

## Features

- Fast Read Access Time - 55 ns
- Automatic Page Write Operation  
Internal Address and Data Latches for 64-Bytes
- Fast Write Cycle Times  
Page Write Cycle Time: 10 ms Maximum  
1 to 64-Byte Page Write Operation
- Low Power Dissipation  
40 mA Active Current  
100  $\mu$ A CMOS Standby Current
- Hardware and Software Data Protection
- DATA Polling and Toggle Bit for End of Write Detection
- High Reliability CMOS Technology  
Endurance: 100,000 Cycles  
Data Retention: 10 Years
- Single 5V  $\pm$  10% Supply
- CMOS and TTL Compatible Inputs and Outputs
- JEDEC Approved Byte-Wide Pinout
- Commercial and Industrial Temperature Ranges

## Description

The AT28HC64B is a high-performance electrically erasable and programmable read only memory (EEPROM). Its 64K of memory is organized as 8,192 words by 8 bits. Manufactured with Atmel's advanced nonvolatile CMOS technology, the device offers access times to 55 ns with power dissipation of just 220 mW. When the device is deselected, the CMOS standby current is less than 100  $\mu$ A.

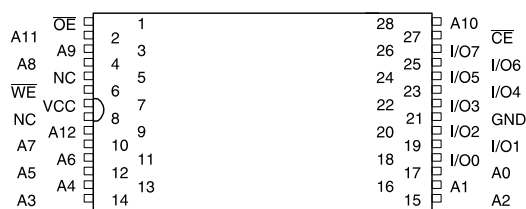
The AT28HC64B is accessed like a Static RAM for the read or write cycle without the need for external components. The device contains a 64-byte page register to allow

(continued)

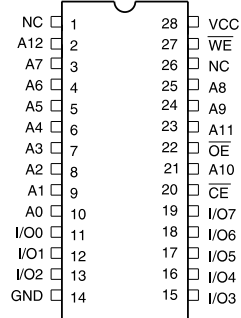
## Pin Configurations

| Pin Name               | Function            |
|------------------------|---------------------|
| A0 - A12               | Addresses           |
| $\overline{\text{CE}}$ | Chip Enable         |
| $\overline{\text{OE}}$ | Output Enable       |
| $\overline{\text{WE}}$ | Write Enable        |
| I/O0 - I/O7            | Data Inputs/Outputs |
| NC                     | No Connect          |
| DC                     | Don't Connect       |

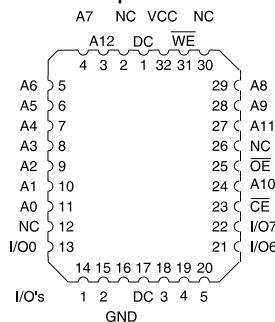
TSOP  
Top View



PDIP, SOIC  
Top View



PLCC  
Top View



Note: PLCC package pins 1 and 17 are DON'T CONNECT.

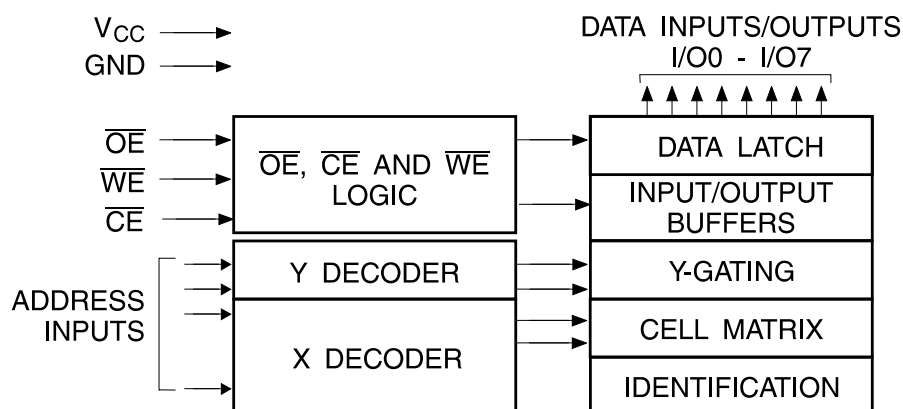
**64K (8K x 8)  
High Speed  
CMOS  
E<sup>2</sup>PROM with  
Page Write and  
Software Data  
Protection**

## Description (Continued)

writing of up to 64-bytes simultaneously. During a write cycle, the addresses and 1 to 64-bytes of data are internally latched, freeing the address and data bus for other operations. Following the initiation of a write cycle, the device will automatically write the latched data using an internal control timer. The end of a write cycle can be detected by DATA Polling of I/O7. Once the end of a write cycle has been detected, a new access for a read or write can begin.

Atmel's AT28HC64B has additional features to ensure high quality and manufacturability. The device utilizes internal error correction for extended endurance and improved data retention. An optional software data protection mechanism is available to guard against inadvertent writes. The device also includes an extra 64-bytes of EEPROM for device identification or tracking.

## Block Diagram



## Absolute Maximum Ratings\*

|                                                                           |                          |
|---------------------------------------------------------------------------|--------------------------|
| Temperature Under Bias.....                                               | -55°C to +125°C          |
| Storage Temperature.....                                                  | -65°C to +150°C          |
| All Input Voltages<br>(including NC Pins)<br>with Respect to Ground ..... | -0.6V to +6.25V          |
| All Output Voltages<br>with Respect to Ground .....                       | -0.6V to $V_{CC} + 0.6V$ |
| Voltage on $\overline{OE}$ and A9<br>with Respect to Ground .....         | -0.6V to +13.5V          |

\*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.

