

## Features

- Fast Read Access Time - 120 ns
- Fast Byte Write - 200  $\mu$ s or 1 ms
- Self-Timed Byte Write Cycle
  - Internal Address and Data Latches
  - Internal Control Timer
  - Automatic Clear Before Write
- Direct Microprocessor Control
  - READY/BUSY Open Drain Output
  - DATA Polling
- Low Power
  - 30 mA Active Current
  - 100  $\mu$ A CMOS Standby Current
- High Reliability
  - Endurance:  $10^4$  or  $10^5$  Cycles
  - Data Retention: 10 Years
- 5V  $\pm$  10% Supply
- CMOS and TTL Compatible Inputs and Outputs
- JEDEC Approved Byte-Wide Pinout
- Commercial and Industrial Temperature Ranges

**64K (8K x 8)**  
**CMOS**  
**E<sup>2</sup>PROM**

## Description

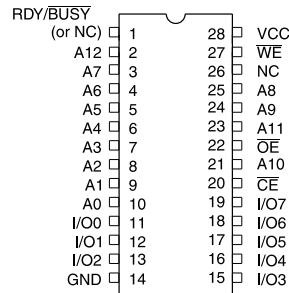
The AT28C64 is a low-power, high-performance 8,192 words by 8 bit nonvolatile Electrically Erasable and Programmable Read Only Memory with popular, easy to use features. The device is manufactured with Atmel's reliable nonvolatile technology.

(continued)

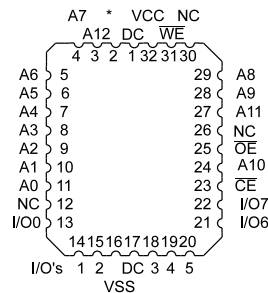
## Pin Configurations

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

PDIP, SOIC  
Top View



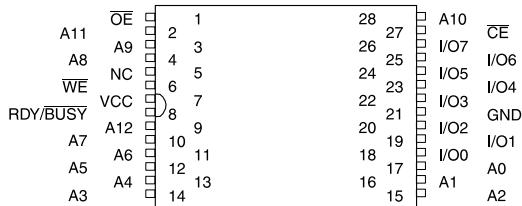
LCC, PLCC  
Top View



\* = RDY/BUSY (or NC)

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

TSOP  
Top View



0001G



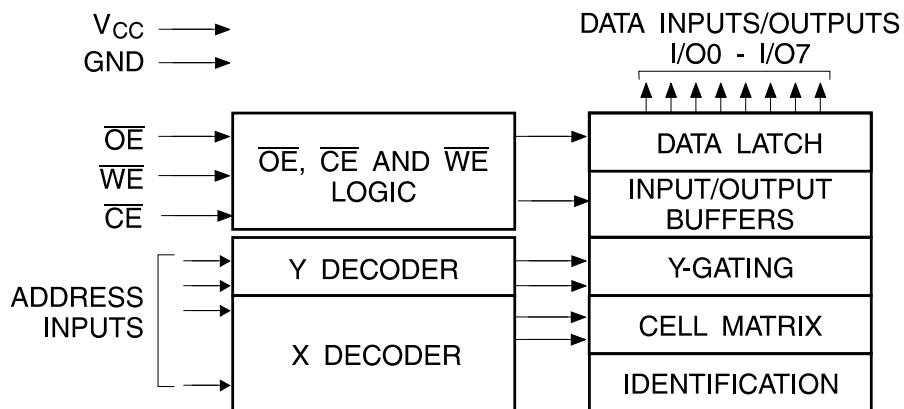
## Description (Continued)

The AT28C64 is accessed like a Static RAM for the read or write cycles without the need for external components. During a byte write, the address and data are latched internally, freeing the microprocessor address and data bus for other operations. Following the initiation of a write cycle, the device will go to a busy state and automatically clear and write the latched data using an internal control timer. The device includes two methods for detecting the end of a write cycle, level detection of RDY/BUSY (unless pin 1 is N.C.) and DATA POLLING of I/O<sub>7</sub>. Once the end of a write cycle has been detected, a new access for a read or write can begin.

