

## Features

- Fast read access time – 120ns
- Dual voltage range operation
  - Unregulated battery power supply range, 2.7V to 3.6V, or
  - Standard power supply range, 5V  $\pm$  10%
- Compatible with JEDEC standard Atmel® AT27C040
- Low-power CMOS operation
  - 20 $\mu$ A max standby (less than 1 $\mu$ A, typical) for  $V_{CC}$  = 3.6V
  - 36mW max active at 5MHz for  $V_{CC}$  = 3.6V
- JEDEC standard packages
  - 32-lead PLCC
  - 32-lead TSOP
- High-reliability CMOS technology
  - 2,000V ESD protection
  - 200mA latchup immunity
- Rapid programming algorithm – 100 $\mu$ s/byte (typical)
- CMOS- and TTL-compatible inputs and outputs
  - JEDEC standard for LVTTTL and LVBO
- Integrated product identification code
- Industrial temperature range
- Green (Pb/halide-free, RoHS compliant) packaging

## 1. Description

The Atmel AT27BV040 chip is a high-performance, low-power, low-voltage, 4,194,304-bit, one-time programmable, read only memory (EPROM) organized as 512K by 8 bits. It requires only one supply in the range of 2.7 to 3.6V in normal read mode operation, making it ideal for fast, portable systems using either regulated or unregulated battery power.

The Atmel innovative design techniques provide fast speeds that rival 5V parts, while keeping the low power consumption of a 3V supply. At  $V_{CC}$  = 2.7V, any byte can be accessed in less than 100ns. With a typical power dissipation of only 18mW at 5MHz and  $V_{CC}$  = 3V, the AT27BV040 consumes less than one-fifth the power of a standard, 5V EPROM. Standby mode supply current is typically less than 1 $\mu$ A at 3V. The AT27BV040 simplifies system design and stretches battery lifetime even further by eliminating the need for power supply regulation.

The AT27BV040 is available in industry-standard, JEDEC-approved, one-time programmable (OTP) PLCC and plastic TSOP packages. All devices feature two-line control ( $\overline{CE}$ ,  $\overline{OE}$ ) to give designers the flexibility to prevent bus contention.

The AT27BV040 operating with  $V_{CC}$  at 3.0V produces TTL-level outputs that are compatible with standard TTL logic devices operating at  $V_{CC}$  = 5.0V. At  $V_{CC}$  = 2.7V, the part is compatible with JEDEC-approved, low-voltage battery operation (LVBO) interface specifications. The device is also capable of standard, 5V operation, making it ideally suited for dual supply range systems or card products that are pluggable in both 3V and 5V hosts.

The Atmel AT27BV040 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



4Mb (512K x 8)  
Unregulated Battery  
Voltage, High-speed,  
One-time  
Programmable, Read  
Only Memory

Atmel AT27BV040

Not recommended for  
new designs

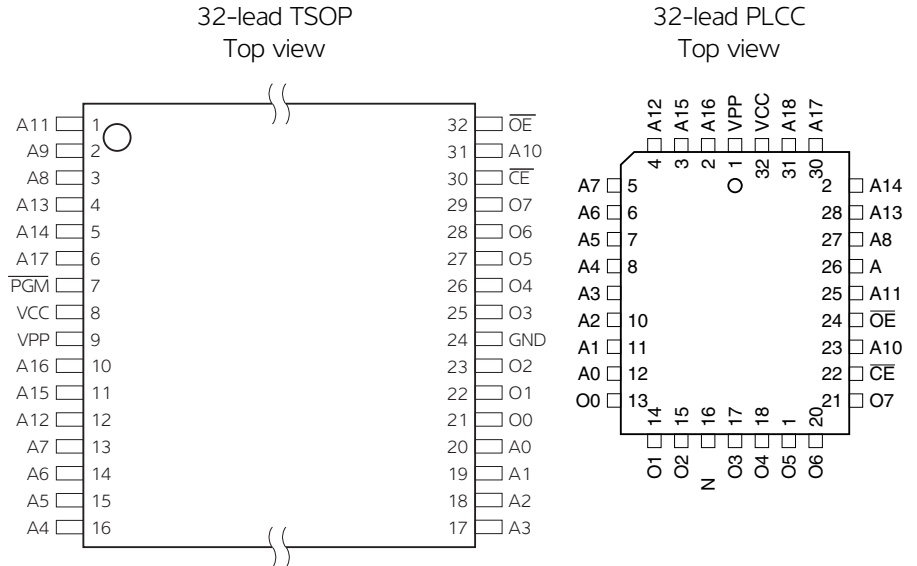
0346H-EPROM-4/11



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. The AT27BV040 programs in exactly the same way as a standard, 5V Atmel AT27C040, and uses the same programming equipment.

