PRODUCT CODE: DEC-8E-XBINA-A-D

PRODUCT NAME: Self-Starting Binary Loader
                 User's Manual

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CHAPTER

SELF-STARTING BINARY LOADER (SS BIN)

1.1 ABSTRACT

The Self-Starting Binary Loader (SS BIN) reads and stores 12-bit data words from binary format papertape from either the low speed reader or the high speed reader. If a starting address is supplied the program will be started at the completion of loading.

2.1 EQUIPMENT

The SS BIN requires a PDP-8/E or PDP-8/M with either a low speed papertape reader or a PC8-E high speed reader. It may be used with MI8-E Bootstrap (RIM) Loader.

3.1 MEMORY REQUIREMENTS

The SS BIN occupies locations 76ØØ-7755 and location 7777 of one memory field. It may reside in any memory field, as long as the RIM loader is in locations 7756-7776 of the same field. Use of the data break facility, which affects locations 7746-7755 of field Ø, will not affect SS BIN. Data may be loaded into fields Ø-7.

4.1 OPERATING INSTRUCTIONS

SS BIN is loaded with the RIM loader as the first part of a two part tape. The format of these tapes is described in the section on papertape format. The second part, separated from SS BIN by leader/trailer, is the object program or data to be loaded. Instructions are given below for use without a switch register and with the MI8-E, and for use with a switch register and without the MI8-E. If the object program is not attached to SS BIN or if there is more than one object tape, see the section on special conditions later in this document.

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4.1.1 With the MI8-E Bootstrap Loader

1. Place the initial leader/trailer of SS BIN over the read head of
the selected reader. If the low speed reader is to be used, turn
the main switch to ON-LINE and the reader control to START. If the
high speed reader is to be used, set its control to ON-LINE.

2. Activate the SW switch, located on the lower left of the front
panel, by moving it from the down to the up position. This will
load and start the RIM loader. It will load SS BIN, which will
start itself, load the object program and start the program. (If
no switch register is present, it is essential that the object pro-
gram specify a starting address).

4.1.2 With the Switch Register

1. Be certain that the RIM loader for the appropriate reader is in
memory. This procedure is described in Introduction to Programming,
Appendix E1.

2. Place the initial leader/trailer of SS BIN under the read head
of the selected reader. If the low speed reader is to be used, turn
the main switch to ON-LINE and the reader control to START. If the
high speed reader is to be used, set its control to ON-LINE.

3. Set the instruction field and data field to the field of the RIM
loader. This is done by multiplying the field number by 11, setting
the result on the switch register, and pressing EXTD ADDR LOAD.

4. Set the switch register to 7756, which is the starting address
of the RIM loader.

5. Press ADDR LOAD, CLEAR, and CONTinue. This will start the RIM
loader. It will load SS BIN, which will start itself and load the
object program. If a starting address was specified, the program
will be started. If no starting address was specified, SS BIN will
halt at the beginning of the final leader/trailer with the accumula-
tor (AC) set to Ø

4.1.3   Checksum Errors

At the end of each binary tape is a two frame code called the check-
sum. Its calculation is explained in the section on papertape format.

It is used to determine if the same holes were read by SS BIN as
were punched in the tape. It was calculated once when the tape was
punched and again as it is being loaded by SS BIN. The two totals
must agree. If they do not, an error has been made and SS BIN halts
with the AC equal to the difference in the calculations. If a
starting address was specified, the program is not started. The
tape should be reloaded, beginning at step 1 of the appropriate pro-
cedure. If SS BIN halts again with the AC equal to the same number
as in the previous load, the fault is probably with the tape. If
SS BIN halts with the AC equal to a different non-zero number, the
fault is probably with the reader. If the AC is Ø or if the program
starts, the load was good.

4.1.4   Special Conditions

If there is a switch register and there are additional tapes to be
loaded, they may be loaded after the loader has halted with the AC
equal to Ø, as in step 5 above. Place a tape in the reader and
press CONTinue. If the load was good SS BIN will again halt with
the AC equal to Ø. If a starting address is specified, it must be
on the last tape loaded. If no switch register is present, addi-
tional tapes, if preceded by SS BIN, may be loaded with the MI8-E
in the same manner as the first tape.

