

BYTESAVER

ASSEMBLY MANUAL



Cromemco

Specialists in computer peripherals

2432 Charleston Rd., Mountain View, CA 94043 • (415) 964-7400

BYTESAVER ASSEMBLY INSTRUCTIONS

The Cromemco BytesaverTM kit can be assembled in about one evening. All components are mounted on the component side of the pc board (the side with the printed legend) and soldered on the opposite side. Be sure to use high-quality rosin core solder for the assembly and a fine-tipped low wattage soldering iron.

() Solder in position the 10 14-pin IC sockets, the 6 16-pin IC sockets, and 8 24-pin IC sockets.

() Solder in position the $\frac{1}{4}$ watt resistors:

R1	47K	yellow-violet-orange
R2	10K	brown-black-orange
R3	180	brown-gray-brown
R4	1K	brown-black-red
R5	9.1K	white-brown-red
R6	1.5K	brown-green-red
R7	1K	brown-black-red
R8	47	yellow-violet-black
R9	1K	brown-black-red
R10	10	brown-black-black
R11	5.6K	green-blue-red
R12	5.6K	green-blue-red
R13	10K	brown-black-orange
R14	5.6K	green-blue-red
R15	180	brown-gray-brown
R16-R39	18K	brown-gray-orange

() Next install the 1N914 diodes. NOTE we recommend that no diode be installed in the diode position just below transistor Q0. When using the Bytesaver we recommend that the PROM containing the Bytemover software be inserted in PROM position zero. By not installing this diode there will be no chance of accidentally programming this PROM.

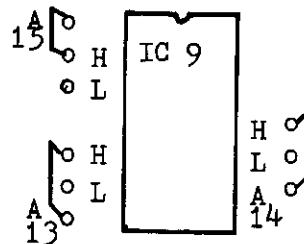
When installing the diodes be careful to orient them properly, noting the position of the cathode (banded) end. Due to the close spacing of the holes in the pc board, the diodes should be mounted on end.

() Now install the 23 capacitors as shown on the pc board. Be careful that the electrolytic capacitors are oriented with the positive (+) end as shown.

() Now solder the transistors in place taking care to orient them properly. Note that Q8 and Q9 are 2N3906 transistors, and Q10 is a type MPS6560. All other transistors are type 2N3904.

() Install the pc board switch, SW1, in the upper left corner of the board.

- () Install the Cromemco high-speed pulse transformer, model XT8K, in position T1. Note that the leads are asymmetrically positioned so that there is only one correct orientation of the transformer.
- () Now install IC14, the positive twelve volt regulator IC, using a 6-32 X $\frac{1}{4}$ screw and nut.
- () Next install the heatsink in the upper right corner of the board just starting the nuts on the 6-32 x 3/8 screws. Install IC12 and IC 13 being sure to place the insulating washer between IC13 and the heat sink. The nylon screw must be used to hold IC13 in place. (The insulating washer supplied may have to be trimmed with a pair of scissors to clear the protrusions of the heatsink.) Tighten the nuts on the screws in the heatsink assembly only after all screws have been inserted. Take care that the leads on the voltage regulators do not come in contact with sides of the openings in the heatsink.
- () Next install three jumper wires to select where the Bytesaver is to reside in memory space. Each of the three high order address lines (A15, A14, and A13) may be tied either to the corresponding "H" or "L" terminal. For the Bytesaver to reside in the top 8K of memory space, for example, the three jumper wires would be installed as shown:



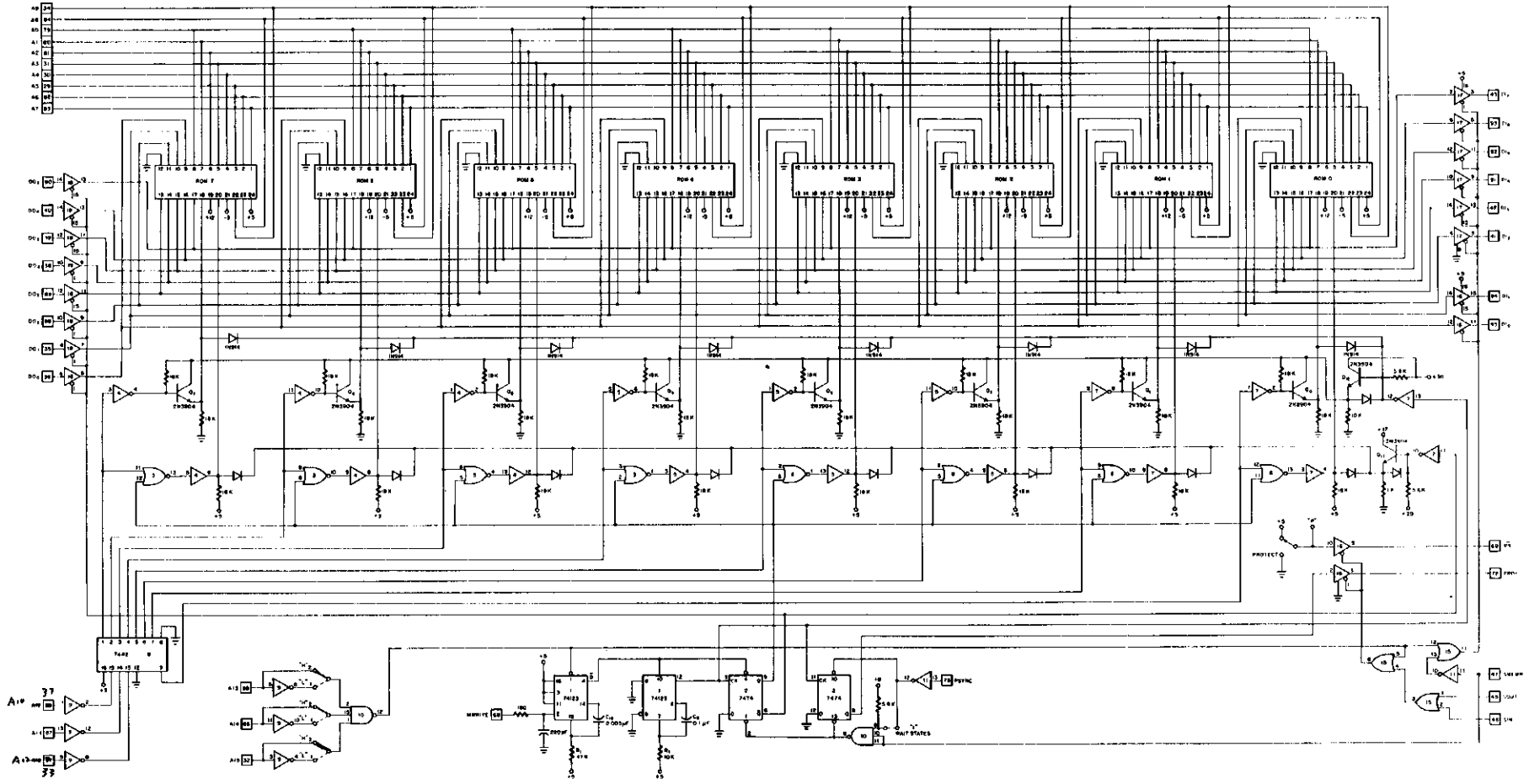
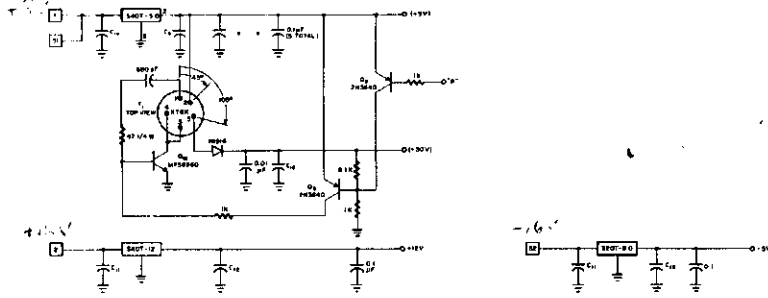
- () Now install the ICs in their sockets being careful to orient pin one of each IC as shown by the small white dot on the pc board at each IC position. Install a PROM containing Bytemover software in PROM position 0.

The assembly of your Bytesaver is now complete. Detailed operating instructions are given in the Bytemover software manual.

PROM AVAILABILITY: Additional 2704 and 2708 PROMs are available from Cromemco. The 2704 is \$50 each, and the 2708 is \$75. Our PROMs are factory fresh, full speed devices that we purchase directly from the manufacturer.

WAIT STATE: Should you wish to use low speed 2704 or 2708 PROMs in your Bytesaver (with access times greater than 450 ns) there is a provision for a wait state. Simply insert a jumper wire, as shown, between IC10 and IC11. No jumper wire need be inserted here when using full-speed PROMs.

REPAIR: If for any reason you need service on your Bytesaver, you may return it to Cromemco along with a check for \$35. The \$35 covers the cost of repair and return postage. We reserve the right to not repair any Bytesaver that we judge to be unserviceable.