## Device Operation

**READ:** The AT28HC64B is accessed like a Static RAM. When  $\overline{CE}$  and  $\overline{OE}$  are low and  $\overline{WE}$  is high, the data stored at the memory location determined by the address pins is asserted on the outputs. The outputs are put in the high-impedance state when either  $\overline{CE}$  or  $\overline{OE}$  is high. This dual line control gives designers flexibility in preventing bus contention in their systems.

**BYTE WRITE:** A low pulse on the  $\overline{WE}$  or  $\overline{CE}$  input with  $\overline{CE}$  or  $\overline{WE}$  low (respectively) and  $\overline{OE}$  high initiates a write cycle. The address is latched on the falling edge of  $\overline{CE}$  or  $\overline{WE}$ , whichever occurs last. The data is latched by the first rising edge of  $\overline{CE}$  or  $\overline{WE}$ . Once a byte write has been started, it will automatically time itself to completion. Once a programming operation has been initiated and for the duration of  $t_{WC}$ , a read operation will effectively be a polling operation.

**PAGE WRITE:** The page write operation of the AT28HC64B allows 1 to 64-bytes of data to be written into the device during a single internal programming period. A page write operation is initiated in the same manner as a byte write; after the first byte is written, it can then be followed by 1 to 63 additional bytes. Each successive byte must be loaded within 150  $\mu s$  ( $t_{BLC}$ ) of the previous byte. If the  $t_{BLC}$  limit is exceeded, the AT28HC64B will cease accepting data and commence the internal programming operation. All bytes during a page write operation must reside on the same page as defined by the state of the A6 to A12 inputs. For each  $\overline{WE}$  high to low transition during the page write operation, A6 to A12 must be the same.

The A0 to A5 inputs specify which bytes within the page are to be written. The bytes may be loaded in any order and may be altered within the same load period. Only bytes which are specified for writing will be written; unnecessary cycling of other bytes within the page does not occur.

**DATA POLLING:** The AT28HC64B features  $\overline{DATA}$  Polling to indicate the end of a write cycle. During a byte or page write cycle, an attempted read of the last byte written will result in the complement of the written data to be presented on I/O7. Once the write cycle has been completed, true data is valid on all outputs, and the next write cycle may begin. DATA Polling may begin at any time during the write cycle.

**TOGGLE BIT:** In addition to  $\overline{DATA}$  Polling, the AT28HC64B provides another method for determining the end of a write cycle. During the write operation, successive attempts to read data from the device will result in I/O6 toggling between one and zero. Once the write has completed, I/O6 will stop toggling, and valid data will be

read. Toggle bit reading may begin at any time during the write cycle.

**DATA PROTECTION:** If precautions are not taken, inadvertent writes may occur during transitions of the host system power supply. Atmel has incorporated both hardware and software features that will protect the memory against inadvertent writes.

**HARDWARE DATA PROTECTION:** Hardware features protect against inadvertent writes to the AT28HC64B in the following ways: (a)  $V_{CC}$  sense - if  $V_{CC}$  is below 3.8V (typical), the write function is inhibited; (b)  $V_{CC}$  power-on delay - once  $V_{CC}$  has reached 3.8V, the device will automatically time out 5 ms (typical) before allowing a write; (c) write inhibit - holding any one of  $\overline{OE}$  low,  $\overline{CE}$  high or  $\overline{WE}$  high inhibits write cycles; (d) noise filter - pulses of less than 15 ns (typical) on the  $\overline{WE}$  or  $\overline{CE}$  inputs will not initiate a write cycle.

**SOFTWARE DATA PROTECTION:** A software-controlled data protection feature has been implemented on the AT28HC64B. When enabled, the software data protection (SDP), will prevent inadvertent writes. The SDP feature may be enabled or disabled by the user; the AT28HC64B is shipped from Atmel with SDP disabled.

SDP is enabled by the user issuing a series of three write commands in which three specific bytes of data are written to three specific addresses (refer to the *Software Data Protection Algorithm* diagram in this data sheet). After writing the 3-byte command sequence and waiting  $t_{WC}$ , the entire AT28HC64B will be protected against inadvertent writes. It should be noted that even after SDP is enabled, the user may still perform a byte or page write to the AT28HC64B. This is done by preceding the data to be written by the same 3-byte command sequence used to enable SDP.

Once set, SDP remains active unless the disable command sequence is issued. Power transitions do not disable SDP, and SDP protects the AT28HC64B during power-up and power-down conditions. All command sequences must conform to the page write timing specifications. The data in the enable and disable command sequences is not actually written into the device; their addresses may still be written with user data in either a byte or page write operation.

After setting SDP, any attempt to write to the device without the 3-byte command sequence will start the internal write timers. No data will be written to the device, however. For the duration of  $t_{WC}$ , read operations will effectively be polling operations.

(continued)

## Device Operation (Continued)

**DEVICE IDENTIFICATION:** An extra 64-bytes of EEPROM memory are available to the user for device identification. By raising A9 to  $12V \pm 0.5V$  and using address

locations 1FC0H to 1FFFH, the additional bytes may be written to or read from in the same manner as the regular memory array.

