

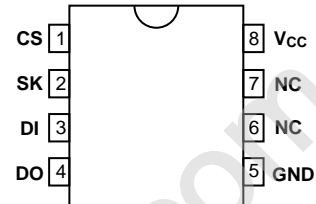
2,048-Bit Serial Electrically Erasable PROM  
with 2V Read Capability

**FEATURES**

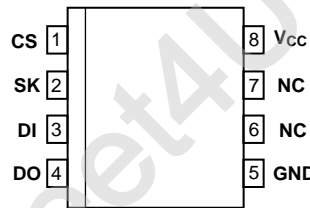
- 2.7 to 5.5V Operation (XL93LC56)  
4.5 to 5.5V Operation (XL93LC56A)
- Extended Temperature Range: -40°C to +85°C
- State-of-the-Art Architecture
  - Nonvolatile data storage
  - Fully TTL compatible inputs and outputs
  - Auto increment for efficient data dump
- Hardware and Software Write Protection
  - Defaults to write-disabled state at power up
  - Software instructions for write-enable/disable
  - V<sub>CC</sub> lockout inadvertent write protection (XL93LC56A)
- Low Power Consumption
  - 1mA active
  - 1µA standby
- Low Voltage Read Operations
  - Reliable read operations down to 2.0 volts
- Advanced Low Voltage CMOS E<sup>2</sup>PROM Technology
- Versatile, Easy-to-Use Interface
  - Self-timed programming cycle
  - Automatic erase-before-write
  - Programming Status Indicator
  - Word and chip erasable
- Durable and Reliable
  - 100-year data retention after 100K write cycles
  - Minimum of 100,000 erase/write cycles
  - Unlimited read cycles
  - ESD protection (EIAJ and JEDEC standard)

**PIN CONFIGURATIONS**

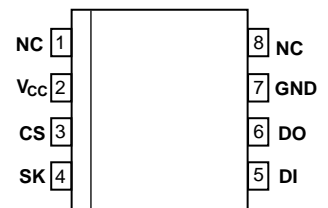
Plastic Dual-in-line  
"P" Package



JEDEC Small Outline  
"RY" Package



JEDEC Small Outline  
"Y" Package



D0005 ILL A01.1

**PIN NAMES**

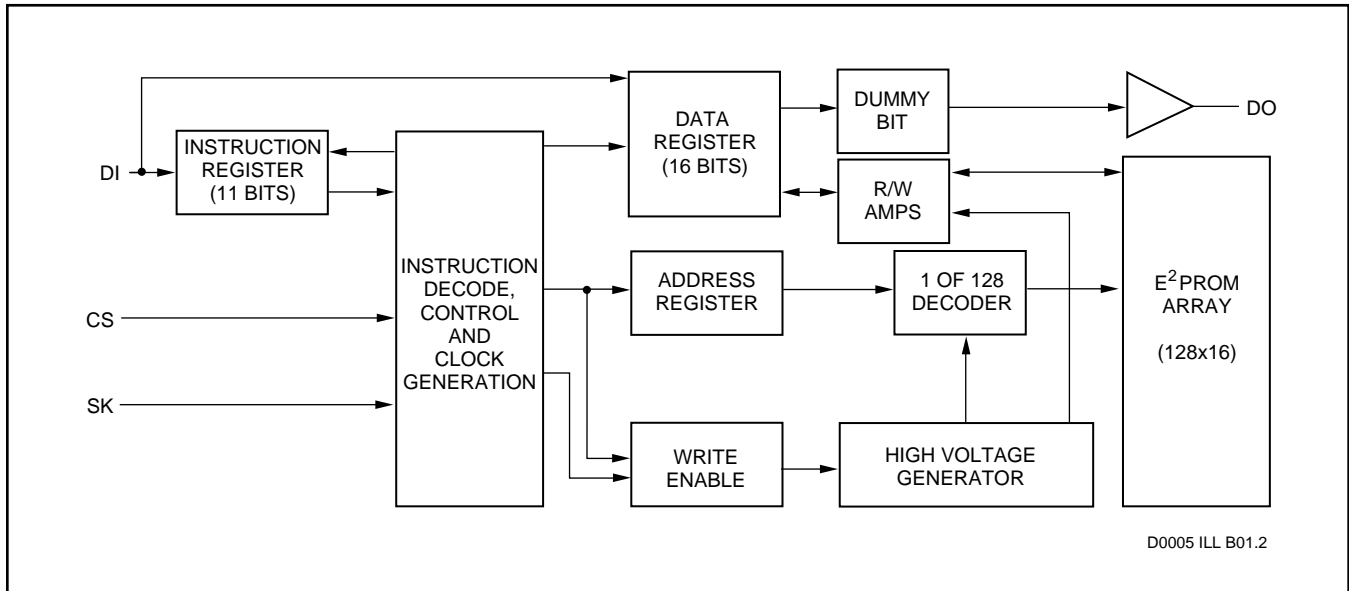
CS	Chip Select
SK	Serial Data Clock
DI	Serial Data Input
DO	Serial Data Output
GND	Ground
V <sub>CC</sub>	Power Supply
NC	Not Connected

**OVERVIEW**

The XL93LC56/56A is a cost effective 2,048-bit, nonvolatile, serial E<sup>2</sup>PROM. It is fabricated using EXEL's advanced CMOS E<sup>2</sup>PROM technology. The XL93LC56/56A provides efficient nonvolatile read/write memory arranged as 128 registers of 16 bits each. Seven 11-bit instructions control the operation of the device, which include read, write, and mode enable functions. The data output pin (DO) indicates the status of the device during the self-timed nonvolatile programming cycle.

