



BETA-8 ASSEMBLER

INTRODUCTION

The BETA-8 Assembler is an extended version of the BETA-4 Assembler, providing operator communication through the console teletype, alternate source input capability and additional features in the area of listing and object tape generation. BETA-8 requires a minimum of 8K words of memory.

ENVIRONMENT

BETA-8 resides in the lower 4K of memory, and will make use of all memory available, as required.

Hardware Required:

1. ALPHA LSI or ALPHA 16 with 8K words of read/write memory and TTY option.
2. ASR 33/35 Teletype or equivalent.

Software Required:

1. Binary Loader (BLD) or Autoload.

Additional Hardware Supported:

1. High speed paper tape reader.
2. High speed paper tape punch.
3. Card reader.
4. Line printer.
5. Open-reel Mag Tape or Digital Cassette (for intermediate storage, available upon request).



PROGRAM DESCRIPTION

The BETA-8 Assembler is an extended version of the BETA-4 Assembler. The extensions are as follows:

Operator Communications

The user exercises the miscellaneous I/O device assignments and other assembly options by responding to questions typed by BETA-8 on the ASR-33 Teletypewriter.

Source Input

BETA-8 supports punched card source input and TTY keyboard source input in addition to the devices supported by BETA-4.

Batch Assembly

BETA-8 has a "batch assembly" mode of operation. Source programs may be stacked in the card reader and assembled without operator intervention.

Library Format Object Output

BETA-8 has a "library" mode of operation to facilitate the creation of a library format object tape (see LAMBDA Object Loader for a description of library tapes and their use).

Error Chaining

The BETA-8 Assembler has the capability of chaining back errors flagged on the assembly listing. Chaining is done in reverse order beginning with the message output at the end of the assembly indicating the number of errors encountered. Each error flagged on the assembly listing will have associated with it the source line number of the preceding error encountered.

Title (TITL) Directive

The BETA-8 Assembler has extended capabilities associated with the TITL directive. A string of ASCII characters separated from the TITL directive mnemonic by a single space will be printed on the first line following the normal top-of-form action. There are no restrictions placed on the character string in the operand field. They are not necessarily surrounded by quotes (' ') and can be of unlimited length.



NOTE

A source record cannot exceed 72 characters in length.

Once a TITL directive has been encountered, the contents of the operand field will be printed on the first line of each page of the current assembly listing. If a new TITL directive is encountered, the contents of its operand field becomes the heading of all subsequent pages.

Symbol Table Printout

At the end of the assembly, BETA-8 will print on the listing device an alphabetized list of all symbols defined in the current assembly. Included with each symbol will be the hexadecimal value assigned to it by the assembler.

Optionally, the symbol may be preceded by a flag providing amplifying information. For example, an M indicates the symbol was multiply defined, and an X indicates the symbol is an external reference.

PROGRAM OPERATION

BETA-8 is loaded into memory using the Binary Loader (BLD) or Autoload (for a binary tape) or the LAMBDA Object Loader (for object tapes).

CAUTION

When the object tapes are loaded, by LAMBDA, it is imperative that the Source Input module (SI) be physically the last tape loaded.

The start address for BETA-8 is location :0100. When control is transferred to location :0100, BETA-8 will type "BETA" followed by a carriage return and line feed. The Assembler will then query the operator regarding assembly options. The general format of this communication is as follows:

SI=# LO=# BO=# SD=# P=#

where:

Assembler type-out is underlined

represents the response to be typed by the operator



If the response to any one of the queries (#) is the character 'blank' (space bar), the assembler will use the previously defined device number or the default value (see Appendix B). The next query will then be typed.

If the response to any one of the queries (#) is the character 'period' (.), the assembler will use the previously defined device number or the default value (see Appendix B) for this, and all subsequent queries and the assembly process will commence.

SI= Query

In response to the message "SI=" that BETA-8 types, the user may enter the device number assigned to the source input device he wants to use (see Appendix B). If the user wishes to do a "batch" assembly, he must precede the device number with the letter "B".

