4 Megabit (512K x 8) OTP CMOS EPROM

Features

- **Fast Read Access Time - 80 ns**
- **Low Power CMOS Operation**
  - **100 µA max. Standby**
  - **30 mA max. Active at 5 MHz**
- **JEDEC Standard Packages**
  - **32-Lead 600-mil PDIP**
  - **32-Lead 450-mil SOIC (SOP)**
  - **32-Lead PLCC**
  - **32-Lead TSOP**
- **5V ± 10% Supply**
- **High Reliability CMOS Technology**
  - **2000V ESD Protection**
  - **200 mA Latchup Immunity**
- **Rapid™ Programming Algorithm - 100 µs/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 80 ns, eliminating the need for speed reducing WAIT states on high-performance microprocessor systems.

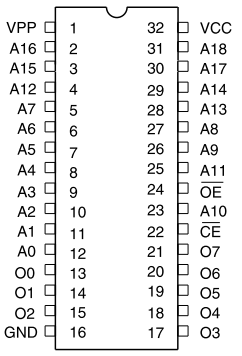
Atmel's scaled CMOS technology provides low active power consumption, and fast programming. Power consumption is typically 8 mA in active mode and less than 10 µA in standby mode.

(continued)

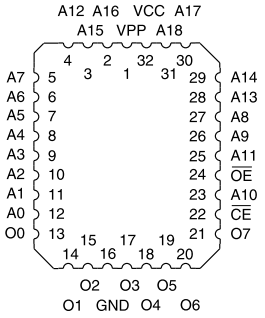
Pin Configurations

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

PDIP, SOIC Top View

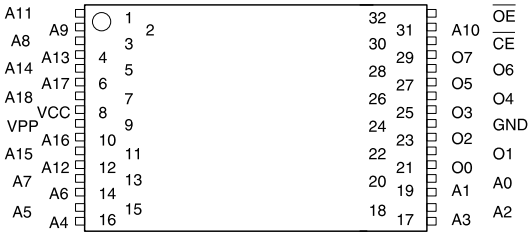


PLCC Top View



TSOP Top View

Type 1



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Description (Continued)

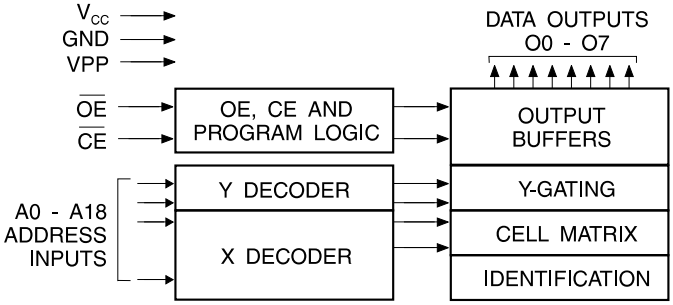
The AT27C040 is available in a choice of industry standard JEDEC-approved one-time programmable (OTP) plastic PDIP, PLCC, SOIC (SOP), and TSOP packages. The device features two-line control ($\overline{CE}$, $\overline{OE}$) to eliminate bus contention in high-speed systems.

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 µs/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.

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 +7.0V for pulses of less than 20 ns.

Operating Modes

Mode \ Pin	$\overline{CE}$	$\overline{OE}$	Ai	V_{PP}	Outputs
Read	V_{IL}	V_{IL}	Ai	X (1)	D_{OUT}
Output Disable	X	V_{IH}	X	X	High Z
Standby	V_{IH}	X	X	X	High Z
Rapid Program (2)	V_{IL}	V_{IH}	Ai	V_{PP}	D_{IN}
PGM Verify	X	V_{IL}	Ai	V_{PP}	D_{OUT}
PGM Inhibit	V_{IH}	V_{IH}	X	V_{PP}	High Z
Product Identification (4)	V_{IL}	V_{IL}	A9 = V_H (3) A0 = V_{IH} or V_{IL} A1 - A18 = V_{IL}	X	Identification Code

Notes: 1. X can be V_{IL} or V_{IH}.
2. Refer to Programming characteristics.
3. V_H = 12.0 ± 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.

