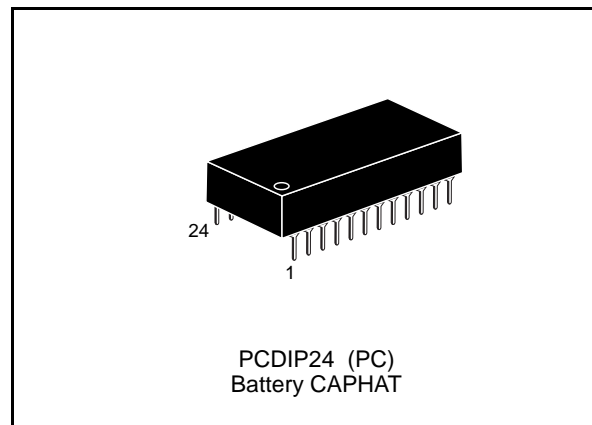




**16 Kbit (2Kb x 8) ZEROPOWER<sup>®</sup> SRAM**

- INTEGRATED ULTRA LOW POWER SRAM, POWER-FAIL CONTROL CIRCUIT and BATTERY
- UNLIMITED WRITE CYCLES
- READ CYCLE TIME EQUALS WRITE CYCLE TIME
- AUTOMATIC POWER-FAIL CHIP DESELECT and WRITE PROTECTION
- WRITE PROTECT VOLTAGES (V<sub>PF</sub>D = Power-fail Deselect Voltage):
  - M48Z02: 4.50V ≤ V<sub>PF</sub>D ≤ 4.75V
  - M48Z12: 4.20V ≤ V<sub>PF</sub>D ≤ 4.50V
- SELF-CONTAINED BATTERY in the CAPHAT DIP PACKAGE
- PIN and FUNCTION COMPATIBLE with JEDEC STANDARD 2K x 8 SRAMs



**DESCRIPTION**

The M48Z02/12 ZEROPOWER<sup>®</sup> RAM is a 2K x 8 non-volatile static RAM which is pin and functional compatible with the DS1220.

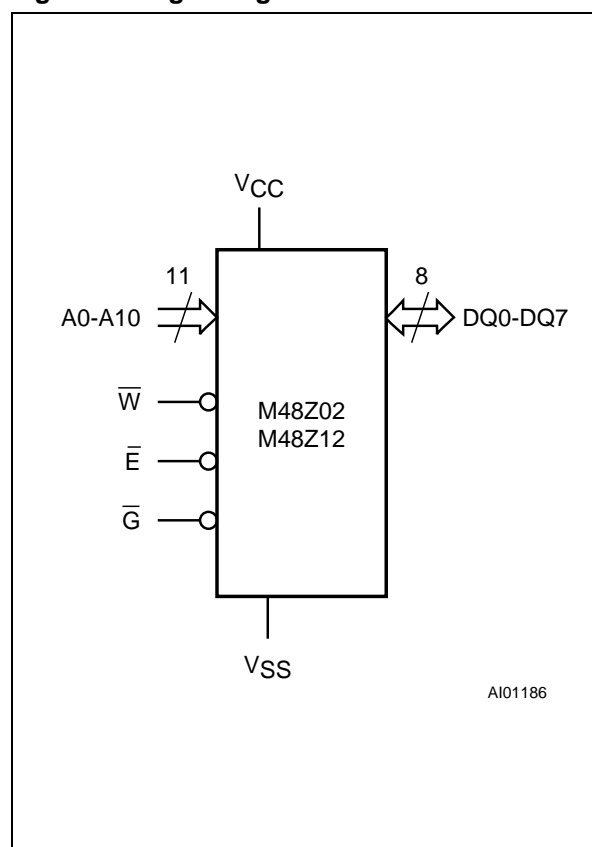
A special 24 pin 600mil DIP CAPHAT<sup>™</sup> package houses the M48Z02/12 silicon with a long life lithium button cell to form a highly integrated battery backed-up memory solution.

The M48Z02/12 button cell has sufficient capacity and storage life to maintain data and clock functionality for an accumulated time period of at least 10 years in the absence of power over the operating temperature range.

**Table 1. Signal Names**

A0-A10	Address Inputs
DQ0-DQ7	Data Inputs / Outputs
$\bar{E}$	Chip Enable
$\bar{G}$	Output Enable
$\bar{W}$	Write Enable
V <sub>CC</sub>	Supply Voltage
V <sub>SS</sub>	Ground

**Figure 1. Logic Diagram**



## M48Z02, M48Z12

**Table 2. Absolute Maximum Ratings** <sup>(1)</sup>

Symbol	Parameter	Value	Unit
T <sub>A</sub>	Ambient Operating Temperature	-40 to 85	°C
T <sub>STG</sub>	Storage Temperature (V <sub>CC</sub> Off)	-40 to 85	°C
T <sub>SLD</sub> <sup>(2)</sup>	Lead Solder Temperature for 10 seconds	260	°C
V <sub>IO</sub>	Input or Output Voltages	-0.3 to 7	V
V <sub>CC</sub>	Supply Voltage	-0.3 to 7	V
I <sub>O</sub>	Output Current	20	mA
P <sub>D</sub>	Power Dissipation	1	W