BYTEMOVER

SOFTWARE FOR THE CROMEMCO BYTESAVER



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CROMEMCO BYTEMOVER 3.1 OPERATING INSTRUCTIONS

Cromemco BYTEMOVER software is designed to be used with the Cromemco 8K BYTESAVER. When you purchase a Bytesaver with one 2704 PROM, the Bytemover software comes preprogrammed in the 2704 PROM.

The 2704 PROM containing the Bytemover software is normally inserted into PROM location 0 on the Bytesaver board. The Bytemover software can be used to program a PROM in any of the PROM locations on the Bytesaver board. The Bytemover software can also be used to transfer programs from PROM to RAM. The operation of the Bytemover software is controlled by the setting of the front panel sense switches on the Altair computer. To use the Bytemover software there must be a RAM board in the Altair beginning at location zero in memory; further, this RAM board must be unprotected for proper execution of the Bytemover software.

STEP-BY-STEP INSTRUCTIONS

- 1) Before using the Bytesaver you must install three jumper wires to set the location of the Bytesaver in memory space. This is shown in Figure 1. The assembled Bytesaver comes with A13, A14, and A15 each tied to the corresponding "Hi" pad to position the board at the very top of memory. In the following instructions it is assumed that this is the jumper connection used.
- 2) With the Altair 8800 power turned off, plug the Bytesaver board into the computer.
- 3) Be sure that the program power on the Bytesaver is turned OFF (program power switch in the down position.)
- 4) Turn on the Altair. Raise the reset switch, then raise the stop switch, and then raise the reset switch once again to initialize the Altair.
- 5) Raise address switches A15, A14, and A13. All other address switches should be down.
- 6) Raise the examine switch. You are now examining the contents of the first byte of PROM in PROM location zero of the Bytesaver memory board (memory location 340 000). If the PROM supplied with your Bytesaver is in this PROM location the data lights will read "061", the first byte of the Bytemover program.

EXAMPLE: Transfer the Bytemover program from PROM to RAM beginning at location zero in RAM.

- 1) Raise the reset switch.
- 2) Depress the unprotect switch (on the Altair front panel).
- 3) Raise A15, A14, and A13. Raise the examine switch. The data lights should read "061" octal.

4) Now set the sense switches for the task to be done, referring to Fig. 2.

A15 - Down	to transfer from PROM to RAM
A14 - Down	for the transfer of 1K bytes.
A13 - Down	All down since we are transferring from the same PROM that contains BYTEMOVER (PROM 0)
A12 - Down	
A11 - Down	
A10 - Down	
A9 - Down	All down for storage to begin at location zero in RAM.
A8 - Down	

5) Push the run switch. In less than one second the contents of PROM will be transferred to RAM. (Of course the contents of the PROM are unaffected by this operation.)

6) Raise the STOP switch.

7) Raise the reset switch. Note that the data lights read "061".

EXAMPLE: Program a 2708 PROM inserted in PROM location 1. This PROM is to be programmed with the contents of the first 1K bytes of RAM beginning at location zero in memory. The Bytemover software is still in the PROM in PROM location zero on the Bytesaver board.

1) Raise the reset switch.

2) Depress the unprotect switch (on the Altair front panel)

3) Raise A15, A14, and A13. Raise the examine switch. The data lights should read "061" octal.

4) Raise the protect switch on the Bytesaver board (i.e. program power switch to the ON position). The protect light on the Altair front panel should go off when this switch is raised.

5) Now set the sense switches for the task to be done:

A15 - Up	to program a PROM
A14 - Down	(always down for PROM programming)
A13 - Down	To select the PROM 1K higher in memory than the PROM that contains BYTEMOVER
A12 - Down	
A11 - Up	
A10 - Down	
A9 - Down	All down for transfer to begin at location zero in RAM.
A8 - Down	

6) Push the RUN switch. Note that panel light A9 is blinking at a rate of about twice per second. When this light stops blinking the PROM programming is complete.

7) Raise the STOP switch.

8) Now note the INTE light on the Altair front panel. If this light is on, the BYTEMOVER VERIFIER has verified that the contents of the programmed PROM are indeed identical to the contents of the selected 1K bytes of RAM. If this light is off, the PROM has not programmed correctly; this could be due, for example, to a defective PROM.

EXAMPLE: Altair 8K BASIC can be stored in seven 2708 PROMs. Given that these seven PROMs are in PROM locations 1 through 7 on the BYTESAVER board, 8K BASIC can easily be transferred into RAM using the following procedure:

- 1) Raise the RESET switch.
- 2) Depress the unprotect switch (on the Altair front panel).
- 3) Raise A15, A14, and A13. Raise the examine switch. The data lights should read "061" octal.
- 4) Now set the sense switches for the task to be done:
 - A15 - Down to transfer from PROM to RAM.
 - A14 - Up for a 7K transfer
 - A13 - Down
 - A12 - Down
 - A11 - Up
 - A10 - Down
 - A9 - Down
 - A8 - DownTo begin transfer from the PROM 1K higher in memory than the BYTEMOVER program.
All down for storage to begin at location zero in RAM.
- 5) Push the RUN switch. In less than one second BASIC will be loaded into RAM (it sure beats paper tape!). Raise the STOP switch.

