SOURCE TAPE PREPARATION (STP)

INTRODUCTION

STP is a conversational utility program which aids the user in preparing and/or editing symbolic source tapes for input to the BETA Assembler.

In the preparation mode, the operator enters source lines through the teletype keyboard. These lines are stored in the source buffer. Backspace, delete and insertion functions allow the operator to correct errors in typing. When the source program has been entered correctly it is punched and a clean listing is produced. In the edit mode the source tape to be corrected is placed in the paper tape reader, and editing commands are typed on the teletype keyboard. Correct source lines from the paper tape are read into the source buffer. Incorrect source lines are skipped, and corrections or insertions are entered through the teletype keyboard. The corrected program is then punched from the source buffer and a new listing is produced.

ENVIRONMENT

Hardware Required:

1. ALPHA LSI or ALPHA 16 with 4K 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.

PROGRAM DESCRIPTION

Upon initial entry, STP immediately types a carriage return, line feed (CRLF), 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 (.), STP 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, STP will type a left arrow (←), CRLF, and " > " and wait for a legal command. Command lines may be aborted by typing a left arrow (←—).

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

Control Commands

Initialize STP

The I command initializes STP by setting the ADD function termination character to period (.), resetting the tape (T) and buffer (B) line counts to zero and clearing the buffer. When STP is entered it automatically executes an initialize command. Subsequent re-entries will not cause initialization.

≥I.
≥
Initialize tape and buffer line counts to zero and set ADD function termination character to period (.).

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 STP 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 STP 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 programs in upper memory. The end of buffer is initially set to : 0FF7 to preserve the Bootstrap.

```
≥Eh.
≥
```
Set the buffer limit to h, a hexadecimal address.

Connect Input/Output Devices

The C command specifies the paper tape devices which are to be used to read and punch source tapes. STP is initially set for teletype reader and punch.

```
≥CRP.
≥
```
Connect high speed reader (R) and high speed punch (P)

```
≥CTT.
≥
```
Connect teletype reader (T) and teletype punch (T).

```
≥CRT.
≥
```
Connect high speed reader (R) and teletype punch (T).

```
≥CTP.
≥
```
Connect teletype reader (T) and high speed punch (P).

Tape Commands

Tape commands control the input of lines from the source tape 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, STP 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. Illegal characters (not in the range : A0 through : DF), are replaced by up arrows (↑). Errors in input will cause tape commands to be terminated, and an error message and the line number of the error line will be printed on the teletype. The line in error is not placed in the buffer but is typed on the teletype. It may be corrected by use of the ADD command (see Buffer Commands). If the end of the tape (up arrow in column one or 30 consecutive nulls) is reached or the buffer becomes full, 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 record before a carriage-return delimiter is found, input will be terminated.

An average of 10 words of memory are required for each source line read.

Read Tape

The R command reads lines from the source tape 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 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 the buffer, skip 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, STP 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. When all source lines have been entered, the command mode is resumed by typing a termination character 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 to allow the operator to lengthen the buffer or punch the contents of the buffer.

>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 as a 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 STP is reinitialized by either the I or E commands or another Q command.

≥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.

≥LF.
FFFF (the last buffer line is listed here)
≥
List the final (last)line in the buffer.

```
>Ln.
nnnn (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.

Punch Buffer Lines

The P command punches specified buffer lines on the teletype or high speed punch. If the teletype is the connected punch device (see C command), the lines punched will also be listed. Leader and/or trailer may be punched by typing an "L" and/or "T" modifier character following the command ID character (P). Source lines are punched with a terminating carriage-return line-feed and null character to facilitate manual editing.

```
>PLT@1@F.
READY P.T. PUNCH AND CYCLE.
AT HALT DISABLE P.T. PUNCH AND CYCLE.
(the computer halts, operator turns teletype punch on and
  depresses RUN)
(tape punched here)
! (the computer halts, operator turns punch off and depresses RUN)
>
```
Punch the entire contents of the buffer with leader and trailer (on teletype). The special message and operator instructions are not applicable when the high speed punch is connected.

When the program is to be reordered or the buffer is too small to hold the entire program, the following commands may be used.

```
>PL@n@m.
(special message if teletype is punch device).
>
```
Punch an initial segment of tape with leader containing buffer lines n through m.

>P@n@m.
(special message if teletype is punch device).

Punch an intermediate segment of tape containing lines n through m.

>P@n.
(special message if teletype is punch device).
>
Punch a single buffer line n.

>PT@n@m.
(special message if teletype is punch device).
>
Punch a final segment of tape containing lines n through m.

PROGRAM OPERATION

Program Loading

STP is loaded into lower memory with the Binary Loader(BLD) or Autoload. STP normally resides in memory starting at location zero in order to utilize as much of available memory as possible for source line storage. It may, however, be loaded any place in memory; the higher STP resides in memory, the less memory available for lines storage.

Initialization

STP is entered at relative location zero of the program (normally zero), at which time it will output "STP" and " > " to indicate to the user that command input is required. The user then enters the appropriate commands, based upon the operations to be performed.

Source Tape Preparation

The procedure to prepare an initial source tape is:

1. INITIALIZE STP (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, type a terminator (normally period) in column one.
5. To check the contents of the buffer (source line storage) enter a LIST command (L1@CF).
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@1@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 STP (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 (L1@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.

Only for complete tape with LEADER and TRAILER

Appendix A

STP OPERATION SUMMARY

The procedure for loading and executing the Source Tape Preparation utility (STP) is as follows:

1. Load STP into lower memory using the Binary Loader (BLD) or Autoload (load location zero recommended).

2. Enter STP at relative location zero.

3. STP will respond by typing "STP" and " > " on the teletypewriter. The program is now ready to accept its first command (see Appendix B).

NOTE

STP may be restarted at any time by entering at relative location zero.

Appendix B

STP COMMAND SUMMARY

≥AF.	Add keyboard lines to buffer after last line.
≥An.	Add keyboard lines to buffer after line n.
≥B.	Clear the buffer.
≥CTT.	Connect teletype reader and teletype punch.
≥CRT.	Connect high speed reader and teletype punch.
≥CRP.	Connect high speed reader and high speed punch.
≥CTP.	Connect teletype reader and high speed punch.
≥DF.	Delete the last buffer line.
≥Dn.	Delete buffer line n.
≥Dn@m.	Delete buffer lines n through m.
≥Eh.	Set end of buffer to h (hexadecimal).
≥I.	Initialize STP (clear buffer and set T to zero).
≥LF.	List the last buffer line.
≥Ln.	List buffer line n.
≥Ln@m.	List buffer lines n through m.
≥PLT@1@F.	Punch the buffer with leader and trailer.
≥PL@n@m.	Punch buffer lines n through m with leader.
≥P@n@m.	Punch buffer lines n through m.
≥PT@n@m.	Punch buffer lines n through m with trailer.
≥Qn.	Set ADD function termination character to n.
≥Rn.	Read tape to line n and add to buffer.
≥Sn.	Read tape to line n-1, add to buffer, and skip line n.
≥Sn@m.	Read tape to line n-1, add to buffer, and skip lines n through m.
≥T.	Reset tape line count to zero.
≥Tn.	Reset tape line count to n.

```
0002                    *  SOURCE TAPE PREPARATION (STP) 96005
0003                    *  COPYRIGHT 1972, COMPUTER AUTOMATION, INC.
0004                    *
0005                    *          FOR ASR-33 TELETYPE AND/OR
0006                    *          HIGH SPEED PAPER TAPE SYSTEM
0007                    *
0008                    *  NOT BINARY RELOCATIBLE
0009                    *
0010  0000                    REL  0
0011        0000  START   EQU  $
0012  0000  FB06            JST  *MSGPP
0013  0001  0341            DATA TITLE
0014  0002  F205  GO        JMP  STP
0015  0003  F2E4            JMP  NXT        INITIALIZE FIRST TIME ONLY
0016  0004  0278  CRLFP     DATA CRLF
0017  0005  0346  KBA       DATA KBB
0018  0006  02B2  ODECP     DATA ODEC
0019  0007  0293  MSGPP     DATA MSG
0020  0008  F603  STP       LDX  KBA        GET KEYBOARD INPUT BUFFER
0021  0009  1328            LLX  1
0022  000A  EA26            STX  KLS        MAKE BYTE ADDRESS
0023  000B  C252            AXI  BFR+BFR-KBB-KBB   GET END OF PROGRAM
0024  000C  EA23            STX  BFRS       STORE BYTE ADDRESS
0025  000D  0110            ZAR
0026  000E  9E0C            STA  GO         RESET 1ST TIME SWITCH
0027  000F  9AF7            STA  SCNT       NO TAPE COUNT
0028  0010  B208            LDA  CAIP
0029  0011  9A59            STA  ESCP
0030  0012  0110  STPC      ZAR
0031  0013  9AF4            STA  BCNT       NO BUFFER COUNT
0032  0014  B21B            LDA  BFRS
0033  0015  9AFA            STA  PTR        SET NEXT ENTRY
0034  0016  9AF3            STA  COL1
0035  0017  F2D0            JMP  NXT
0036                    *
0037                    *       INITIALIZE STP
0038                    *
0039  0018  FBFB  INIT      JST  *IKBP      GET CHARACTER
0040  0019  C0AE  CAIP      CAI  '.'        PERIOD?
0041  001A  F612            JMP  STP
0042  001B  F2E8            JMP  ERR        NO, ERROR
0043                    *
0044                    *       LIST THE BUFFER
0045                    *
0046  001C  FAA1  LIST      JST  INP        GET LINES TO LIST
0047  001D  FF19  LS1       JST  *CRLFP     OUTPUT CR/LF
0048  001E  B2EE            LDA  FRST       GET FIRST
0049  001F  FF19            JST  *ODECP     LIST LINE
0050  0020  C0A0            LAP  ' '                OUTPUT SPACE
0051  0021  FDF1            JST  *OTTP
0052  0022  E2E8            LDX  BPTR       GET ADDRESS OF BUFFER
0053  0023  FBED            JST  *GETP      GET CHARACTER
```