Examples:

SI = 4 read source input from the card reader

SI = B4 perform a batch assembly with source input from the card reader

A "batch" assembly is terminated whenever the Assembler reads a slash (/) in the first character position of the first source statement following an END statement.

The Assembler retains the source input device number from assembly to assembly. Consequently, the user need not enter a device number unless he wishes to change the previously selected device number. If he responds to "SI=" by entering a blank (space bar), the Assembler will use the previously defined device number. The "batch" assembly ("B" preceding a device number) is effective until the end-of-batch sentinel (/) is encountered. The Assembler initially defaults to a "non-batch" status.

Source input device zero has been assigned a special meaning; that is, it does not specify a source input device. When the user enters "0" in response to the message "SI=", the Assembler will punch an EOF (end-of-file) on the object tape (see BO= Query below).

LO= Query

In response to the message "LO=" that BETA-8 types, the user may enter the device number assigned to the list output device he wants to use (see Appendix B). If the user wishes to select the "Error Only" listing mode, he must precede the device number with the letter "X". LO=0 will be taken to mean suppress listed output.

**Examples:**

LO=3 List on Centronic line printer

LO=X1 Error only listing on Teletypewriter

The Assembler retains the list output device number from assembly to assembly. Consequently, the user need not enter a device number unless he wishes to change the previously selected device number. If he responds to "LO=" by entering a blank (space bar), the Assembler will use the previously defined device number.

The "error only" option ("X" preceding a device number) is only effective for the current assembly. The Assembler initializes each assembly to a "normal" list status.

BO= Query

In response to the message "BO=" that BETA-8 types, the user may enter the device number assigned to the object output device he wants to use (see Appendix B). If the user wishes to select the "library" mode of assembly, he must precede the device number with the letter "L". BO=0 will be taken to mean suppress object output.

Examples:

BO=1 Punch object output on TTY punch

BO=L3 Punch object output on high speed punch. Do not punch EOF (end-of-file) at the end of assembly (library tape being punched).

The Assembler retains the object output device number from assembly to assembly. Consequently, the user need not enter a device number unless he wishes to change the previously selected device number. If he responds to "BO=" by entering a blank (space bar), the Assembler will use the previously defined device number.

The "library" tape option ("L" preceding a device number) is only effective for the current assembly (or until the end-of-batch sentinel is found if doing a "batch" assembly).

Since "library" tapes are defined as a series of object programs without intervening EOF codes, a means has been provided to punch an EOF (end-of-file) at the end of a "library" tape (see SI Query above). The EOF is required to flag, for the Object Loader, the physical end of a "library" object tape. Refer to the programming documentation of the LAMBDA Object Loader for additional information about "library" object tapes.



SD= Query

In response to the message "SD=" that BETA-8 types, the user may enter the device number assigned to the source save device he wants to use (see Appendix B). SD=0 will be taken to mean suppress source save.

The Assembler retains the "save device" response from assembly to assembly. Consequently, the user need not enter a numeric response unless he wishes to change a previously selected option. If he responds by entering a blank (space bar), the Assembler will use the previously set option.

P#= Query

This option allows the user to repeat pass 2 of an assembly. If the user responds to the message "P#=" by entering a 2, pass 2 of the previous assembly will be repeated. Any other response (including blank) will result in the Assembler initializing for pass 1 of a new assembly.

The assembly process commences as soon as the user responds to the message "P#=".

Error Detection

If the user responds to a message by typing an invalid character, the message will be output again. If the user responds by typing a back arrow (←), the entire message sequence will be repeated starting with "SI=".



Appendix A

BETA-8 OPERATION SUMMARY

The procedure to assemble programs using the BETA-8 Assembler is as follows:

1. Load the BETA-8 Assembler into memory using the Binary Loader (BLD) or Autoload (for a binary tape) or the LAMBDA Object Loader (for object tapes).
2. Enter the BETA-8 Assembler at location :0100.
3. BETA-8 will respond by typing "BETA" in the teletypewriter and then requesting option selection, per Appendix B.



