

## Features

- Fast read access time – 70ns
- Low-power CMOS operation
  - 100µA max standby
  - 30mA max active at 5MHz
- JEDEC standard packages
  - 32-lead PDIP
  - 32-lead PLCC
- 5V ± 10% supply
- High-reliability CMOS technology
  - 2000V ESD protection
  - 200mA latchup immunity
- Rapid programming algorithm – 100µs/byte (typical)
- CMOS- and TTL-compatible inputs and outputs
- Industrial temperature range
- Green (Pb/halide-free) packaging option

## 1. Description

The Atmel® AT27C040 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 70ns, eliminating the need for speed reducing wait states on high-performance microprocessor systems.

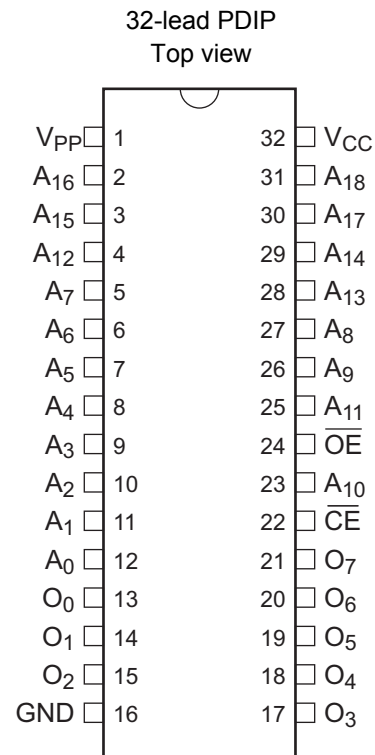
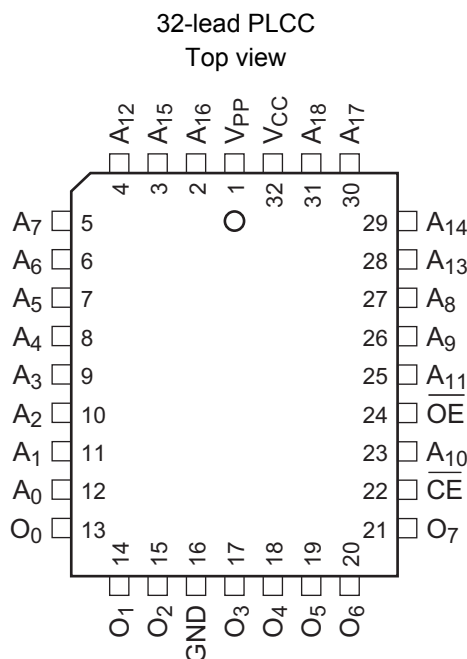
The Atmel scaled CMOS technology provides low active power consumption and fast programming. Power consumption is typically 8mA in active mode and less than 10µA in standby mode.

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

The 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 100µs/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.

## 2. Pin Configurations and Pinouts

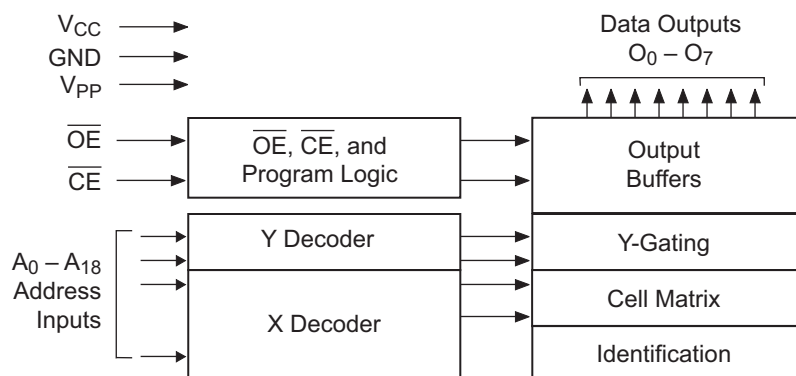
| Pin Name                         | Function             |
|----------------------------------|----------------------|
| V <sub>PP</sub>                  | Peak to Peak Voltage |
| A <sub>0</sub> - A <sub>18</sub> | Address Inputs       |
| O <sub>0</sub> - O <sub>7</sub>  | Outputs              |
| GND                              | Ground               |
| $\overline{\text{CE}}$           | Chip Enable          |
| $\overline{\text{OE}}$           | Output Enable        |
| V <sub>CC</sub>                  | Device Power Supply  |



