

/OPTIMISED 8/9+1 LOCATION INITIAL LOADERS 30/10/67
 /USED TO RESTORE BINARY LOADER AFTER A 'SCREW UP'.
 /THEY LOAD MOST OF BIN LOADER IN ARK FORMAT, THEN
 /TRANSFER CONTROL TO IT TO FINISH OF THE JOB.

/METHOD OF USE:

/ LOAD VERSION TO USE THE REQUIRED READER
 / USING SWITCHES, PUT ARK TAPE IN READER, START
 / AT ADDRESS 7777. PROGRAM SHOULD STOP AT START
 / OF TRAILER CODES ON TAPE WITH PC=7777 & AC=0000
 / IF OPERATION WAS SUCCESSFUL. IF NOT, LOAD & READ AGAIN.

BEND=7770 ; BTEM=36 /DEFINITIONS FOR ASSEMBLER.

/VERSION TO USE HIGH SPEED READER

0010	0007	0105	7	/LOADING POINTER
7770	6014	0BEND;	KFC	/START THINGS MOVING
7771	6011		RSF	/FLAG SET YET ?
7772	5371		JMP BEND+1	/NO, HAVE ANOTHER LOOK
7773	7430		SZL	/COMPLETE WORD ?
7774	3410		DCA I 10	/YES, STORE IT
7775	7106		CLL RTL	/ROTATE 2 PLACES LEFT
7776	6012		KRB	/OR IN NEXT CHAR.
7777	5370		JMP BEND	/REPEAT

/VERSION TO USE TELETYPE READER

0010	0007	AUTO,	*-1	/DON'T FORGET THIS ONE !
		0BEND-1		
7767	7430	BOOT,	SZL	/READY TO STORE ?
7770	3410		DCA I AUTO	/YES
7771	6031		KSF	/FLAG SET ?
7772	5371		JMP *-1	/NO, WAIT FOR IT !
7773	7106		CLL RTL	/MOVE READY FOR NEXT 2 BITS
7774	3036		DCA BTEM	/SAVE ACC
7775	6036		KRB KFC	/CLEAN ACC READ CHAR & FETCH NEXT
7776	1036		TAD BTEM	/ADD ACCUMULATED VALUE
7777	5367		JMP BOOT	/DO IT ALL OVER AGAIN !

AUTO	0010
BEND	7770
BOOT	7767
BTEM	0036

/BINARY LOADER WITH AUTOMATIC READER SELECTION.
 /AND LOAD-AND-RUN FACILITY IC. 8-102-U-SYM
 /CONTAINS INPUT SUBROUTINES AVAILABLE TO ALL PROGRAMS
 / @*: IS USED TO MAKE ASSEMBLER PUNCH IN RIM FORMAT

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@7650
/INPUT SUBROUTINES
R750, XX
M200,F ; F=600 /TO GET M200
7651 7402 XX /INITIALISE TIMER
7652 7200 CLA DCA TIMER
7653 3000 ISZ TIMER
7654 2000 SKP /NO, LOOK AT FLAG
7655 7410 JMP I R750 /YES, RETURN
7656 5650 RSF /FLAG SET YFT ?
7657 6011 JMP *-4 /NO, CHECK TIME AGAIN
7658 5253 RRB RFC /YES, READ CHAR.& FECH NEXT
7660 6016 JMP I R750 /THEN RETURN
7661 5650

R33, XX /FLAG SET YFT ?
7662 7402 KSF. /NO, CHECK AGAIN
7663 6031 JMP *-1 /YES, READ CHAR.& FECH NEXT
7664 5263 KRB KFC /THEN RETURN
7665 6036 JMP I R33
7666 5662

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7667 0012 @*:, R33 - R750 /SHARED VARIABLE LOCATION
CHAR = K33