```
0054  0024  FBEE  LS2     JST   *OTTP     OUTPUT
0055  0025  0128          IXR             BUMP POINTER
0056  0026  FBEA          JST   *GETP     GET NEXT
0057  0027  C08D          CAI   :8D       CARRIAGE RETURN?
0058  0028  F201          JMP   $+2       YES
0059  0029  F605          JMP   LS2       NO, KEEP LISTING
0060  002A  0128          IXR             POINT TO NEXT CHARACTER
0061  002B  EADF          STX   BPTR      SAVE POINTER
0062  002C  DAE0          IMS   FRST      UP LINE NUMBER
0063  002D  DADE          IMS   LCNT      DONE?
0064  002E  F611          JMP   LS1       NO
0065  002F  F2B8          JMP   NXT       YES
0066                *
0067                *
0068  0030                ORG   :30
0069  0030        BFRS    RES   1
0070  0031        LLS     RES   1
0071                *
0072  003C                ORG   :3C       RESERVE SPACE FOR AUTOLOAD
0073                *
0074                *       DELETE THE SELECTED BUFFER LINES
0075                *
0076  003C  FA81  DELT    JST   INP       GET LINE TO DELETE
0077  003D  B2CA          LDA   BCNT      GET PRESENT NUMBER OF LINES
0078  003E  8ACD          ADD   LCNT      LESS COUNT TO DELETE
0079  003F  9AC8          STA   BCNT      SAVE AS NEW COUNT
0080  0040  FBD0  DE1     JST   *GETP     <
0081  0041  0128          IXR             < GET PAST DELETE
0082  0042  C08D          CAI   :8D       < SOURCE RECORDS
0083  0043  F201          JMP   $+2       <
0084  0044  F604          JMP   DE1       I
0085  0045  DAC6          IMS   LCNT      .
0086  0046  F606          JMP   DE1       .
0087  0047  0030          TXA
0088  0048  92C7          SUB   PTR       AT NEXT ENTRY?
0089  0049  210A          JAZ   DE3       YES, DONE
0090  004A  FBC6  DE2     JST   *GETP     GET CHATACRER
0091  004B  0128          IXR
0092  004C  EAC2          STX   TEMP
0093  004D  E2BD          LDX   BPTR      PUT IN NEW LOAATION
0094  004E  FBC3          JST   *PUTP
0095  004F  EABB          STX   BPTR
0096  0050  E2BF          LDX   TEMP      GET PRESENT CHARACTER ADDRE
0097  0051  003M          TXA
0098  0052  92BD          SUB   PTR       SAME AS END OF BUFF?
0099  0053  20C9          JAM   DE2       NO, CONTINUE
0100  0054  B2B6  DE3     LDA   BPTR      YES, SET NEW END OF BUFF
0101  0055  9ABA          STA   PTR
0102  0056  F291          JMP   NXT
0103                *
0104                *     ADD TO BUFFER
0105                *
```

```
0106  0057  FAC3  ADD     JST   IBLN      GET PARAMETERS
0107  0058  C0AE          CAI   '.'
0108  0059  F201          JMP   $+2
0109  005A  F2A9          JMP   ERR
0110  005B  0030          TXA               X=WHERE TO INSERT
0111  005C  92AB          SUB   BCNT        IN RANGE?
0112  005D  2181          JAL   $+2
0113  005E  F2A5          JMP   ERR         NO, ERROR
0114  005F  0030          TXA               YES
0115  0060  FA7A          JST   SBP         GET PAST PART OF BUFFER
0116  0061  FF5D          JST   *CRLFP      OUTPUT CR/LF
0117  0062  B2AD  AD1     LDA   PTR         NEXT CHARACTER STORE
0118  0063  92A5          SUB   EOB         INTO PROCTET MEMORY?
0119  0064  2084          JAM   AD2
0120  0065  FBB1          JST   *MSGP       YES, OVERFLOW
0121  0066  030D          DATA  BFRF        MESSAGE
0122  0067  FBB2          JST   *LINEP
0123  0068  F27F          JMP   NXT
0124  0069  E638  AD2     LDX   KLS         ADDRESS OF INPUT BUFFER
0125  006A  FBAA          JST   *RDKP       GET CHARACTER
0126  006B  C000  ESCP    CAI   0           INSTRUCTION IS BUILT
0127  006C  F27B          JMP   NXT         YES
0128  006D  C08D          CAI   :8D         CARRIAGE RETURN?
0129  006E  F605          JMP   AD2         YES,GET NEW SOURCE
0130  006F  C0DF          CAI   :DF         BACK ARROW?
0131  0070  F60F          JMP   AD1-1       YES, START LINE OVER
0132  0071  FBA0          JST   *PUTP       SAVE CHARACTER
0133  0072  FBA2  AD3     JST   *RDKP       GET NEXT CHARACTER
0134  0073  C0DF  AD4     CAI   :DF         BACK ARROW?
0135  0074  F204          JMP   AD5         YES
0136  0075  FB9C          JST   *PUTP       NO, PUT IN INPUT BUFFER
0137  0076  C08D          CAI   :8D         DONE?
0138  0077  F209          JMP   AD6         YES
0139  0078  F606          JMP   AD3         NO
0140  0079  00A8  AD5     DXR               BACK OOINTER UP 1 LOCATION
0141  007A  0030          TXA
0142  007B  964A          SUB   KLS         PAST START OF BUFFER?
0143  007C  215B          JAZ   AD1-1       YES, RESET
0144  007D  FB97          JST   *RDKP       GET NEXT CHARACTER
0145  007E  C08D          CAI   :8D         CARRIAGE RETURN?
0146  007F  F616          JMP   AD2         YES, IGNORE LAST LINE ENTER
0147  0080  F63D          JMP   AD4         NO, CONTINUE
0148  0081  0030  AD6     TXA
0149  0082  9651          SUB   KLS         DETERMINE INPUT COUNT
0150  0083  8A8C          ADD   PTR         DETERMINE WHERE TO MOVE TO
0151  0084  9A89          STA   LAST
0152  0085  BA8A          EMA   PTR
0153  0086  9A88          STA   TEMP
0154                *  CREATE A HOLE
0155  0087  E287  AD7     LDX   TEMP        GET FROM ADDRESS
0156  0088  0030          TXA
0157  0089  9281          SUB   BPTR        SAME AS START?
```

```
0158  008A  2108          JAZ  AD8       YES
0159  008B  00A8          DXR            BACKUP
0160  008C  FB84          JST  *GETP     GET CHARACTER
0161  008D  EA81          STX  TEMP
0162  008E  E27F          LDX  LAST      SET STORE LOCATION
0163  008F  00A8          DXR            BACKUP 1
0164  0090  EA7D          STX  LAST
0165  0091  FB80          JST  *PUTP     STORE CHARACTER
0166  0092  F60B          JMP  AD7       LOOP AGAIN
0167                *  FILL HOLE
0168  0093  E662    AD8   LDX  KLS
0169  0094  EA78          STX  FRST      GET FIRST CHARACTER ADDRESS
0170  0095  E277    AD9   LDX  FRST
0171  0096  FB7A          JST  *GETP     GET CHARACTER
0172  0097  0128          IXR
0173  0098  EA74          STX  FRST
0174  0099  E271          LDX  BPTR
0175  009A  FB77          JST  *PUTP     PUT INTO BUFFER
0176  009B  EA6F          STX  BPTR      SAVE POINTER
0177  009C  C08D          CAI  :8D       CARRIAGE RETURN?
0178  009D  F201          JMP  $+2
0179  009E  F609          JMP  AD9       NO, CONTINUE
0180  009F  DA68          IMS  BCNT      BUMP RECORD COUNT
0181  00A0  F63F          JMP  AD1
0182                *
0183                *  CLEAR BUFFER AREA
0184                *
0185  00A1  FB72    CLR   JST  *IKBP     GET NEXT CHAR
0186  00A2  C0AE          CAI  '.'       PERIOD?
0187  00A3  F691          JMP  STPC
0188  00A4  F25F          JMP  ERR       NO, ERROR
0189                *
0190                *     RESET TAPE COUNT
0191                *
0192  00A5  FB72    RSET  JST  *IDECP    GET TAPE RECORD NUMBER
0193  00A6  C0AE          CAI  '.'       LAST CHARACTER PERIOD?
0194  00A7  F201          JMP  $+2
0195  00A8  F25B          JMP  ERR       NO, ERROR
0196  00A9  EA5D          STX  SCNT      SAVE AS NEW COUNT
0197  00AA  F23D          JMP  NXT
0198                *
0199                * SET  END OF BUFFER BYTE ADDRESS
0200                *
0201  00AB  FB6D    END   JST  *IHEXP    GET WORD ADDRESS
0202  00AC  C0AE          CAI  '.'
0203  00AD  F201          JMP  $+2
0204  00AE  F255          JMP  ERR
0205  00AF  C328          SXI  40        LESS 40 WORDS
0206  00B0  1328          LLX  1         MAKE BYTE ADDRESS
0207  00B1  EA57          STX  EOB       SAVE
0208  00B2  F235          JMP  NXT
0209        00B3  QTERM   EQU  $
```