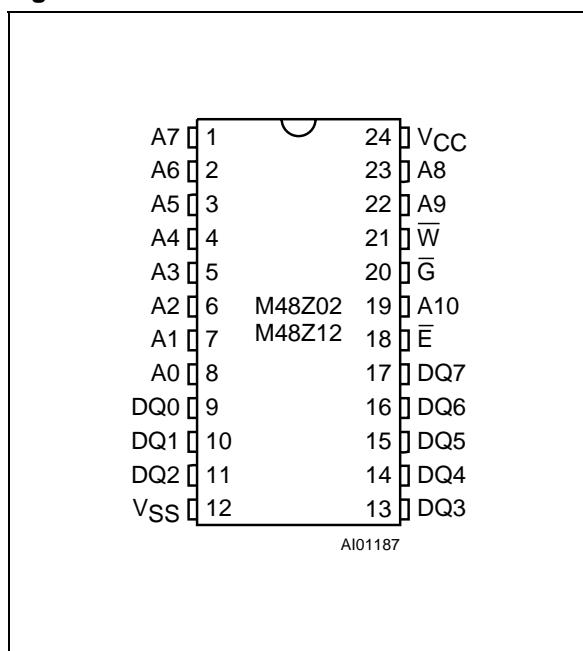
**Notes:** 1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to the absolute maximum rating conditions for extended periods of time may affect reliability.  
 2. Soldering temperature not to exceed 260°C for 10 seconds (total thermal budget not to exceed 150°C for longer than 30 seconds).  
**CAUTION:** Negative undershoots below -0.3 volts are not allowed on any pin while in the Battery Back-up mode.

**Table 3. Operating Modes**

Mode	V <sub>CC</sub>	$\bar{E}$	$\bar{G}$	$\bar{W}$	DQ0-DQ7	Power
Deselect	4.75V to 5.5V or 4.5V to 5.5V	V <sub>IH</sub>	X	X	High Z	Standby
Write		V <sub>IL</sub>	X	V <sub>IL</sub>	D <sub>IN</sub>	Active
Read		V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	D <sub>OUT</sub>	Active
Read		V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>	High Z	Active
Deselect	V <sub>SO</sub> to V <sub>PF</sub> D (min)	X	X	X	High Z	CMOS Standby
Deselect	≤ V <sub>SO</sub>	X	X	X	High Z	Battery Back-up Mode

**Notes:** X = V<sub>IH</sub> or V<sub>IL</sub>; V<sub>SO</sub> = Battery Back-up Switchover Voltage.

**Figure 2. DIP Pin Connections**

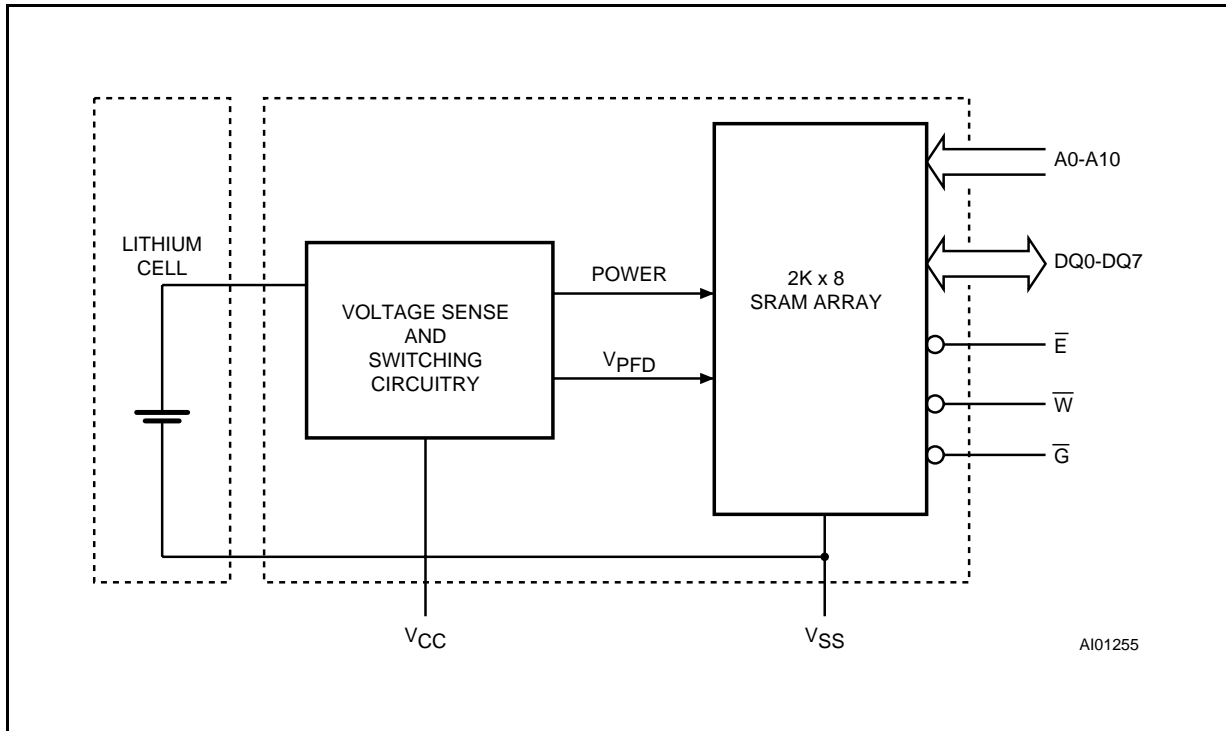


### DESCRIPTION (cont'd)

The M48Z02/12 is a non-volatile pin and function equivalent to any JEDEC standard 2K x 8 SRAM. It also easily fits into many ROM, EPROM, and EEPROM sockets, providing the non-volatility of PROMs without any requirement for special write timing or limitations on the number of writes that can be performed.

The M48Z02/12 also has its own Power-fail Detect circuit. The control circuitry constantly monitors the single 5V supply for an out of tolerance condition. When V<sub>CC</sub> is out of tolerance, the circuit write protects the SRAM, providing a high degree of data security in the midst of unpredictable system operation brought on by low V<sub>CC</sub>. As V<sub>CC</sub> falls below approximately 3V, the control circuitry connects the battery which maintains data and clock operation until valid power returns.