The CMOS technology offers fast access times of 120 ns at low power dissipation. When the chip is deselected the standby current is less than 100  $\mu$ A.

Atmel's 28C64 has additional features to ensure high quality and manufacturability. The device utilizes error correction internally for extended endurance and for improved data retention characteristics. An extra 32-bytes of E<sup>2</sup>PROM are available 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 <sub>CC</sub> + 0.6V |
| Voltage on $\overline{OE}$ and A <sub>9</sub><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 AT28C64 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 a high impedance state whenever  $\overline{CE}$  or  $\overline{OE}$  is high. This dual line control gives designers increased flexibility in preventing bus contention.

**BYTE WRITE:** Writing data into the AT28C64 is similar to writing into a Static RAM. A low pulse on the  $\overline{WE}$  or  $\overline{CE}$  input with  $\overline{OE}$  high and  $\overline{CE}$  or  $\overline{WE}$  low (respectively) initiates a byte write. The address location is latched on the falling edge of  $\overline{WE}$  (or  $\overline{CE}$ ); the new data is latched on the rising edge. Internally, the device performs a self-clear before write. 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.

**FAST BYTE WRITE:** The AT28C64E offers a byte write time of 200  $\mu$ s maximum. This feature allows the entire device to be rewritten in 1.6 seconds.

**READY/BUSY:** Pin 1 is an open drain  $\overline{RDY}/\overline{BUSY}$  output that can be used to detect the end of a write cycle.  $\overline{RDY}/\overline{BUSY}$  is actively pulled low during the write cycle and is released at the completion of the write. The open drain connection allows for OR-tying of several devices to the same  $\overline{RDY}/\overline{BUSY}$  line. Pin 1 is not connected for the AT28C64X.

**DATA POLLING:** The AT28C64 provides  $\overline{DATA POLLING}$  to signal the completion of a write cycle. During a write cycle, an attempted read of the data being written results in the complement of that data for I/O<sub>7</sub> (the other outputs are indeterminate). When the write cycle is finished, true data appears on all outputs.

**WRITE PROTECTION:** Inadvertent writes to the device are protected against 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 byte write. (c) Write Inhibit— holding any one of  $\overline{OE}$  low,  $\overline{CE}$  high or  $\overline{WE}$  high inhibits byte write cycles.

**CHIP CLEAR:** The contents of the entire memory of the AT28C64 may be set to the high state by the CHIP CLEAR operation. By setting  $\overline{CE}$  low and  $\overline{OE}$  to 12 volts, the chip is cleared when a 10 msec low pulse is applied to  $\overline{WE}$ .

**DEVICE IDENTIFICATION:** An extra 32-bytes of E<sup>2</sup>PROM memory are available to the user for device identification. By raising A<sub>9</sub> to 12  $\pm$  0.5V and using address locations 1FE0H 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

|                              |      | AT28C64-12   | AT28C64-15   | AT28C64-20   | AT28C64-25   |
|------------------------------|------|--------------|--------------|--------------|--------------|
| 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 | -40°C - 85°C |
| V <sub>CC</sub> Power Supply |      | 5V ± 10%     | 5V ± 10%     | 5V ± 10%     | 5V ± 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 AC Programming Waveforms.

