BYTESAVER

INSTRUCTION MANUAL

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Introduction

The Cromemco Bytesaver is a read/write, non-volatile memory board, plug compatible with the Standard-100 (S-100) microcomputer bus. The Bytesaver has the capacity for eight 2708 U.V. erasable PROMs for a full 8K bytes of memory.

The Bytesaver contains an integral PROM programmer along with a DC-to-DC supply for generating the programming voltage. Programming is accomplished by a series of memory write operations to the PROM being programmed.

Cromemco provides the necessary programming software. Our Bytemover software, described later in this manual, allows convenient PROM programming using your computer's front panel sense switches to control the operation (e.g. to select one of the eight PROMS to be programmed). Programming can also be carried out using the Z-80 Monitor supplied with our Z-80 CPU card and our Z-80 microcomputer system.

Assembly Instructions

The Cromemco Bytesaver™ kit can be assembled in about one evening. All components are mounted on the component side of the p.c. 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.

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

2. Solder the following ¼ Watt resistors in position:

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

3. Next, install the 1N914 diodes. **We recommend that no diode be installed in the diode position just below transistor Q0.** Since we recommend that the PROM containing the Bytemover software be inserted in PROM position zero, installing this diode may allow accidental programming of this PROM.

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

4. Install the 23 capacitors as shown on the p.c. board. Be careful to orient the electrolytic capacitors with the positive (+) end as shown on the board.

5. 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.

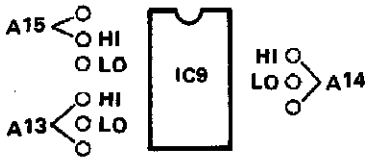
6. Install the p.c. board switch (SW1) in the upper left corner of the p.c. board.

7. Install the Cromemco high-speed pulse transformer (Model XT8K) in position T1. Note that the leads are asymmetrically arranged so there is only one possible orientation.

8. Install IC14, the positive 12V regulator IC. Use a 6-32 by 1/4" screw and nut.

9. Initially install the heatsink in the upper right corner of the p.c. board by just starting the nuts on the 6-32 by 3/8" screws. Install IC12 and IC13 but be sure to place the insulating washer between IC13 and the heatsink. **The nylon screw must be used to secure IC13.** It is important that the screw be inserted from the p.c. board side so the screw head is against the foil side. Be aware that the insulating washer may have to be trimmed with a pair of scissors to clear the protrusions in the heatsink. Tighten the nuts on the screws in the heatsink assembly only after all the screws have been inserted. Take care that the leads of the voltage regulators do not come in contact with the sides of the openings in the heatsink. **Although voltage regulators IC12, IC13 and IC14 may look similar, they are not interchangeable.**

10. Install three jumper wires to select where the Bytesaver is to reside in memory. Each of the three high-order address lines (A^{15}, A^{14} and A^{13}) may be tied to either the corresponding "H" or "L" terminal. For example, in order for the Bytesaver to reside in the top 8K of memory, the three jumpers should be installed as shown below:



This adjustment causes the Bytesaver to reside in the top 8K of the memory map.

11. Install the ICs in their sockets, being careful to orient pin 1 of each IC as shown by the small white dot on the p.c. board at each IC position. Install a PROM containing the Bytemover software in PROM position zero.

Your Bytesaver is now fully assembled. Detailed operating instructions are given in the Bytemover software section of this manual.

Notes

PROM Availability: Additional 2704 or 2708 PROMs are available from Cromemco. The 2704s are $50 each and the 2708s are $75 each. Our PROMs are factory fresh, full speed devices which we purchase directly from the manufacturer.

Wait State: Should you wish to use low speed 2704s or 2708s (access times greater than 450 ns) in your Bytesaver, be aware there is a provision for a wait state. Simply insert the jumper wire between IC10 and IC11. No jumper need be inserted when using full speed PROMs.

Repair: If 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 not to repair any Bytesaver we judge to be unserviceable.

Bytesaver Parts List

Capacitors

C1-C8	.0.1 uF
C9-C15	.10 uF, 50V
C16	.005
C17	680 pF
C18	.01 uF
C19	680 pF
C20	220 pF
C21-C23	.0.1 uF

Diodes

D1-D19	.1N914 or 1N4531

Transistors

Q0-Q7	.2N3904
Q8, Q9	.2N3906
Q10	.MPS6560
Q11, Q12	.2N3904

Resistors

R1	.47K
R2	.10K
R3	180
R4	.1K
R5	.9.1K
R6	.1.5K
R7	.1K
R8	.47
R9	.1K
R10	.10
R11	.5.6K
R12	.5.6K
R13	.10K
R14	.5.6K
R15	.180
R16-R39	.18K

Integrated Circuits

IC1	.74123
IC2	.7474
IC3	.7402
IC4	.7406
IC5	.7406
IC6	.7402
IC7	.7406
IC8	.7442
IC9	.74LS04
IC10	.74LS10
IC11	.74LS04
IC12*	.340T-5.0 or 7805
IC13*	.320T-5.0 or 7905
IC14*	.340T-12 or 7812
IC15	.7432 or 74LS32
IC16	.74367
IC17	.74367
IC18	.74367
IC19	.74367

Miscellaneous

SW1	.p.c. board switch
T1	XT8K pulse transformer

Sockets

10	.14-pin
6	.16-pin
8	.24-pin

Hardware

3	.6-32 by 3/8" screws
1	6-32 by 1/4" screw
1**	.6-32 by 3/8" nylon screw
5	6-32 nuts
1	Heatsink
1	Insulating washer

Notes

*The three voltage regulator ICs (IC12, IC13 & IC14) may look physically similar, however they are not interchangeable. Each must be in the proper IC location.

**The nylon screw is used to secure IC13. It is important that the screw be inserted from the p.c. board side of the assembly so the head of the screw is against the foil side of the board.

Introduction

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

The PROM containing the Bytemover software is normally inserted into PROM location zero 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 setting front panel sense switches on any S-100 bus-compatible computer. However, to use the Bytemover software there must be at least one RAM board in the computer beginning at location zero in the memory map. Furthermore, this RAM board must be unprotected for proper execution of the Bytemover software.