Figure 3. Block Diagram



**READ MODE**

The M48Z02/12 is in the Read Mode whenever  $\overline{W}$  (Write Enable) is high and  $\overline{E}$  (Chip Enable) is low. The device architecture allows ripple-through access of data from eight of 16,384 locations in the static storage array. Thus, the unique address specified by the 11 Address Inputs defines which one of the 2,048 bytes of data is to be accessed. Valid data will be available at the Data I/O pins within Address Access time ( $t_{AVQV}$ ) after the last address input signal is stable, providing that the  $\overline{E}$  and  $\overline{G}$  access times are also satisfied. If the  $\overline{E}$  and  $\overline{G}$  access times are not met, valid data will be available after the latter of the Chip Enable Access time ( $t_{ELQV}$ ) or Output Enable Access time ( $t_{GLQV}$ ).

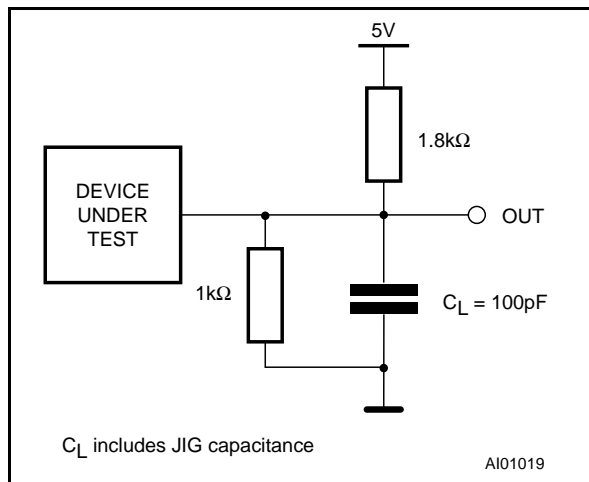
The state of the eight three-state Data I/O signals is controlled by  $\overline{E}$  and  $\overline{G}$ . If the outputs are activated before  $t_{AVQV}$ , the data lines will be driven to an indeterminate state until  $t_{AVQV}$ . If the Address Inputs are changed while  $\overline{E}$  and  $\overline{G}$  remain active, output data will remain valid for Output Data Hold time ( $t_{AXQX}$ ) but will go indeterminate until the next Address Access.

Table 4. AC Measurement Conditions

Input Rise and Fall Times	$\leq 5\text{ns}$
Input Pulse Voltages	0V to 3V
Input and Output Timing Ref. Voltages	1.5V

Note that Output Hi-Z is defined as the point where data is no longer driven.

Figure 4. AC Testing Load Circuit



## M48Z02, M48Z12

**Table 5. Capacitance <sup>(1)</sup>**  
(T<sub>A</sub> = 25 °C)

Symbol	Parameter	Test Condition	Min	Max	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0V		10	pF
C <sub>IO</sub> <sup>(2)</sup>	Input / Output Capacitance	V <sub>OUT</sub> = 0V		10	pF

**Notes:** 1. Effective capacitance measured with power supply at 5V.  
2. Outputs deselected

**Table 6. DC Characteristics**  
(T<sub>A</sub> = 0 to 70°C or -40 to 85°C; V<sub>CC</sub> = 4.75V to 5.5V or 4.5V to 5.5V)

Symbol	Parameter	Test Condition	Min	Max	Unit
I <sub>LI</sub> <sup>(1)</sup>	Input Leakage Current	0V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub>		±1	μA
I <sub>LO</sub> <sup>(1)</sup>	Output Leakage Current	0V ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub>		±5	μA
I <sub>CC</sub>	Supply Current	Outputs open		80	mA
I <sub>CC1</sub>	Supply Current (Standby) TTL	$\bar{E} = V_{IH}$		3	mA
I <sub>CC2</sub>	Supply Current (Standby) CMOS	$\bar{E} = V_{CC} - 0.2V$		3	mA
V <sub>IL</sub> <sup>(2)</sup>	Input Low Voltage		-0.3	0.8	V
V <sub>IH</sub>	Input High Voltage		2.2	V <sub>CC</sub> + 0.3	V
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 2.1mA		0.4	V
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -1mA	2.4		V

**Notes:** 1. Outputs Deselected.  
2. Negative spikes of -1V allowed for up to 10ns once per cycle.

**Table 7. Power Down/Up Trip Points DC Characteristics <sup>(1)</sup>**  
(T<sub>A</sub> = 0 to 70°C or -40 to 85°C)

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>PDF</sub>	Power-fail Deselect Voltage (M48Z02)	4.5	4.6	4.75	V
V <sub>PDF</sub>	Power-fail Deselect Voltage (M48Z12)	4.2	4.3	4.5	V
V <sub>SO</sub>	Battery Back-up Switchover Voltage		3.0		V
t <sub>DR</sub>	Expected Data Retention Time	10			YEARS

