

1. Features

- Low-voltage and Standard-voltage Operation
  - 1.8 (V<sub>CC</sub> = 1.8V to 5.5V)
- Internal Organization
  - 64 x 16
- Three-wire Serial Interface
- 2 MHz Clock Rate (5V) Compatibility
- Self-timed Write Cycle (5 ms max)
- High Reliability
  - Endurance: 1 Million Write Cycles
  - Data Retention: 100 Years
- 8-lead PDIP, 8-lead JEDEC SOIC, and 8-lead TSSOP Packages
- Lead-free/Halogen-free Devices

2. Description

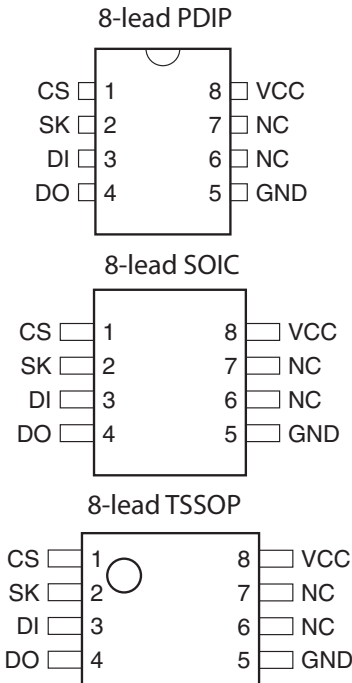
The AT93C46E provides 1024 bits of serial electrically-erasable programmable read-only memory (EEPROM) organized as 64 words of 16 bits each. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential. The AT93C46E is available in space-saving 8-lead PDIP, 8-lead JEDEC SOIC, and 8-lead TSSOP packages.

The AT93C46E is enabled through the Chip Select pin (CS) and accessed via a three-wire serial interface consisting of Data Input (DI), Data Output (DO), and Shift Clock (SK). Upon receiving a Read instruction at DI, the address is decoded and the data is clocked out serially on the data output DO pin. The write cycle is completely self-timed and no separate erase cycle is required before write. The write cycle is only enabled when the part is in the erase/write enable state. When CS is brought high following the initiation of a write cycle, the DO pin outputs the ready/busy status of the part.

The AT93C46E is available in 1.8V (1.8V to 5.5V) version.

Table 2-1. Pin Configuration

Pin Name	Function
CS	Chip Select
SK	Serial Data Clock
DI	Serial Data Input
DO	Serial Data Output
GND	Ground
VCC	Power Supply
NC	No Connect



Three-wire  
Serial EEPROM

1K (64 x 16)

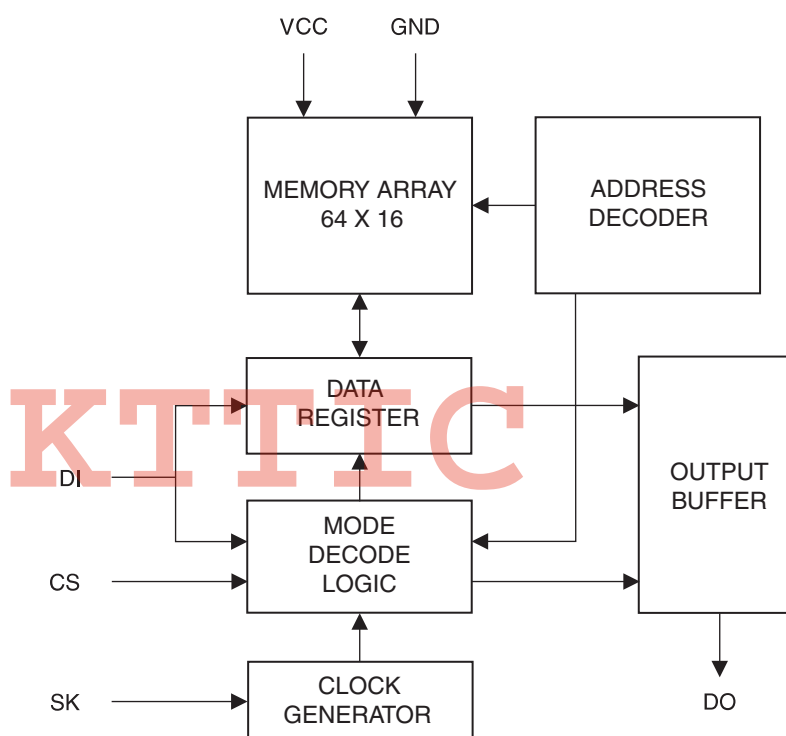
AT93C46E



Operating Temperature .....	-55°C to +125°C
Storage Temperature .....	-65°C to +150°C
Voltage on Any Pin with Respect to Ground .....	-1.0V to +7.0V
Maximum Operating Voltage .....	6.25V
DC Output Current.....	5.0 mA

**\*NOTICE:** Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions beyond 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.

**Figure 2-1. Block Diagram**



**Table 2-2.** Pin Capacitance<sup>(1)</sup>

Applicable over recommended operating range from  $T_A = 25^\circ\text{C}$ ,  $f = 1.0\text{ MHz}$ ,  $V_{CC} = +5.0\text{V}$  (unless otherwise noted)

Symbol	Test Conditions	Max	Units	Conditions
C <sub>OUT</sub>	Output Capacitance (DO)	5	pF	V <sub>OUT</sub> = 0V
C <sub>IN</sub>	Input Capacitance (CS, SK, DI)	5	pF	V <sub>IN</sub> = 0V

Note: This parameter is characterized and is not 100% tested.