DC and AC Operating Conditions for Read Operation

		AT27C040			
		-80	-10	-12	-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_{CC} Power Supply		5V ± 5%	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} ± 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 or before V_{PP}, and removed simultaneously or after V_{PP}.

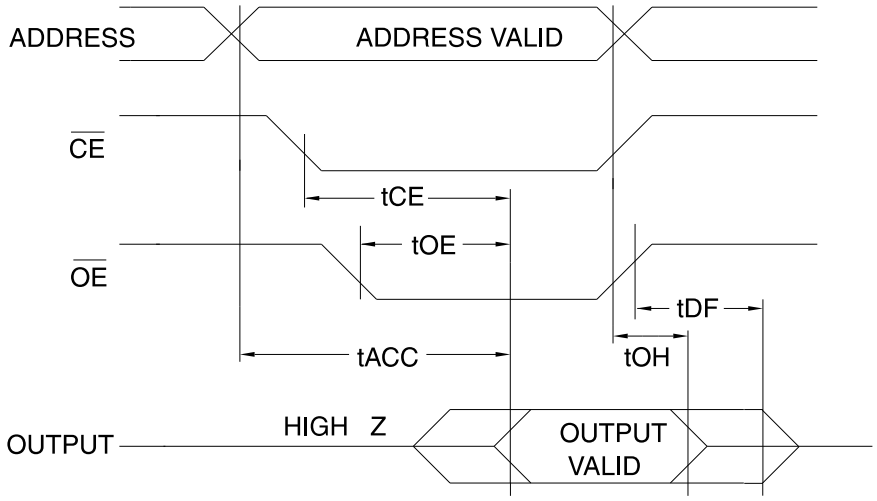
2. V_{PP} may be connected directly to V_{CC}, except during programming. The supply current would then be the sum of I_{CC} and I_{PP}.

AC Characteristics for Read Operation

			AT27C040								
			-80		-10		-12		-15		
Symbol	Parameter	Condition	Min	Max	Min	Max	Min	Max	Min	Max	Units
t_{ACC} (3)	Address to Output Delay	$\overline{CE}$ = $\overline{OE}$ = V_{IL}		80		100		120		150	ns
t_{CE} (2)	$\overline{CE}$ to Output Delay	$\overline{OE}$ = V_{IL}		80		100		120		150	ns
t_{OE} (2, 3)	$\overline{OE}$ to Output Delay	$\overline{CE}$ = V_{IL}		35		35		35		40	ns
t_{DF} (4, 5)	$\overline{OE}$ or $\overline{CE}$ High to Output Float, whichever occurred first			30		30		30		30	ns
t_{OH}	Output Hold from Address, $\overline{CE}$ or $\overline{OE}$, whichever occurred first		0		0		0		0		ns

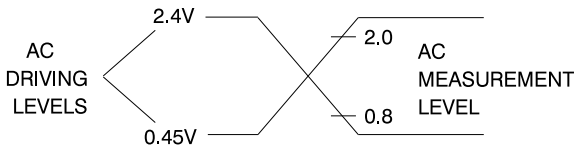
Notes: 2, 3, 4, 5. - see AC Waveforms for Read Operation.

AC Waveforms for Read Operation (1)



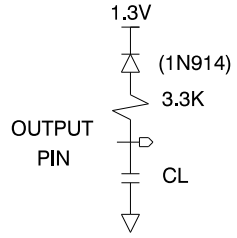
Notes: 1. Timing measurement references are 0.8V and 2.0V. Input AC drive levels are 0.45V and 2.4V, unless otherwise specified.
2. $\overline{OE}$ may be delayed up to $t_{CE} - t_{OE}$ after the falling edge of $\overline{CE}$ without impact on t_{CE} .
3. $\overline{OE}$ may be delayed up to $t_{ACC}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