## 2. Pin configurations

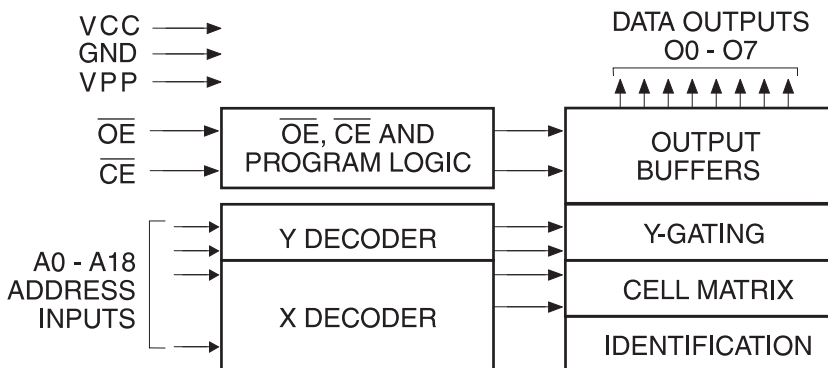
Pin name	Function
A0 - A18	Addresses
O0 - O7	Outputs
$\overline{CE}$	Chip enable
$\overline{OE}$	Output enable



## 3. 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.

Figure 3-1. Block diagram



#### 4. Absolute maximum ratings\*

Temperature under bias . . . . .	-40°C to +85°C
Storage temperature . . . . .	-65°C to +125°C
Voltage on any pin with respect to ground . . . . .	-2.0V to +7.0V <sup>(1)</sup>
Voltage on A9 with respect to ground . . . . .	-2.0V to +14.0V <sup>(1)</sup>
V <sub>pp</sub> supply voltage with 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 20ns. Maximum output pin voltage is  $V_{CC} + 0.75V$  DC, which may be exceeded if certain precautions are observed (consult application notes), and which may overshoot to +7.0V for pulses of less than 20ns.

#### 5. AC and DC characteristics

Table 5-1. Operating mode

Mode/Pin	$\overline{CE}$	$\overline{OE}$	Ai	V <sub>pp</sub>	V <sub>CC</sub>	Outputs
Read <sup>(2)</sup>	V <sub>IL</sub>	V <sub>IL</sub>	Ai	X <sup>(1)</sup>	V <sub>CC</sub> <sup>(2)</sup>	D <sub>OUT</sub>
Output disable <sup>(2)</sup>	X	V <sub>IH</sub>	X	X	V <sub>CC</sub> <sup>(2)</sup>	High Z
Standby <sup>(2)</sup>	V <sub>IH</sub>	X	X	X	V <sub>CC</sub> <sup>(2)</sup>	High Z
Rapid program <sup>(3)</sup>	V <sub>IL</sub>	V <sub>IH</sub>	Ai	V <sub>pp</sub>	V <sub>CC</sub> <sup>(3)</sup>	D <sub>IN</sub>
PGM verify <sup>(3)</sup>	X	V <sub>IL</sub>	Ai	V <sub>pp</sub>	V <sub>CC</sub> <sup>(3)</sup>	D <sub>OUT</sub>
PGM inhibit <sup>(3)</sup>	V <sub>IH</sub>	V <sub>IH</sub>	X	V <sub>pp</sub>	V <sub>CC</sub> <sup>(3)</sup>	High Z
Product identification <sup>(3)(5)</sup>	V <sub>IL</sub>	V <sub>IL</sub>	A9 = V <sub>H</sub> <sup>(4)</sup> A0 = V <sub>IH</sub> or V <sub>IL</sub> A1 - A18 = V <sub>IL</sub>	X	V <sub>CC</sub> <sup>(3)</sup>	Identification code

Notes: 1. X can be V<sub>IL</sub> or V<sub>IH</sub>.  
 2. Read, output disable, and standby modes require  $2.7V \leq V_{CC} \leq 3.6V$  or  $4.5V \leq V_{CC} \leq 5.5V$ .  
 3. Refer to programming characteristics. Programming modes require  $V_{CC} = 6.5V$ .  
 4.  $V_H = 12.0 \pm 0.5V$ .  
 5. 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.