## 3. Switching Considerations

Switching between active and standby conditions via the Chip Enable ( $\overline{\text{CE}}$ ) pin may produce transient voltage excursions. Unless accommodated by the system design, these transients may exceed datasheet limits, resulting in device nonconformance. At a minimum, a 0.1  $\mu\text{F}$ , high-frequency, low inherent inductance, ceramic capacitor should be utilized for each device. This capacitor should be connected between the V<sub>CC</sub> 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  $\mu\text{F}$  bulk electrolytic capacitor should be utilized, again connected between the V<sub>CC</sub> and ground terminals. This capacitor should be positioned as close as possible to the point where the power supply is connected to the array.

## 4. Block Diagram



## 5. 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

Voltage on A<sub>9</sub> with respect to ground . . . . . -2.0V to +14.0V

V<sub>PP</sub> supply voltage with 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.

## 6. Electrical Characteristics

### 6.1 DC and AC characteristics

Table 6-1. 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> | A <sub>9</sub> = V <sub>H</sub> <sup>(3)</sup><br>A <sub>0</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>A <sub>1</sub> – A <sub>18</sub> = 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 A<sub>9</sub>, which is set to V<sub>H</sub>, and A<sub>0</sub>, 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.

## 6.2 DC and AC Operating Conditions for Read Operation

|                                         | Atmel AT27C040-70 | Atmel AT27C040-90 |
|-----------------------------------------|-------------------|-------------------|
| Industrial Operating Temperature (Case) | -40°C to 85°C     | -40°C to 85°C     |
| V <sub>CC</sub> Power Supply            | 5V ± 10%          | 5V ± 10%          |

## 6.3 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 = 5MHz, I <sub>OUT</sub> = 0mA, $\overline{CE} = V_{IL}$              |      | 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> = 2.1mA                                                 |      | 0.4                   | V     |
| V <sub>OH</sub>                 | Output High Voltage                                 | I <sub>OH</sub> = -400μA                                                | 2.4  |                       | V     |

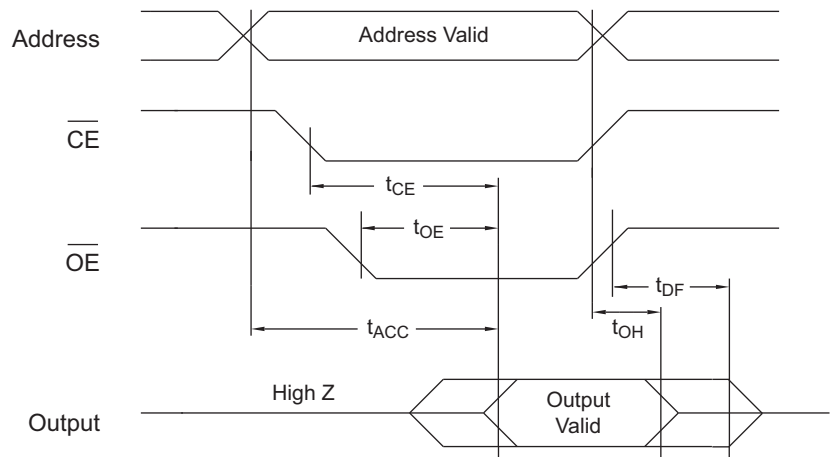
- Notes: 1. V<sub>CC</sub> must be applied simultaneously with or before V<sub>PP</sub>, and removed simultaneously with or after V<sub>PP</sub>.  
2. V<sub>PP</sub> may be connected directly to V<sub>CC</sub>, except during programming. The supply current would then be the sum of I<sub>CC</sub> and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