Programming Partially Filled PROMs

Software can be loaded into a 2704 or 2708 in as small increments as you desire provided it is added to previously unused areas in that PROM.

This is done by first using Bytemover to move the current contents of the PROM down to RAM, adding the new software to an area of RAM which corresponds to the unused portion of the PROM and finally using Bytemover again to re-program the PROM with the new software.

Although the entire PROM must always be programmed, it never hurts to re-write the same information over again. And, of course, an erased PROM in which all bits are "1" may be programmed at any time.

In general, it is OK to write a "1" over a "1", a "0" over a "0", or a "0" over a "1". But in order to write a "1" over a "0", the PROM must first be completely erased.

If the PROM to which you want to add software is PROM zero on the Bytesaver board, turn off the A.C. power to the computer and install a 1N914 diode just below Q0 (see step 3 of the Bytesaver assembly instructions).

Turn the power back on and move Bytemover down to RAM zero by following Example 1. Add the new software to an area of RAM which corresponds to an unused portion of PROM zero.

Re-program PROM zero by following Example 4 of this manual. Note that you need not erase the PROM to do this.

Turn the computer power off and remove the 1N914 diode below Q0.

PROM Programming Time

The Bytesaver software supplied here is designed to program a PROM in approximately 30 seconds. We have found that this is generally a sufficiently long period of programming time. However—to be completely within the manufacturer's specifications—the PROM should be programmed for 2 to 3 minutes.

If you wish to program your PROMs for longer than 30 seconds, the Bytemover software may be easily modified. Simply change the contents of location 77H from 40H to 00H. Now you must manually time the programming operation and depress the stop switch at the end of the operation.

Step By Step Instructions

1. Before using the Bytesaver, you must install three jumper wires to set the location of Bytesaver in memory. This adjustment is shown in Figure 1. The assembled Bytesaver comes with A^{13}, A^{14} and A^{15} each tied to the corresponding HI pad to position the board at the very top of memory. In the following instructions it is assumed this is the jumper connection used.

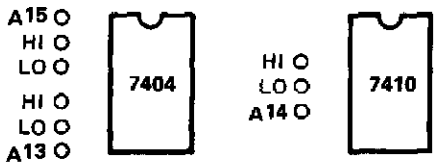


FIGURE 1. This diagram illustrates the positioning of the Bytesaver address in memory. The preassembled Bytesaver comes with A^{15}, A^{14} and A^{13} connected to the corresponding HI terminals so memory address occurs when these lines are HI. Any or all of these address lines may be connected to the corresponding LO terminal to move the memory board lower in memory. Consequently, there are eight positions in which this board may be used.

2. Turn off all power to the computer and plug in the Bytesaver board.
3. Be sure the program power on the Bytesaver is turned off (program power switch in the down position).
4. Turn on the computer. Raise the reset switch, the stop switch and then raise the reset switch once again to initialize the computer.
5. Raise address switches A^{15}, A^{14} and A^{13}. All other address switches should be in the down position.
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 1: 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 A^{15}, A^{14} and A^{13}. Raise the examine switch. The data lights should read "061" octal.
4. Now set the sense switches for the task to be done, refering to Figure 2.

A^{15}	Down	to transfer from Prom to Ram.
A^{14}	Down	for the transfer of 1K bytes.
A^{13}	Down	All down since we are transferring from the PROM that contains Bytemover (PROM 0).
A^{12}	Down	
A^{11}	Down	
A^{10}	Down	
A9	Down	All down for storage to begin at location zero in RAM.
A8	Down	

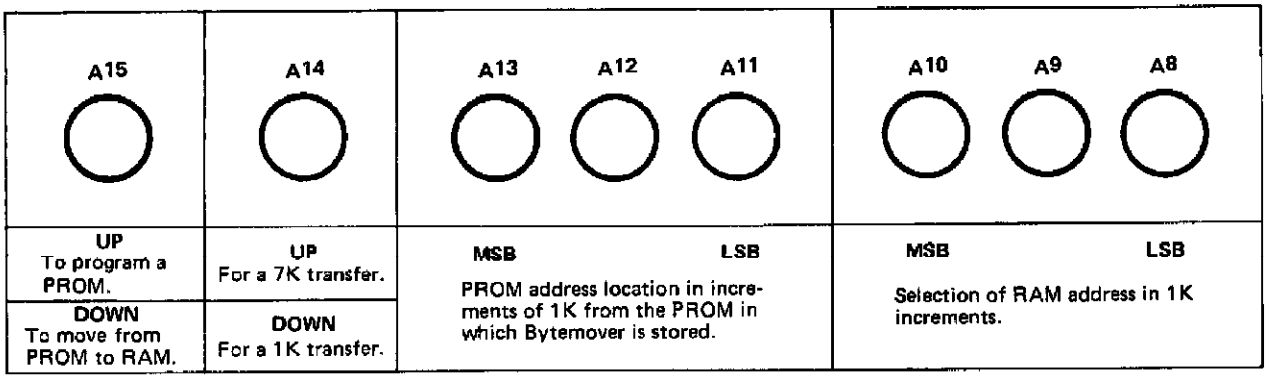


FIGURE 2: Function of the sense switches in Bytemover.

5. Push the run switch. In less than one second, the contents of PROM will be transfered to RAM. The contents of PROM are unaffected by this operation.
6. Raise the stop switch.
7. Raise the reset switch. Note that the data lights read "061".

Example 2: Program a 2708 PROM inserted in PROM location one. This PROM is to be programmed with the contents of the first 1K bytes of RAM beginning at location zero in memory. The Bytesaver software is still in the PROM installed at PROM location zero on the Bytesaver board.

1. Raise the reset switch.
2. Depress the unprotect switch (on the Altair front panel).
3. Raise A^{15}, A^{14} and A^{13}. Raise the examine switch. The data lights should read "061" octal.
4. Raise the protect switch on the Bytsaver board (i.e. program power switch to the on position). The protect light on the front panel should go off when this switch is raised.
5. Now set the sense switches for the task to be done:

A^{15}	Up	to program a PROM.
A^{14}	Down	(always down for PROM programming).
A^{13}	Down	To select the PROM 1K higher in memory than the PROM that contains Bytemover.
A^{12}	Down	
A^{11}	Up	
A^{10}	Down	All down for transfer to begin at location zero in RAM.
A^{9}	Down	
A^{8}	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 front panel. If this light is on, the Bytemover Verifier has verifed 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 to a defective PROM.