3. V<sub>H</sub> = 12.0V ± 0.5V.

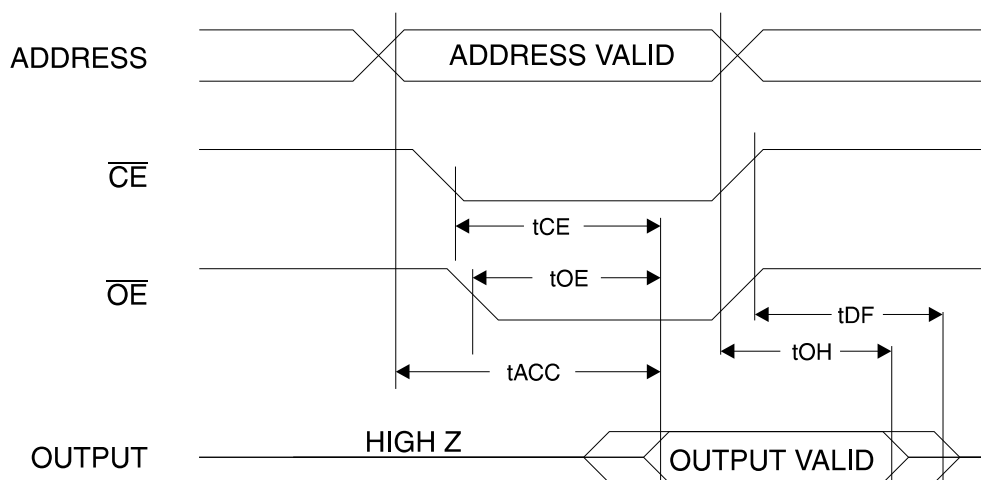
## DC Characteristics

| 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> + 1.0V |      | 100 | μA    |
| I <sub>SB2</sub> | V <sub>CC</sub> Standby Current TTL  | $\overline{CE}$ = 2.0V to V <sub>CC</sub> + 1.0V                   | Com. | 2   | mA    |
|                  |                                      |  | Ind. | 3   | mA    |
| I <sub>CC</sub>  | V <sub>CC</sub> Active Current AC    | f ≅ 5 MHz; I <sub>OUT</sub> = 0 mA<br>CE = V <sub>IL</sub>         | Com. | 30  | mA    |
|                  |                                      |  | Ind. | 45  | 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<br>= 4.0 mA for RDY/ $\overline{BUSY}$    |      | .45 | V     |
| V <sub>OH</sub>  | Output High Voltage                  | I <sub>OH</sub> = -400 μA  | 2.4  |     | V     |

## AC Read Characteristics

| Symbol           | Parameter   | AT28C64-12 |     | AT28C64-15 |     | AT28C64-20 |     | AT28C64-25 |     | Units |
|------------------|---|------------|-----|------------|-----|------------|-----|------------|-----|-------|
|                  |   | Min        | Max | Min        | Max | Min        | Max | Min        | Max |       |
| $t_{ACC}$        | Address to Output Delay   |            | 120 |            | 150 |            | 200 |            | 250 | ns    |
| $t_{CE}^{(1)}$   | $\overline{CE}$ to Output Delay   |            | 120 |            | 150 |            | 200 |            | 250 | ns    |
| $t_{OE}^{(2)}$   | $\overline{OE}$ to Output Delay   | 10         | 60  | 10         | 70  | 10         | 80  | 10         | 100 | ns    |
| $t_{DF}^{(3,4)}$ | $\overline{CE}$ or $\overline{OE}$ High to Output Float                                 | 0          | 45  | 0          | 50  | 0          | 55  | 0          | 60  | ns    |
| $t_{OH}$         | Output Hold from $\overline{OE}$ , $\overline{CE}$ or Address, whichever occurred first | 0          |     | 0          |     | 0          |     | 0          |     | ns    |

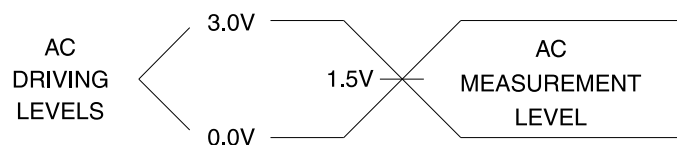
## AC Read Waveforms (1, 2, 3, 4)



- Notes:
- $\overline{CE}$  may be delayed up to  $t_{ACC} - t_{CE}$  after the address transition without impact on  $t_{ACC}$ .
  - $\overline{OE}$  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  $t_{ACC}$ .

