'S CONVENIENCE. THESE FIELDS MUST BE PREFIXED BY A SLASH (/) SIGN AND BE THE LAST (OR ONLY) FIELD IN A LINE. WHEN THE ASSEMBLER ENCOUNTERS A SLASH (/) SIGN IT WILL IGNORE ALL THE REMAINING DATA ON THE LINE (FOR ASSEMBLY PURPOSES) UNTIL A CARRIAGE RETURN CHARACTER IS DETECTED.

A SPECIAL MNEMONIC WHICH IS NOT A PART OF THE STANDARD INSTRUCTION SET HAS BEEN INCLUDED IN THE ASSEMBLER. THIS MNEMONIC IS ENCODED AS "LMM." WHEN THE ASSEMBLER ENCOUNTERS THIS SPECIAL "LMM" MNEMONIC IT WILL ASSEMBLE IT AS A HALT INSTRUCTION USING THE OCTAL CODE 377. THIS FEATURE HAS BEEN ADDED AS A CONVENIENCE TO ALLOW TWO FORMS OF THE HALT INSTRUCTION TO BE READILY ASSEMBLED. THE "HLT" MNEMONIC ITSELF IS ASSEMBLED AS THE OCTAL CODE 000. IN THE SCALBI-8B, WHEN A PROGRAM ENCOUNTERS A HALT INSTRUCTION, THE MEMORY CONTENTS LAMPS WILL DISPLAY THE INSTRUCTION. IT IS OFTEN CONVENIENT TO USE THE 000 HALT CODE FOR "NORMAL"

PROGRAM HALTS (RESULTING IN ALL THE MEMORY CONTENTS LAMPS BEING "OFF"). FOR "ABNORMAL" OR "ERROR CONDITION" HALTS ONE MAY ELECT TO USE THE 377 HALT CODE SO THAT THE MEMORY CONTENTS LAMPS ARE ALL "ON." THE OPERATOR CAN THEN TELL AT A GLANCE WHAT TYPE OF HALT OCCURED SHOULD A PROGRAM STOP. HENCE, THE ADDITION OF THE SPECIAL "LMM" MNEMONIC IN THE ASSEMBLER. (NOTE - NATURALLY THE HALT CODES OR ANY OTHER INSTRUCTION MAY ALSO BE PLACED IN A PROGRAM USING THE ACTUAL MACHINE CODES IN THE FORM OF OCTAL NUMBERS AS MENTIONED ABOVE.)

ASSEMBLER FORMAT EXAMPLES

VALID LABELS: START, START1, START2, S1, A, B, C, A1, B2, C3,

INVALID LABELS: START; (SEMI-COLON IS AN INVALID TERMINATOR)
START (MISSING THE COMMA TERMINATOR)
2START, (LABEL MUST START WITH A LETTER)
ST ART, (LABEL CONTAINS AN ILLEGAL SPACE)

TYPICAL MNEMONICS: LAB LBA INH INL NDA LAM LMA

MNEMONIC WITH OPERAND: LAI 246

MNEMONICS WITH ADDRESSES: JMP 020 001

JMP START

CAL 200 010

CAL A1

VALID OCTAL NUMBERS: 001 021 321 377

INVALID OCTAL NUMBERS: 400 777 1A5

PSUEDO OPERATORS

THE MEA ASSEMBLER USES TWO SPECIAL "PSUEDO OPERATORS" TO IMPLEMENT THE ASSEMBLY PROCESS. THEY ARE THE "ORG" AND "END" PSUEDO OPERATORS.

THE "ORG" PSUEDO OPERATOR IS USED TO INFORM THE ASSEMBLER WHERE TO SET THE CURRENT LOCATION COUNTER (PSUEDO PROGRAM COUNTER) DURING THE ASSEMBLY PROCESS. THIS IS ACCOMPLISHED BY GIVING THE "ORG" PSUEDO OPERATOR FOLLOWED BY TWO CONSECUTIVE OCTAL NUMBER FIELDS SPECIFYING THE HIGH ORDER (PAGE) AND THEN LOW ORDER PORTION OF THE ADDRESS THAT THE ASSEMBLER IS TO USE FOR PRODUCING THE EFFECTIVE ADDRESSES IN THE OBJECT CODE. THE "ORG" PSUEDO OPERATOR MAY BE USED AS MANY TIMES AS DESIRED IN AN ASSEMBLY TO ALLOW LOCATING ROUTINES IN VARIOUS SECTIONS OF MEMORY.

