Features

- **Fast Read Access Time - 45 ns**
- **Low Power CMOS Operation**
  - **100 µA max. Standby**
  - **30 mA max. Active at 5 MHz**
- **JEDEC Standard Packages**
  - **44-Lead PLCC**
  - **40-Lead VSOP (10mm x 14mm)**
- **5V ± 10% Power Supply**
- **High Reliability CMOS Technology**
  - **2000V ESD Protection**
  - **200 mA Latchup Immunity**
- **Rapid™ Programming Algorithm - 50 µs/word (typical)**
- **CMOS and TTL Compatible Inputs and Outputs**
- **Integrated Product Identification Code**
- **Commercial and Industrial Temperature Ranges**

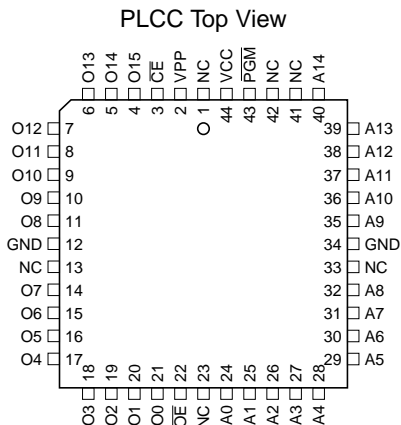**512K (32K x 16) OTP EPROM**

AT27C516

Description

The AT27C516 is a low-power, high performance 524,288-bit one-time programmable read only memory (OTP EPROM) organized 32K by 16 bits. It requires only one 5V power supply in normal read mode operation. Any word can be accessed in less than 45 ns, eliminating the need for speed reducing WAIT states. The by-16 organization make this part ideal for high-performance 16- and 32-bit microprocessor systems.

In read mode, the AT27C516 typically consumes 15 mA. Standby mode supply current is typically less than 10 µA. *(continued)*
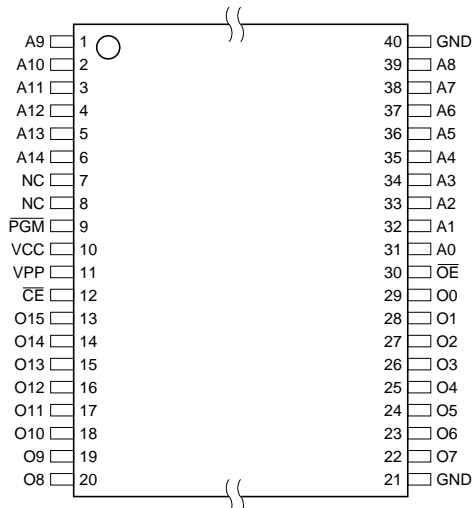
Pin Configurations

Pin Name	Function
A0 - A14	Addresses
O0 - O15	Outputs
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{PGM}$	Program Strobe
NC	No Connect

Note: Both GND pins must be connected.

PLCC Top View

Note: PLCC Package Pins 1 and 23 are DON'T CONNECT.

VSOP Top View
Type 1

Rev. 0362C–10/98

1

The AT27C516 is available in industry standard JEDEC-approved one-time programmable (OTP) plastic PLCC and VSOP packages. The device features two-line control ($\overline{CE}$, $\overline{OE}$) to eliminate bus contention in high-speed systems.

With 32K word storage capability, the AT27C516 allows firmware to be stored reliably and to be accessed by the system without the delays of mass storage media.

Atmel's 27C516 have 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 50 µs/word. The Integrated Product Identification Code electronically identifies the device and manufacturer. This feature is used by industry standard programming equipment to select the proper programming algorithms and voltages.

System Considerations

Switching between active and standby conditions via the Chip Enable pin may produce transient voltage excursions. Unless accommodated by the system design, these transients may exceed data sheet limits, resulting in device non-conformance. At a minimum, a 0.1 µF 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 µF bulk electrolytic capacitor should be utilized, again connected between the V_{CC} and Ground terminals. This capacitor should be positioned as close as possible to the point where the power supply is connected to the array.

