64K (8K x 8) Paged CMOS E^2PROM

Features

- **Fast Read Access Time - 150ns**
- **Automatic Page Write Operation**
  - **Internal Address and Data Latches for 32 Bytes**
  - **Internal Control Timer**
- **Fast Write Cycle Times**
  - **Maximum Page Write Cycle Time: 2ms**
  - **1 to 32 Byte Page Write Operation**
- **Low Power Dissipation**
  - **80mA Active Current**
  - **100µA CMOS Standby Current**
- **Direct Microprocessor Control**
  - **$\overline{\text{DATA}}$ Polling**
- **High Reliability CMOS Technology**
  - **Endurance: 10^4 or 10^5 Cycles**
  - **Data Retention: 10 years**
- **Single 5V ± 10% Supply**
- **CMOS and TTL Compatible Inputs and Outputs**
- **JEDEC Approved Byte-Wide Pinout**
- **Full Military, Commercial, and Industrial Temperature Ranges**

Description

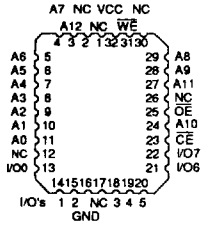
The AT28PC64 is a high-speed, low-power Electrically Erasable and Programmable Read Only Memory. Its 64k of memory is organized as 8,192 words by 8 bits. Manufactured with Atmel's advanced non-volatile CMOS technology, the device offers access times to 150ns with power dissipation of just 440mW. When the device is deselected the standby current is less than 100µA.

The AT28PC64 is accessed like a Static RAM for the read or write cycles without the need for external components. The device contains a 32-byte page register to allow writing of up to 32 bytes simultaneously. During a write cycle, the addresses and 1 to 32 bytes of data are internally latched, freeing the address and data bus for other operations. Following the initiation of a write cycle, the device will automatically write the latched data using an internal control timer. The end of a write cycle can be detected by $\overline{\text{DATA}}$ polling of I/O7. Once the end of a write cycle has been detected a new access for a read or write can begin.

Atmel's 28PC64 has additional features to ensure high quality and manufacturability. The device utilizes internal error correction for extended endurance and improved data retention characteristics. The AT28PC64 also includes an extra 32 bytes of E^2PROM for device identification or tracking.

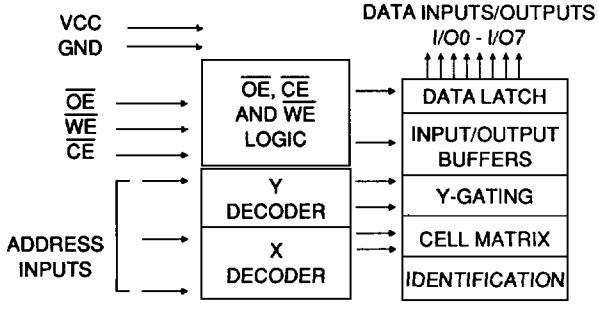
Pin Configurations

Pin Name	Function
A0 - A12	Addresses
$\overline{\text{CE}}$	Chip Enable
$\overline{\text{OE}}$	Output Enable
$\overline{\text{WE}}$	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
NC	No Connect



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

Block Diagram



Operating Modes

Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	I/O
Read	V_{IL}	V_{IL}	V_{IH}	D_{OUT}
Write[2]	V_{IL}	V_{IH}	V_{IL}	D_{IN}
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. $V_H = 12.0V \pm 0.5V$.

Description

READ: The AT28PC64 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 the high impedance state whenever $\overline{CE}$ or $\overline{OE}$ is high. This dual line control gives designers flexibility in preventing bus contention.

WRITE: A low pulse on the $\overline{WE}$ or $\overline{CE}$ input with $\overline{CE}$ or $\overline{WE}$ low (respectively) and $\overline{OE}$ high initiates a write cycle. The address is latched on the falling edge of $\overline{CE}$ or $\overline{WE}$, whichever occurs last. The data is latched by the first rising edge of $\overline{CE}$ or $\overline{WE}$. Once a byte write has been started it will automatically time itself to completion.

