

## Features

- Fast Read Access Time – 55 ns
- Low-power CMOS Operation
  - 100  $\mu$ A Max Standby
  - 25 mA Max Active at 5 MHz
- JEDEC Standard Packages
  - 32-lead PDIP
  - 32-lead PLCC
  - 32-lead TSOP
- 5V  $\pm$  10% Supply
- High-reliability CMOS Technology
  - 2,000V ESD Protection
  - 200 mA Latch-up Immunity
- Rapid Programming Algorithm – 100  $\mu$ s/Byte (Typical)
- CMOS- and TTL-compatible Inputs and Outputs
- Integrated Product Identification Code
- Industrial and Automotive Temperature Ranges
- Green (Pb/Halide-free) Packaging Option

## 1. Description

The AT27C020 is a low-power, high-performance, 2,097,152-bit, one-time programmable read-only memory (OTP EPROM) organized as 256K by 8 bits. It requires only one 5V power supply in normal read mode operation. Any byte can be accessed in less than 55 ns, eliminating the need for speed-reducing WAIT states on high-performance microprocessor systems.

In read mode, the AT27C020 typically consumes 8 mA. Standby mode supply current is typically less than 10  $\mu$ A.

The AT27C020 is available in a choice of industry-standard JEDEC-approved one-time programmable (OTP) plastic PDIP, PLCC and TSOP packages. All devices feature two-line control ( $\overline{\text{CE}}$ ,  $\overline{\text{OE}}$ ) to give designers the flexibility to prevent bus contention.

With 256K bytes storage capability, the AT27C020 allows firmware to be stored reliably and to be accessed by the system without the delays of mass storage media.

Atmel's AT27C020 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.



**2-megabit  
(256K x 8)  
OTP EPROM**

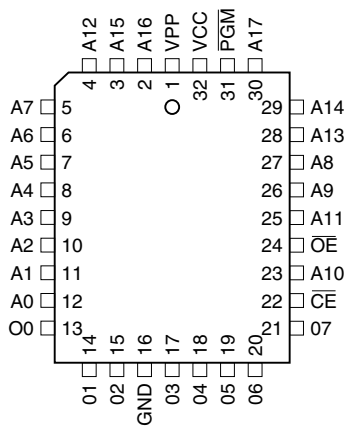
**AT27C020**



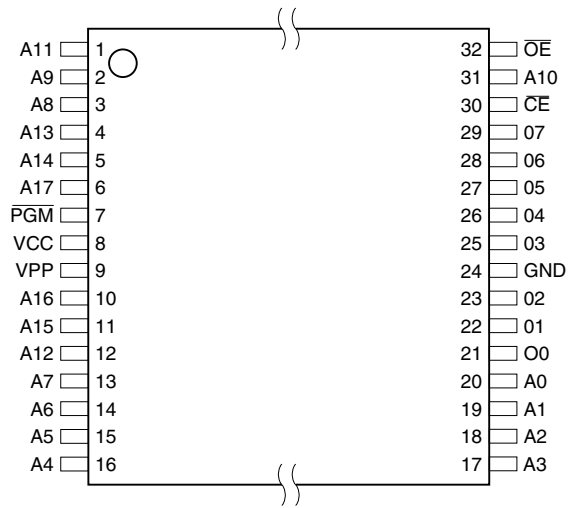
## 2. Pin Configurations

| Pin Name         | Function       |
|------------------|----------------|
| A0 - A17         | Addresses      |
| O0 - O7          | Outputs        |
| $\overline{CE}$  | Chip Enable    |
| $\overline{OE}$  | Output Enable  |
| $\overline{PGM}$ | Program Strobe |