The self-timed write cycle includes an automatic erase-before-write capability. To protect against inadvertent writes, the WRITE instruction is accepted only while the chip is in the write enabled state. Data is written in 16 bits per write instruction into the selected register. If Chip Select (CS) is brought HIGH after initiation of the write cycle, the Data Output (DO) pin will indicate the READY/BUSY status of the chip.

**BLOCK DIAGRAM**



**APPLICATIONS**

The XL93LC56/56A is ideal for high volume applications requiring low power and low density storage. This device uses a cost effective, space saving 8-pin package. Candidate applications include robotics, alarm devices, electronic locks, meters and instrumentation settings.

**ENDURANCE AND DATA RETENTION**

The XL93LC56/56A is designed for applications requiring up to 100,000 erase/write cycles per bit. It provides 100 years of secure data retention without power after the execution of 100,000 write cycles.

**DEVICE OPERATION**

The XL93LC56/56A is controlled by seven 11-bit instructions. Instructions are clocked in (serially) on the DI pin. Each instruction begins with a logical “1” (the start bit). This is followed by the opcode (2 bits), the address field (8 bits), and data, if appropriate. The clock signal (SK) may be halted at any time and the XL93LC56/56A will remain in its last state. This allows full static flexibility and maximum power conservation.

**Read (READ)**

The READ instruction is the only instruction that results in serial data on the DO pin. After the read instruction and address have been decoded, data is transferred from the selected memory register into a 16-bit serial shift register. (Please note that one logical “0” bit precedes the actual 16-bit output data string). The output on DO changes during the LOW-TO-HIGH transitions of SK. (See Figure 2.)

**Low Voltage Read**

The XL93LC56/56A has been designed to ensure that data read operations are reliable in low voltage environments. The XL93LC56/56A is guaranteed to provide accurate data during read operations with V<sub>CC</sub> as low as 2.0V.

**Auto Increment Read Operations**

In order to facilitate memory transfer operations, the XL93LC56/56A has been designed to output a continuous stream of memory content in response to a single read operation instruction. To utilize this function, the system asserts a read instruction specifying a start location address. Once the 16 bits of the addressed word have been clocked out, the data in consecutively higher address locations is output. The address will wrap around continuously with CS HIGH until the Chip Select control pin is brought LOW. This allows for single instruction data dumps to be executed with a minimum of firmware overhead.

**Write Enable (WEN)**

The write enable (WEN) instruction must be executed before any device programming can be done. When V<sub>CC</sub> is applied, this device powers up in the write disabled state. The device then remains in a write disabled state until a WEN instruction is executed. Thereafter the device remains enabled until a WDS instruction is executed or until V<sub>CC</sub> is removed. (NOTE: Neither the WEN nor the WDS instruction has any effect on the READ instruction. See Figure 3.)

**Write (WRITE)**

The WRITE instruction includes 16 bits of data to be written into the specified register. After the last data bit has been clocked into DI, and before the next rising edge of SK, CS must be brought LOW. The falling edge of CS initiates the self-timed programming cycle.

After a minimum wait of 250ns from the falling edge of CS ( $t_{CS}$ ), if CS is brought HIGH, DO will indicate the READY/BUSY status of the chip: logical "0" means programming is still in progress; logical "1" means the selected register has been written, and the part is ready for another instruction. (See Figure 4.) (NOTE: The combination of CS HIGH, DI HIGH and the rising edge of the SK clock, resets the READY/BUSY flag. Therefore, it is important not to reset the READY/BUSY flag through this combination of control signals, if you want to access it). Before a WRITE instruction can be executed, the device must be write enabled (see WEN).

**Write All (WRALL)**

The write all (WRALL) instruction programs all registers with the data pattern specified in the instruction.

As with the WRITE instruction, if CS is brought HIGH after a minimum wait of 250ns ( $t_{CS}$ ), the DO pin indicates the READY/BUSY status of the chip. (See Figure 5.)

**Write Disable (WDS)**

The write disable (WDS) instruction disables all programming capabilities. This protects the entire memory array against accidental modification of data until a WEN in-

struction is executed. (When  $V_{CC}$  is applied, the part powers up in the write disabled state.) To protect data, a WDS instruction should be executed upon completion of each programming operation. (NOTE: Neither the WEN nor the WDS instruction has any effect on the READ instruction. See Figure 6.)

**Erase**

The Erase instruction (ERASE) programs the addressed memory location to all "1s." Once the address is clocked in, the falling edge of CS will initiate the internal programming cycle. After waiting a minimum 250ns, the READY/BUSY status can be monitored on DO.

**Erase All (ERAL)**

Full chip erase is provided for ease of programming. Erasing the entire chip involves setting all bits in the entire memory array to a logical "1." (See Figure 8.)

**$V_{CC}$  Lockout - Inadvertent Write Protection (XL93LC56A only)**

To ensure against inadvertent write operations, the XL93LC56A has been equipped with an internal  $V_{CC}$  sensor circuit which inhibits data alteration when the supply voltage ( $V_{CC}$ ) falls below  $V_{WI}$ . If the applied  $V_{CC}$  is below 3.75V (typical), the XL93LC56A is inhibited from executing write operations thereby protecting the non-volatile data from inadvertent operations.