PAGE WRITE MODE: The page write operation of the AT28PC64 allows one to 32 bytes of data to be loaded into the device and then simultaneously written during the internal programming period. After the first data byte has been loaded, successive bytes may be loaded in the same manner. Each byte to be written must be loaded into the AT28PC64 within 150µs of the first byte. A5 to A12 determine the page address. The page address must be valid during each high to low transition of $\overline{WE}$ (or $\overline{CE}$). A0 to A4 are used to specify which bytes within the page are to be written. All bytes to be written must share the same page address. The bytes may be loaded in any order and may be altered within the same load period. Only bytes which are specified for writing will be written; unnecessary cycling of other bytes within the page does not occur.

$\overline{DATA}$ POLLING: The AT28PC64 features $\overline{DATA}$ Polling to indicate the end of a write cycle. During a byte or page write cycle an attempted read of the last byte written will result in the complement of the written data on I/O7. Once the write cycle has been completed, true data is valid on all outputs, and the next cycle may begin. $\overline{DATA}$ Polling may begin at any time during the write cycle.

DATA PROTECTION: Hardware features protect against inadvertent writes to the AT28PC64 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 write. (c) Write inhibit— holding any one of $\overline{OE}$ low, $\overline{CE}$ high or $\overline{WE}$ high inhibits write cycles. (d) Noise filter— pulses of less than 15ns (typical) on the $\overline{WE}$ or $\overline{CE}$ inputs will not initiate a write cycle.

CHIP CLEAR: The contents of the entire memory of the AT28PC64 may be set to the high state by the use of the CHIP CLEAR operation. By setting $\overline{CE}$ low and $\overline{OE}$ to 12 volts, the chip is cleared when a 10ms low pulse is applied to the $\overline{WE}$ pin.

DEVICE IDENTIFICATION: An extra 32 bytes of E^2PROM memory are available to the user for device identification. By raising A9 to $12 \pm 0.5V$ and using address locations 1FE0H to 1FFFH 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.

2

D.C. and A.C. Operating Range

		AT28PC64-15	AT28PC64-20	AT28PC64-25
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	$V_{I/O}$=0V to V_{CC}			10	µA
I_{SB1}	V_{CC} Standby Current CMOS	$\overline{CE}$=V_{CC}-.3V to V_{CC} + 1V	Com., Ind.		100	µA
			Mil.		200	µA
I_{SB2}	V_{CC} Standby Current TTL	$\overline{CE}$=2.0V to V_{CC} + 1V			3	mA
I_{CC}	V_{CC} Active Current	f=5MHz; 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}=2.1mA			.4	V
V_{OH}	Output High Voltage	I_{OH}=-400µA		2.4		V

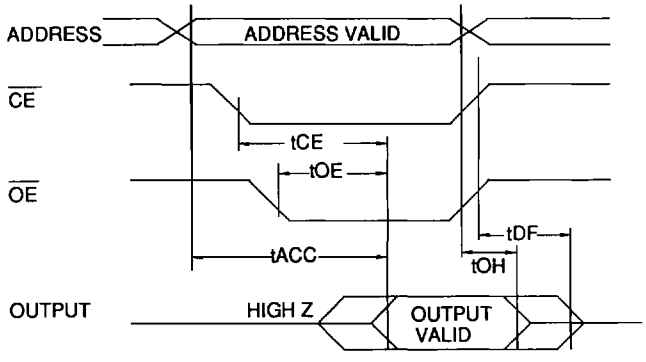
Pin Capacitance (f=1MHz T=25°C) [5]

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

A.C. Characteristics [1]