```
0210  00B3  FB60          JST  *IKBP    GET DELIMITER
0211  00B4  0048          TAX           SAVE
0212  00B5  FB5E          JST  *IKBP    GET NEXT
0213  00B6  C0AE          CAI  '.'      PERIOD?
0214  00B7  F201          JMP  $+2      YES
0215  00B8  F24B          JMP  ERR      NO, ERROR
0216  00B9  0030          TXA
0217  00BA  A202          IOR  QCAI     MAKE INSTRUCTION
0218  00BB  9E50          STA  ESCP
0219  00BC  F22B          JMP  NXT      DONE
0220  00BD  C000  QCAI    CAI  0
0221                *
0222                *   GET LIST PARAMETERS ROUTINE
0223                *
0224  00BE  0800  INP     ENT
0225  00BF  FA5B          JST  IBLN     GET DECIMAL VALUES
0226  00C0  EA4C          STX  FRST     SAVE FIRST VALUE
0227  00C1  C0AE          CAI  '.'      DONE?
0228  00C2  F207          JMP  INP1     YES
0229  00C3  C0A0          CAI  '        '              MORE?
0230  00C4  F201          JMP  $+2      YES
0231  00C5  F23F          JMP  ERR      NO, ERROR
0232  00C6  FA54          JST  IBLN     GET SECOND PARAMETER
0233  00C7  C0AE          CAI  '.'      DONE?
0234  00C8  F201          JMP  $+2      YES
0235  00C9  F23A          JMP  ERR      NO, ERROR
0236  00CA  EA43  INP1    STX  LAST     SAVE SECOND PARAMETER
0237  00CB  0030          TXA
0238  00CC  9240          SUB  FRST     LAST>FIRST?
0239  00CD  3081          JAP  $+2
0240  00CE  F235          JMP  ERR      NO, ERROR
0241  00CF  0210          CAR           MAKE CONNT NEG
0242  00D0  9A3B          STA  LCNT
0243  00D1  B236          LDA  BCNT     LAST KNOWN RECORD>DELETELAS
0244  00D2  923B          SUB  LAST
0245  00D3  3081          JAP  $+2
0246  00D4  F22F          JMP  ERR      NO, ERROR
0247  00D5  B237          LDA  FRST     FIRST=0?
0248  00D6  3101          JAN  $+2      YES, ERROR
0249  00D7  F22C          JMP  ERR
0250  00D8  00D0          DAR
0251  00D9  FA01          JST  SBP
0252  00DA  F71C          RTN  INP
0253                *
0254                *  GET PAST NOT DELETE PART
0255                *
0256  00DB  0800  SBP     ENT
0257  00DC  0210          CAR           ONE'S COMPLEMENT
0258  00DD  9A31          STA  TEMP     SAVE COUNT
0259  00DE  E6AF          LDX  BFRS     BET BYTE ADDRESS OF BUFFER
0260  00DF  DA2F  SB1     IMS  TEMP     DONE?
0261  00E0  F202          JMP  SB2      NO
```

```
0262  00E1  EA29          STX  BPTR      SAVE BYTE ADDRESS
0263  00E2  F707          RTN  SBP       EXIT
0264  00E3  FB2D  SB2     JST  *GETP     GET CHARACTER
0265  00E4  0128          IXR            BUMP POINTER
0266  00E5  C08D          CAI  :8D       CARRIAGE RETURN?
0267  00E6  F607          JMP  SB1       YES
0268  00E7  F604          JMP  SB2       NO
0269                *
0270                *  GET OPERATOR OPTION
0271                *
0272  00E8  FFE4  NXT     JST  *CRLFP    OUTPUT CR/LF
0273  00E9  C6BF          LAP  '>'
0274  00EA  FB28          JST  *OTTP     ISSUE ">"
0275  00EB  FB28          JST  *IKBP     GET NEXT CHAR
0276  00EC  C0C9          CAI  'I'       WHICH OPTION?
0277  00ED  F6D5          JMP  INIT
0278  00EE  C0CC          CAI  'L'
0279  00EF  F6D3          JMP  LIST
0280  00F0  C0C4          CAI  'D'
0281  00F1  F6B5          JMP  DELT
0282  00F2  C0C1          CAI  'A'
0283  00F3  F69C          JMP  ADD
0284  00F4  C0D4          CAI  'T'
0285  00F5  F650          JMP  RSET
0286  00F6  C0C2          CAI  'B'
0287  00F7  F656          JMP  CLR
0288  00F8  C0D0          CAI  'P'
0289  00F9  F242          JMP  PNCH
0290  00FA  C0D1          CAI  'Q'
0291  00FB  F648          JMP  QTERM
0292  00FC  C0C5          CAI  'E'
0293  00FD  F652          JMP  END
0294  00FE  C0C3          CAI  'C'
0295  00FF  F225          JMP  CIO
0296  0100  C0D2          CAI  'R'
0297  0101  F26B          JMP  TAPE
0298  0102  C0D3          CAI  'S'
0299  0103  F269          JMP  TAPE
0300  0104  C6DF  ERR     LAP  :DF       NONE, OUTPUT BACK ARROW
0301  0105  FB0D          JST  *OTTP
0302  0106  F61E          JMP  NXT
0303                *
0304                *      DATA/ITEMS
0305                *
0306  0107  0800  SCNT    HLT
0307  0108  0800  BCNT    HLT
0308  0109  1F9E  EOB     DATA :1F9E     (:FF7-40)*2
0309  010A  0800  COL1    HLT
0310  010B  0800  BPTR    HLT
0311  010C  0800  LCNT    HLT
0312  010D  0800  FRST    HLT
0313  010E  0800  LAST    HLT
```

```
0314  010F  0800  TEMP   HLT
0315  0110  0800  PTR    HLT
0316              *
0317              *       INDIRECT POINTERS
0318              *
0319  0111  0257  GETP   DATA GET
0320  0112  0246  PUTP   DATA PUT
0321  0113  0273  OTTP   DATA OTT
0322  0114  0266  IKBP   DATA IKB
0323  0115  0281  RDKP   DATA RDK
0324  0116  026C  LDRP   DATA LDR
0325  0117  0293  MSGP   DATA MSG
0326  0118  029F  IDECP  DATA IDEC
0327  0119  02CB  IHEXP  DATA IHEX
0328  011A  01FB  LINEP  DATA LINE
0329              *
0330              *    GET NUMBER TO INSERT AFTER
0331              *
0332  011B  0800  IBLN   ENT
0333  011C  FF04        JST  *IDECP    GET DECIMAL NUMBER
0334  011D  C0C6        CAI  'F'       LAST?
0335  011E  F201        JMP  $+2       YES
0336  011F  F704        RTN  IBLN      NO, EXIT
0337  0120  2801        JXZ  $+2       CHECK NO VALUE
0338  0121  F61D        JMP  ERR       VALUE, ERROR
0339  0122  E61A        LDX  BCNT      GET NEXT SOURCE ADDRESS
0340  0123  FF0F        JST  *IKBP     GET NEXT CHAR
0341  0124  F709        RTN  IBLN      EXIT
0342              *
0343              *     SELECT I/O DEVICES
0344              *
0345  0125  FF11  CIO    JST  *IKBP     GET OPTION
0346  0126  C0D4        CAI  'T'       INPUT TELETYPE READER
0347  0127  F203        JMP  C1
0348  0128  C0D2        CAI  'R'       INPUT HIGH SPEED READER
0349  0129  F201        JMP  C1
0350  012A  F626        JMP  ERR
0351  012B  9E1C  C1     STA  TEMP      SAVE
0352  012C  FF18        JST  *IKBP     GET OUTPUT DEVICE
0353  012D  C0D4        CAI  'T'       TELETYPE PUNCH
0354  012E  F203        JMP  C2
0355  012F  C0D0        CAI  'P'       HIGH SPEED PUNCH
0356  0130  F201        JMP  C2
0357  0131  F62D        JMP  ERR
0358  0132  0048  C2     TAX
0359  0133  FF1F        JST  *IKBP     GET NEXT CHAR
0360  0134  C0AE        CAI  '.'       PERIOD?
0361  0135  F201        JMP  $+2       YES
0362  0136  F632        JMP  ERR       NO, ERROR
0363  0137  EAC9        STX  OCHR      SAVE OUT CHARACTER
0364  0138  B629        LDA  TEMP      SAVE IN CHARACTER
0365  0139  9A01        STA  ICHR
```

```
0366  013A  F652          JMP  NXT
0367  013B  00D4  ICHR    DATA :D4
0368                      *
0369                      *     PUNCH THE BUFFER FROM INPUT PARAMETERS
0370                      *
0371  013C  0108  PNCH    ZXR              GET PARAMETER
0372  013D  FF29  P1      JST  *IKBP       GET PARAMETER
0373  013E  C0A0          CAI  ' '         ' '                SPACE=NO LEADER OR
0374  013F  F208          JMP  P4          LEA
0375  0140  C0CC          CAI  'L'         LEADER?
0376  0141  F204          JMP  P3          YES
0377  0142  C0D4          CAI  'T'         TRAILER?
0378  0143  F201          JMP  P2          YES
0379  0144  F640          JMP  ERR         NO, ERROR
0380  0145  C201  P2      AXI  1           0=NEITHFR 1=LEADER 2=
0381  0146  C201  P3      AXI  1           TRAILER 3=BOTH
0382  0147  F60A          JMP  P1
0383  0148  EA6E  P4      STX  RDL         SAVE LEADER TRAILER PARAMET
0384  0149  FE8B          JST  INP         GET PUNCH PARAMETER
0385  014A  B2B6          LDA  OCHR        GET OUTPUT DEVICE
0386  014B  C0D0          CAI  'P'         HIGH SPEED PUNCH?
0387  014C  F203          JMP  P5          NO, OUTPUT A MESSAGE
0388  014D  FF36          JST  *MSGP
0389  014E  02E7          DATA PRDY
0390  014F  0801          STOP 1
0391  0150  E266  P5      LDX  RDL         PUNCH LEADER?
0392  0151  11A8          RRX  1
0393  0152  3201          JOR  P6
0394  0153  FF3D          JST  *LDRP       YES, PUNCH IT
0395  0154  E649  P6      LDX  BPTR        GET POINTER OF DATA TO OUTP
0396  0155  FF44  P7      JST  *GETP       GET CHATACTER
0397  0156  FAE2          JST  OPT         OUTPUT IT
0398  0157  0128          IXR              BUMP POINTER
0399  0158  C08D          CAI  :8D         CARRIAGE RETURN?
0400  0159  F201          JMP  $+2         YES
0401  015A  F605          JMP  P7          NO, CONTINUE
0402  015B  C68A          LAP  :8A         OUT PUT LINE FEED
0403  015C  FADC          JST  OPT
0404  015D  0110          ZAR              OUTPUT A NULL FRAME
0405  015E  FADA          JST  OPT
0406  015F  DE53          IMS  LCNT        DONE?
0407  0160  F6AB          JMP  P7          NO
0408  0161  B255          LDA  RDL         YES, PUNCH TRAILER?
0409  0162  11D1          RRA  2
0410  0163  3205          JOR  P8
0411  0164  C6DE          LAP  :DE         YES, FIRST PUNCH UP ARROW
0412  0165  FAD3          JST  OPT
0413  0166  C68D          LAP  :8D         AND A CARRIAGE RETURN
0414  0167  FAD1          JST  OPT
0415  0168  FF52          JST  *LDRP       NOW TRAILER
0416  0169  B297  P8      LDA  OCHR        OUTPUT DEVICE TTY?
0417  016A  C0D4          CAI  'T'
```