EXAMPLE: If you do not have BYTEMOVER in PROM, you can program a PROM with BYTEMOVER that is stored in RAM. The BYTEMOVER software (a listing of which is attached) must first be loaded into RAM beginning at location zero in memory. The BYTEMOVER software can then be burned into a PROM using the following procedure:

- 1) Raise the reset switch.
- 2) Depress the unprotect switch (on the Altair front panel).
- 3) Insert an erased PROM into PROM location 0 on the BYTESAVER board.
- 4) Examine location 000 240 in memory.
- 5) Raise the program power switch on the BYTESAVER board.
- 6) Set the sense switches with A15 and A14 and A13 up.
- 7) Push the RUN switch. When light A9 stops blinking the programming is complete. The INTE light will be on to verify correct programming.
- 8) Turn off PROM program power by depressing the switch on the BYTESAVER.

ERASING PROMS: The 2704 and 2708 PROMs are erased by shining intense UV light through their quartz window. One such UV source, the UV-85 PROM ERASER, is available for \$37.50 from the BYTE SHOP, 1063 El Camino Real, Mountain View, CA 94040.

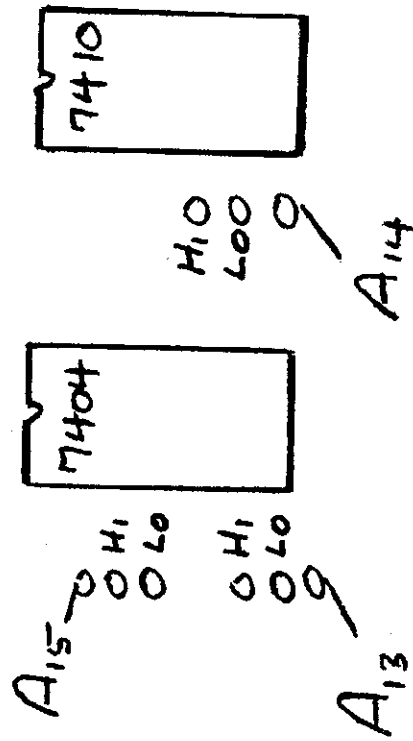


Fig. 1. How to set the Bytesaver address in memory. The built Bytesaver comes with A15, A14, and A13 connected to the corresponding "Hi" terminals so that memory address occurs when these three bits are high. Any or all of these address lines may be connected to the corresponding "Lo" terminal to move the memory board lower in memory. There are thus eight positions in memory that this board can be used.