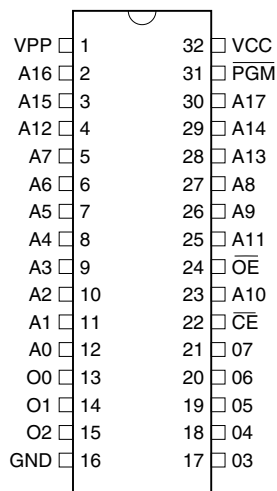
### 2.1 32-lead PLCC Top View



### 2.3 32-lead TSOP (Type 1) Top View



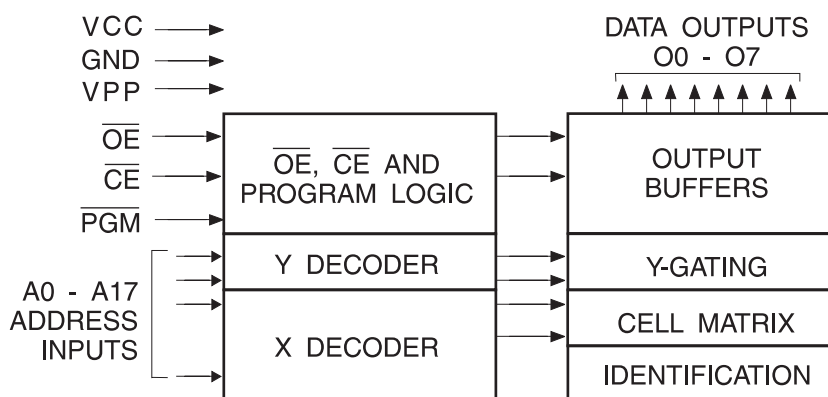
### 2.2 32-lead PDIP Top View



### 3. 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 datasheet limits, resulting in device non-conformance. 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  $V_{CC}$  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  $\mu\text{F}$  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.

### 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<br>Respect to Ground .....      | -2.0V to +7.0V <sup>(1)</sup>  |
| Voltage on A9 with<br>Respect to Ground .....           | -2.0V to +14.0V <sup>(1)</sup> |
| $V_{PP}$ Supply Voltage with<br>Respect to Ground ..... | -2.0V to +14.0V <sup>(1)</sup> |

**\*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  $V_{CC} + 0.75\text{V}$  DC, which may overshoot to +7.0V for pulses of less than 20 ns.

## 6. Operating Modes

| Mode/Pin                              | $\overline{CE}$ | $\overline{OE}$ | $\overline{PGM}$ | Ai                                                                                                          | V <sub>PP</sub> | Outputs             |
|---------------------------------------|-----------------|-----------------|------------------|-------------------------------------------------------------------------------------------------------------|-----------------|---------------------|
| Read                                  | V <sub>IL</sub> | V <sub>IL</sub> | X <sup>(1)</sup> | Ai                                                                                                          | X               | D <sub>OUT</sub>    |
| Output Disable                        | X               | V <sub>IH</sub> | X                | X                                                                                                           | X               | High-Z              |
| Standby                               | V <sub>IH</sub> | X               | X                | X                                                                                                           | X               | High-Z              |
| Rapid Program <sup>(2)</sup>          | V <sub>IL</sub> | V <sub>IH</sub> | V <sub>IL</sub>  | Ai                                                                                                          | V <sub>PP</sub> | D <sub>IN</sub>     |
| PGM Verify                            | V <sub>IL</sub> | V <sub>IL</sub> | V <sub>IH</sub>  | Ai                                                                                                          | V <sub>PP</sub> | D <sub>OUT</sub>    |
| PGM Inhibit                           | V <sub>IH</sub> | X               | X                | X                                                                                                           | V <sub>PP</sub> | High-Z              |
| Product Identification <sup>(4)</sup> | V <sub>IL</sub> | V <sub>IL</sub> | X                | A9 = V <sub>H</sub> <sup>(3)</sup><br>A0 = V <sub>IH</sub> or V <sub>IL</sub><br>A1 - A17 = 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.