**XL93LC56/56A INSTRUCTION SET**

Instruction	Start Bit	OP Code	Address	Input Data
READ	1	10	X(A6-A0)	
WEN (Write Enable)	1	00	11XXXXXX	
WRITE	1	01	X(A6-A0)	D15-D0
WRALL (Write All Registers)	1	00	01XXXXXX	D15-D0
WDS (Write Disable)	1	00	00XXXXXX	
ERASE	1	11	X(A6-A0)	
ERAL (Erase All Registers)	1	00	10XXXX	

## 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 ..... -0.3 to V<sub>CC</sub> + 0.3V  
 ESD Rating ..... 2000V

NOTE: These are STRESS ratings only. Appropriate conditions for operating these devices are given elsewhere in this specification. Stresses beyond those listed here may permanently damage the part. Prolonged exposure to maximum ratings may adversely affect device reliability.

## DC ELECTRICAL CHARACTERISTICS

T<sub>A</sub> = -40°C to +85°C

Symbol	Parameter	Conditions	XL93LC56		XL93LC56/56A		XL93LC56/56A		Units
			V <sub>CC</sub> = 3.0V±10%		V <sub>CC</sub> = 5.0V±10%		V <sub>CC</sub> = 2.0V (Read Only)		
			Min	Max	Min	Max	Min	Max	
I <sub>CC1</sub>	Operating Current CMOS Input Levels	CS = V <sub>CC</sub> , SK = 250KHz		2		2		2	mA
I <sub>CC2</sub>	Operating Current TTL Input Levels	CS = V <sub>IH</sub> , SK = 1MHz		n/a		5		n/a	mA
I <sub>SB</sub>	Standby Current	CS = DI = SK = 0V		2		2		2	µA
I <sub>LI</sub>	Input Leakage	V <sub>IN</sub> = 0V to V <sub>CC</sub> (CS, SK, DI)		1		1		1	µA
I <sub>LO</sub>	Output Leakage	V <sub>OUT</sub> = 0V to V <sub>CC</sub> , CS = 0V		1		1		1	µA
V <sub>IL</sub>	Input Low Voltage		-0.1	0.15V <sub>CC</sub>	-0.1	0.8	-0.1	0.1 V <sub>CC</sub>	V
V <sub>IH</sub>	Input High Voltage		0.8 V <sub>CC</sub>	V <sub>CC</sub> +0.2	2	V <sub>CC</sub> +0.2	0.9 V <sub>CC</sub>	V <sub>CC</sub> +0.2	V
V <sub>OL1</sub>	Output Low Voltage	I <sub>OL</sub> = 2.1mA TTL		n/a		0.4		n/a	V
V <sub>OH1</sub>	Output High Voltage	I <sub>OH</sub> = -400µA TTL	n/a		2.4		n/a		V
V <sub>OH2</sub>	Output High Voltage	I <sub>OH</sub> = -10µA CMOS		0.2		0.2		0.2	V
V <sub>OH2</sub>	Output High Voltage	I <sub>OH</sub> = -10µA CMOS	V <sub>CC</sub> -0.2		V <sub>CC</sub> -0.2		V <sub>CC</sub> -0.2		V
V <sub>WI</sub>	Write Inhibit Threshold		n/a	n/a	2.7	4.4	n/a	n/a	V

D0005 PGM T02.1

## AC ELECTRICAL CHARACTERISTICS

T<sub>A</sub> = -40°C to +85°C

Symbol	Parameter	Conditions	XL93LC56		XL93LC56/56A		XL93LC56/56A		Units
			V <sub>CC</sub> = 3.0V±10%		V <sub>CC</sub> = 5.0V±10%		V <sub>CC</sub> = 2.0V (Read Only)		
			Min	Max	Min	Max	Min	Max	
f <sub>SK</sub>	SK Clock Frequency		0	250	0	1000	0	250	KHz
t <sub>SKH</sub>	SK High Time		1000		400		2000		ns
t <sub>SKL</sub>	SK Low Time		1000		250		2000		ns
t <sub>CS</sub>	Minimum CS Low Time		1000		250		1000		ns
t <sub>CSS</sub>	CS Setup Time	Relative to SK $\uparrow$	200		50		200		ns
t <sub>DIS</sub>	DI Setup Time	Relative to SK $\uparrow$	400		100		400		ns
t <sub>CSH</sub>	CS Hold Time	Relative to SK $\downarrow$	0		0		0		ns
t <sub>DIH</sub>	DI Hold Time	Relative to SK $\uparrow$	400		100		400		ns
t <sub>PD1</sub>	Output Delay to "1"	AC Test		2000		500		2000	ns
t <sub>PD0</sub>	Output Delay to "0"	AC Test		2000		500		2000	ns
t <sub>SV</sub>	CS to Status Valid	AC Test C <sub>L</sub> = 100pF		2000		500		2000	ns
t <sub>DF</sub>	CS to DO in 3-state	CS = Low to DO = Hi-Z		400		100		400	ns
t <sub>WP</sub>	Write Cycle Time	CS = Low to DO = Ready		25		10		n/a	ms