**Table 2-3.** DC Characteristics

Applicable over recommended operating range from:  $T_{AI} = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +1.8\text{V}$  to  $+5.5\text{V}$ , (unless otherwise noted)

Symbol	Parameter	Test Condition		Min	Typ	Max	Units
$V_{CC1}$	Supply Voltage			1.8		5.5	V
$V_{CC2}$	Supply Voltage			2.7		5.5	V
$V_{CC3}$	Supply Voltage			4.5		5.5	V
$I_{CC}$	Supply Current	$V_{CC} = 5.0\text{V}$	Read at 1.0 MHz		0.5	2.0	mA
			Write at 1.0 MHz		0.5	2.0	mA
$I_{SB1}$	Standby Current	$V_{CC} = 1.8\text{V}$	CS = 0V		0.4	1.0	$\mu\text{A}$
$I_{SB2}$	Standby Current	$V_{CC} = 2.7\text{V}$	CS = 0V		6.0	10.0	$\mu\text{A}$
$I_{SB3}$	Standby Current	$V_{CC} = 5.0\text{V}$	CS = 0V		10.0	15.0	$\mu\text{A}$
$I_{IL}$	Input Leakage	$V_{IN} = 0\text{V}$ to $V_{CC}$			0.1	1.0	$\mu\text{A}$
$I_{OL}$	Output Leakage	$V_{IN} = 0\text{V}$ to $V_{CC}$			0.1	1.0	$\mu\text{A}$
$V_{IL1}^{(1)}$ $V_{IH1}^{(1)}$	Input Low Voltage Input High Voltage	$2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$		-0.6 2.0		0.8 $V_{CC} + 1$	V
$V_{IL2}^{(1)}$ $V_{IH2}^{(1)}$	Input Low Voltage Input High Voltage	$1.8\text{V} \leq V_{CC} \leq 2.7\text{V}$		-0.6 $V_{CC} \times 0.7$		$V_{CC} \times 0.3$ $V_{CC} + 1$	V
$V_{OL1}$ $V_{OH1}$	Output Low Voltage Output High Voltage	$2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$	$I_{OL} = 2.1\text{ mA}$			0.4	V
			$I_{OH} = -0.4\text{ mA}$	2.4			V
$V_{OL2}$ $V_{OH2}$	Output Low Voltage Output High Voltage	$1.8\text{V} \leq V_{CC} \leq 2.7\text{V}$	$I_{OL} = 0.15\text{ mA}$			0.2	V
			$I_{OH} = -100\text{ }\mu\text{A}$	$V_{CC} - 0.2$			V

Note: 1.  $V_{IL}$  min and  $V_{IH}$  max are reference only and are not tested.

**Table 2-4.** AC Characteristics

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.7\text{V}$  to  $+5.5\text{V}$ ,  
 $CL = 1$  TTL Gate and  $100\text{ pF}$  (unless otherwise noted)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
$f_{SK}$	SK Clock Frequency	$4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	0 0 0		2 1 0.25	MHz
$t_{SKH}$	SK High Time	$4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	250 250 1000			ns
$t_{SKL}$	SK Low Time	$4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	250 250 1000			ns
$t_{CS}$	Minimum CS Low Time	$4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	250 250 1000			ns
$t_{CSS}$	CS Setup Time	Relative to SK $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	50 50 200			ns
$t_{DIS}$	DI Setup Time	Relative to SK $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	100 100 400			ns
$t_{CSH}$	CS Hold Time	Relative to SK	0			ns
$t_{DIH}$	DI Hold Time	Relative to SK $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$	100 100 400			ns
$t_{PD1}$	Output Delay to "1"	AC Test $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$			250 250 1000	ns
$t_{PD0}$	Output Delay to "0"	AC Test $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$			250 250 1000	ns
$t_{SV}$	CS to Status Valid	AC Test $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$			250 250 1000	ns
$t_{DF}$	CS to DO in High Impedance	AC Test CS = $V_{IL}$ $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$			100 150 400	ns
$t_{WP}$	Write Cycle Time		0.1	3	5	ms
Endurance <sup>(1)</sup>	5.0V, $25^{\circ}\text{C}$		1M			Write Cycle

Note: 1. This parameter is ensured by characterization.

### 3. Functional Description

The AT93C46E is accessed via a simple and versatile three-wire serial communication interface. Device operation is controlled by seven instructions issued by the host processor. **A valid instruction starts with a rising edge of CS** and consists of a start bit (logic "1") followed by the appropriate op code and the desired memory address location.

Table 3-1. Instruction Set for the AT93C46E

Instruction	SB	Op Code	Address	Comments
			x 16	
READ	1	10	$A_5 - A_0$	Reads data stored in memory, at specified address
EWEN	1	00	11XXXX	Write enable must precede all programming modes
ERASE	1	11	$A_5 - A_0$	Erase memory location $A_n - A_0$
WRITE	1	01	$A_5 - A_0$	Writes memory location $A_n - A_0$
ERAL	1	00	10XXXX	Erases all memory locations. Valid only at $V_{CC} = 4.5V$ to $5.5V$
WRAL	1	00	01XXXX	Writes all memory locations. Valid only at $V_{CC} = 4.5V$ to $5.5V$
EWDS	1	00	00XXXX	Disables all programming instructions

**READ (READ):** The Read (READ) instruction contains the address code for the memory location to be read. After the instruction and address are decoded, data from the selected memory location is available at the serial output pin DO. Output data changes are synchronized with the rising edges of serial clock SK. It should be noted that a dummy bit (logic “0”) precedes the 16-bit data output string.

