

X9514

PushPot™ Potentiometer (Push Button Controlled)

DESCRIPTION

- The Xicor X9514 is a push button controlled, logarithmic taper potentiometer and is ideal for push button controlled resistance trimming.

The X9514 is a resistor array composed of 31 resistive elements. Between each element and at either end are tap points accessible to the wiper element. The position of the wiper element is controlled by the $\overline{\text{PU}}$ and $\overline{\text{PD}}$ inputs. The position of the wiper can be automatically stored in E² memory and then be recalled upon a subsequent power-on operation.

All Xicor nonvolatile products are designed and tested for applications requiring extended endurance and data retention.

The diagram illustrates the 16K16B16 architecture, which is a non-volatile memory device. It consists of several key components:

- Control Section:**
 - 5-BIT UP/DOWN COUNTER:** Receives $\overline{\text{PU}}$ and $\overline{\text{PD}}$ inputs. It provides a 5-bit address to the 5-BIT EEPROM MEMORY and the ONE OF THIRTY-TWO DECODER.
 - 5-BIT EEPROM MEMORY:** Receives a 5-bit address from the counter and provides a 5-bit data output to the STORE AND RECALL CONTROL CIRCUITRY.
 - STORE AND RECALL CONTROL CIRCUITRY:** Receives a $\overline{\text{ASE}}$ input and provides a control signal to the ONE OF THIRTY-TWO DECODER.
- Memory Array:**
 - ONE OF THIRTY-TWO DECODER:** Receives a 5-bit address from the counter and a control signal from the STORE AND RECALL CONTROL CIRCUITRY. It activates one of 32 rows in the array.
 - TRANSFER GATES:** A series of 32 gates, each connected to a row in the array. They are controlled by the decoder's output lines (labeled 0, 1, 2, ..., 28, 29, 30, 31).
 - RESISTOR ARRAY:** A series of 32 resistors, each connected to a row in the array. They are controlled by the decoder's output lines (labeled 0, 1, 2, ..., 28, 29, 30, 31).

The array is connected to V_H and V_L supply lines. The output of the array is connected to V_H and V_L .

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PIN DESCRIPTIONS

V_H and V_L

The high (V_H) and low (V_L) terminals of the X9514 are equivalent to the fixed terminals of a mechanical potentiometer. The minimum voltage is $-5V$ and the maximum is $+5V$. It should be noted that the terminology of V_L and V_H references the relative position of the terminal in relation to wiper movement direction selected by the $\overline{PU}$ and $\overline{PD}$ inputs and not the voltage potential on the terminal.

$\overline{PU}$

The debounced $\overline{PU}$ input is for incrementing the wiper position. An on-chip pull-up holds the $\overline{PU}$ input HIGH. A switch closure to ground or a LOW logic level will, after a debounce time, move the wiper to the next adjacent higher tap position.

$\overline{PD}$

The debounced $\overline{PD}$ input is for decrementing the wiper position. An on-chip pull-up holds the $\overline{PD}$ input HIGH. A switch closure to ground or a LOW logic level will, after a debounce time, move the wiper to the next adjacent lower tap position.

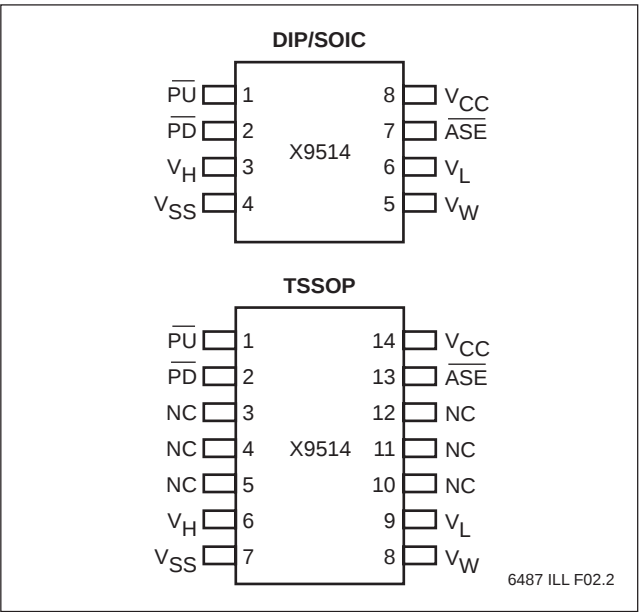
$\overline{ASE}$

The debounced $\overline{ASE}$ (AUTOSTORE enable) pin can be in one of two states:

V_{IL} – AUTOSTORE is enabled. When V_{CC} powers-down an automatic store cycle takes place.

V_{IH} – AUTOSTORE is disabled. A LOW to HIGH will initiate a manual store operation. This is for a user who wishes to connect a push button switch to this pin. For every valid push, the X9514 will store the current wiper position to the E^2PROM .