EXAMPLE OF THE "ORG" PSUEDO OPERATOR: ORG 003 100

AN "ORG" PSUEDO OPERATOR SHOULD ALWAYS BE PLACED ON THE FIRST LINE IN A SOURCE LISTING. HOWEVER, IN THE EVENT THE SOURCE CODE DOES NOT START WITH AN "ORG" STATEMENT THE ASSEMBLER WILL ASSUME A DEFAULT "ORG" ADDRESS OF PAGE 00 LOCATION 000.

THE "END" PSUEDO OPERATOR MUST BE THE LAST STATEMENT IN THE SOURCE

CODE FOR AN ASSEMBLY. THIS PSEUDO OPERATOR INFORMS THE ASSEMBLER PROGRAM THAT THE CURRENT PASS HAS BEEN COMPLETED AND STOPS THE ASSEMBLY PROCESS.

NOTE: NEITHER THE WORD "ORG" OR "END" SHOULD EVER BE ASSIGNED AS A "LABEL" OR "NAME" IN THE SOURCE CODING.

ASSEMBLER OPERATION - PASS ONE

WHEN THE OPERATOR HAS ENTERED THE DESIRED SOURCE CODING FOR A PROGRAM TO BE ASSEMBLED, IN THE INDICATED FORMAT, INTO THE TEXT BUFFER BY USING THE EDITOR PORTION OF THE MEA PACKAGE, OPERATION OF THE ASSEMBLER PROGRAM IS SIMPLICITY ITSELF.

TO PERFORM THE FIRST PASS OF THE ASSEMBLER PROGRAM THE OPERATOR SIMPLY TYPES IN THE FOLLOWING COMMAND SEQUENCE:

```
PI **DEPRESS SPACE BAR** (CTRL/L)
```

THE ASSEMBLER PROGRAM WILL THEN PROCEED TO PERFORM THE FIRST PASS OPERATIONS - BUILDING UP THE USER DEFINED SYMBOL TABLE AND CHECKING FOR SYNTAX ERRORS. IF THE PASS IS SUCCESSFULLY COMPLETED (WITH NO SYNTAX ERRORS DETECTED) CONTROL WILL RETURN TO THE MONITOR WHEN THE PASS IS COMPLETED. THE AMOUNT OF TIME REQUIRED TO COMPLETE THE PASS WILL DEPEND ON THE LENGTH OF LINES, THE NUMBER OF LINES, AND THE AMOUNT OF SYMBOLS USED IN THE SOURCE LISTING. AS A ROUGH RULE OF THUMB, THE FIRST PASS WILL REQUIRE ABOUT ONE SECOND OF TIME FOR EACH 30 TO 40 LINES OF SOURCE CODING.

IF SYNTAX ERRORS ARE DETECTED DURING THE FIRST PASS, AN ERROR MESSAGE WILL BE DISPLAYED IN THE FOLLOWING FORMAT:

```
MMM NNN XXX
```

WHERE "MMM NNN" REFERS TO THE OCTAL LINE NUMBER FOUND TO BE IN ERROR AND "XXX" IS AN ERROR TYPE CODE NUMBER. THE FOLLOWING LIST GIVES THE ERROR CODE NUMBERS AND THE TYPE OF ERROR ASSOCIATED WITH EACH CODE NUMBER.

CODE NUMBER	TYPE OF ERROR
001	ILLEGAL USE OF LABEL TERMINATOR (,)
002	SYMBOL TABLE IS FULL
003	SAME LABEL NAME USED TWICE
004	INVALID OCTAL NUMBER
005	LINE CONTAINS AN EXTRA TERM
006	LINE IS MISSING A TERM
007	INVALID LABEL USED

SHOULD A SYNTAX ERROR MESSAGE BE DISPLAYED, THE OPERATOR MAY IMMEDIATELY USE THE EDITOR PORTION OF THE MEA TO EXAMINE THE LINE IN ERROR AND MAKE NECESSARY CORRECTIONS. (THE "CTRL/D" COMMAND MAY BE USED TO RETURN TO THE MONITOR COMMAND MODE AFTER A SYNTAX ERROR MESSAGE HAS BEEN DISPLAYED.) THE OPERATOR WOULD THEN PERFORM THE PASS ONE OPERATION AGAIN TO CHECK FOR PROPER ASSEMBLY OF THE CORRECTED SOURCE LISTING.

