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	1.2K	brown-red-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-R31	18K	brown-gray-orange
R32-R39	4.7K	yellow-violet-red

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.

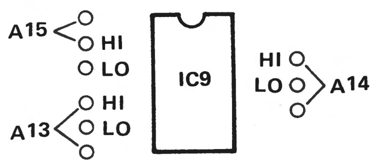
6. Install the p.c. board switch (SW1) in the upper left corner of the p.c. board.

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

Interrupts: If you plan to have your computer respond to interrupts while executing a program stored in the Bytesaver memory, a small modification is required to the Bytesaver circuit . This modification is shown in Note 1 on the Bytesaver schematic.

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. Jumper is also required for 4MHz operation.

Programming PROMs

PROM programming with the Bytesaver is carried out by a sequence of memory write operations to the Bytesaver card. A sequence of approximately 100 memory write operations is required to write the data into each location of every PROM that you wish to program. This sequence of memory write operations is carried out automatically when using the special instructions of Cromemco software. The Cromemco Z-80 Monitor, the Resident Operating System, and the 3K Control Basic Interpreter all have provision for PROM programming with the Bytesaver card. If your computer is equipped with front panel sense switches, our Bytemover software can be used for PROM programming. Operation of the Bytemover software is described in the next section.

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	150 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	1.2K
R8	47
R9	1K
R10	10
R11	5.6K
R12	5.6K
R13	10K
R14	5.6K
R15	180
R16-R31	18K
R32-39	4.7K

Integrated Circuits

IC1	74123
IC2	7474
IC3	7402
IC4	7406
IC5	7406
IC6	7402
IC7	7406
IC8	7442
IC9	74L04
IC10	7410
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 2708 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 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 this is the jumper connection used.

FIGURE 1. This diagram illustrates the positioning of the Bytesaver address in memory. The preassembled Bytesaver comes with A15, A14 and A13 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 A15, A14 and A13. 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 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, refering to Figure 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 PROM that contains Bytemover (PROM 0).
A12	Down	
A11	Down	
A10	Down	All down for storage to begin at location zero in RAM.
A9	Down	
A8	Down	

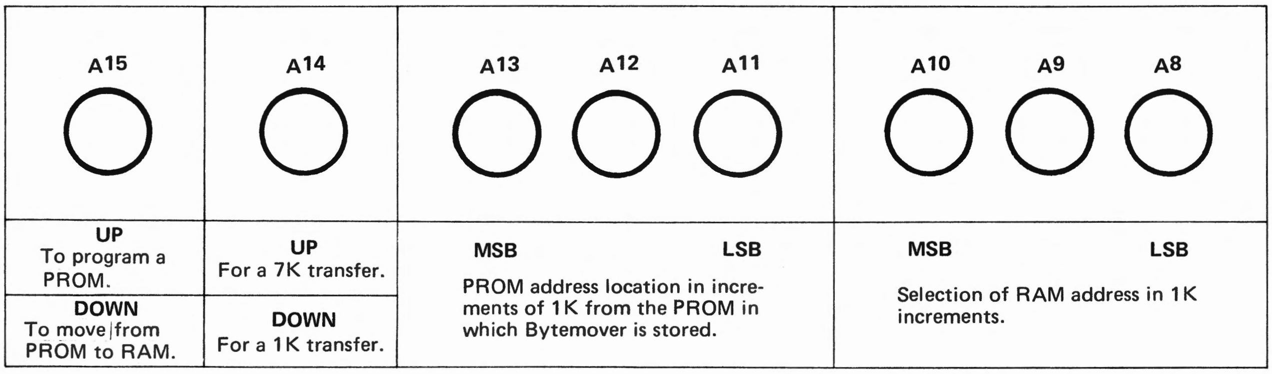


FIGURE 2: Function of the sense switches in Bytemover.

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 A15, A14 and A13. 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:

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

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 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 A12 A11	Down Down Up	To begin transfer from the PROM 1K higher in memory than the Bytemover program.
A10 A9 A8	Down Down Down	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!). 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 A15, A14 and A13 up.
7. Push the run switch. When light A9 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.

