MOTOROLA

TMS2716
TMS27A16

MOS

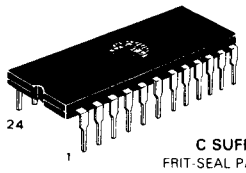
(N-CHANNEL, SILICON-GATE)

2048 X 8-BIT
UV ERASABLE PROM

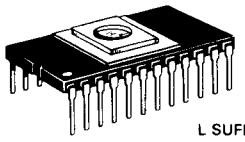
2048 X 8 ERASABLE PROM

The TMS2716 and TMS27A16 are 16,384-bit Erasable and Electrically Reprogrammable PROMs designed for system debug usage and similar applications requiring nonvolatile memory that could be reprogrammed periodically. The transparent window on the package allows the memory content to be erased with ultraviolet light. The TMS2716 is pin compatible with 2708 EPROMs, allowing easy memory size doubling.

- Organized as 2048 Bytes of 8 Bits
- Fully Static Operation (No Clocks, No Refresh)
- Standard Power Supplies of +12 V, +5 V, and −5 V
- Maximum Access Time = 300 ns — TMS27A16
  450 ns — TMS2716
- Chip-Select Input for Memory Expansion
- TTL Compatible — No Pull-up Resistors Required
- Three-State Outputs for OR-Tie Capability
- The TMS2716 is Pin Compatible to MCM2708 and MCM68708 EPROMs

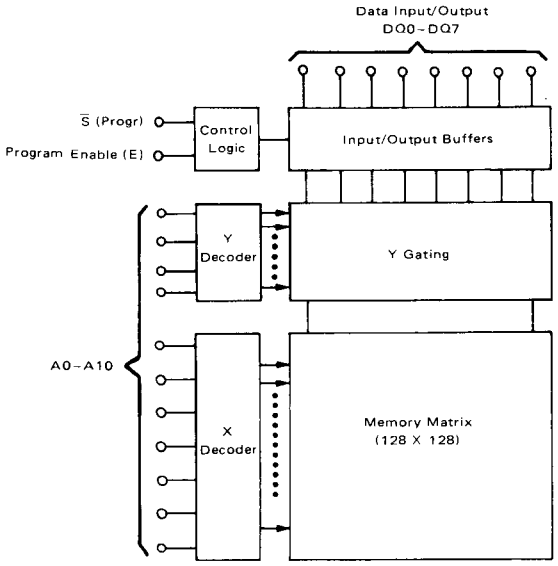


C SUFFIX
FRIT-SEAL PACKAGE
CASE 623A

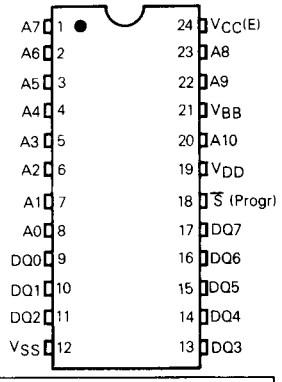


L SUFFIX
CERAMIC PACKAGE
CASE 716

BLOCK DIAGRAM



PIN ASSIGNMENT



PIN NAMES	
A0-A10	Address Inputs
DQ0-DQ7	Data Input (Program or Output (Read)
(E)	Program Enable
$\overline{S}$	Chip Select
(Progr)	Program Pulse
V_{BB}	−5 V Power Supply
V_{CC}	+5 V Power Supply
V_{DD}	+12 V Power Supply
V_{SS}	Ground

EPROM

DS9518 R1/1-79

ABSOLUTE MAXIMUM RATINGS (1)

Rating	Value	Unit
Operating Temperature	0 to +70	°C
Storage Temperature	−65 to +125	°C
V_{DD} with Respect to V_{BB}	+20 to −0.3	V
V_{CC} and V_{SS} with Respect to V_{BB}	+15 to −0.3	V
All Input or Output Voltage with Respect to V_{BB} During Read	+15 to −0.3	V
(E) Input with Respect to V_{BB} During Programming	+20 to −0.3	V
Program Input with Respect to V_{BB}	+35 to −0.3	V
Power Dissipation	1.8	Watts

NOTE 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMMENDED OPERATING CONDITIONS. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.

