

## Features

- Fast Read Access Time – 70 ns
- Low Power CMOS Operation
  - 100  $\mu$ A Max Standby
  - 30 mA Max Active at 5 MHz
- JEDEC Standard Packages
  - 32-lead, 600-mil PDIP
  - 32-lead PLCC
  - 32-lead TSOP
- 5V  $\pm$ 10% Supply
- High Reliability CMOS Technology
  - 2000V ESD Protection
  - 200 mA Latchup Immunity
- Rapid™ Programming Algorithm – 100  $\mu$ s/Byte (Typical)
- CMOS and TTL Compatible Inputs and Outputs
- Integrated Product Identification Code
- Commercial and Industrial Temperature Ranges

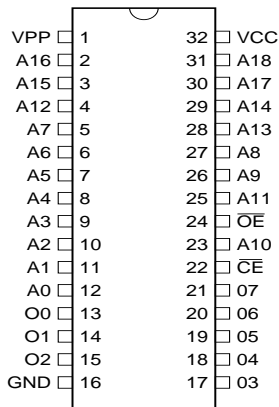
## Description

The AT27C040 chip is a low-power, high-performance, 4,194,304-bit one-time programmable read-only memory (OTP EPROM) organized as 512K by 8 bits. The AT27C040 requires only one 5V power supply in normal read mode operation. Any byte can be accessed in less than 70 ns, eliminating the need for speed reducing WAIT states on high-performance microprocessor systems.

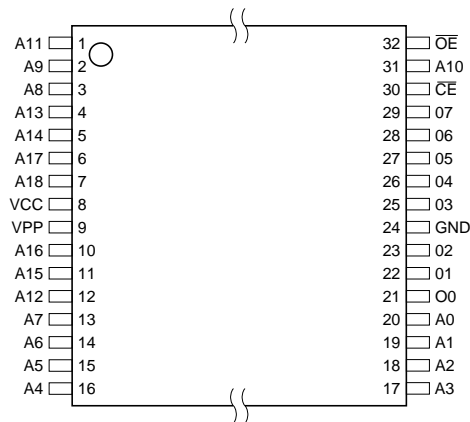
## Pin Configurations

| Pin Name        | Function      |
|-----------------|---------------|
| A0 - A18        | Addresses     |
| O0 - O7         | Outputs       |
| $\overline{CE}$ | Chip Enable   |
| $\overline{OE}$ | Output Enable |

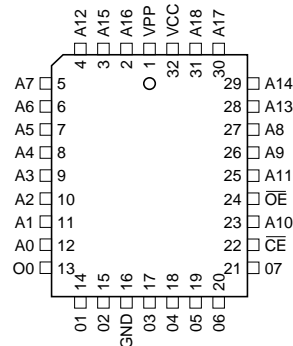
PDIP Top View



TSOP Top View



PLCC Top View



## 4-Megabit (512K x 8) OTP EPROM

## AT27C040





Atmel's scaled CMOS technology provides low active power consumption, and fast programming. Power consumption is typically 8 mA in active mode and less than 10  $\mu$ A in standby mode.

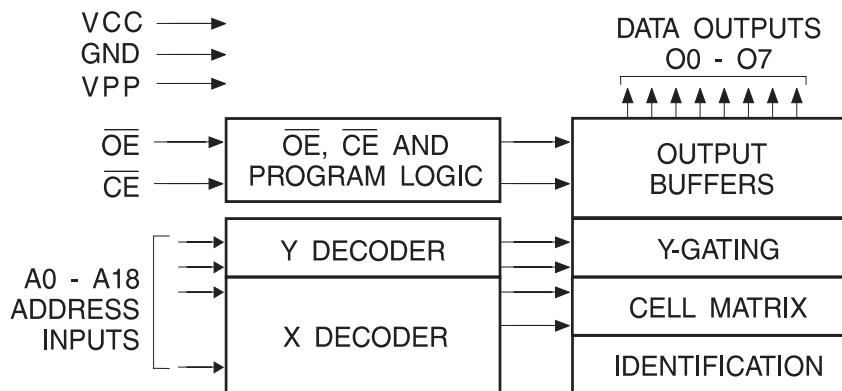
The AT27C040 is available in a choice of industry standard JEDEC-approved one-time programmable (OTP) plastic PDIP, PLCC and TSOP packages. The device features two-line control ( $\overline{CE}$ ,  $\overline{OE}$ ) to eliminate bus contention in high-speed systems.

Atmel's AT27C040 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  $\mu$ 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.