**ERASE/WRITE ENABLE (EWEN):** To assure data integrity, the part automatically goes into the Erase/Write Disable (EWDS) state when power is first applied. An Erase/Write Enable (EWEN) instruction must be executed first before any programming instructions can be carried out. Please note that once in the EWEN state, programming remains enabled until an EWDS instruction is executed or  $V_{CC}$  power is removed from the part.

**ERASE (ERASE):** The Erase (ERASE) instruction programs all bits in the specified memory location to the logical “1” state. The self-timed erase cycle starts once the Erase instruction and address are decoded. The DO pin outputs the ready/busy status of the part if CS is brought high after being kept low for a minimum of 250 ns ( $t_{CS}$ ). A logic “1” at pin DO indicates that the selected memory location has been erased and the part is ready for another instruction.

**WRITE (WRITE):** The Write (WRITE) instruction contains the 16 bits of data to be written into the specified memory location. The self-timed programming cycle,  $t_{WP}$ , starts after the last bit of data is received at serial data input pin DI. The DO pin outputs the ready/busy status of the part if CS is brought high after being kept low for a minimum of 250 ns ( $t_{CS}$ ). A logic “0” at DO indicates that programming is still in progress. A logic “1” indicates that the memory location at the specified address has been written with the data pattern contained in the instruction and the part is ready for further instructions. **A ready/busy status cannot be obtained if the CS is brought high after the end of the self-timed programming cycle,  $t_{WP}$ .**

**ERASE ALL (ERAL):** The Erase All (ERAL) instruction programs every bit in the memory array to the logic “1” state and is primarily used for testing purposes. The DO pin outputs the ready/busy status of the part if CS is brought high after being kept low for a minimum of 250 ns ( $t_{CS}$ ). The ERAL instruction is valid only at  $V_{CC} = 5.0V \pm 10\%$ .

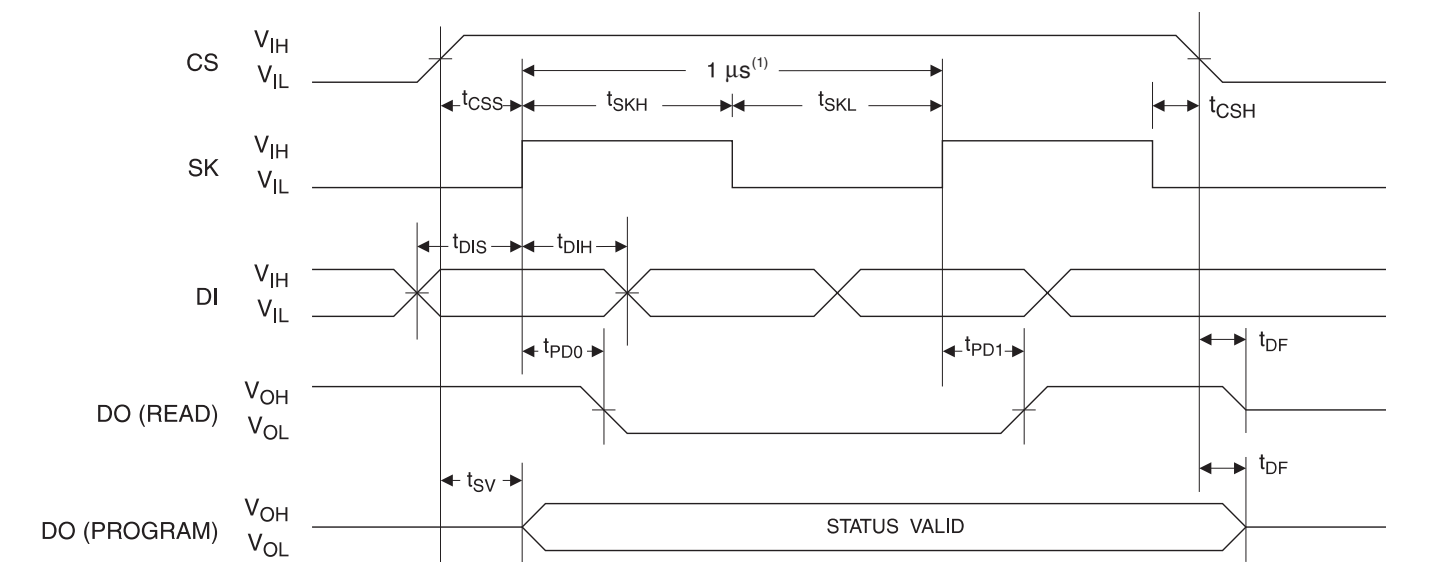
**WRITE ALL (WRAL):** The Write All (WRAL) instruction programs all memory locations with the data patterns specified in the instruction. The DO pin outputs the ready/busy status of the part if CS is brought high after being kept low for a minimum of 250 ns ( $t_{CS}$ ). The WRAL instruction is valid only at  $V_{CC} = 5.0V \pm 10\%$ .

**ERASE/WRITE DISABLE (EWDS):** To protect against accidental data disturb, the Erase/Write Disable (EWDS) instruction disables all programming modes and should be executed after all programming operations. The operation of the Read instruction is independent of both the EWEN and EWDS instructions and can be executed at any time.

# KTTIC

4. Timing Diagrams

Figure 4-1. Synchronous Data Timing



Note: 1. This is the minimum SK period.