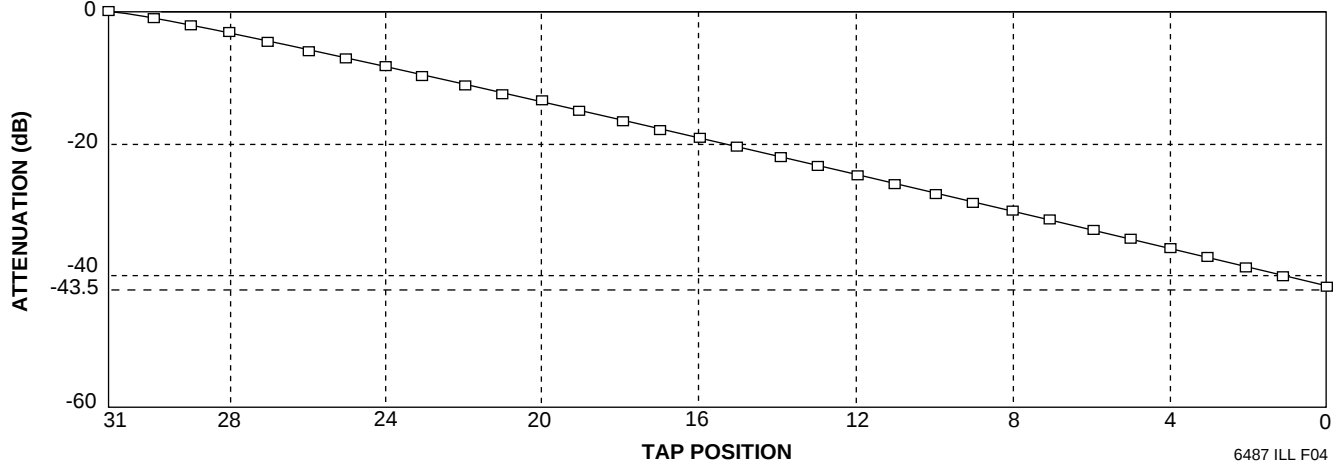
PIN CONFIGURATION



PIN NAMES

Symbol	Description
V_H	High Terminal
V_W	Wiper Terminal
V_L	Low Terminal
V_{SS}	Ground
V_{CC}	Supply Voltage
$\overline{PU}$	Push Up Input
$\overline{PD}$	Push Down Input
$\overline{ASE}$	AUTOSTORE Enable Input
NC	No Connect

Typical Attenuation Characteristics (dB)



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DEVICE OPERATION

There are three sections of the X9514: the input control, counter and decode section; the E²PROM memory; and the resistor array. The input control section operates just like an up/down counter. The output of this counter is decoded to turn on a single electronic switch connecting a point on the resistor array to the wiper output. Under the proper conditions the contents of the counter can be stored in E²PROM memory and retained for future use. The resistor array is comprised of 31 individual resistors connected in series. At either end of the array and between each resistor is an electronic switch that transfers the potential at that point to the wiper.

The X9514 is designed to interface directly to two push button switches for effectively moving the wiper up or down. The $\overline{\text{PU}}$ and $\overline{\text{PD}}$ inputs increment or decrement a 5-bit counter respectively. The output of this counter is decoded to select one of the thirty-two wiper positions along the resistive array. The wiper increment input, $\overline{\text{PU}}$ and the wiper decrement input, $\overline{\text{PD}}$ are both connected to an internal pull-up so that they normally remain HIGH. When pulled LOW by an external push button switch or a logic LOW level input, the wiper will be switched to the next adjacent tap position.

Internal debounce circuitry prevents inadvertent switching of the wiper position if $\overline{\text{PU}}$ or $\overline{\text{PD}}$ remain LOW for less than 40ms, typical. Each of the buttons can be pushed either once for a single increment/decrement or continuously for a multiple increments/decrements. The number of increments/decrements of the wiper position depend on how long the button is being pushed. When

making a continuous push, after the first second, the increment/decrement speed increases. For the first second the device will be in the slow scan mode. Then if the button is held for longer than 1 second the device will be in the fast scan mode. As soon as the button is released the X9514 will return to a standby condition.

The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. That is, the counter does not wrap around when clocked to either extreme.

AUTOSTORE

The value of the counter is stored in E²PROM memory whenever the chip senses a powers-down of V_{CC} while $\overline{\text{ASE}}$ is enabled (held LOW). When power is restored, the content of the memory is recalled and the counter reset to the last value stored.

If AUTOSTORE is to be implemented, $\overline{\text{ASE}}$ is typically hard wired to V_{SS} . If $\overline{\text{ASE}}$ is held HIGH during power up and then taken LOW, the wiper will not respond to the $\overline{\text{PU}}$ or $\overline{\text{PD}}$ inputs until $\overline{\text{ASE}}$ is brought HIGH and held HIGH.