SS BIN will remain in memory unless locations 76ØØ-7745 are used for
another purpose. If a switch register is present, tapes without
SS BIN attached may be loaded later by placing them in the reader
and starting at 7777.

If SS BIN is not attached to the object tape, the following procedure
may be followed:

1. Examine the SS BIN tape. Carefully remove any tape after the
final leader/trailer which contains characters other than leader/
trailer or blank tape. Be sure the end of the tape is torn smoothly
and squarely. With scissors remove the last inch of sprocket holes,

as in the example which follows. Do not cut into any of the 8 information channels of the tape. This is to prevent extraneous characters from being read from the end of the tape.

DIGITAL EQUIPMENT CORPORATION • PROGRAM
PDP
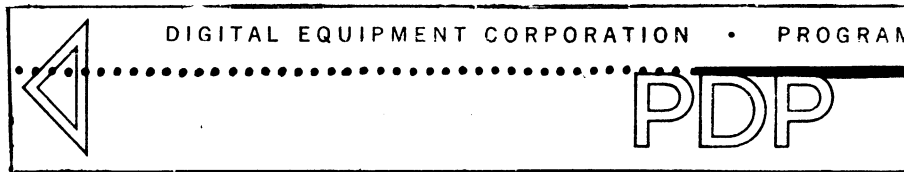
2. Load SS BIN alone according to the procedure described for a normal load. When the tape has run out of the reader, the reader will halt, but the computer will not (the RUN light will be on).

3. If the Teletype reader is being used, set the switch to STOP; if the high speed reader is being used, set the switch to OFF-LINE.

4. Remove the SS BIN tape and insert the object program tape with leader/trailer or blank tape under the read head. Set the reader switch to START if the Teletype is used or ON-LINE if the high speed reader is used. The tape will be loaded in the usual way. If the SS BIN tape has not been trimmed, it may still be used, but the reader must be turned off as in step 3 before the end of the tape is reached.

5.1 PAPERTAPE FORMAT

RIM and SS BIN expect the papertapes to be in the following format:
   1. Leader/trailer (ASCII code 2ØØ).
   2. Self-starting Binary loader in RIM format.
   3. Checksum of SS BIN or two frames of leader/trailer.
   4. Leader/trailer or blank tape.
   5. Program to be loaded, beginning with an origin setting.
       If it is to be loaded into a field other than the field
       of the loaders, it must also begin with a field setting.
   6. An origin setting at the end of the program, if it is to
       be started by SS BIN.
   7. Checksum of the program portion of the tape.
   8. Leader/trailer.

There are 8 channels (or columns) in a papertape.. If the tape is held vertically, with the arrows pointing up, the leftmost channel on the printed side is channel 8; the rightmost is channel 1. The small holes are the sprocket holes. In the examples, 1 signifies a punched hole.

Examples of format:

TAPE CHANNEL	MEANING	NOTES
87 654 S 321 10 000 . 000	leader/trailer	There should be at least an inch where it is required.
11 011 . 000	field setting	Channels 7 and 8 identify a field setting. Channels 4, 5, and 6 contain the number of the field; in this case, 3.
01 000 . 010 00 011 . 100	origin setting	Channel 7 identifies an origin setting. Channels 6, 5, 4, and 3, 2, 1 of both frames indicate the address; in this case, Ø234.
00 111 . 110 00 101 . 100	data word	Two frames are necessary for each 12 bit data word. Channels 7 and 8 of each are not punched. In this case, the word is 7654.

SS BIN itself must be in RIM format. This means that origin and data words are alternated for the length of the tape; for example:

01 111 . 110 00 000 . 000	origin	7600
00 100 . 011 00 010 . 011	data	4323
01 111 . 110 00 000 . 001	origin	7601
00 111 . 000 00 100 . 001	data	7041

The RIM loader places each data word into the location specified by the previous origin.

The object tape must be in binary format. It should begin with an origin setting or with a field setting and an origin setting.