Appendix B

I/O DEVICE SELECTION

QUERY	RESPONSE	MEANING
SI=	0	Punch EOF
	1	TTY keyboard input
	2	TTY paper tape reader
	3	High speed paper tape reader
	*4	Card reader
	5-:9	Same as SI=4
	B#	Select batch assembly — Slash (/) in position one of a source record means end of batch assembly.
LO=	0	No source listing
	1	Teletypewriter
	2	Data Products line printer
	*3	Centronics line printer
	4 -:9	Same as LO=3
	X#	Error only listing
BO=	0	No object listing
	1	TTY punch
	2	Same as BO=1
	*3	High speed paper tape punch
	4 -:9	Same as BO=1
	L#	Select 'library' mode
SD=	0	Source not saved
	*1	Source saved in memory
	**2	Source saved on bulk device - Unit 0
	**3	Source saved on bulk device - Unit 1
	**4	Source saved on bulk device - Unit 2
	**5	Source saved on bulk device - Unit 3
6 -:9	Same as SD=1	
P#	2	Repeat Pass 2
	0, 1, 3 -:9	Start with Pass 1

*Preset or default values initially assumed by BETA.

**Versions of BETA-8 are available from CAI which allow intermediate storage of source on open-reel Mag Tape or Digital Cassette.





REQUEST FOR PROGRAMMING ACTION (RPA)

PROGRAM NAME ALPHA 16/LSI OMEGA Assembler	PROGRAM ID # 96007-40D1	ORIGINATOR	DATE 11-13-73	RPA # 71
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DESCRIPTION OF PROBLEM

The OMEGA Assembler defaults to source input from the card reader, listing on the Data Products line printer, and punching on the high speed punch. The previous OMEGA assemblers defaulted to all teletype I/O.

PROBLEM VERIFIED YES NO BY: _____
 COMMENTS DATE: 11-13-73

1. The user can connect to the teletype for all I/O using the 'C' command; i.e., CI2 ~~01~~ L1.
2. Optionally, the user can load OMEGA, make the patches, and dump OMEGA using BDP/VER (transfer address of OMEGA is :100).

TEMPORARY PATCH AVAILABLE YES NO

<u>LOCATION *</u>	<u>OLD CONTENTS</u>	<u>NEW CONTENTS</u>
:0018	:0002	:0001
:0019 (Input)	:0004	:0002
:001B (Output)	:0003	:0001

*Absolute

UPDATED PROGRAM RELEASE
 SCHEDULED DATE _____ NEW PROGRAM ID _____

APPROVED BY

M.S.





OMEGA

INTRODUCTION

OMEGA is an interactive assembly system combining the assembly features of the BETA-4 assembler with the editing capability of the Source Tape Preparation program (STP).

OMEGA allows the paper tape user to input a source program (from paper tape or the keyboard), edit the source program, assemble the program, reedit and re-assemble etc., without having to punch any intermediate paper tape. The source program is stored in memory and editing and assembly are performed using the memory resident source program. The size of the program to be assembled and/or edited is restricted only by the amount of memory available. OMEGA is supplied as an absolute binary tape and can be loaded into memory using either the Binary Loader (BLD) program or Autoload (if installed).

ENVIRONMENTHardware Required:

1. ALPHA LSI or ALPHA 16 with 8K read/write memory and TTY option.
2. ASR 33/35 Teletype.

Software Required:

1. Binary Loader (BLD) or Autoload

Additional Hardware Supported:

1. High speed paper tape reader
2. High speed paper tape punch
3. Card reader
4. Line printer



PROGRAM DESCRIPTION

Upon initial entry, OMEGA immediately types a carriage-return line-feed (CRLF), the name "OMEGA", and ">" to indicate to the operator that it is ready to accept a command. Command lines consist of a single letter command ID character followed by one or more parameters separated by a single space and terminated by a period (.). Upon inputting the command line terminator (.), OMEGA will perform a legality check on the parameters, execute the command, and output a CRLF and ">" to indicate that it is ready to accept another command. If an illegal parameter or command ID character is entered, OMEGA will type a left arrow (←), CRLF, and ">" and wait for a legal command. Command lines may be aborted by entering a left arrow (←).