→ This is the high order address of prom board

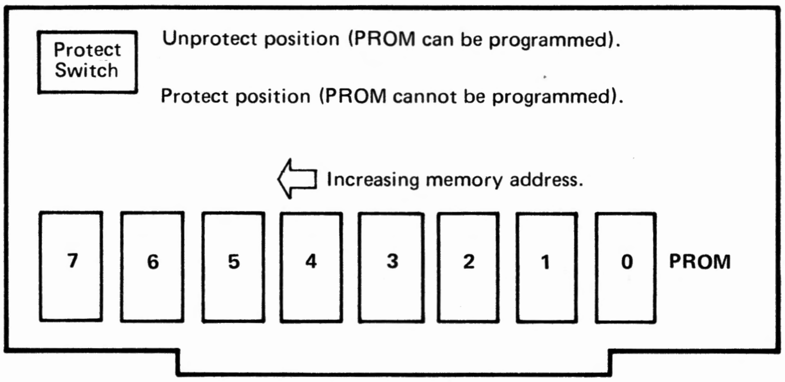


FIGURE 3: Bytesaver phsical layout.

Erasing PROMS: The 2704 and 2708 PROMs are erased by shining intense U.V. light through their quartz windows. One such U.V. source 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 78         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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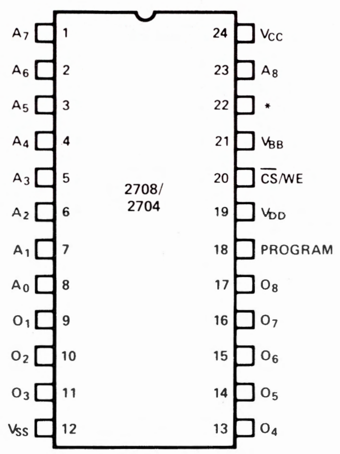
009E 47           1495   MOV B,A
009F              1499 * GO BACK TO 1090
009F E9           1500   PCHL
00A0              2000 * ROUTINE TO LOAD BYEMOVER INTO ROM
00A0 DB FF        2010   IN 255
00A2 47           2020   MOV B,A
00A3 E6 E0        2030   ANI 224
00A5 1E 00        2040   MVI E, 0
00A7 4B           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
```

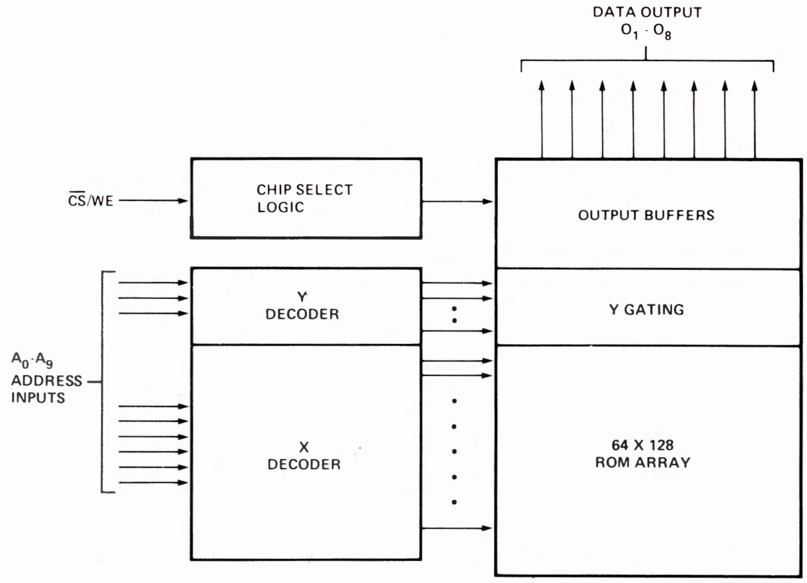
```
00DE 7A          2650  MOV A,D
00DF C6 04       2660  ADI 4
00E1 57          2670  MOV D,A
00E2 FE 38       2680  CPI 56
00E4 3F          2685  CMC
00E5 3E 00       2690  MVI A, 0
00E7 1F          2700  RAR
00E8 85          2710  ADD L
00E9 6F          2720  MOV L,A
00EA E9          2730  PCHL
00EB             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