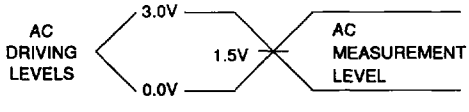
Symbol	Parameter	AT28PC64-15		AT28PC64-20		AT28PC64-25		Units
		Min	Max	Min	Max	Min	Max	
t_{ACC}	Address to Output Delay		150		200		250	ns
t_{CE} [2]	$\overline{CE}$ to Output Delay		150		200		250	ns
t_{OE} [3]	$\overline{OE}$ to Output Delay	0	70	0	80	0	100	ns
t_{DF} [4,5]	$\overline{CE}$ or $\overline{OE}$ 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



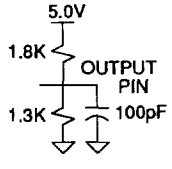
Notes:
1. C_L = 100pF.
2. $\overline{CE}$ may be delayed up to t_{ACC} - t_{CE} after the address transition without impact on t_{ACC}.
3. $\overline{OE}$ may be delayed up to t_{CE} - t_{OE} after the falling edge of $\overline{CE}$ without impact on t_{CE} or by t_{ACC} - t_{OE} after an address change 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

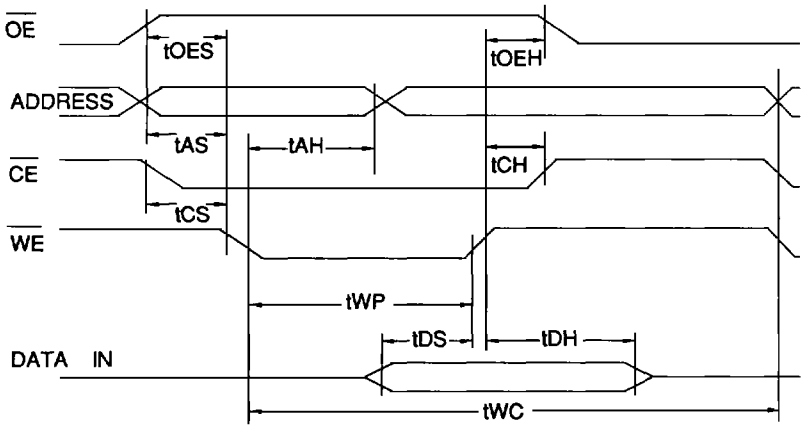
Output Test Load



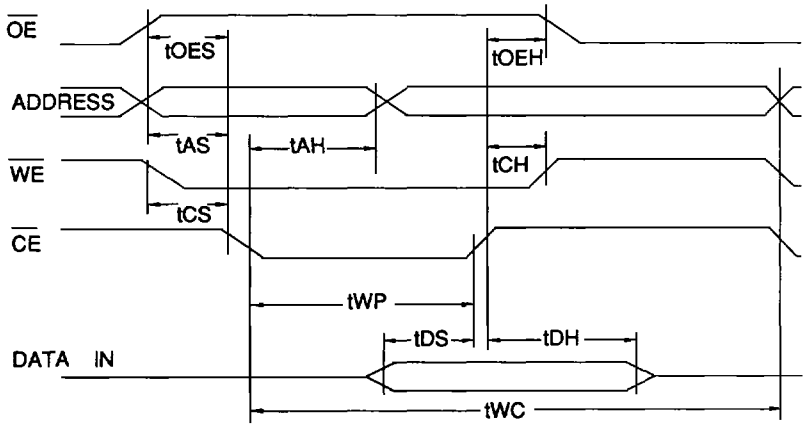
A.C. Write Characteristics

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_{CS}	Chip Select Set-up Time	0			ns
t_{CH}	Chip Select Hold Time	0			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	0			ns
t_{WC}	Write Cycle Time		1.0	2.0	ms