## 7. DC and AC Operating Conditions for Read Operation

|                              |       | AT27C020     |               |
|------------------------------|-------|--------------|---------------|
|                              |       | -55          | -90           |
| Operating Temperature (Case) | Ind.  | -40°C - 85°C | -40°C - 85°C  |
|                              | Auto. |              | -40°C - 125°C |
| V <sub>CC</sub> Power Supply |       | 5V ± 10%     | 5V ± 10%      |

## 8. 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> (Com., Ind.)                    |      | ±1.0                  | μA    |
| I <sub>LO</sub>                | Output Leakage Current                              | V <sub>OUT</sub> = 0V to V <sub>CC</sub> (Com., Ind.)                   |      | ±5.0                  | μA    |
| I <sub>PP</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>CC</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 |      | 1.0                   | mA    |
| I <sub>CC</sub>                | V <sub>CC</sub> Active Current                      | f = 5 MHz, I <sub>OUT</sub> = 0 mA, $\overline{CE} = V_{IL}$            |      | 25                    | 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     |

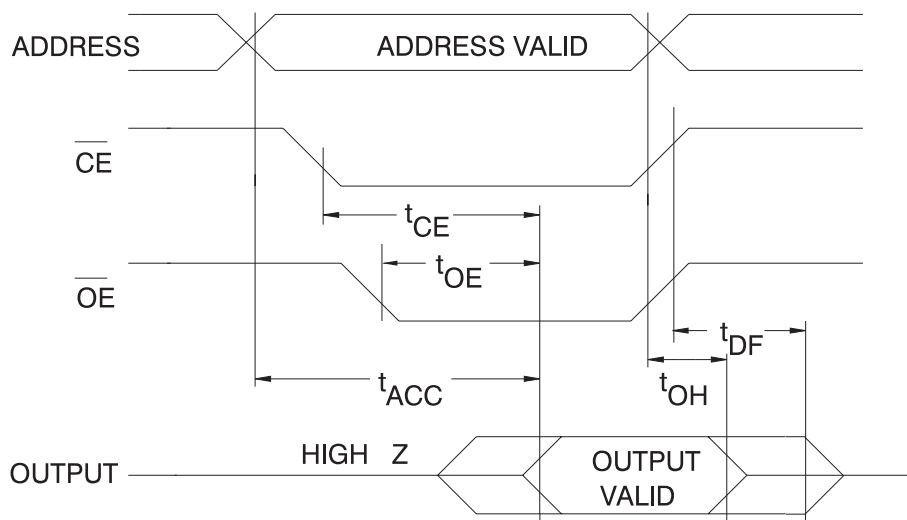
Notes: 1. V<sub>CC</sub> must be applied simultaneously or before V<sub>PP</sub>, and removed simultaneously or after V<sub>PP</sub>.

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>.

## 9. AC Characteristics for Read Operation

| Symbol                            | Parameter                                                                                  | Condition                                            | AT27C020 |     |     |     | Units |
|-----------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------------------|----------|-----|-----|-----|-------|
|                                   |                                                                                            |                                                      | -55      |     | -90 |     |       |
|                                   |                                                                                            |                                                      | Min      | Max | Min | Max |       |
| t <sub>ACC</sub> <sup>(3)</sup>   | Address to Output Delay                                                                    | $\overline{CE} = \overline{OE}$<br>= V <sub>IL</sub> |          | 55  |     | 90  | ns    |
| t <sub>CE</sub> <sup>(2)</sup>    | $\overline{CE}$ to Output Delay                                                            | $\overline{OE} = V_{IL}$                             |          | 55  |     | 90  | ns    |
| t <sub>OE</sub> <sup>(2)(3)</sup> | $\overline{OE}$ to Output Delay                                                            | $\overline{CE} = V_{IL}$                             |          | 20  |     | 35  | ns    |
| t <sub>DF</sub> <sup>(4)(5)</sup> | $\overline{OE}$ or $\overline{CE}$ High to Output Float,<br>Whichever Occurred First       |                                                      |          | 18  |     | 20  | ns    |
| t <sub>OH</sub>                   | Output Hold from Address, $\overline{CE}$ or $\overline{OE}$ ,<br>Whichever Occurred First |                                                      | 7        |     | 0   |     | ns    |