Table 4-1. Organization Key for Timing Diagrams

AT93C46E	
I/O	x 16
A <sub>N</sub>	A <sub>5</sub>
D <sub>N</sub>	D <sub>15</sub>

Figure 4-2. READ Timing

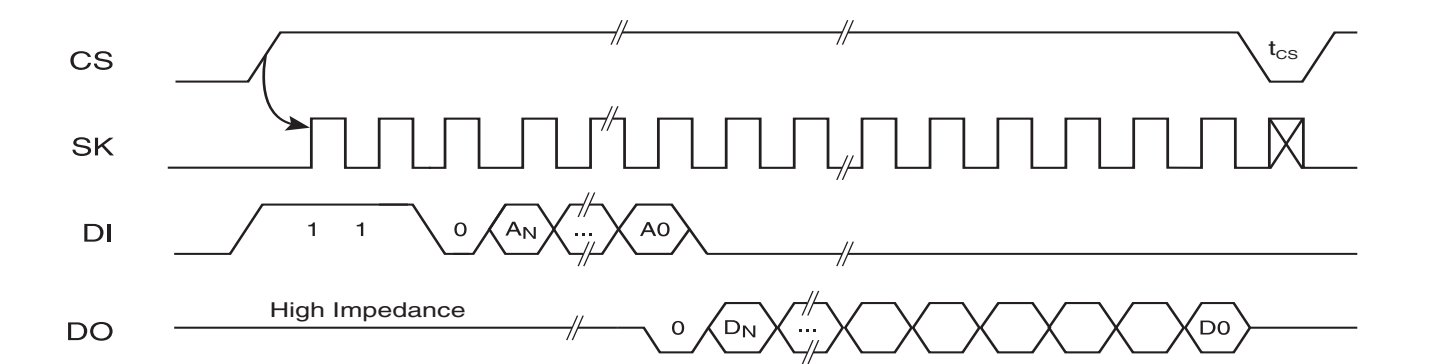
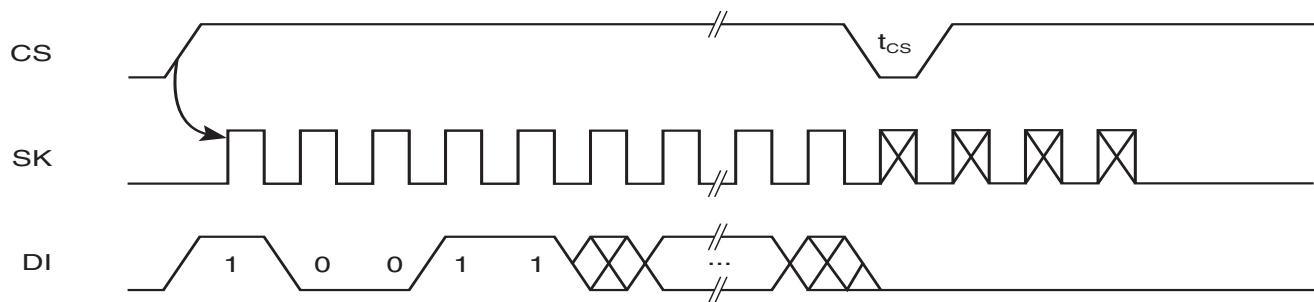
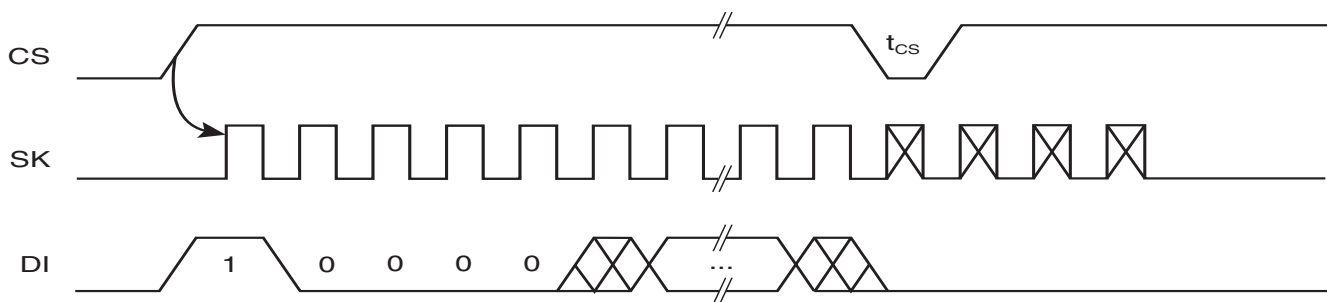


Figure 4-3. EWEN Timing<sup>(1)</sup>



Note: 1. Requires a minimum of nine clock cycles.

Figure 4-4. EWDS Timing<sup>(1)</sup>



Note: 1. Requires a minimum of nine clock cycles.

