

## Features

- Low Voltage and Standard Voltage Operation
  - 5.0 (V<sub>CC</sub> = 4.5V to 5.5V)
  - 2.7 (V<sub>CC</sub> = 2.7V to 5.5V)
  - 2.5 (V<sub>CC</sub> = 2.5V to 5.5V)
- 3-Wire Serial Interface
- 2 MHz Clock Rate (5V) Compatibility
- Self-Timed Write Cycle (10 ms max)
- High Reliability
  - Endurance: 1 Million Cycles
  - Data Retention: 100 Years
- Automotive Grade and Extended Temperature Devices Available
- 8-Pin PDIP and JEDEC SOIC Packages

## Description

The AT93C46A 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 AT93C46A is available in space saving 8-pin PDIP and 8-pin JEDEC packages.

The AT93C46A is enabled through the Chip Select pin (CS), and accessed via a 3-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 pin DO. 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.

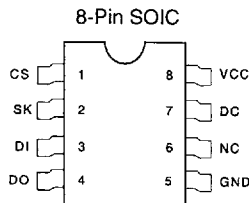
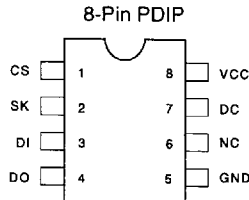
The AT93C46A is available in 4.5V to 5.5V, 2.7V to 5.5V, and 2.5V to 5.5V versions.

## 3-Wire Serial CMOS E<sup>2</sup>PROMs

1K (64 x 16)

## Pin Configurations

| Pin Name        | Function           |
|-----------------|--------------------|
| CS              | Chip Select        |
| SK              | Serial Data Clock  |
| DI              | Serial Data Input  |
| DO              | Serial Data Output |
| GND             | Ground             |
| V <sub>CC</sub> | Power Supply       |
| NC              | No Connect         |
| DC              | Don't Connect      |



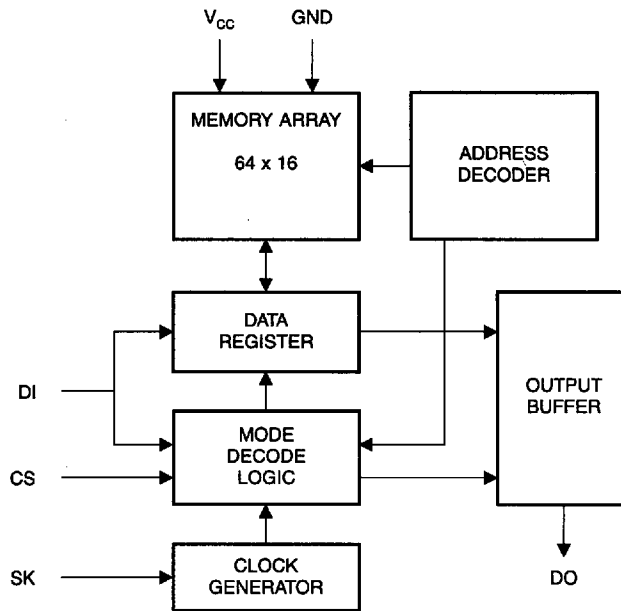


## Absolute Maximum Ratings\*

|                                                    |                 |
|----------------------------------------------------|-----------------|
| Operating Temperature.....                         | -55°C to +125°C |
| Storage Temperature.....                           | -65°C to +150°C |
| Voltage on Any Pin<br>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.

## Block Diagram



## 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).

| Test Conditions |                                | Max | Units | Conditions            |
|-----------------|--------------------------------|-----|-------|-----------------------|
| $C_{OUT}$       | Output Capacitance (DO)        | 5   | pF    | $V_{OUT} = 0\text{V}$ |
| $C_{IN}$        | Input Capacitance (CS, SK, DI) | 5   | pF    | $V_{IN} = 0\text{V}$  |

Note: 1. This parameter is characterized and is not 100% tested.