PIN CONNECTION DURING READ OR PROGRAM

Mode	Pin Number 9–11, 13–17	Pin Number 18	Pin Number 24
Read	D_{out}	V_{IL} or V_{IH}	V_{CC}
Program	D_{in}	Pulsed V_{IHP}	V_{IHW}

DC READ OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

RECOMMENDED DC READ OPERATING CONDITIONS

Parameter		Symbol	Min	Nom	Max	Unit
Supply Voltage	TMS2716	V_{CC}	4.75	5.0	5.25	V
		V_{DD}	11.4	12	12.6	V
		V_{BB}	−5.25	−5.0	−4.75	V
	TMS27A16	V_{CC}	4.5	5.0	5.5	V
		V_{DD}	10.8	12	13.2	V
		V_{BB}	−5.5	−5.0	−4.5	V
Input High Voltage		V_{IH}	2.2	–	V_{CC} + 1.0	V
Input Low Voltage		V_{IL}	V_{SS}	–	0.65	V

READ OPERATING DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	$V_{in} = V_{CC}$max or $V_{in} = V_{IL}$	I_{in}	–	1	10	μA
Output Leakage Current	$V_{out} = V_{CC}$max and $\overline{S} = 5$ V	I_{LO}	–	1	10	μA
V_{DD} Supply Current	Worst-Case Supply Currents All Inputs High (E) = 5.0 V, $T_A = 0°C$	I_{DD}	–	–	65	mA
V_{CC} Supply Current		I_{CC}	–	–	12	mA
V_{BB} Supply Current		I_{BB}	–	–	45	mA
Output Low Voltage	$I_{OL} = 1.6$ mA	V_{OL}	–	–	0.45	V
Output High Voltage	$I_{OH} = -100$ μA	V_{OH1}	3.7	–	–	V
Output High Voltage	$I_{OH} = -1.0$ mA	V_{OH2}	2.4	–	–	V

V_{BB} must be applied prior to V_{CC} and V_{DD}. V_{BB} must also be the last power supply switched off.

CAPACITANCE (periodically sampled rather than 100% tested)

Characteristic	Condition	Symbol	Typ	Max	Unit
Input Capacitance (f = 1.0 MHz)	$V_{in} = 0$ V, $T_A = 25°C$	C_{in}	4.0	6.0	pF
Output Capacitance (f = 1.0 MHz)	$V_{out} = 0$ V, $T_A = 25°C$	C_{out}	8.0	12	pF

EPROM

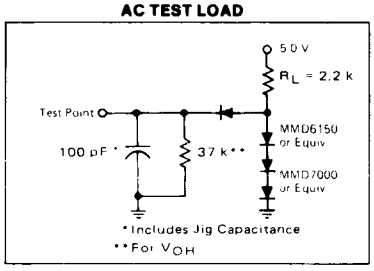
AC READ OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)
(All timing with $t_r = t_f = 20$ ns, Load per Note 2)

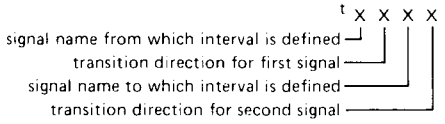
Characteristic	Symbol	TMS2716		TMS27A16		Unit
		Min	Max	Min	Max	
Address to Output Delay	t_{AVQV}	–	450	–	300	ns
Chip Select to Output Delay	t_{SLQV}	–	120	–	120	ns
Data Hold from Address	t_{AXQZ}	10	–	10	–	ns
Data Hold from Deselection	t_{SHQZ}	10	120	10	120	ns

NOTE 2: Output Load = 1 TTL Gate and C_L = 100 pF (Includes Jig Capacitance)
Timing Measurement Reference Levels – Inputs: 0.8 V and 2.8 V
Outputs: 0.8 V and 2.4 V

AC TEST LOAD



TIMING PARAMETER ABBREVIATIONS



The transition definitions used in this data sheet are:

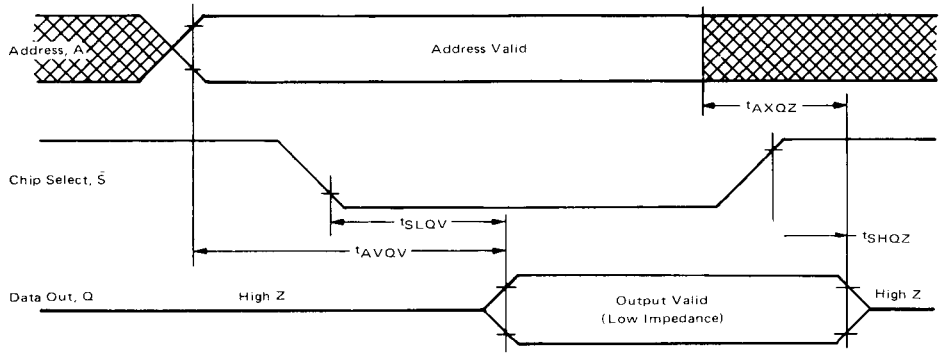
- H = transition to high
- L = transition to low
- V = transition to valid
- X = transition to invalid or don't care
- Z = transition to off (high impedance)

TIMING LIMITS

The table of timing values shows either a minimum or a maximum limit for each parameter. Input requirements are specified from the external system point of view. Thus, address setup time is shown as a minimum since the system must supply at least that much time (even though most devices do not require it). On the other hand, responses from the memory are specified from the device point of view. Thus, the access time is shown as a maximum since the device never provides data later than that time.