Table 5-2. AC and DC operating conditions for read operation

Atmel AT27BV040-12	
Industrial operating temperature (case)	-40°C - 85°C
V <sub>CC</sub> power supply	2.7V to 3.6V
	5V ± 10%

Table 5-3. DC and operating characteristics for read operation

Symbol	Parameter	Condition	Min	Max	Units
$V_{CC} = 2.7V$ to $3.6V$					
$I_{LI}$	Input load current	$V_{IN} = 0V$ to $V_{CC}$		$\pm 1$	$\mu A$
$I_{LO}$	Output leakage current	$V_{OUT} = 0V$ to $V_{CC}$		$\pm 5$	$\mu A$
$I_{PP1}^{(2)}$	$V_{PP}^{(1)}$ read/standby current	$V_{PP} = V_{CC}$		10	$\mu A$
$I_{SB}$	$V_{CC}^{(1)}$ standby current	$I_{SB1}$ (CMOS), $\overline{CE} = V_{CC} \pm 0.3V$		20	$\mu A$
		$I_{SB2}$ (TTL), $\overline{CE} = 2.0$ to $V_{CC} + 0.5V$		100	$\mu A$
$I_{CC}$	$V_{CC}$ active current	$f = 5MHz$ , $I_{OUT} = 0mA$ , $\overline{CE} = V_{IL}$ , $V_{CC} = 3.6V$		10	mA
$V_{IL}$	Input low voltage	$V_{CC} = 3.0$ to $3.6V$	-0.6	0.8	V
		$V_{CC} = 2.7$ to $3.6V$	-0.6	$0.2 \times V_{CC}$	V
$V_{IH}$	Input high voltage	$V_{CC} = 3.0$ to $3.6V$	2.0	$V_{CC} + 0.5$	V
		$V_{CC} = 2.7$ to $3.6V$	$0.7 \times V_{CC}$	$V_{CC} + 0.5$	V
$V_{OL}$	Output low voltage	$I_{OL} = 2.0mA$		0.4	V
		$I_{OL} = 100\mu A$		0.2	V
		$I_{OL} = 20\mu A$		0.1	V
$V_{OH}$	Output high voltage	$I_{OH} = -2.0mA$	2.4		V
		$I_{OH} = -100\mu A$	$V_{CC} - 0.2$		V
		$I_{OH} = -20\mu A$	$V_{CC} - 0.1$		V
$V_{CC} = 4.5V$ to $5.5V$					
$I_{LI}$	Input load current	$V_{IN} = 0V$ to $V_{CC}$		$\pm 1$	$\mu A$
$I_{LO}$	Output leakage current	$V_{OUT} = 0V$ to $V_{CC}$		$\pm 5$	$\mu A$
$I_{PP1}^{(2)}$	$V_{PP}^{(1)}$ read/standby current	$V_{PP} = V_{CC}$		10	$\mu A$
$I_{SB}$	$V_{CC}^{(1)}$ standby current	$I_{SB1}$ (CMOS), $\overline{CE} = V_{CC} \pm 0.3V$		100	$\mu A$
		$I_{SB2}$ (TTL), $\overline{CE} = 2.0$ to $V_{CC} + 0.5V$		1	mA
$I_{CC}$	$V_{CC}$ active current	$f = 5MHz$ , $I_{OUT} = 0mA$ , $\overline{CE} = V_{IL}$		30	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	$I_{OL} = 2.1mA$		0.4	V
$V_{OH}$	Output high voltage	$I_{OH} = -400\mu A$	2.4		V

