



## 2K X 8 Electrically Erasable PROM

### FEATURES

- **Fast Read Access Times**
  - 250ns, 300ns, 350ns, 450ns
- **5 Volt-only Operation**
  - Including Write
- **Industrial Temperature Range Available (XL2816A)**
- **Fast Nonvolatile Write Cycle**
  - Internally Latched Data and Address
  - 10ms Nonvolatile Write Cycle
- **Automatic Erase Before Write**
- **Automatic Write Timeout**
- **On-chip Inadvertent Write Protection**
- **Unlimited Read Cycle Endurance**
- **10,000 Rewrites per Byte**
- **10 Year Secure Data Retention**
- **TTL Compatible Inputs and Outputs**
- **JEDEC Approved Byte Wide Memory Pinout**

### OVERVIEW

The XL2816A is a full-featured, 2K x 8 bit E<sup>2</sup>PROM (Electrically Erasable Programmable Read Only Memory). Operationally, it is compatible with industry standard 16K bit E<sup>2</sup>PROM devices, and it offers improved speed and power efficiency. Read access times are as low as 250ns; standby current, less than 40mA. The device is fully functional with a single 5V power supply, and the XL2816A is manufactured with EXEL's 2.5µ NMOS E<sup>2</sup>PROM process.

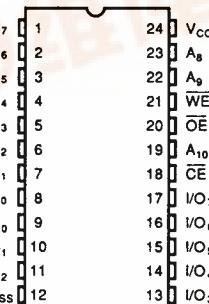
The sophisticated architecture of this device provides complete and automatic control of the nonvolatile write cycle eliminating the need for external timers, latches, high voltage generators and inadvertent write protection circuitry. It fits into a standard SRAM socket and responds to typical SRAM write commands.

### PIN CONFIGURATION

24 Pin PDIP  
Type "P" Package

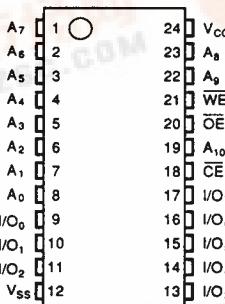


24 Pin CERDIP  
Type "C" Package

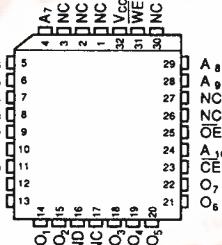


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Small Outline  
Type "J" Package