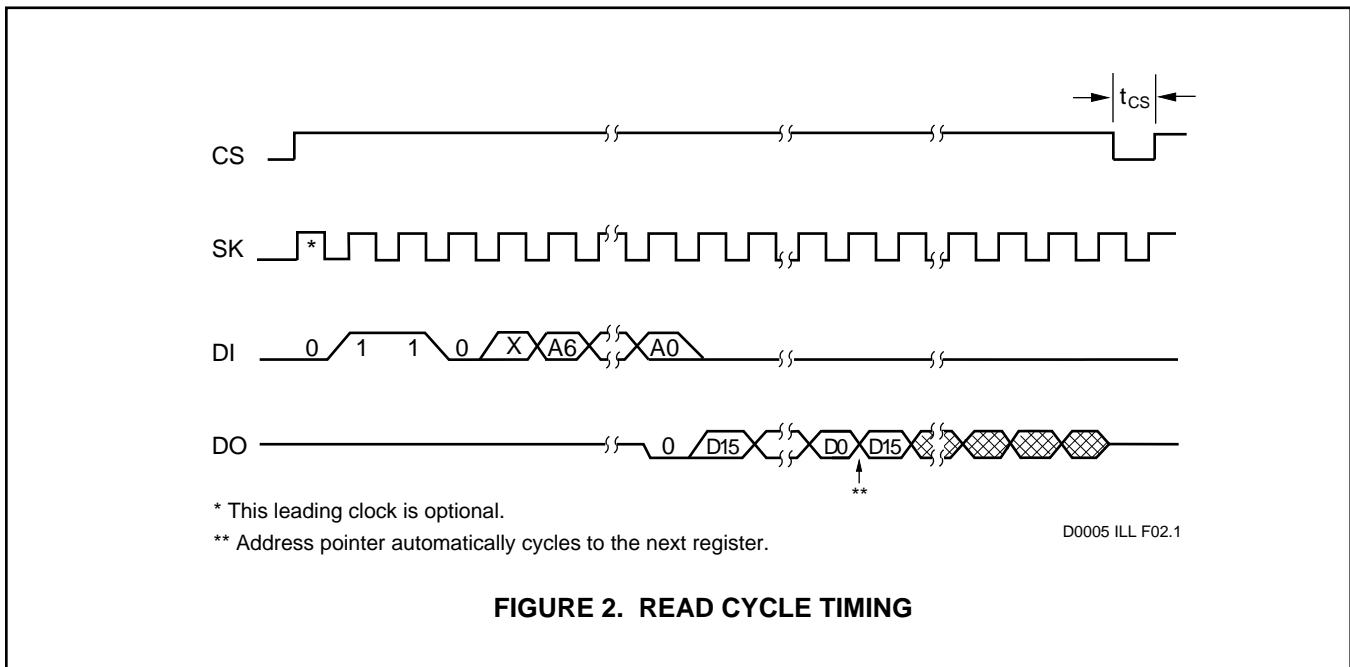
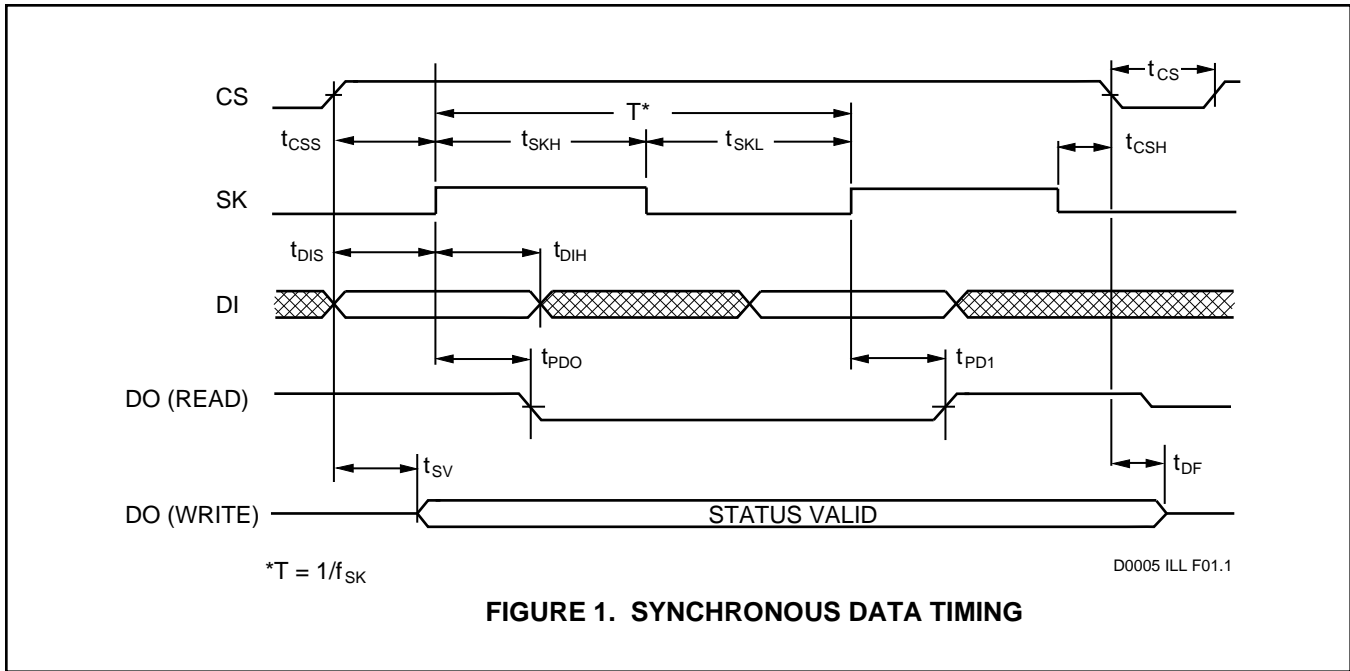
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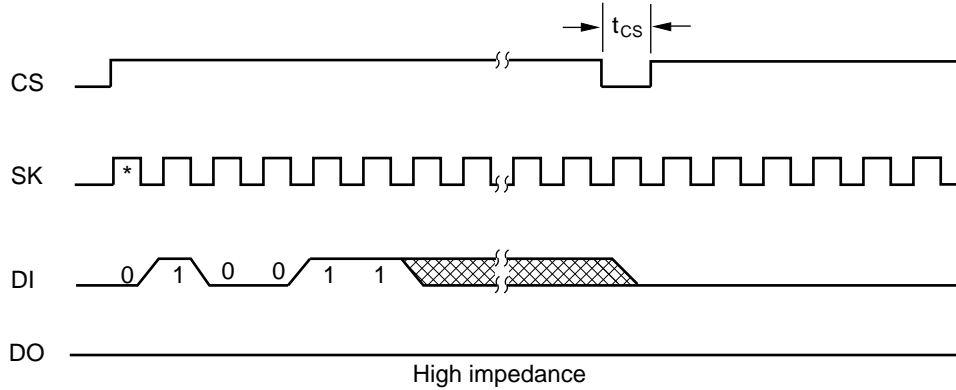
**CAPACITANCE**