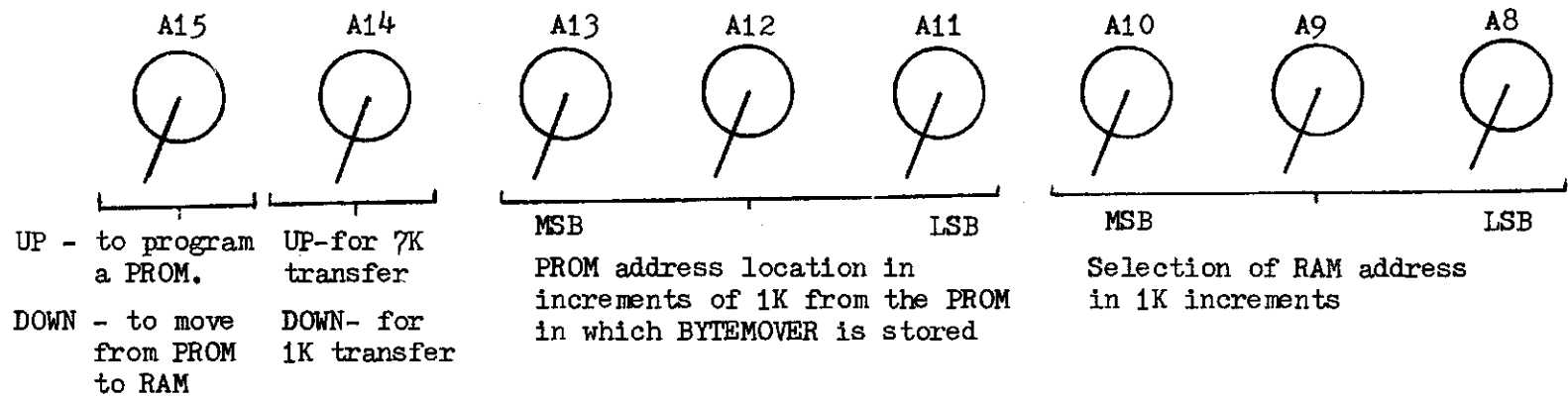
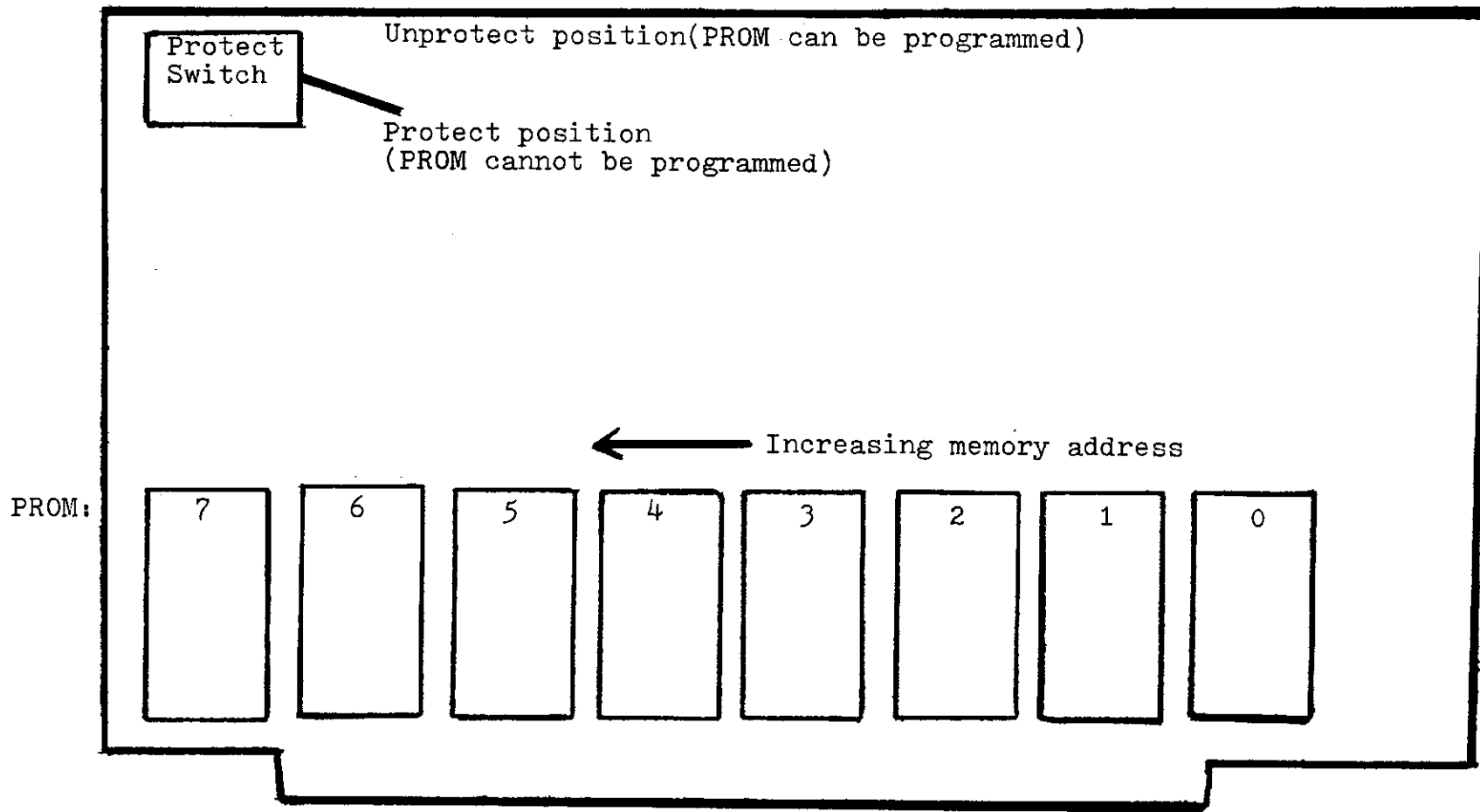


FIGURE 2. FUNCTION OF THE SENSE SWITCHES IN THE BYTEOVER PROGRAM.

Fig. 3. Bytesaver physical layout.