In the example print-outs of the command descriptions, capital letters represent OMEGA command identification or modifier characters, small letters represent unsigned decimal parameters, the "@" symbol represents a single space, CRLF represents carriage-return line-feed. All OMEGA responses are underlined.

Control Commands

Initialize OMEGA

The I command initializes OMEGA by setting the ADD function terminator to period (.), and by resetting the tape (T), and buffer (B), line counts to zero and clearing the buffer. When OMEGA is first entered (entry point is :100) it automatically executes an initialize command. Subsequent reentries will not cause initialization.

```

>I.
>
Initialize tape and buffer line counts to zero, set ADD function terminator
to (.).

```

Clear Buffer

The B command clears the buffer and resets the buffer line count to zero (no lines in the buffer).

```

>B.
>
Clear the buffer.

```



Set Tape Line Count

The T command allows the user to set or reset the source tape line count. Lines on the source tape are numbered consecutively starting with line 1 corresponding to the BETA Assembly listing of the program. The OMEGA tape line count always refers to the line number of the last line read from the source tape and does NOT refer to the buffer line count, which may be different due to insertions or deletions. On entry OMEGA sets the tape line count to zero (no lines read).

>T.

>

Reset the source tape line count to zero.

>Tn.

>

Set the source tape line count to n (n lines read and ready to read line n+1).

Set End of Buffer

The E command enables the user to specify the address of the last buffer word so that he may protect the loaders or other required programs in upper memory. The end of buffer is initially determined by OMEGA. OMEGA determines the end of memory less 16 words for the mag tape, cassette or disk bootstraps. This command also initializes OMEGA (see I command).

>Eh.

>

Set the buffer limit to h (a hexadecimal address) and reinitialize OMEGA.

Connect Input/Output Devices

The C command specifies the devices which are to be used. OMEGA is initially set for teletype reader, teletype punch and teletype printer.

The specific device assignment numbers are listed below:

DEVICE SELECTION

Input: (I)

0 = Punch EOF on object output device

1 = Teletype Keyboard

2 = Teletype Paper Tape

3 = High Speed Paper Tape

4 = Card Reader

5 = Memory (assemble)

**Object: (O)**

- 0 = None
- 1 = Teletype Paper Tape
- 2 = N/A
- 3 = High Speed Paper Tape

List: (L)

- 0 = None
- 1 = Teletype
- 2 = Data Products Printer
- 3 = Centronics Printer

>CI3@L3@O0.

|
|
|

Input source from high speed reader, list on Centronics Printer, no object device.

>CI5.

|
|
|

Input from memory (assemble source from memory).

>CO1@L1.

|
|
|

Object on teletype punch, list on teletype printer.

Tape Commands

Tape commands control the input of lines from the source device to the buffer. Source lines are always placed in the buffer following the last line, that is they are added to the current contents of the buffer. When reading source tape OMEGA edits out rub-outs (all channels punched), nulls (no channels punched), and superfluous carriage-returns and line-feeds. Extra blanks between the label, op code and address/comments fields are removed to minimize buffer storage requirements and source tape length. If the end of tape (up arrow (↑) or a slash (/)) in column one is reached, or the buffer becomes filled, the tape command is terminated. An appropriate message and the line number of the last line entered into the buffer is printed on the teletype. If more than 80 characters appear in a single source, an error message will be printed followed by a CRLF and ">".



Read Tape

The R command reads from the source device up to a specified line and adds them to the buffer. The R command is normally used just before an ADD command to insert lines. The last line read (and placed in the buffer), is printed on the teletype to enable verification of the line count.

>Rn.

(source line n printed here)

≥

Read source lines to line n and add them to the buffer.

Skip Tape

The S command adds source lines to the buffer and then skips one or more source lines, effectively deleting them. The S command is used to delete source lines or, if used just before an ADD command, to correct error lines. The first and last lines skipped are listed to enable verification of the lines deleted from the tape.

>Sn.

(source line n listed here)

≥

Read source lines to line n-1, add them to the buffer, and skip (read but do not input), line n.

>Sn@m.

(source line n listed here)

(source line m listed here)

Read source lines to line n-1, add them to buffer, skip lines n through m. Next source line to be read is m+1.