## 6.4 AC Characteristics for Read Operation

| Symbol                          | Parameter                                                                                | Condition                                            | Atmel AT27C040 |     |     |     | Units |
|---------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------|----------------|-----|-----|-----|-------|
|                                 |                                                                                          |                                                      | -70            |     | -90 |     |       |
|                                 |                                                                                          |                                                      | Min            | Max | Min | Max |       |
| t <sub>ACC</sub> <sup>(1)</sup> | Address to Output Delay                                                                  | $\overline{CE} = \overline{OE}$<br>= V <sub>IL</sub> |                | 70  |     | 90  | ns    |
| t <sub>CE</sub> <sup>(1)</sup>  | $\overline{CE}$ to Output Delay                                                          | $\overline{OE} = V_{IL}$                             |                | 70  |     | 90  | ns    |
| t <sub>OE</sub> <sup>(1)</sup>  | $\overline{OE}$ to Output Delay                                                          | $\overline{CE} = V_{IL}$                             |                | 30  |     | 35  | ns    |
| t <sub>DF</sub> <sup>(1)</sup>  | $\overline{OE}$ or $\overline{CE}$ High to Output Float; whichever occurred first.       |                                                      |                | 20  |     | 20  | ns    |
| t <sub>OH</sub>                 | Output Hold from Address, $\overline{CE}$ or $\overline{OE}$ ; whichever occurred first. |                                                      | 0              |     | 0   |     | ns    |

- Note: 1. See AC waveforms for read operation.

Figure 6-1. 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.

