Features

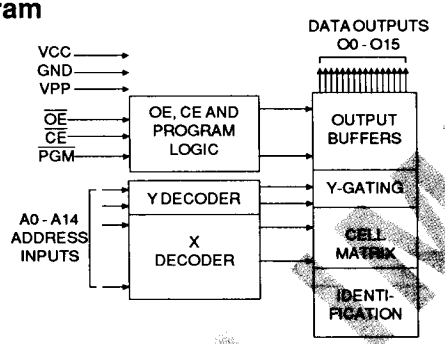
- Low Power CMOS Operation
  - 100 µA max. Standby
  - 30 mA max. Active at 5 MHz
- Fast Read Access Time - 150ns
- JEDEC Standard Packages
  - 40-Lead 600 mil OTP Plastic DIP
  - 44-Pad OTP PLCC
- 5V±10% Supply
- High Reliability CMOS Technology
  - 2000V ESD Protection
  - 200mA Latchup Immunity
- Rapid Programming - 100µs/word (typical)
- Two-line Control
- CMOS and TTL Compatible Inputs and Outputs
- Integrated Product Identification Code
- Commercial and Industrial Temperature Ranges

512K (32K x 16) One Time Programmable (OTP) CMOS PROM

5

Preliminary

Block Diagram



Description

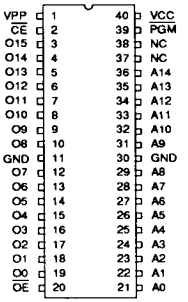
The AT32C16 chip is a low-power, high-performance One Time Programmable (OTP) Read Only Memory (PROM) organized 32K x 16. It requires only one 5V power supply in normal read mode operation. Any word can be accessed in less than 150ns, eliminating the need for speed reducing WAIT states. The by-16 organization makes these parts ideal for high-performance 16 and 32 bit microprocessor systems.

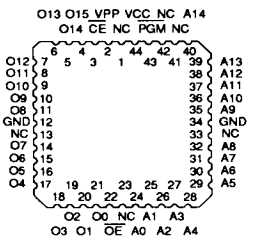
The AT32C16 is ideal for replacing the two 256K EPROMs normally used on personal computer motherboards.

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.





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

Description (Continued)

The AT32C16 comes in a choice of industry standard JEDEC-approved packages including; 40-pin DIP one time programmable (OTP) plastic or OTP plastic J-leaded chip carrier (PLCC). All devices feature two line control ($\overline{CE}$, $\overline{OE}$) to give designers the flexibility to prevent bus contention.

With high density 32K word storage capability, the AT32C16 allow firmware to be stored reliably and to be accessed by the system without the delays of mass storage media.

Atmel's 32C16 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 100µs/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.

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.

Notes:
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 overshoot to +7.0V for pulses of less than 20ns.

Operating Modes

MODE \ PIN	$\overline{CE}$	$\overline{OE}$	$\overline{PGM}$	Ai	V_{PP}	V_{CC}	Outputs
Read	V_{IL}	V_{IL}	X(1)	Ai	X	V_{CC}	D_{OUT}
Output Disable	X	V_{IH}	X	X	X	V_{CC}	High Z
Standby	V_{IH}	X	X	X	X(5)	V_{CC}	High Z
Rapid Program(2)	V_{IL}	V_{IH}	V_{IL}	Ai	V_{PP}	V_{CC}	D_{IN}
PGM Verify	V_{IL}	V_{IL}	V_{IH}	Ai	V_{PP}	V_{CC}	D_{OUT}
PGM Inhibit	V_{IH}	X	X	X	V_{PP}	V_{CC}	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}	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}.