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/OUTPUT SUBROUTINE
P33, XX
7670 7402 TSF /FLAG SET YET ?
7671 6041 JMP *-1 /NO, CHECK AGAIN
7672 5271 TLS /CLEAR FLAG & PRINT CHAR.
7673 6046 JMP I P33 /THEN RETURN
7674 5670

```

CONTD,

```

/LINKS WITH PROGRAMS ON OTHER PAGES
@0: @0:
@4: @4:
@*: @*:
@*: @*:
R750 R750

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```

@CONTD
/ROUTINE TO READ CHARACTERS IGNORING ERROR
/MESSAGES AND FIELD SETTINGS.
READIN, XX
7675 7402 /RESET RUBOUT SWITCH
7676 7100 CLL /JMS R750 OR JMS R33 TO GET CHAR
7677 7402 XX /SAVE IT
7700 3262 DCA CHAR
7701 1000 TAD TIMER
7702 7650 SNA CLA
7703 5277 JMP *-4 /WAS IT END-OF-TAPE ?
7704 1262 TAD CHAR /YES TRY AGAIN
7705 1337 TAD M377 /RUBOUT OR BETWEEN RUBOUTS
7706 7670 SNA SZL CLA /YES, IGNORE THIS CHAR.
7707 5277 JMP READIN+2
7710 1262 TAD CHAR
7711 0315 AND M100 /LEADER-TRAILER ?
7712 1251 TAD M200 /YES, RETURN TO CALL+1
7713 7450 SNA /FIELD SETTING ?
7714 5675 JMP I READIN /YES, IGNORE THIS CHAR.
7715 7700 SMA CLA /NO, MUST BE BINARY
7716 5276 JMP READIN+1 /RETURN TO CALL+2
7717 2275 ISZ READIN
7720 5675 JMP I READIN

```

/MAIN LOADER ROUTINE

7721	@*:	6014	BFGN,	RFC	/ENTRY POINT
7722	@*:	4250	JMS	R750	
7723	@*:	1000	TAD	TIMER	
7724	@*:	7650	SNA	CLA	/WHICH READER ?
7725	@*:	1267	TAD	LOW	
7726	@*:	1322	TAD	CJMSH	
7727	@*:	3277	DCA	READIN+2	/SET JUMP TO INPUT SR.
7730	@*:	3214	DCA	CHKSUM	/RESET CHECKSUM
7731	@*:	2000	ISZ	TIMER	/SET NON-ZERO IN CASE OF ITY
7732	@*:	4275	JMS	READIN	
7733	@*:	5332	JMP	*-1	/IGNOKE LEADER
7734	@*:	1262	TAD	CHAR	
7735	@*:	3215	DCA	WORD	/SAVE FIRST CHAN OF PAIR
7736	@*:	4275	JMS	READIN	
7737	@*:	7401	-377		/EAE NOP, NORMALLY SKIPPED
7740	@*:	1215	TAD	WORD	
7741	@*:	1262	TAD	CHAR	
7742	@*:	3213	DCA	CKT	/ADD PAIR TOGETHER FOR CHECKSUM
7743	@*:	1215	TAD	WORD	
7744	@*:	7106	CLL	RFL	
7745	@*:	7006	RTL		/ROTATE FIRST ONE OF PAIR
7746	@*:	7006	RTL		/ADD SECOND ONE TO IT
7747	@*:	1262	TAD	CHAR	/TO FORM COMPLETE WORD
7750	@*:	3215	DCA	WORD	
7751	@*:	7250	STA	KAR	/STORE -1 IF LINK SET
7752	@*:	3212	DCA	MEM	
7753	@*:	4275	JMS	READIN	/TRAILER, END OF BLOCK
7754	@*:	5370	JMP	BEND	
7755	@*:	1213	TAD	CKT	
7756	@*:	1214	TAD	CHKSUM	/UPDATE CHECKSUM
7757	@*:	3214	DCA	CHKSUM	
7760	@*:	1215	TAD	WORD	/WAS IT ORIGIN SETTING ?
7761	@*:	2212	ISZ	MEM	
7762	@*:	5365	JMP	*+3	/RESET ORIGIN
7763	@*:	3216	DCA	ORIGIN	
7764	@*:	5334	JMP	GO	/LOAD IT
7765	@*:	3616	DCA	I ORIGIN	
7766	@*:	2216	ISZ	ORIGIN	
7767	@*:	5334	JMP	GO	
7770	@*:	1215	TAD	WORD	/BLOCK END
7771	@*:	7041	CMA	IAC	
7772	@*:	1214	TAD	CHKSUM	
7773	@*:	7450	SNA		/CHECKSUM OK IF AC=0
7774	@*:	2212	ISZ	MEM	/LOAD AND RUN ?
7775	@*:	7412	SKP	HLT	/NO, DISPLAY CHECKSUM ERROR
7776	@*:	5616	JMP	I ORIGIN	/YES, GO EXECUTE PROGRAM
7777	@*:	5321	JMP	BEGN	

/VARIABLE STORAGE

7612	@7612	MEM,	XX
7613	@*:	CKT,	XX
7614	@*:	CHKSUM,	XX
7615	@*:	WORD,	XX
7616	@*:	ORIGIN,	XX

/END OF PROGRAM
PAUSE

BEGN	7721
BEND	7770
CHAR	7662
CHKSUM	7614
CJMSH	7722
CKT	7613
CONTD	7675

A Note on the New System for Loading the PDP-8 Binary Loader

