1 Megabit (128K x 8) OTP CMOS EPROM

Features

- **Fast Read Access Time - 45 ns**
- **Low Power CMOS Operation**
  - **100 µA max. Standby**
  - **25 mA max. Active at 5 MHz (AT27C010L)**
  - **35 mA max. Active at 5 MHz (AT27C010)**
- **JEDEC Standard Packages**
  - **32-Lead 600-mil PDIP**
  - **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 AT27C010/L is a low-power, high performance 1,048,576 bit one-time programmable read only memory (OTP EPROM) organized as 128K by 8 bits. They require only one 5V power supply in normal read mode operation. Any byte can be accessed in less than 45 ns, eliminating the need for speed reducing WAIT states on high performance microprocessor systems.

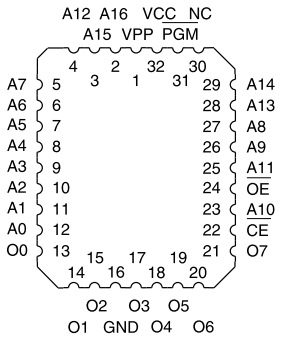
Two power versions are offered. In read mode, the AT27C010 typically consumes 25 mA while the AT27C010L requires only 8 mA. Standby mode supply current for both parts is typically less than 10 µA.

(continued)

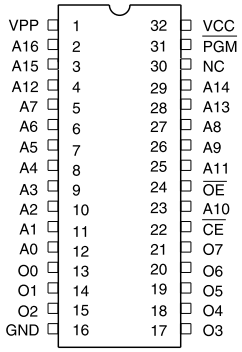
Pin Configurations

Pin Name	Function
A0 - A16	Addresses
O0 - O7	Outputs
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{PGM}$	Program Strobe
NC	No Connect

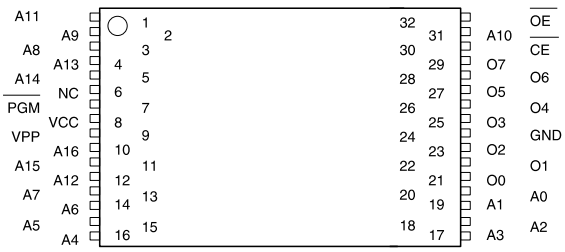
PLCC Top View



PDIP Top View



TSOP Top View
Type 1



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Description (Continued)

The AT27C010/L in 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 ($\overline{CE}$, $\overline{OE}$) to give designers the flexibility to prevent bus contention.

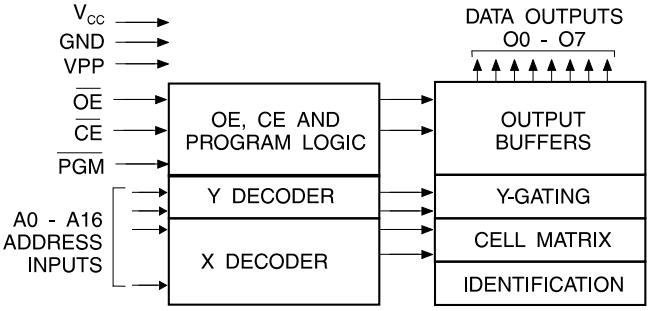
With 128K byte storage capability, the AT27C010/L allows firmware to be stored reliably and to be accessed by the system without the delays of mass storage media.

Atmel's 27C010/L 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 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	$\overline{CE}$	$\overline{OE}$	$\overline{PGM}$	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	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 - A16 = 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

		AT27C010 / AT27C010L					
		-45	-55	-70	-90	-12	-15
Operating Temp. (Case)	Com.	0°C - 70°C	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	-40°C - 85°C
V_{CC} Supply		5V ± 10%	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} ± 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}	AT27C010L		25	mA
			AT27C010		35	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