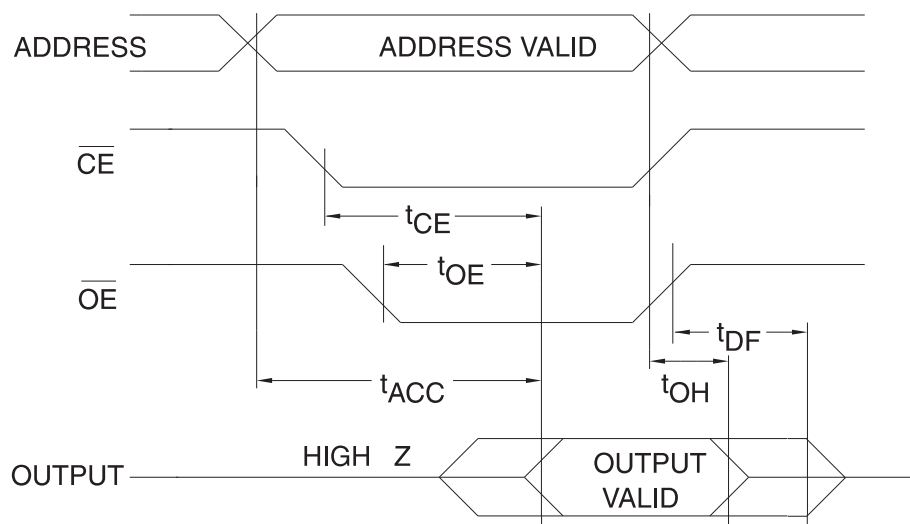
- Notes:
- $V_{CC}$  must be applied simultaneously with or before  $V_{pp}$ , and removed simultaneously with or after  $V_{pp}$ .
  - $V_{pp}$  may be connected directly to  $V_{CC}$ , except during programming. The supply current would then be the sum of  $I_{CC}$  and  $I_{pp}$ .

Table 5-4. AC characteristics for read operations

$V_{CC} = 2.7V$  to  $3.6V$  and  $4.5V$  to  $5.5V$

Symbol	Parameter	Condition	Atmel AT27BV040-12		Units
			Min	Max	
$t_{ACC}^{(3)}$	Address to output delay	$\overline{CE} = \overline{OE} = V_{IL}$		120	ns
$t_{CE}^{(2)}$	$\overline{CE}$ to output delay	$\overline{OE} = V_{IL}$		120	ns
$t_{OE}^{(2)(3)}$	$\overline{OE}$ to output delay	$\overline{CE} = V_{IL}$		50	ns
$t_{DF}^{(4)(5)}$	$\overline{OE}$ or $\overline{CE}$ high to output float, whichever occurred first			40	ns
$t_{OH}$	Output hold from address, $\overline{CE}$ or $\overline{OE}$ , whichever occurred first		0		ns

Figure 5-1. 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 5-2. Input test waveforms and measurement levels

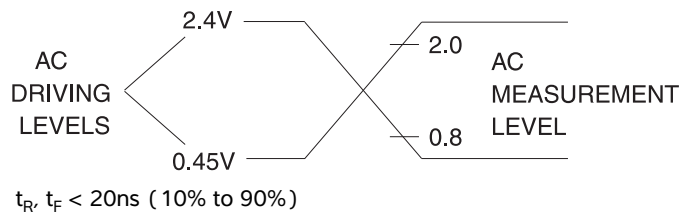
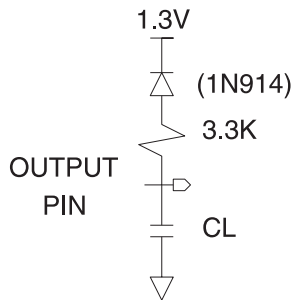


Figure 5-3. Output test load



Note: CL = 100pF including jig capacitance.