Introduction

The PDP-8 has no hardware read-in or bootstrap facilities to get the normal binary loader into core when it has been accidentally overwritten. DEC supply a 16 instruction loader-loader which will read a tape in RIM format (this is used to load the BIN loader and some maintenance programs). A shorter (9 + 1 locations) loader has been developed which will load the binary loader in 'ARK' format. This note describes the techniques used.

Description

A paper tape loader must include the following

functions:

- a) Differentiate between the leader/trailer (needed to thread the reader) and the body of the tape.
- b) Assemble one or more tape characters to form a complete computer word.
- c) Know when in memory to store each word.
- d) Stop when loading is complete.

It may also test for a correct checksum or parity etc.

The methods of meeting these requirements with the simplest possible program are described below.

- a) and b) To produce a 12 bit word needs at least 2, 8 bit tape characters. In BIN and RIM formats 6 bits of each tape character are used, the first being rotated six places left before being 'ORed' with the second to get the complete word. If however 2 bits of each character are used (needing 4 characters to form a 12 bit word) they can be combined using

a single RIM instruction each time. If this is combined in a loop with the read instructions we need to count $\frac{4}{100\%}$ iterations of the loop to know when a complete word has been assembled. This can be done neatly by punching the 100% ~~third~~ bit of the first character of the group of 4, this will be shifted into the link when the complete word is assembled; it also enables us to ignore blank loader.

c) There are several methods of defining where each word should be stored - successive words may be stored in sequential addresses starting at a defined one, or each address may be defined individually (as in RIM). In the first case the 'origin' may be defined in the loader or from special codes on the tape (e.g. the 100% bit punched as in RIM-BIN). The method chosen for ARX format is to make the first word on the tape the address definition and to load in successive locations thereafter. This can be handled by storing via an auto index register and initialising so that the first word is stored in the auto index register itself.

d) There are several ways of deciding when loading is complete - the program may read to the physical end of tape (as in RIM) - it may detect trailer words (as in BIN) - it may count the words it is loading, or it may overwrite itself with the program it is loading. The latter is the one chosen as it results in the simplest possible program. This means that the program must be located at the end of the area occupied by the BINARY loader, and can therefore use the same starting address which is convenient.

There is of course no checksum or parity check in this format.

The basic loop is therefore:

Wait for reader and or char into acc.