Example 3: Altair 8K BASIC can be stored in seven 2708 PROMs. Given that these seven PROMs are in PROM locations one through seven of 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 A^{15}, A^{14} and A^{13}. Raise the examine switch. The data lights should read "061" octal.
4. Now set the sense switches for the task to be done:

A^{15}	Down	to transfer from PROM to RAM.
A^{14}	Up	for a 7K transfer.
A^{13}	Down	To begin transfer from the PROM 1K higher in memory than the Bytemover program.
A^{12}	Down	
A^{11}	Up	
A^{10}	Down	All down for storage to begin at location zero in RAM.
A^{9}	Down	
A^{8}	Down	

5. Push the run switch. In less than one second BASIC will be loaded into RAM (it sure beats paper tape!). Now raise the stop switch.

Example 4: If you do not have Bytemover in PROM, you can program a PROM with Bytemover that is stored in RAM. The Bytemover software (see listing) 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 zero.
4. Examine location 000 240 in memory.
5. Raise the program power switch on the Bytesaver board.
6. Set the sense switches with A^{15}, A^{14} and A^{13} up.
7. Push the run switch. When light A^{9} stops blinking, the programming is complete. The INTE light will be on.
8. Turn off PROM program power by depressing the switch on the Bytesaver.

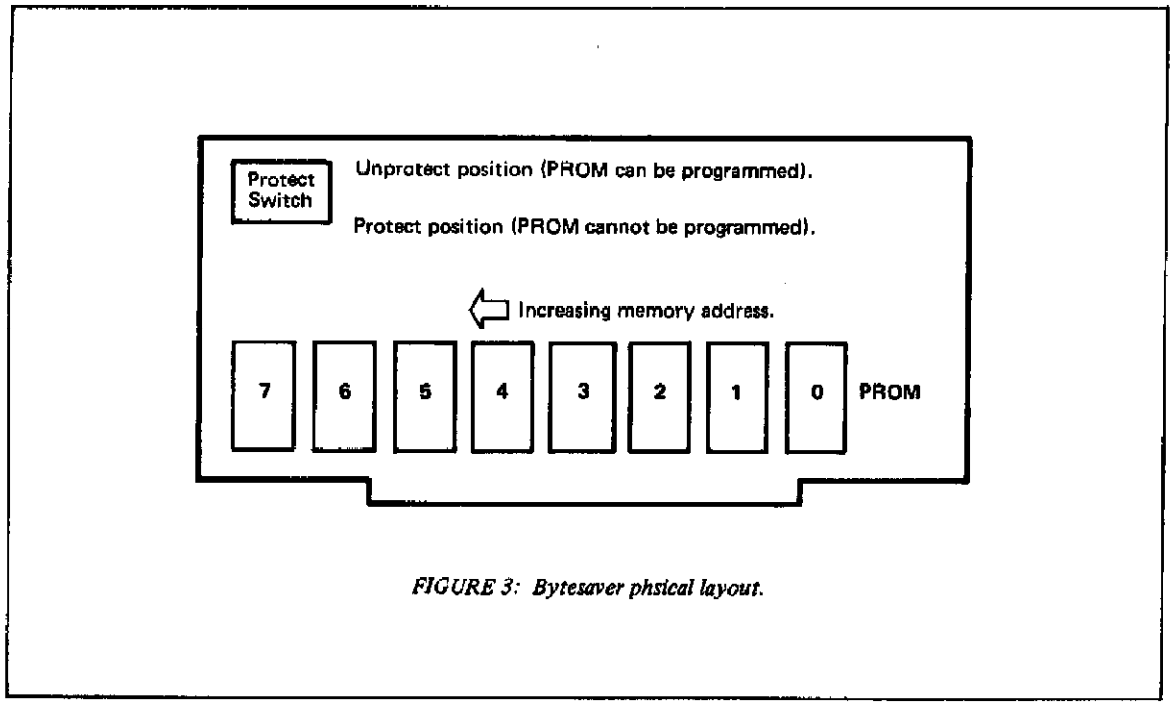


FIGURE 3: Bytesaver phsical layout.

Erasing PROMS: The 2704 and 2708 PROMs are erased by shining intense U.V. light through their quartz windows. One such U.V. source, the UV-85 PROM Eraser, is available for $37.50 from the **Byte Shop**, 1063 El Camino Real, Mountain View, CA 94040. A more expensive, but professional quality PROM eraser is available for $125 from **Prometrics**, 5345 North Kedzie Av., Chicago, IL 60625.