## Switching 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 datasheet limits, resulting in device non-conformance. At a minimum, a 0.1  $\mu$ 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  $\mu$ 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



## Operating Modes

| Mode/Pin                              | $\overline{CE}$ | $\overline{OE}$ | Ai  | V <sub>PP</sub>  | Outputs             |
|---------------------------------------|-----------------|-----------------|---|------------------|---------------------|
| Read                                  | V <sub>IL</sub> | V <sub>IL</sub> | Ai  | X <sup>(1)</sup> | D <sub>OUT</sub>    |
| Output Disable                        | X               | V <sub>IH</sub> | X   | X                | High Z              |
| Standby                               | V <sub>IH</sub> | X               | X   | X                | High Z              |
| Rapid Program <sup>(2)</sup>          | V <sub>IL</sub> | V <sub>IH</sub> | Ai  | V <sub>PP</sub>  | D <sub>IN</sub>     |
| PGM Verify                            | X               | V <sub>IL</sub> | Ai  | V <sub>PP</sub>  | D <sub>OUT</sub>    |
| PGM Inhibit                           | V <sub>IH</sub> | V <sub>IH</sub> | X   | V <sub>PP</sub>  | High Z              |
| Product Identification <sup>(4)</sup> | V <sub>IL</sub> | V <sub>IL</sub> | A9 = V <sub>H</sub> <sup>(3)</sup><br>A0 = V <sub>IH</sub> or V <sub>IL</sub><br>A1 - A18 = V <sub>IL</sub> | X                | Identification Code |

- Notes:
1. X can be V<sub>IL</sub> or V<sub>IH</sub>.
  2. Refer to Programming Characteristics
  3. V<sub>H</sub> = 12.0 ± 0.5V.
  4. Two identifier bytes may be selected. All Ai inputs are held low (V<sub>IL</sub>), except A9 which is set to V<sub>H</sub> and A0 which is toggled low (V<sub>IL</sub>) to select the Manufacturer's Identification byte and high (V<sub>IH</sub>) to select the Device Code byte.

## Absolute Maximum Ratings\*

|   |                 |
|---|-----------------|
| Temperature Under Bias.....                                   | -55°C to +125°C |
| Storage Temperature.....                                      | -65°C to +150°C |
| Voltage on Any Pin with<br>Respect to Ground.....             | -2.0V to +7.0V  |
| Voltage on A9 with<br>Respect to Ground.....                  | -2.0V to +14.0V |
| V <sub>PP</sub> Supply Voltage with<br>Respect to Ground..... | -2.0V to +14.0V |

\*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.



## DC and AC Operating Conditions for Read Operation

|                              |      | AT27C040-70  | AT27C040-90  | AT27C040-12  | AT27C040-15  |
|------------------------------|------|--------------|--------------|--------------|--------------|
| 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%     |

## DC and Operating Characteristics for Read Operation

| Symbol                          | Parameter   | Condition   | Min  | Max                   | Units |
|---------------------------------|---|---|------|-----------------------|-------|
| I <sub>LI</sub>                 | Input Load Current                                  | V <sub>IN</sub> = 0V to V <sub>CC</sub>                                 |      | ±1                    | μA    |
| I <sub>LO</sub>                 | Output Leakage Current                              | V <sub>OUT</sub> = 0V to V <sub>CC</sub>                                |      | ±5                    | μA    |
| I <sub>PP1</sub> <sup>(2)</sup> | V <sub>PP</sub> <sup>(1)</sup> Read/Standby Current | V <sub>PP</sub> = V <sub>CC</sub>                                       |      | 10                    | μA    |
| I <sub>SB</sub>                 | V <sub>CC1</sub> <sup>(1)</sup> Standby Current     | I <sub>SB1</sub> (CMOS), $\overline{CE} = V_{CC} \pm 0.3V$              |      | 100                   | μA    |
|                                 |   | I <sub>SB2</sub> (TTL), $\overline{CE} = 2.0$ to V <sub>CC</sub> + 0.5V |      | 1                     | mA    |
| I <sub>CC</sub>                 | V <sub>CC</sub> Active Current                      | f = 5 MHz, I <sub>OUT</sub> = 0 mA, $\overline{CE} = V_{IL}$            |      | 30                    | mA    |
| V <sub>IL</sub>                 | Input Low Voltage                                   |   | -0.6 | 0.8                   | V     |
| V <sub>IH</sub>                 | Input High Voltage                                  |   | 2.0  | V <sub>CC</sub> + 0.5 | V     |
| V <sub>OL</sub>                 | Output Low Voltage                                  | I <sub>OL</sub> = 2.1 mA  |      | 0.4                   | V     |
| V <sub>OH</sub>                 | Output High Voltage                                 | I <sub>OH</sub> = -400 μA   | 2.4  |                       | V     |