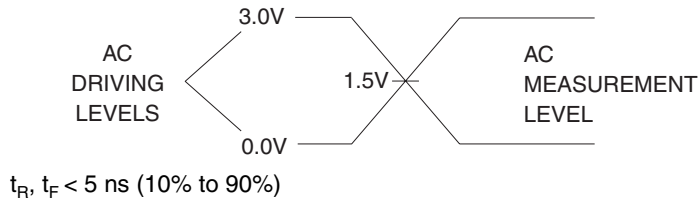
## 10. AC Waveforms for Read Operation<sup>(1)</sup>



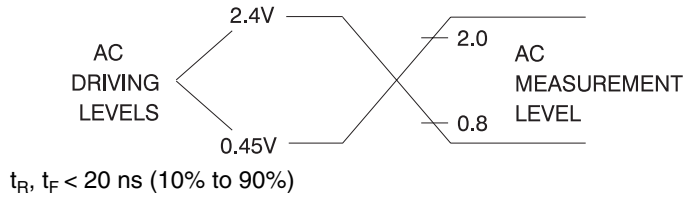
- Notes:
1. Timing measurement references are 0.8V and 2.0V. Input AC drive levels are 0.45V and 2.4V, unless otherwise specified.
  2.  $\overline{OE}$  may be delayed up to  $t_{CE} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{CE}$ .
  3.  $\overline{OE}$  may be delayed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

## 11. Input Test Waveforms and Measurement Levels

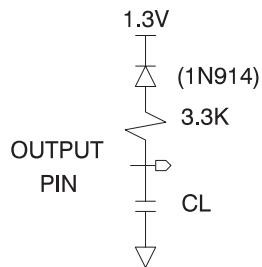
For -55 devices only:



For -90 devices only:



## 12. Output Test Load



Note: CL = 100 pF including jig capacitance except -55 devices, where CL = 30 pF.

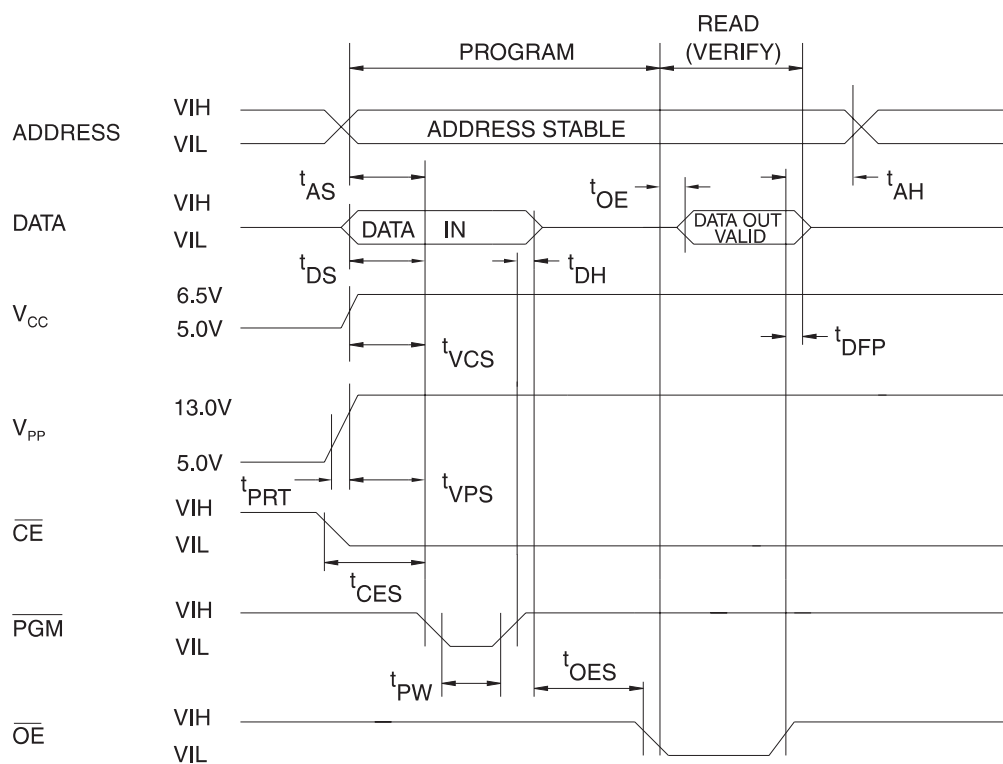
## 13. Pin Capacitance

f = 1 MHz, 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.