Bytemover 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
172 346 004 007 007 000 205 157 351 000 000 076 126 205 157 351
000 151 174 140 371 147 056 153 001 000 000 073 361 022 023 003
170 376 374 077 037 037 346 100 056 175 205 157 351 056 153 170
346 004 007 007 007 205 157 351 000 000 000 174 041 000 374 071
371 041 000 374 031 353 147 056 153 170 346 370 306 010 107 351
333 377 107 346 340 036 000 113 127 170 346 037 107 147 056 140
351 306 032 157 333 377 346 100 017 017 205 157 351 174 041 000
374 071 371 056 315 147 351 000 000 000 000 373 351 174 041 000
374 031 353 056 361 147 001 000 000 351 000 326 220 157 172 306
004 127 376 070 077 076 000 037 205 157 351 000 000 373 351 351
351 073 361 353 276 353 027 346 001 057 074 205 157 073 073 361
057 353 206 353 306 007 077 027 346 001 057 074 205 157 003 023
170 346 004 057 074 205 157 351 000 000 000 000 000 000 000 000
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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
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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
004B                      0588 * START OF TRANSFER LOOP
004B                      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
0062 7C                   1030  MOV A,H
0063 60                   1040  MOV H,B
0064                      1049 * MOVE RAM ADDRESS INTO SP
0064 F9                   1050  SPHL
0065 67                   1060  MOV H,A
0066 2E 6B                1070  MVI L, 107
0068                      1079 * INCREMENT RAM ADDRESS
0068 01 00 00             1080  LXI B, 0
006B                      1089 * INCREMENT RAM ADDRESS
006B 3B                   1090  DCX SP
006C                      1098 * USE STAX AND POP 6 (PSW)
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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 78                 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 78                 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 QUITS