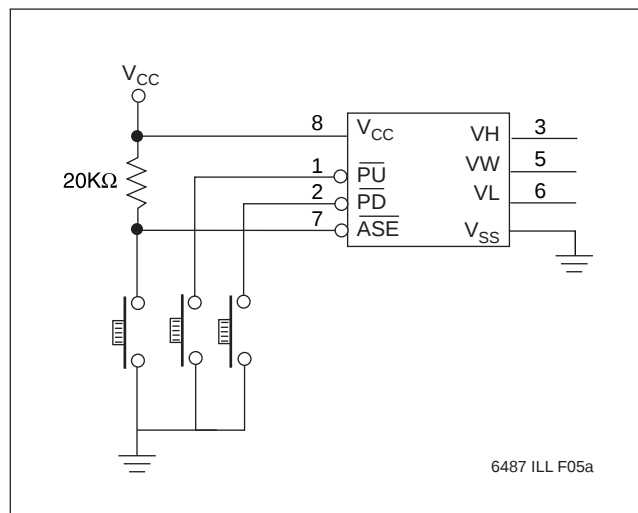
Manual (Push Button) Store

When $\overline{\text{ASE}}$ is not enabled (held HIGH) a push button switch may be used to pull $\overline{\text{ASE}}$ LOW and released to perform a manual store of the wiper position.

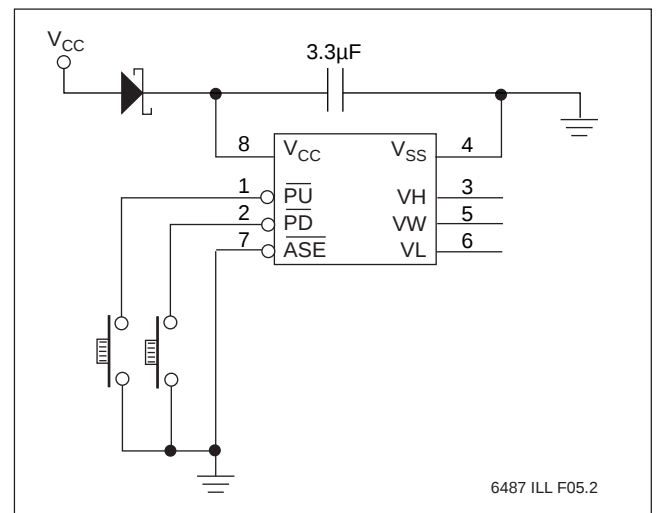
R_{TOTAL} with V_{CC} Removed

The end to end resistance of the array will fluctuate once V_{CC} is removed.

Typical circuit with $\overline{\text{ASE}}$ store pin controlled by push button switch



Typical circuit with $\overline{\text{ASE}}$ store pin used in AUTOSTORE mode



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ABSOLUTE MAXIMUM RATINGS*

Temperature under Bias -65°C to $+135^{\circ}\text{C}$
Storage Temperature -65°C to $+150^{\circ}\text{C}$
Voltage on $\overline{\text{PU}}$, $\overline{\text{PD}}$, $\overline{\text{ASE}}$ and V_{CC}
with Respect to V_{SS} -1V to $+7\text{V}$
Voltage on V_{H} and V_{L} Referenced to V_{SS}
 $\Delta\text{V} = |\text{V}_{\text{H}} - \text{V}_{\text{L}}|$ 10V
Lead Temperature (Soldering 10 seconds) 300°C
Wiper Current $\pm 1\text{mA}$

*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 listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ANALOG CHARACTERISTICS

Electrical Characteristics

End-to-End Resistance Tolerance $\pm 20\%$
Power Rating at 25°C
X9514W 10mW
Wiper Current $\pm 1\text{mA}$ Max.
Typical Wiper Resistance 40Ω at 1mA
Typical Noise $< -120\text{dB}/\sqrt{\text{Hz}}$ Ref: 1V

Relative Variation

Relative variation is a measure of the error in step size between taps = $\log(\text{V}_{\text{W}(n)}) - \log(\text{V}_{\text{W}(n-1)}) = 0.08 \pm 0.05$ for tap $n = 2 - 31$

Temperature Coefficient

(-40°C to $+85^{\circ}\text{C}$)

X9514W $+600 \text{ ppm}/^{\circ}\text{C}$ Typical
Ratiometric Temperature Coefficient $\pm 20 \text{ ppm}$