EPROM

READ OPERATION TIMING DIAGRAM



DC PROGRAMMING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature range unless otherwise noted)

RECOMMENDED PROGRAMMING OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage — TMS2716 and TMS27A16	V_{CC} V_{DD} V_{BB}	4.75 11.4 -5.25	5.0 12 -5.0	5.25 12.6 -4.75	Vdc Vdc Vdc
Input High Voltage for Data	V_{IHD}	3.8	–	V_{CC} + 1	Vdc
Input Low Voltage for Data	V_{ILD}	V_{SS}	–	0.65	Vdc
Input High Voltage for Addresses	V_{IHA}	3.8	–	V_{CC} + 1	Vdc
Input Low Voltage for Addresses	V_{ILA}	V_{SS}	–	0.4	Vdc
Program Enable (E) Input High Voltage (Note 3)	V_{IHW}	11.4	12	12.6	Vdc
Program Enable (E) Input Low Voltage (Note 3)	V_{ILW}=V_{CC}	4.75	5.0	5.25	Vdc
Program Pulse Input High Voltage (Note 3)	V_{IHP}	25	–	27	Vdc
Program Pulse Input Low Voltage (Note 4)	V_{ILP}	V_{SS}	–	1.0	Vdc

NOTE 3: Referenced to V_{SS}.
NOTE 4: $V_{IHP} - V_{ILP} = 25$ V min.

PROGRAMMING OPERATION DC CHARACTERISTICS

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Address Input Sink Current	$V_{in} = 5.25$ V	I_{LI}	–	–	10	μAdc
Program Pulse Source Current		I_{IPL}	–	–	3.0	mAdc
Program Pulse Sink Current		I_{IPH}	–	–	20	mAdc
V_{DD} Supply Current	Worst-Case Supply Currents All Inputs High (E) = 5 V, $T_A = 0^{\circ}C$	I_{DD}	–	–	65	mAdc
V_{CC} Supply Current		I_{CC}	–	–	15	mAdc
V_{BB} Supply current		I_{BB}	–	–	45	mAdc