ASSEMBLER OPERATION - PASS TWO

WHEN PASS ONE HAS BEEN SUCCESSFULLY COMPLETED WITH NO SYNTAX ERRORS THE OPERATOR MAY IMMEDIATELY PROCEED TO DIRECT THE MEA ASSEMBLER PROGRAM TO PERFORM PASS TWO. DURING PASS TWO THE ASSEMBLED OBJECT CODE IS WRITTEN OUT TO THE MAGNETIC TAPE UNIT. PASS TWO IS INITIATED BY PERFORMING THE FOLLOWING SEQUENCE:

P2 **START TAPE UNIT** (CTRL/L)

THE TAPE WRITING PROCESS WILL TAKE APPROXIMATELY TWICE AS LONG AS THAT REQUIRED FOR PASS ONE. WHEN THE PASS IS COMPLETED CONTROL WILL RETURN TO THE MONITOR. THE OPERATOR SHOULD THEN STOP THE TAPE UNIT.

THE ASSEMBLED OBJECT CODE RESIDING ON THE MAGNETIC TAPE MAY THEN BE LOADED BACK INTO IT'S OPERATING AREA IN MEMORY USING THE MONITOR TAPE READ (R) FACILITY. IT'S OPERATION MAY THEN BE CHECKED OUT USING THE MONITOR FEATURES OF THE MEA PACKAGE.

ASSEMBLER OPERATION - PASS THREE

AN OPTIONAL THIRD PASS OF THE ASSEMBLER MAY BE UTILIZED TO OBTAIN A COMBINED LISTING OF THE ORIGINAL SOURCE CODE ALONG WITH THE OBJECT CODE AND ADDRESSING INFORMATION FOR THE ASSEMBLED PROGRAM. PASS THREE OF THE ASSEMBLER PROGRAM IS INITIATED BY TYPING IN THE FOLLOWING:

P3 (CTRL/L)

IF A TELETYPE DEVICE IS BEING USED FOR I/O, THE THIRD PASS LISTING WILL APPEAR ON THE PRINTER AS ILLUSTRATED FOR AN EXAMPLE PROGRAM SHOWN BELOW.

```
000 000          ORG 020 000
020 000 056 024  LHI 024
020 002 066 200  LLI 200
020 004 307      LAM
020 005 104 010 020 JMP NEXT
020 010 000      HLT
020 011          END
```

WHEN THE LISTING IS COMPLETED, CONTROL WILL RETURN TO THE MONITOR.

IF AN OSCILLOSCOPE DISPLAY DEVICE IS BEING USED, THE THIRD PASS LISTING WILL APPEAR IN THE FOLLOWING MANNER. WHEN THE THIRD PASS COMMAND IS INITIALLY ISSUED, THE CRT SCREEN WILL GO BLANK. THE OPERATOR MUST THEN DEPRESS THE "SPACE BAR." DOING SO WILL RESULT IN THE FIRST LINE ON THE DISPLAY SHOWING THE ORIGINAL SOURCE LISTING FOR A LINE AND THE SECOND LINE OF THE DISPLAY SHOWING THE ADDRESSING INFORMATION AND OBJECT CODE(S) PRODUCED BY THE ORIGINAL SOURCE LISTING. TO VIEW THE NEXT LINE OF SOURCE CODE AND IT'S ASSOCIATED OBJECT CODE, THE OPERATOR DEPRESSES THE SPACE BAR. THE FOLLOWING IS AN EXAMPLE OF HOW THE EXAMPLE PROGRAM ILLUSTRATED FOR THE TELETYPE I/O ABOVE WOULD APPEAR ON THE CRT DISPLAY. A ** IS USED TO DENOTE THE OPERATOR DEPRESSING THE SPACE BAR TO CAUSE THE NEXT PIECE OF DATA TO BE DISPLAYED.

```

      **
      ORG 020 000
      000 000
      **
      LHI 024
      020 000 056 024
      **
      LLI 200
      020 002 066 200
      **
      LAM
      020 004 307
      **
      JMP NEXT
      020 005 104 010 020
      **
      HLT
      020 010 000
      **
      >

```

WHEN THE CRT DISPLAY IS USED, CONTROL WILL RETURN TO THE MONITOR WHEN THE "END" PSEUDO OPERATOR IS ENCOUNTERED. (THE "END" STATEMENT WILL NOT APPEAR ON THE CRT DISPLAY.) IF THE OPERATOR SHOULD DECIDE TO TERMINATE THE LISTING WHEN THE CRT IS IN USE, DEPRESSING THE LETTER "E" WILL RETURN CONTROL TO THE MONITOR.