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 F8              1480  ANI 248
009C                    1489 * INCREMENT PASS CONTER BY ONE
009C C6 08              1490  ADI 8
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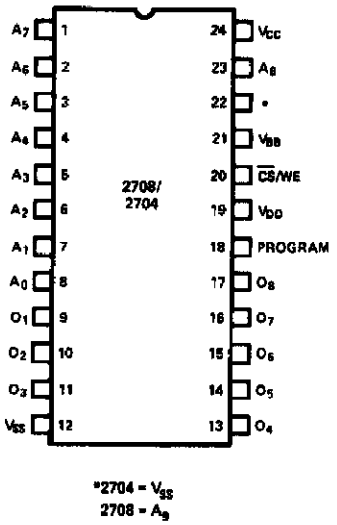
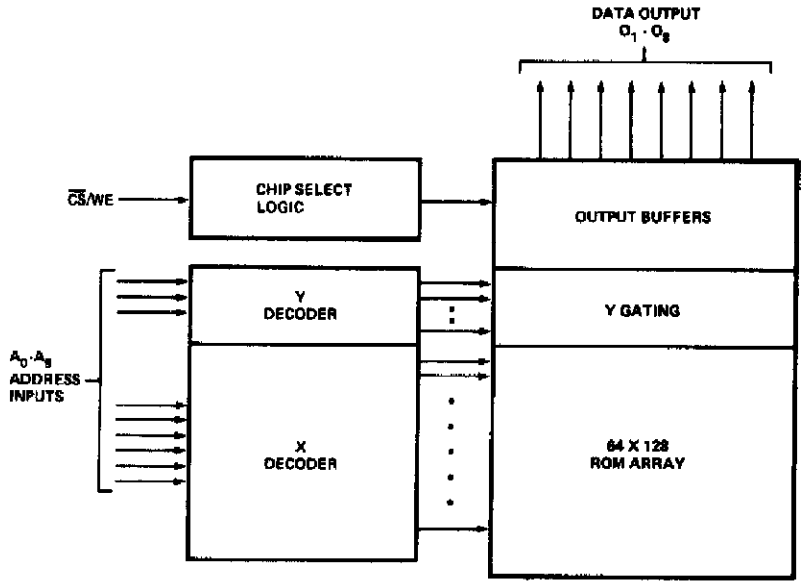
009E 47                  1495  MOV B,A
009F                     1499 * GO BACK TO 1090
009F E9                  1500  PCHL
00A0                     2000 * ROUTINE TO LOAD BYEMOVER INTO ROM
00A0 DB FF               2010  IN 255
00A2 47                  2020  MOV B,A
00A3 E6 E0               2030  ANI 224
00A5 1E 00               2040  MVI E, 0
00A7 4B                  2050  MOV C,E
00A8 57                  2060  MOV D,A
00A9 78                  2070  MOV A,B
00AA E6 1F               2080  ANI 31
00AC 47                  2090  MOV B,A
00AD 67                  2100  MOV H,A
00AE 2E 60               2110  MVI L, 96
00B0 E9                  2120  PCHL
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, 0CDH
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 78                  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
```

PIN CONFIGURATIONS



BLOCK DIAGRAM



PIN NAMES

A_0-A_8	ADDRESS INPUTS
O_1-O_8	DATA OUTPUTS
$\overline{CS}$/WE	CHIP SELECT/WRITE ENABLE INPUT

READ OPERATION

DC & Operating Characteristics

T_A = 0°C to 70°C, V_{CC} = +5V ±5%, V_{DD} = +12V ±5%, V_{BB} = -5V ±5%, V_{SS} = 0V, Unless Otherwise Noted.

Symbol	Parameter	Min.	Typ.[1]	Max.	Unit	Conditions
I_{LI}	Address and Chip Select Input Load Current			10	µA	V_{IN} = 5.25V
I_{LO}	Output Leakage Current			10	µA	V_{OUT} = 5.25V, $\overline{CS}$/WE = 5V
I_{DD}	V_{DD} Supply Current		50	65	mA	Worst Case Supply Currents:
I_{CC}	V_{CC} Supply Current		6	10	mA	All Inputs High