BYTEMOVER ASSEMBLY LANGUAGE LISTING

0000		0000 * BYTEMOVER (T.M.) SOFTWARE FOR
0000		0001 * CROMEMCO 8K BYTESAVER (T.M.)
0000		0002 * VERSION 3.1
0000		0003 * SELF-RELOCATING SOFTWARE LOCATABLE AT ANY
0000		0004 * 1024 BYTE (1K) BOUNDARY IN MEMORY
0000		0009 * ROUTINE TO FIND ONESELF IN MEMORY
0000		0010 SP EQU 6
0000		0019 * DEFINE FIRST 4 BYTES IN MEMORY AS STACK
0000	31 00 00	0020 LXI SP, 0
0003		0029 * SAVE FIRST FOUR BYTES IN REGISTERS
0003	C1	0030 POP B
0004	D1	0040 POP D
0005		0049 * REPLACE BYTE 0 WITH A 'RETURN'
0005	2E C9	0050 MVI L, 0C9H
0007	F3	0051 DI
0008	E5	0060 PUSH H
0009	E5	0070 PUSH H
000A	00	0080 NOP
000B	00	0081 NOP
000C	00	0082 NOP
000D	31 04 00	0090 LXI SP, 4
0010	CD 00 00	0100 CALL 0
0013		0101 * ROM LOCATION NOW IN BYTE 3
0013	31 02 00	0110 LXI SP, 2
0016	E1	0120 POP H
0017		0129 * RETURN BYTES 0-3
0017	31 04 00	0130 LXI SP, 4
001A	D5	0140 PUSH D
001B	C5	0150 PUSH B
001C		0159 * STORE ROM LOCATION IN SP
001C	F9	0160 SPHL
001D	0E 00	0170 MVI C, 0
001F	59	0180 MOV E, C
0020	69	0190 MOV L, C
0021		0199 * INPUT SENSE SW COMMANDS
0021	DB FF	→ 0200 IN 255
0023	57	0210 MOV D, A
0024		0219 * STRIP RAM ADDRESS
0024	E6 07	0220 ANI 7
0026	07	0230 RLC
0027	07	0240 RLC
0028		0249 * STORE RAM ADDRESS IN BC
0028	47	0250 MOV B, A
0029	7A	0260 MOV A, D
002A		0269 * STRIP ROM ADDRESS
002A	E6 38	0270 ANI 56
002C	0F	0280 RRC
002D	00	0290 NOP
002E	67	0300 MOV H, A
002F	39	0310 DAD SP
0030	2E 00	0320 MVI L, 0
0032	7A	0330 MOV A, D
0033	EB	0340 XCHG
0034		0341 * ADDRESS OF ROM BEING PROCESSED IN DE
0034		0349 * BRANCH TO TRANSFER OR PROGRAM ROUTINE

0034	E6	80	0350	ANI	128
0036	0F		0360	RRC	
0037	0F		0370	RRC	
0038	C6	2D	0380	ADI	45
003A	21	00 00	0390	LXI	H, 0
003D	6F		0400	MOV	L, A
003E	39		0410	DAD	SP
003F	E9		0420	PCHL	
0040			0500	* ROUTINE TO TRANSFER ROM TO RAM	
0040	F9		0510	SPHL	
0041	21	0B 00	0520	LXI	H, 11
0044	39		0530	DAD	SP
0045	EB		0550	XCHG	
0046	F9		0560	SPHL	STACK CONTAINS ROM LOCATION
0047	EB		0570	XCHG	H&L CONTAIN LOOP ADDRESS
0048	11	00 00	0580	LXI	D, 0
0048			0588	* START OF TRANSFER LOOP	
0048			0589	* INCREMENT ROM ADDRESS	
004B	3B		0590	DCX	SP
004C			0599	* MOVE DATA FROM ROM TO RAM	
004C	F1		0600	POP	6
004D	02		0610	STAX	B
004E			0619	* INCREMENT RAM ADDRESS	
004E	03		0620	INX	B
004F			0629	* INCREMENT BYTE COUNT	
004F	13		0630	INX	D
0050	7A		0640	MOV	A, D
0051	E6	04	0650	ANI	4
0053	07		0660	RLC	
0054	07		0670	RLC	
0055	00		0680	NOP	
0056	85		0690	ADD	L
0057	6F		0700	MOV	L, A
0058	E9		0710	PCHL	
0059	00		0716	NOP	
005A	00		0717	NOP	
005B			0719	* JUMP TO 00B1 FROM TRANSFER ROUTINE	
005B	3E	56	0720	MVI	A, 56H
005D	85		0725	ADD	L
005E	6F		0730	MOV	L, A
005F	E9		0740	PCHL	
0060			1000	* ROUTINE TO PROGRAM ROM	
0060	00		1010	NOP	
0061			1019	* MOVE RAM ADDRESS INTO HL	
0061	69		1020	MOV	L, C ; ZERO
0062	7C		1030	MOV	A, H ; ZERO
0063	60		1040	MOV	H, B ; ZERO
0064			1049	* MOVE RAM ADDRESS INTO SP	
0064	F9		1050	SPHL	; ZERO
0065	67		1060	MOV	H, A ; ZERO
0066	2E	6B	1070	MVI	L, 107 ; 6BH
0068			1079	* INCREMENT RAM ADDRESS	
0068	01	00 00	1080	LXI	B, 0 ; ZERO B & C
006B			1089	* INCREMENT RAM ADDRESS	
006B	3B		1090	DCX	SP
006C			1098	* USE STAX AND POP 6 (PSW)	
006C			1099	* TO MOVE DATA FROM ROM TO RAM	

