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 76$\emptyset\emptyset$-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 $\emptyset$, will not affect SS BIN. Data may be loaded into fields $\emptyset$-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.

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.
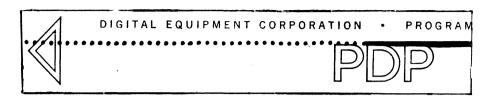
4.1.4 Special Conditions

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.

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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.

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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	leader/trailer	There should be at least
10 000 . 000		an inch where it is re-
		quired.
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	origin setting	Channel 7 identifies an
00 011 . 100		origin setting. Channels
		6, 5, 4, and 3, 2, 1 of
		both frames indicate the
		address; in this case,
		Ø234.
00 111 . 110	data word	Two frames are necessary
00 101 . 100		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	origin	7600
00 000 . 000		
00 100 . 011	data	4323
00 010 . 011		
01 111 . 110	origin	7601
00 000 . 001		
00 111 . 000	data	7041
00 100 . 001		

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 Ø 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 Ø literals and links to be punched, to punch the field setting, and to supply an origin of ØØ2ØØ. The actual starting address may be supplied after the FIELD pseudo-op.

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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    /SELF-STARTING BINARY LOADER                        .
2
3    /NOVEMBER 1971                        SM
4
5    /COPYRIGHT 1971  DIGITAL EQUIPMENT CORPORATION
6    /      MAYNARD, MASSACHUSETTS 01754
7
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            /LOAD O.K.  NOT SELF START
 30    07617 6032          BEGIN,  KCC
 31    07620 6014                  RFC
 32    07621 6214                  RDF
 33    07622 1341                  TAD COF0       /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   7631   3274   *.       DCA LEAD        /NO LONGER IGNORE BLANK TAPE
 67
 68   07632   7632   3352   LOAD,    DCA CKSUM
 69
 70   07633   7633   1346   *.       TAD CHAR
 71
 72   07634   7634   3350   *.       DCA WORD1       /STORE FIRST HALF
 73
 74   07635   7635   4306   *.       JMS READ        /GET SECOND HALF
 75
 76   07636   7636   3351   *.       DCA WORD2       /STORE IT
 77
 78   07637   7637   4261   *.       JMS FETCH       /IS NEXT WORD LEADER/TRAILER?
 79
 80   07640   7640   5200   *.       JMP END         /YES--THIS IS THE CHECKSUM
 81
 82   07641   7641   4332   *.       JMS ASSEMB      /NO--PUT WORD TOGETHER
 83
 84   07642   7642   7420   RESTOR,  SNL             /IS IT AN ORIGIN?
 85
 86   07643   7643   5252   *.       JMP FLD         /NO
 87
 88   07644   7644   3347   *.       DCA ORIGIN      /YES--RESET ORIGIN
 89
 90   07645   7645   3353   *.       DCA SWITCH      /RESET ORIGIN SWITCH
 91
 92   07646   7646   1350   SUM,     TAD WORD1
 93
 94   07647   7647   1351   *.       TAD WORD2
 95
 96   07650   7650   1352   *.       TAD CKSUM       /UPDATE CHECKSUM
 97
 98   07651   7651   5232   *.       JMP LOAD
 99
100   07652   7652   7402   FLD,     HLT             /SHOULD CONTAIN CDF N0
101
102   07653   7653   3747   *.       DCA I ORIGIN    /LOAD DATA
103
104   07654   7654   2353   *.       ISZ SWITCH
105
106   07655   7655   0070   C70,     70              /EFFECTIVE NOP
107
108   07656   7656   2347   *.       ISZ ORIGIN
109
110   07657   7657   0177   C177,    177
111
112   07660   7660   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                    *.
121   07661   0000    FETCH,  0
122                    *.
123   07662   3332            DCA ASSEMB      /RESET RUBOUT SWITCH
124                    *.
125   07663   4306            JMS READ        /FETCH A CHARACTER
126                    *.
127   07664   1216            TAD M376
128                    *.
129   07665   7740    M40,    SMA SZA CLA     /IS IT A RUBOUT?
130                    *.
131   07666   2332            ISZ ASSEMB      /YES--WAS SWITCH -1?
132                    *.
133   07667   1332            TAD ASSEMB
134                    *.
135   07670   7010            RAR             /NO--
136                    *.
137   07671   7630            SZL CLA         /IS RUBOUT SWITCH SET?
138                    *.
139   07672   5263            JMP FETCH+2     /YES--IGNORE CHARACTER
140                    *.
141   07673   1346            TAD CHAR        /CHARACTER IS GOOD DATA
142                    *.
143   07674   7402    LEAD,   HLT             /WILL BE TAD M200 OR AND C177
144                    *.
145   07675   7650            SNA CLA         /IS IT LEADER/TRAILER?
146                    *.
147   07676   5661            JMP I FETCH     /YES--RETURN--
148                    *.
149   07677   1346            TAD CHAR
150                    *.
151   07700   1301            TAD M300
152                    *.
153   07701   7500    M300,   SMA             /IS IT A FIELD SETTING?
154                    *.
155   07702   5326            JMP FSET        /YES--HANDLE IT
156                    *.
157   07703   2261            ISZ FETCH       /NO--ORIGIN OR DATA
158                    *.
159   07704   7600    M200,   7600            /CLA
160                    *.
161   07705   5661            JMP I FETCH     /--RETURN--
```