Wiper Adjustability

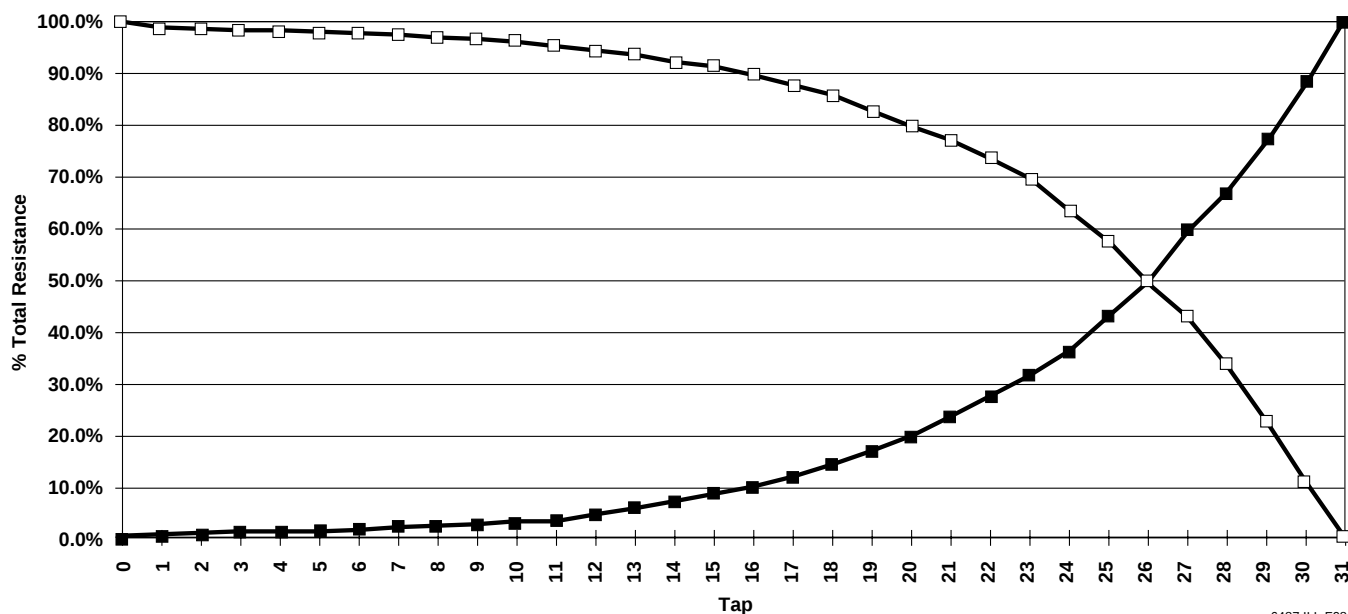
Unlimited Wiper Adjustment (Non-Store operation)
Wiper Position Store Operations 100,000
Data Changes

Physical Characteristics

Marking Includes

Manufacturer's Trademark
Resistance Value or Code
Date Code

Typical Electrical Taper



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RECOMMENDED OPERATING CONDITIONS

Temperature	Min.	Max.
Commercial	0°C	+70°C
Industrial	-40°C	+85°C
Military	-55°C	+125°C

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Supply Voltage	Limits
X9514	5V ±10%

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D.C. OPERATING CHARACTERISTICS (Over recommended operating conditions unless otherwise specified.)

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ. ⁽⁴⁾	Max.		
I _{CC}	V _{CC} Active Current		1	3	mA	$\overline{PU}$ or $\overline{PD}$ held at V _{IL} the others at V _{IH}
I _{SB}	Standby Supply Current			200	μA	$\overline{PU} = \overline{PD} = V_H$
I _{LI}	$\overline{ASE}$, $\overline{PU}$, $\overline{PD}$ Input Leakage Current			10	μA	V _{IN} = V _{SS} to V _{CC}
V _{IH}	$\overline{ASE}$, $\overline{PU}$, $\overline{PD}$ Input HIGH Voltage	2		V _{CC} + 1	V	
V _{IL}	$\overline{ASE}$, $\overline{PU}$, $\overline{PD}$ Input LOW Voltage	-1		0.8	V	
R _W	Wiper Resistance		40	100	Ω	Max. Wiper Current ±1mA
V _{VH}	VH Terminal Voltage	-5		+5	V	
V _{VL}	VL Terminal Voltage	-5		+5	V	
C _{IN} ⁽⁵⁾	$\overline{ASE}$, $\overline{PU}$, $\overline{PD}$ Input Capacitance			10	pF	V _{CC} = 5V, V _{IN} = 0V, T _A = 25°C, f = 1MHz

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STANDARD PARTS

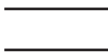
Part Number	Maximum Resistance	Wiper Increments	Minimum Resistance
X9514W	10KΩ	Log Taper	40Ω

Notes: (4) Typical values are for T_A = 25°C and nominal supply voltage.

(5) This parameter is periodically sampled and not 100% tested.