I_{BB}	V_{BB} Supply Current		30	45	mA	$\overline{CS}$/WE = 5V; T_A = 0°C
V_{IL}	Input Low Voltage	V_{SS}		0.65	V	
V_{IH}	Input High Voltage	3.0		V_{CC}+1	V	
V_{OL}	Output Low Voltage			0.45	V	I_{OL} = 1.6mA
V_{OH1}	Output High Voltage	3.7			V	I_{OH} = -100µA
V_{OH2}	Output High Voltage	2.4			V	I_{OH} = -1mA
P_D	Power Dissipation			800	mW	T_A = 70°C

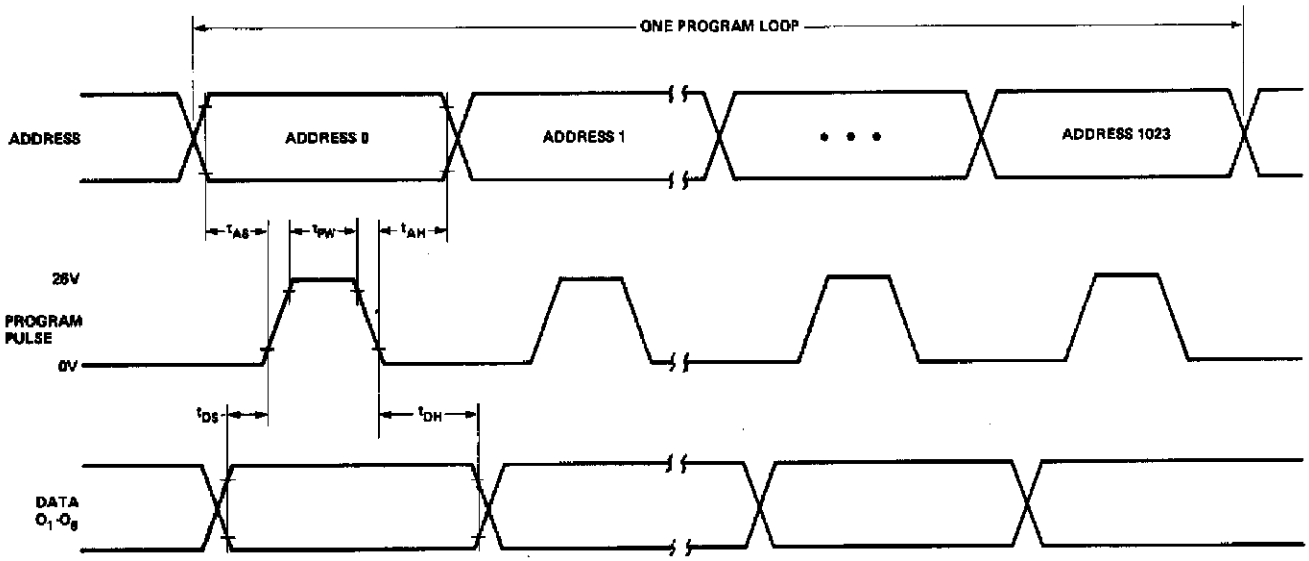
NOTES: 1. Typical values are for T_A = 25°C and nominal supply voltages.
2. The program input (Pin 18) may be tied to V_{SS} or V_{CC} during the read mode.

Waveforms

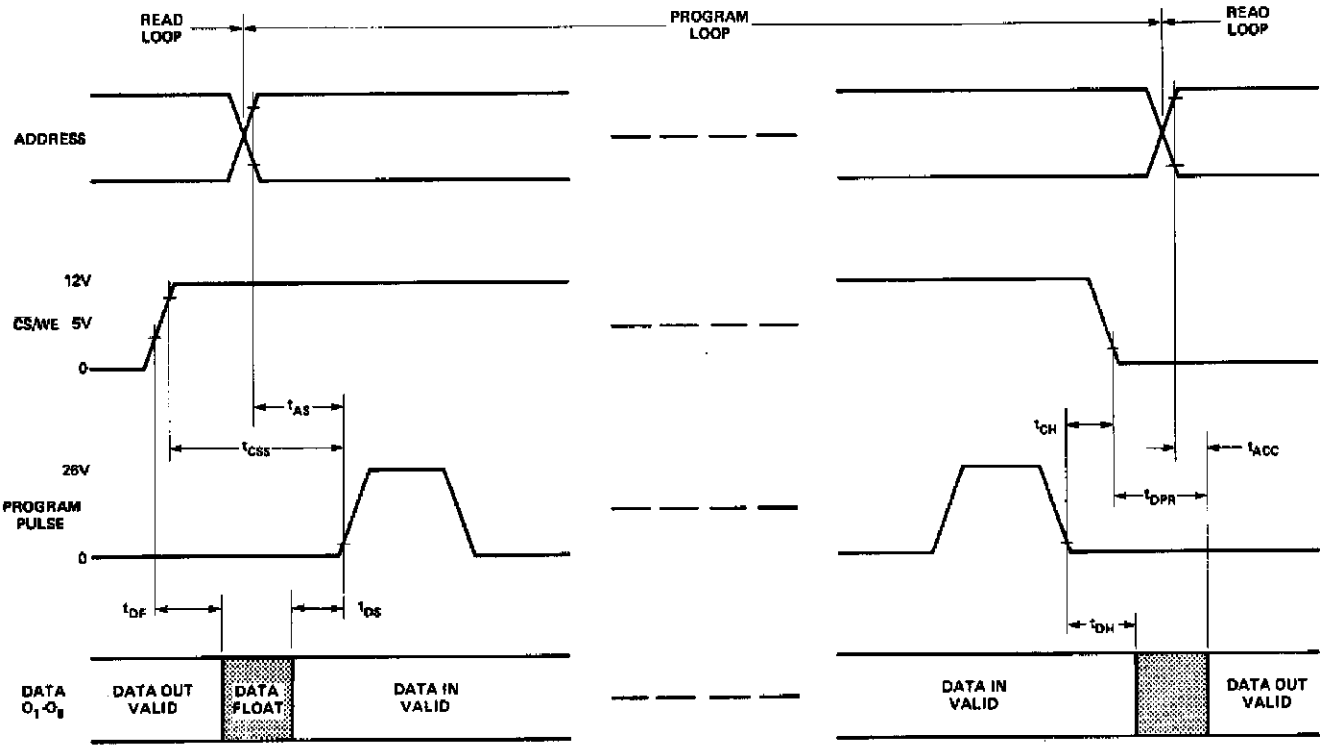
(Logic levels and timing reference levels same as in the Read Mode unless noted otherwise.)

Program Mode

$\overline{CS}$/WE = +12V



Read/Program/Read Transitions



AC Characteristics

T_A = 0°C to 70°C, V_{CC} = +5V ±5%, V_{DD} = +12V ±5%, V_{BB} = -5V ±5%, V_{SS} = 0V, Unless Otherwise Noted.

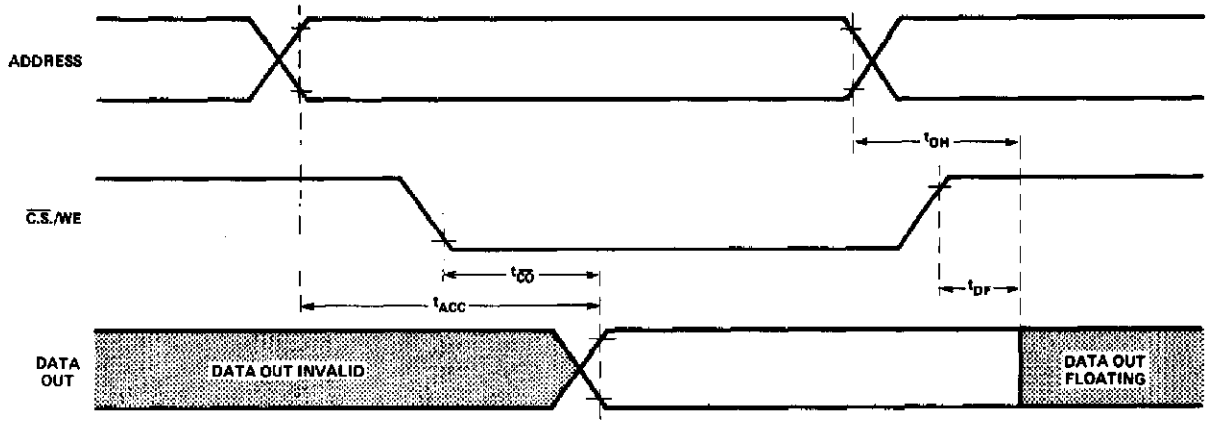
Symbol	Parameter	Min.	Typ.	Max.	Unit
t_{ACC}	Address to Output Delay		280	450	ns
$t_{\overline{CO}}$	Chip Select to Output Delay			120	ns
t_{DF}	Chip De-Select to Output Float	0		120	ns
t_{OH}	Address to Output Hold	0			ns

Capacitance[1] T_A = 25°C, f = 1MHz

Symbol	Parameter	Typ.	Max.	Unit	Conditions
C_{IN}	Input Capacitance	4	6	pF	V_{IN}=0V
C_{OUT}	Output Capacitance	8	12	pF	V_{OUT}=0V

Note 1. This parameter is periodically sampled and not 100% tested.

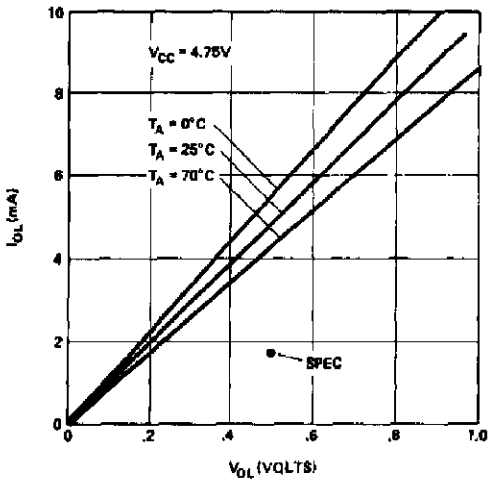
Waveforms



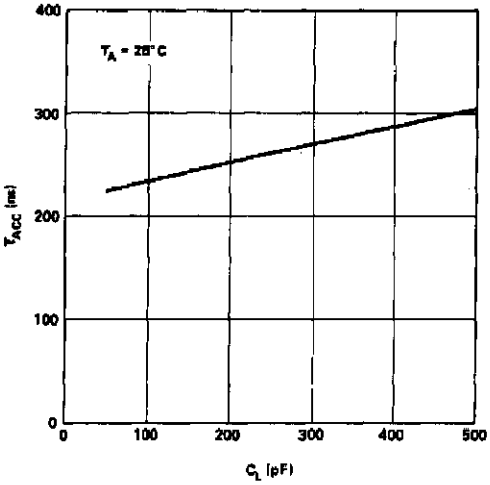
Typical Characteristics

(Nominal supply voltages unless otherwise noted):

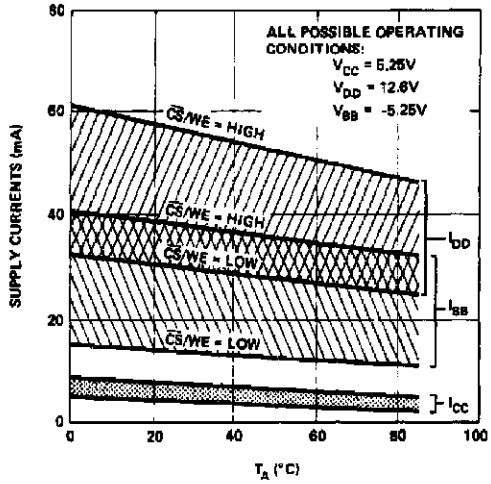
OUTPUT SINK CURRENT VS. OUTPUT VOLTAGE



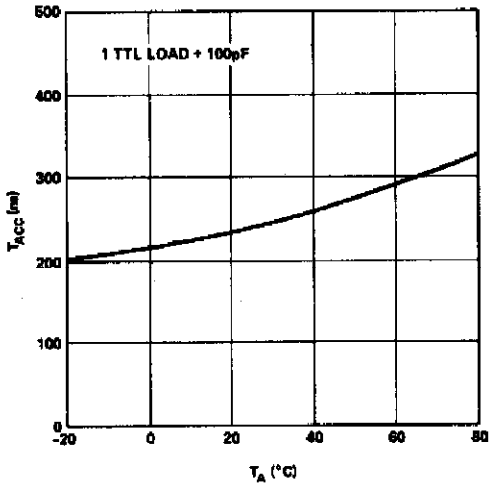
ACCESS TIME VS. LOAD CAPACITANCE



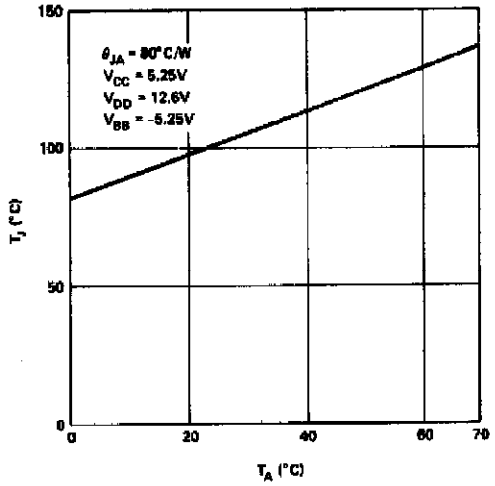
RANGE OF SUPPLY CURRENTS VS. TEMPERATURE



ACCESS TIME VS. TEMPERATURE



MAXIMUM JUNCTION TEMPERATURE VS. AMBIENT TEMPERATURE