## DC and AC Operating Range

|                              |      | AT28HC64B-55 | AT28HC64B-70 | AT28HC64B-90 | AT28HC64B-120 |
|------------------------------|------|--------------|--------------|--------------|---------------|
| Operating Temperature (Case) | Com. | 0°C - 70°C   | 0°C - 70°C   | 0°C - 70°C   | 0°C - 70°C    |
|                              | Ind. |              | -40°C - 85°C | -40°C - 85°C | -40°C - 85°C  |
| V <sub>CC</sub> Power Supply |      | 5V $\pm$ 10% | 5V $\pm$ 10% | 5V $\pm$ 10% | 5V $\pm$ 10%  |

## Operating Modes

| Mode                  | $\overline{CE}$ | $\overline{OE}$               | $\overline{WE}$ | I/O              |
|-----------------------|-----------------|-------------------------------|-----------------|------------------|
| Read                  | V <sub>IL</sub> | V <sub>IL</sub>               | V <sub>IH</sub> | D <sub>OUT</sub> |
| Write <sup>(2)</sup>  | V <sub>IL</sub> | V <sub>IH</sub>               | V <sub>IL</sub> | D <sub>IN</sub>  |
| Standby/Write Inhibit | V <sub>IH</sub> | X <sup>(1)</sup>              | X               | High Z           |
| Write Inhibit         | X               | X                             | V <sub>IH</sub> |                  |
| Write Inhibit         | X               | V <sub>IL</sub>               | X               |                  |
| Output Disable        | X               | V <sub>IH</sub>               | X               | High Z           |
| Chip Erase            | V <sub>IL</sub> | V <sub>H</sub> <sup>(3)</sup> | V <sub>IL</sub> | High Z           |

Notes: 1. X can be V<sub>IL</sub> or V<sub>IH</sub>.

2. Refer to the *AC Write Waveforms* diagrams in this data sheet.

3. V<sub>H</sub> = 12.0V  $\pm$  0.5V.

## DC Characteristics

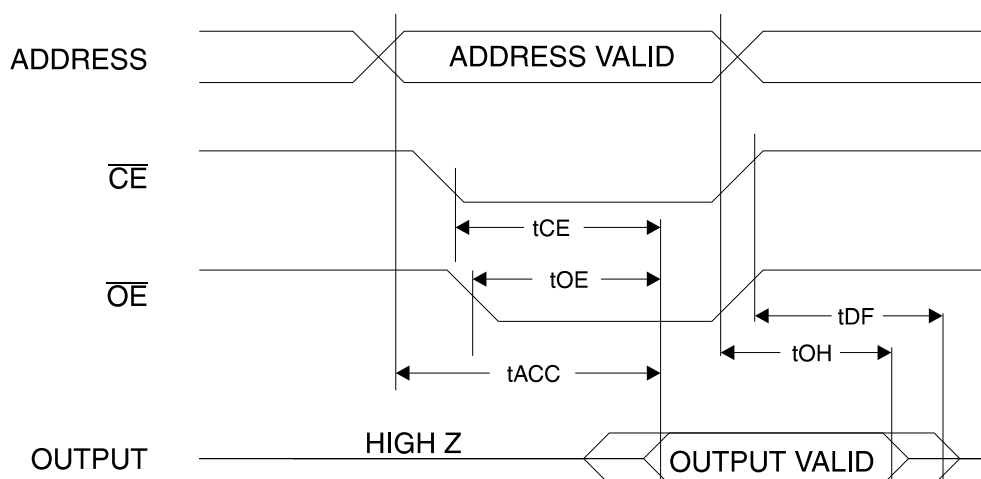
| Symbol           | Parameter                            | Condition                                                                   | Min | Max                | Units |
|------------------|--------------------------------------|-----------------------------------------------------------------------------|-----|--------------------|-------|
| I <sub>LI</sub>  | Input Load Current                   | V <sub>IN</sub> = 0V to V <sub>CC</sub> + 1V                                |     | 10                 | μA    |
| I <sub>LO</sub>  | Output Leakage Current               | V <sub>I/O</sub> = 0V to V <sub>CC</sub>                                    |     | 10                 | μA    |
| I <sub>SB1</sub> | V <sub>CC</sub> Standby Current CMOS | $\overline{CE}$ = V <sub>CC</sub> - 0.3V to V <sub>CC</sub> + 1V Com., Ind. |     | 100 <sup>(1)</sup> | μA    |
| I <sub>SB2</sub> | V <sub>CC</sub> Standby Current TTL  | $\overline{CE}$ = 2.0V to V <sub>CC</sub> + 1V                              |     | 2 <sup>(1)</sup>   | mA    |
| I <sub>CC</sub>  | V <sub>CC</sub> Active Current       | f = 5 MHz; I <sub>OUT</sub> = 0 mA                                          |     | 40                 | mA    |
| V <sub>IL</sub>  | Input Low Voltage                    |                                                                             |     | 0.8                | V     |
| V <sub>IH</sub>  | Input High Voltage                   |                                                                             | 2.0 |                    | V     |
| V <sub>OL</sub>  | Output Low Voltage                   | I <sub>OL</sub> = 2.1 mA                                                    |     | .40                | V     |
| V <sub>OH</sub>  | Output High Voltage                  | I <sub>OH</sub> = -400 μA                                                   | 2.4 |                    | V     |

Note: 1. I<sub>SB1</sub> and I<sub>SB2</sub> for the 55 ns part is 40 mA maximum.

