

AT28C04

T-46-13-27

Features

- Fast Read Access Time - 150ns
- Fast Byte Write - 200µs or 1 ms
- Self-Timed Byte Write Cycle
 - Internal Address and Data Latches
 - Internal Control Timer
 - Automatic Clear Before Write
- Direct Microprocessor Control
 - DATA POLLING
- Low Power
 - 30mA Active Current
 - 100µA CMOS Standby Current
- High Reliability
 - Endurance: 10^4 or 10^5 cycles
 - Data Retention: 10 years
- 5V $\pm$ 10% Supply
- CMOS & TTL Compatible Inputs and Outputs
- JEDEC Approved Byte Wide Pinout
- Full Military, Commercial, and Industrial Temperature Ranges

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4K (512K x 8)
CMOS
E²PROM

Description

The AT28C04 is a low-power, high-performance Electrically Erasable and Programmable Read Only Memory with easy to use features. The AT28C04 is a 4k memory organized as 512 words x 8 bits. The device is manufactured with Atmel's reliable non-volatile CMOS technology.

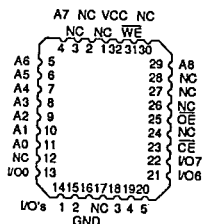
The AT28C04 is accessed like a static RAM for the read or write cycles without the need of external components. During a byte write, the address and data are latched internally, freeing the microprocessor address and data bus for other operations. Following the initiation of a write cycle, the device will go to a busy state and automatically clear and write the latched data using an internal control timer. The end of a write cycle can be determined by DATA polling of I/O7. Once the end of a write cycle has been detected, a new access for a read or a write can begin.

The CMOS technology offers fast access times of 150ns at low power dissipation. When the chip is deselected the standby current is less than 100µA. Atmel's 28C04 has additional features to ensure high quality and manufacturability, including internal error correction for extended endurance and for improved data retention characteristics.

Pin Configurations

A7	1	24	VCC
A6	2	23	A8
A5	3	22	NC
A4	4	21	WE
A3	5	20	OE
A2	6	19	NC
A1	7	18	CE
A0	8	17	VO7
VO0	9	16	VO8
VO1	10	15	VO5
VO2	11	14	VO4
GND	12	13	VO3

Pin Name	Function
A0 - A8	Addresses
OE	Chip Enable
OE	Output Enable
WE	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
NC	No Connect



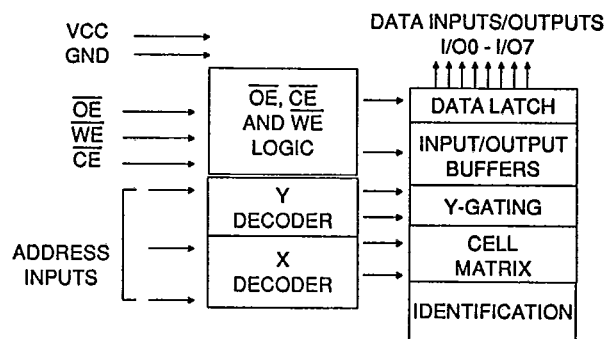
Note: PLCC package pins 1 and 17 are DON'T CONNECT.





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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 AT28C04 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 AT28C04 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.

FAST BYTE WRITE: The AT28C04F offers a byte write time of 200 μ s maximum. This feature allows the entire device to be rewritten in 0.1 seconds.

DATA POLLING: The AT28C04 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.

CHIP CLEAR: The contents of the entire memory of the AT28C04 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 $\overline{WE}$.

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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 $\overline{OE}$

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

		AT28C04-15	AT28C04-20	AT28C04-25
Operating Temperature (Case)	Com.	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
	Mil.	-55°C - 125°C	-55°C - 125°C	-55°C - 125°C
V_{CC} Power Supply		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	$V_{IO}=0V$ to V_{CC}		10	μA
I_{SB1}	V_{CC} Standby Current CMOS	$\overline{OE}=V_{CC}-0.3V$ to $V_{CC} + 1.0V$		100	μA
I_{SB2}	V_{CC} Standby Current TTL	$\overline{OE}=2.0V$ to $V_{CC} + 1.0V$	Com.	2	mA
			Ind., Mil.	3	mA
I_{CC}	V_{CC} Active Current A.C.	$f=5MHz$; $I_{OUT}=0mA$ $\overline{OE}=V_{IL}$	Com.	30	mA
			Ind., Mil.	45	mA
V_{IL}	Input Low Voltage			0.8	V
V_{IH}	Input High Voltage		2.0		V
V_{OL}	Output Low Voltage	$I_{OL}=2.1mA$		.4	V
V_{OH}	Output High Voltage	$I_{OH}=-400\mu A$	2.4		V