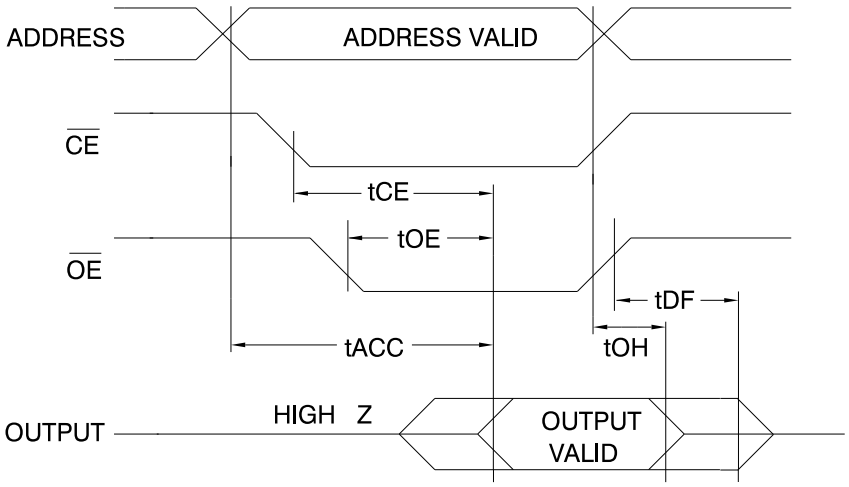
Notes: 1. V_{CC} must be applied simultaneously or before V_{PP}, and removed simultaneously or after V_{PP}.
2. V_{PP} may be connected directly to V_{CC}, except during programming. The supply current would then be the sum of I_{CC} and I_{PP}.

AC Characteristics for Read Operation

			AT27C010 / AT27C010L										
			-45		-55		-70		-90		-12		-15		
Symbol	Parameter	Condition	Min	Max	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		90		120		150	ns
t_{CE} (2)	$\overline{CE}$ to Output Delay	$\overline{OE}$ = V_{IL}		45		55		70		90		120		150	ns
t_{OE} (2, 3)	$\overline{OE}$ to Output Delay	$\overline{CE}$ = V_{IL}		20		25		30		35		35		40	ns
t_{DF} (4, 5)	$\overline{OE}$ or $\overline{CE}$ High to Output Float, whichever occurred first			20		20		25		25		30		35	ns
t_{OH}	Output Hold from Address, $\overline{CE}$ or $\overline{OE}$, whichever occurred first		7		7		7		0		0		0		ns

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

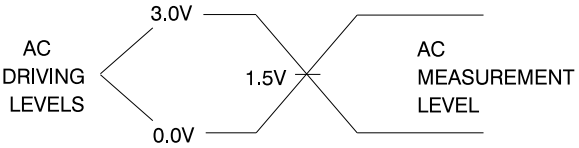
AC Waveforms for Read Operation [1]



Notes:
1. Timing measurement 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.

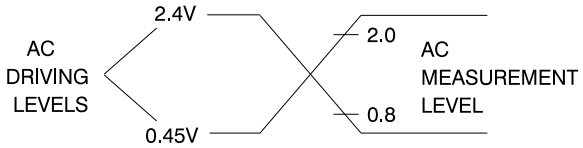
Input Test Waveforms and Measurement Levels

For -45 and -55 devices only:



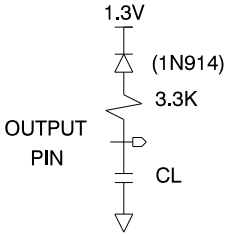
t_R, t_F < 5 ns (10% to 90%)

For -70, -90, -12, -15, and -20 devices:



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

Output Test Load



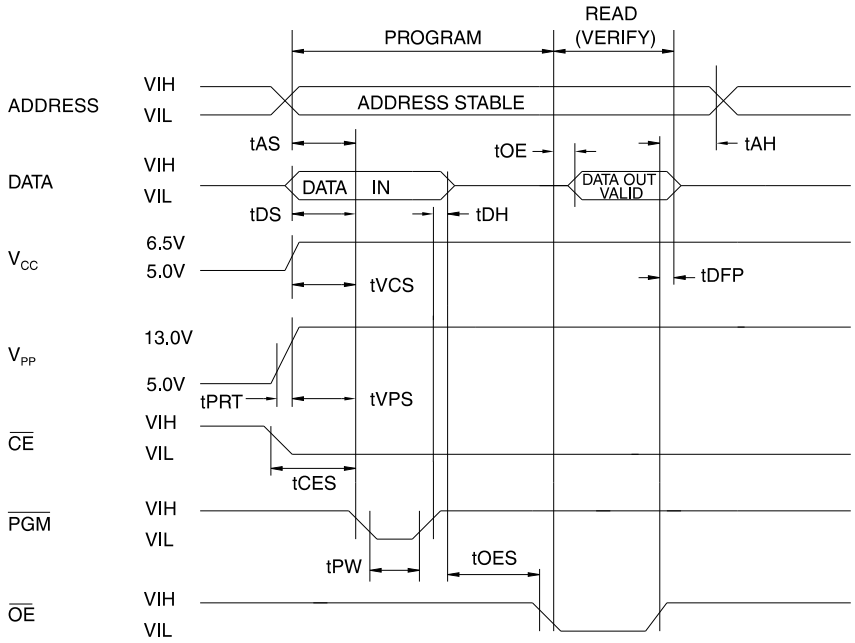
Note: CL = 100 pF including jig capacitance, except for the -45 and -55 devices, where CL= 30 pF.

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 AT27C010/L, 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} + 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)			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

AC Programming Characteristics

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

Symbol	Parameter	Test Conditions* (1)	Limits Min	Limits Max	Units
t_{AS}	Address Setup Time		2		µs
t_{CES}	$\overline{CE}$ 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}	$\overline{PGM}$ Program Pulse Width (3)		95	105	µs
t_{OE}	Data Valid from $\overline{OE}$			150	ns
t_{PRT}	V_{PP} Pulse Rise TIme During Programming		50		ns

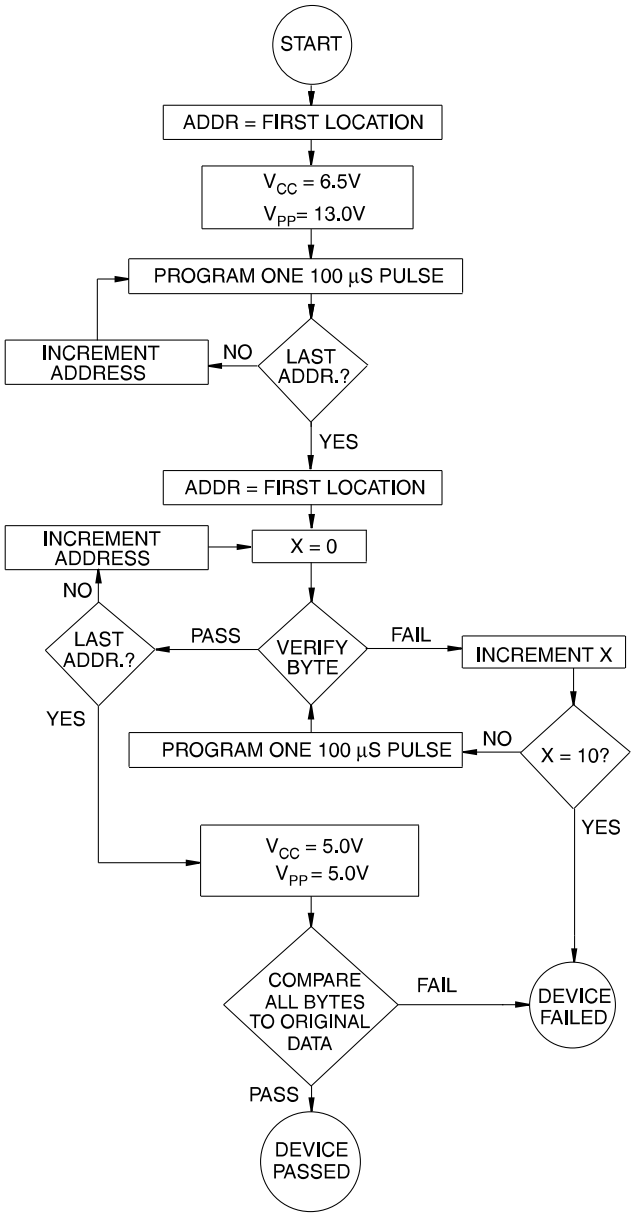
*AC Conditions of Test:

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 27C010/L 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	0	1	0	1	05

Rapid Programming Algorithm

A 100 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 100 µs $\overline{PGM}$ 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 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.