## AC Read Characteristics

| Symbol           | Parameter                       | AT28HC64B-55 |     | AT28HC64B-70 |     | AT28HC64B-90 |     | AT28HC64B-120 |     | Units |
|------------------|---------------------------------|--------------|-----|--------------|-----|--------------|-----|---------------|-----|-------|
|                  |                                 | Min          | Max | Min          | Max | Min          | Max | Min           | Max |       |
| $t_{ACC}$        | Address to Output Delay         |              | 55  |              | 70  |              | 90  |               | 120 | ns    |
| $t_{CE}^{(1)}$   | $\overline{CE}$ to Output Delay |              | 55  |              | 70  |              | 90  |               | 120 | ns    |
| $t_{OE}^{(2)}$   | $\overline{OE}$ to Output Delay | 0            | 30  | 0            | 35  | 0            | 40  | 0             | 50  | ns    |
| $t_{DF}^{(3,4)}$ | $\overline{OE}$ to Output Float | 0            | 30  | 0            | 35  | 0            | 40  | 0             | 50  | ns    |
| $t_{OH}$         | Output Hold                     | 0            |     | 0            |     | 0            |     | 0             |     | ns    |

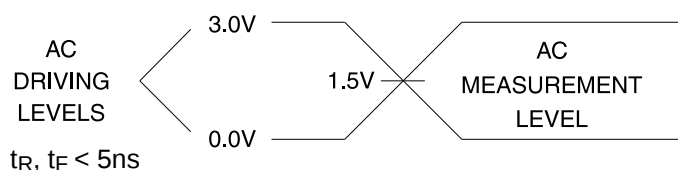
## AC Read Waveforms (1, 2, 3, 4)



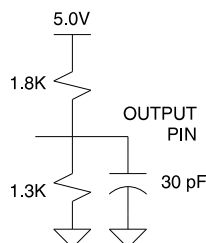
- Notes: 1.  $\overline{CE}$  may be delayed up to  $t_{ACC} - t_{CE}$  after the address transition without impact on  $t_{ACC}$ .  
 2.  $\overline{OE}$  may be delayed up to  $t_{CE} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{CE}$  or by  $t_{ACC} - t_{OE}$  after an address change without impact on  $t_{ACC}$ .

3.  $t_{DF}$  is specified from  $\overline{OE}$  or  $\overline{CE}$ , whichever occurs first ( $C_L = 5 \text{ pF}$ ).  
 4. This parameter is characterized and is not 100% tested.

## Input Test Waveforms and Measurement Level



## Output Test Load



## Pin Capacitance ( $f = 1 \text{ MHz}$ , $T = 25^\circ\text{C}$ ) <sup>(1)</sup>

|           | Typ | Max | Units | Conditions     |
|-----------|-----|-----|-------|----------------|
| $C_{IN}$  | 4   | 6   | pF    | $V_{IN} = 0V$  |
| $C_{OUT}$ | 8   | 12  | pF    | $V_{OUT} = 0V$ |

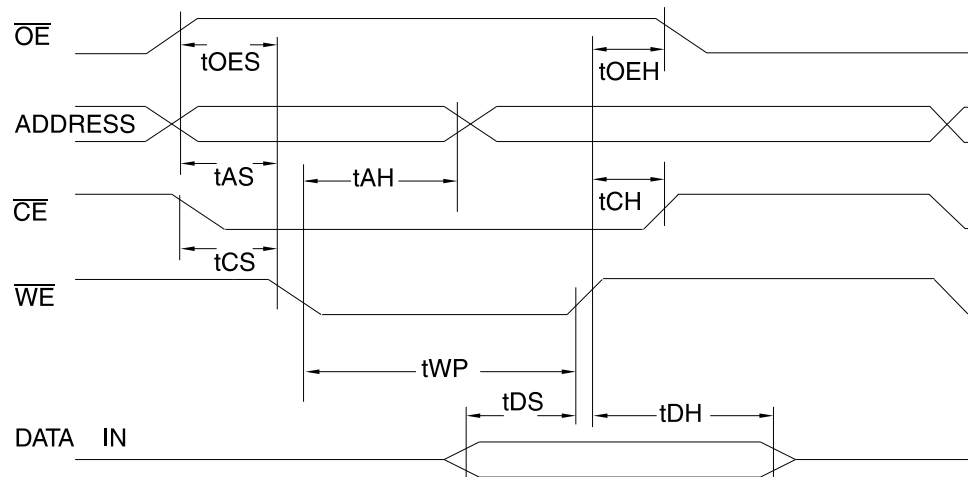
Note: 1. This parameter is characterized and is not 100% tested.

## AC Write Characteristics

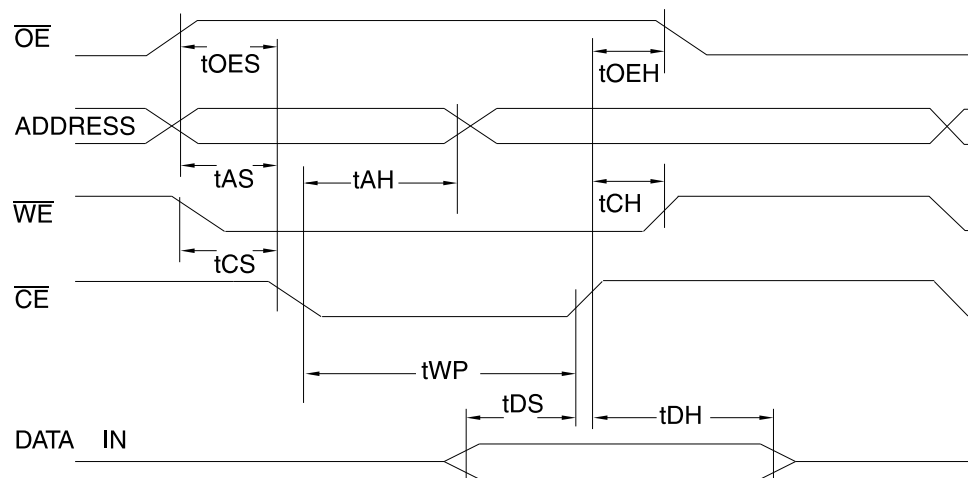
| Symbol            | Parameter                                                | Min | Max | Units |
|-------------------|----------------------------------------------------------|-----|-----|-------|
| $t_{AS}, t_{OES}$ | Address, $\overline{OE}$ Set-up Time                     | 0   |     | ns    |
| $t_{AH}$          | Address Hold Time                                        | 50  |     | ns    |
| $t_{CS}$          | Chip Select Set-up Time                                  | 0   |     | ns    |
| $t_{CH}$          | Chip Select Hold Time                                    | 0   |     | ns    |
| $t_{WP}$          | Write Pulse Width ( $\overline{WE}$ or $\overline{CE}$ ) | 100 |     | ns    |
| $t_{DS}$          | Data Set-up Time                                         | 50  |     | ns    |
| $t_{DH}, t_{OEH}$ | Data, $\overline{OE}$ Hold Time                          | 0   |     | ns    |