Until a field setting is found, the program will be placed in the same field as SS BIN. The first word of data following the origin will be placed in the location specified by that origin. Successive data words will be placed in sequential locations following that until another origin or more leader/trailer is found. No notice is taken of page boundaries. After location 7777 of a field is loaded, loading continues with location 0 of the same field. The field setting is used to specify into which field the data is to be loaded.

If the object program is to be started by SS BIN, the starting address may be given as an origin setting immediately preceding the checksum. It should be preceded by a field setting. SS BIN will transfer control to the object program at the address indicated with the instruction field and data field equal to the field specified in the latest field setting, or in the field of SS BIN if no field settings were found.

The checksum is a sum of all the frames punched on the tape except the leader/trailer and field settings. For example, the data word 7654 would be added into the checksum as 76+54 or 152 (octal). Any bits carried beyond 12 bits are ignored. The checksum is punched as a data word immediately before the final leader/trailer. As the tape is loaded, SS BIN adds the frames and accumulates its own checksum. When the tape has been loaded, the punched checksum is compared with the one accumulated by the SS BIN. If they are not the same, an error has occurred.

Some assemblers, including PAL III and MACRO-8, will punch error messages into the binary tapes on the Teletype punch if errors occur during assembly. These are preceded and followed by rubouts (ASCII code 377--all 8 channels punched). SS BIN will ignore all data between the rubouts.

6.1 GENERATING TAPES TO BE LOADED WITH SS BIN

The starting address for the object program may be generated with an origin statement as the last statement of the source program. If the source program contains literals, the FIELD pseudo-op should be used to cause the page 0 literals and links to be punched, to punch the field setting, and to supply an origin of 00200. The actual starting address may be supplied after the FIELD pseudo-op.

6

If OS/8 is being used to produce the binary tapes, the /B option of
PIP may be used to combine the binary file of SS BIN and the object
program. The resulting combined file may then be punched as one tape.

If the papertape assemblers are used, SS BIN should be copied first,
and then the punch turned off. The source program may then be assem-
bled. When the assembler is ready to punch the object program, the
punch should be turned on. This will cause the object program to
be punched onto the same tape as SS BIN.