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SYMBOL TABLE

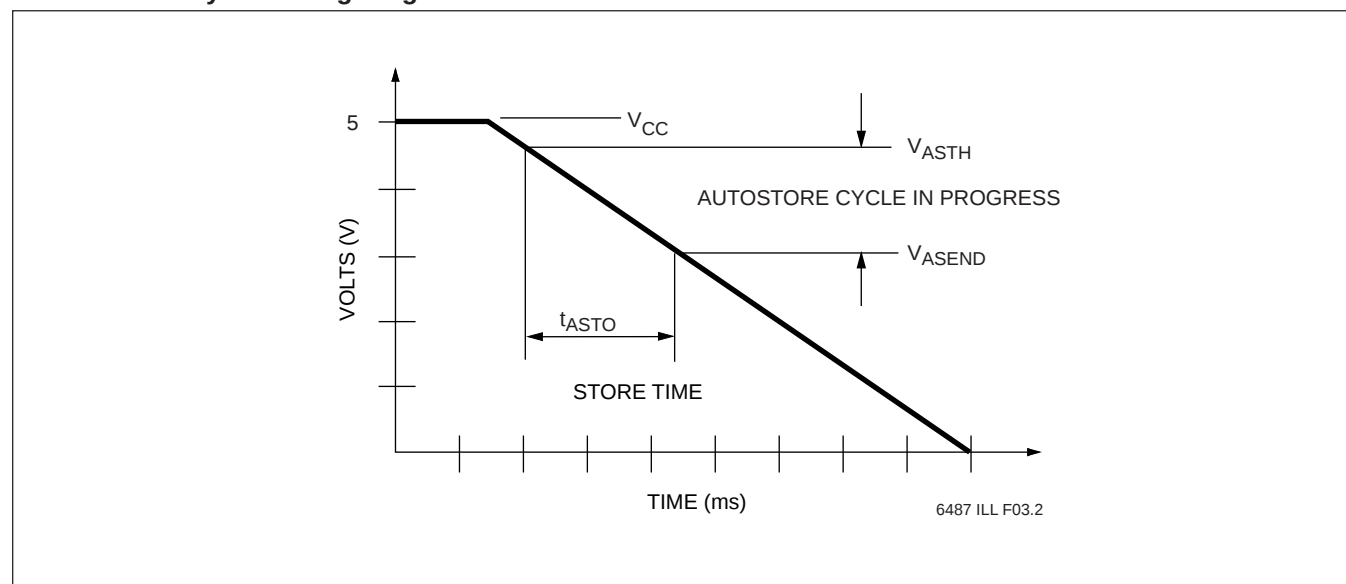
WAVEFORM	INPUTS	OUTPUTS
	Must be steady	Will be steady
	May change from LOW to HIGH	Will change from LOW to HIGH
	May change from HIGH to LOW	Will change from HIGH to LOW
	Don't Care: Changes Allowed	Changing: State Not Known
	N/A	Center Line is High Impedance

A.C. OPERATING CHARACTERISTICS (Over recommended operating conditions unless otherwise specified)

Symbol	Parameter	Limits			Units
		Min.	Typ.(6)	Max.	
t_{GAP}	Time Between Two Separate Push Button Events	0			μs
t_{DB}	Debounce Time			60	ms
$t_{S\ SLOW}$	After Debounce to Wiper Change on a Slow Mode	100	250	375	ms
$t_{S\ FAST}^{(7)}$	Wiper Change on a Scan Mode	25	50	75	ms
$t_{PU}^{(7)}$	Power Up to Wiper Stable			500	μs
$t_R\ V_{CC}^{(7)}$	V_{CC} Power-up Rate	0.2		50	mV/ μs
$t_{ASTO}^{(7)}$	AUTOSTORE Cycle Time	2			ms
$V_{ASTH}^{(7)}$	AUTOSTORE Threshold Voltage		4		V
$V_{ASEND}^{(7)}$	AUTOSTORE Cycle End Voltage		3.5		V

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AUTOSTORE Cycle Timing Diagram



Notes: V_{ASTH} – AUTOSTORE threshold voltage

V_{ASEND} – AUTOSTORE cycle end voltage

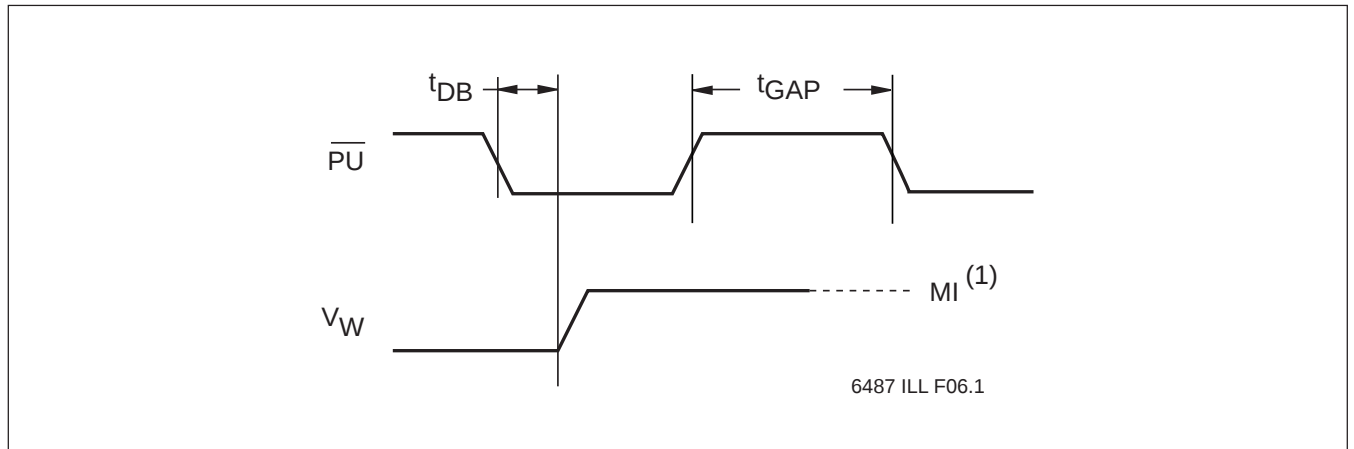
t_{ASTO} – AUTOSTORE cycle time

(6) Typical values are for $T_A = 25^\circ C$ and nominal supply voltage.