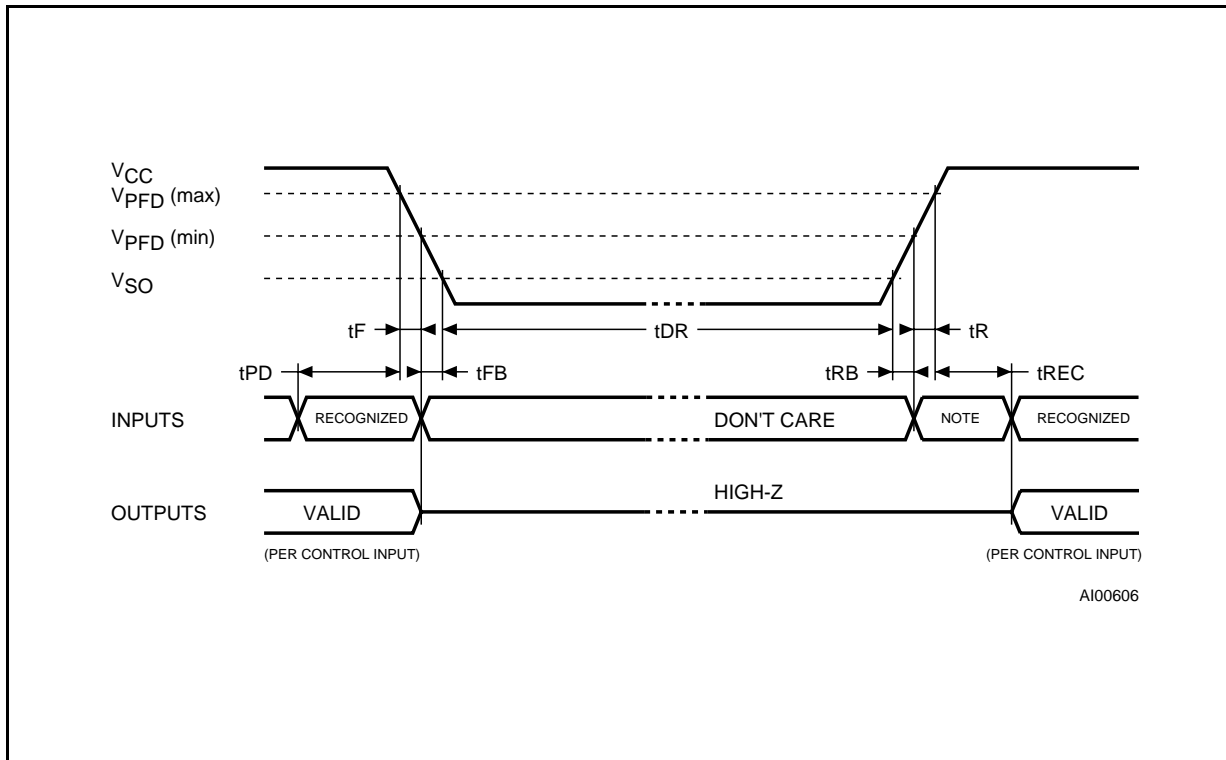
**Note:** 1. All voltages referenced to V<sub>SS</sub>.

**Table 8. Power Down/Up Mode AC Characteristics**  
 ( $T_A = 0$  to  $70^\circ\text{C}$  or  $-40$  to  $85^\circ\text{C}$ )

Symbol	Parameter	Min	Max	Unit
$t_{PD}$	$\bar{E}$ or $\bar{W}$ at $V_{IH}$ before Power Down	0		$\mu\text{s}$
$t_F^{(1)}$	$V_{PFD}(\text{max})$ to $V_{PFD}(\text{min})$ $V_{CC}$ Fall Time	300		$\mu\text{s}$
$t_{FB}^{(2)}$	$V_{PFD}(\text{min})$ to $V_{SO}$ $V_{CC}$ Fall Time	10		$\mu\text{s}$
$t_R$	$V_{PFD}(\text{min})$ to $V_{PFD}(\text{max})$ $V_{CC}$ Rise Time	0		$\mu\text{s}$
$t_{RB}$	$V_{SO}$ to $V_{PFD}(\text{min})$ $V_{CC}$ Rise Time	1		$\mu\text{s}$
$t_{REC}$	$\bar{E}$ or $\bar{W}$ at $V_{IH}$ after Power Up	2		ms

**Notes:** 1.  $V_{PFD}(\text{max})$  to  $V_{PFD}(\text{min})$  fall time of less than  $t_F$  may result in deselection/write protection not occurring until  $50 \mu\text{s}$  after  $V_{CC}$  passes  $V_{PFD}(\text{min})$ .  
 2.  $V_{PFD}(\text{min})$  to  $V_{SO}$  fall time of less than  $t_{FB}$  may cause corruption of RAM data.

**Figure 5. Power Down/Up Mode AC Waveforms**



**Note:** Inputs may or may not be recognized at this time. Caution should be taken to keep  $\bar{E}$  high as  $V_{CC}$  rises past  $V_{PFD}(\text{min})$ . Some systems may perform inadvertent write cycles after  $V_{CC}$  rises above  $V_{PFD}(\text{min})$  but before normal system operations begin. Even though a power on reset is being applied to the processor, a reset condition may not occur until after the system clock is running.