Block Diagram
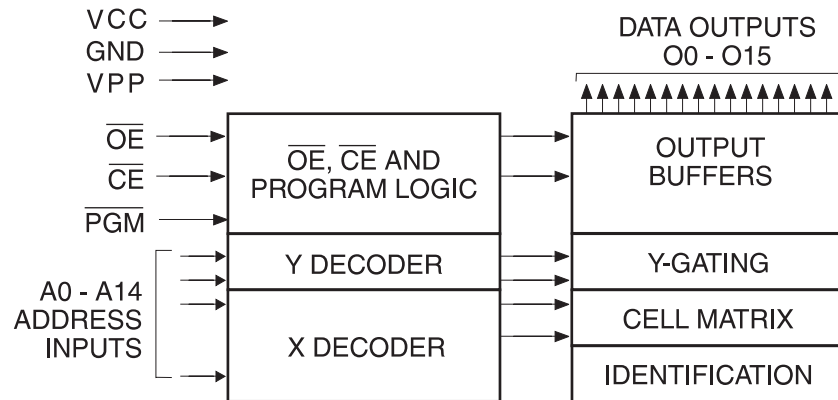
Absolute Maximum Ratings*

Temperature Under Bias .... -55°C to +125°C

Storage Temperature .... -65°C to +150°C

Voltage on Any Pin with
Respect to Ground ....-2.0V to +7.0V[1]

Voltage on A9 with
Respect to Ground ....-2.0V to +14.0V[1]

V_{PP} Supply Voltage with
Respect to Ground ....-2.0V to +14.0V[1]

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability

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

Operating Modes

Mode \ Pin	$\overline{CE}$	$\overline{OE}$	$\overline{PGM}$	Ai	V_{PP}	Outputs
Read	V_{IL}	V_{IL}	$X^{(1)}$	Ai	X	D_{OUT}
Output Disable	X	V_{IH}	X	X	X	High Z
Standby	V_{IH}	X	X	X	$X^{(5)}$	High Z
Rapid Program[2]	V_{IL}	V_{IH}	V_{IL}	Ai	V_{PP}	D_{IN}
PGM Verify	V_{IL}	V_{IL}	V_{IH}	Ai	V_{PP}	D_{OUT}
PGM Inhibit	V_{IH}	X	X	X	V_{PP}	High Z
Product Identification[4]	V_{IL}	V_{IL}	X	A9 = V_H[3] A0 = V_{IH} or V_{IL} A1 - A14 = V_{IL}	V_{CC}	Identification Code

Notes: 1.   X can be V_{IL} or V_{IH}.

2.   Refer to Programming Characteristics.

3. $V_H = 12.0 \pm 0.5V$.

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

5.   Standby V_{CC} current (I_{SB}) is specified with $V_{PP} = V_{CC}$. $V_{CC} > V_{PP}$ will cause a slight increase in I_{SB}.
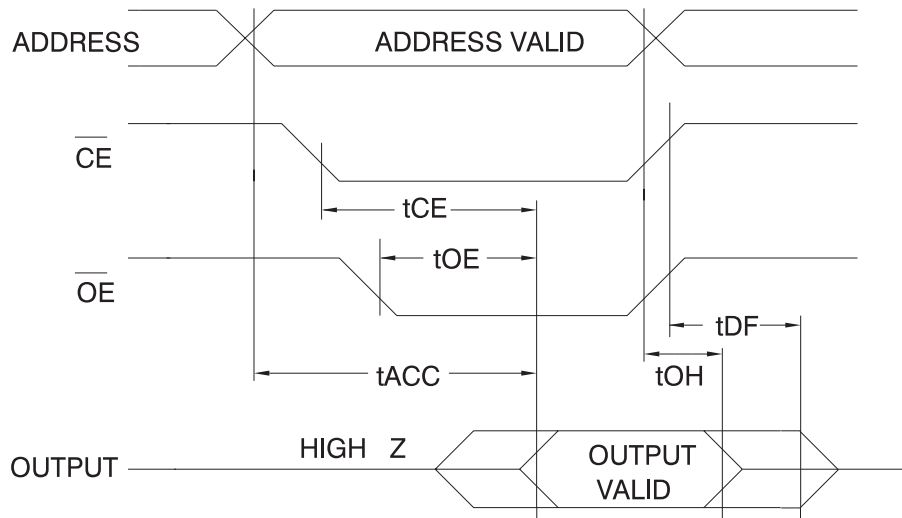
3

