

Features

- Fast Read Access Time - 45 ns
- Low Power CMOS Operation
 - 100 μ A max. Standby
 - 20 mA max. Active at 5 MHz
- JEDEC Standard Packages
 - 28-Lead 600-mil PDIP
 - 32-Lead PLCC
 - 28-Lead TSOP and SOIC
- 5V \pm 10% Supply
- High Reliability CMOS Technology
 - 2,000V ESD Protection
 - 200 mA Latchup Immunity
- Rapid™ Programming Algorithm - 100 μ s/byte (typical)
- CMOS and TTL Compatible Inputs and Outputs
- Integrated Product Identification Code
- Commercial and Industrial Temperature Ranges

Description

The AT27C512R is a low-power, high performance 524,288 bit one-time programmable read only memory (OTP EPROM) organized 64K by 8 bits. It requires only one 5V power supply in normal read mode operation. Any byte can be accessed in less than 45 ns, eliminating the need for speed reducing WAIT states on high performance microprocessor systems.

Atmel's scaled CMOS technology provides high speed, lower active power consumption, and significantly faster programming. Power consumption is typically only 8 mA in Active Mode and less than 10 μ A in Standby.

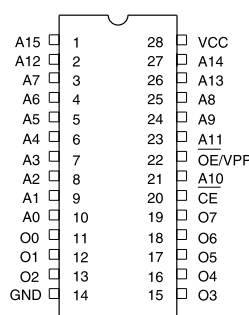
(continued)

**512K (64K x 8)
OTP
CMOS
EPROM**

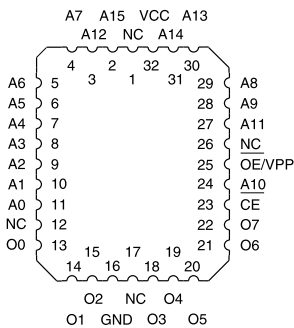
Pin Configurations

| Pin Name | Function |
|------------------------|-------------------------|
| A0 - A15 | Addresses |
| O0 - O7 | Outputs |
| \overline{CE} | Chip Enable |
| \overline{OE}/V_{PP} | Output Enable/ V_{PP} |
| NC | No Connect |

PDIP, SOIC Top View



PLCC Top View



TSOP Top View
Type 1



Note: PLCC Package Pins 1 and 17 are DON'T CONNECT.

0015H



Description (Continued)

The AT27C512R is available in a choice of industry standard JEDEC-approved one-time programmable (OTP) plastic PDIP, PLCC, SOIC, and TSOP packages. All devices feature two-line control (\overline{CE} , \overline{OE}) to give designers the flexibility to prevent bus contention.

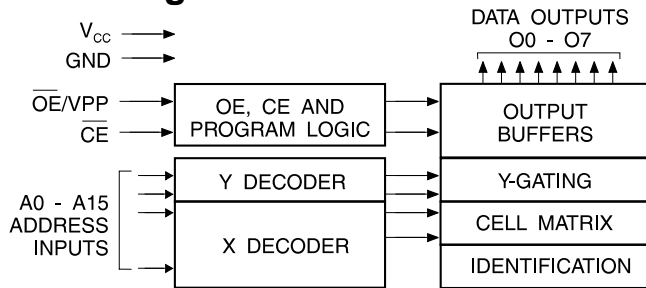
With 64K byte storage capability, the AT27C512R allows firmware to be stored reliably and to be accessed by the system without the delays of mass storage media.

Atmel's 27C512R has additional features to ensure high quality and efficient production use. The Rapid™ Programming Algorithm reduces the time required to program the part and guarantees reliable programming. Programming time is typically only 100 μ s/byte. The Integrated Product Identification Code electronically identifies the device and manufacturer. This feature is used by industry standard programming equipment to select the proper programming algorithms and voltages.

System Considerations

Switching between active and standby conditions via the Chip Enable pin may produce transient voltage excursions. Unless accommodated by the system design, these transients may exceed data sheet limits, resulting in device non-conformance. At a minimum, a 0.1 μ F high frequency, low inherent inductance, ceramic capacitor should be utilized for each device. This capacitor should be connected between the V_{CC} and Ground terminals of the device, as close to the device as possible. Additionally, to stabilize the supply voltage level on printed circuit boards with large EPROM arrays, a 4.7 μ F bulk electrolytic capacitor should be utilized, again connected between the V_{CC} and Ground terminals. This capacitor should be positioned as close as possible to the point where the power supply is connected to the array.