Figure 4-5. WRITE Timing

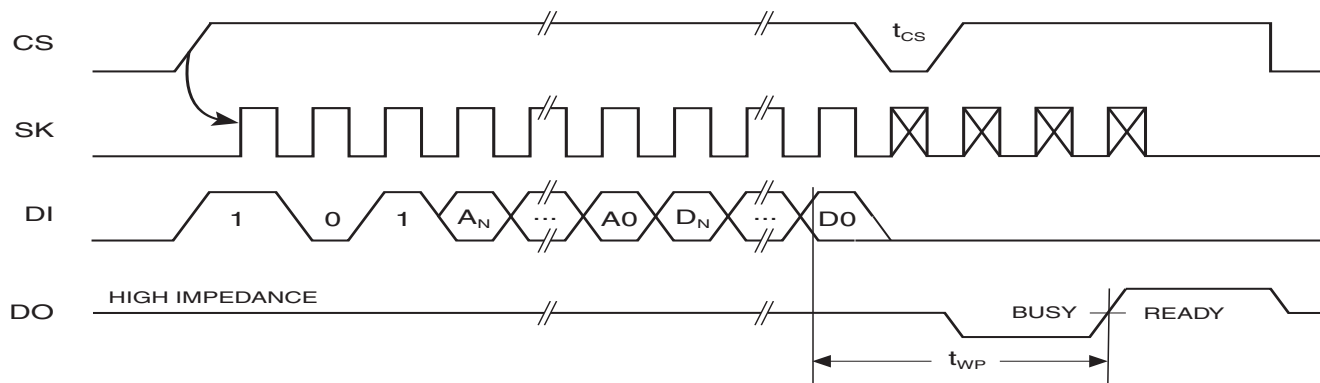
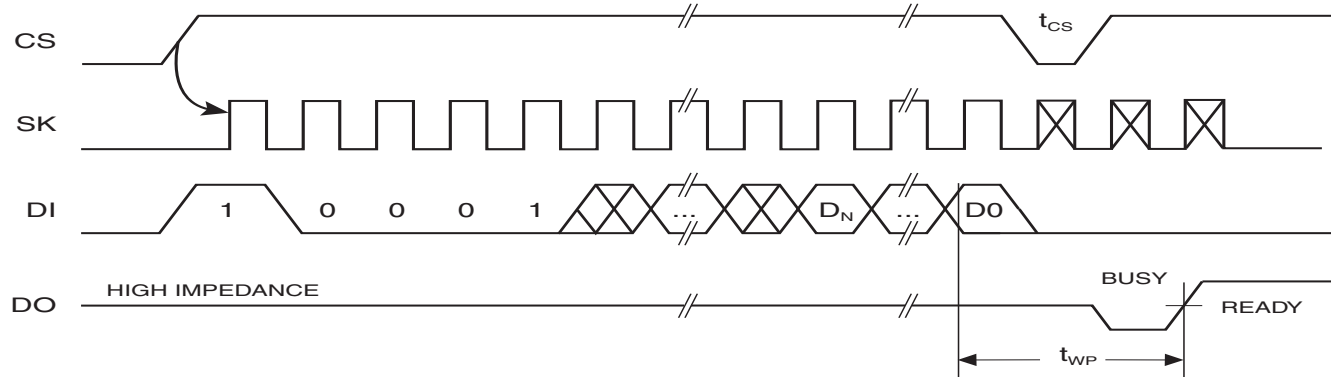




Figure 4-6. WRAL Timing<sup>(1),(2)</sup>



- Notes:
- 1. Valid only at  $V_{CC} = 4.5V$  to  $5.5V$ .
  - 2. Requires a minimum of nine clock cycles.

Figure 4-7. ERASE Timing

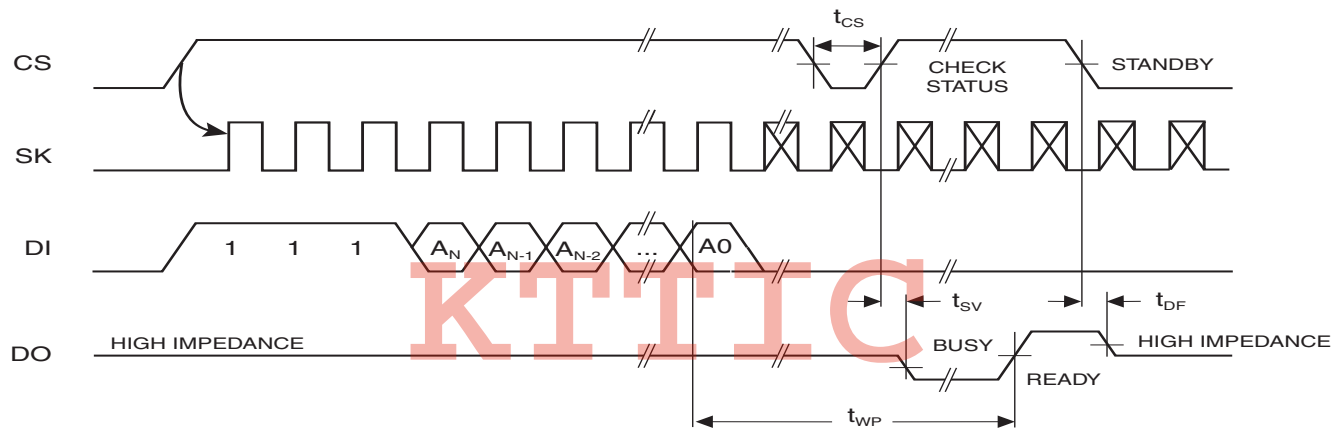
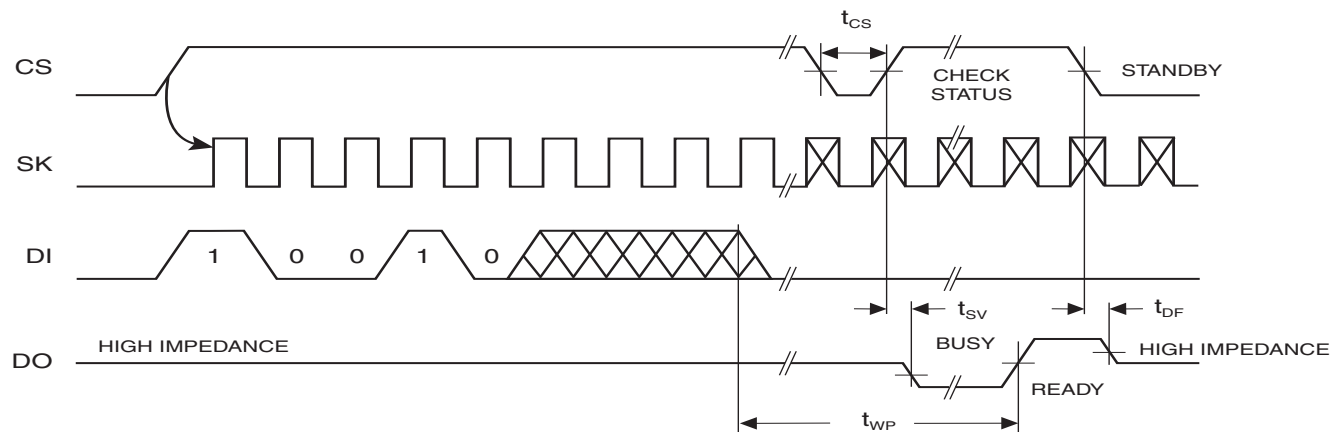