T<sub>A</sub> = 25°C, f = 250KHz

Symbol	Parameter	Max	Units
C <sub>IN</sub>	Input Capacitance	5	pF
C <sub>OUT</sub>	Output Capacitance	5	pF

D0005 PGM T04.1

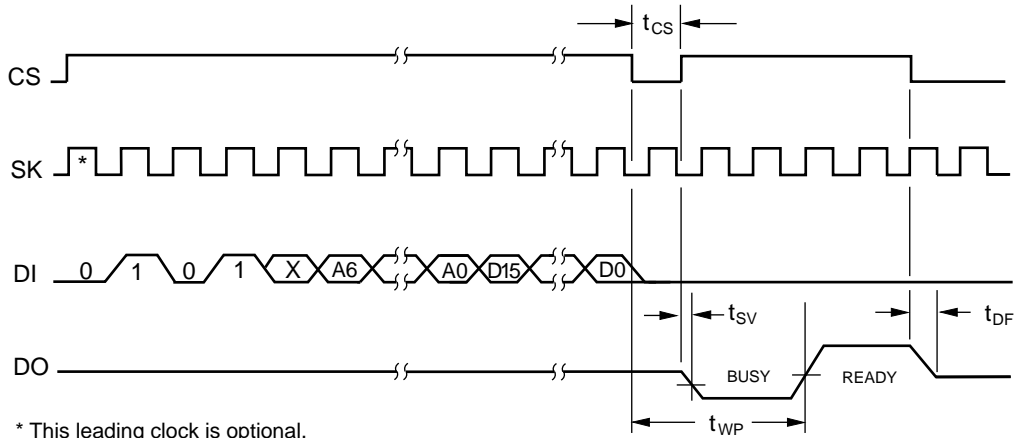




\* This leading clock is optional.

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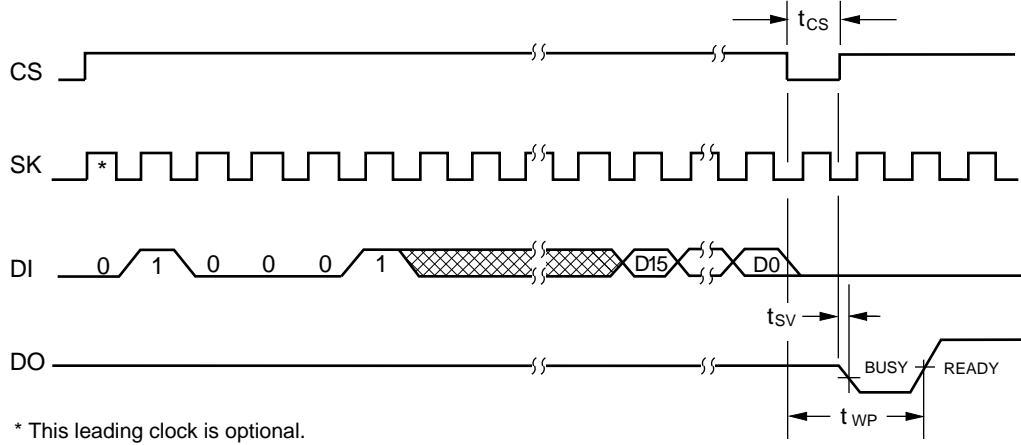
**FIGURE 3. WRITE ENABLE (WEN) CYCLE TIMING**



\* This leading clock is optional.

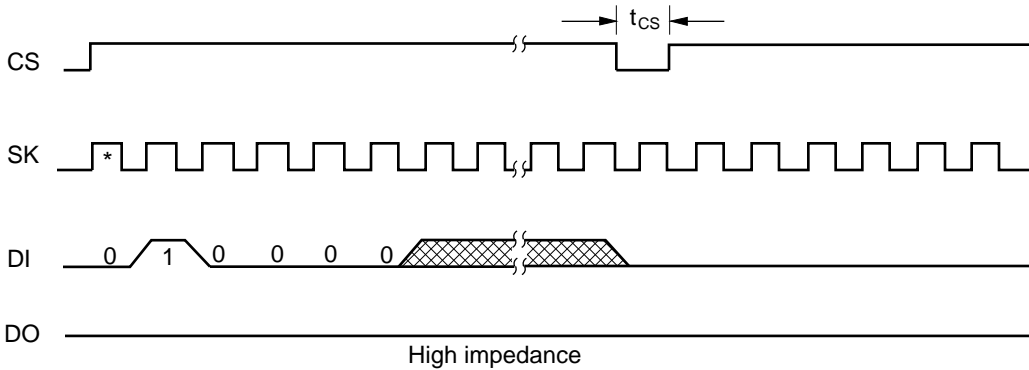
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**FIGURE 4. WRITE CYCLE TIMING**