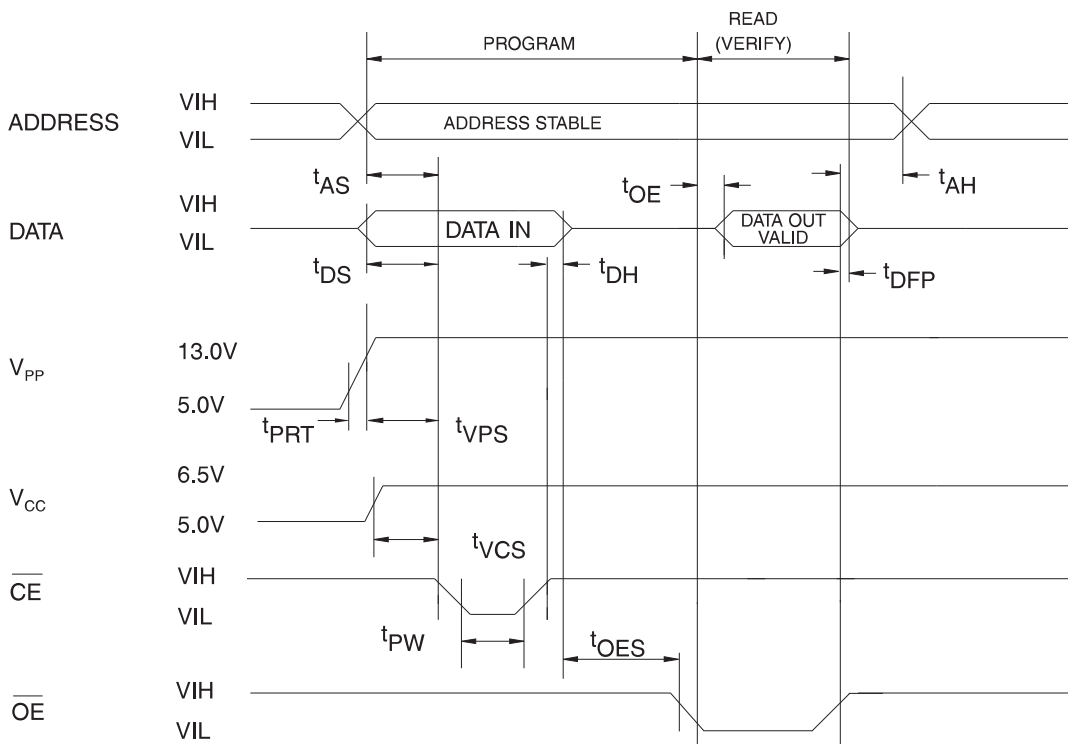
Table 5-5. Pin capacitance

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 5-4. 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 Atmel AT27BV040, a 0.1μF capacitor is required across V<sub>pp</sub> and ground to suppress spurious voltage transients.

Table 5-6. 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
$V_{ID}$	A9 product identification voltage		11.5	12.5	V

Table 5-7. 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: (10% to 90%) 20 ns	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		0		$\mu\text{s}$
$t_{DH}$	Data hold time	Input pulse levels: 0.45V to 2.4V	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: 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: 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  $100\mu\text{sec} \pm 5\%$ .

Table 5-8. The Atmel AT27BV040 integrated product identification code<sup>(1)</sup>

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

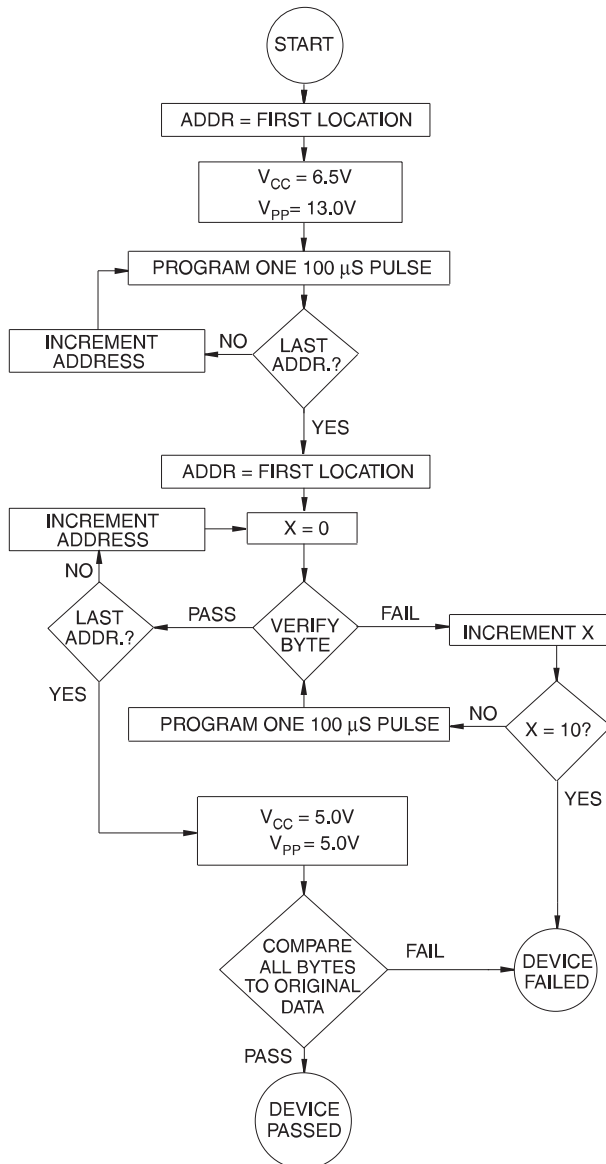
Note: 1. The Atmel AT27BV040 has the same product identification code as the Atmel AT27C040. Both are programming compatible.