Buffer Commands

Buffer commands allow the operator to insert, delete or list the lines in the buffer. The lines in the buffer are implicitly numbered starting with line one. As lines are inserted or deleted the lines are renumbered, hence it must be remembered that buffer commands refer to buffer line numbers and NOT source line numbers. As a convenience to the operator the letter "F" when supplied as a parameter, is used to denote the final (last) line in the buffer.



Add Buffer Lines from the Keyboard

The A command is used to add or insert lines into the buffer from the teletype keyboard. Upon accepting an ADD command, OMEGA enters the keyboard insertion mode. In this mode, lines typed on the keyboard are added to the buffer following a specified line. If an error is made in typing one or more characters, they may be deleted by typing a left arrow (←) for each character to be deleted. An entire line may be deleted by typing a left arrow followed by a carriage-return line-feed (← CRLF). When all source lines have been entered, the command mode is resumed by typing a terminator character (default is period) in column one. If the addition of another source line would cause the buffer to overflow, an appropriate message is printed together with the line number of the last tape line read and the command mode is entered.

>AF.
(source lines are typed in by the operator)

·
>
 Add the following lines to the buffer until the command mode is resumed.

>An.
(source lines are typed in by the operator)

·
>
 Insert the following lines in the buffer between buffer lines n and n+1.
 (If n=0 lines are inserted at the beginning of the buffer.)

ADD Function Terminator

The ADD function is normally terminated by typing a period (.) in column one of a source record. Since BETA Assemblers recognize a period in column one of a source record as a top-of-form command, the user is unable to enter a top-of-form command source record. The Q function alleviates this problem by allowing the user to specify which ASCII character is to be used as the ADD function terminator. Once a character has been entered as the ADD function terminator, it will be recognized as such until OMEGA is reinitialized by either of the I or E command or a new Q function is entered.

>Qn.
>
 Set the ADD function terminator to the ASCII character specified by n.



Delete Buffer Lines

The D command deletes lines from the buffer.

>DF.

>

Delete the final (last) line in the buffer.

>Dn.

>

Delete line n from the buffer.

>Dn@m.

>

Delete lines n through m from the buffer.

List Buffer Lines

The L command is used to list one or more lines in the buffer. Each line specified is listed together with its line number on a page. A page listing consists of 54 printed lines and 11 blank lines. The last page (or first page if only one page) is not formatted on the teletype.

>LF.

FFFF (the last buffer line is listed here)

>

List the final (last) line in the buffer.

>Ln.

n n n n (buffer line n is listed here)

>

List buffer line n.

>Ln@m.

(buffer lines n through m are listed here)

>

List buffer lines n through m.

>L1@F.

(the contents of the buffer are listed here)

>

List the contents of the buffer.



Assembly Command

The X command will cause an assembly.

>XE.

>

Assemble program from I device (see C command), list only errors on L device and output object to O device.

>XA.

>

Assemble program from I device (see C command), list on L device and output object to O device.

>XA2. or XE2.

>

Assemble program from pass 2 from I device (see C command), list on L device, and output object to O device.

>XLE. or XLA.

>

An end-of-file will not be output to the object output device (O device) at the end of the current assembly.

NOTE

The input device (see C command) must be set to 5 if assembling from memory. OMEGA must have been previously initialized (I command) if not assembling from memory.

PROGRAM OPERATION

Program Loading

OMEGA is loaded into lower memory with the Binary Loader (BLD) or Autoload. OMEGA resides in memory starting at location zero in order to utilize as much of available memory as possible for source line storage.

NOTE

The OMEGA system may be optionally ordered as a series of Object Tapes, allowing the user to write non-standard device drivers. In this situation, the OMEGA system must be loaded with LAMBDA; and the SI device must be loaded last.



Initialization

OMEGA is entered at location : 0100 at which time it will output "OMEGA" and " > ". The user then enters the appropriate commands, based upon the operations to be performed.