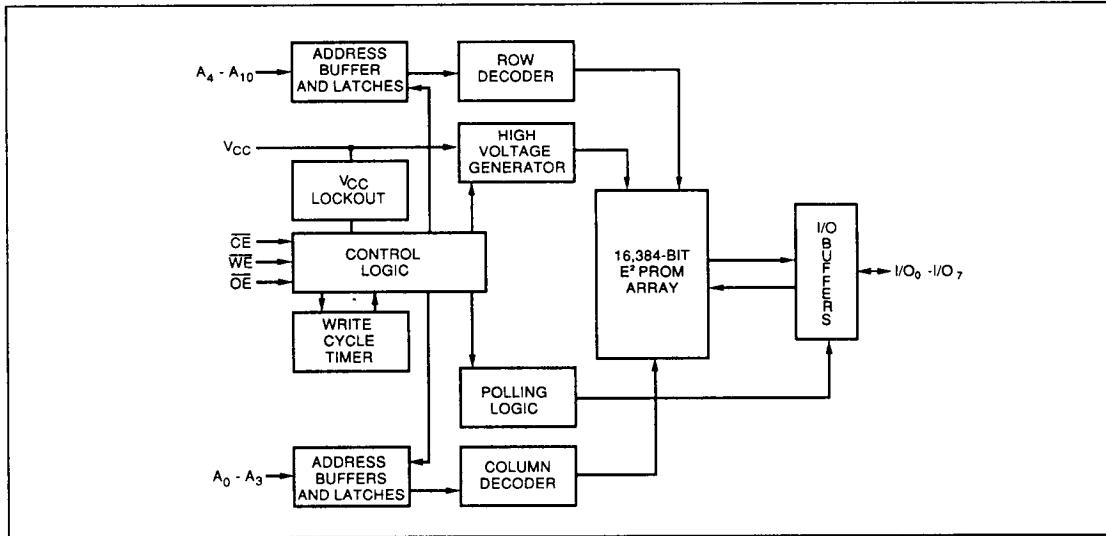
32 Pin PLCC  
Type "D" Package



### PIN NAMES

A <sub>0</sub> -A <sub>10</sub>	Address Inputs
I/O <sub>0</sub> -I/O <sub>7</sub>	Data Inputs/Outputs
CE	Chip Enable
OE	Output Enable
WE	Write Enable
V <sub>CC</sub>	Supply Voltage
V <sub>SS</sub>	Power and Signal Ground
NC	No Connect

## BLOCK DIAGRAM



The XL2816A features  $\overline{OE}$  write inhibit logic and noise protected  $\overline{WE}$ , to inhibit inadvertent writes.

The XL2816A is compatible with industrial standard 2K x 8 E<sup>2</sup>PROMS — its pinouts and operating modes conform to established standards. This compatibility extends to higher and lower density EXEL E<sup>2</sup>PROMS as well.

## APPLICATIONS

The XL2816A provides secure and reliable data storage throughout your system's lifetime both during periods of power on and power off. It may be written to through standard microprocessor protocols as if it were a Static RAM, yet it retains its data in the absence of system power for at least 10 years after the data is written. This flexibility has resulted in a wide variety of digital system applications.

The nonvolatile storage in the XL2816A replaces dip switches as a means of storing configuration data. It delivers firmware for booting up systems, and for operating industrial and process controllers, traffic controllers, robotics and telemetry, measuring instruments and appliance controls. It retains phone numbers and messages in facsimile machines. The XL2816A is ideal in applications that are self-adapting such as video games and systems that require automatic re-calibration, as well as those that are subject to power failures.

## ENDURANCE and DATA RETENTION

The XL2816A is designed for applications requiring up to 10,000 data changes per E<sup>2</sup>PROM byte ensuring a guaranteed endurance of 20 million data changes per device. It provides 10 years of secure data retention, with or without power applied after the data is written.

## DEVICE OPERATION-STANDARD MODES

Three control pins ( $\overline{CE}$ ,  $\overline{OE}$  and  $\overline{WE}$ ) select all standard, user operating modes for the XL2816A. Chip erase (typically executed during test procedures) requires a higher supply voltage on one input pin. This conforms with existing E<sup>2</sup>PROM standards.

## Read Mode

Data is read from the XL2816A by bringing both  $\overline{CE}$  and  $\overline{OE}$  LOW while keeping  $\overline{WE}$  HIGH. With the read mode selected, address lines can be changed at any time, in any order to read data at various locations in the E<sup>2</sup>PROM array. Read access time is measured from the time when the final controlling line ( $\overline{CE}$  or  $\overline{OE}$ ) goes LOW, or the time when the address is established.

The device can be read an unlimited number of times, because the stored charge that defines the bit state is not affected by a read cycle. (See Figure 2.)

**Write Mode**

In the XL2816A the write cycle is initiated by applying a logical "0" to both WE and CE while OE is logical "1." The address inputs are latched into the device on the falling edge of WE or CE (whichever is last) to specify the address that is to be written. Data on the I/O pins is then latched into the device by bringing either WE or CE HIGH. Both addresses and data are latched in a brief 200ns interval using a 5V supply and TTL write signals. Once the data is latched, the XL2816A will automatically erase the selected byte and write the new data in less than 10ms. The system is therefore freed to proceed with other operations while the XL2816A autonomously executes its internal write cycle. The I/O pins will be in a high impedance state while the write operation is in progress with the exception of I/O7 if a read command is asserted. (See monitoring device status in the next column of this page.) (See Figures 3 and 4.)