Figure 6-2. Input Test Waveforms and Measurement Levels

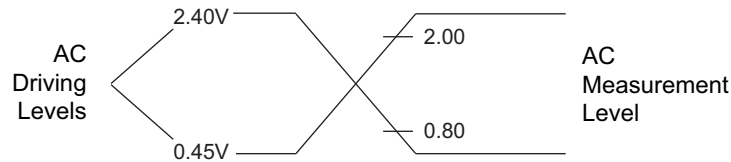


Figure 6-3. Output Test Load

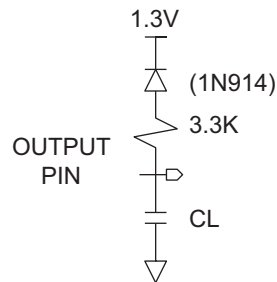


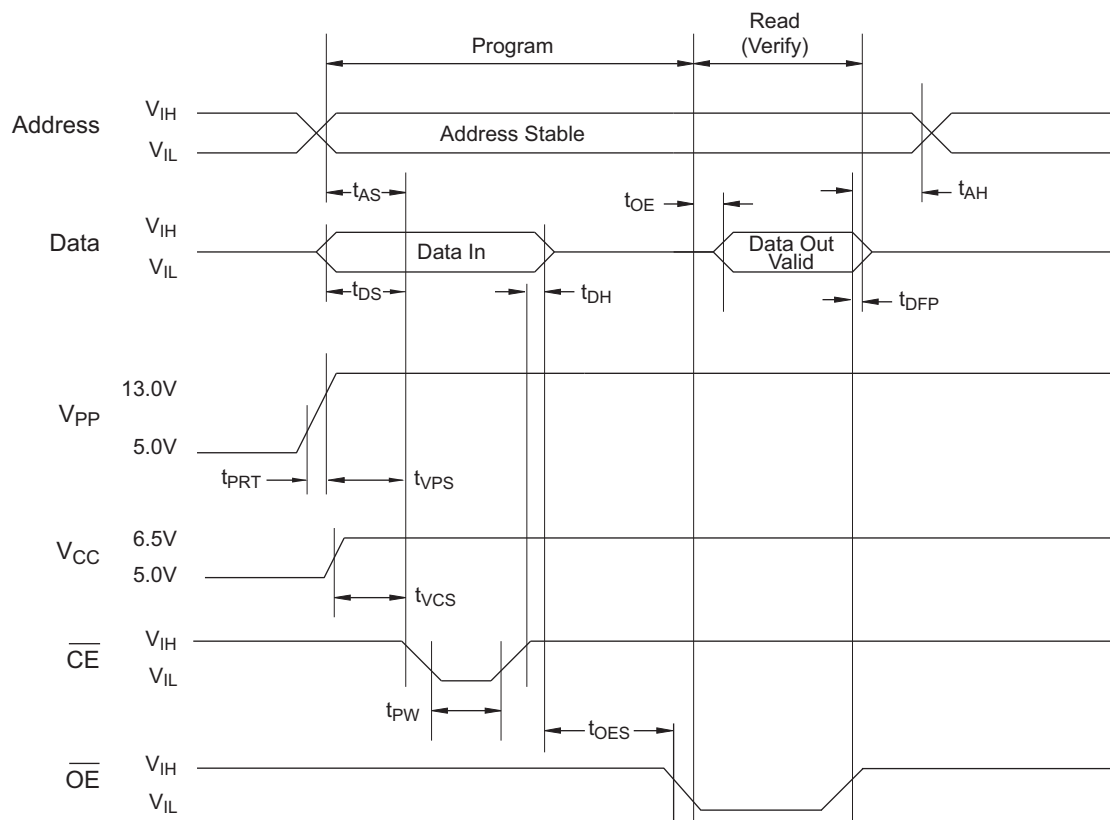
Table 6-2. Pin Capacitance

f = 1MHz, T = 25°C<sup>(1)</sup>

| Symbol           | Typ | Max | Units | Conditions            |
|------------------|-----|-----|-------|-----------------------|
| C <sub>IN</sub>  | 4   | 8   | pF    | V <sub>IN</sub> = 0V  |
| C <sub>OUT</sub> | 8   | 12  | pF    | V <sub>OUT</sub> = 0V |

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

**Figure 6-4. Programming Waveforms<sup>(1)</sup>**



- 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.
  3. When programming the AT27C040, a 0.1 $\mu$ F capacitor is required across  $V_{PP}$  and ground to suppress spurious voltage transients.

**Table 6-3. DC 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            | Limits |                | Units         |
|-----------|----------------------------------------------|----------------------------|--------|----------------|---------------|
|           |                                              |                            | Min    | Max            |               |
| $I_{LI}$  | Input Load Current                           | $V_{IN} = V_{IL}, V_{IH}$  |        | $\pm 10$       | $\mu\text{A}$ |
| $V_{IL}$  | Input Low Level                              |                            | -0.6   | 0.8            | V             |
| $V_{IH}$  | Input High Level                             |                            | 2.0    | $V_{CC} + 0.7$ | 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) |                            |        | 40             | mA            |
| $I_{PP2}$ | $V_{PP}$ Supply Current                      | $\overline{CE} = V_{IL}$   |        | 20             | mA            |
| $V_{ID}$  | $A_9$ Product Identification Voltage         |                            | 11.5   | 12.5           | V             |

**Table 6-4. 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%) 20ns | 2      |     | $\mu\text{s}$ |
| $t_{OES}$ | $\overline{OE}$ Setup Time                                |                                                 | 2      |     | $\mu\text{s}$ |
| $t_{DS}$  | Data Setup Time                                           |                                                 | 2      |     | $\mu\text{s}$ |
| $t_{AH}$  | Address Hold Time                                         | Input pulse levels:<br>0.45V to 2.4V            | 0      |     | $\mu\text{s}$ |
| $t_{DH}$  | Data Hold Time                                            |                                                 | 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                                       | Input 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>        | Output timing reference level:<br>0.8V to 2.0V  | 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: 1.  $V_{CC}$  must be applied simultaneously with or before  $V_{PP}$  and removed simultaneously with or after  $V_{PP}$ .  
 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  $100\mu\text{s} \pm 5\%$ .