PROGRAMMING OPERATION

Description

Initially, and after each erasure, all bits of the 2708/2704 are in the "1" state (Output High). Information is introduced by selectively programming "0" into the desired bit locations.

The circuit is set up for programming operation by raising the $\overline{CS}$/WE input (Pin 20) to +12V. The word address is selected in the same manner as in the read mode. Data to be programmed are presented, 8-bits in parallel, to the data output lines (O_1-O_8). Logic levels for address and data lines and the supply voltages are the same as for the read mode. After address and data set up one program pulse (V_P) per address is applied to the program input (Pin 18). One pass through all addresses to be programmed is defined as a program loop. The number of loops (N) required is a function of the program pulse width (t_{PW}) according to $N \times t_{PW} \geqslant 100$ ms.

For program verification, program loops may be alternated as shown on page 12.

Program Characteristics

T_A = 25°C, V_{CC} = +5V ±5%, V_{DD} = +12V ±5%, V_{BB} = -5V ±5%, V_{SS} = 0V, $\overline{CS}$/WE = +12V, Unless Otherwise Noted.

Symbol	Parameter	Min.	Typ.	Max.	Units
t_{AS}	Address Setup Time	10			μs
t_{CSS}	$\overline{CS}$/WE Setup Time	10			μs
t_{DS}	Data Setup Time	10			μs
t_{AH}	Address Hold Time	1			μs
t_{CH}	$\overline{CS}$/WE Hold Time	.5			μs
t_{DH}	Data Hold Time	1			μs
t_{DF}	Chip Deselect to Output Float Delay	0		120	ns
t_{DPR}	Program To Read Delay			10	μs
t_{PW}	Program Pulse Width	.1		1.0	ms
t_{PR}	Program Pulse Rise Time	.5		2.0	μs
t_{PF}	Program Pulse Fall Time	.5		2.0	μs
I_P	Programming Current		10	20	mA
V_P	Program Pulse Amplitude	25		27	V

CROMEMCO ONE FIRST STREET, LOS ALTOS, CALIFORNIA, 94022
Phone: (415) 941-2967

8K BYTESAVER™

The Cromemco Bytesaver™ is a full speed 8K ROM board with built-in PROM programmer. The Bytesaver plugs directly into the Altair 8800 computer.