(7) This parameter is periodically sampled and not 100% tested.

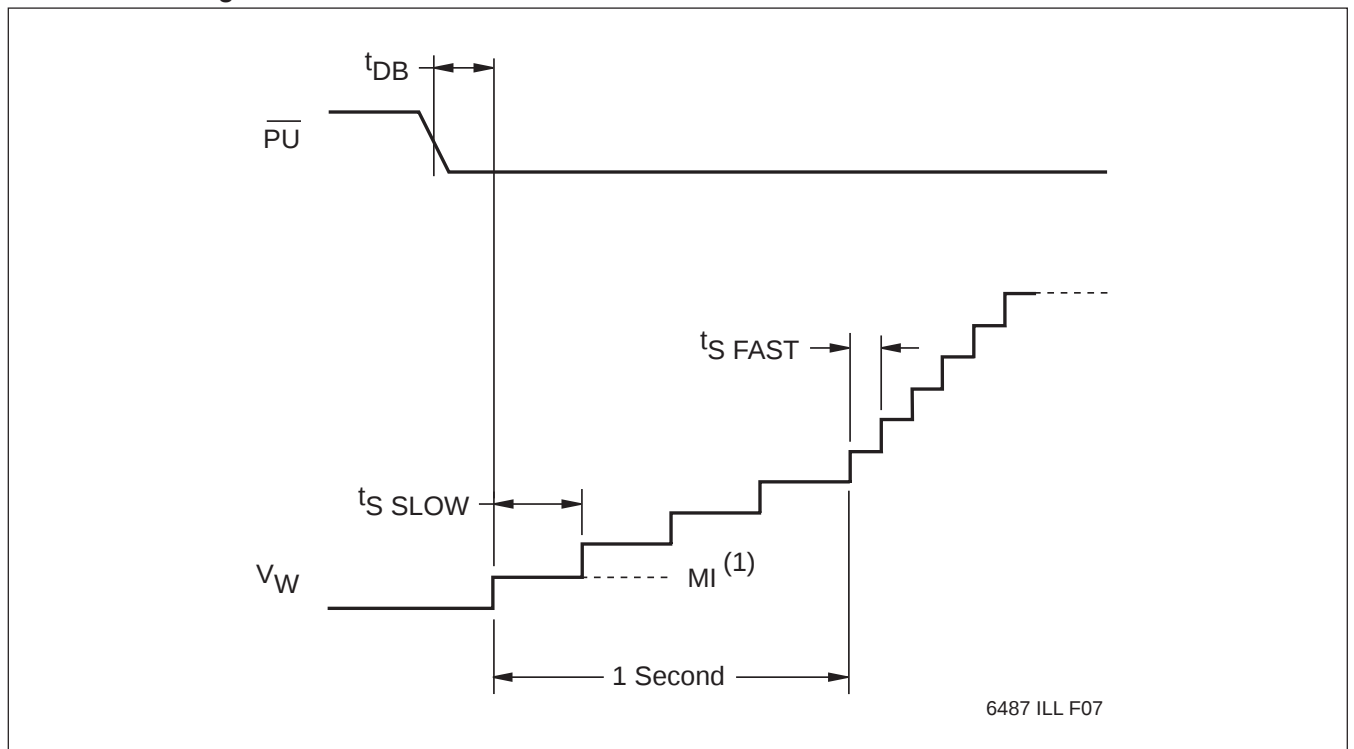
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Slow Mode Timing



Notes: (1) MI in the A.C. timing diagram refers to the minimum incremental change in the wiper voltage.