## AC Write Waveforms

### $\overline{WE}$ Controlled



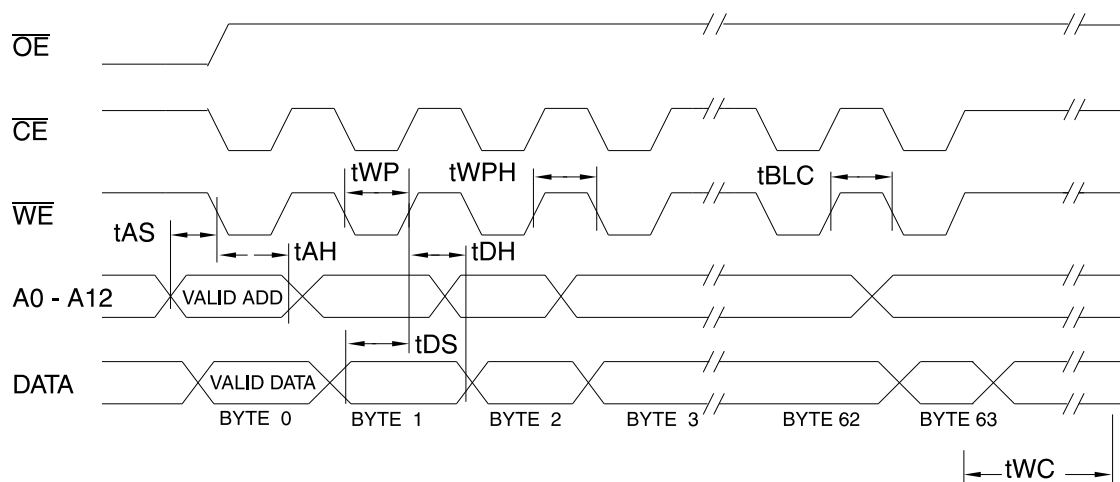
### $\overline{CE}$ Controlled



## Page Mode Characteristics

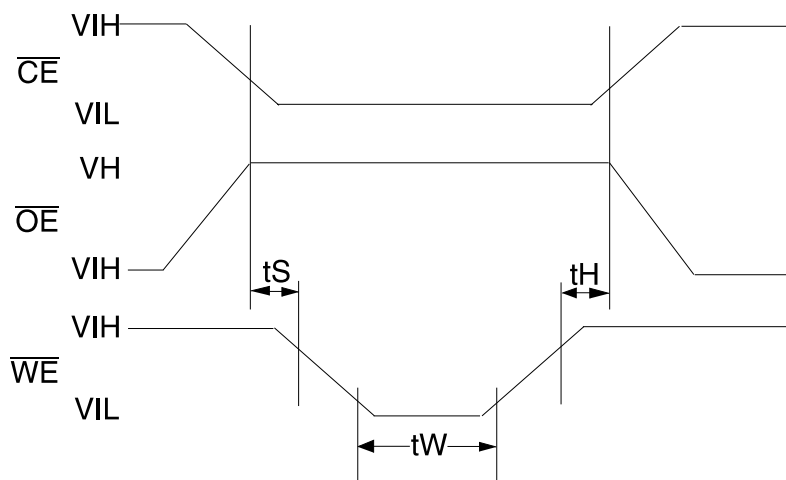
| Symbol           | Parameter              | Min | Max | Units |
|------------------|------------------------|-----|-----|-------|
| t <sub>WC</sub>  | Write Cycle Time       |     | 10  | ms    |
| t <sub>AS</sub>  | Address Set-up Time    | 0   |     | ns    |
| t <sub>AH</sub>  | Address Hold Time      | 50  |     | ns    |
| t <sub>DS</sub>  | Data Set-up Time       | 50  |     | ns    |
| t <sub>DH</sub>  | Data Hold Time         | 0   |     | ns    |
| t <sub>WP</sub>  | Write Pulse Width      | 100 |     | ns    |
| t <sub>BLC</sub> | Byte Load Cycle Time   |     | 150 | μs    |
| t <sub>WPH</sub> | Write Pulse Width High | 50  |     | ns    |

## Page Mode Write Waveforms (1, 2)



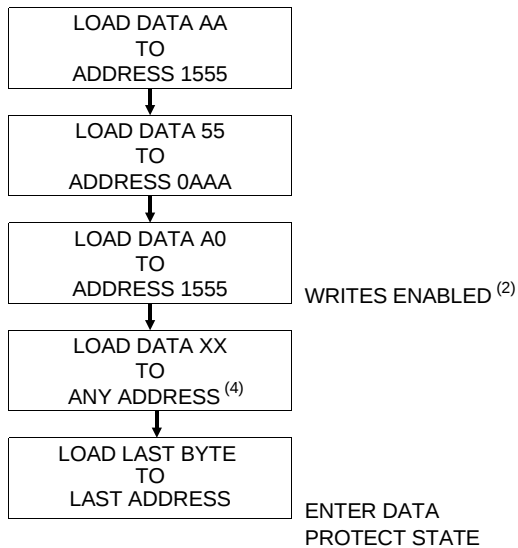
- Notes: 1. A6 through A12 must specify the same page address during each high to low transition of  $\overline{WE}$  (or  $\overline{CE}$ ).  
2. OE must be high only when WE and CE are both low.