D.C. and A.C. Operating Conditions for Read Operation

		AT32C16			
		-15	-17	-20	-25
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
Vcc Power Supply		5V ± 10%	5V ± 10%	5V ± 10%	5V ± 10%

D.C. and Operating Characteristics for Read Operation

Symbol	Parameter	Condition		Min	Max	Units
I_{LI}	Input Load Current	V_{IN}=-0.1V to V_{CC}+1V			5	µA
I_{LO}	Output Leakage Current	V_{OUT}=-0.1V to V_{CC}+0.1V			10	µA
I_{PP1} (2)	V_{PP} (1) Read/Standby Current	V_{PP}=3.8 to V_{CC}+0.3V			10	µA
I_{SB}	V_{CC} (1) Standby Current	I_{SB1} (CMOS) $\overline{CE}$=V_{CC}-0.3 to V_{CC}+1.0V			100	µA
		I_{SB2} (TTL) $\overline{CE}$=2.0 to V_{CC}+1.0V			1	mA
I_{CC}	V_{CC} Active Current	f=5MHz,I_{OUT}=0mA, $\overline{CE}$=V_{IL}	Com.		30	mA
			Ind.		40	mA
V_{IL}	Input Low Voltage			-0.6	0.8	V
V_{IH}	Input High Voltage			2.0	V_{CC}+1	V
V_{OL}	Output Low Voltage	I_{OL}=2.1mA			.45	V
V_{OH}	Output High Voltage	I_{OH}=-100µA		V_{CC}-0.3		V
		I_{OH}=-2.5mA		3.5		V
		I_{OH}=-400µA		2.4		V

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

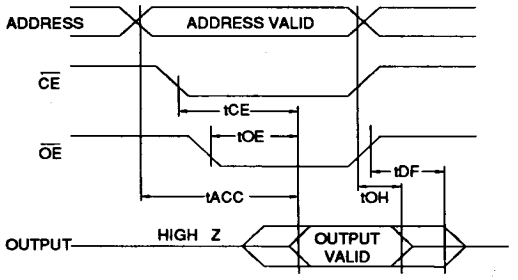
2. V_{PP} may be connected directly to V_{CC}, except during programming. The supply current would then be the sum of I_{CC} and I_{PP}.

A.C. Characteristics for Read Operation

				AT32C16								
				-15		-17		-20		-25		
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}	Com.		150		170		200		250	ns
			Ind.				170		200		250	ns
t_{CE} (2)	$\overline{CE}$ to Output Delay	$\overline{OE}$=V_{IL}			150		170		200		250	ns
t_{OE} (2,3)	$\overline{OE}$ to Output Delay	$\overline{CE}$=V_{IL}			65		65		75		100	ns
t_{DF} (4,5)	$\overline{OE}$ High to Output Float	$\overline{CE}$=V_{IL}			40		50		55		60	ns
t_{OH}	Output Hold from Address, $\overline{CE}$ or $\overline{OE}$, whichever occurred first	$\overline{CE}$=$\overline{OE}$ =V_{IL}			0		0		0		0	ns

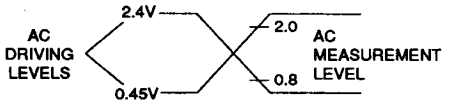
Notes: 2, 3, 4, 5. - see AC Waveforms for Read Operation.

A.C. Waveforms for Read Operation [1]



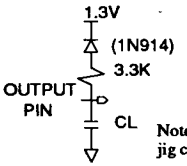
Notes:
1. Timing measurement references are 0.8V and 2.0V. Input AC driving levels are 0.45V and 2.4V, unless otherwise specified.
2. $\overline{OE}$ may be delayed up to t_{CE}-t_{OE} after the falling edge of $\overline{CE}$ without impact on t_{CE}.
3. $\overline{OE}$ may be delayed up to t_{ACC}-t_{OE} 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 < 20ns (10% to 90%)

Output Test Load



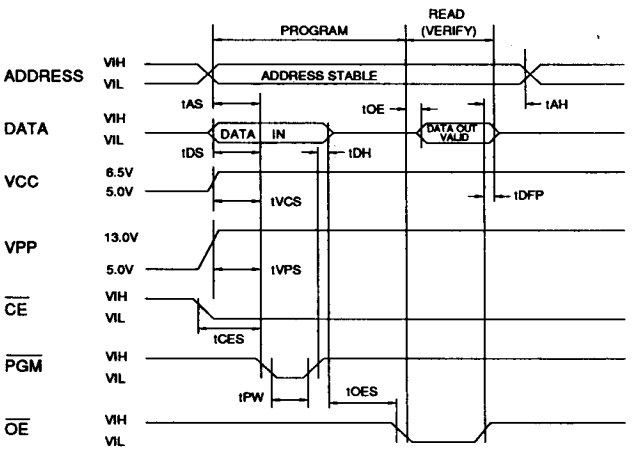
Note: C_L=100pF including jig capacitance.