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

## Input Test Waveforms and Measurement Level



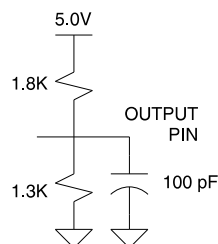
$t_R, t_F < 20 \text{ ns}$

## 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.

## Output Test Load

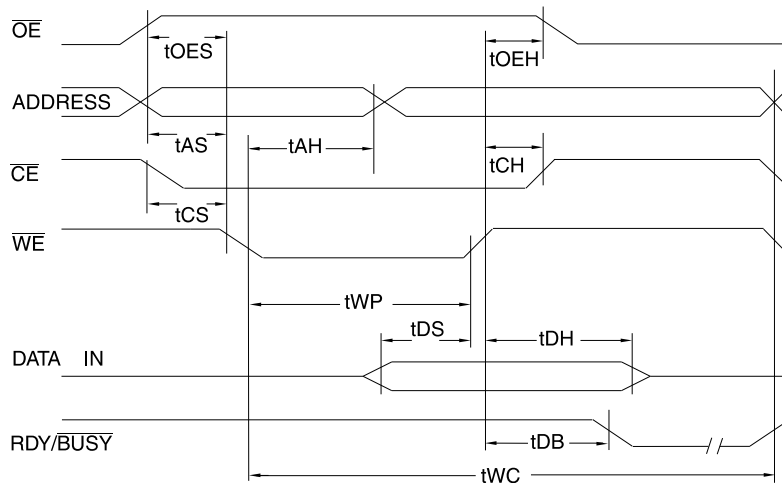


## AC Write Characteristics

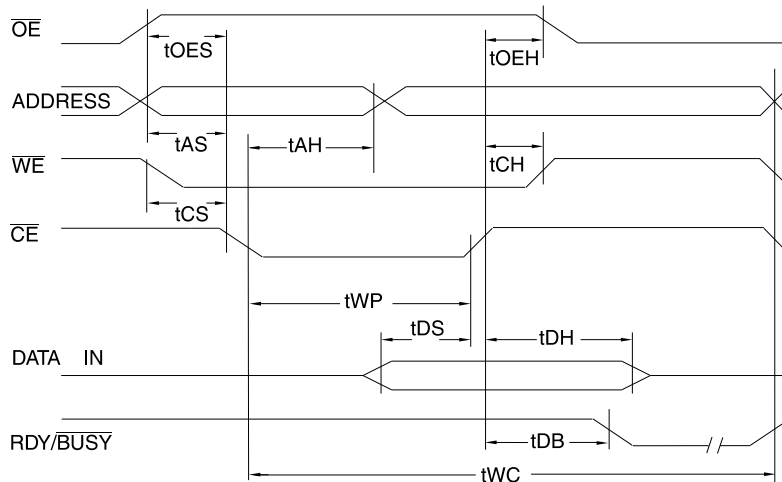
| Symbol            | Parameter  | Min      | Max  | Units   |
|-------------------|--|----------|------|---------|
| $t_{AS}, t_{OES}$ | Address, $\overline{OE}$ Set-up Time   | 10       |      | ns      |
| $t_{AH}$          | Address Hold Time  | 50       |      | ns      |
| $t_{WP}$          | Write Pulse Width ( $\overline{WE}$ or $\overline{CE}$ )                                       | 100      | 1000 | ns      |
| $t_{DS}$          | Data Set-up Time   | 50       |      | ns      |
| $t_{DH}, t_{OEH}$ | Data, $\overline{OE}$ Hold Time  | 10       |      | ns      |
| $t_{CS}, t_{CH}$  | $\overline{CE}$ to $\overline{WE}$ and $\overline{WE}$ to $\overline{CE}$ Set-up and Hold Time | 0        |      | ns      |
| $t_{DB}$          | Time to Device Busy  |          | 50   | ns      |
| $t_{WC}$          | Write Cycle Time   | AT28C64  |      | 1.0     |
|                   |  | AT28C64E |      | 200     |
|                   |  |          |      | $\mu s$ |