**2**

## DC Characteristics

Applicable over recommended operating range from:  $T_{AI} = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$ ,  $T_{AC} = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = +2.5\text{V}$  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      |                                            | 2.5                                |     | 5.5                 | V                  |
| $V_{CC3}$       | Supply Voltage      |                                            | 2.7                                |     | 5.5                 | V                  |
| $V_{CC4}$       | 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     | $V_{CC} = 2.5\text{V}$                     | $CS = 0\text{V}$                   |     | 14.0                | 20.0 $\mu\text{A}$ |
| $I_{SB2}$       | Standby Current     | $V_{CC} = 2.7\text{V}$                     | $CS = 0\text{V}$                   |     | 14.0                | 20.0 $\mu\text{A}$ |
| $I_{SB3}$       | Standby Current     | $V_{CC} = 5.0\text{V}$                     | $CS = 0\text{V}$                   |     | 35.0                | 50.0 $\mu\text{A}$ |
| $I_{IL}$        | 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                 | $\mu\text{A}$      |
| $V_{IL1}^{(1)}$ | Input Low Voltage   | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | -0.1                               |     | 0.8                 | V                  |
| $V_{IH1}^{(1)}$ | Input High Voltage  |                                            | 2.0                                |     | $V_{CC} + 1$        |                    |
| $V_{IL2}^{(1)}$ | Input Low Voltage   | $1.8\text{V} \leq V_{CC} \leq 2.7\text{V}$ | 0.0                                |     | $V_{CC} \times 0.3$ | V                  |
| $V_{IH2}^{(1)}$ | Input High Voltage  |                                            | $V_{CC} \times 0.7$                |     | $V_{CC} + 1$        |                    |
| $V_{OL1}$       | Output Low Voltage  | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | $I_{OL} = 2.1\text{ mA}$           |     | 0.4                 | V                  |
| $V_{OH1}$       | Output High Voltage |                                            | $I_{OH} = -0.4\text{ mA}$          |     | 2.4                 | V                  |
| $V_{OL2}$       | Output Low Voltage  | $1.8\text{V} \leq V_{CC} \leq 2.7\text{V}$ | $I_{OL} = 0.15\text{ mA}$          |     | 0.2                 | V                  |
| $V_{OH2}$       | Output High Voltage |                                            | $I_{OH} = -100\text{ }\mu\text{A}$ |     | $V_{CC} - 0.2$      | V                  |

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





## AC Characteristics

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  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 <sub>SK</sub>  | SK Clock Frequency         | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 0    |     | 2    | MHz   |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 0    |     | 1    |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 0    |     | 0.5  |       |
|                  |                            | $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 0    |     | 0.25 |       |
| t <sub>SKH</sub> | SK High Time               | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 250  |     |      | ns    |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 250  |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 500  |     |      |       |
|                  |                            | $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 1000 |     |      |       |
| t <sub>SKL</sub> | SK Low Time                | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 250  |     |      | ns    |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 250  |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 500  |     |      |       |
|                  |                            | $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 1000 |     |      |       |
| t <sub>CS</sub>  | Minimum CS Low Time        | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 250  |     |      | ns    |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 250  |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 500  |     |      |       |
|                  |                            | $1.8\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 1000 |     |      |       |
| t <sub>CSS</sub> | CS Setup Time              | Relative to SK                             |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 50   |     |      |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 50   |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 100  |     |      |       |
| t <sub>DIS</sub> | DI Setup Time              | Relative to SK                             |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 100  |     |      |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 100  |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 200  |     |      |       |
| t <sub>CSH</sub> | CS Hold Time               | Relative to SK                             |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 0    |     |      |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 0    |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 200  |     |      |       |
| t <sub>DIH</sub> | DI Hold Time               | Relative to SK                             |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 100  |     |      |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 100  |     |      |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | 200  |     |      |       |
| t <sub>PD1</sub> | Output Delay to '1'        | AC Test                                    |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 250  |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 250  |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 500  |       |
| t <sub>PD0</sub> | Output Delay to '0'        | AC Test                                    |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 250  |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 250  |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 500  |       |
| t <sub>SV</sub>  | CS to Status Valid         | AC Test                                    |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 250  |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 250  |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 500  |       |
| t <sub>DF</sub>  | CS to DO in High Impedance | AC Test                                    |      |     |      | ns    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 100  |       |
|                  |                            | $2.7\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 100  |       |
|                  |                            | $2.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      |     | 200  |       |
| t <sub>WP</sub>  | Write Cycle Time           |                                            | 0.1  |     | 10   | ms    |
|                  |                            | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ |      | 1   |      | ms    |