The Bytesaver provides a new convenience in program storage. Once a PROM is programmed, power may be turned off without affecting the contents of the PROM. The PROMs used in Bytesaver may be erased with ultraviolet light, so that they may be used again and again.

The Bytesaver may be used with 2304 or 2308 ROMs or with 2704 or 2708 PROMs. The 2704 is a 512-byte PROM. The 2708 is a 1024-byte PROM. Both the 2704 and the 2708 are high-speed devices (450 nanosecond access time) that allow the 8080 to run at full speed during memory read. A PROM in any of the eight sockets on the Bytesaver board may be programmed under software control. A protect switch, located in the upper left corner of the Bytesaver board, may be used to disable the PROM programmer to prevent accidental PROM programming.

PRICE and DELIVERY

The Bytesaver comes with one 2704 PROM and is available either as a kit or as a wired and tested unit. The price of the Bytesaver kit (model 8KBS-K) is $195. The price of the wired and tested Bytesaver (model 8KBS-W) is $295. Delivery is 30 days.

ORDERING INFORMATION

Individuals within U.S. - When payment accompanies order we pay shipping charges. We welcome C.O.D. orders, but you must pay shipping and C.O.D. charges.

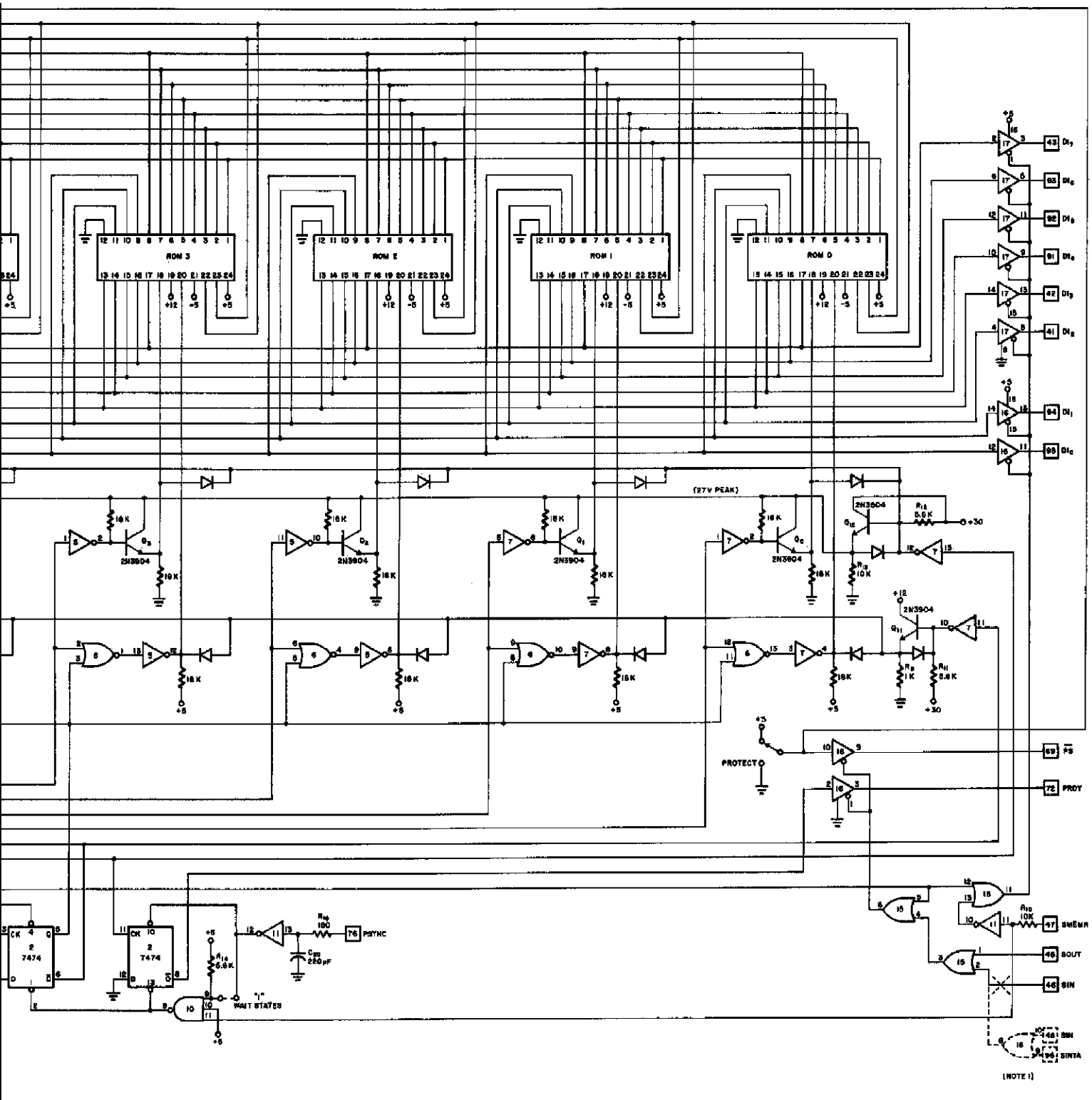
Corporations within U.S. - Purchase orders accepted subject to credit approval. Prices F.O.B. Los Altos. Terms net 30.

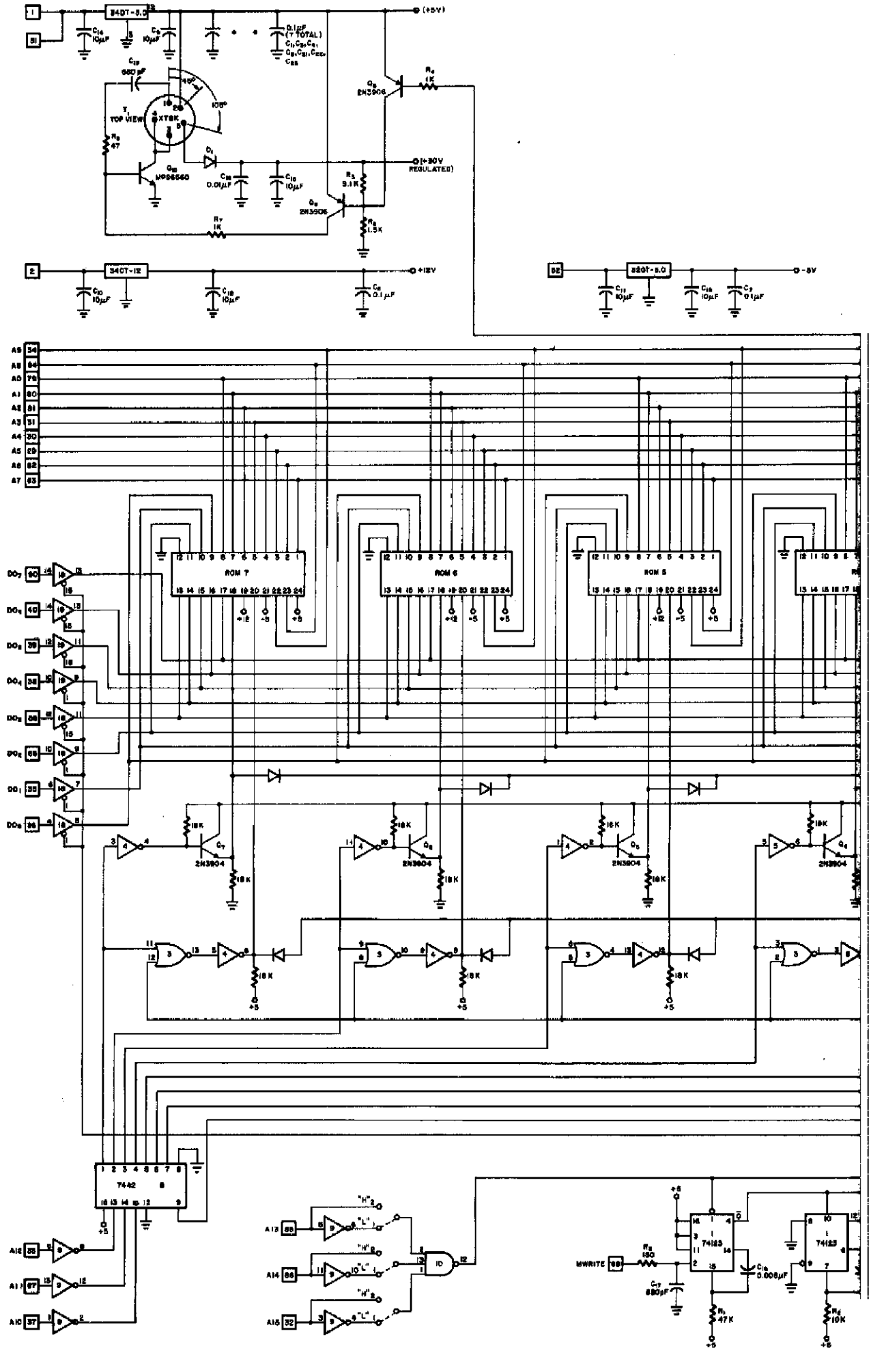
Shipments to outside U.S. - Payment must accompany order and must include a 10% surcharge to cover additional shipping and handling charges.

Cromemco 8K Bytesaver™

BOARD REV. 2
SCHEMATIC REV. 2

NOTE:
1. DASHED MODIFICATION FOR ROM RESIDENT INTERRUPT OPERATION (NOT INCLUDED ON STANDARD CARD)
2. ALL DIODES ARE IDENTICAL (IN914 OR EQUIV.)




+5V
+12V
-5V
+30V REGULATED
ROM 7
ROM 6
ROM 5
2N3904
MWRITE
74123
74LS42