## AC Write Waveforms

### $\overline{WE}$ Controlled



### $\overline{CE}$ Controlled

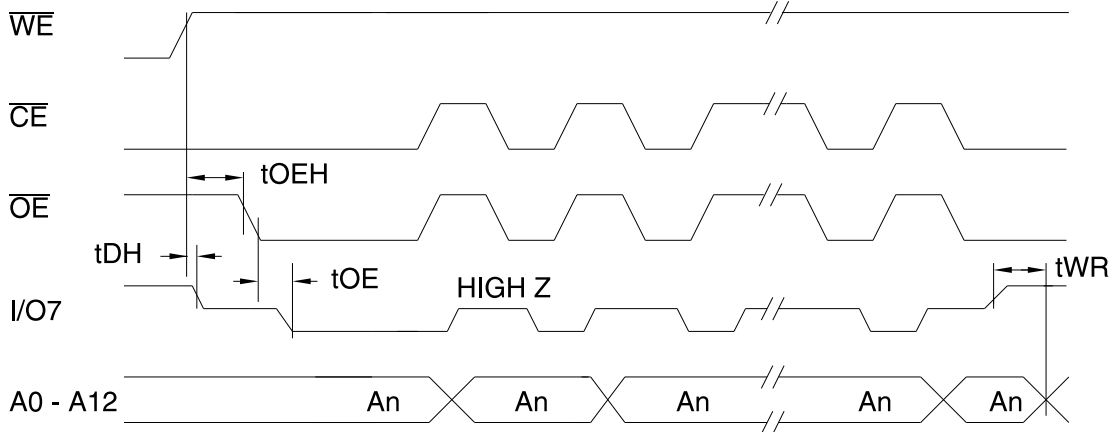


### Data Polling Characteristics <sup>(1)</sup>

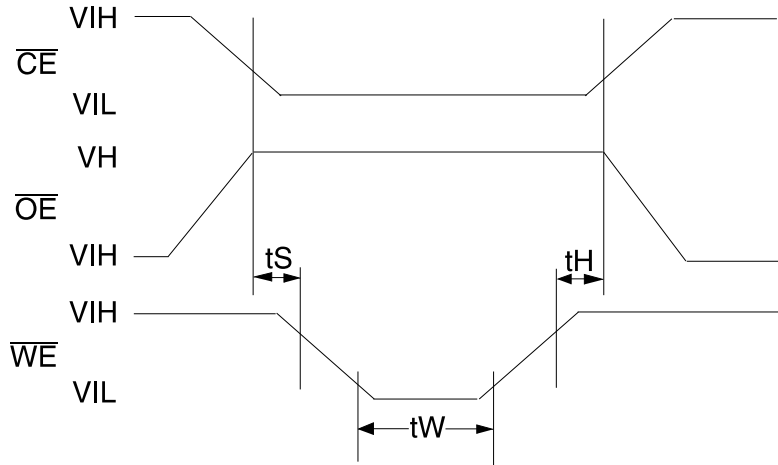
| Symbol           | Parameter   | Min | Typ | Max | Units |
|------------------|---|-----|-----|-----|-------|
| t <sub>DH</sub>  | Data Hold Time  | 10  |     |     | ns    |
| t <sub>OEH</sub> | $\overline{\text{OE}}$ Hold Time                      | 10  |     |     | ns    |
| t <sub>OE</sub>  | $\overline{\text{OE}}$ 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

