16K (2K x 8) High Speed CMOS E^2PROM

Features

- Fast Read Access Time - 45ns
- Fast Byte Write - 1ms
- Self-Timed Byte Write Cycle
  - Internal Address and Data Latches
  - Internal Control Timer
  - Automatic Clear Before Write
- Direct Microprocessor Control
  - DATA POLLING
- Low Power
  - 80mA Active Current
  - 500µA CMOS Standby Current (28HC16L)
- High Reliability CMOS Technology
  - Endurance: 10^4 cycles
  - Data Retention: 10 years
- 5 V ± 10% Supply
- CMOS & TTL Compatible Inputs and Outputs
- JEDEC Approved Byte-Wide Pinout
- Full Military, Commercial, and Industrial Temperature Ranges

Description

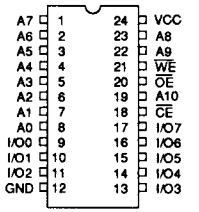
The AT28HC16/16L is a high-speed, low-power Electrically Erasable and Programmable Read Only Memory. The device is optimized for high speed applications, featuring access times to 45ns. Its 16k of memory is organized as 2,048 words by 8 bits. The AT28HC16/16L comes in a space saving 24 pin DIP.

The AT28HC16/16L is accessed like a static RAM for the read or write cycles without the need of external components. During a byte write, the address and data are latched internally, freeing the microprocessor address and data bus for other operations. Following the initiation of a write cycle, the device being written will go to a busy state and automatically clear and write the latched data using an internal control timer. Data polling of I/O7 may be used to detect the end of the write cycle. Once a write cycle has been completed, a new access for a read or a write may begin immediately.

Atmel's high-speed CMOS technology is used to achieve access times of 45ns for the AT28HC16 with under 440mW of power dissipation. The AT28HC16L offers ultra low standby power consumption of under 2.75mW at access time to 55ns.

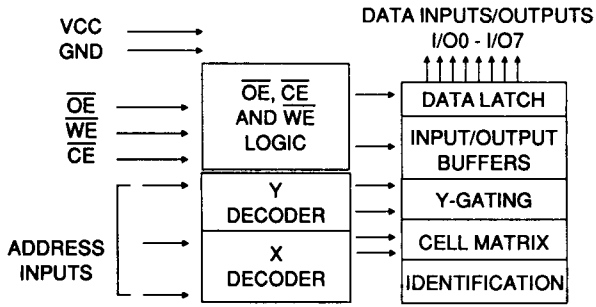
The AT28HC16/16L has additional features to ensure high quality and manufacturability. The device utilizes internal error correction for extended endurance and for improved data retention characteristics. An extra 16 bytes of E^2PROM are available for device identification or tracking.

Pin Configurations



Pin Name	Function
A0 - A10	Addresses
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
NC	No Connect

Block Diagram



Operating Modes

Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	I/O
Read	V_{IL}	V_{IL}	V_{IH}	DOUT
Write[2]	V_{IL}	V_{IH}	V_{IL}	DIN
Standby/Write Inhibit	V_{IH}	X[1]	X	High Z
Write Inhibit	X	X	V_{IH}	
Write Inhibit	X	V_{IL}	X	
Output Disable	X	V_{IH}	X	High Z
Chip Erase	V_{IL}	V_H [3]	V_{IL}	High Z

Notes: 1. X can be V_{IL} or V_{IH}.
2. Refer to A.C. Programming Waveforms.
3. $V_H = 12.0V \pm 0.5V$.

Device Operation

READ: The AT28HC16/16L is accessed like a Static RAM. When $\overline{CE}$ and $\overline{OE}$ are low and $\overline{WE}$ is high, the data stored at the memory location determined by the address pins is asserted on the outputs. The outputs are put in a high impedance state whenever $\overline{CE}$ or $\overline{OE}$ is high. This dual line control gives designers increased flexibility in preventing bus contention.