**Output Disable Mode**

If, while in the read mode, OE is brought HIGH, the device remains in the read mode, but with the outputs disabled. (I/O pins are in a high impedance state.)

**Standby Mode**

Whenever CE is brought high, the device is set into its standby mode, placing the I/O pins in a high impedance state. Standby power dissipation is less than 40mA with TTL level inputs. While CE remains HIGH, all other input pins are disabled, insulating the device from activity on the system busses.

**Chip Erase — High Voltage Mode**

The chip erase mode allows the user to erase the entire E<sup>2</sup>PROM array with a single command. The method requires the application of high voltage (V<sub>H</sub>) on the OE pin, with CE at a logical "0." Chip erase is initiated by a standard byte write command while holding the data on the I/O pins HIGH. A byte containing all "1's" is automatically written to all locations in the E<sup>2</sup>PROM array. (Refer to Mode Selection chart.)

**MONITORING DEVICE STATUS**

Because the internal nonvolatile write cycle is completely managed by the XL2816A, a status indicator has been incorporated to provide for the system to monitor the READY/BUSY status of the device. This is accomplished through a system software routine which simply re-reads the XL2816A until it determines a simple logical condition.

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**WRITE PROTECT MECHANISMS**

The XL2816A features several integrated mechanisms to protect it from inadvertent writes that might occur during system power supply transitions or periods of system noise. In addition to the user-controlled protection mechanisms, the following specialized circuit is built in.

**OE Write Inhibit**

If OE is brought LOW before the CE and WE write command sequence, the internal nonvolatile write cycle will be inhibited.

**MODE SELECTION**

<u>CE</u>	<u>OE</u>	<u>WE</u>	Mode	I/O	Power
VIH	X	X	Standby	HIGH Z	Standby
VIL	VIL	VIH	Read	DOUT	Active
VIL	VIH		Byte Write (WE Controlled)	DIN	Active
	VIH	VIL	Byte Write (CE Controlled)	DIN	Active
VIL	VH	VIL	Chip Erase*	Data In=VIH	Active
X	VIL	X	Write Inhibit	—	—

\*Contact EXEL for details.

**ABSOLUTE MAXIMUM RATINGS**

Temperature Under Bias .....	-40°C to +85°C
Storage Temperature. ....	-65°C to +150°C
Lead Soldering Temperature (less than 10 seconds) .....	300°C
Supply Voltage .....	0 to 6.5V
Voltage on Any Pin*	-0.5V to +6.0V
ESD Rating .....	2000V
DC Output Current .....	.5mA

\*With respect to ground

Note: 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 indicated in the operational sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Although this product includes specific circuitry to protect it from electrostatic discharge, conventional precautions should be taken to protect it from any voltages higher than the rated maxima.

**DC CHARACTERISTICS** $T_A = 0^\circ\text{C}$  to  $+75^\circ\text{C}$  for the XLS2816A or  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  for the XLE2816A,  $V_{CC} = 5\text{V} \pm 5\%$ 

Symbol	Parameter	Test Conditions	Min	Max	Units
$I_{CC}$	$V_{CC}$ Current — Active (TTL)	$CE = \overline{OE} = V_{IL}$ I/Os = open Other Inputs = 5.25V		110	mA
$I_{SB}$	$V_{CC}$ Current — Standby (TTL)	$CE = V_{IH}$ $OE = V_{IL}$ I/Os = open Other Inputs = 5.25V		40	mA
$I_{LI}$	Input Leakage Current	$V_{IN} = 0$ to 5.25V		10	$\mu\text{A}$
$I_{LO}$	Output Leakage Current	$V_{OUT} = 0$ to 5.25V		10	$\mu\text{A}$
$V_{IL}$	Input Low Voltage			0.8	V
$V_{IH}$	Input High Voltage		2.0		V
$V_{OL}$	Output Low Voltage	$I_{OL} = 2.1\text{mA}$		0.4	V
$V_{OH}$	Output High Voltage	$I_{OH} = -400\mu\text{A}$	2.4		V
$V_H$	High Voltage for Chip Erase		15	18	V