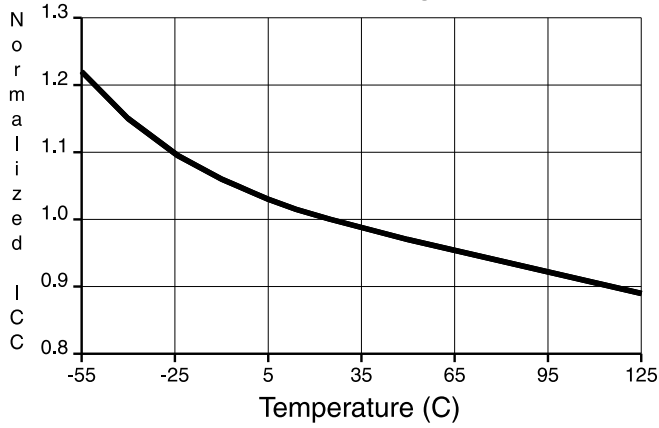


### Chip Erase Waveforms

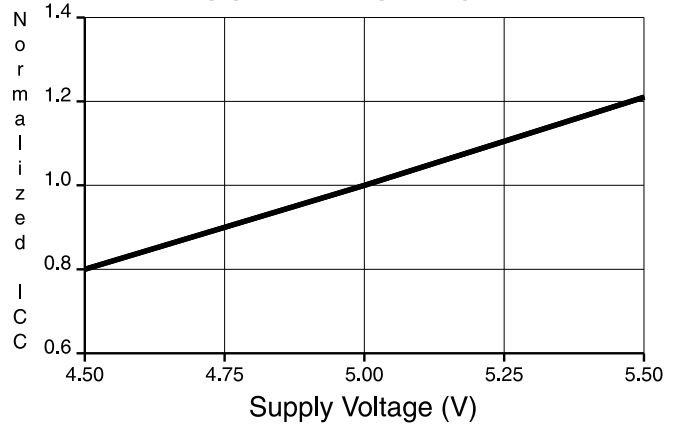


t<sub>S</sub> = t<sub>H</sub> = 1 μsec (min.)  
 t<sub>W</sub> = 10 msec (min.)  
 V<sub>H</sub> = 12.0V ± 0.5V

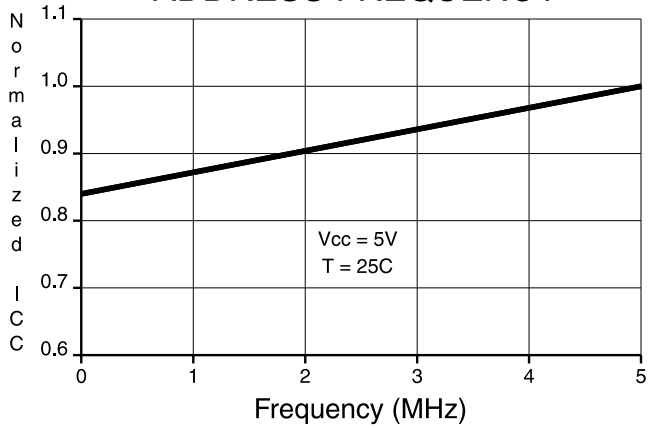
NORMALIZED SUPPLY CURRENT vs. TEMPERATURE



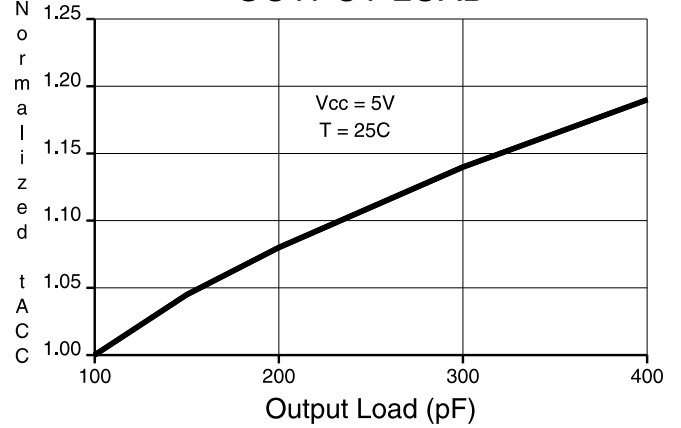
NORMALIZED SUPPLY CURRENT vs. SUPPLY VOLTAGE