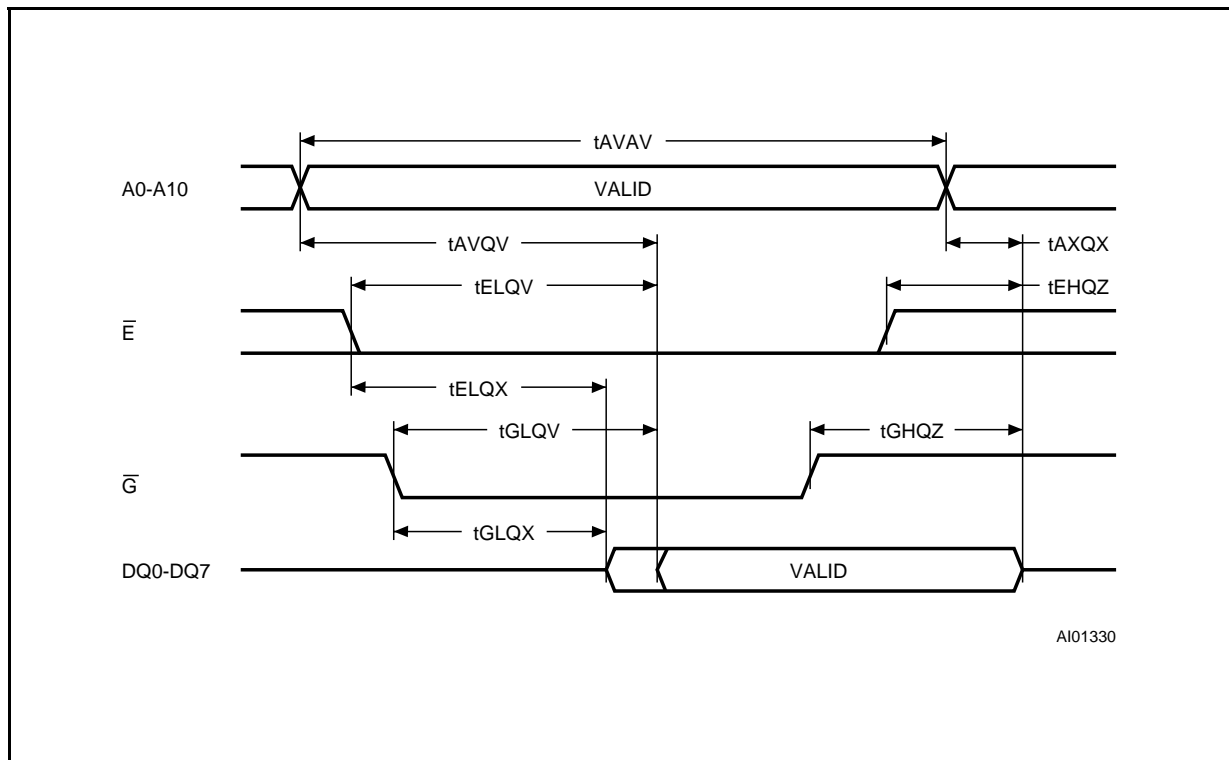
## M48Z02, M48Z12

**Table 9. Read Mode AC Characteristics**

( $T_A = 0$  to  $70^\circ\text{C}$  or  $-40$  to  $85^\circ\text{C}$ ;  $V_{CC} = 4.75\text{V}$  to  $5.5\text{V}$  or  $4.5\text{V}$  to  $5.5\text{V}$ )

Symbol	Parameter	M48Z02 / M48Z12						Unit
		-70		-150		-200		
		Min	Max	Min	Max	Min	Max	
$t_{AVAV}$	Read Cycle Time	70		150		200		ns
$t_{AVQV}$	Address Valid to Output Valid		70		150		200	ns
$t_{ELQV}$	Chip Enable Low to Output Valid		70		150		200	ns
$t_{GLQV}$	Output Enable Low to Output Valid		35		75		80	ns
$t_{ELQX}$	Chip Enable Low to Output Transition	5		10		10		ns
$t_{GLQX}$	Output Enable Low to Output Transition	5		5		5		ns
$t_{EHQZ}$	Chip Enable High to Output Hi-Z		25		35		40	ns
$t_{GHQZ}$	Output Enable High to Output Hi-Z		25		35		40	ns
$t_{AXQX}$	Address Transition to Output Transition	10		5		5		ns

**Figure 6. Read Mode AC Waveforms**



**Note:** Write Enable ( $\bar{W}$ ) = High.

**Table 10. Write Mode AC Characteristics**(T<sub>A</sub> = 0 to 70°C or -40 to 85°C; V<sub>CC</sub> = 4.75V to 5.5V or 4.5V to 5.5V)

Symbol	Parameter	M48Z02 / M48Z12						Unit
		-70		-150		-200		
		Min	Max	Min	Max	Min	Max	
t <sub>AVAV</sub>	Write Cycle Time	70		150		200		ns
t <sub>AVWL</sub>	Address Valid to Write Enable Low	0		0		0		ns
t <sub>AVEL</sub>	Address Valid to Chip Enable Low	0		0		0		ns
t <sub>WLWH</sub>	Write Enable Pulse Width	50		90		120		ns
t <sub>LELH</sub>	Chip Enable Low to Chip Enable High	55		90		120		ns
t <sub>WHAX</sub>	Write Enable High to Address Transition	0		10		10		ns
t <sub>EHAX</sub>	Chip Enable High to Address Transition	0		10		10		ns
t <sub>DVWH</sub>	Input Valid to Write Enable High	30		40		60		ns
t <sub>DVEH</sub>	Input Valid to Chip Enable High	30		40		60		ns
t <sub>WHDX</sub>	Write Enable High to Input Transition	5		5		5		ns
t <sub>EHDX</sub>	Chip Enable High to Input Transition	5		5		5		ns
t <sub>WLQZ</sub>	Write Enable Low to Output Hi-Z		25		50		60	ns
t <sub>AVWH</sub>	Address Valid to Write Enable High	60		120		140		ns
t <sub>AVEH</sub>	Address Valid to Chip Enable High	60		120		140		ns
t <sub>WHQX</sub>	Write Enable High to Output Transition	5		10		10		ns

**WRITE MODE**

The M48Z02/12 is in the Write Mode whenever  $\overline{W}$  and  $\overline{E}$  are active. The start of a write is referenced from the latter occurring falling edge of  $\overline{W}$  or  $\overline{E}$ . A write is terminated by the earlier rising edge of  $\overline{W}$  or  $\overline{E}$ . The addresses must be held valid throughout the cycle.  $\overline{E}$  or  $\overline{W}$  must return high for a minimum

of t<sub>EHAX</sub> from Chip Enable or t<sub>WHAX</sub> from Write Enable prior to the initiation of another read or write cycle. Data-in must be valid t<sub>DVWH</sub> prior to the end of write and remain valid for t<sub>WHDX</sub> afterward.  $\overline{G}$  should be kept high during write cycles to avoid bus contention; although, if the output bus has been activated by a low on  $\overline{E}$  and  $\overline{G}$ , a low on  $\overline{W}$  will disable the outputs t<sub>WLQZ</sub> after  $\overline{W}$  falls.