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

Output Test Load



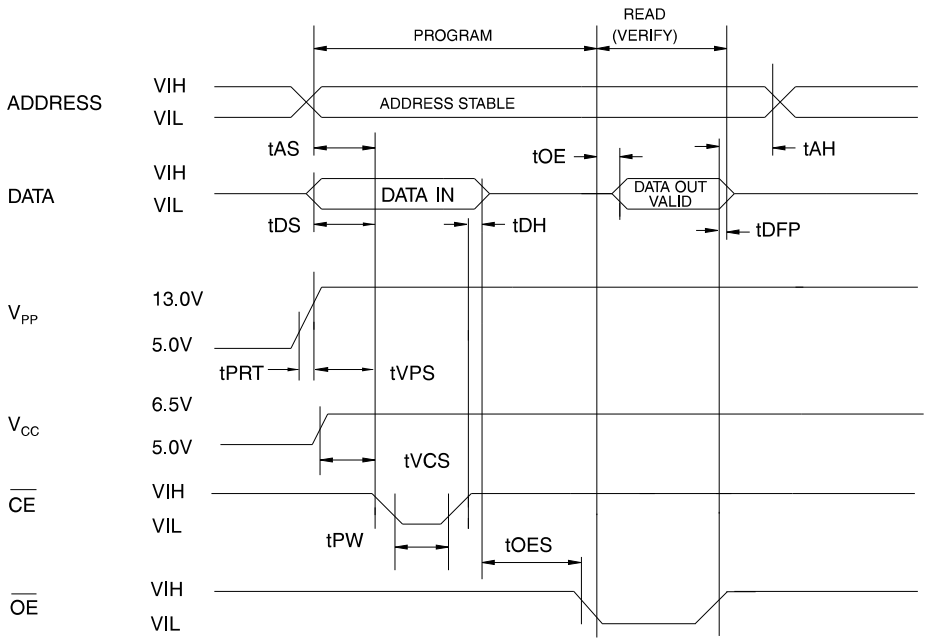
Note: CL = 100 pF including jig capacitance.

Pin Capacitance (f = 1 MHz, T = 25°C) (1)

	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 [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 AT27C040 a 0.1 µF capacitor is required across V_{PP} and ground to suppress spurious voltage transients.

DC Programming Characteristics

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

Symbol	Parameter	Test Conditions	Limits Min	Limits Max	Units
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} + 0.7	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)			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

AC Programming Characteristics

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

Symbol	Parameter	Test Conditions* (1)	Limits Min	Limits Max	Units
t_{AS}	Address Setup Time		2		µs
t_{OES}	$\overline{OE}$ Setup Time		2		µs
t_{DS}	Data Setup Time		2		µs
t_{AH}	Address Hold Time		0		µs
t_{DH}	Data Hold Time		2		µs
t_{DFP}	$\overline{OE}$ High to Output Float Delay (2)		0	130	ns
t_{VPS}	V_{PP} Setup Time		2		µs
t_{VCS}	V_{CC} Setup Time		2		µs
t_{PW}	$\overline{CE}$ Program Pulse Width (3)		95	105	µs
t_{OE}	Data Valid from $\overline{OE}$ (2)			150	ns
t_{PRT}	V_{PP} Pulse Rise Time During Programming		50		ns

*AC Conditions of Test:

Input Rise and Fall Times (10% to 90%).....20 ns
Input Pulse Levels.....0.45V to 2.4V
Input Timing Reference Level.....0.8V to 2.0V
Output Timing Reference Level.....0.8V to 2.0V