```
0418  016B  0802          STOP 2          YES,   HALT
0419  016C  F684          JMP  NXT
0420                *
0421                *   READ TAPE INTO BUFFER
0422                *
0423  016D  9E61  TAPE    STA  LCNT       SAVE OPTION (R OR S)
0424  016E  FF56          JST  *IDECP     GET PARAMETER
0425  016F  9E60          STA  TEMP       SAVE INPUT CHARACTER
0426  0170  0030          TXA
0427  0171  966A          SUB  SCNT       PARAMETER>PRESENT COUNTER
0428  0172  3181          JAG  $+2
0429  0173  F66F          JMP  ERR        NO, ERROR
0430  0174  B665          LDA  TEMP
0431  0175  EE68          STX  FRST       SAVE PARAMETER
0432  0176  E66A          LDX  LCNT       WHICH OPTION?
0433  0177  C1D3          CXI  'S'
0434  0178  F204          JMP  T1         SKIP
0435  0179  E66C          LDX  FRST       MUST BE READ
0436  017A  C0AE          CAI  '.'        LAST CHARACTER PERIOD?
0437  017B  F208          JMP  T2         YES
0438  017C  F678          JMP  ERR        NO, ERROR
0439                *  SKIP OPTION
0440  017D  E670  T1      LDX  FRST
0441  017E  C0AE          CAI  '.'
0442  017F  F204          JMP  T2
0443  0180  C0A0          CAI  '          '              SPACE MEANS GET PA
0444  0181  F201          JMP  $+2        .
0445  0182  F67E          JMP  ERR
0446  0183  FF6B          JST  *IDECP     GET FINAL PARAMETER
0447                *   READ OPTION
0448  0184  EE76  T2      STX  LAST       SAVE LAST VALUE
0449  0185  C0AE          CAI  '.'        LAST CHARACTER PERIOD?
0450  0186  F201          JMP  $+2        YES
0451  0187  F683          JMP  ERR        NO, ERROR
0452  0188  0030          TXA             FIRST PARAM > LAST?
0453  0189  967C          SUB  FRST
0454  018A  3081          JAP  $+2
0455  018B  F687          JMP  ERR        YES, ERROR
0456  018C  B67C  T3      LDA  PTR        OVERFLOW MEMORY?
0457  018D  9684          SUB  EOB
0458  018E  2083          JAM  T4
0459  018F  FF78          JST  *MSGP      YES, OUTPUT MESSAGE
0460  0190  030D          DATA BFRF
0461  0191  F205          JMP  TERR
0462  0192  FA24  T4      JST  RDL        READ A RECORD
0463  0193  DE8C          IMS  SCNT       BUMP RECORD NUMBER
0464  0194  2105          JAZ  T5         NEW RECORD OK?
0465  0195  FF7E          JST  *MSGP      NO, OUTPUT MESSAGE
0466  0196  032E          DATA ERRM
0467  0197  FA63  TERR    JST  LINE
0468  0198  FA59          JST  LLL        LIST LAST LINE
0469  0199  F6B1          JMP  NXT
```

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0470  019A  DE92  T5      IMS   BCNT      BUMP BUFFER COUNT
0471  019B  B094          LDA   SCNT      DONE INPUTTING?
0472  019C  968F          SUB   FRST
0473  019D  20D1          JAM   T3        NO, CONTINUE
0474  019E  B092          LDA   LCNT      YES
0475  019F  C0D2          CAI   'R'       READ OPTION?
0476  01A0  F205          JMP   T6        YES
0477  01A1  B097          LDA   COL1      NO, SKIP , SETUP FAKE STORE
0478  01A2  9E92          STA   PTR
0479  01A3  B09B          LDA   BCNT      DECREMENT BUFFER COUNT
0480  01A4  00D0          DAR
0481  01A5  9E9D          STA   BCNT
0482  01A6  C0A0  T6      LAP   '         '           OUTPUT SPACE
0483  01A7  FF94          JST   *OTTP
0484  01A8  FA49          JST   LLL       AND LAST LINE INPUT
0485  01A9  B09B          LDA   LAST      DONE SKIPPING?
0486  01AA  96A3          SUB   SCNT
0487  01AB  3101          JAN   $+2
0488  01AC  F0C4          JMP   NXT       YES
0489  01AD  FACA          JST   CRLF      NO
0490  01AE  FA0B  T7      JST   RDL       READ A RECORD
0491  01AF  DEAB          IMS   SCNT      UPDATE TAPE COUNT
0492  01B0  E0A6          LDX   COL1      RESET FAKE STORE POINTER
0493  01B1  CE91          STX   PTR
0494  01B2  B0AB          LDA   SCNT      DONE?
0495  01B3  96A6          SUB   LAST
0496  01B4  20C6          JAM   T7        NO
0497  01B5  FA3C          JST   LLL       YES, LIST LAST LINE INPUT
0498  01B6  F0CE          JMP   NXT
0499                *
0500                *   READ SOURCE LINE FROM TAPE
0501                *
0502  01B7  0800  RDL     ENT
0503  01B8  B07D          LDA   ICHR      WHICH INPUT DEVICE?
0504  01B9  C0D4          CAI   'T'
0505  01BA  403B          SEL   073       READ FROM TTY
0506  01BB  C0D2          CAI   'R'
0507  01BC  4033          SEL   063       READ FROM HS READER
0508  01BD  E0AD          LDX   PTR       POINT TO NEXT ENTRY BUFFER
0509  01BE  CEAF          STX   TEMP
0510  01BF  0110  EEG     ZAR
0511  01C0  9EB5          STA   BPTR      RESET ERROR FLAG
0512  01C1  E0B2          LDX   TEMP
0513                *  PROCESS LABEL FIELD
0514  01C2  FA42          JST   RDT       GET CHARACTER
0515  01C3  FFF1          JST   *PUTP     PUT IN BUFFER
0516  01C4  C0DF          CAI   :DE       UP ARROW?
0517  01C5  F20B          JMP   EOT       YES, END OF PAPE
0518  01C6  C0AA          CAI   '*'       COMMENT?
0519  01C7  F21D          JMP   CMT       YES
0520  01C8  C0A0  LBL     CAI   '         '           SPACE?
0521  01C9  F203          JMP   GOP       YES
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0522  01CA  FA3A          JST  RDT
0523  01CB  FFB9          JST  *PUTP
0524  01CC  F604          JMP  LBL
0525                *  PROCESS OPERAND FIELD
0526  01CD  FA37  GOP     JST  RDT       GET NEXT CHARACTER
0527  01CE  C0A0          CAI  ' '       SPACE?
0528  01CF  F602          JMP  GOP       YES
0529  01D0  FFBF          JST  *PUTP     NO, PUT IN BUFFER
0530  01D1  FA33  OP      JST  RDT       GET NEXT CHARACTER
0531  01D2  FFC0          JST  *PUTP     PUT IN BUFFER
0532  01D3  C0A0          CAI  ' '       SPCE?
0533  01D4  F201          JMP  GAD       YES
0534  01D5  F604          JMP  OP        NO, CONTINUE WITH OPERAND
0535                *  PROCESS EXPRESSION FIELD
0536  01D6  FA2F  GAD     JST  RDT       GET NEXT CHARACTER
0537  01D7  C0A0          CAI  ' '       SPACE
0538  01D8  F602          JMP  GAD       YES, GET PAST SPACES
0539  01D9  FFC7          JST  *PUTP
0540  01DA  C0A7          CAI  ''''      TEXT STRING?
0541  01DB  F209          JMP  CMT       YES
0542  01DC  FA28  AD      JST  RDT       NO, GET NEXT CHARACTER
0543  01DD  FFCB          JST  *PUTP     PUT IN BUFFER
0544  01DE  C0A0          CAI  ' '       SPACE?
0545  01DF  F201          JMP  $+2       YES
0546  01E0  F604          JMP  AD        NO
0547  01E1  FA23          JST  RDT
0548  01E2  C0A0          CAI  ' '
0549  01E3  F602          JMP  $-2
0550  01E4  FFD2          JST  *PUTP
0551  01E5  FA1F  CMT     JST  RDT
0552  01E6  F602          JMP  $-2
0553                *
0554                *     END OF LINE (:8D) ENCOUNTER
0555                *
0556  01E7  FFD5  EOL     JST  *PUTP     PUT :8D INTO BUFFER
0557  01E8  00B0          DXA            INPUT ANNY?
0558  01E9  96DA          SUB  TEMP
0559  01EA  216B          JAZ  BEG       NO, START OVER
0560  01EB  EEDB          STX  PTR       SAVE NEXT STORE ADDRESS
0561  01EC  B6DD          LDA  TEMP
0562  01ED  9EE3          STA  COL1      SAVE NEXT STORE ADDRESS
0563  01EE  B6E3          LDA  BPTR
0564  01EF  4034          SEL  064       STOP READERS
0565  01F0  403C          SEL  074
0566  01F1  F73A          RTN  RDL
0567                *
0568                *     LIST LAST LINE ROUTINE
0569                *
0570  01F2  0800  LLL     ENT
0571  01F3  FA84          JST  CRLF      OUTPUT CR/LF
0572  01F4  E6EA          LDX  COL1      HET ADDRESS OF DATA
0573  01F5  FFE4  LL1     JST  *GETP     GET CHARACTER
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0574  01F6  C08D          CAI  :8D       DONE?
0575  01F7  F705          RTN  LLL       YES, EXIT
0576  01F8  FFE5          JST  *OTTP     NO, OUTPUT
0577  01F9  0128          IXR            BUMP POINTER
0578  01FA  F005          JMP  LL1       LOOP AGAIN
0579                *
0580                *     OUTPUT ERROR MESSAGE
0581                *
0582  01FB  0800  LINE    ENT
0583  01FC  FFE5          JST  *MSGP     OUTPUT MESSAGE
0584  01FD  0329          DATA LINM
0585  01FE  B6F6          LDA  BCNT      ERROR LINE AND LAST NUMBER
0586  01FF  FAB2          JST  ODEC
0587  0200  F705          RTN  LINE
0588  0201  00D4  OCHR    DATA :D4       OUTPUT DEFAULT TO TELETYPE
0589                *
0590                *     READ PAPER TAPE ROUTINE
0591                *
0592  0202  C6DE  RD4     LAP  :DE       A=UPARROW
0593  0203  DEF8          IMS  BPTR      SET BAD INPUT FLAG
0594  0204  F300          RTN  RDT
0595                * READ FROM TAPE DRIVER
0596  0205  0800  RDT     ENT
0597  0206  C71F          LAM  30        SET TIME OUT COUNTER
0598  0207  9A31          STA  OPT
0599  0208  B6CD  RD1     LDA  ICHR      WHICH DEVICE?
0600  0209  C0D4          CAI  'T'
0601  020A  F204          JMP  RD2
0602  020B  4931          SEN  061       HS READER INPUT
0603  020C  F601          JMP  $-1
0604  020D  5830          INA  060
0605  020E  F203          JMP  RD3
0606  020F  4939  RD2     SEN  071       TTY INPUT
0607  0210  F601          JMP  $-1
0608  0211  5838          INA  070
0609                *  PROCESS CHARACTER
0610  0212  A27C  RD3     IOR  H80       SET PARITY BIT
0611  0213  9A58          STA  LDR       SAVE
0612  0214  C352          SXI  82        80 CHART C.R. + 1 MORE
0613  0215  0030          TXA            IS ERROR
0614  0216  C252          AXI  82        OVER LIMIT?
0615  0217  934D          SUB  *PTRP