*2704 = V_{SS}
2708 = A_9

BLOCK DIAGRAM



PIN NAMES

A_0-A_9	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

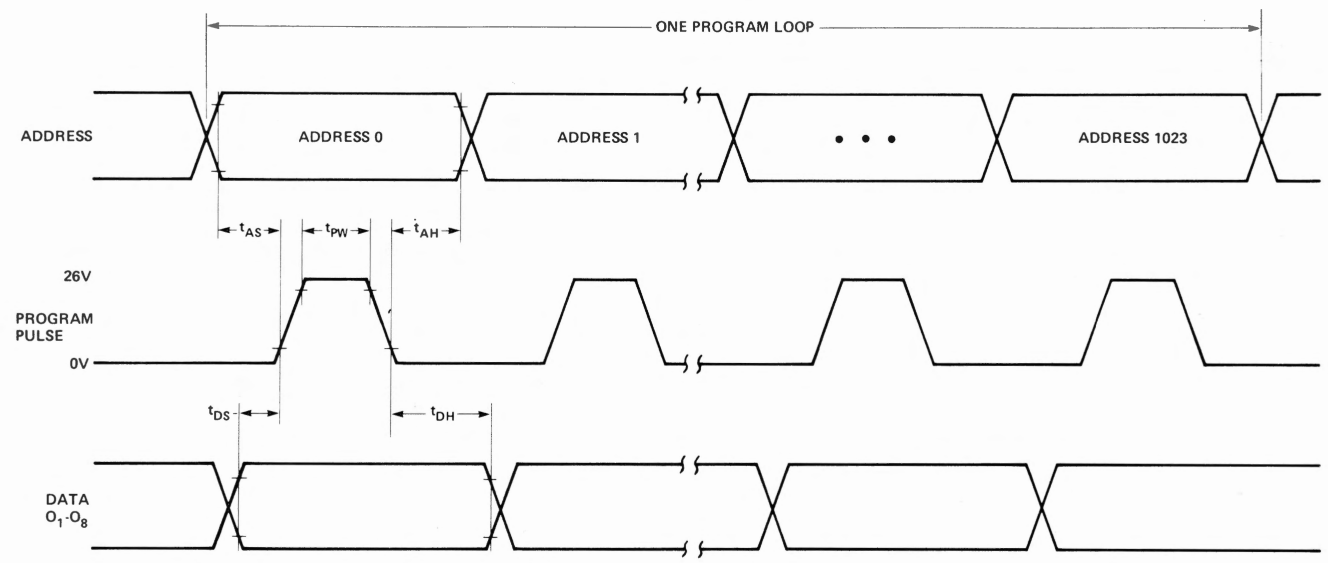
NOTES: 1. Typical values are for T_A = 25°C and nominal supply voltages.
2. The program input (Pin 18) may be tied to V_{SS} or V_{CC} during the read mode.

Waveforms

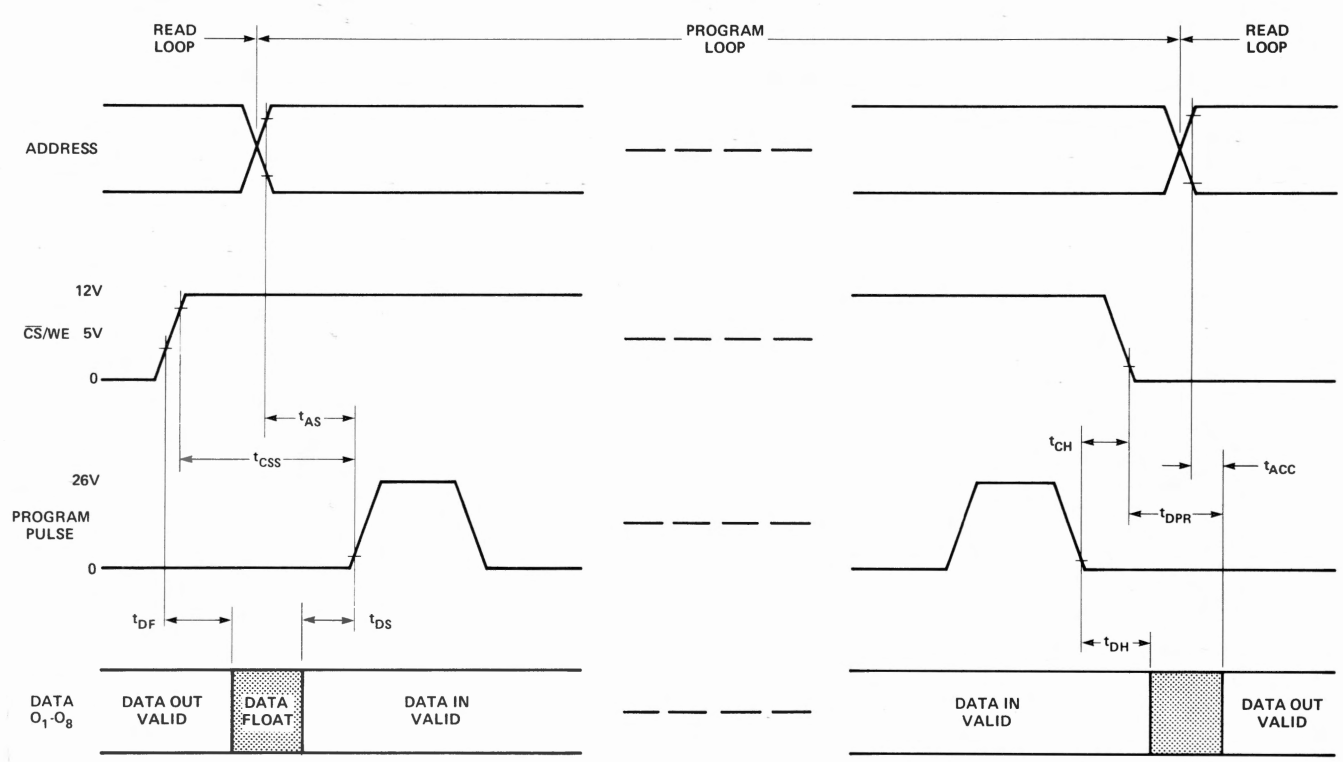
(Logic levels and timing reference levels same as in the Read Mode unless noted otherwise.)