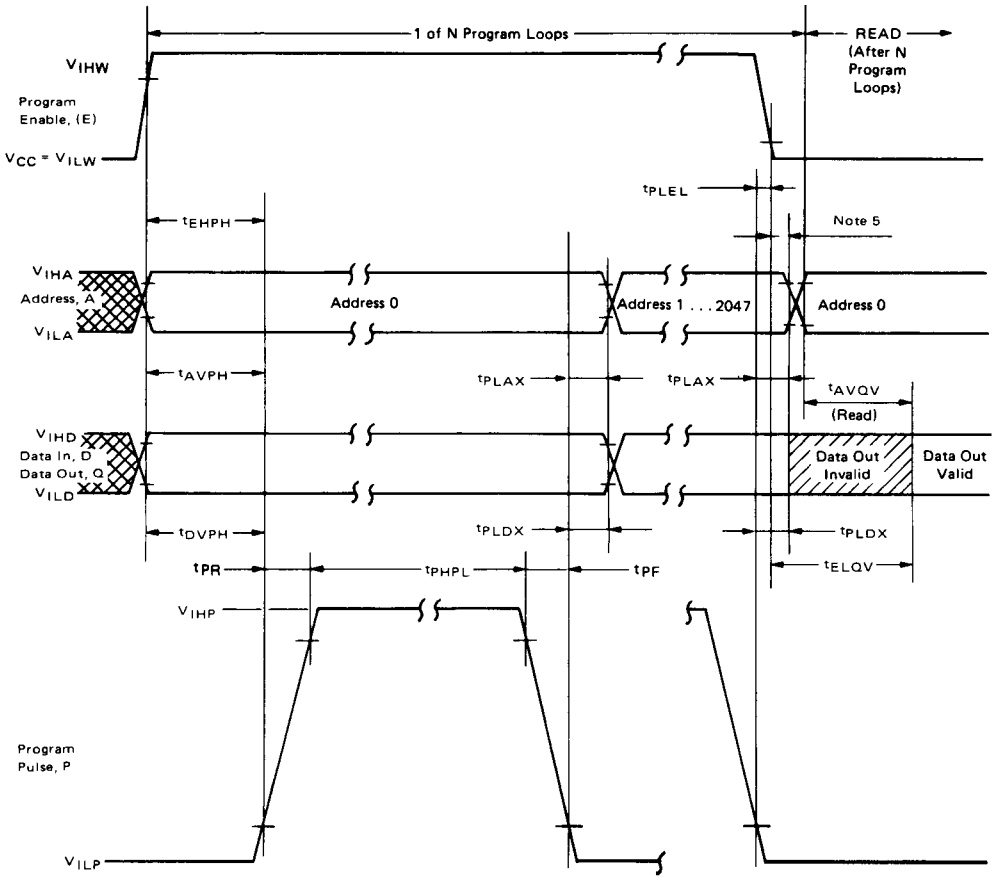
EPROM

AC PROGRAMMING OPERATING CONDITIONS AND CHARACTERISTICS

(Full operating voltage and temperature unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Address Setup Time	t_{AVPH}	10	–	μs
(E) Setup Time	t_{EHPH}	10	–	μs
Data Setup Time	t_{DVPH}	10	–	μs
Address Hold Time	t_{PLAX}	1.0	–	μs
(E) Hold Time	t_{PLEL}	0.5	–	μs
Data Hold Time	t_{PLDX}	1.0	–	μs
Program to Read Delay	t_{ELQV}	–	10	μs
Program Pulse Width	t_{PHPL}	0.1	1.0	ms
Program Pulse Rise Time	t_{PR}	0.5	2.0	μs
Program Pulse Fall Time	t_{PF}	0.5	2.0	μs

PROGRAMMING OPERATION TIMING DIAGRAM



NOTE 5: This Program Enable tranistion must occur after the Program Pulse transition and before the Address Transition.

WAVEFORM DEFINITIONS

Waveform Symbol	Input	Output
———	MUST BE VALID	WILL BE VALID
▨	CHANGE FROM H TO L	WILL CHANGE FROM H TO L
▨	CHANGE FROM L TO H	WILL CHANGE FROM L TO H

Waveform Symbol	Input	Output
▨	DON'T CARE ANY CHANGE PERMITTED	CHANGING STATE UNKNOWN
⟩		HIGH IMPEDANCE

EPROM

PROGRAMMING INSTRUCTIONS

After the completion of an ERASE operation, every bit in the device is in the "1" state (represented by Output High). Data are entered by programming zeros (Output Low) into the required bits. The words are addressed the same way as in the READ operation. A programmed "0" can only be changed to a "1" by ultraviolet light erasure.

To set the memory up for programming mode, the V_{CC}(E) input (Pin 24) should be raised to +12 V. Programming data is entered in 8-bit words through the data output terminals (DQ0 to DQ7).

The V_{DD} and V_{BB} supply voltages are the same as for the READ operation.

After address and data setup, one program pulse per address is applied to the program input. A program loop is a full pass through all addresses. Total programming time/address, $T_{Ptotal} = N \times t_{PHPL} \geqslant 100$ ms. The required number of program loops (N) is a function of the program pulse width (t_{PHPL}) where: $0.1 \text{ ms} \leqslant t_{PHPL} \leqslant 1.0$ ms; correspondingly, N is: $100 \leqslant N \leqslant 1000$. There must be N successive loops through all 2048 addresses. It is not permitted to apply more than one program pulse in succession to the same address (i.e., N program pulses to an address and then change to the next address to be programmed). At the end of a program sequence the Program Enable (E) falling edge transition must occur before the first address transition, when changing from a PROGRAM to a READ cycle. The program pin should be pulled down to V_{ILP} with an active device, because this pin sources a small amount of current (I_{IPL}) when (E) is at V_{IHW} (12 V) and the program pulse is at V_{ILP}.

EXAMPLE FOR PROGRAMMING

Always use the $T_{Ptotal} = N \times t_{PHPL} \geqslant 100$ ms relationship.

1. All 16,384 bits should be programmed with a 0.2 ms program pulse width.

The minimum number of program loops:

$$N = \frac{T_{Ptotal}}{t_{PHPL}} = \frac{100 \text{ ms}}{0.2 \text{ ms}} = 500.$$

One program loop consists of words 0 to 2047.

2. Words 0 to 200 and 300 to 700 are to be programmed. All other bits are "don't care". The program pulse width is 0.5 ms. The minimum number of program loops, N = 100/0.5 = 200. One program loop consists of words 0 to 2047. The data entered into the "don't care" bits should be all 1s.

3. Same requirements as example 2, but the EPROM is now to be updated to include data for words 850 to 880. The minimum number of program loops is the same as in the previous example, N = 200. One program loop consists of words 0 to 2047. The data entered into the "don't care" bits should be all 1s. Addresses 0 to 200 and 300 to 700 must be reprogrammed with their original data pattern.

ERASING INSTRUCTIONS

The TMS2716/27A16 can be erased by exposure to high intensity shortwave ultraviolet light, with a wavelength of 2537 Å. The recommended integrated dose (i.e., UV-intensity × exposure time) is 12.5 Ws/cm^2. As an example, using the "Model 30-000" UV-Eraser (Turner Designs, Mountain View, CA 94043) the ERASE-time is 30 minutes. The lamps should be used without shortwave filters and the TMS2716/27A16 should be positioned about one inch away from the UV-tubes.