MEA SUMMARY

AS MENTIONED AT THE BEGINNING OF THIS MANUAL, THE BEST WAY TO LEARN ABOUT THE MEA PROGRAM PACKAGE IS TO SIT AT YOUR I/O CONSOLE AND OPERATE THE PROGRAM. IF YOU HAVEN'T BEEN TRYING THE VARIOUS COMMANDS AS YOU READ THROUGH THIS MANUAL YOU HAVE BEEN MISSING OUT ON SOME REAL FUN! TO MAKE YOUR INITIAL OPERATING OF THE MEA PACKAGE ESPECIALLY EASY, SEVERAL APPENDIXES ARE INCLUDED ON THE NEXT SEVERAL PAGES. APPENDIX "A" GIVES A SUMMARY OF THE VARIOUS MEA COMMANDS FOR QUICK REFERENCE. APPENDIX "B" LISTS THE VARIOUS MNEMONICS (ALONG WITH THEIR EQUIVALENT MACHINE CODES) THAT MAY BE USED IN THE SOURCE LISTING FOR PROGRAMS THAT ARE TO BE ASSEMBLED BY THE MEA ASSEMBLER PROGRAM.

APPENDIX A - MEA COMMAND SUMMARY

AN "I" MEANS COMMAND INPUT ERROR
USE "CTRL/D" TO RECOVER FROM ERROR CONDITION

MONITOR COMMANDS

M PPP LLL (CTRL/L)	MODIFY MEMORY (SPACE = NEXT, CR = EXIT)
F PPP LLL,HHH AAA (CTRL/L)	MEMORY DUMP
XA ... XL (CTRL/L)	EXAMINE/MODIFY VIRTUAL CPU REGISTERS
B1 PPP LLL (CTRL/L)	BREAKPOINT ONE (SAVES A, B, C & FLAGS)
B2 PPP LLL (CTRL/L)	BREAKPOINT TWO (SAVES D, E, H, L & FLAGS)
G1 PPP LLL (CTRL/L)	GO TO "1" (INITIALIZES A, B AND C)
G2 PPP LLL (CTRL/L)	GO TO "2" (INITIALIZES D, E, H AND L)
R *START TAPE UNIT* (CTRL/L)	READ MAGNETIC TAPE

MONITOR TAPE WRITE: SET UP H & L (VIRTUAL) TO STARTING ADDRESS. SET UP D & E TO ENDING ADDRESS. TYPE: G2 063 357 *START TAPE UNIT* (CTRL/L).

EDITOR COMMANDS

K (CTRL/L)	DELETE ALL TEXT FROM TEXT BUFFER
A "	APPEND TEXT TO END OF TEXT BUFFER
L "	LIST ENTIRE TEXT BUFFER
L HHH LLL (CTRL/L)	LIST LINE "HHH LLL" OF TEXT BUFFER
L HHH LLL,MMM NNN (CTRL/L)	LIST LINES "HHH LLL" THROUGH "MMM NNN"
D HHH LLL (CTRL/L)	DELETE LINE "HHH LLL" FROM TEXT BUFFER
D HHH LLL,MMM NNN (CTRL/L)	DELETE LINES "HHH LLL" THROUGH "MMM NNN"
I HHH LLL (CTRL/L)	INSERT LINE(S) BEFORE LINE "HHH LLL"
C HHH LLL (CTRL/L)	CHANGE LINE "HHH LLL" IN TEXT BUFFER
C HHH LLL,MMM NNN (CTRL/L)	CHANGE LINES "HHH LLL" THROUGH "MMM NNN"
S HHH LLL (CTRL/L)	SEARCH LINE "HHH LLL" FOR SEARCH CHARACTER
E *START TAPE UNIT* (CTRL/L)	READ EDITOR TAPE INTO TEXT BUFFER
W *START TAPE UNIT* (CTRL/L)	WRITE TEXT BUFFER TO TAPE IN EDITOR FORMAT