0616  0218  3105          JAN  RD31      NO
0617  0219  4034          SEL  064       YES, STOP
0618  021A  403C          SEL  074       ALL
0619  021B  FA77          JST  MSG       ERROR MESSAGE
0620  021C  0335          DATA 081
0621  021D  F31A          JMP  *NXTP
0622  021E  B24D  RD31    LDA  LDR       REBUILD
0623  021F  C08A          CAI  :8A       LINE FEED?
0624  0220  F618          JMP  RD1       YES, INNORE
0625  0221  C08D          CAI  :8D       CARRIAGE RETURN?
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0026  0222  F63B          JMP  EOL       YES, END OF LINE
0027  0223  C080          CAI  :80       NULL?
0028  0224  F20A          JMP  RD5       YES, BUMP COUNTER
0029  0225  C0DF          CAI  :DF       BACK ARROW?
0030  0226  F667          JMP  BEG       YES, START OVER
0031  0227  C0FF          CAI  :FF       ERROR PUNCH(RUB OUT)?
0032  0228  F620          JMP  RD1       YES, IGNORE
0033  0229  9266          SUB  HE0       IN RANGE OC CHARACTERS
0034  022A  30E8          JAP  RD4       NO
0035  022B  8A65          ADD  H40
0036  022C  20EA          JAM  RD4       NO
0037  022D  8A64          ADD  HA0       REBUILD
0038  022E  F729          RTN  RDT       EXIT
0039  022F  DA09  RD5     IMS  OPT       TIMED OUT?
0040  0230  F628          JMP  RD1       NO
0041                *
0042                * NO MORE TAPE IN READER
0043                *
0044  0231  4034  EOT     SEL  064
0045  0232  403C          SEL  074       STOP READERS
0046  0233  FA5F          JST  MSG       OUTPUT MESSAGE
0047  0234  0320          DATA EOTM
0048  0235  FE3A          JST  LINE      AND LINE MEESAGE
0049  0236  FE44          JST  LLL
0050  0237  F300          JMP  *NXTP     GO TO START
0051  0238  00E8  NXTP    DATA NXT
0052                *
0053                *     OUTPUT TO PUNCH
0054                *
0055  0239  0800  OPT     ENT
0056  023A  BE39          EMA  OCHR
0057  023B  C0D4          CAI  'T'       WHICH OUTPUT DEVICE?
0058  023C  F206          JMP  OP1
0059  023D  BE3C          EMA  OCHR      GET CHARACTER
0060  023E  4034          SEL  064
0061  023F  6C30          OTA  060       OUTPUT TO HS PUNCH
0062  0240  4931          SEN  061
0063  0241  F601          JMP  $-1
0064  0242  F709          RTN  OPT
0065  0243  BE42  OP1     EMA  OCHR      GET CHARACTER
0066  0244  FA2F          JST  OTT       OUTPUT TO TELETYPE
0067  0245  F70C          RTN  OPT
0068                *
0069                *       PUT CHARACTER INTO MEMORY
0070                *        X=BYTE ADDRESS WHERE TO STORE
0071  0246  0800  PUT     ENT
0072  0247  9A18          STA  A         SAVE CHARACTER
0073  0248  EA18          STX  X         SAVE ADDRESS
0074  0249  13A8          LRX  1         STORE WHICH WAY?
0075  024A  2204          JOS  $+5
0076  024B  1357          LLA  8         STORE LEFT
0077  024C  BC00          EMA  @0
```

```
0678  024D  8214          AND  KFF
0679  024E  F202          JMP  $+3
0680  024F  BC00          EMA  @0
0681  0250  8212          AND  KFF0      STORE RIGHT
0682  0251  A400          IOR  @0
0683  0252  9C00          STA  @0
0684  0253  E20D          LDX  X
0685  0254  0128          IXR            BUMP ADDRESS POINTER
0686  0255  B20A          LDA  A
0687  0256  F710          RTN  PUT
0688                *
0689                *     GET  A CHARACTER FROM MEMORY
0690                *    X=BYTE ADDRESS OF CHARACTER
0691  0257  0800    GET     ENT
0692  0258  EA08            STX  X         SAVE ADDRESS
0693  0259  13A8            LRX  1         WHICH CHARACTER
0694  025A  B400            LDA  @0
0695  025B  2201            JOS  $+2
0696  025C  13D7            LRA  8         LEFT
0697  025D  8204            AND  KFF       RIGHT
0698  025E  E202            LDX  X
0699  025F  F708            RTN  GET       EXIT
0700  0260  0800    A       HLT
0701  0261  0800    X       HLT
0702  0262  00FF    KFF     DATA :FF
0703  0263  FF00    KFF0    DATA :FF00
0704  0264  1250    TCON    DATA :1250
0705  0265  0110    PTRP    DATA PTR
0706                *
0707                *     KEYBOARD DRIVER
0708                *
0709  0266  0800    IKB     ENT
0710  0267  4038            SEL  070       AUTO-ECHO
0711  0268  5939            RDA  071       INPUT
0712  0269  A225            IOR  H80       SET PARITY BIT
0713  026A  403C            SEL  074       INITIALIZE
0714  026B  F705            RTN  IKB
0715                *
0716                *     PUNCH LEADER/TRAILER
0717                *
0718  026C  0800    LDR     ENT
0719  026D  0110            ZAR
0720  026E  C43C            LXP  60        60 BLANK FRAMES
0721  026F  FE36            JST  OPT
0722  0270  00A8            DXR
0723  0271  3842            JXN  $-2       DONE?
0724  0272  F706            RTN  LDR       YES, EXIT
0725                *
0726                *     OUTPUT 'A' TO TELETYPE
0727                *
0728  0273  0800    OTT     ENT            OUTPUT
0729  0274  6C38            OTA  070       OUTPUT
```

```
0730  0275  4939          SEN  071
0731  0276  F601          JMP  $-1        WAIT FOR DONE
0732  0277  F704          RTN  OTT        EXIT
0733                *
0734                *     OUTPUT CARRIAGERETURN & LINE FEED TO TTY
0735                *
0736  0278  0800  CRLF    ENT
0737  0279  B615          LDA  TCON
0738  027A  00D0          DAR
0739  027B  3141          JAN  $-1        TIME OUT
0740  027C  C68D          LAP  :8D        CARRIAGE RETURN
0741  027D  FE0A          JST  OTT
0742  027E  C68A          LAP  :8A        LINEFEED
0743  027F  FE0C          JST  OTT
0744  0280  F708          RTN  CRLF
0745                *
0746                *  INPUT FROM KEYBOARD
0747                *   INPUT FOR VALID RANGE
0748  0281  0800  RDK     ENT
0749  0282  FE1C          JST  IKB        GET CHARACTER
0750  0283  C08A          CAI  :8A
0751  0284  F602          JMP  $-2
0752  0285  C08D          CAI  :8D        CARR RETURN?
0753  0286  F201          JMP  $+2        YES
0754  0287  F706          RTN  RDK        NO
0755  0288  B624          LDA  TCON
0756  0289  00D0          DAR
0757  028A  3141          JAN  $-1        TIME OUT
0758  028B  C68A          LAP  :8A        LINE FEED
0759  028C  FE19          JST  OTT
0760  028D  C68D          LAP  :8D
0761  028E  F70D          RTN  RDK
0762  028F  0080  H80     DATA :80
0763  0290  00E0  HE0     DATA :E0
0764  0291  0040  H40     DATA :40
0765  0292  00A0  HA0     DATA :A0
0766                *
0767                *     OUTPUT MESSAGE TO TELETYPE.
0768                *     CALLING SEQUENCE:    JST  MSG  CALL ROUTINE
0769                *                          DATA  MESSAGE
0770                *
0771  0293  0800  MSG     ENT
0772  0294  E701          LDX  *MSG
0773  0295  B400  M1      LDA  *0         GET 2 CHARACTERS
0774  0296  2106          JAZ  M2         A=0?
0775  0297  11D7          RRA  8          NO
0776  0298  FE25          JST  OTT        OUTPUT LEFT
0777  0299  1157          RLA  8
0778  029A  FE27          JST  OTT        OUTPUT RIGHT
0779  029B  0128          IXR
0780  029C  F607          JMP  M1         LOOP AGAIN
0781  029D  DE0A  M2      IMS  MSG
```

```
0782  029E  F70B          RTN  MSG       RETURN P+1
0783                *
0784                *     INPUT DECIMAL AND CONVERT TO BINARY
0785                *
0786  029F  0800  IDEC    ENT
0787  02A0  0110          ZAR             SAVE VALUE
0788  02A1  9A3F  ID1     STA  V
0789  02A2  FE3C          JST  IKB        GET CHAR
0790  02A3  9A3E          STA  T          SAVE
0791  02A4  9241          SUB  CBA        RANGE TEST
0792  02A5  3089          JAP  ID2        0-9?
0793  02A6  8A3D          ADD  KA
0794  02A7  2087          JAM  ID2        NO
0795  02A8  BA38          EMA  V
0796  02A9  1350          LLA  1          MULTIPLY BY 10
0797  02AA  9A37          STA  T          *
0798  02AB  1351          LLA  2          *
0799  02AC  8A35          ADD  T          *
0800  02AD  8A33          ADD  V          AND NEW VALUE
0801  02AE  F60D          JMP  ID1
0802  02AF  E231  ID2     LDX  V          X=FINAL VALUE
0803  02B0  B231          LDA  T          T=LAST INPUT CHARACTER
0804  02B1  F712          RTN  IDEC
0805                *
0806                *     CONVERT A TO DECIMAL & PRINT
0807                *
0808  02B2  0800  ODEC    ENT
0809  02B3  9A2D          STA  V          SAVE VALUE
0810  02B4  E211          LDX  S          GET TABLE POINTER
0811  02B5  EA0F          STX  P
0812  02B6  C504          LXM  4          SET LOOP COUNTER
0813  02B7  EA2A          STX  T
0814  02B8  B228  OD1     LDA  V          GET VALUE
0815  02B9  C4AF          LXP  :AF        MAKE ASCHII CHARACTER
0816  02BA  930A          SUB  *P         TEST RANGE
0817  02BB  0128          IXR             BUMP ASCII
0818  02BC  30C2          JAP  $-2        TEST RANGE
0819  02BD  8B07          ADD  *P         REBUILD VALUE
0820  02BE  9A22          STA  V          SAVE
0821  02BF  0030          TXA
0822  02C0  FE4D          JST  OTT        OUTPUT
0823  02C1  DA03          IMS  P          POINT TO NEXT LIMIT
0824  02C2  DA1F          IMS  T          DONE?
0825  02C3  F60B          JMP  OD1        NO
0826  02C4  F712          RTN  ODEC       YES
0827  02C5  0800  P       HLT
0828  02C6  02C7  S       DATA TBL
0829  02C7  03E8  TBL     DATA 1000,100,10,1
      02C8  0064
      02C9  000A
      02CA  0001
0830                *
```

```
0831                    *     INPUT HEX AND CONVERT TO BINARY