## 14. 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 AT27C020, a 0.1  $\mu$ F capacitor is required across  $V_{PP}$  and ground to suppress voltage transients.

## 15. 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    | $V_{CC} + 1.0$ | V             |
| $V_{OL}$  | Output Low Voltage                           | $I_{OL} = 2.1\text{ mA}$                  |        | 0.4            | V             |
| $V_{OH}$  | Output High Voltage                          | $I_{OH} = -400\text{ }\mu\text{A}$        | 2.4    |                | V             |
| $I_{CC2}$ | $V_{CC}$ Supply Current (Program and Verify) |                                           |        | 40             | mA            |
| $I_{PP2}$ | $V_{PP}$ Supply Current                      | $\overline{CE} = \overline{PGM} = V_{IL}$ |        | 20             | mA            |
| $V_{ID}$  | A9 Product Identification Voltage            |                                           | 11.5   | 12.5           | V             |

## 16. 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 Condition <sup>(1)</sup>                    | Limits |     | Units         |
|-----------|-----------------------------------------------------------|--------------------------------------------------|--------|-----|---------------|
|           |                                                           |                                                  | Min    | Max |               |
| $t_{AS}$  | Address Setup Time                                        | Input Rise and Fall Times:<br>(10% to 90%) 20 ns | 2      |     | $\mu\text{s}$ |
| $t_{CES}$ | $\overline{CE}$ Setup Time                                |                                                  | 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> | Input Timing Reference Level:<br>0.8V to 2.0V    | 0      | 130 | ns            |
| $t_{VPS}$ | $V_{PP}$ Setup Time                                       |                                                  | 2      |     | $\mu\text{s}$ |
| $t_{VCS}$ | $V_{CC}$ Setup Time                                       | Output Timing Reference Level:<br>0.8V to 2.0V   | 2      |     | $\mu\text{s}$ |
| $t_{PW}$  | $\overline{PGM}$ Program Pulse Width <sup>(3)</sup>       |                                                  | 95     | 105 | $\mu\text{s}$ |
| $t_{OE}$  | Data Valid from $\overline{OE}$                           |                                                  |        | 150 | ns            |
| $t_{PRT}$ | $V_{PP}$ Pulse Rise Time During Programming               |                                                  | 50     |     | ns            |