Figure 4-8. ERAL Timing<sup>(1)</sup>



- Note:
- 1. Valid only at  $V_{CC} = 4.5V$  to  $5.5V$ .

AT93C46E Ordering Information

Ordering Code	Package	Operation Range
AT93C46E-PU (Bulk Form only)	8P3	Lead-free/Halogen-free/ Industrial Temperature (−40°C to 85°C)
AT93C46EN-SH-B <sup>(1)</sup> (NiPdAu Lead Finish)	8S1	
AT93C46EN-SH-T <sup>(2)</sup> (NiPdAu Lead Finish)	8S1	
AT93C46E-TH-B <sup>(1)</sup> (NiPdAu Lead Finish)	8A2	
AT93C46E-TH-T <sup>(2)</sup> (NiPdAu Lead Finish)	8A2	

Notes: 1. “B” denotes bulk.  
2. “-T” denotes tape and reel. SOIC = 4K per reel. TSSOP = 5K per reel.

KTTIC

Package Type	
8P3	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
8S1	8-lead, 0.150" Wide, Plastic Gull Wing Small Outline (JEDEC SOIC)
8A2	8-lead, 0.170" Wide, Thin Small Outline Package (TSSOP)
Options	
−1.8	Low Voltage (1.8V to 5.5V)

Part marking scheme:

**AT93C46E 8-PDIP**

TOP MARK	Seal Year   Seal Week 	Y = SEAL YEAR 6: 2006 0: 2010 7: 2007 1: 2011 8: 2008 2: 2012 9: 2009 3: 2013	WW = SEAL WEEK 02 = Week 2 04 = Week 4 :: : :::: : :: : :::: :: 50 = Week 50 52 = Week 52
--- --- --- --- --- --- --- ---	--- --- --- ---		
A T M L U Y W W			
--- --- --- --- --- --- --- ---	--- --- --- ---		
4 6 E 1			
--- --- --- --- --- --- --- ---	--- --- --- ---		
* Lot Number		Lot Number to Use ALL Characters in Marking	
--- --- --- --- --- --- --- ---	--- --- --- ---		
Pin 1 Indicator (Dot)		<b>BOTTOM MARK</b>	No Bottom Mark

**AT93C46E 8-SOIC**

TOP MARK	Seal Year   Seal Week 	Y = SEAL YEAR 6: 2006 0: 2010 7: 2007 1: 2011 8: 2008 2: 2012 9: 2009 3: 2013	WW = SEAL WEEK 02 = Week 2 04 = Week 4 :: : :::: : :: : :::: :: 50 = Week 50 52 = Week 52
--- --- --- --- --- --- --- ---	--- --- --- ---		
A T M L H Y W W			
--- --- --- --- --- --- --- ---	--- --- --- ---		
4 6 E 1			
--- --- --- --- --- --- --- ---	--- --- --- ---		
* Lot Number		Lot Number to Use ALL Characters in Marking	
--- --- --- --- --- --- --- ---	--- --- --- ---		
		<b>BOTTOM MARK</b>	No Bottom Mark
Pin 1 Indicator (Dot)			

**AT93C46E 8-TSSOP**

**TOP MARK**

Pin 1 Indicator (Dot)  
|  
|---|---|---|---|  
\* H Y W W  
|---|---|---|---|  
4 6 E 1  
|---|---|---|---|

Y = SEAL YEAR		WW = SEAL WEEK
6: 2006	0: 2010	02 = Week 2
7: 2007	1: 2011	04 = Week 4
8: 2008	2: 2012	:: : :::: :
9: 2009	3: 2013	:: : :::: ::
		50 = Week 50
		52 = Week 52