The source tape of SS BIN produces a RIM format tape with a checksum.
SS BIN will cause the RIM loader to ignore this checksum. SS BIN
may, therefore, be assembled with any of the PAL-type PDP-8 assemblers.

```
1
2   /SELF-STARTING BINARY LOADER      .
3
4   /NOVEMBER 1971                          SM
5
6   /COPYRIGHT 1971   DIGITAL EQUIPMENT CORPORATION
7   /      MAYNARD, MASSACHUSETTS 01754
8
```

```
 9          6007           CAF=6007
10          7767           RIMS2=7767
11          7761           RIMR1=7761
12          7776           COUNT=7776
13
14          7600           *7600
15   07600  4332   END,    JMS ASSEMB      /PUT CHECKSUM TOGETHER
16   07601  7041           CIA
17   07602  1352           TAD CKSUM       /GET TOTAL
18   07603  7440           SZA             /GOOD LOAD?
19   07604  7402           HLT             /NO--HALT AND DISPLAY DISCREPENCY
20   07605  1353           TAD SWITCH      /WAS LAST DATA AN ORIGIN?
21   07606  7640           SZA CLA
22   07607  5216           JMP .+7         /NO--DO NOT START EXECUTION
23   07610  6007           CAF             /YES--RESTORE MACHINE STATE TO START
24   07611  1252           TAD FLD
25   07612  7001           IAC
26   07613  3214           DCA .+1         /SET INSTRUCTION FIELD TO LAST LOADED FIELD
27   07614  7402           HLT
28   07615  5747           JMP I ORIGIN    /**EXIT TO LOADED PROGRAM**
29   07616  7402   M376,   HLT
30   07617  6032   BEGIN,  KCC             /LOAD O.K.  NOT SELF START
31   07620  6014           RFC
32   07621  6214           RDF
33   07622  1341           TAD CDF0        /SET FIELD FROM SWITCHES
34   07623  3252           DCA FLD
35   07624  1342           TAD MASK
36   07625  3274           DCA LEAD        /SET UP TO IGNORE BLANK TAPE & LEADER/TRAILER
37   07626  4261           JMS FETCH       /GET FIRST CHARACTER
38   07627  5226           JMP .-1         /IGNORE UNTIL FIRST REAL DATA
39   07630  1343           TAD LT          /CHARACTER IS ORIGIN OR DATA
```

```
 64
 65
 66   07631   3274           DCA LEAD      /NO LONGER IGNORE BLANK TAPE
 67
 68   07632   3352           DCA CKSUM
 69
 70   07633   1346   LOAD,   TAD CHAR
 71
 72   07634   3350           DCA WORD1     /STORE FIRST HALF
 73
 74   07635   4306           JMS READ      /GET SECOND HALF
 75
 76   07636   3351           DCA WORD2     /STORE IT
 77
 78   07637   4261           JMS FETCH     /IS NEXT WORD LEADER/TRAILER?
 79
 80   07640   5200           JMP END       /YES--THIS IS THE CHECKSUM
 81
 82   07641   4332           JMS ASSEMB    /NO--PUT WORD TOGETHER
 83
 84   07642   7420   RESTOR, SNL           /IS IT AN ORIGIN?
 85
 86   07643   5252           JMP FLD       /NO
 87
 88   07644   3347           DCA ORIGIN    /YES--RESET ORIGIN
 89
 90   07645   3353           DCA SWITCH    /RESET ORIGIN SWITCH
 91
 92   07646   1350   SUM,    TAD WORD1
 93
 94   07647   1351           TAD WORD2
 95
 96   07650   1352           TAD CKSUM     /UPDATE CHECKSUM
 97
 98   07651   5232           JMP LOAD
 99
100   07652   7402   FLD,    HLT           /SHOULD CONTAIN CDF N0
101
102   07653   3747           DCA I ORIGIN  /LOAD DATA
103
104   07654   2353           ISZ SWITCH
105
106   07655   0070   C70,    70            /EFFECTIVE NOP
107
108   07656   2347           ISZ ORIGIN
109
110   07657   0177   C177,   177
111
112   07660   5246           JMP SUM
```

```
113          /SUBROUTINE TO FETCH A CHARACTER FROM INPUT TAPE
114          /RETURNS TO CALL+1 IF LEADER/TRAILER
115          /RETURNS TO CALL+2 IF DATA OR ORIGIN
116          /HANDLES FIELD SETTINGS AND RUBOUTS
117
118
119
120   07661  7661    *.
121   07661  0000    FETCH, 0
122   07662  3332    *.    DCA ASSEMB      /RESET RUBOUT SWITCH
123   07663  4306    *.    JMS READ        /FETCH A CHARACTER
124   07664  1216    *.    TAD M376
125   07665  7740    M40,  SMA SZA CLA     /IS IT A RUBOUT?
126   07666  2332    *.    ISZ ASSEMB      /YES--WAS SWITCH -1?
127   07667  1332    *.    TAD ASSEMB
128   07670  7010    *.    RAR             /NO--
129   07671  7630    *.    SZL CLA         /IS RUBOUT SWITCH SET?
130   07672  5263    *.    JMP FETCH+2     /YES--IGNORE CHARACTER
131   07673  1346    *.    TAD CHAR        /CHARACTER IS GOOD DATA
132   07674  7402    LEAD, HLT             /WILL BE TAD M200 OR AND C177
133   07675  7650    *.    SNA CLA         /IS IT LEADER/TRAILER?
134   07676  5661    *.    JMP I FETCH     /YES--RETURN--
135   07677  1346    *.    TAD CHAR
136   07700  1301    *.    TAD M300