Figure 7. Write Enable Controlled, Write AC Waveforms

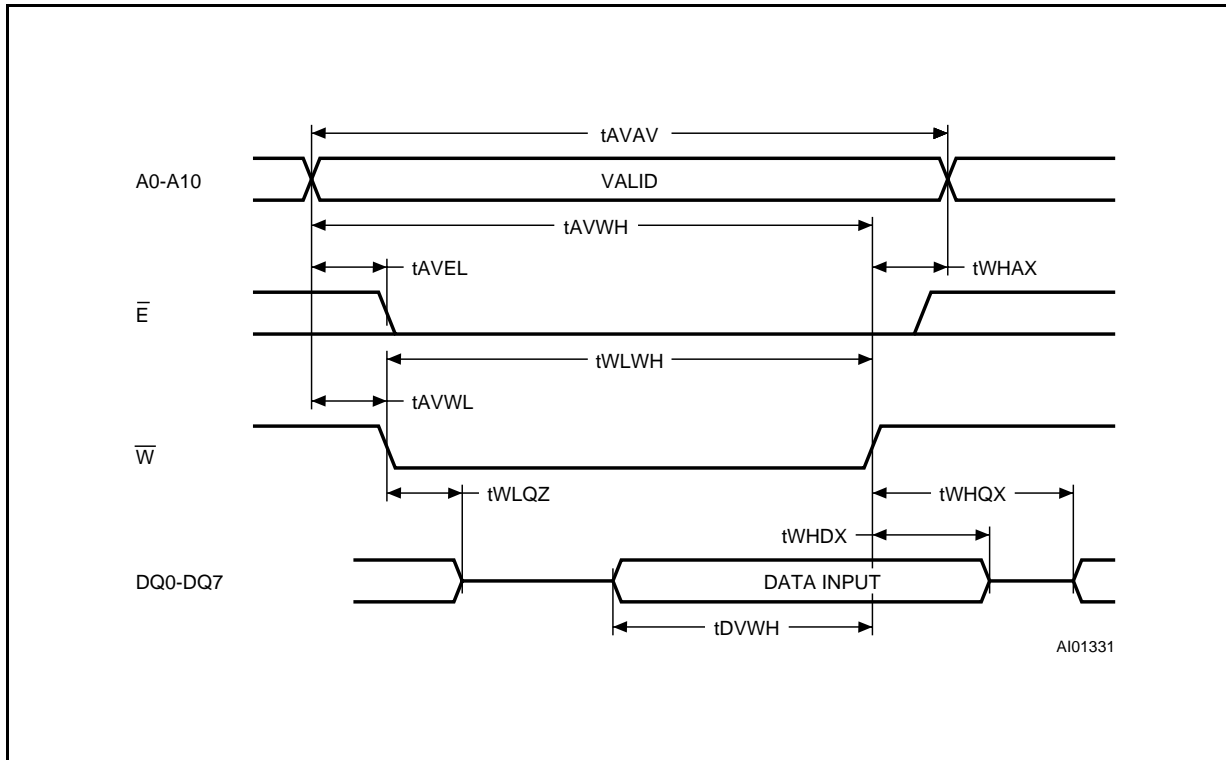
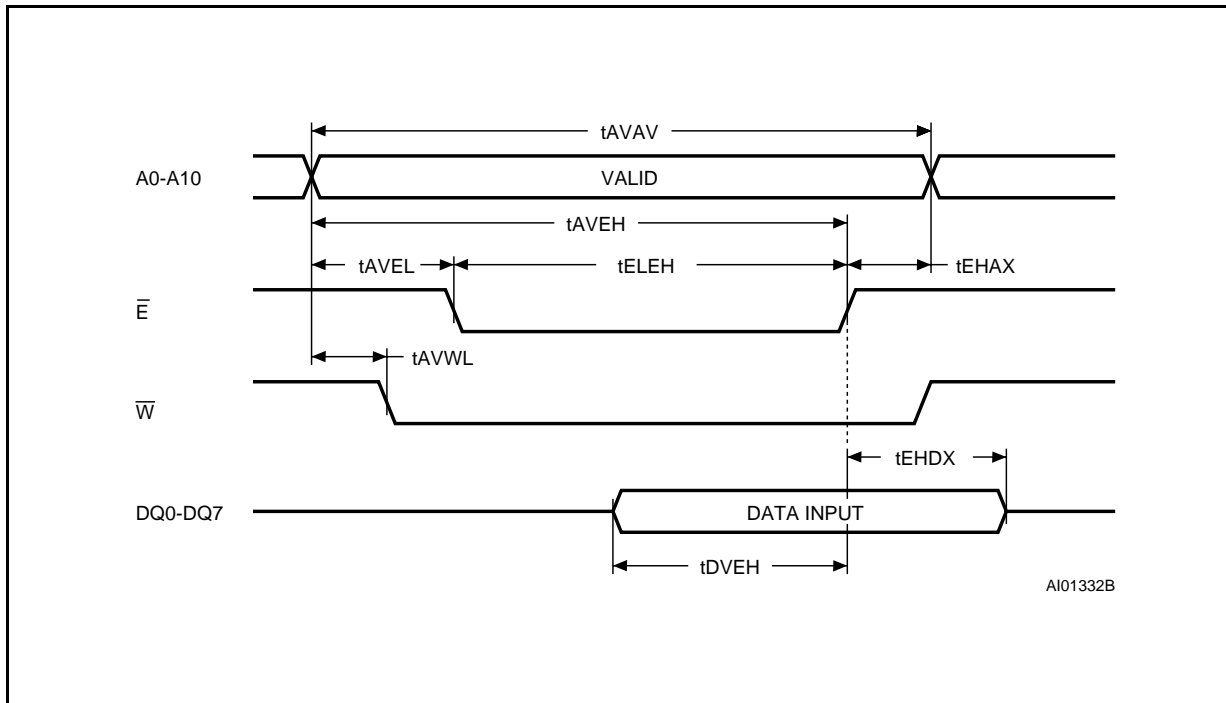


Figure 8. Chip Enable Controlled, Write AC Waveforms





### DATA RETENTION MODE

With valid  $V_{CC}$  applied, the M48Z02/12 operates as a conventional BYTEWIDE™ static RAM. Should the supply voltage decay, the RAM will automatically power-fail deselect, write protecting itself when  $V_{CC}$  falls within the  $V_{PFD(max)}$ ,  $V_{PFD(min)}$  window. All outputs become high impedance, and all inputs are treated as "don't care."