## Chip Erase Waveforms



t<sub>S</sub> = t<sub>H</sub> = 5 μsec (min.)  
t<sub>W</sub> = 10 msec (min.)  
V<sub>H</sub> = 12.0V ± 0.5V

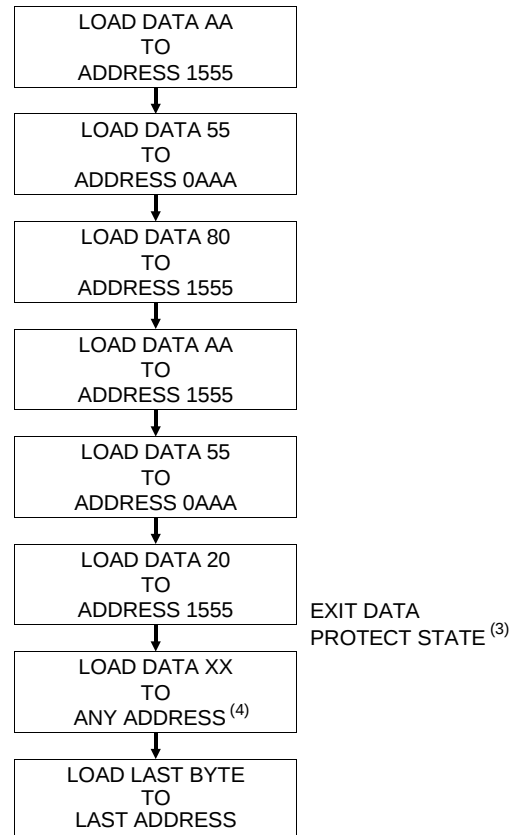
## Software Data Protection Enable Algorithm <sup>(1)</sup>



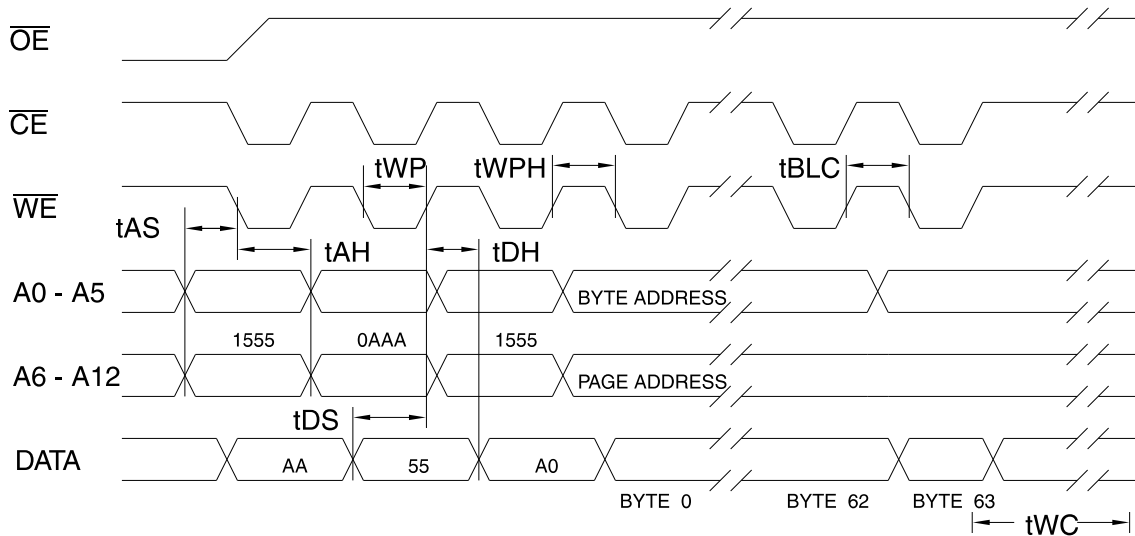
Notes for software program code:

1. Data Format: I/O7 - I/O0 (Hex);  
Address Format: A12 - A0 (Hex).
2. Write Protect state will be activated at end of write even if no other data is loaded.
3. Write Protect state will be deactivated at end of write period even if no other data is loaded.
4. 1 to 64-bytes of data are loaded.