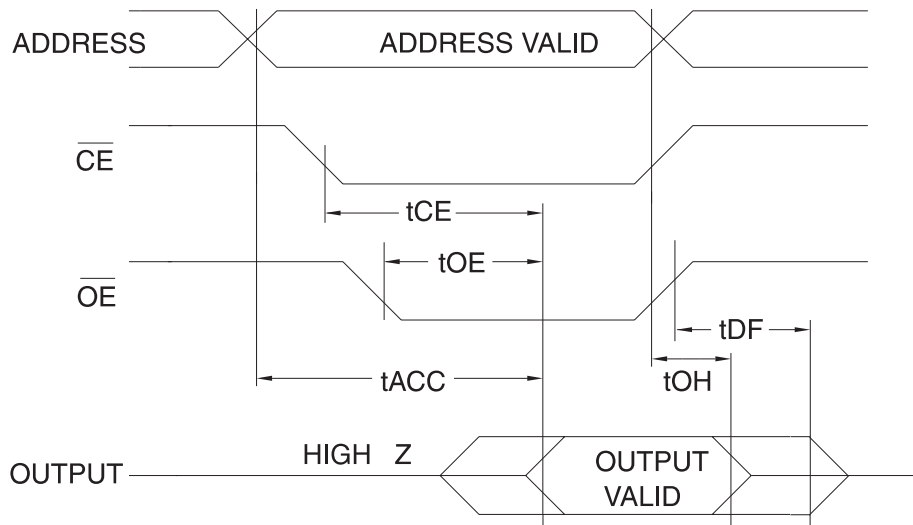
- Notes: 1. V<sub>CC</sub> must be applied simultaneously or before V<sub>PP</sub> and removed simultaneously or after V<sub>PP</sub>  
 2. V<sub>PP</sub> may be connected directly to V<sub>CC</sub>, except during programming. The supply current would then be the sum of I<sub>CC</sub> and I<sub>PP</sub>

## AC Characteristics for Read Operation

| Symbol                            | Parameter   | Condition                                | AT27C040 |     |     |     |     |     |     |     | Units |
|-----------------------------------|---|--|----------|-----|-----|-----|-----|-----|-----|-----|-------|
|                                   |   |  | -70      |     | -90 |     | -12 |     | -15 |     |       |
|                                   |   |  | Min      | Max | Min | Max | Min | Max | Min | Max |       |
| t <sub>ACC</sub> <sup>(3)</sup>   | Address to Output Delay   | $\overline{CE} = \overline{OE} = V_{IL}$ |          | 70  |     | 90  |     | 120 |     | 150 | ns    |
| t <sub>CE</sub> <sup>(2)</sup>    | $\overline{CE}$ to Output Delay   | $\overline{OE} = V_{IL}$                 |          | 70  |     | 90  |     | 120 |     | 150 | ns    |
| t <sub>OE</sub> <sup>(2)(3)</sup> | $\overline{OE}$ to Output Delay   | $\overline{CE} = V_{IL}$                 |          | 30  |     | 35  |     | 35  |     | 40  | ns    |
| t <sub>DF</sub> <sup>(4)(5)</sup> | $\overline{OE}$ or $\overline{CE}$ High to Output Float, whichever occurred first       |  |          | 20  |     | 20  |     | 30  |     | 30  | ns    |
| t <sub>OH</sub>                   | Output Hold from Address, $\overline{CE}$ or $\overline{OE}$ , whichever occurred first |  | 0        |     | 0   |     | 0   |     | 0   |     | ns    |

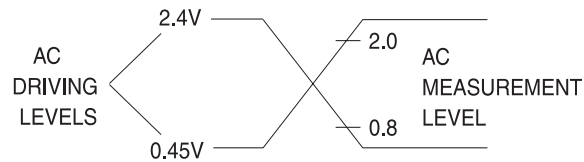
- Note: 1. 2, 3, 4, 5 – see AC Waveforms for Read Operation

## AC Waveforms for Read Operation<sup>(1)</sup>

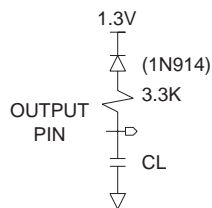


- Notes:
1. Timing measurement references are 0.8V and 2.0V. Input AC drive levels are 0.45V and 2.4V, unless otherwise specified.
  2.  $\overline{OE}$  may be delayed up to  $t_{CE} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{CE}$ .
  3.  $\overline{OE}$  may be delayed 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