137   07701  7500    M300, SMA             /IS IT A FIELD SETTING?
138   07702  5326    *.    JMP FSET        /YES--HANDLE IT
139   07703  2261    *.    ISZ FETCH       /NO--ORIGIN OR DATA
140   07704  7600    M200, 7600            /CLA
141   07705  5661    *.    JMP I FETCH     /--RETURN--
```

```
                                /INPUT ROUTINE
                                /SET BY INITIALIZATION CODE FOR EITHER ASR33 OR HIGH SPEED READER
                                /ENTER WITH AC=0
                                /EXIT WITH CHARACTER IN AC AND IN CHAR
            7706                *.
07706       0000    READ,       0
07707       3376                DCA COUNT       /PREPARE TO TIME OUT
            7710                *.
07710       2376                ISZ COUNT       /IF OUT OF TAPE
07711       5321                JMP WAIT
            7712                *.
07712       6036    NOTAPE,     KRB             /OR RCC=6016
            7713                *.
07713       6031    TAPE,       KSF             /OR RSF=6011
            7714                *.
07714       5310                JMP .-4
            7715                *.
07715       6036                KRB             /OR RCC=6016
07716       3346                DCA CHAR
07717       1346                TAD CHAR
07720       5706                JMP I READ      /--RETURN--
            7721                *.
07721       1265    WAIT,       TAD M40
07722       3344                DCA INIT
07723       2344                ISZ INIT
07724       5323                JMP .-1
07725       5313                JMP TAPE

                                /HANDLER FOR FIELD SETTING
                                /ENTERED FROM FETCH
            7726                *.
07726       0255    FSET,       AND C70         /MASK OUT ALL BUT FIELD NUMBER
07727       1341                TAD CDF0        /GET REST OF CDF
            7730                *.
07730       3252                DCA FLD         /INSERT WHERE IT WILL BE EXECUTED
            7731                *.
07731       5263                JMP FETCH+2
```

```
213        /SUBROUTINE TO ASSEMBLE TWO CHARACTERS INTO ONE WORD FOR STORAGE
214        /ENTER WITH AC=0
215        /EXIT WITH WORD IN AC
216
217
218   7732        *.
219 07732 0000    ASSEMB,   0
220   7733        *.
221 07733 1350              TAD WORD1
222   7734        *.
223 07734 7106              CLL RTL
224   7735        *.
225 07735 7006              RTL
226   7736        *.
227 07736 7006              RTL
228   7737        *.
229 07737 1351              TAD WORD2
230   7740        *.
231 07740 5732              JMP I ASSEMB    /--RETURN--
232        /CONSTANTS
233   7741        *.
234 07741 6201    CDF0,     CDF 0
235   7742        *.
236 07742 0257    MASK,     AND C177
237   7743        *.
238 07743 1304    LT,       TAD M200
```

```
239
240
241                     /INITIALIZATION CODE
242                     /USED ONCE ONLY--MAY BE OVERWRITTEN BY DATA BREAKS
243
244
245                     /TEMPORARY STORAGE LOCATIONS
246                     /MAY ALSO BE OVERWRITTEN BY DATA BREAKS
247
248     07744   7744    *.
249     07744   7200    INIT,   CLA
250             7745    *.
251     07745   1361            TAD RIMR1
252             7746    *.
253     07746   3312    CHAR,   DCA NOTAPE
254             7747    *.
255     07747   1367    ORIGIN, TAD RIMS2
256             7750    *.
257     07750   3313    WORD1,  DCA TAPE
258             7751    *.
259     07751   1361    WORD2,  TAD RIMR1
260             7752    *.
261     07752   3315    CKSUM,  DCA TAPE+2
262             7753    *.
263     07753   1242    SWITCH, TAD RESTOR
264             7754    *.
265     07754   3372            DCA 7772
266             7755    *.
267     07755   5217            JMP BEGIN
268
269                     /STARTING ADDRESS FOR MANUAL START
270             7777    *7777
271     07777   5217            JMP BEGIN
272
273
274                     /LOCATION TO OVERLAY RIM AND START LOADER
275             7772    *7772
276     07772   5344            JMP INIT
277
278                     $
```

```
ASSEMB 7732
BEGIN  7617
CAF    6007
CDF0   7741
CHAR   7746
CKSUM  7752
COUNT  7776
C177   7657
C70    7655
END    7600
FETCH  7661
FLD    7652
FSET   7726
INIT   7744
LEAD   7674
LOAD   7632
LT     7743
MASK   7742
M200   7704
M300   7701
M376   7616
M40    7665
NOTAPE 7712
ORIGIN 7747
READ   7706
RESTOR 7642
RIMR1  7761
RIMS2  7767
SUM    7646
SWITCH 7753
TAPE   7713
WAIT   7721
WORD1  7750
WORD2  7751
279
```