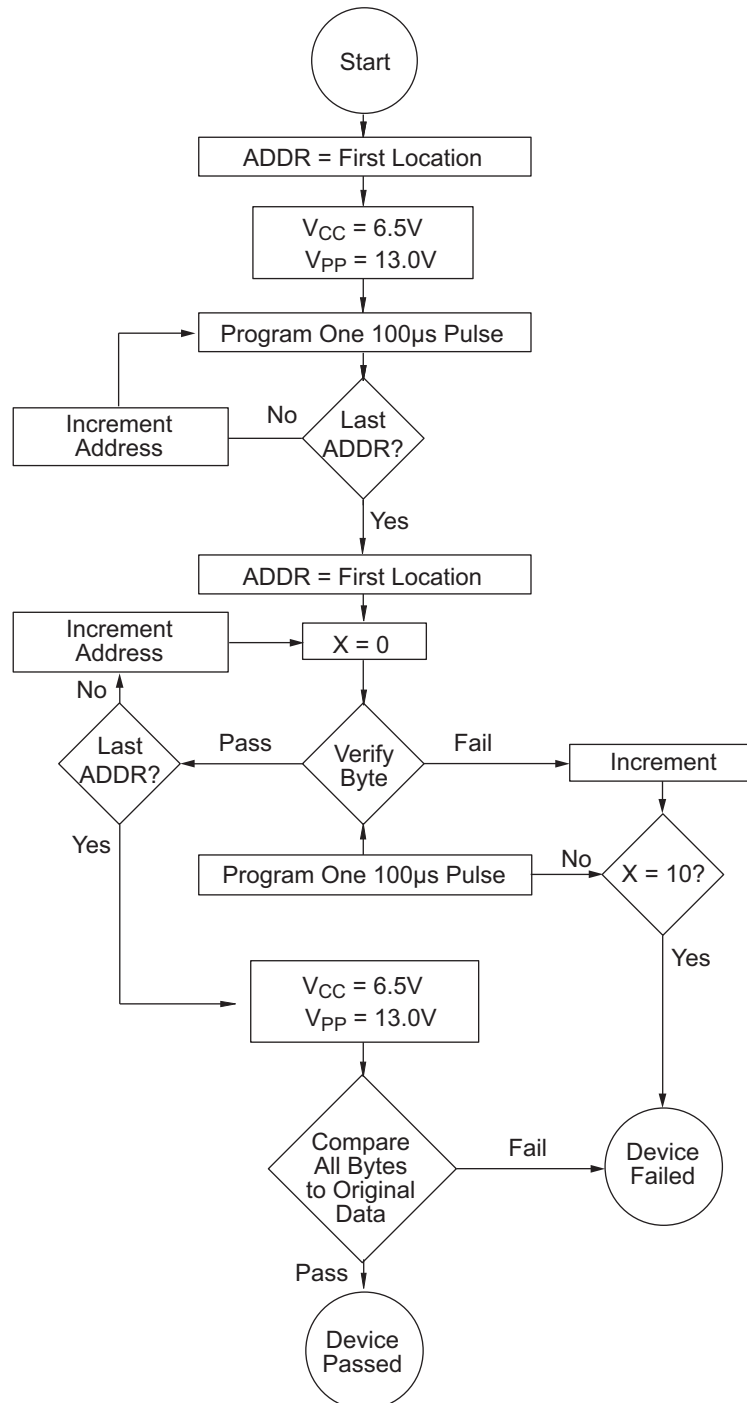
**Table 6-5. Atmel AT27C040 Integrated Product Identification Code**

| Codes        | Pins           |                |                |                |                |                |                |                |                | Hex Data |
|--------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------|
|              | A <sub>0</sub> | O <sub>7</sub> | O <sub>6</sub> | O <sub>5</sub> | O <sub>4</sub> | O <sub>3</sub> | O <sub>2</sub> | O <sub>1</sub> | O <sub>0</sub> |          |
| Manufacturer | 0              | 0              | 0              | 0              | 1              | 1              | 1              | 1              | 0              | 1E       |
| Device Type  | 1              | 0              | 0              | 0              | 0              | 1              | 0              | 1              | 1              | 0B       |

## 7. 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 ten successive  $100\mu\text{s}$  pulses are applied with a verification after each pulse. If the byte fails to verify after ten 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.