## Output Test Load



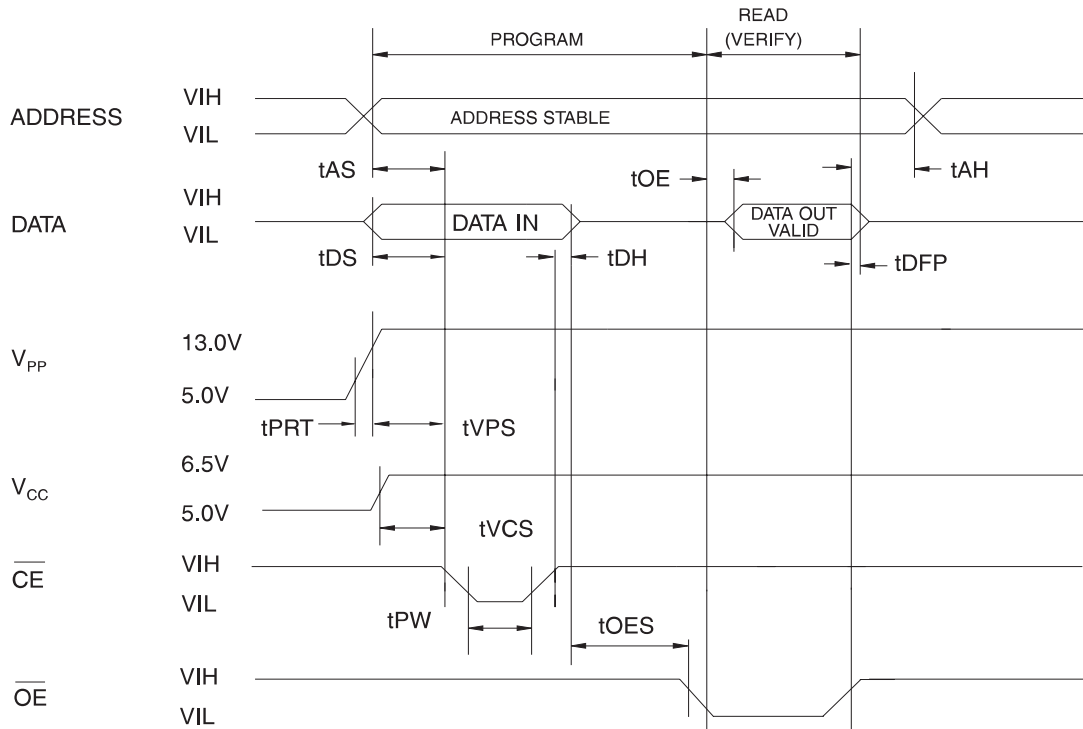
## Pin Capacitance

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

| Symbol    | Typ | Max | Units | Conditions     |
|-----------|-----|-----|-------|----------------|
| $C_{IN}$  | 4   | 8   | 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<sup>(1)</sup>



- Notes:
1. The Input Timing Reference is 0.8V for V<sub>IL</sub> and 2.0V for V<sub>IH</sub>.
  2. t<sub>OE</sub> and t<sub>DFP</sub> are characteristics of the device but must be accommodated by the programmer.
  3. When programming the AT27C040 a 0.1 μF capacitor is required across V<sub>PP</sub> and ground to suppress spurious voltage transients.

## DC Programming Characteristics

T<sub>A</sub> = 25 ± 5°C, V<sub>CC</sub> = 6.5 ± 0.25V, V<sub>PP</sub> = 13.0 ± 0.25V

| Symbol           | Parameter   | Test Conditions                                     | Limits |                       | Units |
|------------------|---|---|--------|-----------------------|-------|
|                  |   |   | Min    | Max                   |       |
| I <sub>LI</sub>  | Input Load Current                                  | V <sub>IN</sub> = V <sub>IL</sub> , V <sub>IH</sub> |        | ±10                   | μA    |
| V <sub>IL</sub>  | Input Low Level                                     |   | -0.6   | 0.8                   | V     |
| V <sub>IH</sub>  | Input High Level                                    |   | 2.0    | V <sub>CC</sub> + 0.7 | V     |
| V <sub>OL</sub>  | Output Low Voltage                                  | I <sub>OL</sub> = 2.1 mA                            |        | 0.4                   | V     |
| V <sub>OH</sub>  | Output High Voltage                                 | I <sub>OH</sub> = -400 μA                           | 2.4    |                       | V     |
| I <sub>CC2</sub> | V <sub>CC</sub> Supply Current (Program and Verify) |   |        | 40                    | mA    |
| I <sub>PP2</sub> | V <sub>PP</sub> Supply Current                      | $\overline{CE} = V_{IL}$                            |        | 20                    | mA    |
| V <sub>ID</sub>  | A9 Product Identification Voltage                   |   | 11.5   | 12.5                  | V     |