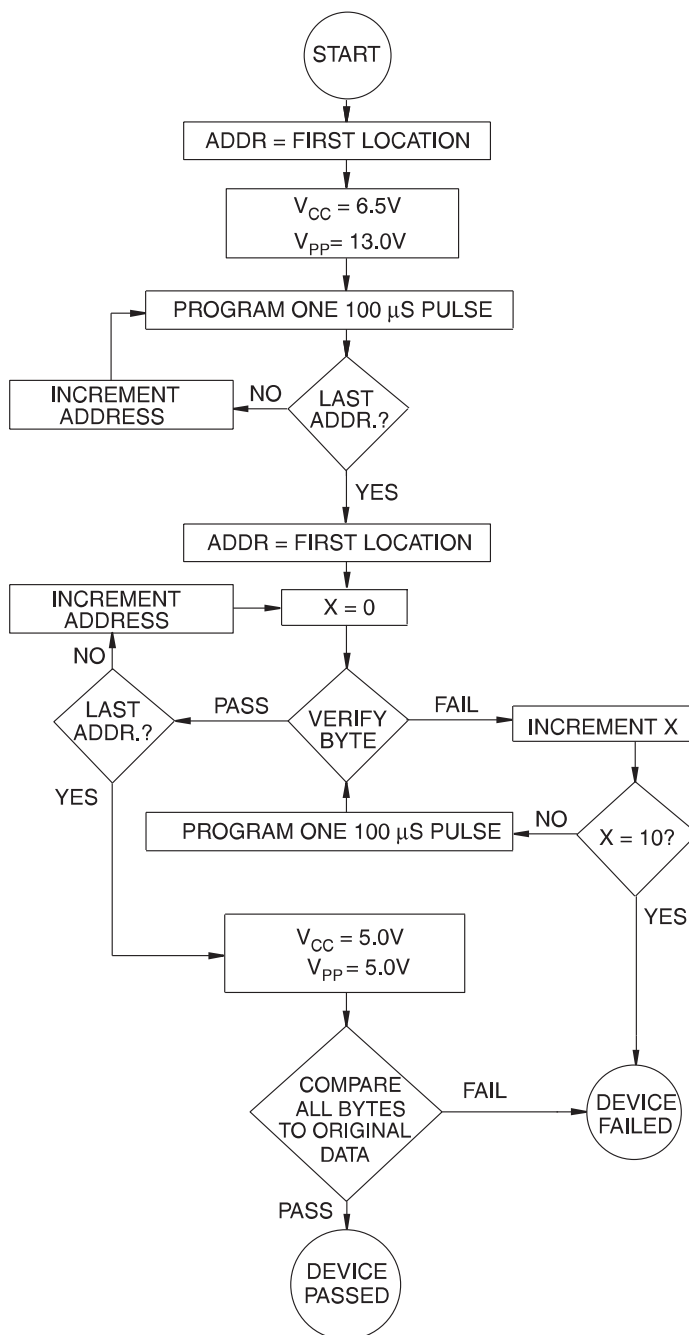
- Notes:
- $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$ .
  - This parameter is only sampled and is not 100% tested. Output Float is defined as the point where data is no longer driven – see timing diagram.
  - Program Pulse width tolerance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

## 17. Atmel's AT27C020 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    | 1  | 0  | 0  | 0  | 0  | 1  | 1  | 0  | 86       |

## 18. Rapid Programming Algorithm

A 100  $\mu\text{s}$   $\overline{\text{PGM}}$  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  $\mu\text{s}$   $\overline{\text{PGM}}$  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.



## 19. Ordering Information

### 19.1 Standard Package

| $t_{ACC}$<br>(ns) | $I_{CC}$ (mA) |         | Ordering Code                                   | Package            | Operation Range                |
|-------------------|---------------|---------|-------------------------------------------------|--------------------|--------------------------------|
|                   | Active        | Standby |                                                 |                    |                                |
| 55                | 25            | 0.1     | AT27C020-55JI<br>AT27C020-55PI<br>AT27C020-55TI | 32J<br>32P6<br>32T | Industrial<br>(-40°C to 85°C)  |
| 90                | 25            | 0.1     | AT27C020-90JI<br>AT27C020-90PI<br>AT27C020-90TI | 32J<br>32P6<br>32T | Industrial<br>(-40°C to 85°C)  |
|                   | 25            | 0.1     | AT27C020-90JA<br>AT27C020-90PA                  | 32J<br>32P6        | Automotive<br>(-40°C to 125°C) |

Note: Refer to PCN# SC042702.