0832                    *
0833  02CB  0800  IHEX    ENT
0834  02CC  0110          ZAR
0835  02CD  9A13          STA  V          SET OLD VALUE TO 0
0836  02CE  FE68  IH1     JST  IKB        GET CHAR
0837  02CF  9A12          STA  T          SAVE
0838  02D0  9215          SUB  CBA        LESS THEN9
0839  02D1  3085          JAP  IH3        NO
0840  02D2  8A11          ADD  KA         >0?
0841  02D3  3088          JAP  IH4        YES
0842  02D4  E20C  IH2     LDX  V          X=VALUE
0843  02D5  B20C          LDA  T          A=LAST CHARACTER
0844  02D6  F708          RTN  IHEX       EXIT
0845  02D7  920D  IH3     SUB  KD         >F?
0846  02D8  30C4          JAP  IH2        YES
0847  02D9  8A09          ADD  K6
0848  02DA  20C6          JAM  IH2        <A?
0849  02DB  8A08          ADD  KA         NO
0850  02DC  BA04  IH4     EMA  V
0851  02DD  1353          LLA  4          SHIFT HEX (4)
0852  02DE  8A02          ADD  V          ADD NEW VALUE
0853  02DF  9A01          STA  V          SAVE
0854  02E0  F612          JMP  IH1        LOOP AGAIN
0855  02E1  0800  V       HLT
0856  02E2  0800  T       HLT
0857  02E3  0006  K6      DATA 6
0858  02E4  000A  KA      DATA :A
0859  02E5  000D  KD      DATA :D
0860  02E6  00BA  CBA     DATA :BA
0861                    *
0862                    *      MESSAGES
0863                    *
0864  02E7  8D8A  PRDY    DATA :8D8A
0865  02E8  D2C5          TEXT 'READY P.T. PUNCH AND CYCLE.'
      02E9  C1C4
      02EA  D9A0
      02EB  D0AE
      02EC  D4AE
      02ED  A0D0
      02EE  D5CE
      02EF  C3C8
      02F0  A0C1
      02F1  CEC4
      02F2  A0C3
      02F3  D9C3
      02F4  CCC5
      02F5  AEA0
0866  02F6  8D8A          DATA :8D8A
0867  02F7  C1D4          TEXT 'AT HALT DISABLE P.T. PUNCH'
      02F8  A0C8
      02F9  C1CC
```

```
        02FA  D4A0
        02FB  C4C9
        02FC  D3C1
        02FD  C2CC
        02FE  C5A0
        02FF  D0AE
        0300  D4AE
        0301  A0D0
        0302  D5CF
        0303  C3C8
0868    0304  A0C1          TEXT ' AND CYCLE. '
        0305  CEC4
        0306  A0C3
        0307  D9C3
        0308  CCC5
        0309  AEA0
0869    030A  8D8A          DATA :8D8A,:8D8A,0
        030B  8D8A
        030C  0000
0870    030D  8D8A  BFRF    DATA :8D8A
0871    030E  C2D5          TEXT 'BUFFER FULL:  LAST SOURCE LINE IS'
        030F  C6C6
        0310  C5D2
        0311  A0C6
        0312  D5CC
        0313  CC53
        0314  A0A0
        0315  CCC1
        0316  D3D4
        0317  A0D3
        0318  CFD5
        0319  D2C3
        031A  C5A0
        031B  CCC9
        031C  CEC5
        031D  A0C9
        031E  D3A0
0872    031F  0000          DATA 0
0873    0320  8D8A  EOTM    DATA :8D8A
0874    0321  A0C5          TEXT ' END OF TAPE:'
        0322  CEC4
        0323  A0CF
        0324  C6A0
        0325  D4C1
        0326  D0C5
        0327  BAA0
0875    0328  0000          DATA 0
0876    0329  CCC9  LINM    TEXT 'LINE NO'
        032A  CEC5
        032B  A0CE
        032C  CFA0
0877    032D  0000          DATA 0
```

```
0878  032E  8D8A  ERRM   DATA :8D8A
0879  032F  A0C5         TEXT ' ERROR IN'
      0330  D2D2
      0331  CFD2
      0332  A0C9
      0333  CEA0
0880  0334  0000         DATA 0
0881  0335  8D8A  081    DATA :8D8A
0882  0336  D2C5         TEXT 'RECORD>80 CHARACTERS'
      0337  C3CF
      0338  D2C4
      0339  BEB8
      033A  B0A0
      033B  C3C8
      033C  C1D2
      033D  C1C3
      033E  D4C5
      033F  D2D3
0883  0340  0000         DATA 0
0884  0341  8D8A  TITLE  DATA :8D8A
0885  0342  8D8A         DATA :8D8A
0886  0343  D3D4         TEXT 'STP'
      0344  D0A0
0887  0345  0000         DATA 0
0888                     *
0889                     *      KEYBOARD AND SOURCE BUFFERS
0890                     *
0891  0346               KBB    RES  40
0892  036E  8D8D         BFR    DATA :8D8D
0893        0000         BFR    END  START
0000 ERRORS
```

```
0700  A       0672* 0686
0542  AD      0546
0117  AD1     0131  0143  0181
0124  AD2     0119  0129  0146
0133  AD3     0139
0134  AD4     0147
0140  AD5     0135
0148  AD6     0138
0155  AD7     0166
0168  AD8     0158
0170  AD9     0179
0106  ADD     0283
0307  BCNT    0031* 0077  0079* 0111  0180* 0243  0339  0476*
              0479  0481* 0585
0510  BEG     0559  0630
0893  BFR     0023  0023
0870  BFRF    0121  0460
0069  BFRS    0024* 0032  0259
0310  BPTR    0052  0061* 0093  0095* 0100  0157  0174  0176*
              0202* 0395  0511* 0563  0593*
0351  C1      0347  0349
0358  C2      0354  0356
0040  CAIP    0028
0860  CBA     0791  0838
0345  CIO     0295
0185  CLR     0287
0551  CMT     0519  0541
0309  COL1    0034* 0477  0492  0562* 0572
0736  CRLF    0016  0489* 0571* 0744
0016  CRLFP   0047* 0116* 0272*
0080  DE1     0084  0086
0090  DE2     0099
0100  DE3     0089
0076  DELT    0281
0201  END     0293
0308  EOB     0118  0207* 0457
0556  EOL     0626
0644  EOT     0517
0873  EOTM    0647
0300  ERR     0042  0109  0113  0188  0195  0204  0215  0231
              0235  0240  0246  0249  0338  0350  0357  0362
              0379  0429  0438  0445  0451  0455
0878  ERRM    0466
0126  ESCP    0029* 0218*
0312  FRST    0048  0062* 0169* 0170  0173* 0226* 0238  0247
              0431* 0435  0440  0453  0472
0536  GAD     0533  0538
0691  GET     0319  0699
0319  GETP    0053* 0056* 0080* 0090* 0160* 0171* 0264* 0396*
              0573*
0014  GO      0026*
0526  GOP     0521  0528
```

```
0764  H40       0635
0762  H80       0610  0712
0765  HA0       0637
0763  HE0       0633
0332  IBLN      0106* 0225* 0232* 0336  0341
0367  ICHR      0365* 0503  0599
0788  ID1       0801
0802  ID2       0792  0794
0786  IDEC      0326  0804
0326  IDECP     0192* 0333* 0424* 0446*
0836  IH1       0854
0842  IH2       0846  0848
0845  IH3       0839
0850  IH4       0841
0833  IHEX      0327  0844
0327  IHEXP     0201*
0709  IKB       0322  0714  0749* 0789* 0836*
0322  IKBP      0039* 0185* 0210* 0212* 0275* 0340* 0345* 0352*
                0359* 0372*
0039  INIT      0277
0224  INP       0046* 0076* 0252  0384*
0236  INP1      0228
0857  K6        0847
0858  KA        0793  0840  0849
0017  KBA       0020
0891  KBB       0017  0023  0023
0859  KD        0845
0702  KFF       0678  0697
0703  KFF0      0681
0070  KLS       0022* 0124  0142  0149  0168
0313  LAST      0151* 0162  0164* 0236* 0244  0448* 0485  0495
0520  LBL       0524
0311  LCNT      0063* 0078  0085* 0242* 0406* 0423* 0432  0474
0718  LDR       0324  0611* 0622  0724
0324  LDRP      0394* 0415*
0582  LINE      0328  0467* 0587  0648*
0328  LINEP     0122*
0876  LINM      0584
0046  LIST      0279
0573  LL1       0578
0570  LLL       0468* 0484* 0497* 0575  0649*
0047  LS1       0064
0054  LS2       0059
0773  M1        0780
0781  M2        0774
0771  MSG       0019  0325  0619* 0646* 0772  0781* 0782
0325  MSGP      0120* 0388* 0459* 0465* 0583*
0019  MSGPP     0012*
0272  NXT       0015  0035  0065  0102  0123  0127  0197  0208
                0219  0302  0366  0419  0469  0488  0498  0651
0651  NXTP      0621  0650
0881  O81       0620
```

```
0568  OCHR      0363* 0385  0416  0656* 0659* 0665*
0814  OD1       0825
0808  ODEC      0018  0586* 0826
0018  ODECP     0049*
0530  OP        0534
0665  OP1       0658
0655  OPT       0397* 0403* 0405* 0412* 0414* 0598* 0639* 0664
                0667  0721*
0728  OTT       0321  0666* 0732  0741* 0743* 0759* 0776* 0778*
                0822*
0321  OTTP      0051* 0054* 0274* 0301* 0483* 0576*
0827  P         0811* 0816  0819  0823*
0372  P1        0382
0380  P2        0378
0381  P3        0376
0383  P4        0374
0391  P5        0387
0395  P6        0393
0396  P7        0401  0407
0416  P8        0410
0371  PNCH      0289
0804  PRDY      0389
0315  PTR       0033* 0088  0098  0101* 0117  0150  0152* 0456
                0478* 0493* 0508  0560* 0705
0705  PTRP      0615
0671  PUT       0320  0687
0320  PUTP      0094* 0132* 0136* 0165* 0175* 0515* 0523* 0529*
                0531* 0539* 0543* 0550* 0556*
0220  QCAI      0217
0209  QTERM     0291
0599  RD1       0624  0632  0640
0606  RD2       0601
0610  RD3       0605
0622  RD31      0616
0592  RD4       0634  0636
0639  RD5       0628
0748  RDK       0323  0754  0761
0323  RDKP      0125* 0133* 0144*
0502  RDL       0383* 0391  0408  0462* 0490* 0566
0596  RDT       0514* 0522* 0526* 0530* 0536* 0542* 0547* 0551*
                0594  0638
0192  RSET      0285
0828  S         0810
0260  SB1       0267
0264  SB2       0261  0268
0256  SBP       0115* 0251* 0263
0306  SCNT      0027* 0196* 0427  0463* 0471  0486  0491* 0494
0011  START     0893
0020  STP       0014  0041
0030  STPC      0187
0856  T         0790* 0797* 0799  0803  0813* 0824* 0837* 0843
0440  T1        0434
```

```
    0448  T2          0437  0442
    0456  T3          0473
    0462  T4          0458
    0470  T5          0464
    0482  T6          0476
    0490  T7          0496
    0423  TAPE        0297  0299
    0829  TBL         0828
    0704  TCON        0737  0755
    0314  TEMP        0092* 0096  0153* 0155  0161* 0258* 0260* 0351*
                      0364  0425* 0430  0509* 0512  0558  0561
    0467  TERR        0461
    0884  TITLE       0013
    0855  V           0788* 0795* 0800  0802  0809* 0814  0820* 0835*
                      0842  0850* 0852  0853*
    0701  X           0673* 0684  0692* 0698
0893 SOURCE LINES
```