BYTE WRITE: Writing data into the AT28HC16/16L is similar to writing into a Static RAM. A low pulse on the $\overline{WE}$ or $\overline{CE}$ input with $\overline{OE}$ high and $\overline{CE}$ or $\overline{WE}$ low (respectively) initiates a byte write. The address location is latched on the last falling edge of $\overline{WE}$ (or $\overline{CE}$); the new data is latched on the first rising edge. Internally, the device performs a self-clear before write. Once a byte write has been started, it will automatically time itself to completion.

$\overline{DATA}$ POLLING: The AT28HC16/16L provides $\overline{DATA}$ POLLING to signal the completion of a write cycle. During a write cycle, an attempted read of the data being written results in the complement of that data for I/O7 (the other outputs are indeterminate). When the write cycle is finished, true data appears on all outputs.

WRITE PROTECTION: Inadvertent writes to the device are protected against in the following ways: (a) Vcc sense— if Vcc is below 3.8V (typical) the write function is inhibited. (b) Vcc power on delay— once Vcc has reached 3.8V the device will automatically time out 5ms (typical) before allowing a byte write. (c) Write Inhibit— holding any one of $\overline{OE}$ low, $\overline{CE}$ high or $\overline{WE}$ high inhibits byte write cycles. (d) Noise Protection— a $\overline{WE}$ or $\overline{CE}$ pulse of less than 10ns (typical) will not initiate a write cycle.

CHIP CLEAR: The contents of the entire memory of the AT28HC16/16L may be set to the high state by the CHIP CLEAR operation. By setting $\overline{CE}$ low and $\overline{OE}$ to 12 volts, the chip is cleared when a 10 msec low pulse is applied to $\overline{WE}$.

DEVICE IDENTIFICATION: In the AT28HC16/16L there are an extra 16 bytes of E^2PROM memory available to the user for device identification. By raising A9 to $12 \pm 0.5V$ and using address locations 7F0H to 7FFH the additional bytes may be written to or read from in the same manner as the regular memory array.

Absolute Maximum Ratings*

Temperature Under Bias	-55°C to +125°C
Storage Temperature	-65°C to +150°C
All Input Voltages (including N.C. Pins) with Respect to Ground	-0.6V to +6.25V
All Output Voltages with Respect to Ground	-0.6V to V_{CC} +0.6V
Voltage on $\overline{OE}$ and A9 with Respect to Ground	-0.6V to +13.5V

*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.

D.C. and A.C. Operating Range

		AT28HC16-45	AT28HC16L-55	AT28HC16-55	AT28HC16-70 AT28HC16L-70	AT28HC16-90 AT28HC16L-90
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
	Mil.		-55°C - 125°C	-55°C - 125°C	-55°C - 125°C	-55°C - 125°C
V_{CC} Power Supply		5V±10%	5V±10%	5V±10%	5V±10%	5V±10%

D.C. Characteristics

Symbol	Parameter	Condition		Min	Max	Units
I_{LI}	Input Load Current	V_{IN}=0V to V_{CC} + 1V			10	µA
I_{LO}	Output Leakage Current	$V_{I/O}$=0V to V_{CC}			10	µA
I_{SB1}	V_{CC} Standby Current CMOS	$\overline{CE}$=V_{CC}-0.3V to V_{CC} + 1.0V	(AT28HC16L)		500	µA
I_{SB2}	V_{CC} Standby Current TTL	$\overline{CE}$=2.0V to V_{CC} + 1.0V	AT28HC16L		3	mA
			AT28HC16		60	mA
I_{CC}	V_{CC} Active Current A.C.	f=10MHz; I_{OUT}=0mA			80	mA
V_{IL}	Input Low Voltage				0.8	V
V_{IH}	Input High Voltage			2.0		V
V_{OL}	Output Low Voltage	I_{OL}=12mA			.4	V
V_{OH}	Output High Voltage	I_{OH}=-4.0mA		2.4		V

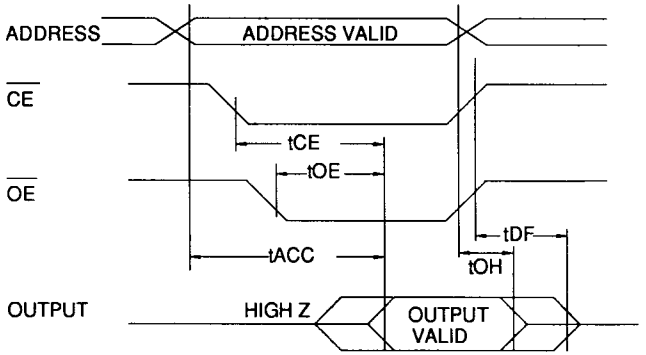
Pin Capacitance (f=1MHz T=25°C) [5]