**Note:** A power failure during a write cycle may corrupt data at the currently addressed location, but does not jeopardize the rest of the RAM's content. At voltages below  $V_{PFD(min)}$ , the user can be assured the memory will be in a write protected state, provided the  $V_{CC}$  fall time is not less than  $t_F$ . The M48Z02/12 may respond to transient noise spikes on  $V_{CC}$  that reach into the deselect window during the time the device is sampling  $V_{CC}$ . Therefore, decoupling of the power supply lines is recommended.

The power switching circuit connects external  $V_{CC}$  to the RAM and disconnects the battery when  $V_{CC}$  rises above  $V_{SO}$ . As  $V_{CC}$  rises, the battery voltage is checked. If the voltage is too low, an internal Battery Not OK (BOK) flag will be set. The BOK flag can be checked after power up. If the BOK flag is set, the first write attempted will be blocked. The flag is automatically cleared after the first write, and normal RAM operation resumes. Figure 9 illustrates how a BOK check routine could be structured.

### POWER SUPPLY DECOUPLING and UNDER-SHOOT PROTECTION

ICC transients, including those produced by output switching, can produce voltage fluctuations, resulting in spikes on the  $V_{CC}$  bus. These transients can be reduced if capacitors are used to store energy, which stabilizes the  $V_{CC}$  bus. The energy stored in the bypass capacitors will be released as low going spikes are generated or energy will be absorbed when overshoots occur. A ceramic bypass capacitor value of  $0.1\mu F$  (as shown in Figure 10) is recommended in order to provide the needed filtering.

In addition to transients that are caused by normal SRAM operation, power cycling can generate negative voltage spikes on  $V_{CC}$  that drive it to values below  $V_{SS}$  by as much as one Volt. These negative spikes can cause data corruption in the SRAM while in battery backup mode. To protect from these voltage spikes, it is recommended to connect a schottky diode from  $V_{CC}$  to  $V_{SS}$  (cathode connected to  $V_{CC}$ , anode to  $V_{SS}$ ). Schottky diode 1N5817 is recommended for through hole and MBRS120T3 is recommended for surface mount.

Figure 9. Checking the BOK Flag Status

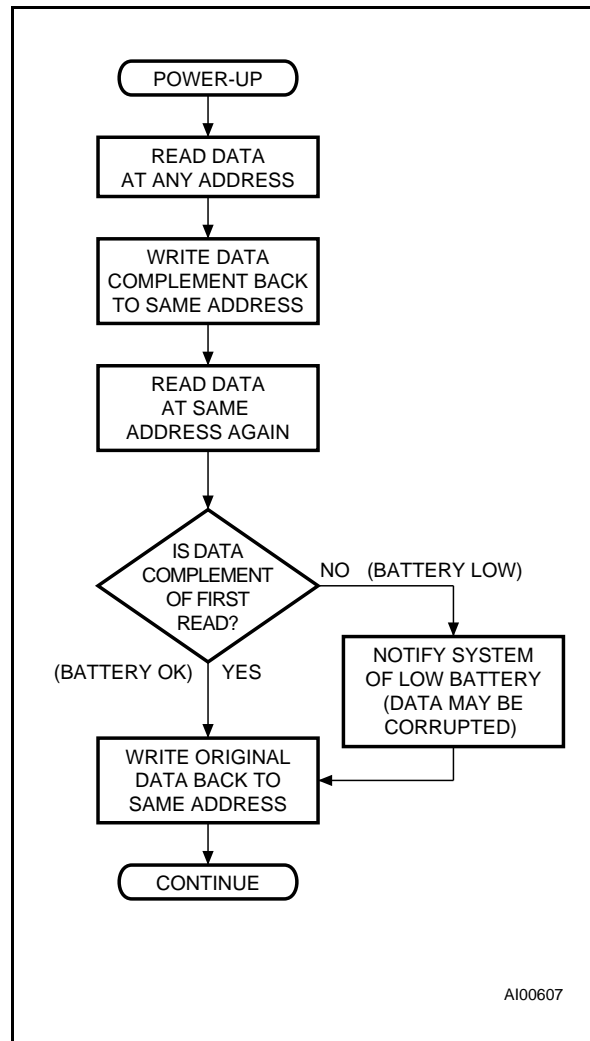
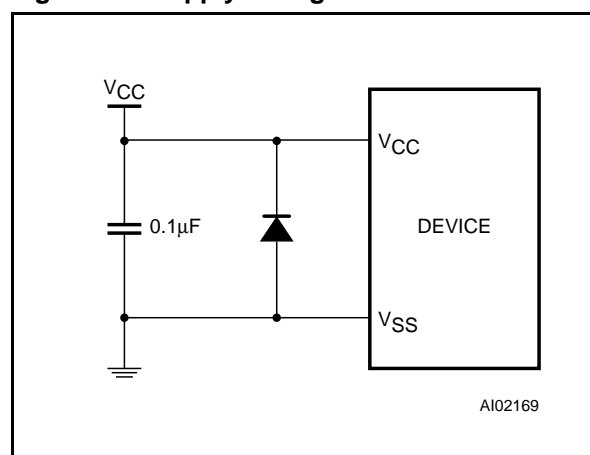
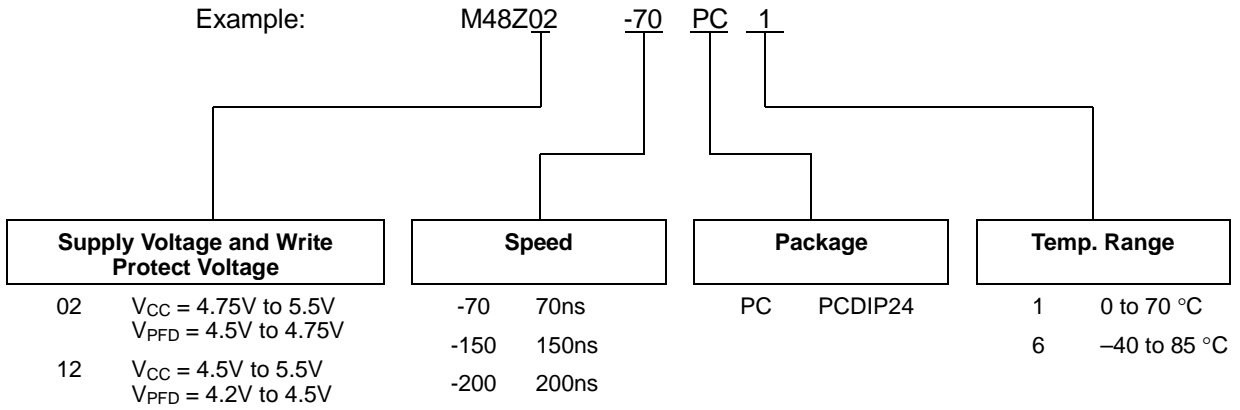