Block Diagram



Absolute Maximum Ratings*

| | |
|--|--------------------------------|
| Temperature Under Bias | -55°C to +125°C |
| Storage Temperature..... | -65°C to +150°C |
| Voltage on Any Pin with Respect to Ground..... | -2.0V to +7.0V ⁽¹⁾ |
| Voltage on A9 with Respect to Ground | -2.0V to +14.0V ⁽¹⁾ |
| V_{PP} Supply Voltage with Respect to Ground..... | -2.0V to +14.0V ⁽¹⁾ |

*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.

Note: 1. Minimum voltage is -0.6V dc which may undershoot to -2.0V for pulses of less than 20 ns. Maximum output pin voltage is $V_{CC} + 0.75V$ dc which may overshoot to +7.0V for pulses of less than 20 ns.

Operating Modes

| Mode \ Pin | \overline{CE} | \overline{OE}/V_{PP} | A_i | Outputs |
|---------------------------------------|-----------------|------------------------|---|---------------------|
| Read | V_{IL} | V_{IL} | A_i | DOUT |
| Output Disable | V_{IL} | V_{IH} | X ⁽¹⁾ | High Z |
| Standby | V_{IH} | X ⁽¹⁾ | X | High Z |
| Rapid Program ⁽²⁾ | V_{IL} | V_{PP} | A_i | DIN |
| PGM Inhibit | V_{IH} | V_{PP} | X ⁽¹⁾ | High Z |
| Product Identification ⁽⁴⁾ | V_{IL} | V_{IL} | $A_9 = V_H$ ⁽³⁾ $A_0 = V_{IH}$ or V_{IL} $A_1 - A_{15} = V_{IL}$ | Identification Code |

Notes: 1. X can be V_{IL} or V_{IH} .
2. Refer to Programming Characteristics.
3. $V_H = 12.0 \pm 0.5V$.

4. Two identifier bytes may be selected. All A_i inputs are held low (V_{IL}), except A9 which is set to V_H and A0 which is toggled low (V_{IL}) to select the Manufacturer's Identification byte and high (V_{IH}) to select the Device Code byte.

DC and AC Operating Conditions for Read Operation

| AT27C512R | | | | | | | |
|------------------------|------|--------------|--------------|--------------|--------------|--------------|--------------|
| | | -45 | -55 | -70 | -90 | -12 | -15 |
| Operating Temp.(Case) | Com. | 0°C - 70°C | 0°C - 70°C | 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 | -40°C - 85°C | -40°C - 85°C |
| V _{CC} Supply | | 5V ± 10% | 5V ± 10% | 5V ± 10% | 5V ± 10% | 5V ± 10% | 5V ± 10% |

DC and Operating Characteristics for Read Operation

| Symbol | Parameter | Condition | Min | Max | Units |
|-----------------|--|---|------|-----------------------|-------|
| I _{LI} | Input Load Current | V _{IN} = 0V to V _{CC} | | ±1 | μA |
| I _{LO} | Output Leakage Current | V _{OUT} = 0V to V _{CC} | | ±5 | μA |
| I _{SB} | V _{CC} ⁽¹⁾ Standby Current | I _{SB1} (CMOS), $\overline{CE} = V_{CC} \pm 0.3V$ | | 100 | μA |
| | | I _{SB2} (TTL), $\overline{CE} = 2.0$ to V _{CC} + 0.5V | | 1 | mA |
| I _{CC} | V _{CC} Active Current | f = 5 MHz, I _{OUT} = 0 mA, $\overline{CE} = V_{IL}$ | | 20 | mA |
| V _{IL} | Input Low Voltage | | -0.6 | 0.8 | V |
| V _{IH} | Input High Voltage | | 2.0 | V _{CC} + 0.5 | V |
| V _{OL} | Output Low Voltage | I _{OL} = 2.1 mA | | 0.4 | V |
| V _{OH} | Output High Voltage | I _{OH} = -400 μA | 2.4 | | V |