## AC Programming Characteristics

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

| Symbol    | Parameter   | Test Conditions <sup>(1)</sup>                   | Limits |     | Units         |
|-----------|---|--|--------|-----|---------------|
|           |   |  | Min    | Max |               |
| $t_{AS}$  | Address Setup Time  | Input Rise and Fall Times:<br>(10% to 90%) 20 ns | 2      |     | $\mu\text{s}$ |
| $t_{OES}$ | $\overline{OE}$ Setup Time                                |  | 2      |     | $\mu\text{s}$ |
| $t_{DS}$  | Data Setup Time   | Input Pulse Levels:<br>0.45V to 2.4V             | 2      |     | $\mu\text{s}$ |
| $t_{AH}$  | Address Hold Time   |  | 0      |     | $\mu\text{s}$ |
| $t_{DH}$  | Data Hold Time  | Input Timing Reference Level:<br>0.8V to 2.0V    | 2      |     | $\mu\text{s}$ |
| $t_{DFP}$ | $\overline{OE}$ High to Output Float Delay <sup>(2)</sup> |  | 0      | 130 | ns            |
| $t_{VPS}$ | $V_{PP}$ Setup Time                                       | Output Timing Reference Level:<br>0.8V to 2.0V   | 2      |     | $\mu\text{s}$ |
| $t_{VCS}$ | $V_{CC}$ Setup Time                                       |  | 2      |     | $\mu\text{s}$ |
| $t_{PW}$  | $\overline{CE}$ Program Pulse Width <sup>(3)</sup>        |  | 95     | 105 | $\mu\text{s}$ |
| $t_{OE}$  | Data Valid from $\overline{OE}$ <sup>(2)</sup>            |  |        | 150 | ns            |
| $t_{PRT}$ | $V_{PP}$ Pulse Rise Time During Programming               |  | 50     |     | ns            |

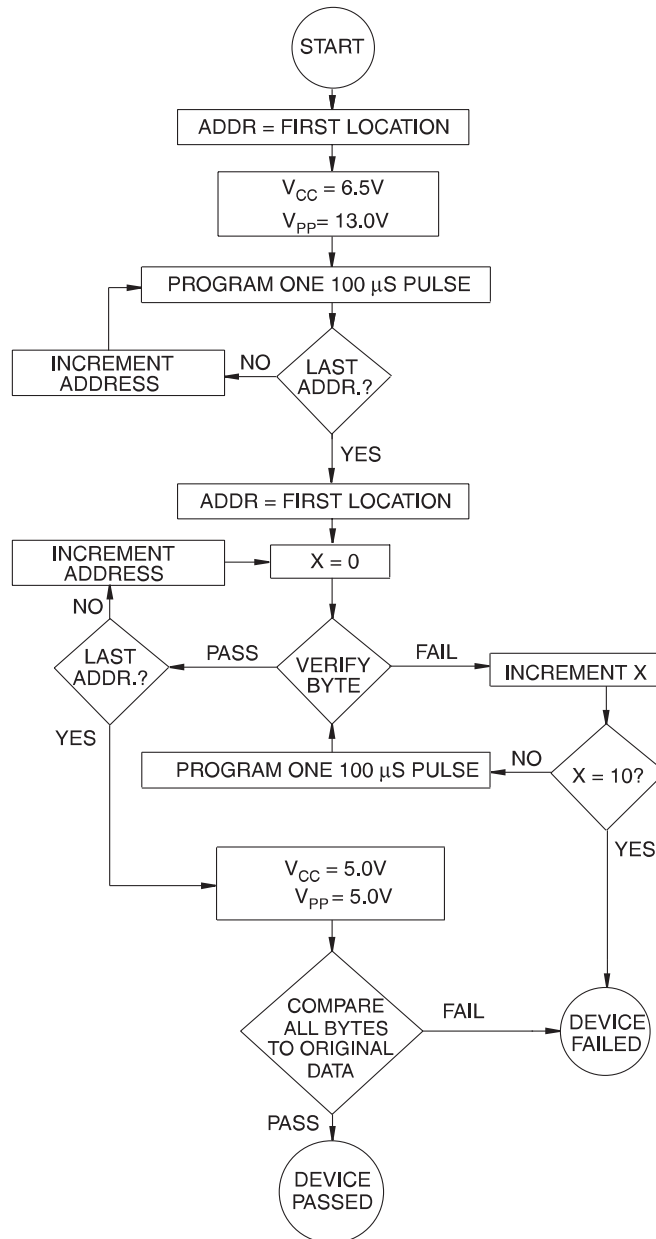
- Notes:
- $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$ .
  - This parameter is only sampled and is not 100% tested. Output Float is defined as the point where data is no longer driven – see timing diagram.
  - Program Pulse width tolerance is  $100 \mu\text{sec} \pm 5\%$ .

## Atmel's AT27C040 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  | 0  | 1  | 1  | 0B       |

## Rapid Programming Algorithm

A  $100\ \mu\text{s}$   $\overline{\text{CE}}$  pulse width is used to program. The address is set to the first location.  $V_{\text{CC}}$  is raised to 6.5V and  $V_{\text{PP}}$  is raised to 13.0V. Each address is first programmed with one  $100\ \mu\text{s}$   $\overline{\text{CE}}$  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  $100\ \mu\text{s}$  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.  $V_{\text{PP}}$  is then lowered to 5.0V and  $V_{\text{CC}}$  to 5.0V. All bytes are read again and compared with the original data to determine if the device passes or fails.