Pin Capacitance ($f=1MHz$ $T=25^\circ C$) ⁽⁴⁾

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



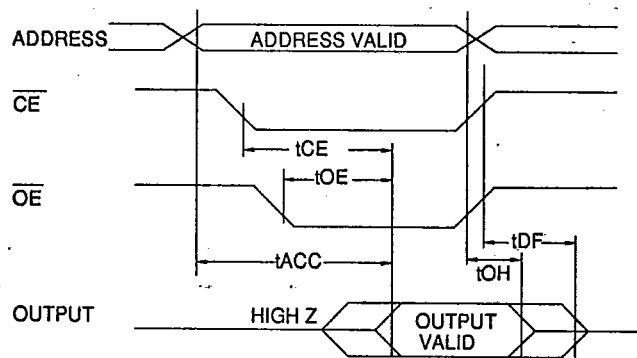


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A.C. Read Characteristics

Symbol	Parameter	AT28C04-15		AT28C04-20		AT28C04-25		Units
		Min	Max	Min	Max	Min	Max	
t_{ACC}	Address to Output Delay		150		200		250	ns
$t_{CE}^{(1)}$	$\overline{CE}$ to Output Delay		150		200		250	ns
$t_{OE}^{(2)}$	$\overline{OE}$ to Output Delay	10	70	10	80	10	100	ns
$t_{DF}^{(3,4)}$	$\overline{CE}$ or $\overline{OE}$ High to Output Float	0	50	0	55	0	60	ns
t_{OH}	Output Hold from $\overline{OE}$, $\overline{CE}$ or Address, whichever occurred first	0		0		0		ns

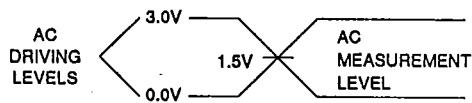
A.C. Read Waveforms



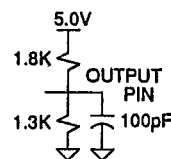
Notes:

- $\overline{CE}$ may be delayed up to $t_{ACC} - t_{CE}$ after the address transition without impact on t_{ACC} .
- $\overline{OE}$ 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} .
- t_{DF} is specified from $\overline{OE}$ or $\overline{CE}$ whichever occurs first ($C_L = 5pF$).
- This parameter is characterized and is not 100% tested.

Input Test Waveforms and Measurement Level

 $t_R, t_F < 20ns$

Output Test Load

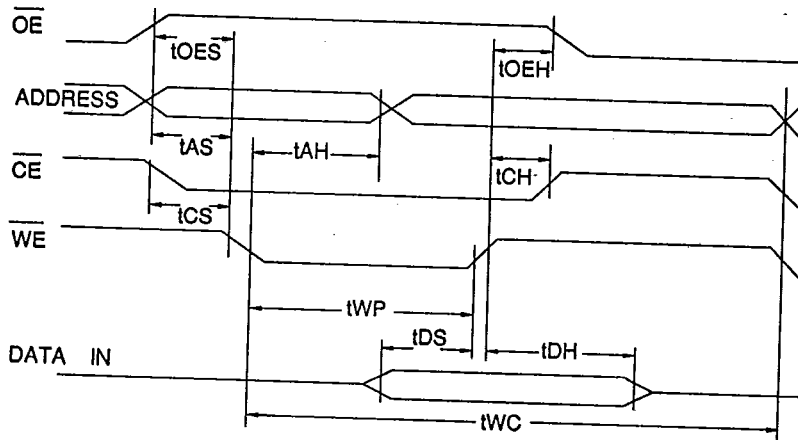
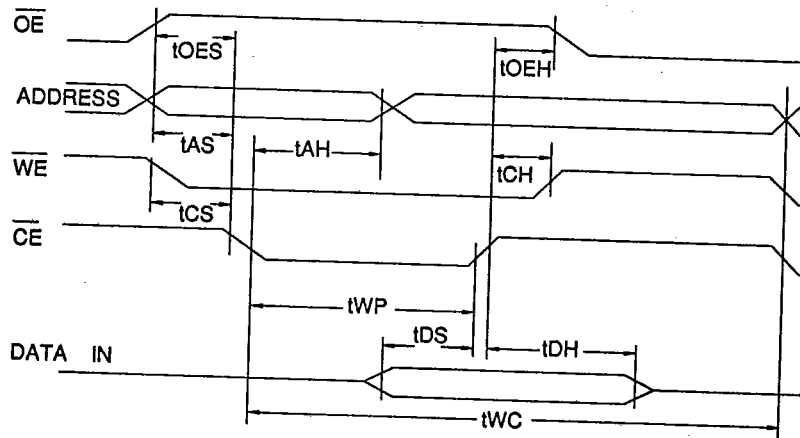


