Electrically Erasable PROM

FEATURES

- **Simple Byte Write Operation**
  - **—No High Voltages Necessary**
  - **—Single TTL Level $\overline{WE}$ Signal Modifies Data**
  - **—Internally Latched Address and Data**
  - **—Self Timed Write**
  - **—Noise Protected $\overline{WE}$ Pin**
- **Reliable N-Channel Floating Gate MOS Technology**
- **Single 5V Supply**
- **Byte Write Time: 10 ms Max.**
- **Fast Access Time: 300 ns Max.**
- **Low Power Dissipation**
  - **—Active Current: 140 mA Max.**
  - **—Standby Current: 60 mA Max.**
- **JEDEC Approved Byte-Wide Pinout**

DESCRIPTION

The Xicor X2816A is a 2K x 8 E^2PROM, fabricated with the same reliable N-channel floating gate MOS technology used in all Xicor 5V programmable nonvolatile memories. The X2816A features the JEDEC approved pinout for byte-wide memories, compatible with industry standard RAMs, ROMs, and EPROMs.

Xicor E^2PROMs are designed and tested for applications requiring extended endurance. Refer to Device Operation for further endurance information. Data retention is specified to be greater than 100 years.

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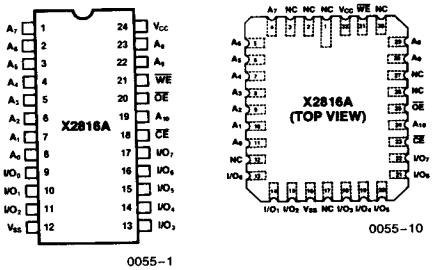
PIN CONFIGURATIONS



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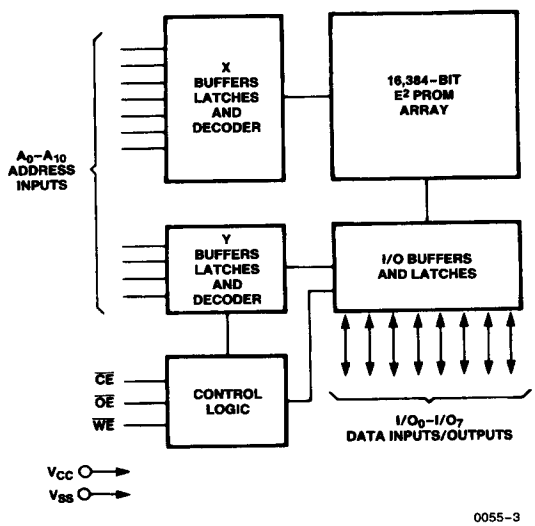
0055-10

PIN NAMES

A_0–A_{10}	Address Inputs
I/O_0–I/O_7	Data Input/Output
$\overline{WE}$	Write Enable
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
V_{CC}	+5V
V_{SS}	Ground
NC	No Connect

FUNCTIONAL DIAGRAM



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ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias ..... −65°C to +135°C
Storage Temperature ..... −65°C to +150°C
Voltage on any Pin with
Respect to Ground ..... −1.0V to +7V
D.C. Output Current ..... 5 mA
Lead Temperature
(Soldering, 10 Seconds) ..... 300°C

*COMMENT

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and the functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. OPERATING CHARACTERISTICS

T_A = −55°C to +125°C, V_{CC} = +5V ±10%, unless otherwise specified.