**Instruction Set for the AT93C46A**

| Instruction | SB | Op Code | Address                         | Comments                                                                   |
|-------------|----|---------|---------------------------------|----------------------------------------------------------------------------|
|             |    |         | x 16                            |                                                                            |
| READ        | 1  | 10      | A <sub>5</sub> - A <sub>0</sub> | Reads data stored in memory, at specified address.                         |
| EWEN        | 1  | 00      | 11XXXX                          | Write enable must precede all programming modes.                           |
| ERASE       | 1  | 11      | A <sub>5</sub> - A <sub>0</sub> | Erase memory location A <sub>n</sub> - A <sub>0</sub> .                    |
| WRITE       | 1  | 01      | A <sub>5</sub> - A <sub>0</sub> | Writes memory location A <sub>n</sub> - A <sub>0</sub> .                   |
| ERALL       | 1  | 00      | 10XXXX                          | Erases all memory locations. Valid only at V <sub>CC</sub> = 4.5V to 5.5V. |
| WRALL       | 1  | 00      | 01XXXX                          | Writes all memory locations. Valid only at V <sub>CC</sub> = 4.5V to 5.5V. |
| EWDS        | 1  | 00      | 00XXXX                          | Disables all programming instructions.                                     |





## Functional Description

The AT93C46A 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.

**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 (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 Erase/Write Enable state, programming remains enabled until an Erase/Write Disable (EWDS) instruction is executed or VCC 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 (tcs). 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 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 (tcs). 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.

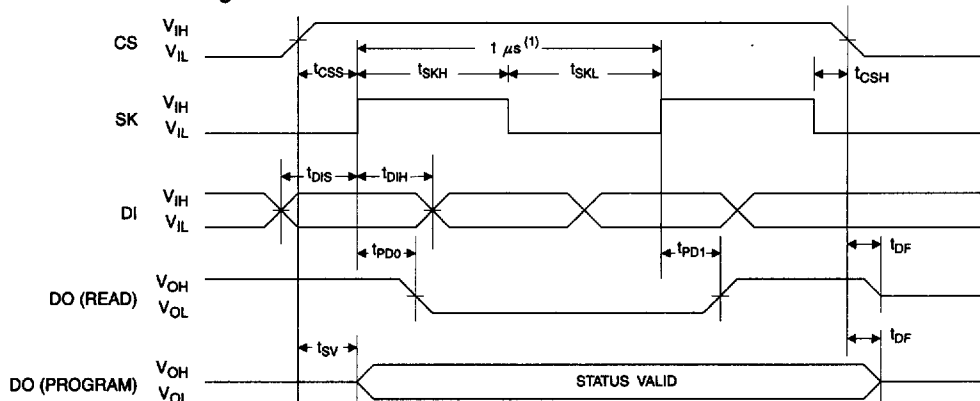
**ERASE ALL (ERAL):** The Erase All (ERAL) instruction programs every bit in the memory array to the logic '1' state and is primarily used for testing purposes. The DO pin outputs the READY/BUSY status of the part if CS is brought high after being kept low for a minimum of 250 ns (tcs). The ERAL instruction is valid only at VCC = 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 (tcs). The WRAL instruction is valid only at VCC = 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.

## Timing Diagrams

### Synchronous Data Timing



Note: 1. This is the minimum SK period.