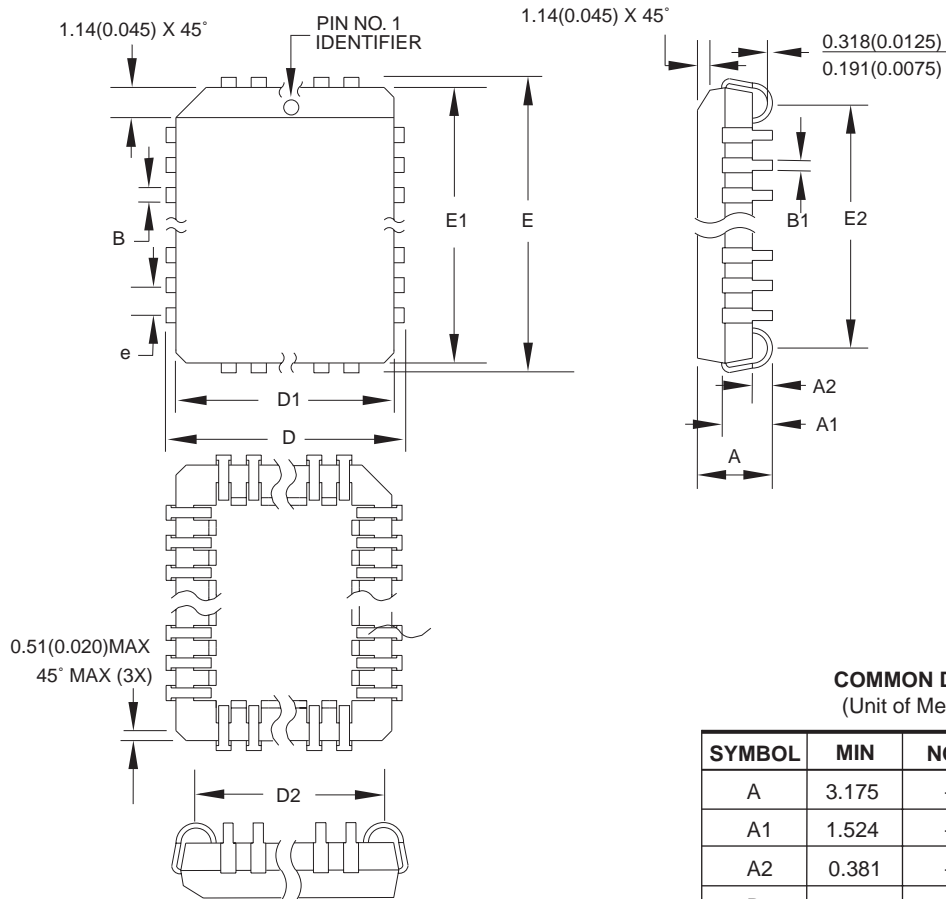
## Ordering Information

| $t_{ACC}$ (ns) | $I_{CC}$ (mA) |         | Ordering Code                                   | Package            | Operation Range                 |
|----------------|---------------|---------|---|--------------------|---------------------------------|
|                | Active        | Standby |   |                    |                                 |
| 70             | 30            | 0.1     | AT27C040-70JC<br>AT27C040-70PC<br>AT27C040-70TC | 32J<br>32P6<br>32T | Commercial<br>(0° C to 70° C)   |
|                | 30            | 0.1     | AT27C040-70JI<br>AT27C040-70PI<br>AT27C040-70TI | 32J<br>32P6<br>32T | Industrial<br>(-40° C to 85° C) |
| 90             | 30            | 0.1     | AT27C040-90JC<br>AT27C040-90PC<br>AT27C040-90TC | 32J<br>32P6<br>32T | Commercial<br>(0° C to 70° C)   |
|                | 30            | 0.1     | AT27C040-90JI<br>AT27C040-90PI<br>AT27C040-90TI | 32J<br>32P6<br>32T | Industrial<br>(-40° C to 85° C) |
| 120            | 30            | 0.1     | AT27C040-12JC<br>AT27C040-12PC<br>AT27C040-12TC | 32J<br>32P6<br>32T | Commercial<br>(0° C to 70° C)   |
|                | 30            | 0.1     | AT27C040-12JI<br>AT27C040-12PI<br>AT27C040-12TI | 32J<br>32P6<br>32T | Industrial<br>(-40° C to 85° C) |
| 150            | 30            | 0.1     | AT27C040-15JC<br>AT27C040-15PC<br>AT27C040-15TC | 32J<br>32P6<br>32T | Commercial<br>(0° C to 70° C)   |
|                | 30            | 0.1     | AT27C040-15JI<br>AT27C040-15PI<br>AT27C040-15TI | 32J<br>32P6<br>32T | Industrial<br>(-40° C to 85° C) |

| Package Type |  |
|--------------|--|
| <b>32J</b>   | 32-lead, Plastic J-leaded Chip Carrier (PLCC)            |
| <b>32P6</b>  | 32-lead, 0.600" Wide, Plastic Dual Inline Package (PDIP) |
| <b>32T</b>   | 32-lead, Plastic Thin Small Outline Package (TSOP)       |