Symbol	Parameter	Limits		Units	Test Conditions
		Min.	Max.		
I_{CC}	V_{CC} Current (Active)		140	mA	$\overline{CE}$ = $\overline{OE}$ = V_{IL} All I/O's = Open Other Inputs = V_{CC}
I_{SB}	V_{CC} Current (Standby)		60	mA	$\overline{CE}$ = V_{IH}, $\overline{OE}$ = V_{IL} All I/O's = Open Other Inputs = V_{CC}
I_{LI}	Input Leakage Current		10	μA	V_{IN} = GND to V_{CC}
I_{LO}	Output Leakage Current		10	μA	V_{OUT} = GND to V_{CC}
V_{IL}	Input Low Voltage	−1.0	0.8	V	
V_{IH}	Input High Voltage	2.2	V_{CC} + 1.0	V	
V_{OL}	Output Low Voltage		0.4	V	I_{OL} = 2.1 mA
V_{OH}	Output High Voltage	2.4		V	I_{OH} = −400 μA

CAPACITANCE T_A = 25°C, f = 1.0 MHz, V_{CC} = 5V

Symbol	Test	Max.	Units	Conditions
$C_{I/O}$[1]	Input/Output Capacitance	10	pF	$V_{I/O}$ = 0V
C_{IN}[1]	Input Capacitance	6	pF	V_{IN} = 0V

A.C. CONDITIONS OF TEST

Input Pulse Levels	0V to 3.0V
Input Rise and Fall Times	10 ns
Input and Output Timing Levels	1.5V
Output Load	1 TTL Gate and C_L = 100 pF

MODE SELECTION

$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	Mode	I/O	Power
L	L	H	Read	D_{OUT}	Active
L	H	L	Write	D_{IN}	Active
H	X	X	Standby and Write Inhibit	High Z	Standby
X	L	X	Write Inhibit	—	—
X	X	H	Write Inhibit	—	—

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

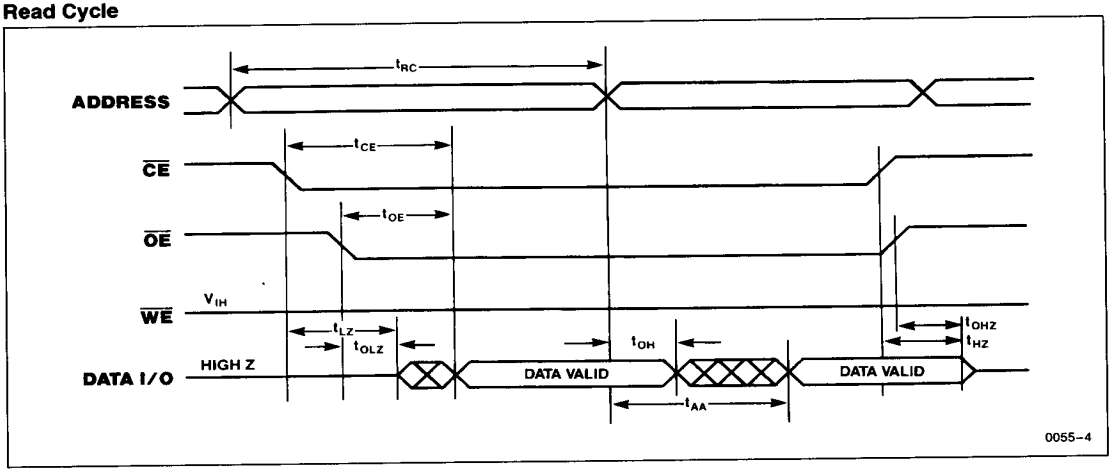
A.C. CHARACTERISTICS

$T_A = -55°C$ to $+125°C$, $V_{CC} = +5V \pm 10\%$, unless otherwise specified.

Read Cycle Limits

Symbol	Parameter	X2816AM		X2816AM-35		X2816AM-45		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{RC}	Read Cycle Time	300		350		450		ns
t_{CE}	Chip Enable Access Time		300		350		450	ns
t_{AA}	Address Access Time		300		350		450	ns
t_{OE}	Output Enable Access Time		120		135		150	ns
t_{LZ}	Chip Enable to Output in Low Z	10		10		10		ns
t_{HZ}(2)	Chip Disable to Output in High Z	10	100	10	150	10	150	ns
t_{OLZ}	Output Enable to Output in Low Z	50		50		50		ns
t_{OHZ}(2)	Output Disable to Output in High Z	10	100	10	150	10	150	ns
t_{OH}	Output Hold from Address Change	20		20		20		ns