```
162
163                   /INPUT ROUTINE
164                   /SET BY INITIALIZATION CODE FOR EITHER ASR33 OR HIGH SPEED READER
165                   /ENTER WITH AC=0
166                   /EXIT WITH CHARACTER IN AC AND IN CHAR
167
168          7706         *.
169  07706   0000     READ,   0
170          7707         *.
171  07707   3376             DCA COUNT       /PREPARE TO TIME OUT
172          7710         *.
173  07710   2376             ISZ COUNT       /IF OUT OF TAPE
174          7711         *.
175  07711   5321             JMP WAIT
176          7712         *.
177  07712   6036     NOTAPE, KRB             /OR RCC=6016
178          7713         *.
179  07713   6031     TAPE,   KSF             /OR RSF=6011
180          7714         *.
181  07714   5310             JMP .-4
182          7715         *.
183  07715   6036             KRB             /OR RCC=6016
184          7716         *.
185  07716   3346             DCA CHAR
186          7717         *.
187  07717   1346             TAD CHAR
188          7720         *.
189  07720   5706             JMP I READ      /--RETURN--
190          7721         *.
191  07721   1265     WAIT,   TAD M40
192          7722         *.
193  07722   3344             DCA INIT
194          7723         *.
195  07723   2344             ISZ INIT
196          7724         *.
197  07724   5323             JMP .-1
198          7725         *.
199  07725   5313             JMP TAPE
200
201                   /HANDLER FOR FIELD SETTING
202                   /ENTERED FROM FETCH
203
204          7726         *.
205  07726   0255     FSET,   AND C70         /MASK OUT ALL BUT FIELD NUMBER
206          7727         *.
207  07727   1341             TAD CDF0         /GET REST OF CDF
208          7730         *.
209  07730   3252             DCA FLD          /INSERT WHERE IT WILL BE EXECUTED
210          7731         *.
211  07731   5263             JMP FETCH+2
212
```

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

```
                    /INITIALIZATION CODE
                    /USED ONCE ONLY--MAY BE OVERWRITTEN BY DATA BREAKS

                    /TEMPORARY STORAGE LOCATIONS
                    /MAY ALSO BE OVERWRITTEN BY DATA BREAKS

          7744            *.
07744     7200      INIT,   CLA
          7745            *.
07745     1361              TAD RIMR1
          7746            *.
07746     3312      CHAR,   DCA NOTAPE
          7747            *.
07747     1367      ORIGIN, TAD RIMS2
          7750            *.
07750     3313      WORD1,  DCA TAPE
          7751            *.
07751     1361      WORD2,  TAD RIMR1
          7752            *.
07752     3315      CKSUM,  DCA TAPE+2
          7753            *.
07753     1242      SWITCH, TAD RESTOR
          7754            *.
07754     3372              DCA 7772
          7755            *.
07755     5217              JMP BEGIN

                    /STARTING ADDRESS FOR MANUAL START
                          *7777
07777     5217              JMP BEGIN

                    /LOCATION TO OVERLAY RIM AND START LOADER
                          *7772
07772     5344              JMP INIT

                          $
```

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