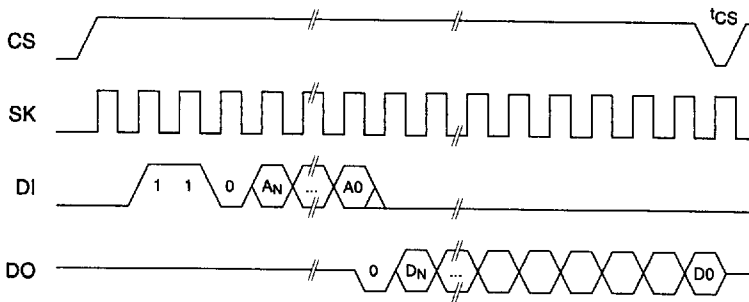
(continued)

## Organization Key for Timing Diagrams

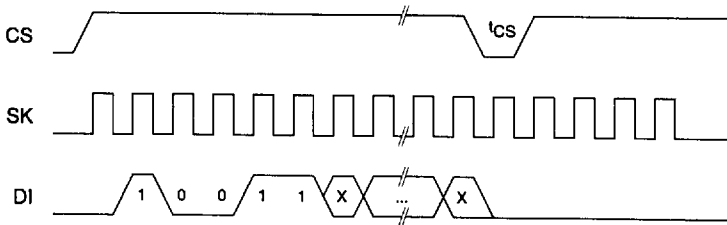
| I/O            | AT93C46A        |
|----------------|-----------------|
|                | x 16            |
| A <sub>N</sub> | A <sub>5</sub>  |
| D <sub>N</sub> | D <sub>15</sub> |

## Timing Diagrams (Continued)

### READ Timing

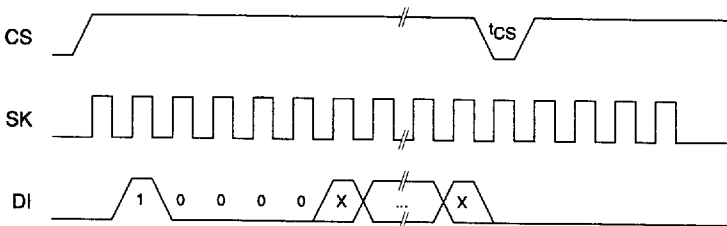


### EWEN Timing <sup>(1)</sup>



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

### EWDS Timing <sup>(1)</sup>



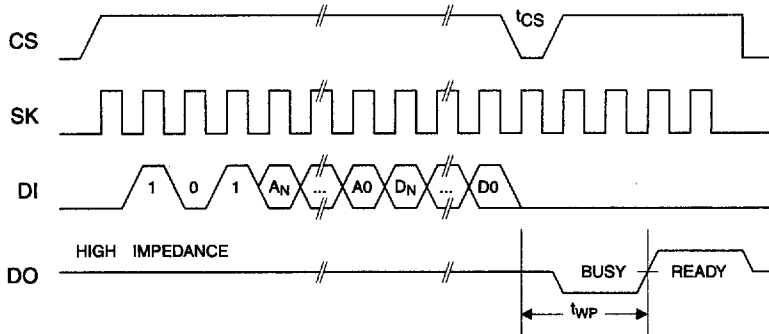
Note: 1. Requires a minimum of nine clock cycles.

(continued)