# Package Information

## 32J – PLCC



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

| SYMBOL | MIN       | NOM | MAX    | NOTE   |
|--------|-----------|-----|--------|--------|
| A      | 3.175     | –   | 3.556  |        |
| A1     | 1.524     | –   | 2.413  |        |
| A2     | 0.381     | –   | –      |        |
| D      | 12.319    | –   | 12.573 |        |
| D1     | 11.354    | –   | 11.506 | Note 2 |
| D2     | 9.906     | –   | 10.922 |        |
| E      | 14.859    | –   | 15.113 |        |
| E1     | 13.894    | –   | 14.046 | Note 2 |
| E2     | 12.471    | –   | 13.487 |        |
| B      | 0.660     | –   | 0.813  |        |
| B1     | 0.330     | –   | 0.533  |        |
| e      | 1.270 TYP |     |        |        |

- Notes:
1. This package conforms to JEDEC reference MS-016, Variation AE.
  2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is .010" (0.254 mm) per side. Dimension D1 and E1 include mold mismatch and are measured at the extreme material condition at the upper or lower parting line.
  3. Lead coplanarity is 0.004" (0.102 mm) maximum.

10/04/01



2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**

**32J, 32-lead, Plastic J-leaded Chip Carrier (PLCC)**

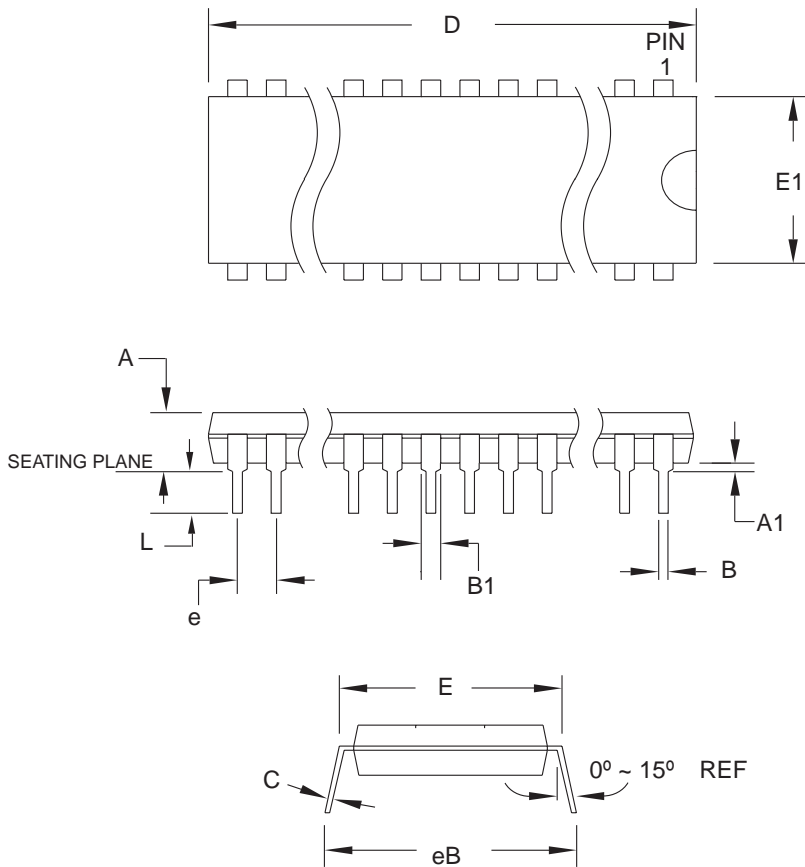
**DRAWING NO.**

32J

**REV.**

B

## 32P6 – PDIP



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

| SYMBOL | MIN       | NOM | MAX    | NOTE   |
|--------|-----------|-----|--------|--------|
| A      | –         | –   | 4.826  |        |
| A1     | 0.381     | –   | –      |        |
| D      | 41.783    | –   | 42.291 | Note 1 |
| E      | 15.240    | –   | 15.875 |        |
| E1     | 13.462    | –   | 13.970 | Note 1 |
| B      | 0.356     | –   | 0.559  |        |
| B1     | 1.041     | –   | 1.651  |        |
| L      | 3.048     | –   | 3.556  |        |
| C      | 0.203     | –   | 0.381  |        |
| eB     | 15.494    | –   | 17.526 |        |
| e      | 2.540 TYP |     |        |        |

Note: 1. Dimensions D and E1 do not include mold Flash or Protrusion.  
Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