Source Tape Preparation

The procedure for preparing an initial source tape is:

1. INITIALIZE OMEGA (I command). This sets the tape and buffer line counts to zero and sets the ADD function terminator to period (.).
2. CONNECT (C command) the desired devices.
3. Enter an ADD(A) command through the keyboard.
4. Enter each source line followed by a carriage-return. When the program has been entered, enter a terminator (normally period) in column one.
5. To check the contents of the buffer (source line storage) enter a LIST command (L1@F).
6. If an error has been made DELETE the erroneous line (Dn.) and ADD the correct line (An-1.).
7. When the program (buffer) is correct PUNCH the source tape (PLT@F.).
8. To prepare another tape, repeat this procedure from step 1.

Source Tape Editing

The procedure for editing an existing source tape is:

1. INITIALIZE OMEGA (I command). This sets the tape and buffer line counts to zero and sets the ADD function terminator to period (.).
2. CONNECT (C command) the desired devices.
3. Use the READ (R) command to read correct lines from tape into the buffer.



4. Use the SKIP (S) command to skip over erroneous tape lines.
5. Use the ADD (A) command to enter corrections and insertions into the buffer.
6. If you want to check the contents of the buffer, enter a LIST command (Ll@F.).
7. If an error has been made DELETE the erroneous line from the buffer (Dn.) and ADD the corrected line (An-1).
8. When the buffer is correct PUNCH the source tape (PLT@1@F.).
9. To edit another tape, repeat this procedure from step 1.

Assembly

The procedure required to assemble source programs is:

1. CONNECT (C command) the desired devices.
2. If assembling from memory, proceed with step 5.
3. INITIALIZE (I command) OMEGA.
4. Load the source tape to be assembled in the selected reader and ready the device.
5. Select the assembly options required (X command). The assembly process will begin immediately.
6. If another assembly is desired, repeat this procedure from step 1.

NOTES

1. If L = 0 (C option) no listing is produced.
2. If O = 0 (C option) no object will be produced.
3. If the teletype prints 'FEED ME'
 - a. Reload the source tape into the selected reader and ready the device.
 - b. Press RUN.



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4. If the teletype prints 'PAUSE' (or computer halts) while reading a source tape, an up arrow (↑) in column one has been encountered.
 - a. Load the next source program segment into the selected reader and ready the device.
 - b. Press RUN.
5. If assembling from memory and there is no 'END' directive, the teletype will print:

NO 'END' DIRECTIVE ←
> (wait for operator input)

The operator must add the END directive to the program before restarting the assembly.

Alteration of OMEGA Variables

The ability to operate OMEGA under non-standard conditions is available through the modification of certain memory locations in lower base page. If it is desired to operate in this condition on a permanent basis, the modifications can be made and the assembler dumped on paper tape with the Binary Dump (BDP) program.

The options available, their absolute memory address and default values are listed below.

<u>Absolute Location</u>	<u>Value</u>	<u>Function</u>
: 0002	Variable	Highest memory location available to BETA Assembler; computed upon initial entry to BETA To alter this address (to preserve utilities, etc.) alter location : 0002 and NOP location : 0100.
: 0003	: 0002	Machine (MACH Directive) value; default is LSI instruction set.



<u>Absolute Location</u>	<u>Value</u>	<u>Function</u>
: 0004	: FFCB(-53)	Negative of maximum lines/page on listing device. Default allows 13 lines for top and bottom page formatting.
: 0005	: FFB0(-80)	Negative of maximum character/line in listing device.



APPENDIX A

OMEGA OPERATION SUMMARY

The procedure for loading and executing the OMEGA Interactive Assembly system is as follows:

1. Load OMEGA into memory using the Binary Loader (BLD) or Autoload.
2. Enter OMEGA at location : 0100.
3. OMEGA will respond by typing "OMEGA" and " > " on the teletypewriter. The program is now ready to accept its first command (see Appendix B).

NOTE

OMEGA may be restarted at any time by entering : 0100.