DC and AC Operating Conditions for Read Operation

		AT27C516				
		-45	**-55**	**-70**	**-85**	**-10**
Operating Temperature (Case)	Com.	0°C - 70°C	0°C - 70°C	0°C - 70°C	0°C - 70°C	0°C - 70°C
	Ind.	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C
V_{CC} Power Supply		5V ± 10%	5V ± 10%	5V ± 10%	5V ± 10%	5V ± 10%

DC and Operating Characteristics for Read Operation

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

Notes: 1. V_{CC} must be applied simultaneously with or before V_{PP} and removed simultaneously with or after V_{PP}

2. 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}
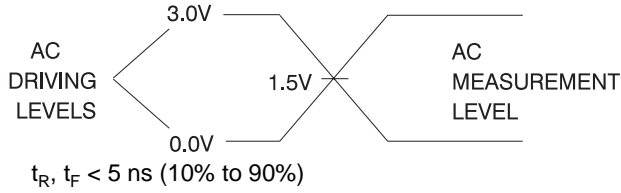
AC Waveforms for Read Operation[1]

AC Characteristics for Read Operation

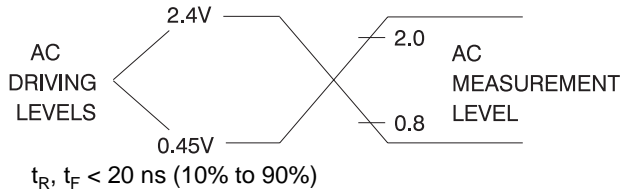| | | | AT27C516 | | | | | | | | | | |
| | | | -45 | | -55 | | -70 | | -85 | | -10 | | |
Symbol	Parameter	Condition	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Units
t_{ACC}[3]	Address to Output Delay	$\overline{CE} = \overline{OE} = V_{IL}$		45		55		70		85		100	ns
t_{CE}[2]	$\overline{CE}$ to Output Delay	$\overline{OE} = V_{IL}$		45		55		70		85		100	ns
t_{OE}[2][3]	$\overline{OE}$ to Output Delay	$\overline{CE} = V_{IL}$		20		25		25		30		30	ns
t_{DF}[4][5]	$\overline{OE}$ or $\overline{CE}$ High to Output Float, whichever occurred first			20		25		25		30		30	ns
t_{OH}	Output Hold from Address, $\overline{CE}$ or $\overline{OE}$, whichever occurred first		7		7		7		0		0		ns

Notes:
1. Timing measurement reference level is 1.5V for -45 and -55 devices. Input AC drive levels are V_{IL} = 0.0V and V_{IH} = 3.0V. Timing measurement reference levels for all other speed grades are V_{OL} = 0.8V and V_{OH} = 2.0V. Input AC drive levels are V_{IL} = 0.45V and V_{IH} = 2.4V.
2. $\overline{OE}$ 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.