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A.C. Write Characteristics

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Symbol	Parameter	Min	Typ	Max	Units
t_{AS}, t_{OES}	Address, $\overline{OE}$ Set-up Time	10			ns
t_{AH}	Address Hold Time	50			ns
t_{WP}	Write Pulse Width ($\overline{WE}$ or $\overline{CE}$)	100		1000	ns
t_{DS}	Data Set-up Time	50			ns
t_{DH}, t_{OEH}	Data, $\overline{OE}$ Hold Time	10			ns
t_{WC}	Write Cycle Time	AT28C04		0.5	1.0
		AT28C04E/F		100	200
					ms
					μs

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



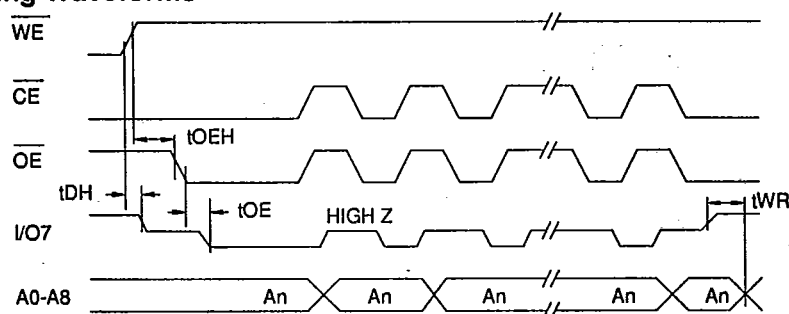
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Data Polling Characteristics⁽¹⁾

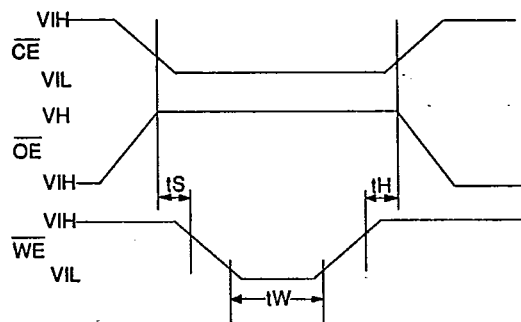
Symbol	Parameter	Min	Typ	Max	Units
t _{DH}	Data Hold Time	10			ns
t _{OE}	$\overline{\text{OE}}$ Hold Time	10			ns
t _{OE}	$\overline{\text{OE}}$ to Output Delay			100	ns
t _{WR}	Write Recovery Time	0			ns

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

Data Polling Waveforms



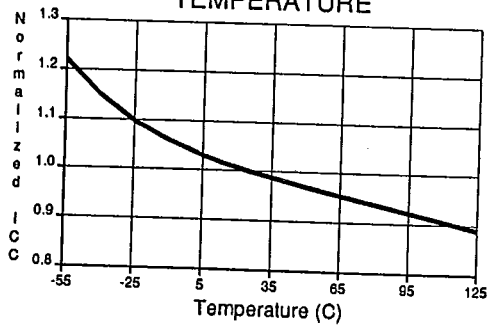
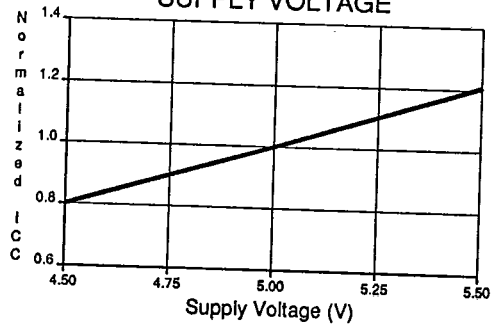
Chip Erase Waveforms