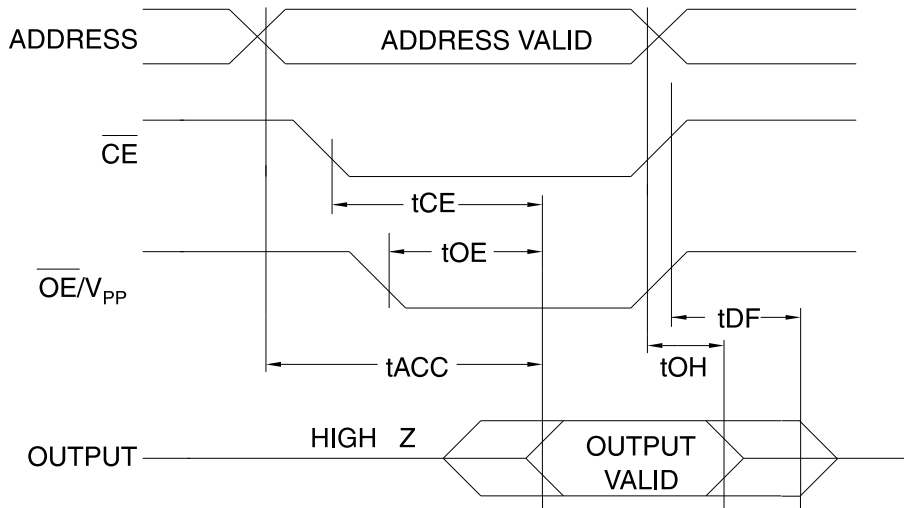
Note: 1. V_{CC} must be applied simultaneously or before \overline{OE}/V_{PP} , and removed simultaneously or after \overline{OE}/V_{PP} .

AC Characteristics for Read Operation

| | | | AT27C512R | | | | | | | | | | | | |
|-----------------------------------|--|--|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| | | | -45 | | -55 | | -70 | | -90 | | -12 | | -15 | | Units |
| Symbol | Parameter | Condition | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | |
| t _{ACC} ⁽³⁾ | Address to Output Delay | $\overline{CE} = \overline{OE}/V_{PP}$ $= V_{IL}$ | 45 | | 55 | | 70 | | 90 | | 120 | | 150 | ns | |
| t _{CE} ⁽²⁾ | \overline{CE} to Output Delay | $\overline{OE}/V_{PP} = V_{IL}$ | 45 | | 55 | | 70 | | 90 | | 120 | | 150 | ns | |
| t _{OE} ^(2, 3) | \overline{OE}/V_{PP} to Output Delay | $\overline{CE} = V_{IL}$ | 20 | | 25 | | 30 | | 35 | | 35 | | 40 | ns | |
| t _{DF} ^(4, 5) | \overline{OE}/V_{PP} or \overline{CE} High to Output Float, whichever occurred first | | 20 | | 20 | | 25 | | 25 | | 30 | | 35 | ns | |
| t _{OH} | Output Hold from Address, \overline{CE} or \overline{OE}/V_{PP} , whichever occurred first | | 7 | | 7 | | 7 | | 0 | | 0 | | 0 | ns | |

Notes: 2, 3, 4, 5. - see AC Waveforms for Read Operation.

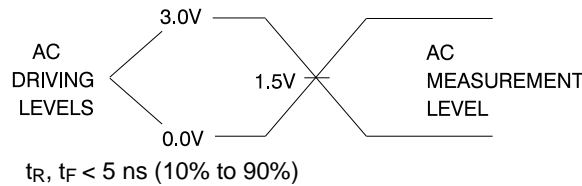
AC Waveforms for Read Operation ⁽¹⁾



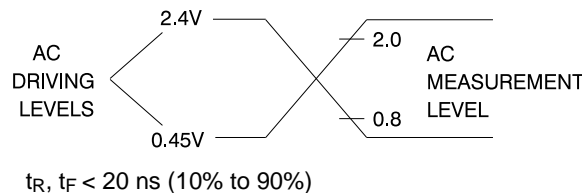
- Notes:
1. Timing measurement reference level is 1.5V for -45 and -55 devices. Input AC drive levels are $V_{IL} = 0.0V$ and $V_{IH} = 3.0V$. Timing measurement reference levels for all other speed grades are $V_{OL} = 0.8V$ and $V_{OH} = 2.0V$. Input AC drive levels are $V_{IL} = 0.45V$ and $V_{IH} = 2.4V$.
 2. \overline{OE}/V_{PP} may be delayed up to $t_{CE} - t_{OE}$ after the falling edge of \overline{CE} without impact on t_{CE} .
 3. \overline{OE}/V_{PP} may be delayed up to $t_{ACC} - t_{OE}$ after the address is valid without impact on t_{ACC} .
 4. This parameter is only sampled and is not 100% tested.
 5. Output float is defined as the point when data is no longer driven.