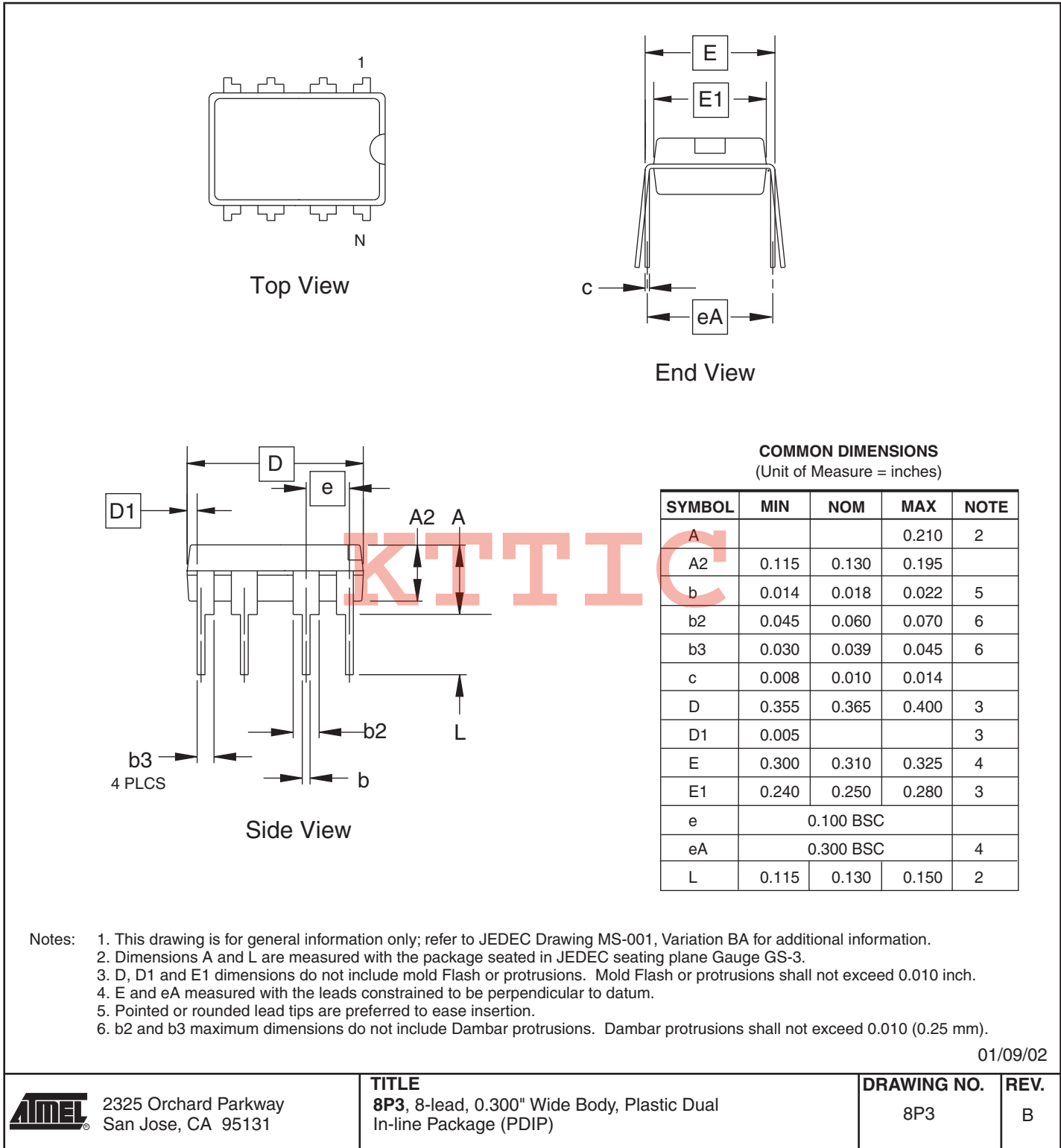
**BOTTOM MARK**

|---|---|---|---|---|---|  
C 0 0  
|---|---|---|---|---|---|  
A A A A A A A  
|---|---|---|---|---|---|  
<- Pin 1 Indicator