## 6. 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.

Figure 6-1. Rapid programming algorithm





## 7. Ordering Information

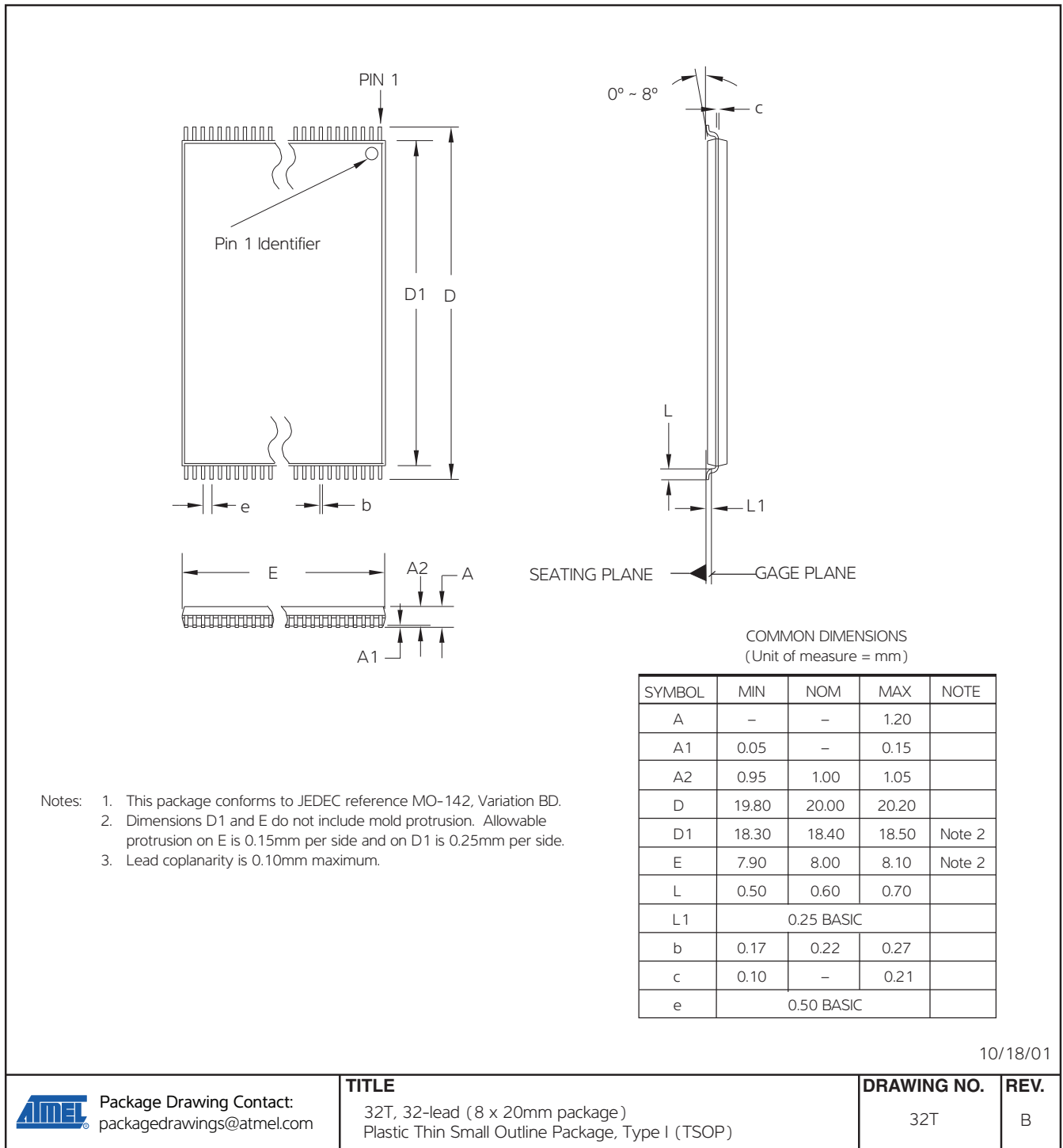
Green package (Pb/halide-free, RoHS compliant)

t <sub>ACC</sub> (ns)	I <sub>CC</sub> (mA) V <sub>CC</sub> = 3.6V		Atmel ordering code	Package	Operation range
	Active	Standby			
120	8	0.02	AT27BV040-12JU AT27BV040-12TU	32J 32T	Industrial (-40°C to 85°C)

Package type	
32J	32-lead, plastic, J-Leaded chip carrier (PLCC)
32T	32-lead, plastic, thin, small outline package (TSOP), 8 x 20mm



32T – TSOP





9. Revision history

Doc. rev.	Date	Comments
0346H	04/2011	Remove VSOP package Add "Not recommended for new designs"
0346G	12/2007	



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