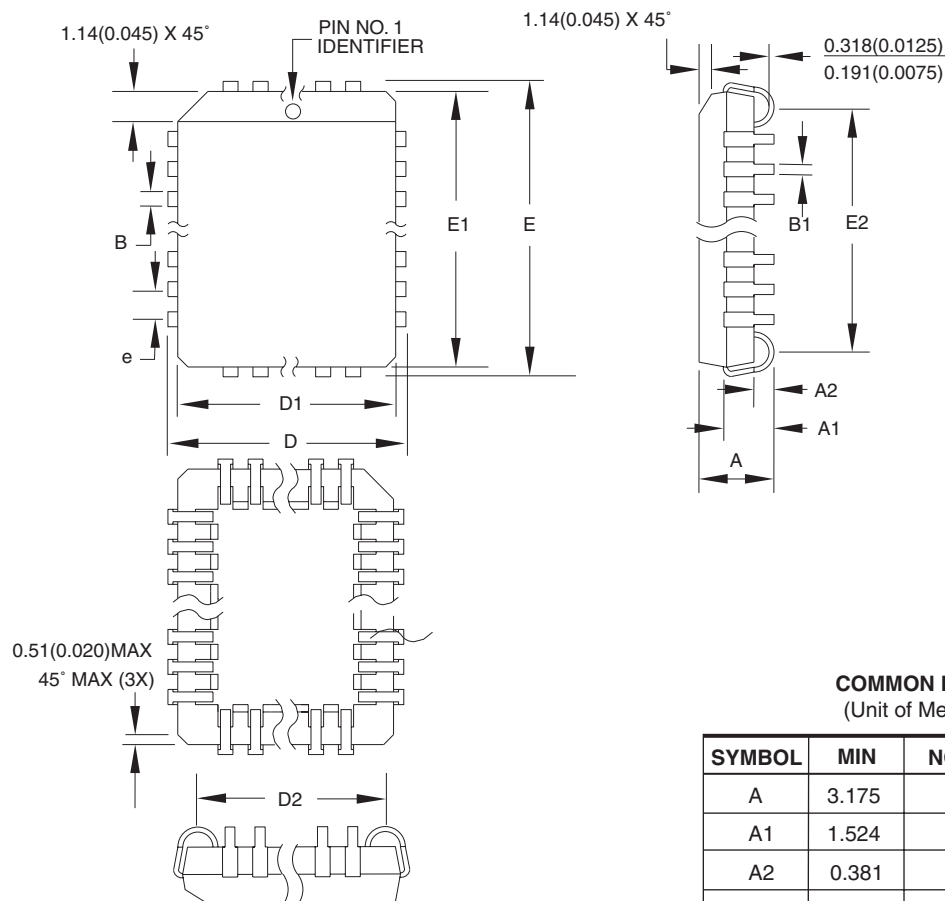
### 19.2 Green Package (Pb/Halide-free)

| $t_{ACC}$<br>(ns) | $I_{CC}$ (mA) |         | Ordering Code                                   | Package            | Operation Range               |
|-------------------|---------------|---------|-------------------------------------------------|--------------------|-------------------------------|
|                   | Active        | Standby |                                                 |                    |                               |
| 55                | 25            | 0.1     | AT27C020-55JU<br>AT27C020-55PU<br>AT27C020-55TU | 32J<br>32P6<br>32T | Industrial<br>(-40°C to 85°C) |
| 90                | 25            | 0.1     | AT27C020-90JU<br>AT27C020-90PU<br>AT27C020-90TU | 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)       |