Read Cycle

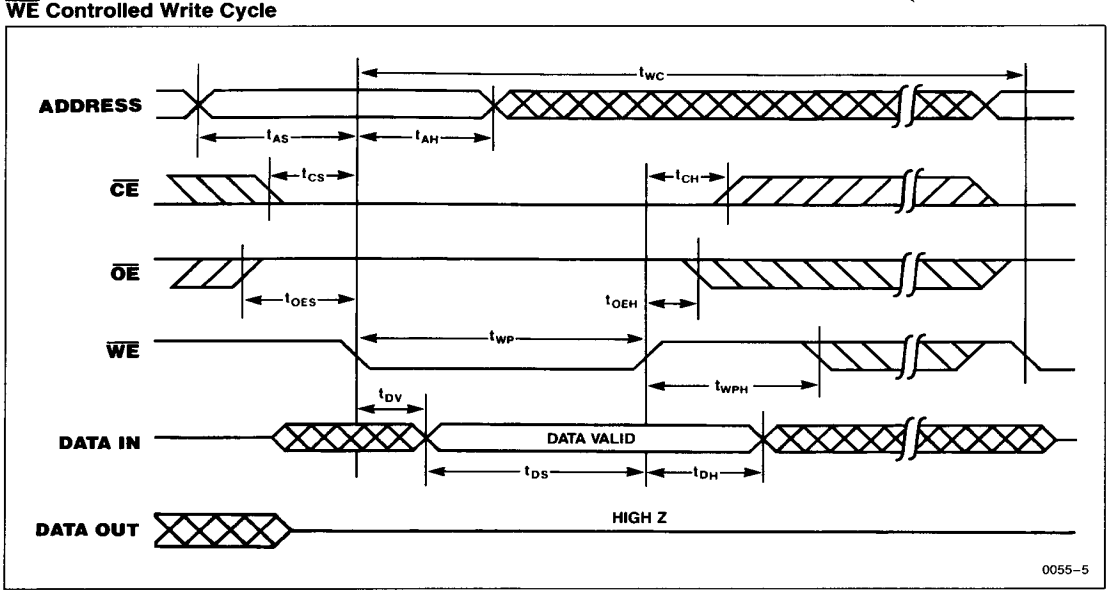


Note: (2) t_{HZ} and t_{OHZ} are measured from the point when $\overline{CE}$ or $\overline{OE}$ return high (whichever occurs first) to the time when the outputs are no longer driven.