Figure 7-1. Rapid Programming Algorithm



## 8. Ordering Information

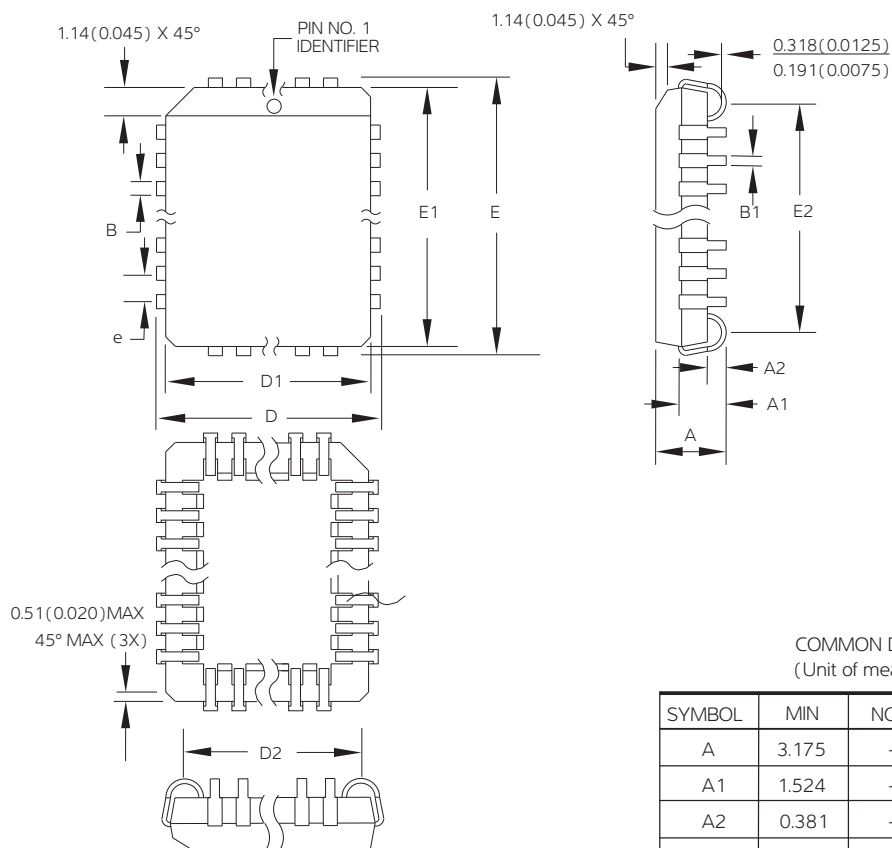
### Green Package Option (Pb/Halide-free)

| Atmel Ordering Code | Package | $t_{ACC}$ (ns) | $I_{CC}$ (mA) |         | Lead Finish | Operation Range               |
|---------------------|---------|----------------|---------------|---------|-------------|-------------------------------|
|                     |         |                | Active        | Standby |             |                               |
| AT27C040-70JU       | 32J     | 70             | 30            | 0.1     | Matte Tin   | Industrial<br>(-40°C to 85°C) |
| AT27C040-70PU       | 32P6    |                |               |         |             |                               |
| AT27C040-90JU       | 32J     | 90             | 30            | 0.1     | Matte Tin   | Industrial<br>(-40°C to 85°C) |
| AT27C040-90PU       | 32P6    |                |               |         |             |                               |

| Package Type |                                                   |
|--------------|---------------------------------------------------|
| 32J          | 32-lead, plastic, J-leaded Chip Carrier (PLCC)    |
| 32P6         | 32-lead, 0.600" wide, plastic, Dual Inline (PDIP) |

## 9. Package information

### 9.1 32J — 32-lead 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" (0.254mm) 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" (0.10mm) maximum.