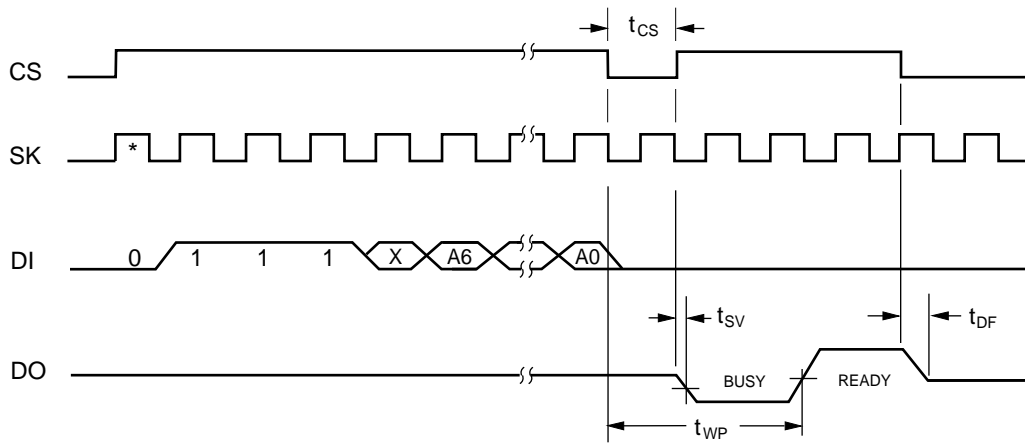
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**FIGURE 5. WRITE ALL (WRALL) CYCLE TIMING**



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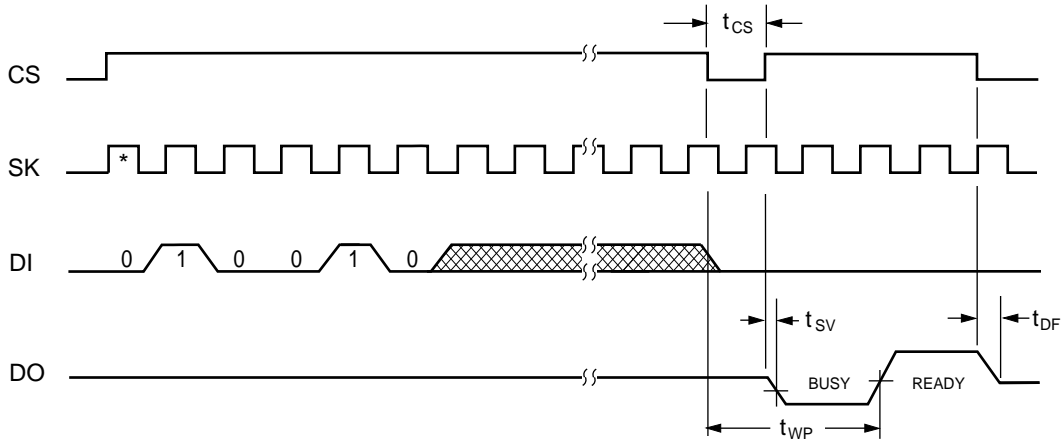
**FIGURE 6. WRITE DISABLE (WDS) CYCLE TIMING**



\* This leading clock is optional.

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**FIGURE 7. ERASE (REGISTER) CYCLE TIMING**



\* This leading clock is optional.

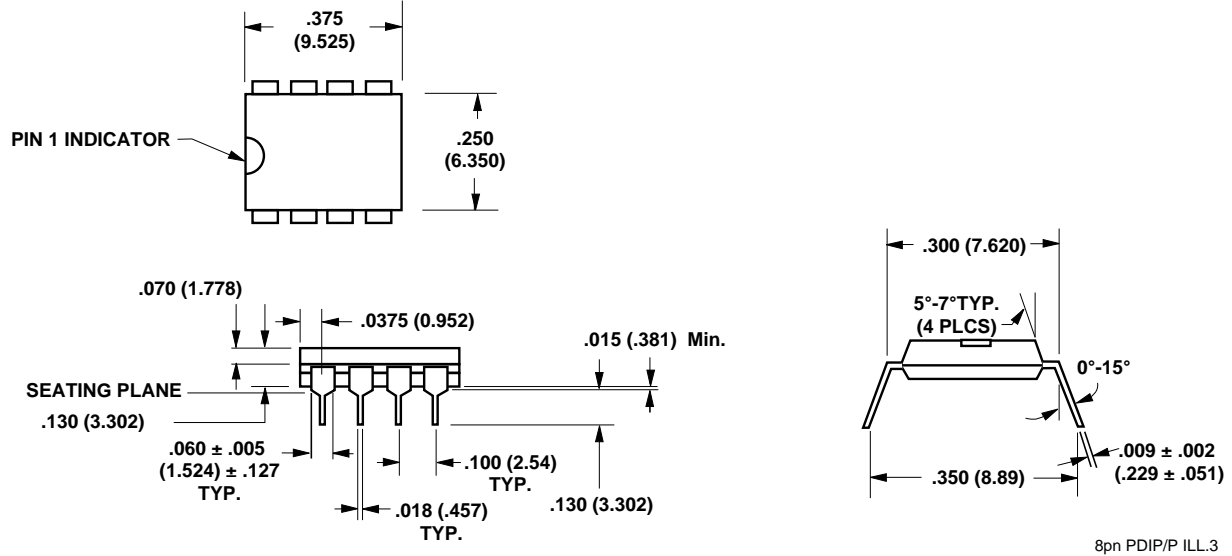
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**FIGURE 8. ERASE ALL (ERAL) CYCLE TIMING**