Input Test Waveforms and Measurement Levels

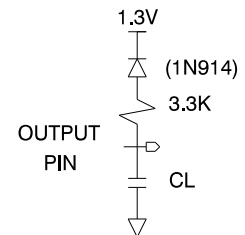
For -45 and -55 devices only:



For -70, -90, -12, -15, and -20 devices:



Output Test Load



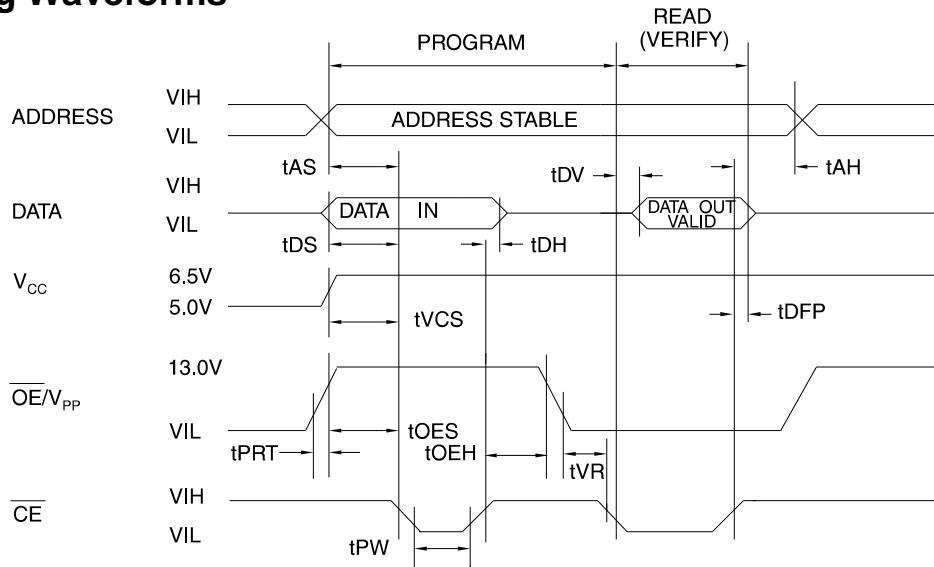
Note: $CL = 100\text{ pF}$ including jig capacitance, except for the -45 and -55 devices, where $CL = 30\text{ pF}$.

Pin Capacitance ($f = 1\text{ MHz}$ $T = 25^\circ\text{C}$) ⁽¹⁾

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

Note: 1. Typical values for nominal supply voltage. This parameter is only sampled and is not 100% tested.

Programming Waveforms



- Notes:
1. The Input Timing Reference is 0.8V for V_{IL} and 2.0V for V_{IH} .
 2. t_{OE} and t_{DFP} are characteristics of the device but must be accommodated by the programmer.

DC Programming Characteristics

$T_A = 25 \pm 5^\circ\text{C}$, $V_{CC} = 6.5 \pm 0.25\text{V}$, $\overline{OE}/V_{PP} = 13.0 \pm 0.25\text{V}$

| Symbol | Parameter | Test Conditions | Limits | | Units |
|-----------|--|-----------------------------|--------|--------------|---------------|
| | | | Min | Max | |
| I_{LI} | Input Load Current | $V_{IN} = V_{IL}, V_{IH}$ | | ± 10 | μA |
| V_{IL} | Input Low Level | | -0.6 | 0.8 | V |
| V_{IH} | Input High Level | | 2.0 | $V_{CC} + 1$ | V |
| V_{OL} | Output Low Voltage | $I_{OL} = 2.1 \text{ mA}$ | | 0.4 | V |
| V_{OH} | Output High Voltage | $I_{OH} = -400 \mu\text{A}$ | 2.4 | | V |
| I_{CC2} | V_{CC} Supply Current (Program and Verify) | | | 25 | mA |
| I_{PP2} | \overline{OE}/V_{PP} Current | $\overline{CE} = V_{IL}$ | | 25 | mA |
| V_{ID} | A9 Product Identification Voltage | | 11.5 | 12.5 | V |