	Typ	Max	Units	Conditions
C_{IN}	4	6	pF	V_{IN} = 0V
C_{OUT}	8	12	pF	V_{OUT} = 0V

A.C. Read Characteristics [1]

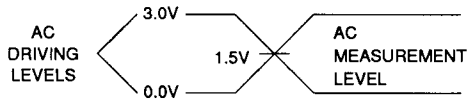
Symbol	Parameter	AT28HC16 -45		AT28HC16 -55		AT28HC16L -55		AT28HC16 -70		AT28HC16L -70		AT28HC16L -90		Units
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{ACC}	Address to Output Delay		45		55		55		70		70		90	ns
t_{CE} [2]	$\overline{CE}$ to Output Delay		30		40		55		50		70		90	ns
t_{OE} [3]	$\overline{OE}$ to Output Delay	0	30	0	40	0	40	0	50	0	50	0	50	ns
t_{DF} [4,5]	$\overline{OE}$ to Output Float	0	30	0	40	0	40	0	50	0	50	0	50	ns
t_{OH}	Output Hold from $\overline{OE}$ or Address, whichever occurred first	0		0		0		0		0		0		ns

A.C. Read Waveforms



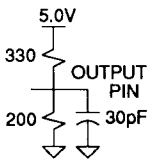
Notes:
1. C_L = 30pF.
2. $\overline{CE}$ may be delayed up to t_{ACC} - t_{CE} after the address transition without impact on t_{ACC}.
3. $\overline{OE}$ may be delayed up to t_{CE} - t_{OE} after the falling edge of $\overline{CE}$ without impact on t_{CE} or by t_{ACC} - t_{OE} after an address change without impact on t_{ACC}.
4. t_{DF} is specified from $\overline{OE}$ or $\overline{CE}$ whichever occurs first (C_L = 5pF).
5. This parameter is characterized and is not 100% tested.