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



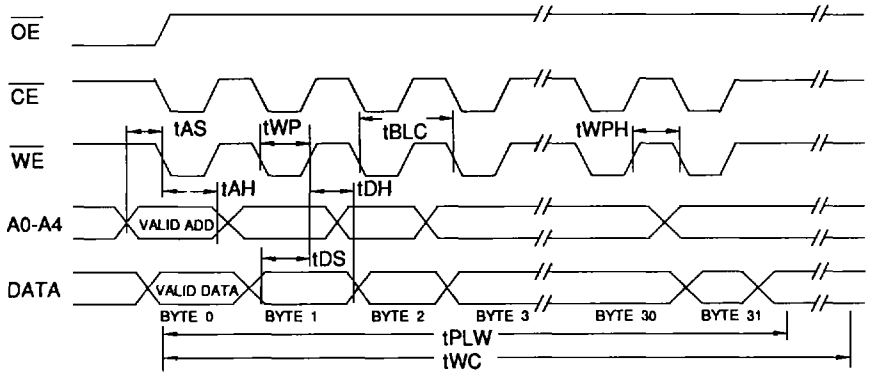
A.C. Write Waveforms- $\overline{CE}$ Controlled



Page Mode Write Characteristics

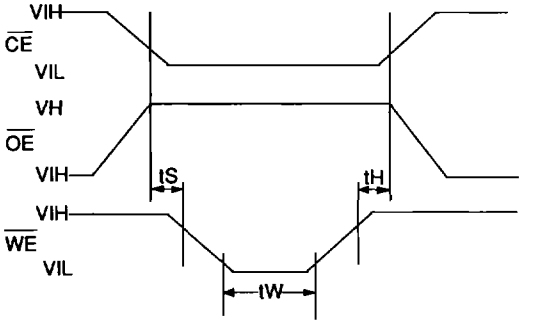
Symbol	Parameter	Min	Typ	Max	Units
t_{WC}	Write Cycle Time		1	2.0	ms
t_{AS}	Address Set-up Time	0			ns
t_{AH}	Address Hold Time	50			ns
t_{DS}	Data Set-up Time	50			ns
t_{DH}	Data Hold Time	0			ns
t_{WP}	Write Pulse Width	100		1000	ns
t_{BLC}	Byte Load Cycle Time	150			ns
t_{PLW}	Page Load Width			150	µs
t_{WPH}	Write Pulse Width High	50			ns

Page Mode Write Waveforms



Notes: A5 through A12 must specify the page address during each high to low transition of $\overline{WE}$ (or $\overline{CE}$).
$\overline{OE}$ must be high only when $\overline{WE}$ and $\overline{CE}$ are both low.

Chip Erase Waveforms



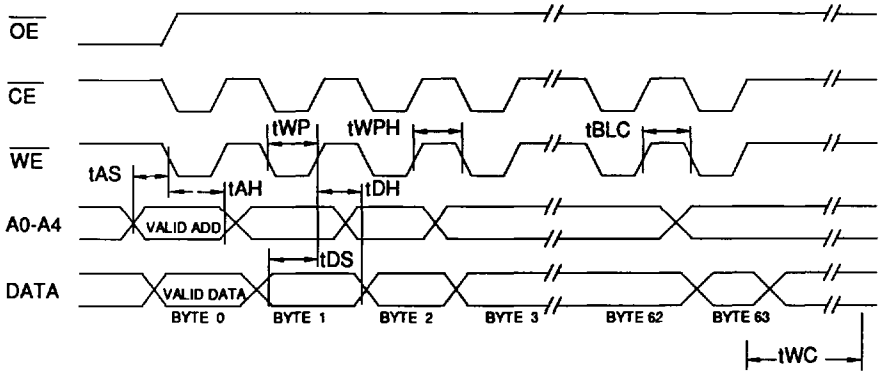
$t_S = t_H = 1\mu sec$ (min.)
$t_W = 10msec$ (min.)
$V_H = 12.0V \pm 0.5V$

Note: Some systems require increased load cycle time, beyond that permitted by the AT28PC64. The following Page Mode Write Characteristics and Waveforms address this situation. Please reference Atmel part number AT28PC64-SL376 to specify this device.