006C	F1	1100	POP 6
006D	12	1110	STAX D
006E		1119	* INCREMENT ROM ADDRESS
006E	13	1120	INX D
006F		1129	* INCREMENT BYTE COUNT
006F	03	1130	INX B
0070		1138	* B STORES TWO CONSTANTS
0070		1139	* # COMPLETE PASSES & IN ROM CNT
0070	7B	1140	MOV A, B
0071		1149	* # PASSES = 32 ?
0071	FE FC	1150	CPI 252
0073	3F	1160	CMC
0074	1F	1170	RAR
0075	1F	1180	RAR
0076		1198	* SET 64 TO 0 FOR TWO MINUTE TIMER VERSION
0076	E6 40	1200	ANI 64
0078		1201	* A=64 IF COMPLETED 32 PASSES
0078	2E 7D	1205	MVI L, 7DH
007A	85	1210	ADD L
007B	6F	1220	MOV L, A
007C	E9	1225	PCHL
007D	2E 6B	1226	MVI L, 6BH
007F	7B	1230	MOV A, B
0080	E6 04	1240	ANI 4
0082		1241	* A=4 IF END OF 1024 BYTE PASS
0082	07	1250	RLC
0083	07	1260	RLC
0084	07	1270	RLC
0085	85	1280	ADD L
0086	6F	1290	MOV L, A
0087		1291	* GO BACK TO 1090 UNLESS OVERFLOW
0087		1292	* THEN GO TO 1380 FOR
0087		1293	* ADDRESS SUBTRACTION
0087		1294	* OR 2135 FOR QUIT
0087	E9	1300	PCHL
0088	00	1350	NOP
0089	00	1360	NOP
008A	00	1370	NOP
008B		1378	* ANOTHER PROGRAM PASS TO BE DONE
008B		1379	* ADJUST ROM AND RAM ADDRESSES
008B	7C	1380	MOV A, H
008C	21 00 FC	1390	LXI H, 64512
008F		1399	* SUBTRACT 1024 FROM ROM ADDRESS
008F	39	1400	DAD SP
0090	F9	1410	SPhL
0091	21 00 FC	1420	LXI H, 64512
0094		1429	* SUBTRACT 1024 FROM RAM ADDRESS
0094	19	1430	DAD D
0095	EB	1440	XCHG
0096	67	1450	MOV H, A
0097	2E 6B	1460	MVI L, 107
0099	7B	1470	MOV A, B
009A	E6 FB	1480	ANI 248
009C		1489	* INCREMENT PASS COUNTER BY ONE
009C	C6 0B	1490	ADI 8
009E	47	1495	MOV B, A
009F		1499	* GO BACK TO 1090