Input Test Waveforms and Measurement Level



t_R, t_F < 5ns

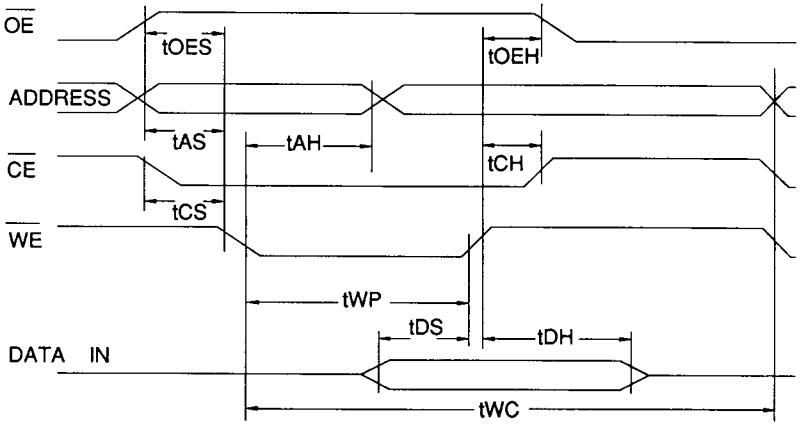
Output Test Load



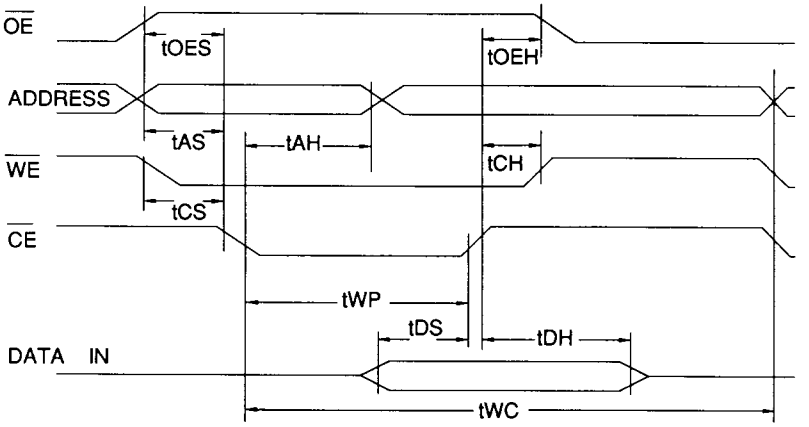
A.C. Write Characteristics

Symbol	Parameter	Min	Typ	Max	Units
t_{AS}, t_{OES}	Address, $\overline{OE}$ Set-up Time	0			ns
t_{AH}	Address Hold Time	50			ns
t_{WP}	Write Pulse Width	100		1000	ns
t_{DS}	Data Set-up Time	50			ns
t_{DH},t_{OEH}	Data, $\overline{OE}$ Hold Time	0			ns
t_{WC}	Write Cycle Time		0.5	1.0	ms

A.C. Write Waveforms- $\overline{WE}$ Controlled



A.C. Write Waveforms- $\overline{CE}$ Controlled

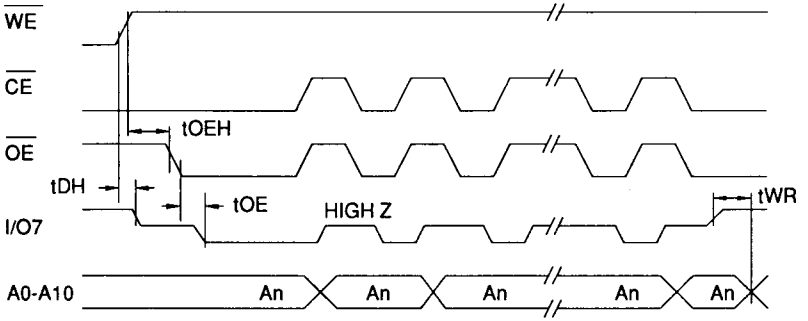


$\overline{\text{Data}}$ Polling Characteristics[1]

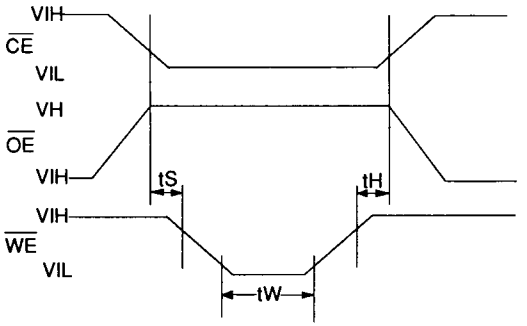
Symbol	Parameter	Min	Typ	Max	Units
t_{DH}	Data Hold Time	0			ns
t_{OEH}	$\overline{OE}$ Hold Time	0			ns
t_{OE}	$\overline{OE}$ to Output Delay			100	ns
t_{WR}	Write Recovery Time	0			ns

Note: 1. These parameters are characterized and not 100% tested.