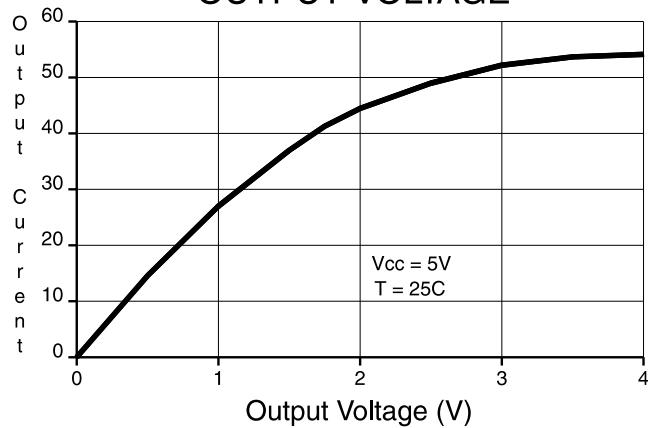
NORMALIZED SUPPLY CURRENT vs. ADDRESS FREQUENCY



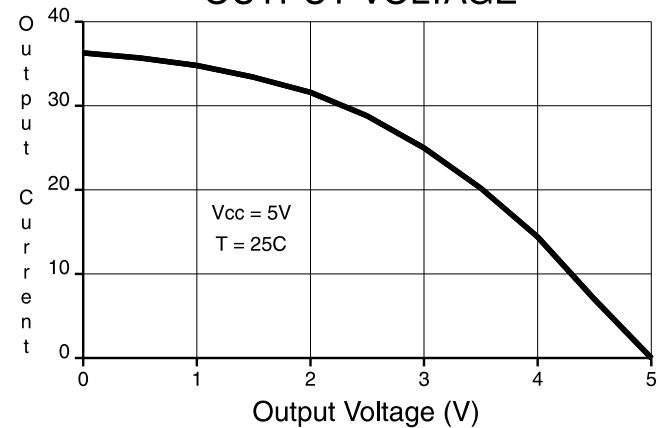
NORMALIZED ACCESS TIME vs. OUTPUT LOAD



OUTPUT SINK CURRENT vs. OUTPUT VOLTAGE



OUTPUT SOURCE CURRENT vs. OUTPUT VOLTAGE





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

| t <sub>ACC</sub><br>(ns) | I <sub>CC</sub> (mA) |         | Ordering Code   | Package                          | Operation Range               |
|--------------------------|----------------------|---------|---|----------------------------------|-------------------------------|
|                          | Active               | Standby |   |                                  |                               |
| 120                      | 30                   | 0.1     | AT28C64(E)-12JC<br>AT28C64(E)-12PC<br>AT28C64(E)-12SC<br>AT28C64(E)-12TC              | 32J<br>28P6<br>28S<br>28T        | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64(E)-12JI<br>AT28C64(E)-12PI<br>AT28C64(E)-12SI<br>AT28C64(E)-12TI              | 32J<br>28P6<br>28S<br>28T        | Industrial<br>(-40°C to 85°C) |
| 150                      | 30                   | 0.1     | AT28C64(E)-15JC<br>AT28C64(E)-15PC<br>AT28C64(E)-15SC<br>AT28C64(E)-15TC              | 32J<br>28P6<br>28S<br>28T        | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64(E)-15JI<br>AT28C64(E)-15PI<br>AT28C64(E)-15SI<br>AT28C64(E)-15TI              | 32J<br>28P6<br>28S<br>28T        | Industrial<br>(-40°C to 85°C) |
| 200                      | 30                   | 0.1     | AT28C64(E)-20JC<br>AT28C64(E)-20PC<br>AT28C64(E)-20SC<br>AT28C64(E)-20TC              | 32J<br>28P6<br>28S<br>28T        | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64(E)-20JI<br>AT28C64(E)-20PI<br>AT28C64(E)-20SI<br>AT28C64(E)-20TI              | 32J<br>28P6<br>28S<br>28T        | Industrial<br>(-40°C to 85°C) |
| 250                      | 30                   | 0.1     | AT28C64(E)-25JC<br>AT28C64(E)-25PC<br>AT28C64(E)-25SC<br>AT28C64(E)-25TC<br>AT28C64-W | 32J<br>28P6<br>28S<br>28T<br>DIE | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64(E)-25JI<br>AT28C64(E)-25PI<br>AT28C64(E)-25SI<br>AT28C64(E)-25TI              | 32J<br>28P6<br>28S<br>28T        | Industrial<br>(-40°C to 85°C) |