ASSEMBLER COMMANDS

P1 *SPACE* (CTRL/L)	PASS 1 - SYNTAX CHECK, BUILD SYMBOL TABLE
P2 *START TAPE* (CTRL/L)	PASS 2 - WRITE OBJECT CODE TO TAPE UNIT
P3 (CTRL/L)	PASS 3 - OPTIONAL ASSEMBLED LISTING

LAA	300	LMA	370	SBA	230	PET	0X7
LAB	301	LMB	371	SBB	231		
LAC	302	LMC	372	SBC	232		
LAD	303	LMD	373	SBD	233	RFC	003
LAE	304	LME	374	SBE	234	RFZ	013
LAH	305	LMH	375	SBH	235	RFS	023
LAL	306	LML	376	SBL	236	RFP	033
LAM	307			SBM	237	RTC	043
						RTZ	053
						RTS	063
						RTP	073
LBA	310	LAI	006 DDD	CPA	270		
LBB	311	LBI	016 DDD	CPB	271		
LBC	312	LCI	026 DDD	CPC	272		
LBD	313	LDI	036 DDD	CPD	273		
LBE	314	LEI	046 DDD	CPE	274	JMP	1X4 LLL HHH
LBH	315	LHI	056 DDD	CPH	275		
LBL	316	LLI	066 DDD	CPL	276	JFC	100 LLL HHH
LBM	317	LMI	076 DDD	CPM	277	JFZ	110 LLL HHH
						JFS	120 LLL HHH
						JFP	130 LLL HHH
LCA	320			NDA	240	JTC	140 LLL HHH
LCB	321	INB	010	NDB	241	JTZ	150 LLL HHH
LCC	322	INC	020	NDC	242	JTS	160 LLL HHH
LCD	323	IND	030	NDD	243	JTP	170 LLL HHH
LCE	324	INE	040	NDE	244		
LCH	325	INH	050	NDH	245		
LCL	326	INL	060	NDL	246		
LCM	327			NDM	247	CAL	1X6 LLL HHH
LDA	330			ORA	260	CFC	102 LLL HHH
LDB	331	DCB	011	ORB	261	CFZ	112 LLL HHH
LDC	332	DCC	021	ORC	262	CFS	122 LLL HHH
LDD	333	DCD	031	ORD	263	CFP	132 LLL HHH
LDE	334	DCE	041	ORE	264	CTC	142 LLL HHH
LDH	335	DCH	051	ORH	265	CTZ	152 LLL HHH
LDL	336	DCL	061	ORL	266	CTS	162 LLL HHH
LDM	337			ORM	267	CTP	172 LLL HHH
LEA	340	ADA	200	XRA	250	RST	0 005
LEB	341	ADB	201	XRB	251	RST	1 015
LEC	342	ADC	202	XRC	252	RST	2 025
LED	343	ADD	203	XRD	253	RST	3 035
LEE	344	ADE	204	XRE	254	RST	4 045
LEH	345	ADH	205	XRH	255	RST	5 055
LEL	346	ADL	206	XRL	256	RST	6 065
LEM	347	ADM	207	XRM	257	RST	7 075
LHA	350	ACA	210	ADI	004 DDD		
LHB	351	ACB	211	ACI	014 DDD	INP	0 101
LHC	352	ACC	212	SUI	024 DDD	INP	1 103
LHD	353	ACD	213	SBI	034 DDD	INP	2 105
LHE	354	ACE	214	NDI	044 DDD	INP	3 107
LHH	355	ACH	215	XRI	054 DDD	INP	4 111
LHL	356	ACL	216	ORI	064 DDD	INP	5 113
LHM	357	ACM	217	CPI	074 DDD		
LLA	360	SUA	220	RLC	002	OUT	10 121
LLB	361	SUB	221	RRC	012	OUT	11 123
LLC	362	SUC	222	RAL	022	OUT	12 125
LLD	363	SUD	223	RAR	032	OUT	13 127
LLE	364	SUE	224			OUT	14 131
LLH	365	SUH	225	HLT	000	OUT	15 133
LLL	366	SUL	226	"	001	OUT	16 135
LLM	367	SUM	227	"	377	OUT	17 137