10/04/01



Package Drawing Contact:  
packagedrawings@atmel.com

TITLE

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

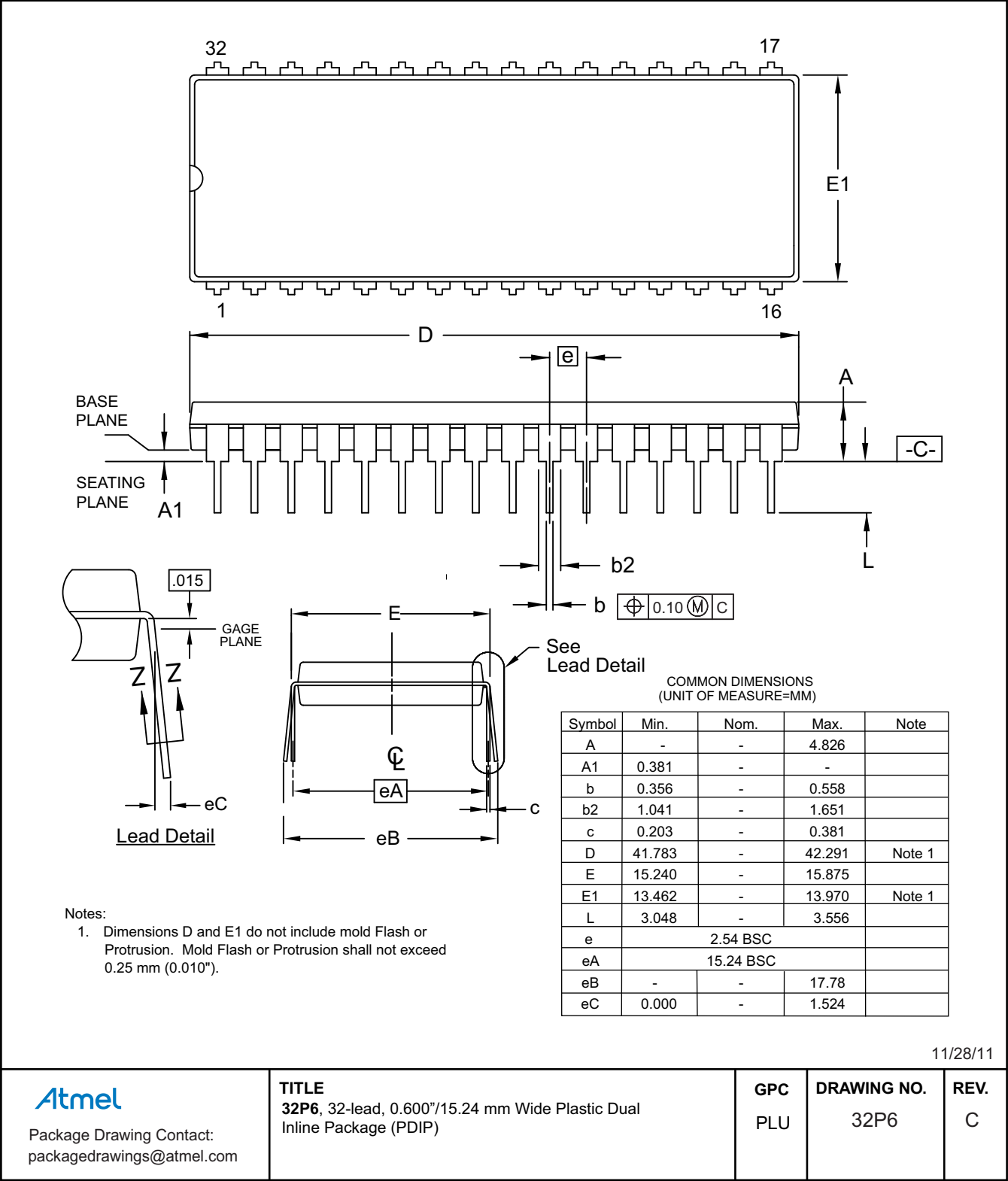
DRAWING NO.

32J

REV.

B

9.2 32P6 — 32-lead PDIP



## 10. Revision History

| Doc. Rev. | Date    | Comments                                                                |
|-----------|---------|-------------------------------------------------------------------------|
| 0189J     | 10/2012 | Update 32P6 package outline drawing.<br>Update template and Atmel logo. |
| 0189I     | 04/2011 | Remove TSOP package.<br>Add lead finish to ordering information.        |
| 0189H     | 12/2007 | Datasheet revision.                                                     |



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