Program Mode

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



Read/Program/Read Transitions



AC Characteristics

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

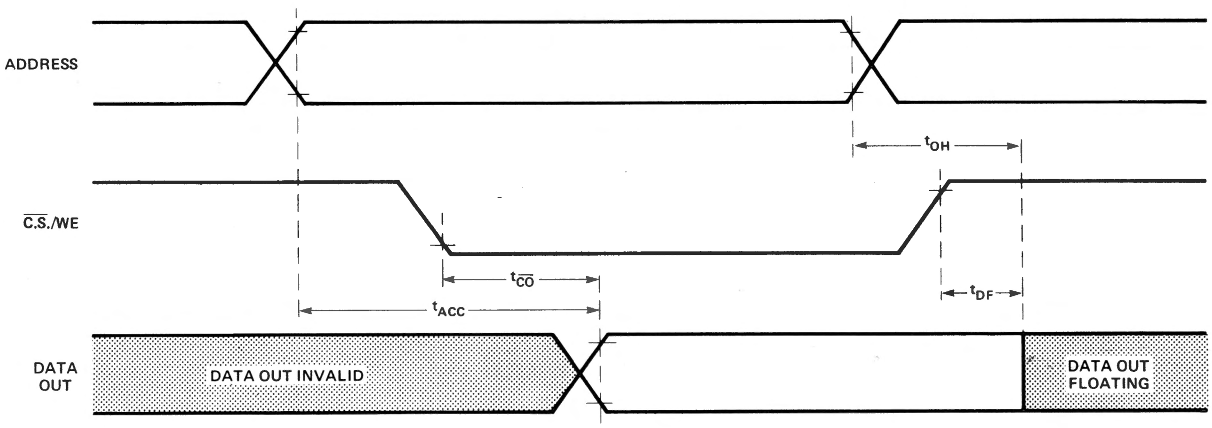
Symbol	Parameter	Min.	Typ.	Max.	Unit
t_{ACC}	Address to Output Delay		280	450	ns
$t_{\overline{CO}}$	Chip Select to Output Delay			120	ns
t_{DF}	Chip De-Select to Output Float	0		120	ns
t_{OH}	Address to Output Hold	0			ns

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.