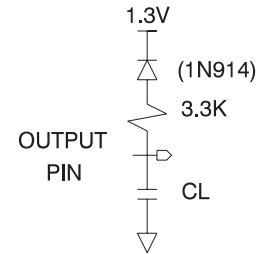## Input Test Waveforms and Measurement Levels

For -45, -55, and -70 devices only:

AC DRIVING LEVELS — 3.0V, 1.5V, 0.0V — AC MEASUREMENT LEVEL

t_R, t_F < 5 ns (10% to 90%)

For -85 and -10 devices only:

AC DRIVING LEVELS — 2.4V, 0.45V — AC MEASUREMENT LEVEL — 2.0, 0.8

t_R, t_F < 20 ns (10% to 90%)

Output Test Load

1.3V
(1N914)
3.3K
OUTPUT PIN
CL

Note: C_L = 100 pF including jig capacitance, except -45, -55, and -70 devices, where C_L = 30 pF.

Pin Capacitance

f = 1 MHz, T = 25°C[1]

Symbol	Typ	Max	Units	Conditions
C_{IN}	4	10	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[1]
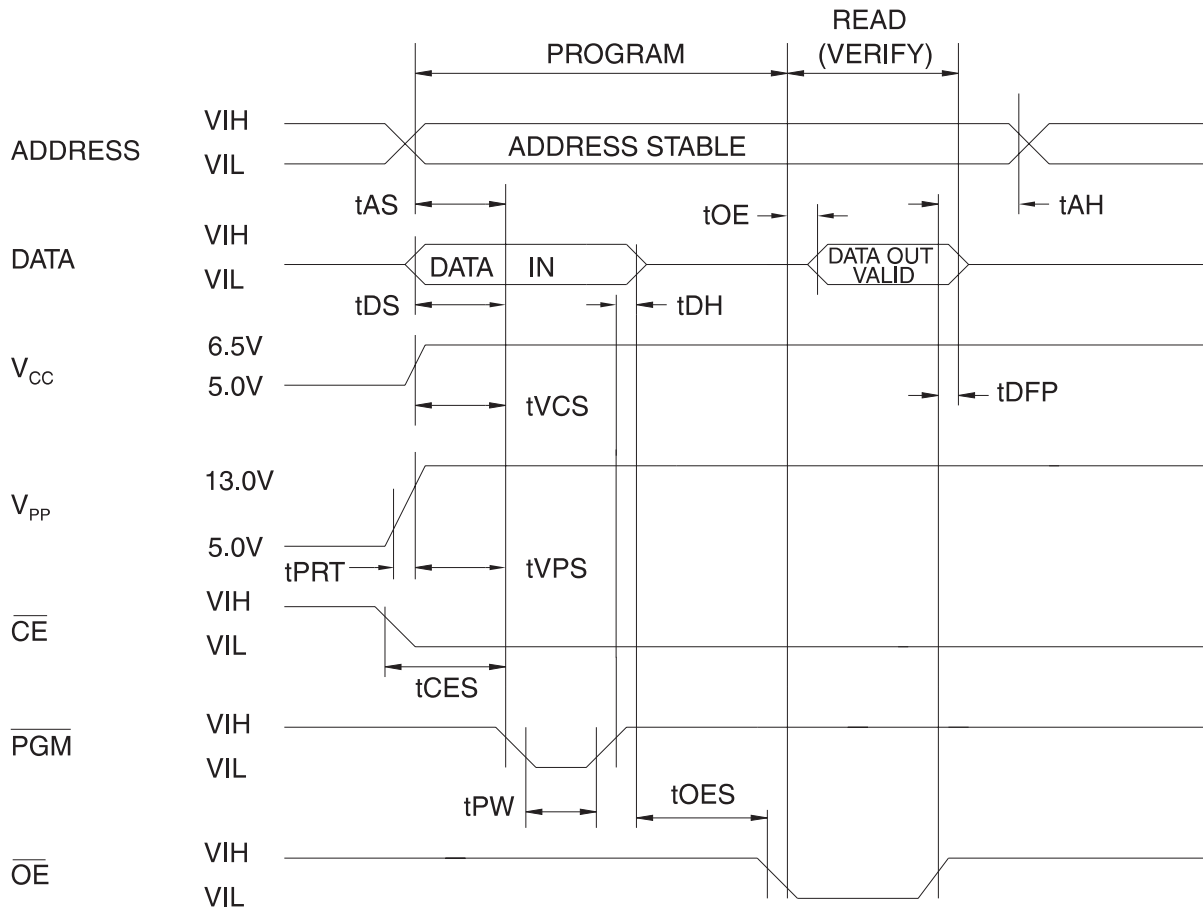
Notes: 1. The Input Timing Reference is 0.8V for V_{IL} and 2.0V for V_{IH}.