Page Mode Write Characteristics (AT28PC64-SL376)

Symbol	Parameter	Min	Typ	Max	Units
t_{WC}	Write Cycle Time		1	2.0	ms
t_{AS}	Address Set-up Time	0			ns
t_{AH}	Address Hold Time	50			ns
t_{DS}	Data Set-up Time	50			ns
t_{DH}	Data Hold Time	0			ns
t_{WP}	Write Pulse Width	100			ns
t_{BLC}	Byte Load Cycle Time			150	µs
t_{WPH}	Write Pulse Width High	50			ns

Page Mode Write Waveforms (AT28PC64-SL376)



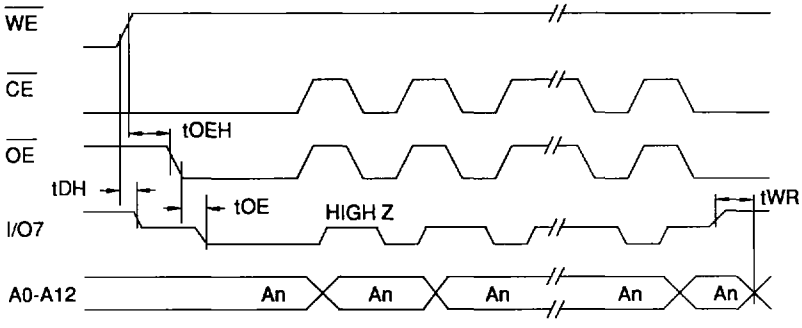
Notes: A5 through A12 must specify the page address during each high to low transition of $\overline{WE}$ (or $\overline{CE}$).
$\overline{OE}$ must be high only when $\overline{WE}$ and $\overline{CE}$ are both low.

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

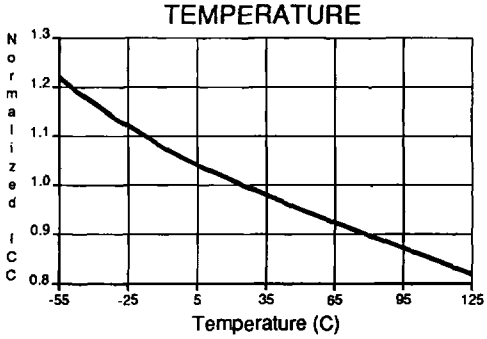
Symbol	Parameter	Min	Typ	Max	Units
t_{DH}	Data Hold Time	0			ns
t_{OEH}	$\overline{OE}$ Hold Time	0			ns
t_{OE}	$\overline{OE}$ to Output Delay			50	ns
t_{WR}	Write Recovery Time	0			ns

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

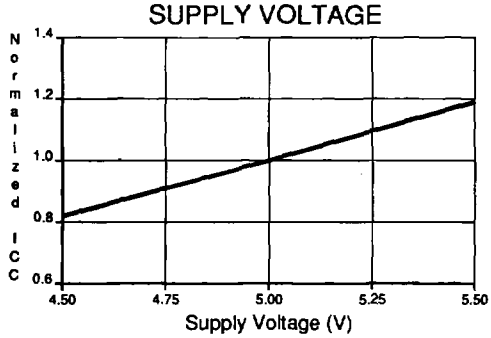
$\overline{\text{Data}}$ Polling Waveforms



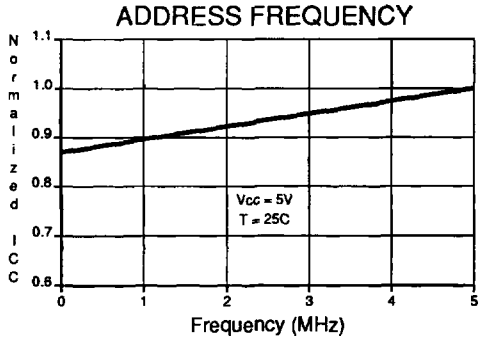
NORMALIZED SUPPLY CURRENT vs. TEMPERATURE