Appendix B

OMEGA COMMAND SUMMARY

<u>></u> AF.	Add keyboard lines to buffer after last line.
<u>></u> An.	Add keyboard lines to buffer after line n.
<u>></u> B.	Clear the buffer.
<u>></u> CInLnOn.	Connect devices.
<u>></u> CI0.	Punch EOF.
<u>></u> DF.	Delete the last buffer line.
<u>></u> Dn.	Delete buffer line n.
<u>></u> Dn@m.	Delete buffer lines n through m.
<u>></u> Eh.	Set end of buffer to h (hexadecimal) and initialize OMEGA.
<u>></u> I.	Initialize OMEGA.
<u>></u> LF.	List the last buffer line.
<u>></u> Ln.	List buffer line n.
<u>></u> Ln@m.	List buffer lines n through m.
<u>></u> PLT@1@F.	Punch the buffer with leader and trailer.
<u>></u> PLT@n@m.	Punch buffer lines n through m with leader.
<u>></u> P@n@m.	Punch buffer lines n through m.
<u>></u> PT@n@m.	Punch buffer lines n through m with trailer.
<u>></u> Rn.	Read source to line n and add to buffer.
<u>></u> Sn.	Read source to line n-1, add to buffer, and skip line n.
<u>></u> Sn@m.	Read source to line n-1, add to buffer and skip lines n through m.
<u>></u> T.	Reset tape line count to zero.
<u>></u> Tn.	Reset tape line count to n.
<u>></u> XA.	Assemble.
<u>></u> XE.	Assemble with ERROR only listing.
<u>></u> XA2. or XE2.	Assemble starting with Pass 2.
<u>></u> XLA. or XLE.	Suppress EOF for current assembly.





BOOTSTRAP (BOOT)

INTRODUCTION

The Bootstrap Loader is an 8-word program used to load the Binary Loader (BLD) into memory. The Binary Loader may then be used to load the Object Loader (LAMBDA) or binary programs. Bootstrap and BLD are usually resident in memory, but may occasionally require restoration.

ENVIRONMENT

Hardware Required:

1. ALPHA LSI Computer
2. ASR 33/35 Teletype or High Speed Paper Tape Reader

PROGRAM OPERATION

The Bootstrap program is hand loaded into memory (nominally in the last eight words) using the Console Load and Console Verify Procedures. The program is then executed (Bootstrap Procedure) to load the Binary Loader (BLD) into memory through the Teletype or HSPT reader.



Console Load Procedure (Load the Bootstrap)

The procedure to store instructions (or data) into memory through the ALPHA LSI console is as follows:

1. Enable the Console by moving the Console Enable slide switch (located in the recess on the right side of the Console) to the enable position (up). The ENABLE indicator on the front panel will turn on.
2. If the STOP indicator is off, press the STOP switch to halt the computer. The indicator will turn on.
3. Press the RESET switch to clear the computer.
4. If the SENSE/DATA indicator is on, press the SENSE/DATA switch to enable the Console Data register. The indicator will turn off.
5. Enter into the Program Counter (P) register the starting memory location for instruction (or data) storage.
 - a. If the WRITE/READ indicator is off, press the WRITE/READ switch to enable register and memory alteration. The indicator will turn on.
 - b. Enter the starting memory location into the Console Data register via the hex keyboard.
 - c. Press the P switch to transfer the address to the P register.
6. Enter the instruction (or data) into memory:
 - a. Enter the word to be stored into the Console Data register via the hex keyboard.
 - b. Depress the Memory Select (M) switch to store into memory. The P register is automatically incremented each time the M switch is depressed.
7. Repeat step 6 for each successive word to be stored into memory.
8. To store instructions (or data) at a new memory location return to step 5.



Console Display Procedure (Display the Bootstrap)

The procedure for displaying the contents of memory on the ALPHA LSI Console is as follows:

1. Enable the Console by moving the Console Enable slide switch (located in the recess on the right side of the Console) to the enable position (up). The ENABLE indicator will turn on.
2. If the STOP indicator is off, press the STOP switch to halt the computer. The indicator will turn on.
3. Press the RESET switch to clear the computer.
4. If the SENSE/DATA indicator is on, press the SENSE/DATA switch to enable the Console Data register. The indicator will turn off.
5. Enter into the P register the starting memory location to be displayed:
 - a. If the WRITE/READ indicator is off, press the WRITE/READ switch to enable register alteration. The indicator will turn on.
 - b. Enter the starting memory location into the Console Data register via the hex keyboard.
 - c. Depress the P switch to transfer the address to the P register.
6. Display the contents of the memory location:
 - a. Press the WRITE/READ switch to enable memory readout. The indicator will turn off.
 - b. Press the M switch to display the contents of the memory location in the Console Data register. The P register is automatically incremented each time M is depressed.
7. Repeat step 6 to display successive locations of memory.
8. To display alternate areas of memory return to step 5.