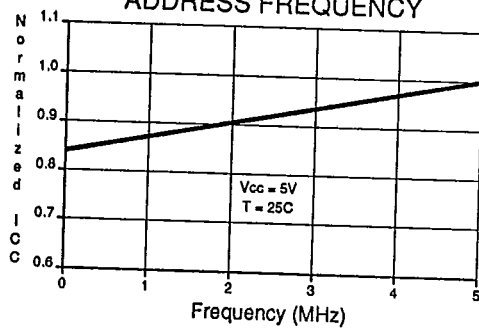
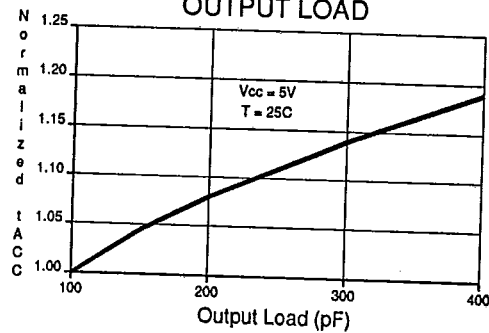
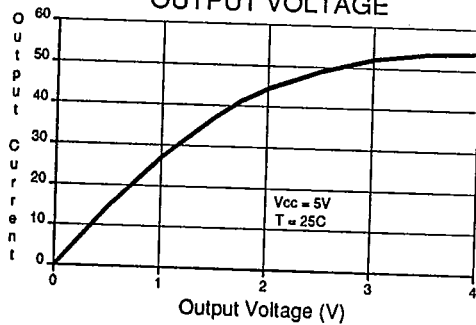
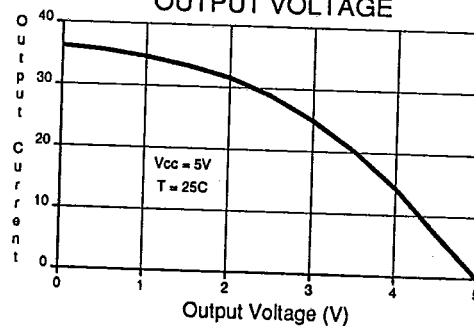
$t_{\text{S}} = t_{\text{H}} = 1\mu\text{sec (min.)}$
 $t_{\text{W}} = 10\text{msec (min.)}$
 $V_{\text{H}} = 12.0\text{V} \pm 0.5\text{V}$

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NORMALIZED SUPPLY CURRENT vs.
TEMPERATURENORMALIZED SUPPLY CURRENT vs.
SUPPLY VOLTAGE

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NORMALIZED SUPPLY CURRENT vs.
ADDRESS FREQUENCYNORMALIZED ACCESS TIME vs.
OUTPUT LOADOUTPUT SINK CURRENT vs.
OUTPUT VOLTAGEOUTPUT SOURCE CURRENT vs.
OUTPUT VOLTAGE

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Ordering Information

t _{ACC} (ns)	I _{CC} (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
150	30	0.1	AT28C04(E,F)-15DC AT28C04(E,F)-15LC AT28C04(E,F)-15PC	24D6 32L 24P6	Commercial (0°C to 70°C)
150	45	0.1	AT28C04(E,F)-15DI AT28C04(E,F)-15LI AT28C04(E,F)-15PI	24D6 32L 24P6	Industrial (-40°C to 85°C)
			AT28C04(E,F)-15DM AT28C04(E,F)-15LM	24D6 32L	Military (-55°C to 125°C)
			AT28C04(E,F)-15DM/883 AT28C04(E,F)-15LM/883	24D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
200	30	0.1	AT28C04(E,F)-20DC AT28C04(E,F)-20LC AT28C04(E,F)-20PC	24D6 32L 24P6	Commercial (0°C to 70°C)
200	45	0.1	AT28C04(E,F)-20DI AT28C04(E,F)-20LI AT28C04(E,F)-20PI	24D6 32L 24P6	Industrial (-40°C to 85°C)
			AT28C04(E,F)-20DM AT28C04(E,F)-20LM	24D6 32L	Military (-55°C to 125°C)
			AT28C04(E,F)-20DM/883 AT28C04(E,F)-20LM/883	24D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
250	30	0.1	AT28C04(E,F)-25DC AT28C04(E,F)-25LC AT28C04(E,F)-25PC AT28C04-W	24D6 32L 24P6 DIE	Commercial (0°C to 70°C)
250	45	0.1	AT28C04(E,F)-25DI AT28C04(E,F)-25LI AT28C04(E,F)-25PI	24D6 32L 24P6	Industrial (-40°C to 85°C)
			AT28C04(E,F)-25DM AT28C04(E,F)-25LM	24D6 32L	Military (-55°C to 125°C)
			AT28C04(E,F)-25DM/883 AT28C04(E,F)-25LM/883	24D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
300	45	0.1	AT28C04(E,F)-30DM/883 AT28C04(E,F)-30LM/883	24D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
350	45	0.1	AT28C04(E,F)-35DM/883 AT28C04(E,F)-35LM/883	24D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
450	45	0.1	AT28C04(E,F)-45DM/883 AT28C04(E,F)-45LM/883	24D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)

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Ordering Information

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Package Type	
24D6	24 Lead, 0.600" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
32L	32 Pad, Non-Windowed, Ceramic Leadless Chip Carrier (LCC)
24P6	24 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)
W	Die
Options	
Blank	Standard Device: Endurance = 10K Write Cycles; Write Time = 1 ms
E	High Endurance Option: Endurance = 100K Write Cycles; Write Time = 200 μ s
F	Fast Write Option: Write Time = 200 μ s

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The Atmel logo, consisting of the word "ATMEL" in a stylized, bold, sans-serif font.