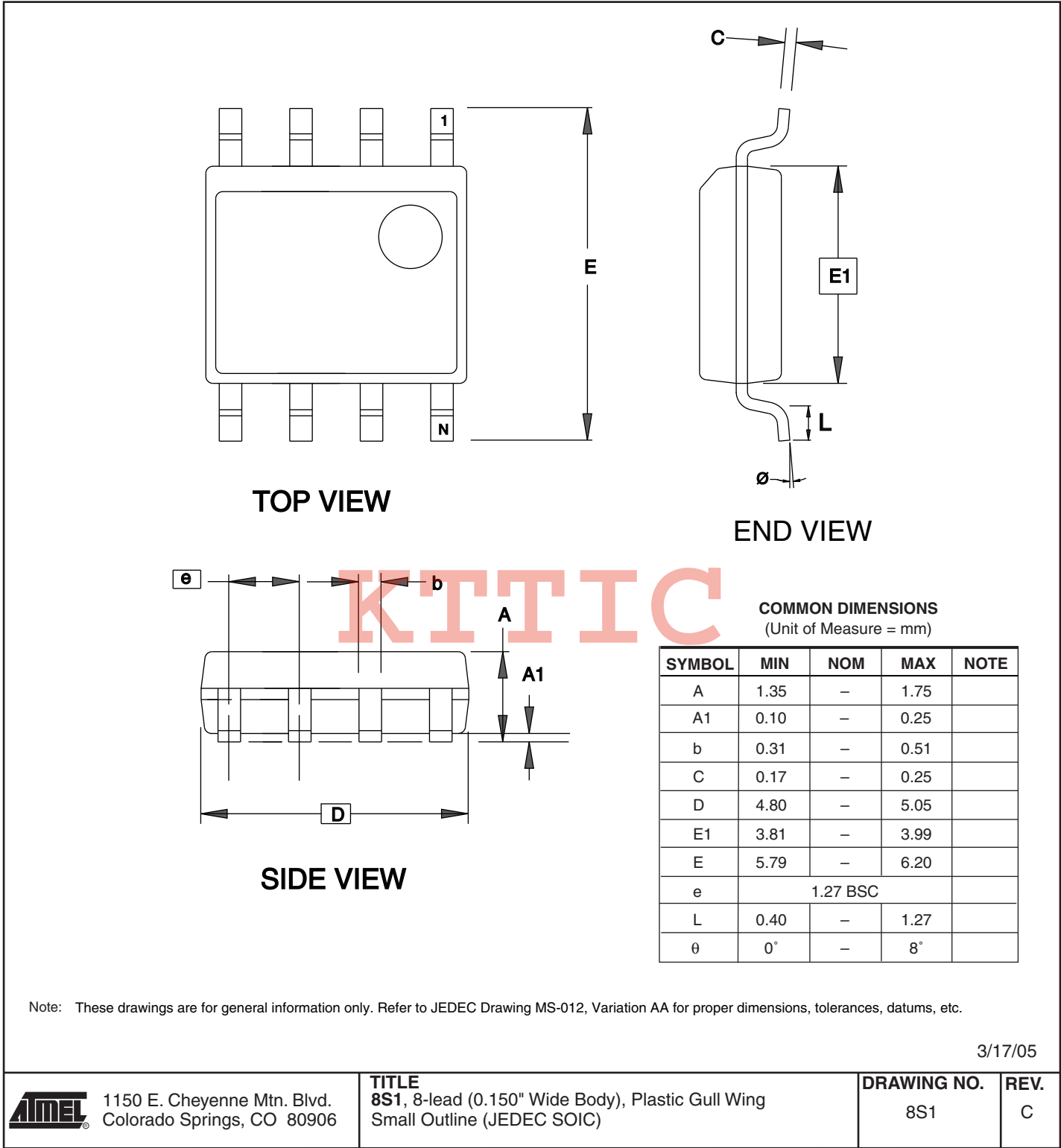
KTTIC

5. Packaging Information

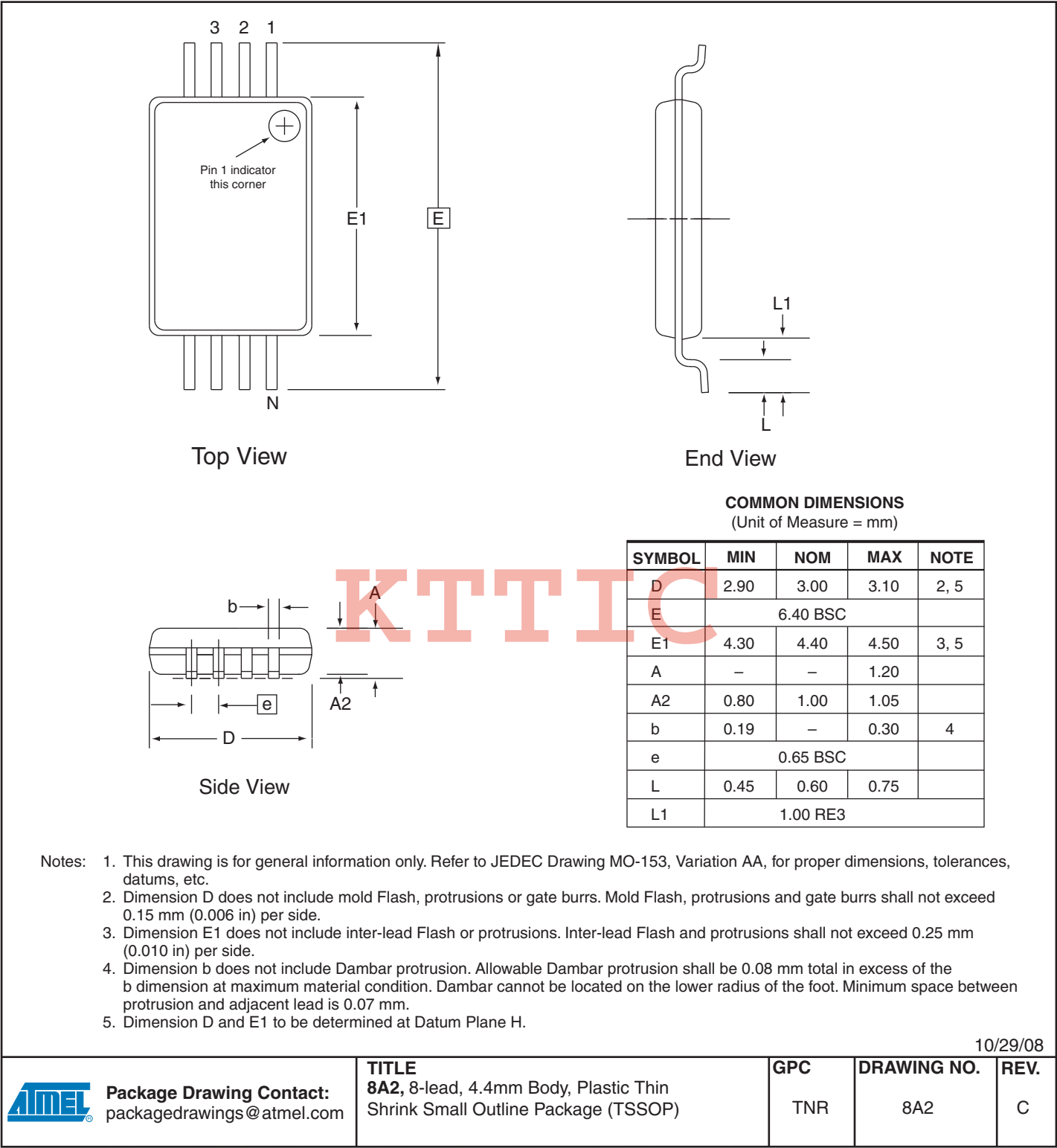
8P3 – PDIP



8S1 – JEDEC SOIC



8A2 - TSSOP



Revision History

Doc. Rev.	Date	Comments
5207D	1/2008	Removed 'preliminary' status
5207C	11/2007	Modified 'max' value on AC Characteristics table
5207B	8/2007	Modified Part Marking Scheme Tables
5207A	1/2007	Initial document release

KTTIC