Figure 10. Supply Voltage Protection



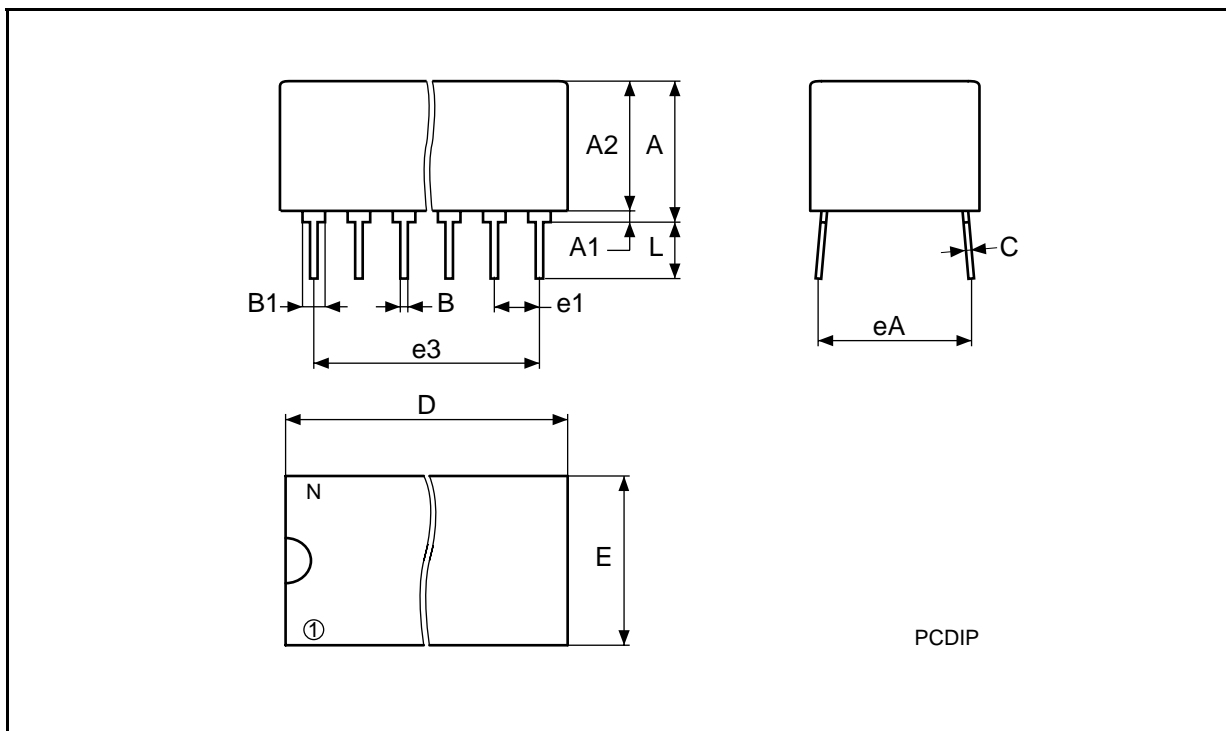
**ORDERING INFORMATION SCHEME**



For a list of available options (Speed, Package, etc...) or for further information on any aspect of this device, please contact the STMicroelectronics Sales Office nearest to you.

### PCDIP24 - 24 pin Plastic DIP, battery CAPHAT

Symb	mm			inches		
	Typ	Min	Max	Typ	Min	Max
A		8.89	9.65		0.350	0.380
A1		0.38	0.76		0.015	0.030
A2		8.38	8.89		0.330	0.350
B		0.38	0.53		0.015	0.021
B1		1.14	1.78		0.045	0.070
C		0.20	0.31		0.008	0.012
D		34.29	34.80		1.350	1.370
E		17.83	18.34		0.702	0.722
e1		2.29	2.79		0.090	0.110
e3		25.15	30.73		0.990	1.210
eA		15.24	16.00		0.600	0.630
L		3.05	3.81		0.120	0.150
N		24			24	



Drawing is not to scale.

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