$\overline{\text{Data}}$ Polling Waveforms

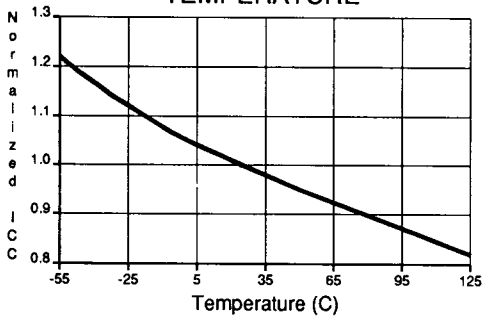


Chip Erase Waveforms

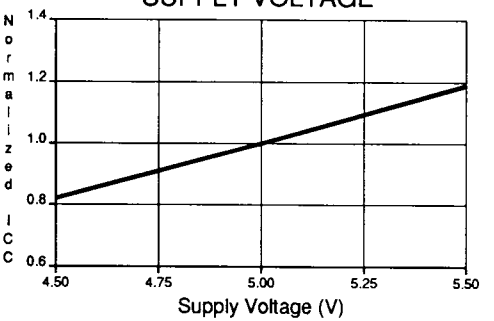


$t_S = t_H = 1\mu sec$ (min.)
$t_W = 10msec$ (min.)
$V_H = 12.0V \pm 0.5V$

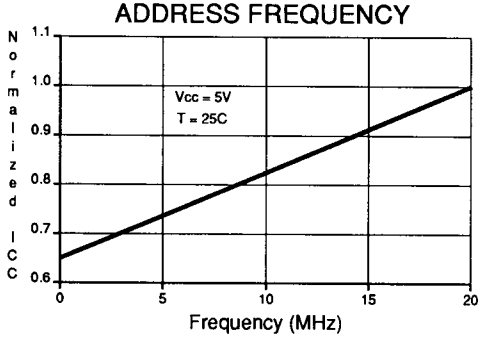
NORMALIZED SUPPLY CURRENT vs. TEMPERATURE



NORMALIZED SUPPLY CURRENT vs. SUPPLY VOLTAGE



NORMALIZED SUPPLY CURRENT vs. ADDRESS FREQUENCY



Ordering Information

(Contact Factory: Not recommended for new designs.)

tACC (ns)	Icc (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
45	80	60	AT28HC16N-45DC AT28HC16-45DC AT28HC16N-45PC AT28HC16-45PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-45DI AT28HC16-45DI AT28HC16N-45PI AT28HC16-45PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
55	80	60	AT28HC16N-55DC AT28HC16-55DC AT28HC16N-55PC AT28HC16-55PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-55DI AT28HC16-55DI AT28HC16N-55PI AT28HC16-55PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16N-55DM AT28HC16-55DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16N-55DM/883 AT28HC16-55DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
70	80	60	AT28HC16N-70DC AT28HC16-70DC AT28HC16N-70PC AT28HC16-70PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-70DI AT28HC16-70DI AT28HC16N-70PI AT28HC16-70PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16N-70DM AT28HC16-70DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16N-70DM/883 AT28HC16-70DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
90	80	60	AT28HC16N-90DC AT28HC16-90DC AT28HC16N-90PC AT28HC16-90PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-90DI AT28HC16-90DI AT28HC16N-90PI AT28HC16-90PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)

Ordering Information

(Contact Factory: Not recommended for new designs.)

t_{ACC} (ns)	I_{CC} (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
90	80	60	AT28HC16N-90DM AT28HC16-90DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16N-90DM/883 AT28HC16-90DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)

Package Type	
24D3	24 Lead, 0.300" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
24D6	24 Lead, 0.600" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
24P3	24 Lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
24P6	24 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)

Ordering Information

(Contact Factory: Not recommended for new designs.)

tACC (ns)	Icc (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
55	80	0.5	AT28HC16LN-55DC AT28HC16L-55DC AT28HC16LN-55PC AT28HC16L-55PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16LN-55DI AT28HC16L-55DI AT28HC16LN-55PI AT28HC16L-55PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16LN-55DM AT28HC16L-55DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16LN-55DM/883 AT28HC16L-55DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
70	80	0.5	AT28HC16LN-70DC AT28HC16L-70DC AT28HC16LN-70PC AT28HC16L-70PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16LN-70DI AT28HC16L-70DI AT28HC16LN-70PI AT28HC16L-70PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16LN-70DM AT28HC16L-70DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16LN-70DM/883 AT28HC16L-70DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
90	80	0.5	AT28HC16LN-90DC AT28HC16L-90DC AT28HC16LN-90PC AT28HC16L-90PC AT28HC16L-W	24D3 24D6 24P3 24P6 DIE	Commercial (0°C to 70°C)
			AT28HC16LN-90DI AT28HC16L-90DI AT28HC16LN-90PI AT28HC16L-90PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16LN-90DM AT28HC16L-90DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16LN-90DM/883 AT28HC16L-90DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)

Ordering Information

(Contact Factory: Not recommended for new designs.)

Package Type	
24D3	24 Lead, 0.300" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
24D6	24 Lead, 0.600" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
24P3	24 Lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
24P6	24 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)
W	Die