## Software Data Protection Disable Algorithm <sup>(1)</sup>



## Software Protected Write Cycle Waveforms <sup>(1, 2)</sup>



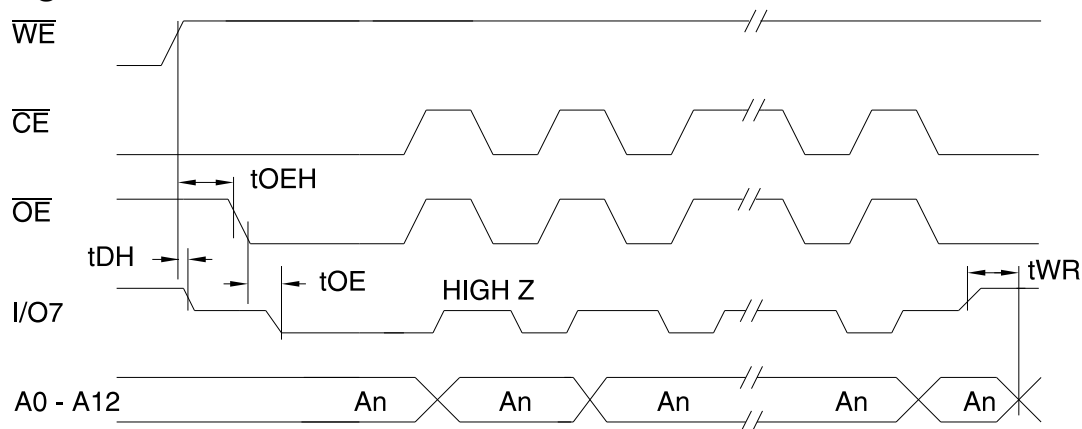
- Notes:
1. A6 through A12 must specify the same page address during each high to low transition of  $\overline{WE}$  (or  $\overline{CE}$ ) after the software code has been entered.
  2.  $\overline{OE}$  must be high only when  $\overline{WE}$  and  $\overline{CE}$  are both low.

## Data Polling Characteristics <sup>(1)</sup>

| Symbol          | Parameter                                             | Min | Typ | Max | Units |
|-----------------|-------------------------------------------------------|-----|-----|-----|-------|
| t <sub>DH</sub> | Data Hold Time                                        | 0   |     |     | ns    |
| t <sub>OE</sub> | $\overline{\text{OE}}$ Hold Time                      | 0   |     |     | ns    |
| t <sub>OE</sub> | $\overline{\text{OE}}$ to Output Delay <sup>(2)</sup> |     |     |     | ns    |
| t <sub>WR</sub> | Write Recovery Time                                   | 0   |     |     | ns    |

Notes: 1. These parameters are characterized and not 100% tested. 2. See AC Read Characteristics.

## Data Polling Waveforms

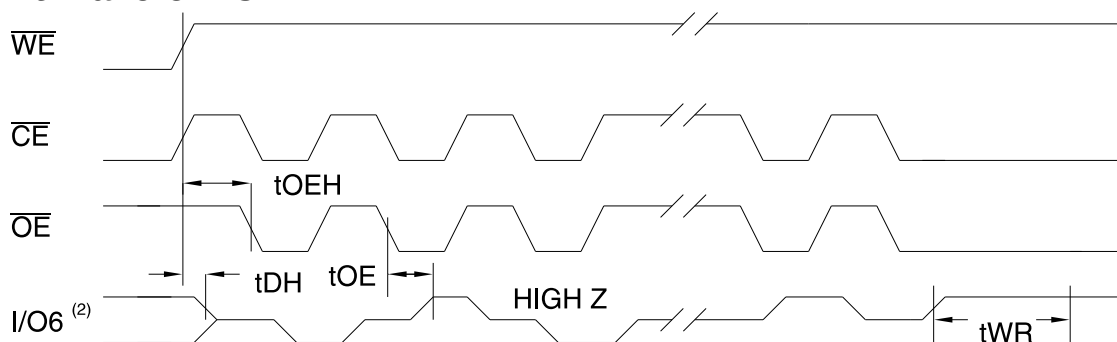


## Toggle Bit Characteristics <sup>(1)</sup>

| Symbol            | Parameter                                             | Min | Typ | Max | Units |
|-------------------|-------------------------------------------------------|-----|-----|-----|-------|
| t <sub>DH</sub>   | Data Hold Time                                        | 10  |     |     | ns    |
| t <sub>OE</sub>   | $\overline{\text{OE}}$ Hold Time                      | 10  |     |     | ns    |
| t <sub>OE</sub>   | $\overline{\text{OE}}$ to Output Delay <sup>(2)</sup> |     |     |     | ns    |
| t <sub>OEHP</sub> | $\overline{\text{OE}}$ High Pulse                     | 150 |     |     | ns    |
| t <sub>WR</sub>   | Write Recovery Time                                   | 0   |     |     | ns    |

Notes: 1. These parameters are characterized and not 100% tested. 2. See AC Read Characteristics.

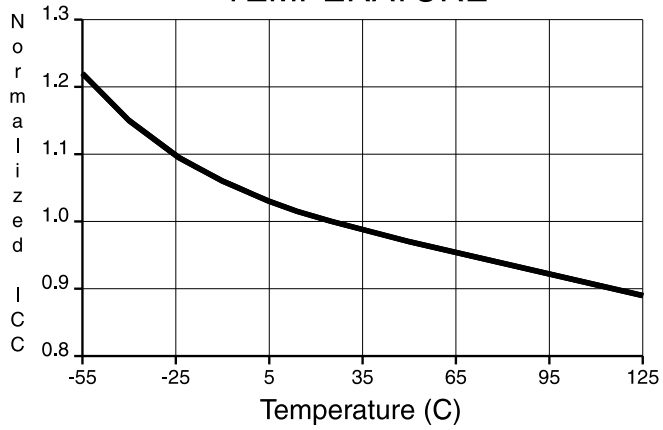
## Toggle Bit Waveforms <sup>(1, 2, 3)</sup>



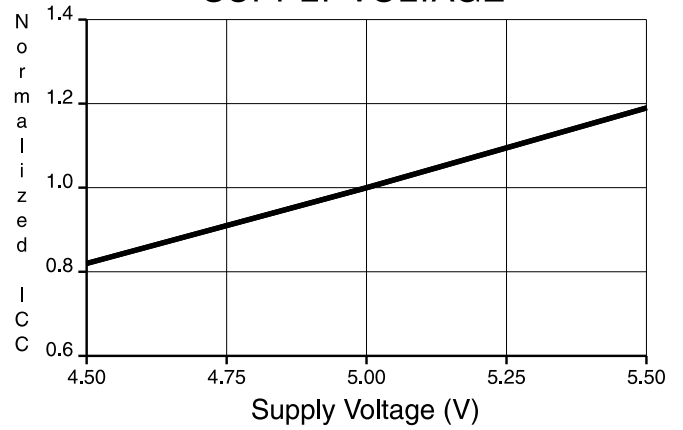
Notes: 1. Toggling either  $\overline{\text{OE}}$  or  $\overline{\text{CE}}$  or both  $\overline{\text{OE}}$  and  $\overline{\text{CE}}$  will operate toggle bit.  
2. Beginning and ending state of I/O6 will vary.