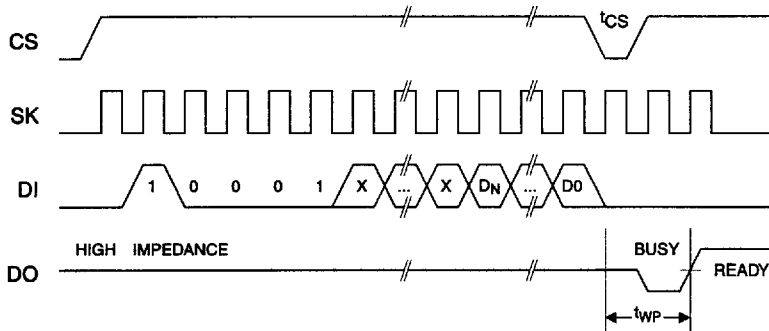


## Timing Diagrams (Continued)

### WRITE Timing

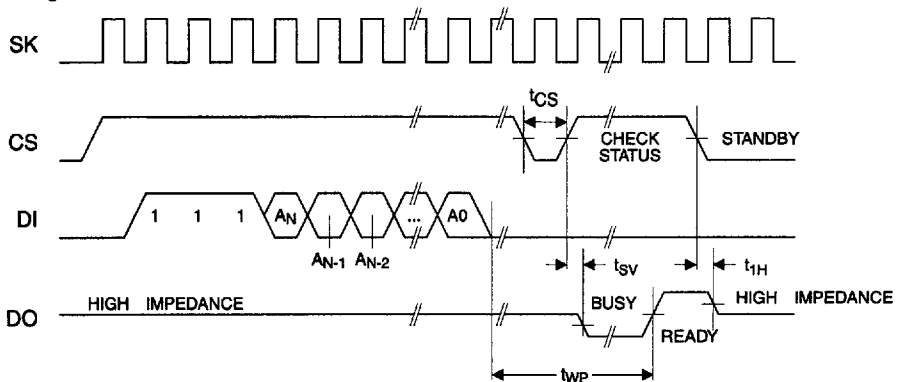


### WRAL Timing <sup>(1, 2)</sup>



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

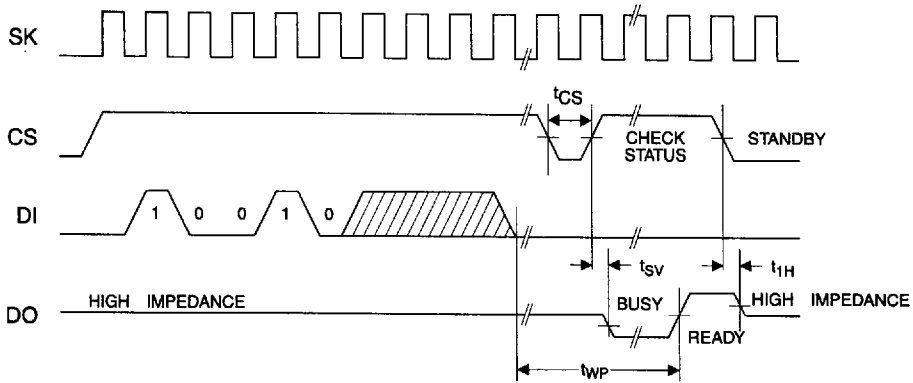
### ERASE Timing



(continued)

# Timing Diagrams (Continued)

## TERAL Timing <sup>(1)</sup>



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





## Ordering Information

| twp (max)<br>(ms) | lcc (max)<br>( $\mu$ A) | lsb (max)<br>( $\mu$ A) | fMAX<br>(kHz) | Ordering Code                          | Package    | Operation Range               |
|-------------------|-------------------------|-------------------------|---------------|----------------------------------------|------------|-------------------------------|
| 10                | 2000                    | 50.0                    | 2000          | AT93C46A-10PC<br>AT93C46A-10SC         | 8P3<br>8S1 | Commercial<br>(0°C to 70°C)   |
| 10                | 800                     | 20.0                    | 1000          | AT93C46A-10PC-2.7<br>AT93C46A-10SC-2.7 | 8P3<br>8S1 | Commercial<br>(0°C to 70°C)   |
| 10                | 600                     | 20.0                    | 500           | AT93C46A-10PC-2.5<br>AT93C46A-10SC-2.5 | 8P3<br>8S1 | Commercial<br>(0°C to 70°C)   |
| 10                | 2000                    | 50.0                    | 2000          | AT93C46A-10PI<br>AT93C46A-10SI         | 8P3<br>8S1 | Industrial<br>(-40°C to 85°C) |
| 10                | 800                     | 20.0                    | 1000          | AT93C46A-10PI-2.7<br>AT93C46A-10SI-2.7 | 8P3<br>8S1 | Industrial<br>(-40°C to 85°C) |
| 10                | 600                     | 20.0                    | 500           | AT93C46A-10PI-2.5<br>AT93C46A-10SI-2.5 | 8P3<br>8S1 | Industrial<br>(-40°C to 85°C) |

| 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) |
| Options      |                                                                   |
| Blank        | Standard Device (4.5V to 5.5V)                                    |
| -2.7         | Low Voltage (2.7V to 5.5V)                                        |
| -2.5         | Low Voltage (2.5V to 5.5V)                                        |
| -1.8         | Low Voltage (1.8V to 5.5V)                                        |