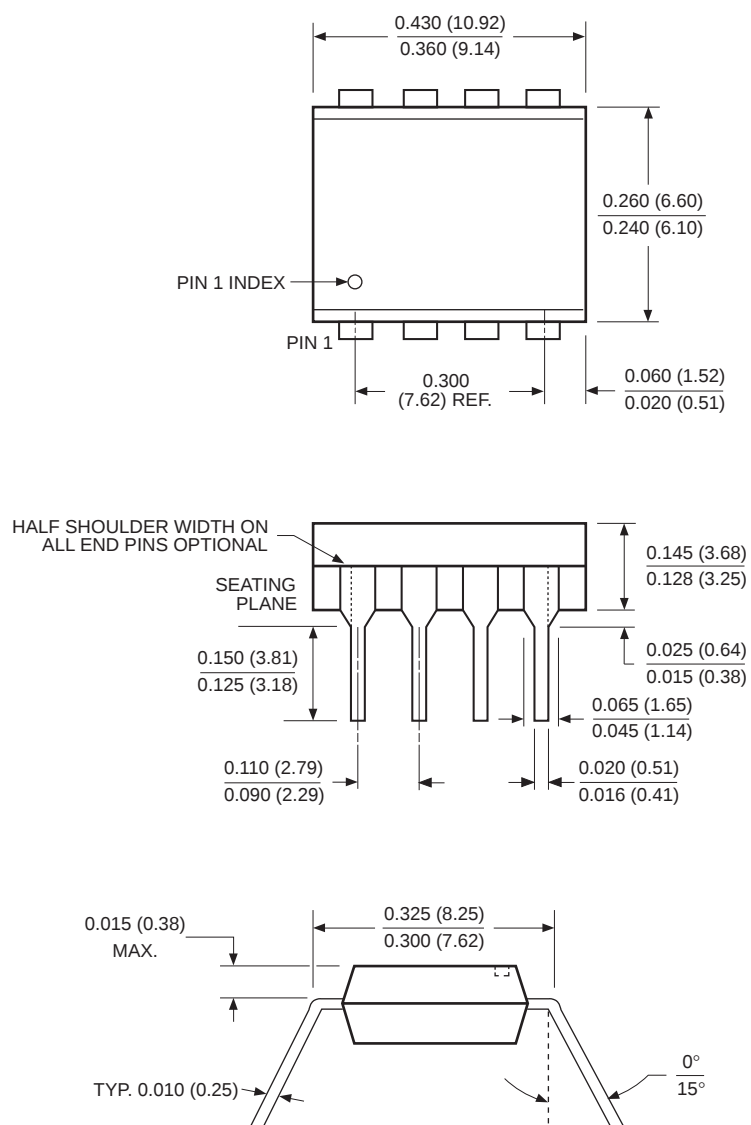
Fast Mode Timing



Notes: (1) MI in the A.C. timing diagram refers to the minimum incremental change in the wiper voltage.

PACKAGING INFORMATION

8-LEAD PLASTIC DUAL IN-LINE PACKAGE TYPE P

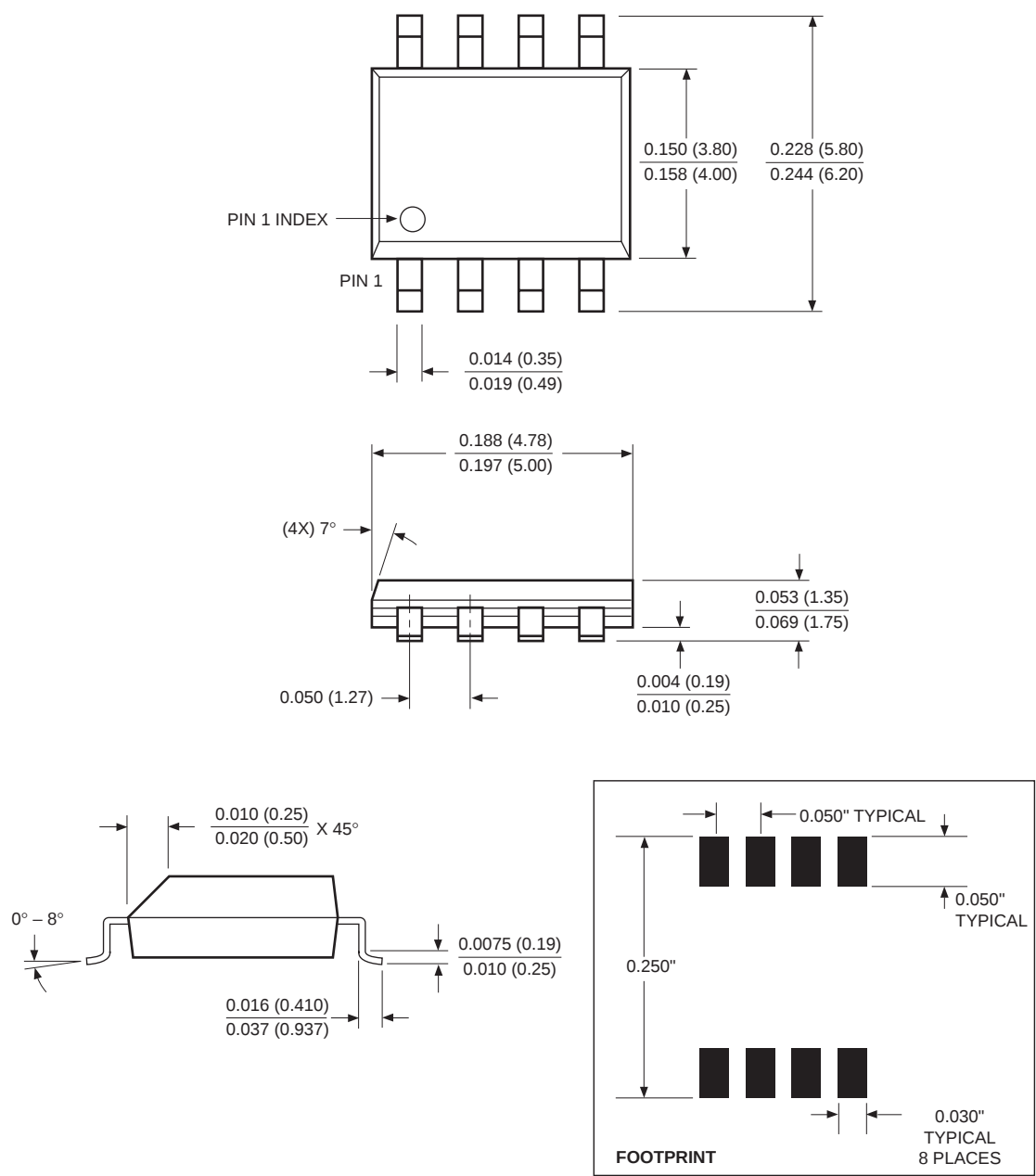


NOTE:

1. ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)
2. PACKAGE DIMENSIONS EXCLUDE MOLDING FLASH

PACKAGING INFORMATION

8-LEAD PLASTIC SMALL OUTLINE GULL WING PACKAGE TYPE S

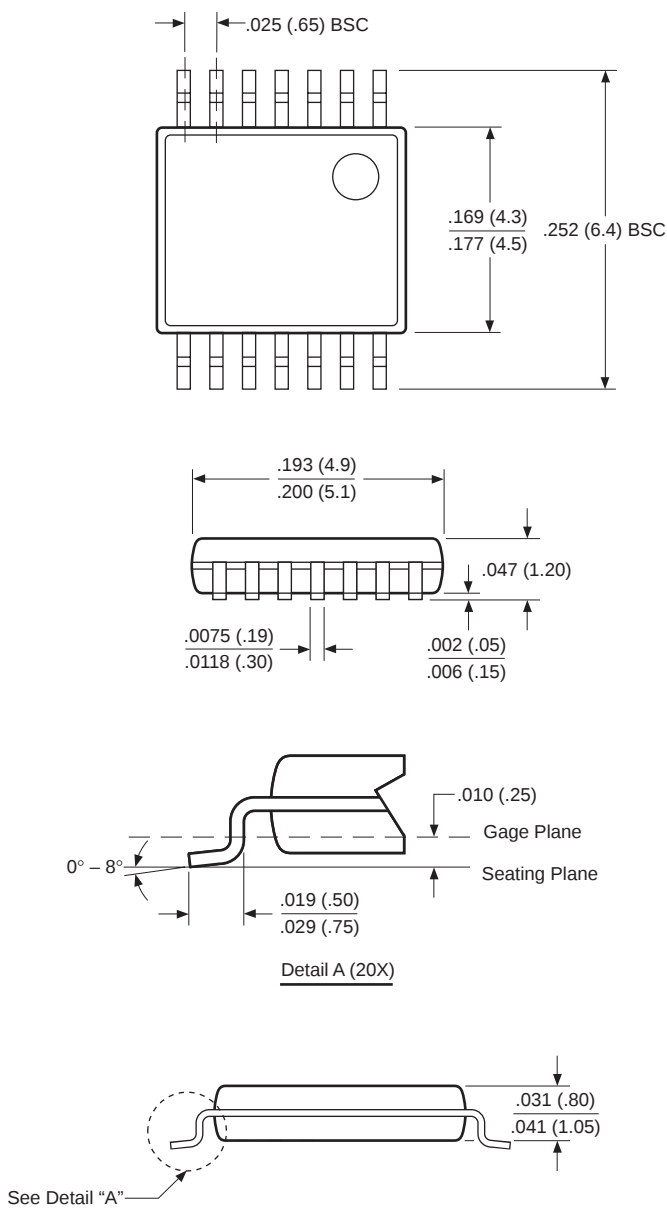


NOTE: ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)

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PACKAGING INFORMATION

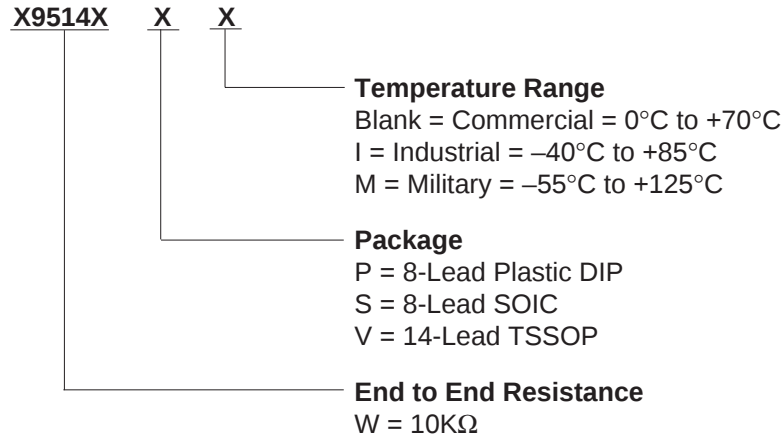
14-LEAD PLASTIC, TSSOP PACKAGE TYPE V



NOTE: ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)

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ORDERING INFORMATION



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U.S. PATENTS

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LIFE RELATED POLICY

In situations where semiconductor component failure may endanger life, system designers using this product should design the system with appropriate error detection and correction, redundancy and back-up features to prevent such an occurrence.

Xicor's products are not authorized for use in critical components in life support devices or systems.

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.