009F E9	1500 PCHL
00A0	2000 * ROUTINE TO LOAD BYEMOVER INTO ROM
00A0 DB FF	* 2010 IN 255 ; IN SENSE (A15, H, 30F)
00A2 47	2020 MOV B, A ; MOV B TO C REG
00A3 E6 E0	2030 ANI 224 ; STRIP A9 FROM A12
00A5 1E 00	2040 MVI E, 0 ; ZERO E REG
00A7 4B	2050 MOV C, E ; ZERO C REG
00A8 57	2060 MOV D, A ; MOVE E0 TO D REG
00A9 7B	2070 MOV A, B ; MOVE B TO ACCUM.
00AA E6 1F	2080 ANI 31 ; CHECK SENSE SW. A8 THRU A15. (THEY FAIL)
00AC 47	2090 MOV B, A ; ZERO
00AD 67	2100 MOV H, A ; ZERO
00AE 2E 60	2110 MVI L, 96 ; 60H
00B0 E9	2120 PCHL ; GO TO 60H (ROUTINE TO RECEIVE ROM)
00B1	2121 * CHECK FOR 7K TRANSFER OF ROM TO RAM
00B1 C6 1A	2122 ADI 1AH
00B3 6F	2123 MOV L, A
00B4 DB FF	* 2124 IN 255
00B6 E6 40	2125 ANI 64
00B8 0F	2126 RRC
00B9 0F	2127 RRC
00BA 85	2128 ADD L
00BB 6F	2129 MOV L, A
00BC E9	2130 PCHL
00BD	2133 * PROGRAMMER VERIFICATION ROUTINE
00BD	2134 * PART 1
00BD 7C	2135 MOV A, H
00BE 21 00 FC	2145 LXI H, 64512
00C1 39	2155 DAD SP
00C2 F9	2165 SPHL
00C3 2E CD	2175 MVI L, OCDH
00C5 67	2185 MOV H, A
00C6 E9	2195 PCHL
00C7 00	2205 NOP
00C8 00	2210 NOP
00C9 00	2215 NOP
00CA 00	2220 NOP
00CB	2229 * ROM TO RAM TRANSFER STOP ROUTINE
00CB FB	2230 EI
00CC E9	2240 PCHL
00CD	2248 * PROGRAMMER VERIFICATION ROUTINE
00CD	2249 * PART 2
00CD 7C	2250 MOV A, H
00CE 21 00 FC	2260 LXI H, 64512
00D1 19	2270 DAD D
00D2 EB	2280 XCHG
00D3 2E F1	2290 MVI L, 0F1H
00D5 67	2300 MOV H, A
00D6 01 00 00	2310 LXI B, 0
00D9 E9	2320 PCHL
00DA 00	2625 NOP
00DB	2629 * 7K TRANSFER COMPLETION CHECK
00DB D6 90	2630 SUI 90H
00DD 6F	2640 MOV L, A
00DE 7A	2650 MOV A, D
00DF C6 04	2660 ADI 4
00E1 57	2670 MOV D, A

00E2	FE	38	2680	CPI	56
00E4	3F		2685	CMC	
00E5	3E	00	2690	MVI	A, 0
00E7	1F		2700	RAR	
00E8	85		2710	ADD	L
00E9	6F		2720	MOV	L, A
00EA	E9		2730	PCHL	
00EB			2879	* ROM PROGRAMMER STOP ROUTINE	
00EB	00		2880	NOP	
00EC	00		2881	NOP	
00ED	FB		2885	EI	
00EE	E9		2890	PCHL	
00EF	E9		2900	PCHL	
00F0	E9		2906	PCHL	
00F1			2918	* PROGRAMMER VERIFICATION ROUTINE	
00F1			2919	* PART 3	
00F1	3B		2920	DCX	SP
00F2	F1		2930	POP	6
00F3	EB		2940	XCHG	
00F4			2949	* COMPARE FOR GREATER	
00F4	BE		2950	CMP	M
00F5	EB		2960	XCHG	
00F6	17		2970	RAL	
00F7	E6	01	3000	ANI	1
00F9	2F		3010	CMA	
00FA	3C		3011	INR	A
00FB	85		3015	ADD	L
00FC	6F		3020	MOV	L, A
00FD	3B		3030	DCX	SP
00FE	3B		3040	DCX	SP
00FF			3050	* COMPARE FOR LESSER	
00FF	F1		3055	POP	6
0100	2F		3056	CMA	
0101	EB		3058	XCHG	
0102	86		3059	ADD	M
0103	EB		3060	XCHG	
0104	C6	07	3061	ADI	A, 1
0106	3F		3065	CMC	
0107	17		3070	RAL	
0108	E6	01	3090	ANI	1
010A	2F		3100	CMA	
010B	3C		3101	INR	A
010C	85		3105	ADD	L
010D	6F		3110	MOV	L, A
010E	03		3130	INX	B
010F	13		3140	INX	D
0110	7B		3150	MOV	A, B
0111	E6	04	3180	ANI	4
0113	2F		3190	CMA	
0114	3C		3191	INR	A
0115	85		3195	ADD	L
0116	6F		3200	MOV	L, A
0117	E9		3210	PCHL	

BYTEMOVER VERSION 3.1 OCTAL LISTING

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061 000 000 301 321 056 311 363 345 345 000 000 000 061 004 000
315 000 000 061 002 000 341 061 004 000 325 305 371 016 000 131
151 333 377 127 346 007 007 007 107 172 346 070 017 000 147 071
056 000 172 353 346 200 017 017 306 055 041 000 000 157 071 351
371 041 013 000 071 353 371 353 021 000 000 073 361 002 003 023
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000 151 174 140 371 147 056 153 001 000 000 073 361 022 023 003
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371 041 000 374 031 353 147 056 153 170 346 370 306 010 107 351
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004 127 376 070 077 076 000 037 205 157 351 000 000 373 351 351
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