AC Programming Characteristics

$T_A = 25 \pm 5^\circ\text{C}$, $V_{CC} = 6.5 \pm 0.25\text{V}$, $\overline{\text{OE}}/V_{PP} = 13.0 \pm 0.25\text{V}$

| Sym- bol | Parameter | Test Conditions* (1) | Limits | | Units |
|------------------|---|-------------------------|--------|-----|-------|
| | | | Min | Max | |
| t _{AS} | Address Setup Time | | 2 | | μs |
| t _{OES} | $\overline{\text{OE}}/V_{PP}$ Setup Time | | 2 | | μs |
| t _{OEH} | $\overline{\text{OE}}/V_{PP}$ Hold Time | | 2 | | μs |
| t _{DS} | Data Setup Time | | 2 | | μs |
| t _{AH} | Address Hold Time | | 0 | | μs |
| t _{DH} | Data Hold Time | | 2 | | μs |
| t _{DFP} | $\overline{\text{CE}}$ High to Output Float Delay (2) | | 0 | 130 | ns |
| t _{VCS} | V _{CC} Setup Time | | 2 | | μs |
| t _{PW} | $\overline{\text{CE}}$ Program Pulse Width (3) | | 95 | 105 | μs |
| t _{DV} | Data Valid from $\overline{\text{CE}}$ (2) | | | 1 | μs |
| t _{VR} | $\overline{\text{OE}}/V_{PP}$ Recovery Time | | 2 | | μs |
| t _{PRT} | $\overline{\text{OE}}/V_{PP}$ Pulse Rise Time During Programming | | 50 | | ns |

*AC Conditions of Test:

Input Rise and Fall Times (10% to 90%)..... 20 ns
 Input Pulse Levels.....0.45V to 2.4V
 Input Timing Reference Level.....0.8V to 2.0V
 Output Timing Reference Level.....0.8V to 2.0V

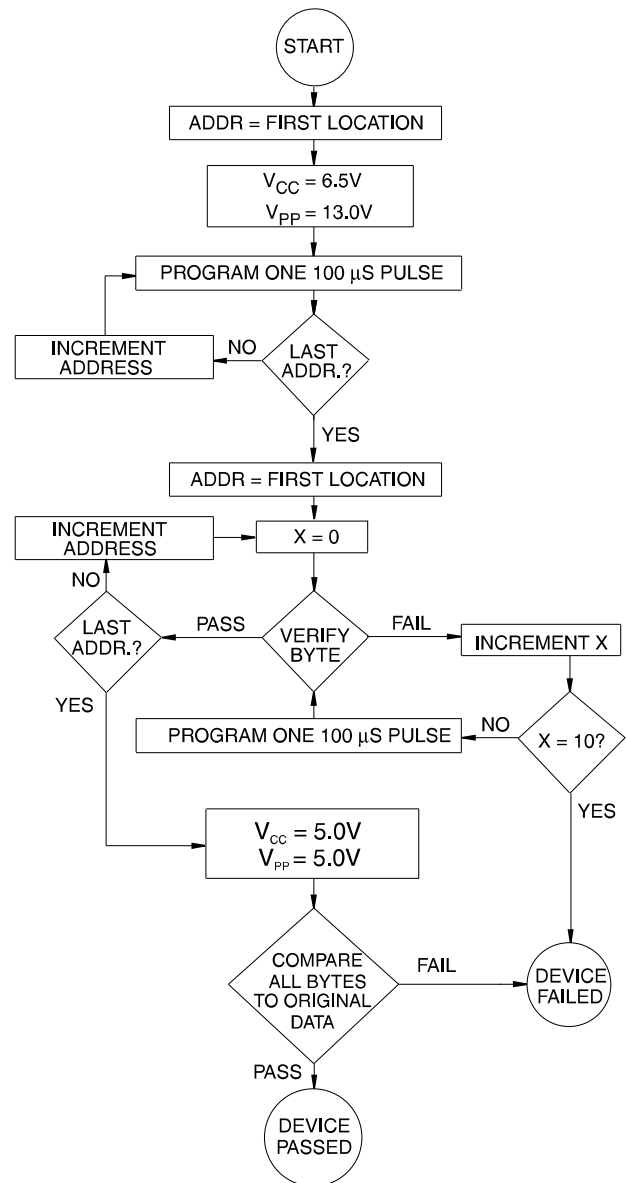
- Notes: 1. V_{CC} must be applied simultaneously or before $\overline{\text{OE}}/V_{PP}$ and removed simultaneously or after $\overline{\text{OE}}/V_{PP}$.
 2. This parameter is only sampled and is not 100% tested. Output Float is defined as the point where data is no longer driven — see timing diagram.
 3. Program Pulse width tolerance is 100 μsec ± 5%.