Pin Capacitance (f=1MHz T=25°C) [1]

	Typ	Max	Units	Conditions
C_{IN}	4	8	pF	V_{IN} = 0V
C_{OUT}	8	12	pF	V_{OUT} = 0V

Notes: 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 AT32C16 a 0.1µF capacitor is required across V_{PP} and ground to suppress spurious voltage transients.

D.C. 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	Max	Units
I_{LI}	Input Load Current	$V_{IN}=V_{IL},V_{IH}$		10	µA
V_{IL}	Input Low Level	(All Inputs)	-0.6	0.8	V
V_{IH}	Input High Level		2.0	V_{CC}+1	V
V_{OL}	Output Low Volt.	I_{OL}=2.1mA		.45	V
V_{OH}	Output High Volt.	I_{OH}=-400µA	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

A.C. Programming Characteristics

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

Symbol	Parameter	Test Conditions* (see Note 1)	Limits Min	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	(Note 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	(Note 3)	95	105	µs
t_{OE}	Data Valid from $\overline{OE}$			150	ns

*A.C. Conditions of Test:

Input Rise and Fall Times (10% to 90%) 20ns
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:

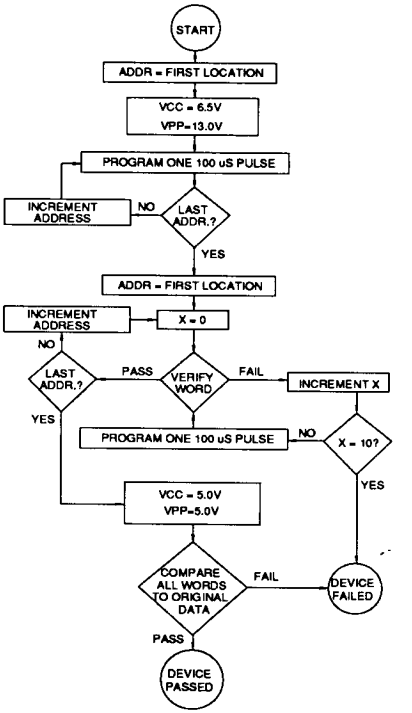
1. V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
2. This parameter is only sampled and is not 100% tested. Output Float is defined as the point where data is no longer driven — see timing diagram.
3. Program Pulse width tolerance is 100µsec±5%.

Atmel's 32C16 Integrated Product Identification Code:

Codes	Pins A0	015-08	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

Rapid Programming Algorithm

A 100µs $\overline{PGM}$ 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 100µs $\overline{PGM}$ 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 100µs 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			
170	30	0.1	AT32C16-17JC AT32C16-17PC	44J 40P6	Commercial (0°C to 70°C)
170	40	0.2	AT32C16-17JI AT32C16-17PI	44J 40P6	Industrial (-40°C to 85°C)
200	30	0.1	AT32C16-20JC AT32C16-20PC	44J 40P6	Commercial (0°C to 70°C)
200	40	0.2	AT32C16-20JI AT32C16-20PI	44J 40P6	Industrial (-40°C to 85°C)
250	30	0.1	AT32C16-25JC AT32C16-25PC	44J 40P6	Commercial (0°C to 70°C)
250	40	0.2	AT32C16-25JI AT32C16-25PI	44J 40P6	Industrial (-40°C to 85°C)

Package Type	
44J	44 Lead, Plastic J-Leaded Chip Carrier OTP (PLCC)
40P6	40 Lead, 0.600" Wide, Plastic Dual Inline Package OTP (PDIP)