2. t_{OE} and t_{DFP} are characteristics of the device but must be accommodated by the programmer.

3. When programming the AT27C516 at 0.1 µF capacitor is required across V_{PP} and ground to suppress spurious voltage transients.

DC Programming Characteristics

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

Symbol	Parameter	Test Conditions	Limits		Units
			Min	Max	
I_{LI}	Input Load Current	$V_{IN} = V_{IL}, V_{IH}$		±10	µA
V_{IL}	Input Low Level		-0.6	0.8	V
V_{IH}	Input High Level		2.0	$V_{CC} + 0.1$	V
V_{OL}	Output Low Voltage	$I_{OL} = 2.1$ mA		0.4	V
V_{OH}	Output High Voltage	$I_{OH} = -400$ µA	2.4		V
I_{CC2}	V_{CC} Supply Current (Program and Verify)			50	mA
I_{PP2}	V_{PP} Supply Current	$\overline{CE} = \overline{PGM} = V_{IL}$		30	mA
V_{ID}	A9 Product Identification Voltage		11.5	12.5	V

AC Programming Characteristics

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

Symbol	Parameter	Test Conditions[1]	Limit Min	Limit Max	Units
t_{AS}	Address Setup Time		2		µs
t_{CES}	$\overline{CE}$ Setup Time		2		µs
t_{OES}	$\overline{OE}$ Setup Time	Input Rise and Fall Times:	2		µs
t_{DS}	Data Setup Time	(10% to 90%) 20 ns	2		µs
t_{AH}	Address Hold Time	Input Pulse Levels:	0		µs
t_{DH}	Data Hold Time	0.45V to 2.4V	2		µs
t_{DFP}	$\overline{OE}$ High to Output Float Delay[2]		0	130	ns
t_{VPS}	V_{PP} Setup Time	Input Timing Reference Level:	2		µs
t_{VCS}	V_{CC} Setup Time	0.8V to 2.0V	2		µs
t_{PW}	$\overline{PGM}$ Program Pulse Width[3]	Output Timing Reference Level:	47.5	52.5	µs
t_{OE}	Data Valid from $\overline{OE}$	0.8V to 2.0V		150	ns
t_{PRT}	V_{PP} Pulse Rise Time During Programming		50		ns

Notes:
1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously 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 50 µsec $\pm$ 5%.

Atmel's 27C516 Integrated Product Identification Code

Codes	Pins A0	O15-O8	O7	O6	O5	O4	O3	O2	O1	O0	Hex Data
Manufacturer	0	0	0	0	0	1	1	1	1	0	001E
Device Type	1	0	1	1	1	1	0	0	1	0	00F2