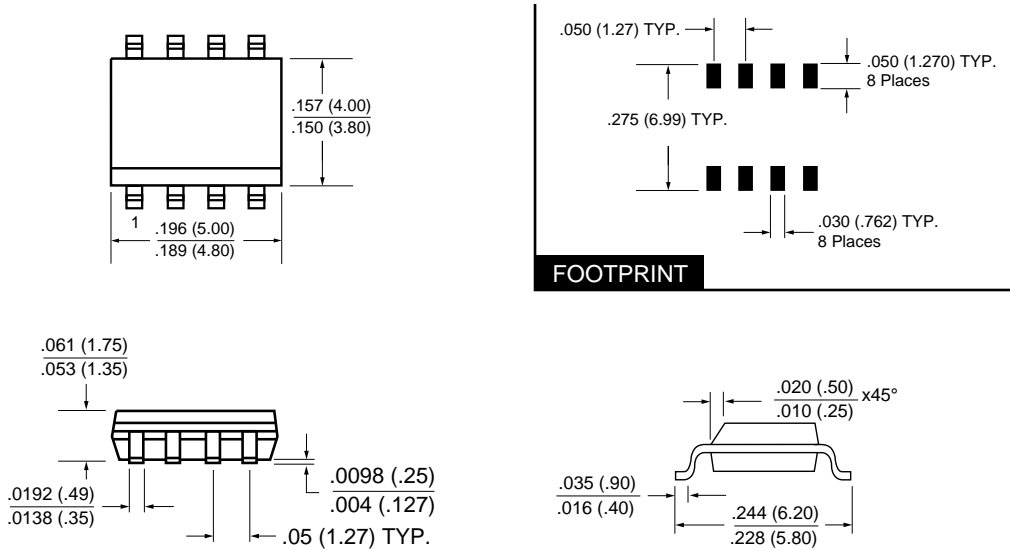
**PACKAGE DIAGRAMS**

**Plastic Dual-in-line (Type "P") Package (PDIP)**



All dimensions in inches (mm).

**8 Pin SOIC (Type "Y," "RY") Package (JEDEC 150 mil body width)**



All dimensions in inches (mm).

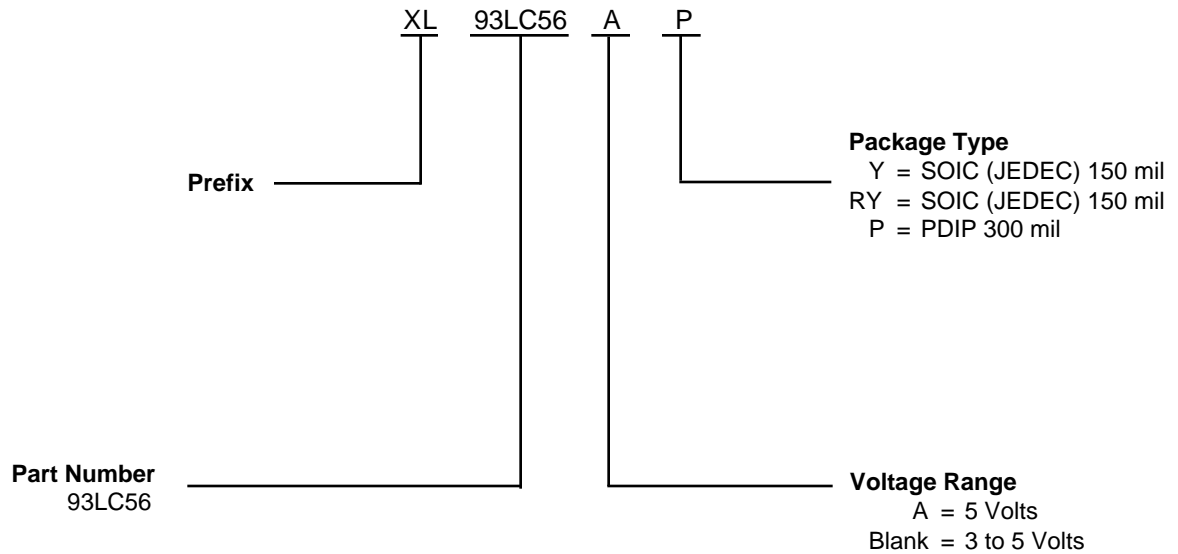
\* See cover page for pinout options.