09/28/01



2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**

**32P6**, 32-lead (0.600"/15.24 mm Wide) Plastic Dual  
Inline Package (PDIP)

**DRAWING NO.**

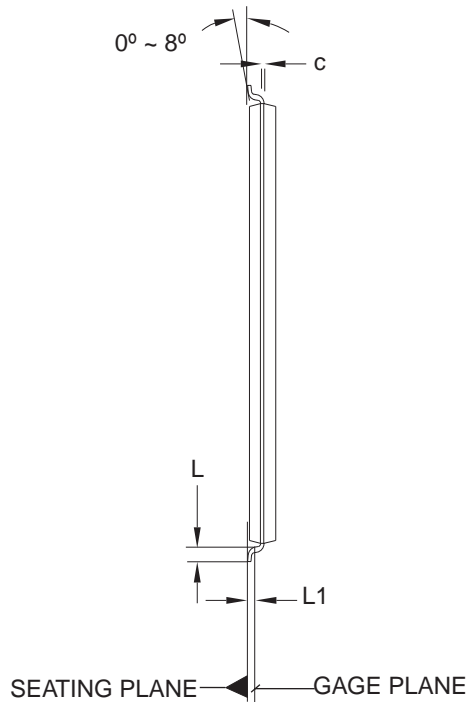
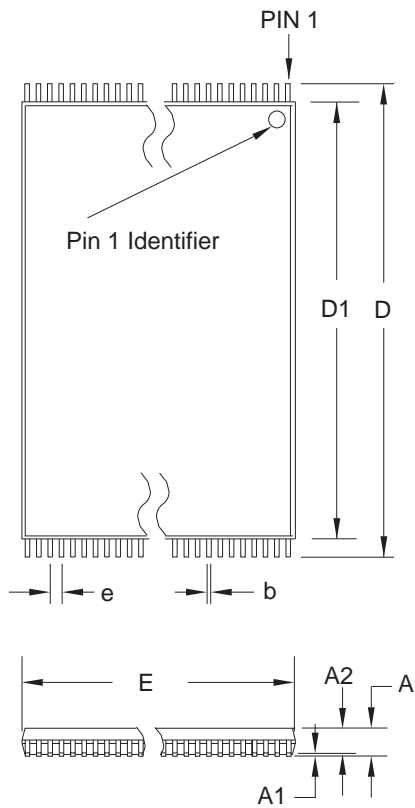
32P6

**REV.**

B



### 32T – TSOP



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

| SYMBOL | MIN        | NOM   | MAX   | NOTE   |
|--------|------------|-------|-------|--------|
| A      | –          | –     | 1.20  |        |
| A1     | 0.05       | –     | 0.15  |        |
| A2     | 0.95       | 1.00  | 1.05  |        |
| D      | 19.80      | 20.00 | 20.20 |        |
| D1     | 18.30      | 18.40 | 18.50 | Note 2 |
| E      | 7.90       | 8.00  | 8.10  | Note 2 |
| L      | 0.50       | 0.60  | 0.70  |        |
| L1     | 0.25 BASIC |       |       |        |
| b      | 0.17       | 0.22  | 0.27  |        |
| c      | 0.10       | –     | 0.21  |        |
| e      | 0.50 BASIC |       |       |        |

- Notes:
1. This package conforms to JEDEC reference MO-142, Variation BD.
  2. Dimensions D1 and E do not include mold protrusion. Allowable protrusion on E is 0.15 mm per side and on D1 is 0.25 mm per side.
  3. Lead coplanarity is 0.10 mm maximum.

10/18/01



2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**

**32T**, 32-lead (8 x 20 mm Package) Plastic Thin Small Outline Package, Type I (TSOP)

**DRAWING NO.**

32T

**REV.**

B



## Atmel Corporation

2325 Orchard Parkway  
San Jose, CA 95131  
Tel: 1(408) 441-0311  
Fax: 1(408) 487-2600

## Regional Headquarters

### Europe

Atmel Sarl  
Route des Arsenalux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
Tel: (41) 26-426-5555  
Fax: (41) 26-426-5500

### Asia

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimshatsui  
East Kowloon  
Hong Kong  
Tel: (852) 2721-9778  
Fax: (852) 2722-1369

### Japan

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
Tel: (81) 3-3523-3551  
Fax: (81) 3-3523-7581

## Atmel Operations

### Memory

2325 Orchard Parkway  
San Jose, CA 95131  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

### Microcontrollers

2325 Orchard Parkway  
San Jose, CA 95131  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

### La Chantrierie

BP 70602  
44306 Nantes Cedex 3, France  
Tel: (33) 2-40-18-18-18  
Fax: (33) 2-40-18-19-60

### ASIC/ASSP/Smart Cards

Zone Industrielle  
13106 Rousset Cedex, France  
Tel: (33) 4-42-53-60-00  
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
Tel: (44) 1355-803-000  
Fax: (44) 1355-242-743

### RF/Automotive

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
Tel: (49) 71-31-67-0  
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

### Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
Tel: (33) 4-76-58-30-00  
Fax: (33) 4-76-58-34-80

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### e-mail

[literature@atmel.com](mailto:literature@atmel.com)

### Web Site

<http://www.atmel.com>

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