**CAPACITANCE** $T_A = +25^\circ\text{C}$ ,  $f = 1.0$  MHz

Symbol	Test	Test Conditions	Max	Units
$C_{I/O}$	Input/Output Capacitance	$V_{I/O} = 0\text{V}$	10	pF
$C_{IN}$	Input Capacitance	$V_{IN} = 0\text{V}$	6	pF

## AC OPERATING CHARACTERISTICS

## READ CYCLE (See Figure 2)

TA = 0°C to +75°C for the XLS2816A or -40°C to +85°C for the XLE2816A, VCC = 5V±5%

Symbol	Parameter	XL2816A-250 Limits		XL2816A-300 Limits		XL2816A-350 Limits		XL2816A-450 Limits		Units
		Min	Max	Min	Max	Min	Max	Min	Max	
t <sub>RC</sub>	Read Cycle Time	250		300		350		450		ns
t <sub>AA</sub>	Address Access Time		250		300		350		450	ns
t <sub>CE</sub>	Chip Enable Access Time		250		300		350		450	ns
t <sub>OE</sub>	Output Enable Access Time		100		120		135		150	ns
t <sub>LZ</sub>	Chip Enable to Output in Low Z	10		10		10		10		ns
t <sub>HZ</sub>	Chip Disable to Output in High Z	10	100	10	100	10	100	10	100	ns
t <sub>OLZ</sub>	Output Enable to Output in Low Z	10		10		10		10		ns
t <sub>OHZ</sub>	Output Disable to Output in High Z	10	70	10	80	10	100	10	100	ns
t <sub>OH</sub>	Output Hold from Address Change	20		20		20		20		ns

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## WRITE CYCLE (See Figures 3 and 4)

TA = 0°C to +75°C for the XLS2816A or -40°C to +85°C for the XLE2816A, VCC = 5V±5%

Symbol	Parameter	Min	Max	Units
t <sub>WC</sub>	Nonvolatile Write Cycle Time		10	ms
t <sub>AS</sub>	Address Setup Time	10		ns
t <sub>AH</sub>	Address Hold Time	70		ns
t <sub>CS</sub>	Chip Enable or Write Enable Setup Time	0		ns
t <sub>CH</sub>	Chip Enable or Write Enable Hold Time	0		ns
t <sub>CW</sub>	Chip Enable Pulse Width	150		ns
t <sub>OES</sub>	Output Enable Setup Time	10		ns
t <sub>OEH</sub>	Output Enable Hold Time	10		ns
t <sub>WP</sub>	Write Enable Pulse Width	150		ns
t <sub>WPH</sub>	Write Recovery Time	50		ns
t <sub>DV</sub>	Data Valid Time		1	μs
t <sub>DS</sub>	Data Setup Time	50		ns
t <sub>DH</sub>	Data Hold Time	10		ns
t <sub>INIT</sub>	Power-up Initialization Period		20	ms

Input Signal Amplitude	0V to 3V
Input Rise and Fall Times	5ns (1V to 2V)
Frequency	1MHz
Timing Reference Value	1.5V