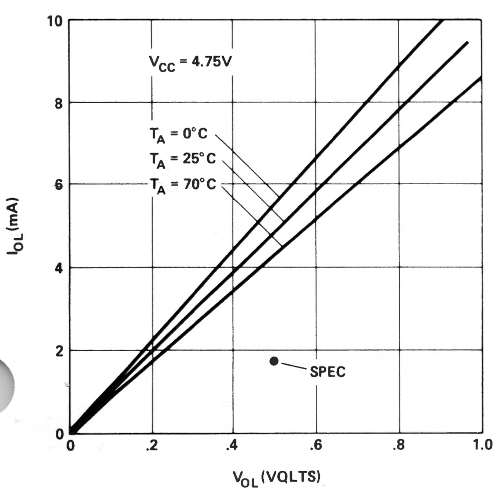
Waveforms



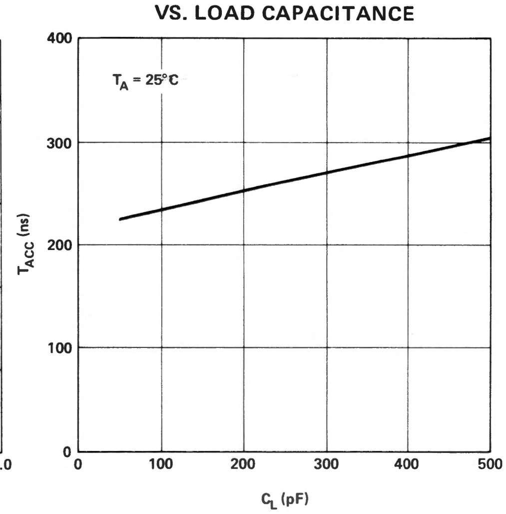
Typical Characteristics

(Nominal supply voltages unless otherwise noted):

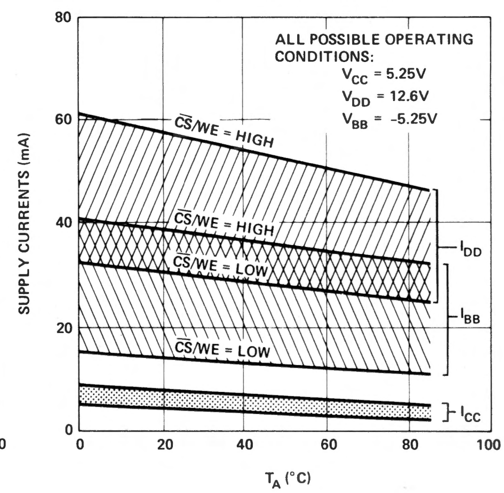
OUTPUT SINK CURRENT VS. OUTPUT VOLTAGE

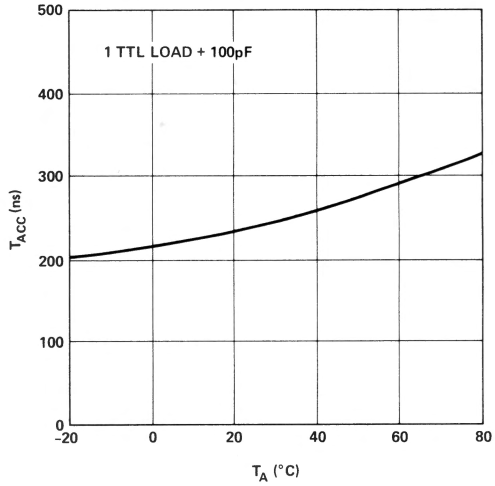


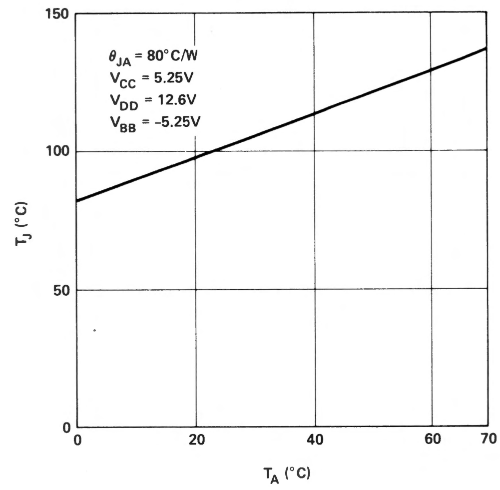
ACCESS TIME VS. LOAD CAPACITANCE



RANGE OF SUPPLY CURRENTS VS. TEMPERATURE







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

$T_A = 25°C$, $V_{CC} = +5V \pm 5\%$, $V_{DD} = +12V \pm 5\%$, $V_{BB} = -5V \pm 5\%$, $V_{SS} = 0V$, $\overline{CS}$/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

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