```
SZL
DCA I AUTO
CLL RFL
JMP * - 4
010
AUTO, * - 1
```

For the high speed reader version the RRE instruction will or the character into the ACC, however reader motion needs to be initiated with a RPC instruction.

For the teletype reader version tape motion is initiated by pressing start, however KPC (needed to fetch next character) clears the accumulator, so the acc. needs to be saved while it is issued.

Because of these considerations ^{the} ~~both~~ versions use ^{respectively} 8 + 9 instructions, and the auto index register.

The versions shown in the listing have been optimised for minimum switch juggling when loading.

Details of operation

The first word of the ARM tape is the address - 1 of the start of the area occupied by the BINARY loader. The loader then loads the main part of BIN up to 7766; in 7767 and 7770 it loads SZLSPA and JMP BGN+1 respectively. When the JMP is executed control is transferred to the binary loader which loads the rest of itself (in BIN format) into 7767 - 7777 (JMP GO is initially duplicated in 7770 to enable loading into 7777, then 7770 is altered to normal) and the links in 0004 - 0006. This completes the operation. The program should halt PC = 7777 AC = 0, ready for use of the binary loader.

/BINARY LOADER WITH AUTOMATIC READER SELECTION.
 /AND LOAD-AND-RUN FACILITY IC. 8-102-U-SYM
 /CONTAINS INPUT SUBROUTINES AVAILABLE TO ALL PROGRAMS
 /VERSION ARRANGED FOR ARK FORMAT INITIAL LOADER

```

07650
/INPUT SUBROUTINES
R750, XX
M200, F
7402 ;F=400 /TO GET M200
7651 /INITIALISE TIMER
7652 /TIME UP ?
7653 /NO, LOOK AT FLAG
7654 /YES, RETURN
7655 /FLAG SET YET ?
7656 /NO, CHECK TIME AGAIN
7657 /YES, READ CHAR.& FETCH NEXT
7660 /THEN RETURN
7661

```

```

R33, XX
7402 /FLAG SET YET ?
7663 /NO, CHECK AGAIN
7664 /YES, READ CHAR.& FETCH NEXT
7665 /THEN RETURN
7666

```

```

7667 0012 LOW , R33 - R750,
CHAR = R33 /SHARED VARIABLE LOCATION

```

```

/OUTPUT SUBROUTINE
P33, XX
7402 /FLAG SET YET ?
7671 /NO, CHECK AGAIN
7672 /CLEAR FLAG & PRINT CHAR.
7673 /THEN RETURN
7674

```

/ROUTINE TO READ CHARACTERS IGNORING ERROR
 /MESSAGES AND FIELD SETTINGS.

```

READIN, XX
7402 /RESET RUBOUT SWITCH
7676 /JMS R750 OR JMS R33 TO READ CHAR.
7677 /SAVE IT
7700 /WAS IT END-OF-TAPE ?
7701 /YES TRY AGAIN
7702 /RUBOUT OR BETWEEN RUBOUTS
7703 /YES, IGNORE THIS CHAR.
7704 /LEADER-TRAILER ?
7705 /YES, RETURN TO CALL+1
7706 /FIELD SETTING ?
7707 /YES, IGNORE THIS CHAR.
7710 /NO, MUST BE BINARY
7711 /RETURN TO CALL+2
7712
7713
7714
7715
7716
7717
7720

```