Bootstrap Procedure

The procedure for bootstrapping the Binary Loader (BLD) program into memory from paper tape is as follows:

1. Load the appropriate Bootstrap program into the last 8 words of memory by using the Console Load Procedure.
2. Verify that the Bootstrap program was entered correctly by following the Console Display Procedure.
3. Depress the Console RESET to clear the computer.
4. Place the TTY power selection switch in the LINE position or place the High Speed Paper Tape Reader selection switch in the LOAD position.
5. Place the Binary Loader paper tape in the teletype paper tape reader with the 12th frame following the record mark (first rubout) directly over the read sensing pins. If the high speed reader is to be used, the 11th frame should be placed under the read station since the reader will advance one frame before reading.
6. Place the TTY paper tape reader selection switch in the START position or place the high speed paper tape reader selection switch in the RUN position.
7. Enter the starting address of the Bootstrap program into the P register (: 0FF8 for 4K, : 1FF8 for 8K, etc.)
 - a. If the WRITE/READ indicator is off, press the WRITE/READ switch to enable register alteration. The indicator will turn on.
 - b. Enter the address into the Console Data register via the hex keyboard.
 - c. Depress the P switch to transfer the address to the P register.
8. Enter the address at which the Binary Loader (BLD) is to be loaded into the Index (X) register:
 - a. If the WRITE/READ indicator is off, press the WRITE/READ switch to enable register alteration. The indicator will turn on.
 - b. Enter the address into the Console Data register via the hex keyboard.
 - c. Depress the X switch to transfer the address to the X register.



9. Press the STOP switch to enable RUN mode (the STOP indicator will turn off). This enables RUN mode, but does not cause the computer to enter RUN mode.
10. Depress the RESET switch to clear the computer.
11. Depress the RUN switch. The Binary Loader program will be read into memory and the computer will halt at location : 1000 (: 2000 for 8K, etc.). Paper tape does not stop when processor halts. To display the halt address (read P):
 - a. Press the STOP switch to disable RUN mode. The STOP indicator will turn on.
 - b. If the WRITE/READ indicator is on, press the WRITE/READ switch to enable register display. The indicator will turn off.
 - c. Depress the P switch to display the contents of the P register in the Console Data register.



Appendix A

BOOTSTRAP ROUTINES

* ALPHA - LSI BOOTSTRAP ROUTINES FOR
* PAPER TAPE
*

* BOOTSTRAP FOR ASR-33 TELETYPE
*

OFF8			ABS	: FF8	
OFF8	403B		SEL	7,3	START READER
OFF9	7939	TTY	RBA	7,1	READ 1ST BYTE
OFFA	1357		LLA	8	SHIFT LEFT
OFFB	7939		RBA	7,1	READ 2ND BYTE
OFFC	9C00		STA	@0	STORE WORD
OFFD	0128		IXR		BUMP STORE ADDRESS
OFFE	3145		JAN	TTY	LOOP IF NOT END OF TAPE
OFFF	0800		HLT		END OF TAPE HLT

* BOOTSTRAP FOR HIGH SPEED READER
*

OFF8			ABS	: FF8	
OFF8	4033		SEL	6,3	START READER
OFF9	7931	HSPT	RBA	6,1	READ 1ST BYTE
OFFA	1357		LLA	8	SHIFT LEFT
OFFB	7931		RBA	6,1	READ 2ND BYTE
OFFC	9C00		STA	@0	STORE WORD
OFFD	0128		IXR		BUMP STORE ADDRESS
OFFE	3145		JAN	HSPT	LOOP IF NOT END OF TAPE
OFFF	0800		HLT		END OF TAPE HALT
			END		