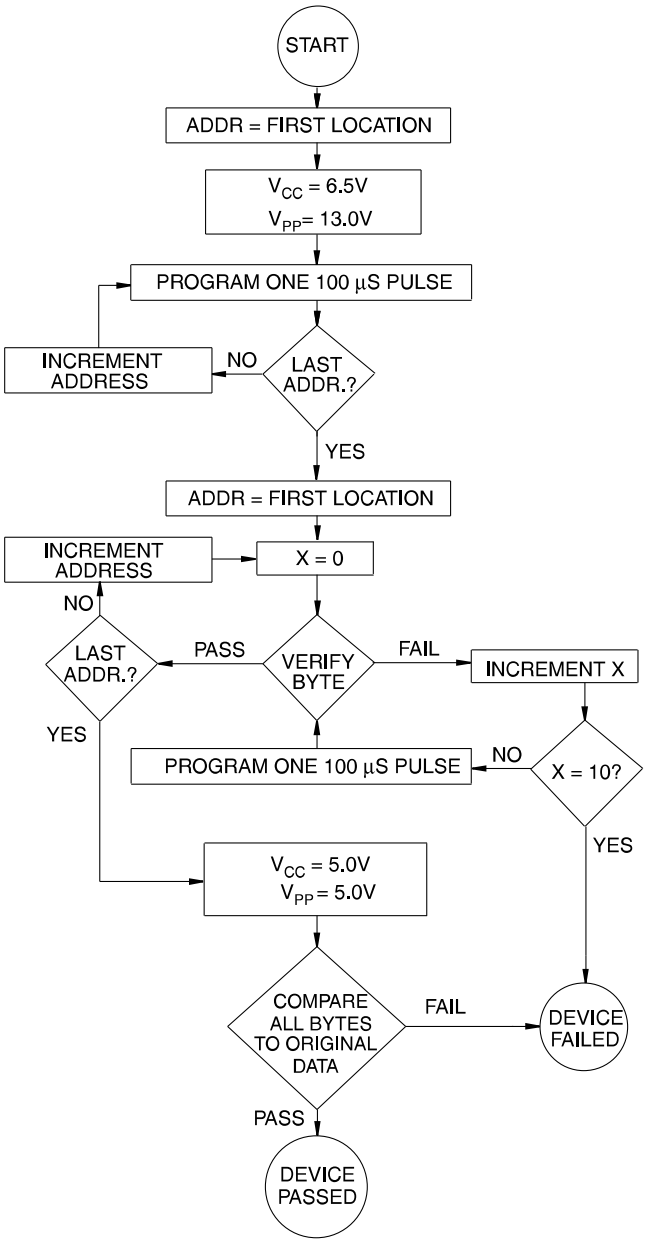
Notes: 1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
2. This parameter is only sampled and is not 100% tested. Output Float is defined as the point where data is no longer driven —see timing diagram.
3. Program Pulse width tolerance is 100 µsec ± 5%.

Atmel's 27C040 Integrated Product Identification Code

Codes	Pins A0	O7	O6	O5	O4	O3	O2	O1	O0	Hex Data
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 µs $\overline{CE}$ 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 100 µs $\overline{CE}$ 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 µs 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_{PP} is then lowered to 5.0V and V_{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			
80	30	0.1	AT27C040-80JC AT27C040-80PC AT27C040-80RC AT27C040-80TC	32J 32P6 32R 32T	Commercial (0°C to 70°C)
	30	0.1	AT27C040-80JI AT27C040-80PI AT27C040-80RI AT27C040-80TI	32J 32P6 32R 32T	Industrial (-40°C to 85°C)
100	30	0.1	AT27C040-10JC AT27C040-10PC AT27C040-10RC AT27C040-10TC	32J 32P6 32R 32T	Commercial (0°C to 70°C)
	30	0.1	AT27C040-10JI AT27C040-10PI AT27C040-10RI AT27C040-10TI	32J 32P6 32R 32T	Industrial (-40°C to 85°C)
120	30	0.1	AT27C040-12JC AT27C040-12PC AT27C040-12RC AT27C040-12TC	32J 32P6 32R 32T	Commercial (0°C to 70°C)
	30	0.1	AT27C040-12JI AT27C040-12PI AT27C040-12RI AT27C040-12TI	32J 32P6 32R 32T	Industrial (-40°C to 85°C)
150	30	0.1	AT27C040-15JC AT27C040-15PC AT27C040-15RC AT27C040-15TC	32J 32P6 32R 32T	Commercial (0°C to 70°C)
	30	0.1	AT27C040-15JI AT27C040-15PI AT27C040-15RI AT27C040-15TI	32J 32P6 32R 32T	Industrial (-40°C to 85°C)

Package Type	
32J	32 Lead, Plastic J-Leaded Chip Carrier (PLCC)
32P6	32 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)
32R	32 Lead, 0.450" Wide, Plastic Gull Wing Small Outline (SOIC)
32T	32 Lead, Plastic Thin Small Outline Package (TSOP)