```

7721 6014 /MAIN LOADER ROUTINE
7722 4250 BEGN, RFC /ENTRY POINT
7723 1000 CJMSH, JMS R750 /WHICH READER ?
7724 7650 SNA CLA /SET JUMP TO INPUT SR.
7725 1267 TAD LOW DCA CHKSUM /RESET CHECKSUM
7726 1322 TAD CJMSH /SET NON-ZERO IN CASE OF TTY
7727 3277 DCA READIN+2 /IGNORE LEADER
7730 3214 DCA CHKSUM /SAVE FIRST CHAR OF PAIR
7731 2000 ISZ TIMER /EAE NOP, NORMALLY SKIPPED
7732 4275 JMS READIN+ /ADD PAIR TOGETHER FOR CHECKSUM
7733 5332 JMP *-1 CLL RTL ; RTL ; ROTATE FIRST ONE OF PAIR
7734 1262 TAD CHAR /ADD SECOND ONE TO IT
7735 3215 DCA WORD /TO FORM COMPLETE WORD
7736 4275 JMS READIN /STORE -1 IF LINK SET
7737 7401 -377 JMP BEND /TRAILER, END OF BLOCK
7740 1215 TAD WORD /UPDATE CHECKSUM
7741 1262 TAD CHAR /WAS IT ORIGIN SETTING ?
7742 3213 DCA CKT DCA ORIGIN /RESET ORIGIN
7743 1215 TAD WORD JMP GO /LOAD IT
7744 7106 CLL RTL ; RTL ; ROTATE FIRST ONE OF PAIR
7745 7006 TAD CHAR /END OF SECTION OF BIN LOADER LOADED BY ARK INITIAL LOADER
7746 7006 DCA WORD /NEEDED FOR TTY VERSION OF ARK LOADS
7747 1262 STA RAR JMP BEGN /TRANSFER FROM ARK TO BIN LOADER RTN
7750 3215 DCA MEM JMS READIN /SECTION TO BE LOADED BY BINARY LOADER
7751 7250 JMS READIN @BEND-1 JMP GO /THIS ENABLES LOADING INTO 7777
7752 3212 JMP BEND CIA TAD CHKSUM /CHECKSUM OK IF AC.=0
7753 4275 TAD CKT SNA /LOAD AND RUN ?
7754 5370 TAD CKT ISZ MEM /NO, DISPLAY CHECKSUM ERROR
7755 1213 TAD CHKSUM JMP I ORIGIN /YES, GO EXECUTE PROGRAM
7756 1214 DCA CHKSUM JMP BEGN /R750 SETS THIS =0 FOR EOT.
7757 3214 TAD WORD /SECTION TO BE LOADED BY BINARY LOADER
7760 1215 ISZ MEM @BEND-1 JMP GO
7761 2212 JMP GO BEND, JMP GO /THIS ENABLES LOADING INTO 7777
7762 5365 DCA ORIGIN CIA TAD CHKSUM /CHECKSUM OK IF AC.=0
7763 3216 JMP GO SNA /LOAD AND RUN ?
7764 5334 DCA I ORIGIN ISZ MEM /NO, DISPLAY CHECKSUM ERROR
7765 3616 ISZ ORIGIN JMP I ORIGIN /YES, GO EXECUTE PROGRAM
7766 2216 JMP BEGN /R750 SETS THIS =0 FOR EOT.

7767 7530 /END OF SECTION OF BIN LOADER LOADED BY ARK INITIAL LOADER
7770 5321 BEND, SZL SPA /NEEDED FOR TTY VERSION OF ARK LOADS
JMP BEGN /TRANSFER FROM ARK TO BIN LOADER RTN

/SECTION TO BE LOADED BY BINARY LOADER
@BEND-1 JMP GO /THIS ENABLES LOADING INTO 7777
BEND, JMP GO /CHECKSUM OK IF AC.=0
CIA TAD CHKSUM /LOAD AND RUN ?
SNA /NO, DISPLAY CHECKSUM ERROR
ISZ MEM /YES, GO EXECUTE PROGRAM
SKP HLT /R750 SETS THIS =0 FOR EOT.
JMP I ORIGIN
JMP BEGN
XX

TIMER,
@4; P33
0004 7670 R33
0005 7662 R750
0006 7650

7770 1215 @BEND; TAD WORD /SET TO PROPER CONTENTS

/DEFINITIONS (STORAGE NOT INITIALISED)
MEM = 7612
CKT = MEM+1
CHKSUM= CKT+1
WORD = CHKSUM+1

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