Atmel's 27C512R Integrated Product Identification Code

| Codes | Pins | | | | | | | | | Hex Data |
|--------------|------|----|----|----|----|----|----|----|----|-------------|
| | A0 | O7 | O6 | O5 | O4 | O3 | O2 | O1 | O0 | |
| Manufacturer | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1E |
| Device Type | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0D |

Rapid Programming Algorithm

A 100 μs $\overline{\text{CE}}$ pulse width is used to program. The address is set to the first location. V_{CC} is raised to 6.5V and $\overline{\text{OE}}/V_{PP}$ is raised to 13.0V. Each address is first programmed with one 100 μs $\overline{\text{CE}}$ pulse without verification. Then a verification/reprogramming loop is executed for each address. In the event a byte fails to pass verification, up to 10 successive 100 μs pulses are applied with a verification after each pulse. If the byte fails to verify after 10 pulses have been applied, the part is considered failed. After the byte verifies properly, the next address is selected until all have been checked. $\overline{\text{OE}}/V_{PP}$ is then lowered to V_{IL} and V_{CC} to 5.0V. All bytes are read again and compared with the original data to determine if the device passes or fails.





Ordering Information

| t _{ACC} (ns) | I _{CC} (mA) | | Ordering Code | Package | Operation Range |
|--------------------------|----------------------|---------|--|---------------------------|-------------------------------|
| | Active | Standby | | | |
| 45 | 20 | 0.1 | AT27C512R-45JC AT27C512R-45PC AT27C512R-45RC AT27C512R-45TC | 32J 28P6 28R 28T | Commercial (0°C to 70°C) |
| | 20 | 0.1 | AT27C512R-45JI AT27C512R-45PI AT27C512R-45RI AT27C512R-45TI | 32J 28P6 28R 28T | Industrial (-40°C to 85°C) |
| 55 | 20 | 0.1 | AT27C512R-55JC AT27C512R-55PC AT27C512R-55RC AT27C512R-55TC | 32J 28P6 28R 28T | Commercial (0°C to 70°C) |
| | 20 | 0.1 | AT27C512R-55JI AT27C512R-55PI AT27C512R-55RI AT27C512R-55TI | 32J 28P6 28R 28T | Industrial (-40°C to 85°C) |
| 70 | 20 | 0.1 | AT27C512R-70JC AT27C512R-70PC AT27C512R-70RC AT27C512R-70TC | 32J 28P6 28R 28T | Commercial (0°C to 70°C) |
| | 20 | 0.1 | AT27C512R-70JI AT27C512R-70PI AT27C512R-70RI AT27C512R-70TI | 32J 28P6 28R 28T | Industrial (-40°C to 85°C) |
| 90 | 20 | 0.1 | AT27C512R-90JC AT27C512R-90PC AT27C512R-90RC AT27C512R-90TC | 32J 28P6 28R 28T | Commercial (0°C to 70°C) |
| | 20 | 0.1 | AT27C512R-90JI AT27C512R-90PI AT27C512R-90RI AT27C512R-90TI | 32J 28P6 28R 28T | Industrial (-40°C to 85°C) |
| 120 | 20 | 0.1 | AT27C512R-12JC AT27C512R-12PC AT27C512R-12RC AT27C512R-12TC | 32J 28P6 28R 28T | Commercial (0°C to 70°C) |
| | 20 | 0.1 | AT27C512R-12JI AT27C512R-12PI AT27C512R-12RI AT27C512R-12TI | 32J 28P6 28R 28T | Industrial (-40°C to 85°C) |
| 150 | 20 | 0.1 | AT27C512R-15JC AT27C512R-15PC AT27C512R-15RC AT27C512R-15TC | 32J 28P6 28R 28T | Commercial (0°C to 70°C) |

(continued)

Ordering Information (Continued)

| t _{ACC} (ns) | I _{CC} (mA) | | Ordering Code | Package | Operation Range |
|--------------------------|----------------------|---------|--|---------------------------|-------------------------------|
| | Active | Standby | | | |
| 150 | 20 | 0.1 | AT27C512R-15JI AT27C512R-15PI AT27C512R-15RI AT27C512R-15TI | 32J 28P6 28R 28T | Industrial (-40°C to 85°C) |

| Package Type | |
|--------------|--|
| 32J | 32 Lead, Plastic J-Leaded Chip Carrier (PLCC) |
| 28P6 | 28 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP) |
| 28R | 28 Lead, 0.330" Wide, Plastic Gull Wing Small Outline (SOIC) |
| 28T | 28 Lead, Thin Small Outline Package (TSOP) |