CONCORDANCE
(CONC)

INTRODUCTION

The Source Concordance program (CONC) accepts ALPHA Assembly Language source statements and produces an alphabetized list of all symbols, their definitions, and references by their Assembler source statement decimal line numbers.

ENVIRONMENT

The Concordance program resides in lower memory and creates a symbol table expanding toward upper memory (see figure 1). It will operate in as little as 2K, and will use all memory available, as required.

Hardware Required:

1. ALPHA LSI or ALPHA 16 with 4K 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. Card reader.
3. Line printer.
4. Open-reel Mag Tape.
5. Digital Cassette.

FEATURES

Operator Communications

The user selects I/O device assignments and other options by responding to questions typed on the Teletypewriter.

Source Input

Concordance supports all standard input devices, including paper tape, card and magnetic tape or cassette when source was saved on mag tape or cassette during a previous BETA-8 assembly.

List Output

Concordance supports all standard list output devices, including teletype and line printers, an will optionally list the source input with decimal line numbers.

Batch Operation

The concordance has a "batch" mode of operation. Source programs may be stacked in the card reader and concorded without operator intervention.

ALPHA-8 Syntax

Although the concordance program operates on a 16-bit ALPHA, it will optionally concord ALPHA-8 assembly source statements.

Insufficient Memory Recovery

If memory is exhausted while CONC is operating, it will list all current symbols and their references, throw away these references and continue.

PROGRAM DESCRIPTION

Main Program Flow

CONC is entered at INIT (location :100), where all program initialization is performed. The upper memory limit is determined by a call to MEMSIZ, located in the SI Source Input module, and the symbol table is initialized by entering a dummy entry whose name is :FFFFFF.

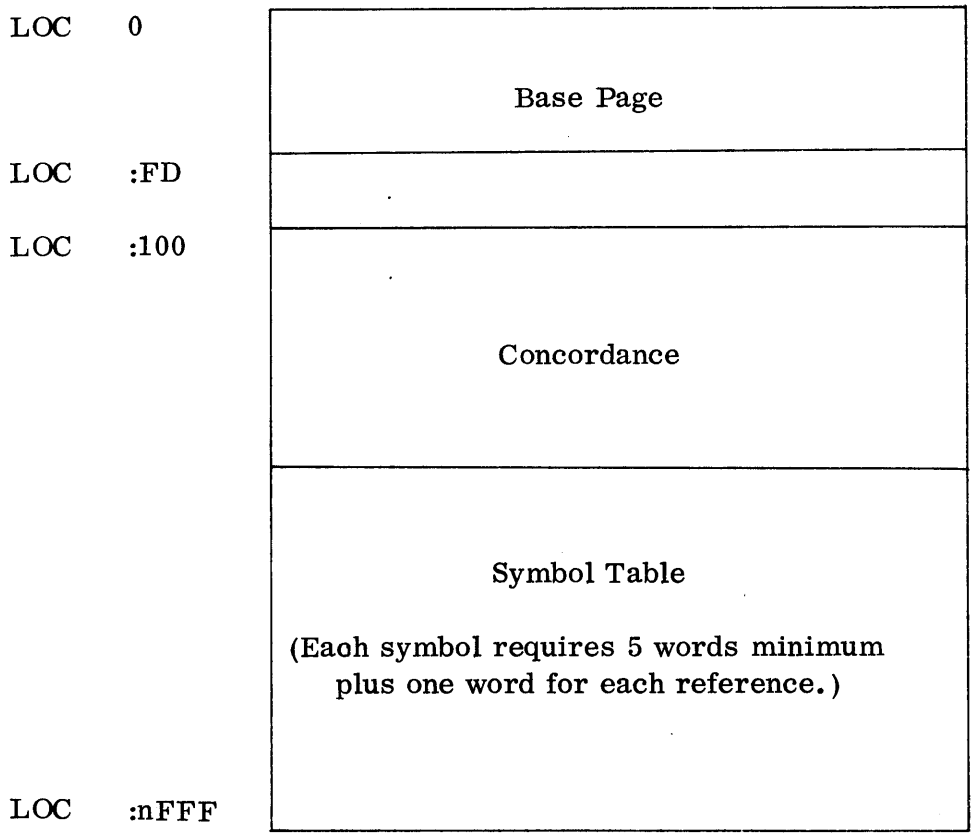


Figure 1. Memory Organization

Next, at QUERY, the title "CONC" is printed on the console teletypewriter, and the I/O device numbers and options accepted from the operator.