**ORDERING INFORMATION**  
Standard Configurations

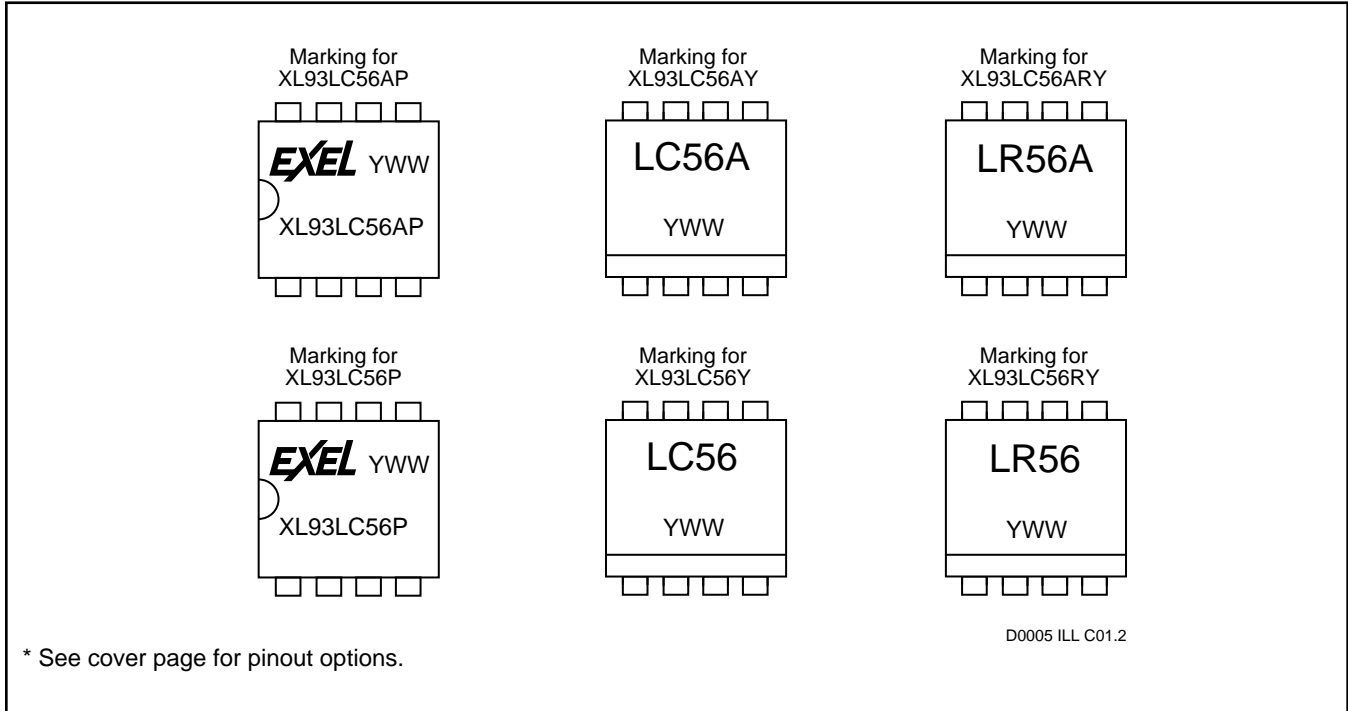
Prefix Type	Part Type	Voltage	Package Range
XL	93LC56	3 Volts, 5 Volts	P, Y, RY

D0005 PGM T05.2

Part Numbers:



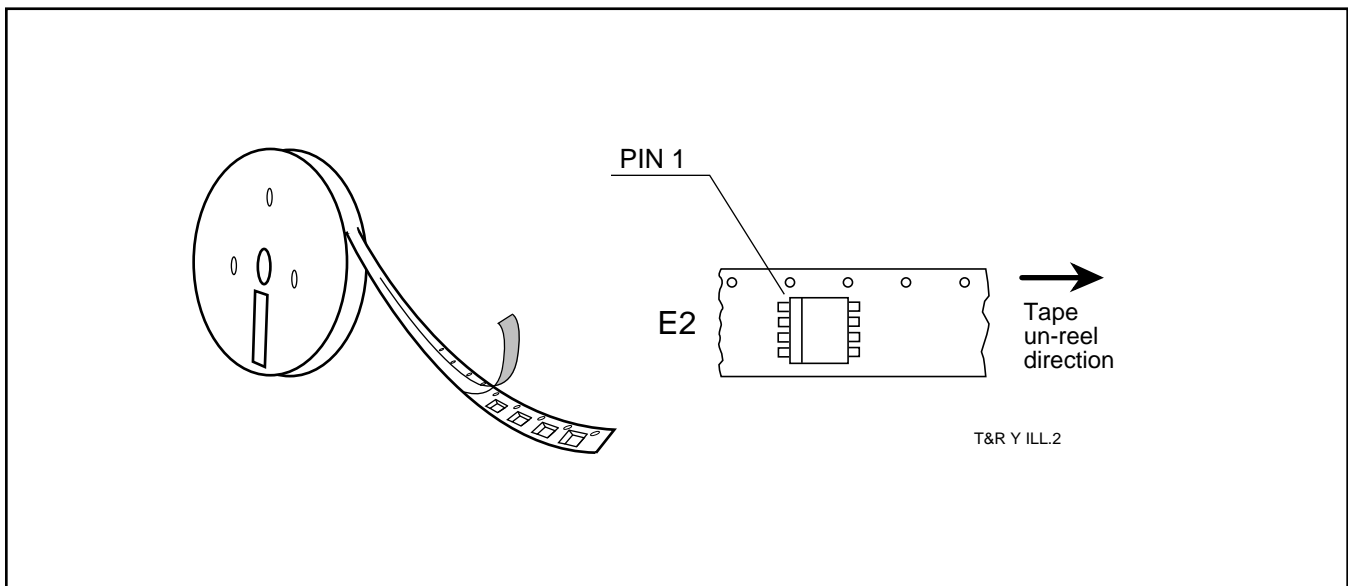
**MARKING INFORMATION**



**TAPE AND REEL (EMBOSSED) INFORMATION**

Surface mount devices, which are normally shipped in antistatic plastic tubes, are also available mounted on embossed tape for customers using automatic placement

systems. The following diagram provides general information regarding the direction of the IC's. Tape "E2" shall be designated with PIN 1 at the trail direction.



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