Note: 1. See Valid Part Number table below.



| <b>Package Type</b> |  |
|---------------------|--|
| <b>32J</b>          | 32 Lead, Plastic J-Leaded Chip Carrier (PLCC)                                  |
| <b>28P6</b>         | 28 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)                       |
| <b>28S</b>          | 28 Lead, 0.300" Wide, Plastic Gull Wing, Small Outline (SOIC)                  |
| <b>28T</b>          | 28 Lead, Plastic Thin Small Outline Package (TSOP)                             |
| <b>W</b>            | Die  |
| <b>Options</b>      |  |
| <b>Blank</b>        | Standard Device: Endurance = 10K Write Cycles; Write Time = 1 ms               |
| <b>E</b>            | High Endurance Option: Endurance = 100K Write Cycles; Write Time = 200 $\mu$ s |

## Ordering Information

| t <sub>ACC</sub><br>(ns) | I <sub>CC</sub> (mA) |         | Ordering Code  | Package                   | Operation Range               |
|--------------------------|----------------------|---------|--|---------------------------|-------------------------------|
|                          | Active               | Standby |  |                           |                               |
| 150                      | 30                   | 0.1     | AT28C64X-15JC<br>AT28C64X-15PC<br>AT28C64X-15SC<br>AT28C64X-15TC | 32J<br>28P6<br>28S<br>28T | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64X-15JI<br>AT28C64X-15PI<br>AT28C64X-15SI<br>AT28C64X-15TI | 32J<br>28P6<br>28S<br>28T | Industrial<br>(-40°C to 85°C) |
| 200                      | 30                   | 0.1     | AT28C64X-20JC<br>AT28C64X-20PC<br>AT28C64X-20SC<br>AT28C64X-20TC | 32J<br>28P6<br>28S<br>28T | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64X-20JI<br>AT28C64X-20PI<br>AT28C64X-20SI<br>AT28C64X-20TI | 32J<br>28P6<br>28S<br>28T | Industrial<br>(-40°C to 85°C) |
| 250                      | 30                   | 0.1     | AT28C64X-25JC<br>AT28C64X-25PC<br>AT28C64X-25SC<br>AT28C64X-25TC | 32J<br>28P6<br>28S<br>28T | Commercial<br>(0°C to 70°C)   |
|                          | 45                   | 0.1     | AT28C64X-25JI<br>AT28C64X-25PI<br>AT28C64X-25SI<br>AT28C64X-25TI | 32J<br>28P6<br>28S<br>28T | Industrial<br>(-40°C to 85°C) |

## Valid Part Numbers

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

| Device Numbers | Speed | Package and Temperature Combinations |
|----------------|-------|--------------------------------------|
| AT28C64 X      | 12    | JC, JI, PC, PI, SC, SI, TC, TI       |
| AT28C64 X      | 15    | JC, JI, PC, PI, SC, SI, TC, TI       |
| AT28C64 X      | 20    | JC, JI, PC, PI, SC, SI, TC, TI       |
| AT28C64 X      | 25    | JC, 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)           |