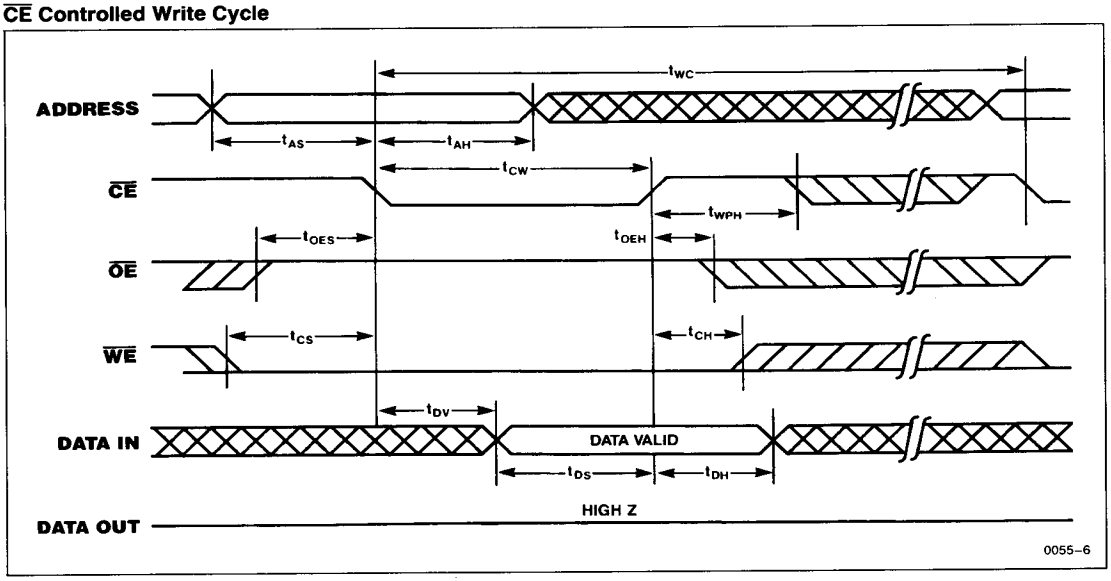
Write Cycle Limits

Symbol	Parameter	X2816AM		X2816AM-35		X2816AM-45		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{WC}	Write Cycle Time	10		10		10		ms
t_{AS}	Address Setup Time	10		10		10		ns
t_{AH}	Address Hold Time	150		150		150		ns
t_{CS}	Write Setup Time	0		0		0		ns
t_{CH}	Write Hold Time	0		0		0		ns
t_{CW}	Chip Enable to End of Write Input	150		175		230		ns
t_{OES}	Output Enable Setup Time	10		10		10		ns
t_{OEH}	Output Enable Hold Time	10		10		10		ns
t_{WP}	Write Pulse Width	150		175		230		ns
t_{WPH}	Write Control Recovery	50		50		50		ns
t_{DV}	Data Valid Time		1		1		1	μs
t_{DS}	Data Setup Time	135		175		230		ns
t_{DH}	Data Hold Time	15		20		30		ns

$\overline{WE}$ Controlled Write Cycle



$\overline{CE}$ Controlled Write Cycle



PIN DESCRIPTIONS

Addresses (A_0–A_{10})
The Address inputs select an 8-bit memory location during a read or write operation.

Chip Enable ($\overline{CE}$)
The Chip Enable input must be LOW to enable all read/write operations. When $\overline{CE}$ is HIGH, power consumption is reduced.

Output Enable ($\overline{OE}$)
The Output Enable input controls the data output buffers and is used to initiate read operations.

Data In/Data Out (I/O_0–I/O_7)
Data is written to or read from the X2816A through the I/O pins.

Write Enable ($\overline{WE}$)
The Write Enable input controls the writing of data to the X2816A.

DEVICE OPERATION

Read
Read operations are initiated by both $\overline{OE}$ and $\overline{CE}$ LOW. The read operation is terminated by either $\overline{CE}$ or $\overline{OE}$ returning HIGH. This 2-line control architecture eliminates bus contention in a system environment. The data bus will be in a high impedance state when either $\overline{OE}$ or $\overline{CE}$ is HIGH.

Write
Write operations are initiated when both $\overline{CE}$ and $\overline{WE}$ are LOW and $\overline{OE}$ is HIGH. The X2816A supports both a $\overline{CE}$ and $\overline{WE}$ controlled write cycle. That is, the address is latched by the falling edge of either $\overline{CE}$ or $\overline{WE}$, whichever occurs last. Similarly, the data is latched internally by the rising edge of either $\overline{CE}$ or $\overline{WE}$, whichever occurs first.

A byte write operation, once initiated, will automatically continue to completion, typically within 5 ms. In order to take advantage of the typical write time as opposed to the maximum specified time, the user can poll the X2816A. The I/O pins are placed in the high impedance state during the internal programming cycle. Once the internal cycle is complete, the X2816A may be accessed without any limitations. Therefore, the host can poll an address with known data (preferably with zeroes), as soon as a compare is true, the X2816A is ready for another write cycle.

WRITE PROTECTION
There are three features that protect the nonvolatile data from inadvertent writes.

- Noise Protection—A $\overline{WE}$ pulse of less than 20 ns will not initiate a write cycle.
- V_{CC} Sense—All functions are inhibited when V_{CC} is $\leq$3V, typically.
- Write Inhibit—Holding either $\overline{OE}$ LOW, $\overline{WE}$ HIGH or $\overline{CE}$ HIGH during power-on and power-off, will inhibit inadvertent writes.