AT27C516

Rapid Programming Algorithm

A 50 µs $\overline{PGM}$ pulse width is used to program. The address is set to the first location. V_{CC} is raised to 6.5V and V_{PP} is raised to 13.0V. Each address is first programmed with one 50 µs $\overline{PGM}$ pulse without verification. Then a verification / reprogramming loop is executed for each address. In the event a word fails to pass verification, up to 10 successive 50 µs pulses are applied with a verification after each pulse. If the word fails to verify after 10 pulses have been applied, the part is considered failed. After the word verifies properly, the next address is selected until all have been checked. V_{PP} is then lowered to 5.0V and V_{CC} to 5.0V. All words are read again and compared with the original data to determine if the device passes or fails.
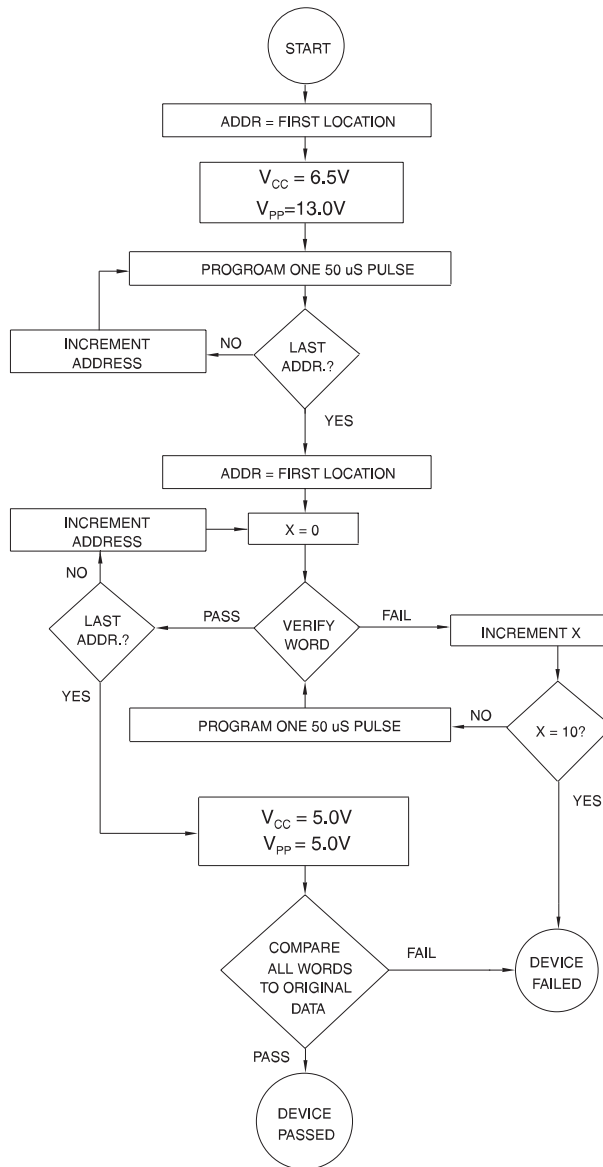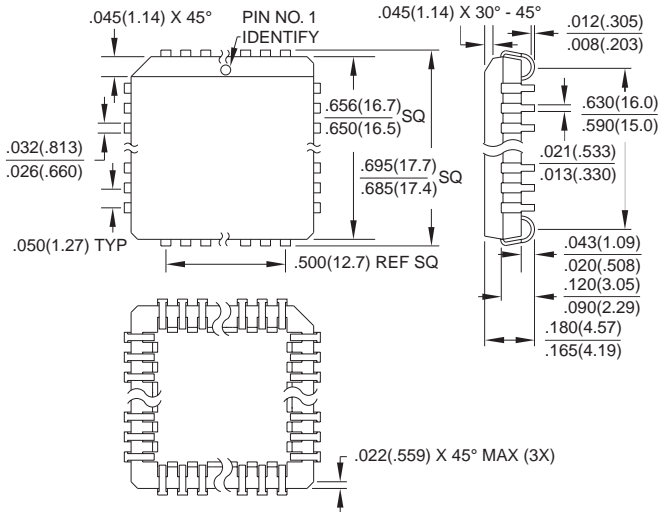
Ordering Information