## 20. Packaging Information

### 20.1 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.

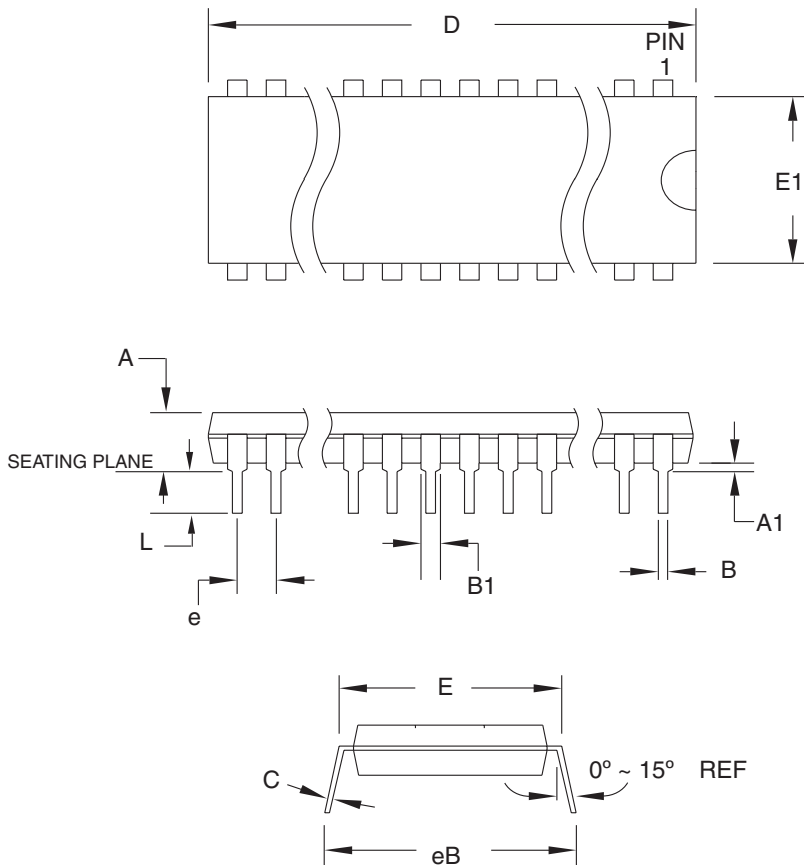
32J

#### REV.

B



## 20.2 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)

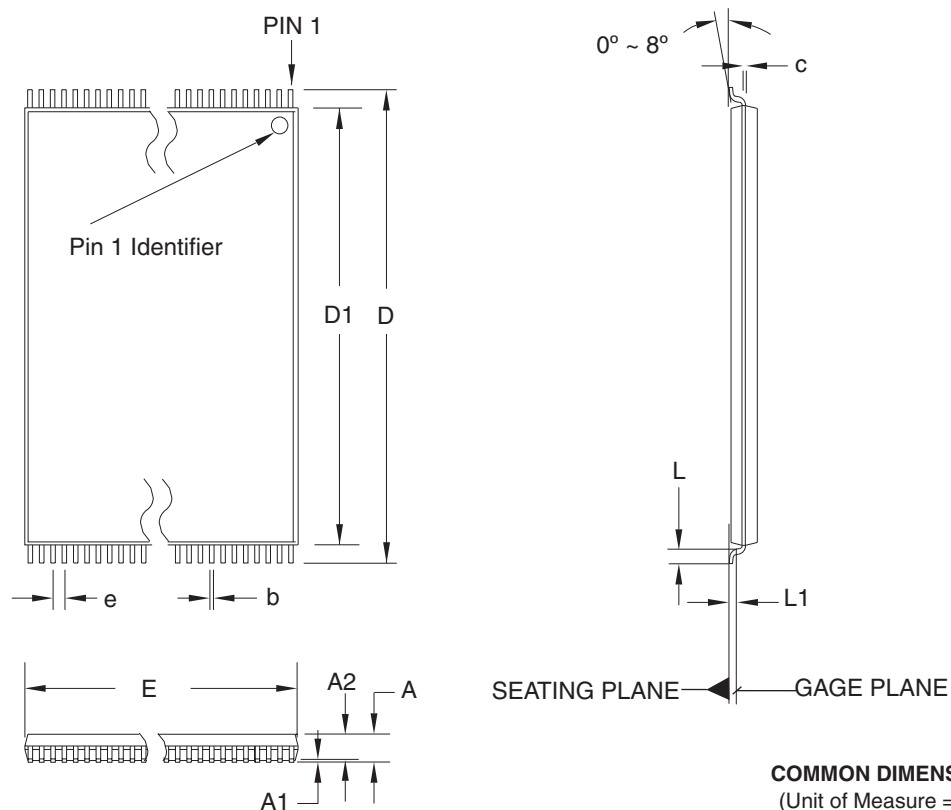
### DRAWING NO.

32P6

### REV.

B

## 20.3 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



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