3. Any address location may be used, but the address should not vary.

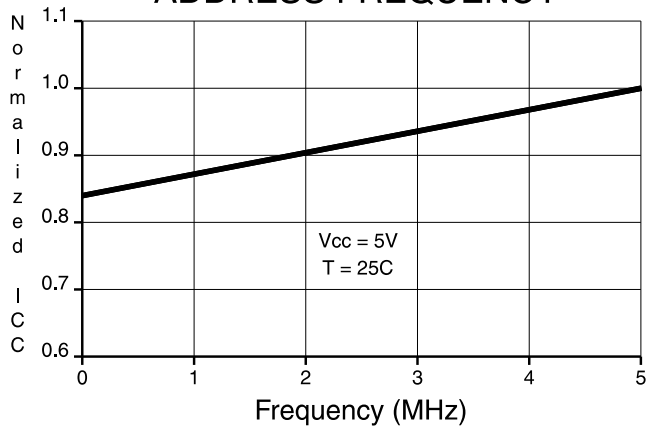
NORMALIZED SUPPLY CURRENT vs.  
TEMPERATURE



NORMALIZED SUPPLY CURRENT vs.  
SUPPLY VOLTAGE



NORMALIZED SUPPLY CURRENT vs.  
ADDRESS FREQUENCY



**Ordering Information** <sup>(1)</sup>

| <b>t<sub>ACC</sub></b><br><b>(ns)</b> | <b>I<sub>CC</sub> (mA)</b> |                | <b>Ordering Code</b> | <b>Package</b> | <b>Operation Range</b>        |
|---------------------------------------|----------------------------|----------------|----------------------|----------------|-------------------------------|
|                                       | <b>Active</b>              | <b>Standby</b> |                      |                |                               |
| 55                                    | 40                         | 0.1            | AT28HC64B-55JC       | 32J            | Commercial<br>(0°C to 70°C)   |
|                                       |                            |                | AT28HC64B-55PC       | 28P6           |                               |
|                                       |                            |                | AT28HC64B-55SC       | 28S            |                               |
| 70                                    | 40                         | 0.1            | AT28HC64B-70JC       | 32J            | Commercial<br>(0°C to 70°C)   |
|                                       |                            |                | AT28HC64B-70PC       | 28P6           |                               |
|                                       |                            |                | AT28HC64B-70SC       | 28S            |                               |
|                                       |                            |                | AT28HC64B-70TC       | 28T            |                               |
|                                       | 40                         | 0.1            | AT28HC64B-70JI       | 32J            | Industrial<br>(-40°C to 85°C) |
|                                       |                            |                | AT28HC64B-70PI       | 28P6           |                               |
| 90                                    | 40                         | 0.1            | AT28HC64B-90JC       | 32J            | Commercial<br>(0°C to 70°C)   |
|                                       |                            |                | AT28HC64B-90PC       | 28P6           |                               |
|                                       |                            |                | AT28HC64B-90SC       | 28S            |                               |
|                                       |                            |                | AT28HC64B-90TC       | 28T            |                               |
|                                       | 40                         | 0.1            | AT28HC64B-90JI       | 32J            | Industrial<br>(-40°C to 85°C) |
|                                       |                            |                | AT28HC64B-90PI       | 28P6           |                               |
| 120                                   | 40                         | 0.1            | AT28HC64B-12JC       | 32J            | Commercial<br>(0°C to 70°C)   |
|                                       |                            |                | AT28HC64B-12PC       | 28P6           |                               |
|                                       |                            |                | AT28HC64B-12SC       | 28S            |                               |
|                                       |                            |                | AT28HC64B-12TC       | 28T            |                               |
|                                       | 40                         | 0.1            | AT28HC64B-12JI       | 32J            | Industrial<br>(-40°C to 85°C) |
|                                       |                            |                | AT28HC64B-12PI       | 28P6           |                               |

Note: 1. See Valid Part Number table below.



## Valid Part Numbers

The following table lists standard Atmel products that can be ordered.

| Device Numbers | Speed | Package and Temperature Combinations |
|----------------|-------|--------------------------------------|
| AT28HC64B      | 55    | PC, SC                               |
| AT28HC64B      | 70    | JI, PC, PI, SC, SI, TC, TI           |
| AT28HC64B      | 90    | JI, PC, PI, SC, SI, TC, TI           |
| AT28HC64B      | 12    | JI, PC, PI, SC, SI, TC, TI           |

| Package Type |                                                              |
|--------------|--------------------------------------------------------------|
| 32J          | 32 Lead, Plastic J-Leaded Chip Carrier (PLCC)                |
| 28P6         | 28 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)     |
| 28S          | 28 Lead, 0.300" Wide, Plastic Gull Wing Small Outline (SOIC) |
| 28T          | 28 Lead, Plastic Thin Small Outline Package (TSOP)           |