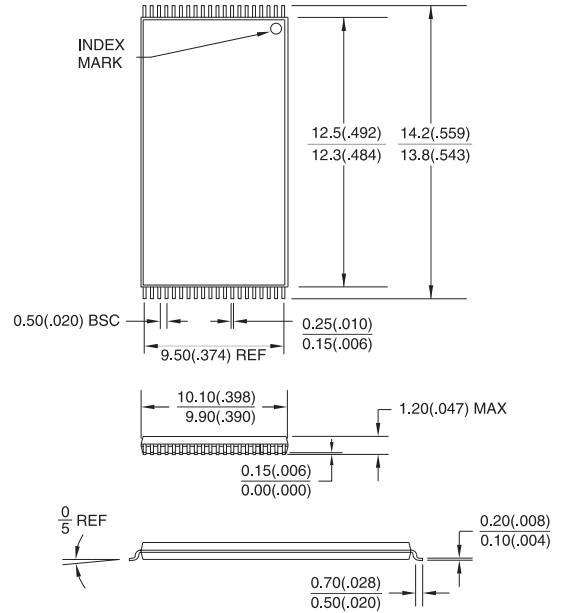| t_{ACC} (ns)	I_{CC} (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
45	30	0.1	AT27C516-45JC AT27C516-45VC	44J 40V	Commercial (0°C to 70°C)
	30	0.1	AT27C516-45JI AT27C516-45VI	44J 40V	Industrial (-40°C to 85°C)
55	30	0.1	AT27C516-55JC AT27C516-55VC	44J 40V	Commercial (0°C to 70°C)
	30	0.1	AT27C516-55JI AT27C516-55VI	44J 40V	Industrial (-40°C to 85°C)
70	30	0.1	AT27C516-70JC AT27C516-70VC	44J 40V	Commercial (0°C to 70°C)
	30	0.1	AT27C516-70JI AT27C516-70VI	44J 40V	Industrial (-40°C to 85°C)
85	30	0.1	AT27C516-85JC AT27C516-85VC	44J 40V	Commercial (0°C to 70°C)
	30	0.1	AT27C516-85JI AT27C516-85VI	44J 40V	Industrial (-40°C to 85°C)
100	30	0.1	AT27C516-10JC AT27C516-10VC	44J 40V	Commercial (0°C to 70°C)
	30	0.1	AT27C516-10JI AT27C516-10VI	44J 40V	Industrial (-40°C to 85°C)

Package Type	
44J	44-Lead, Plastic J-Leaded Chip Carrier (PLCC)
40V	40-Lead, Plastic Thin Small Outline Package (VSOP) (10mm x 14mm)

AT27C516

Packaging Information

44J, 44-Lead, Plastic J-Leaded Chip Carrier (PLCC)
Dimensions in Inches and (Millimeters)
JEDEC STANDARD MS-018 AC

.045(1.14) X 45°   PIN NO. 1
                   IDENTIFY

.045(1.14) X 30° - 45°

$\frac{.012(.305)}{.008(.203)}$

$\frac{.656(16.7)}{.650(16.5)}$ SQ

$\frac{.630(16.0)}{.590(15.0)}$

$\frac{.032(.813)}{.026(.660)}$

$\frac{.695(17.7)}{.685(17.4)}$ SQ

$\frac{.021(.533)}{.013(.330)}$

.050(1.27) TYP

$\frac{.043(1.09)}{.020(.508)}$

.500(12.7) REF SQ

.120(3.05)
.090(2.29)
$\frac{.180(4.57)}{.165(4.19)}$

.022(.559) X 45° MAX (3X)

40V, 40-Lead, Plastic Thin Small Outline Package (TSOP)
Dimensions in Millimeters and (Inches)
JEDEC OUTLINE MO-142 CA

INDEX
MARK

$\frac{12.5(.492)}{12.3(.484)}$ $\frac{14.2(.559)}{13.8(.543)}$

0.50(.020) BSC

$\frac{0.25(.010)}{0.15(.006)}$

9.50(.374) REF

$\frac{10.10(.398)}{9.90(.390)}$

1.20(.047) MAX

$\frac{0.15(.006)}{0.00(.000)}$

$\frac{0}{5}$ REF

$\frac{0.20(.008)}{0.10(.004)}$

$\frac{0.70(.028)}{0.50(.020)}$

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