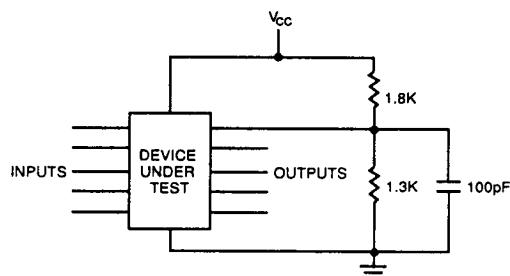


FIGURE 1. AC TEST CONDITIONS

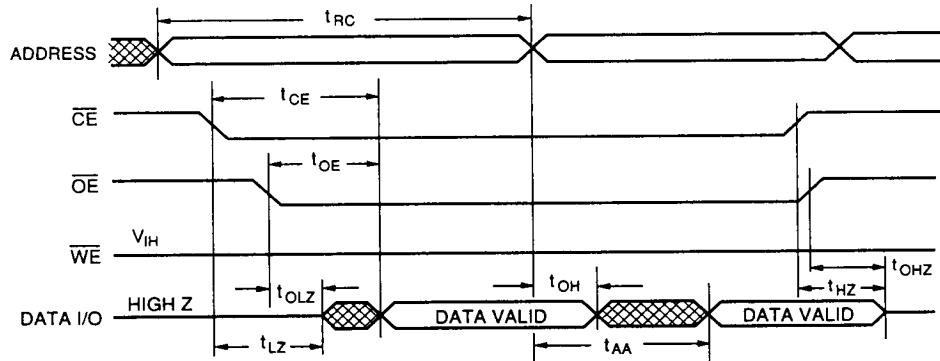


FIGURE 2. READ CYCLE TIMING

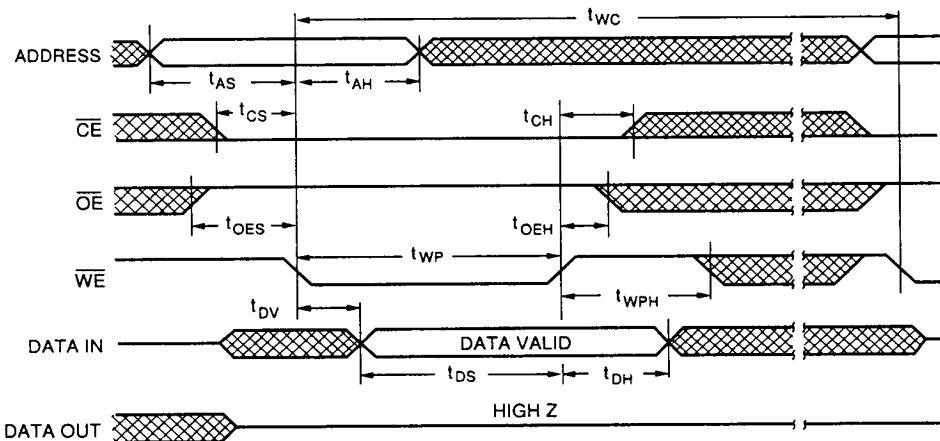


FIGURE 3. WE CONTROLLED WRITE CYCLE TIMING

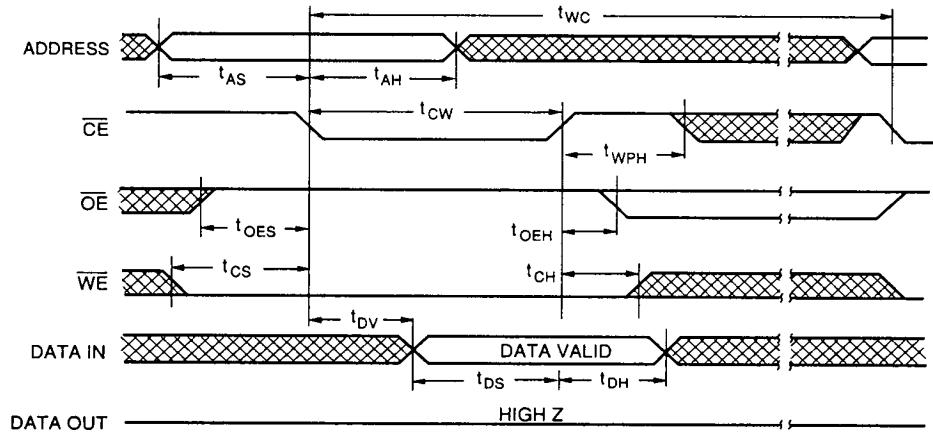


FIGURE 4. CE CONTROLLED WRITE CYCLE TIMING