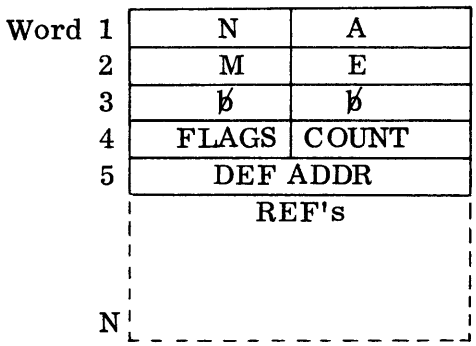
Source statement decode is performed by SCAN. Here, a source line is accessed (by READ), and dissected into its label, operation and operand fields. Each label is entered into the symbol table as a definition, and each symbol in the operand field is entered as a reference, by repetitive calls to SRCH. Also, the operation field is examined by SRCHOP for special processing requirements. Then, if the list option was requested, the source statement is printed with its decimal line number by a call to LIST1.

When an END statement is encountered, GEN is entered and the concordance listing is printed. Here, each symbol is printed, along with its error flags, definition line number and all reference line numbers. When all symbols have been printed, the total source line count is printed.

Symbol Table Operation

The symbol table starts in low memory, behind the concordance program, and expands toward upper memory. A symbol is entered once (multiple definitions generate multiple entries) and all references to it are appended in sequence. Each symbol maintains a count of its own length in words.

As each symbol (or reference) is entered, a space in the table is created by moving all higher symbols toward higher memory by a call to PUSH. There are no empty or unused words in the symbol table (see figure 2).



NAME: 6-character ASCII name, left justified, with trailing blanks.

FLAGS: BIT
- 15 - Unused
- 14 - ON = Multiple Definition
- 13 - ON = Defined at REF directive
- 12 - ON = Defined at EXTR directive
- 11 - ON = Defined at NAM directive
- 10 - ON = Defined at SET directive

COUNT: Binary count of number of words in this symbol table entry ($5 \leq N \leq 256$)

DEF ADDR: Binary (equivalent of decimal) line number of the symbols definition. An undefined symbol has value of :FFFF.

REF's: Binary (equivalent of decimal) line number of each reference. Sign bit on indicates a memory modification reference (STA, IMS, etc.).

Figure 2. Symbol Table Description

PROGRAM OPERATION

Program Loading

CONC is loaded into memory using the Binary Loader (BLD) or Autoload.

Operation

The start address for CONC is location :0100. When control is transferred to CONC, it will query the operator by printing a line on the teletypewriter of the form:

CONC
SI = # LO=#

where:

a. Concordance type-out is underlined
b. # represents the response to be typed by the operator

SI= Query

In response to "SI=" typed by the Concordance, the user types the device number assigned to the source input device he wants to use (see appendix B). If the user wishes to "batch" concordances, he must precede the device number with the letter "B" and if the listing is to be "repeated", the letter "R" must be entered.

Examples:

SI = 4 read source input from the card reader

SI = B4 read source input from the card reader in the batch mode

SI = R repeat the listing just generated, without re-reading source input.

Batch mode is terminated whenever the Concordance program reads a slash (/) in the first character position of the first source statement following an END statement.

The Concordance program accepts as source input the intermediate source saved by BETA-8 on magnetic tape or cassette. This may be used in lieu of rereading the source statements. See appendix B for unit assignments.

The Concordance program retains the source input device number from run to run. Consequently, the user need not type a device number unless he wishes to change the previously selected one. If he responds to "SI=" by typing a blank (space bar), the previously selected device will be used. If he responds with a period (.), all previous assignments will be used (including "LO="). Batch mode is effective until an end-of-batch sentinel (/) is encountered.

LO= Query

In response to the message "LO=", the user may type the device number assigned to the list output device he desires (see table 2). If the user wishes to list his source input on the list output device (with decimal line numbers), he must precede the device number with the letter "L".

Examples:

LO = 3 print concordance on the Centronics line printer

LO = L3 print condordance on the Centronics line printer, including 80/80 list of source input

The Concordance retains the list output device (but not the list function) on subsequent runs. Consequently, the user need not type a device number unless he wishes to change the previously selected one. If he responds to "LO=" by typing a blank (space bar) or period, the previously selected device will be used.

Program Information Collection

The Concordance program collects certain program information and prints it in the listing; either as flags to the left of the symbol definition, or as an asterisk following the reference line number. For example:

"M" indicates the symbol is multiply defined.

"N" indicates the symbol was defined on a NAM directive.

"R" indicates the symbol was defined on a REF directive.

"S" indicates the symbol was defined on a SET directive.

"U" indicates the symbol was never defined.

"X" indicates the symbol was defined on an EXTR directive.

"*" indicates that reference is a memory modification instruction, such as STA, STX, IMS, etc.

Error Detection

If the user responds to a message by typing a character other than a blank, a valid decimal number, or a period, the query will be output again. If the user responds by typing a back arrow (←), the entire message sequence will be repeated from the beginning.

ALPHA-8 Mode of Operation

Programs written in ALPHA-8 assembly language may also be concorded by setting the SENSE switch.

"PAUSE" Message

If a "PAUSE" statement (up arrow in record position one) is encountered. CONC will print "PAUSE" on the teletypewriter and halt to allow the user to reload the source input device. To continue, the user need only press RUN.

"MEMORY FULL" Message

If CONC finds its symbol table has exhausted all available memory, it will print the message "MEMORY FULL" and produce a concordance listing of all symbols and their current references (the undefined "U" error will be suppressed). It will then compress the symbol table, purging all current references, and continue the concordance process. This will continue until the program has been concorded or no more memory can be obtained by reference compression.

Alteration of Concordance Variables

The Concordance can operate under non-standard conditions by modifying certain memory locations in lower base page. To operate in this condition on a permanent basis, the modifications can be made and the Concordance dumped on paper tape with the Binary Dump (BDP) program.

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

Absolute Location	Value	Function
:0002	Variable	Highest memory location available to concordance; computed upon initial entry. To alter this address (to preserve utilities, etc.), alter location :0002 and NOP location :0100.
:0003	:FFCB (-53)	Negative of maximum line per page on listing device. Default allows 13 lines for top and bottom page formatting
:0004	:FFB8 (-72)	Negative of maximum character per line on listing device.

Appendix A

CONC OPERATION SUMMARY

The procedure to concord Assembler Source programs using CONC is as follows:

1. Load the Concordance program into memory using the Binary Loader (BLD) or Autoload.

2. Ready the input and output devices, as required.

3. Set the SENSE switch if ALPHA-8 mode is desired.

4. Enter CONC at location :0100. CONC will respond by typing "CONC" on the teletypewriter and then requesting option selection, per Appendix B.

Appendix B

I/O DEVICE SELECTION

QUERY	RESPONSE	MEANING
SI=	1	TTY keyboard input
	2	TTY paper tape reader
	3	High speed paper tape reader
	4	Card reader
	5	Magnetic tape or cassette - unit 0
	6	Magnetic tape or cassette - unit 1
	7	Magnetic tape or cassette - unit 2
	8	Magnetic tape or cassette - unit 3
	B#	Select batch mode. (Slash (/) in position one means end of batch operation.)
	R	Repeat the concordance listing just generated without rereading source input.
LO=	1	Teletypewriter
	2	Data Products line printer
	3	Centronics line printer
	L#	Select source input list

NOTE

Responses to SI= of 5-8 are valid only for versions 96065-41 (Magnetic Tape) and version 96065-42 (Cassette).

Appendix C

SAMPLE CONCORDANCE LISTING

```
CONC:

SI = 4   LO = L1


PAGE  0001

0001                    TITL  CONCORDANCE SAMPLE LISTING
0002          $5        LINK  :F910    CALL SUB
0003                    NAM   CNTR,START
0004                    EXTR  RETURN
0005                    REL   0
0006          START     EQU   $
0007                    LDA   MINSU4
0008                    STA   CNT
0009                    LINK                 GOTO SUB
0010          A         JST   *READ
0011          B         LDA   TEST
0012          B         JST   *WRITE
0013                    IMS   CNT
0014                    JMP   A
0015                    LAP   X
0016                    JMP   RETURN
0017          CNT       RES   1
0018          READ      REF
0019          WRITE     REF
0020          X         SET   :8D
0021          X         SET   :8C
0022                    END
```

PAGE 0002

	0010	A	0014	
	0011	B		
M	0012	B		
	0017	CNT	0008*	0013*
NU	0000	CNTR	0003	
U	0000	MINSU4	0007	
R	0018	READ	0010*	
X	0004	RETURN	0004	0016
N	0006	START	0003	
U	0000	TEST	0011	
R	0019	WRITE	0012*	
S	0020	X	0015	
S	0021	X		

0022 SOURCE LINES