ENDURANCE
Xicor E²PROMs are designed and tested for applications requiring extended endurance. The process average for endurance of Xicor E²PROMs is approximately ½ million cycles, as documented in RR504, the *Xicor Reliability Report on Endurance*. Included in that report is a method for determining the expected endurance of the device based upon the specific application environment. RR504 and additional reliability reports are available from Xicor.

SYSTEM CONSIDERATIONS

Because the X2816A is frequently used in large memory arrays it is provided with a two line control architecture for both read and write operations. Proper usage can provide the lowest possible power dissipation and eliminate the possibility of contention where multiple I/O pins share the same bus.

To gain the most benefit it is recommended that $\overline{CE}$ be decoded from the address bus and be used as the primary device selection input. Both $\overline{OE}$ and $\overline{WE}$ would then be common among all devices in the array. For a read operation this assures that all deselected devices are in their standby mode and that only the selected device(s) is outputting data on the bus.

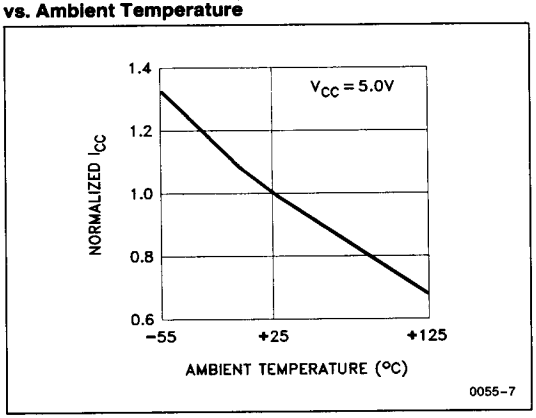
Because the X2816A has two power modes, standby and active, proper decoupling of the memory array is of prime concern. Enabling $\overline{CE}$ will cause transient current spikes. The magnitude of these spikes is dependent on the output capacitive loading of the I/Os. Therefore, the larger the array sharing a common bus, the larger the transient spikes. The voltage peaks associated with the current transients can be suppressed by the proper selection and placement of decoupling capacitors. As a minimum, it is recommended that a 0.1 μF high frequency ceramic capacitor be used between V_{CC} and GND at each device. Depending on the size of the array, the value of the capacitor may have to be larger.

In addition, it is recommended that a 4.7 μF electrolytic bulk capacitor be placed between V_{CC} and GND for each eight devices employed in the array. This bulk capacitor is employed to overcome the voltage droop caused by the inductive effects of the PC board traces.

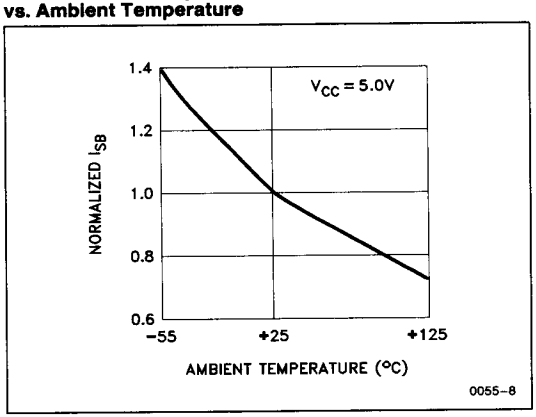
SYMBOL TABLE

WAVEFORM	INPUTS	OUTPUTS
	Must be steady	Will be steady
	May change from Low to High	Will change from Low to High
	May change from High to Low	Will change from High to Low
	Don't Care: Changes Allowed	Changing: State Not Known
	N/A	Center Line is High Impedance

Normalized Active Supply Current vs. Ambient Temperature



Normalized Standby Supply Current vs. Ambient Temperature



Normalized Access Time vs. Ambient Temperature