NORMALIZED SUPPLY CURRENT vs. SUPPLY VOLTAGE



NORMALIZED SUPPLY CURRENT vs. ADDRESS FREQUENCY



Ordering Information

t_{ACC} (ns)	I_{CC} (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
150	80	0.1	AT28PC64(E)-15DC AT28PC64(E)-15JC AT28PC64(E)-15LC AT28PC64(E)-15PC	28D6 32J 32L 28P6	Commercial (0°C to 70°C)
			AT28PC64(E)-15DI AT28PC64(E)-15JI AT28PC64(E)-15LI AT28PC64(E)-15PI	28D6 32J 32L 28P6	Industrial (-40°C to 85°C)
150	80	0.2	AT28PC64(E)-15DM AT28PC64(E)-15LM	28D6 32L	Military (-55°C to 125°C)
			AT28PC64(E)-15DM/883 AT28PC64(E)-15LM/883	28D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
200	80	0.1	AT28PC64(E)-20DC AT28PC64(E)-20JC AT28PC64(E)-20LC AT28PC64(E)-20PC	28D6 32J 32L 28P6	Commercial (0°C to 70°C)
			AT28PC64(E)-20DI AT28PC64(E)-20JI AT28PC64(E)-20LI AT28PC64(E)-20PI	28D6 32J 32L 28P6	Industrial (-40°C to 85°C)
200	80	0.2	AT28PC64(E)-20DM AT28PC64(E)-20LM	28D6 32L	Military (-55°C to 125°C)
			AT28PC64(E)-20DM/883 AT28PC64(E)-20LM/883	28D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
250	80	0.1	AT28PC64(E)-25DC AT28PC64(E)-25JC AT28PC64(E)-25LC AT28PC64(E)-25PC AT28PC64-W	28D6 32J 32L 28P6 DIE	Commercial (0°C to 70°C)
			AT28PC64(E)-25DI AT28PC64(E)-25JI AT28PC64(E)-25LI AT28PC64(E)-25PI	28D6 32J 32L 28P6	Industrial (-40°C to 85°C)
250	80	0.2	AT28PC64(E)-25DM AT28PC64(E)-25LM	28D6 32L	Military (-55°C to 125°C)
			AT28PC64(E)-25DM/883 AT28PC64(E)-25LM/883	28D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
300	80	0.2	AT28PC64(E)-30DM/883 AT28PC64(E)-30LM/883	28D6 32L	Military/883 Class B, Fully Compliant (-55°C to 125°C)
350	80	0.2	AT28PC64(E)-35DM/883 AT28PC64(E)-35LM/883	28D6 32L	Military/883 Class B, Fully Compliant (-55°C to 125°C)

Ordering Information

t_{ACC} (ns)	I_{CC} (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
200	80	0.2	5962-87514 09 UX 5962-87514 09 XX 5962-87514 09 YX	32K 28D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
250	80	0.2	5962-87514 08 UX 5962-87514 08 XX 5962-87514 08 YX	32K 28D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
300	80	0.2	5962-87514 07 UX 5962-87514 07 XX 5962-87514 07 YX	32K 28D6 32L	Military/883C Class B, Fully Compliant (-55°C to 125°C)
350	80	0.2	5962-87514 06 UX 5962-87514 06 XX 5962-87514 06 YX	32K 28D6 32L	Military/883 Class B, Fully Compliant (-55°C to 125°C)

Package Type	
28D6	28 Lead, 0.600" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
32J	32 Lead, Plastic J-Leaded Chip Carrier OTP (PLCC)
32K	32 Lead, Non-Windowed, Ceramic J-Leaded Chip Carrier (JLCC)
32L	32 Pad, Non-Windowed, Ceramic Leadless Chip Carrier OTP (LCC)
28P6	28 Lead, 0.600" Wide, Plastic Dual Inline Package OTP (PDIP)
W	Die
Options	
Blank	Standard Device: Endurance = 10K Write Cycles; Write Time = 2 ms
E	High Endurance Option: Endurance = 100K Write Cycles