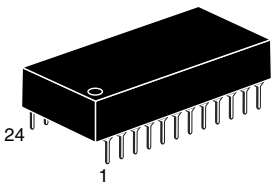
M48Z02
M48Z12

5V, 16Kbit (2Kb x 8) ZEROPOWER® SRAM

Features

- Integrated, ultra low power SRAM and power-fail control circuit
- Unlimited WRITE cycles
- READ cycle time equals WRITE cycle time
- Automatic power-fail chip deselect and WRITE protection
- WRITE protect voltages (V_{PFD} = Power-fail deselect voltage):
  - M48Z02: V_{CC} = 4.75 to 5.5V; 4.5V ≤ V_{PFD} ≤ 4.75V
  - M48Z12: V_{CC} = 4.5 to 5.5V; 4.2V ≤ V_{PFD} ≤ 4.5V
- Self-contained battery in the CAPHAT™ DIP package
- Pin and function compatible with JEDEC standard 2K x 8 SRAMs
- RoHS compliant
  - Lead-free second level interconnect



PCDIP24 (PC)
battery CAPHAT™

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1 Summary

The M48Z02/12 ZEROPOWER® 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™ 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 functionality for an accumulated time period of at least 10 years in the absence of power over commercial operating temperature range.

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.

Figure 1. Logic diagram

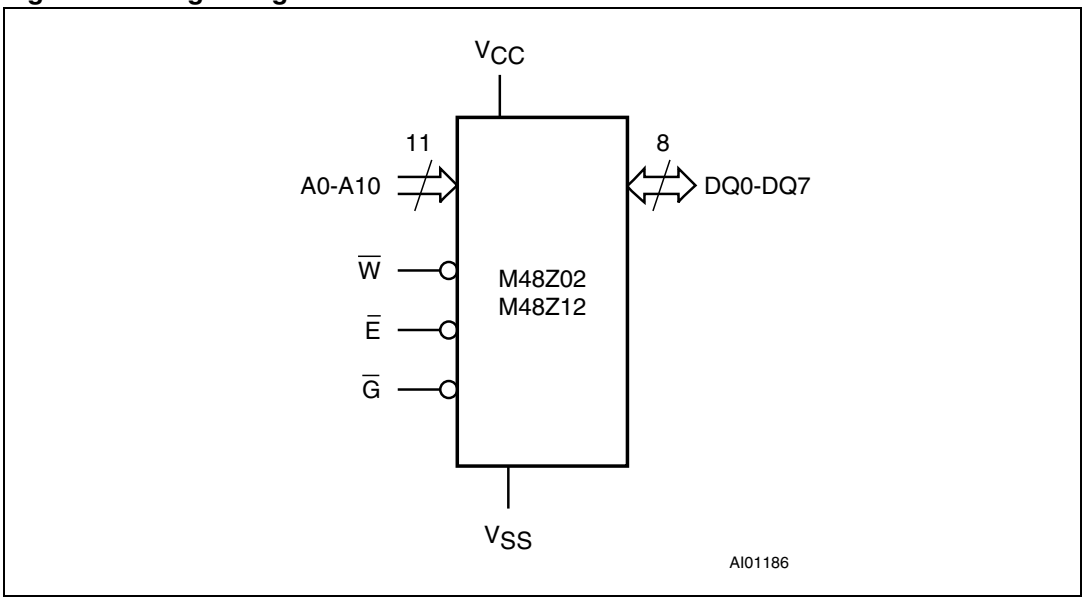


Table 1. Signal names

A0-A10	Address inputs
DQ0-DQ7	Data inputs / outputs
$\overline{E}$	Chip enable
$\overline{G}$	Output enable
$\overline{W}$	WRITE enable
V_{CC}	Supply voltage
V_{SS}	Ground

Figure 2. DIP connections

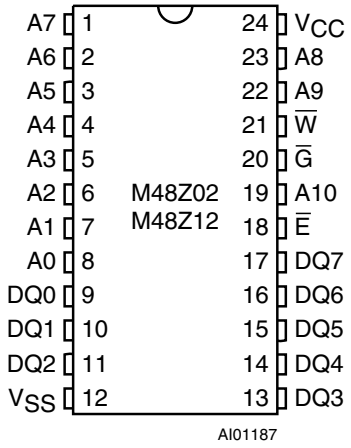
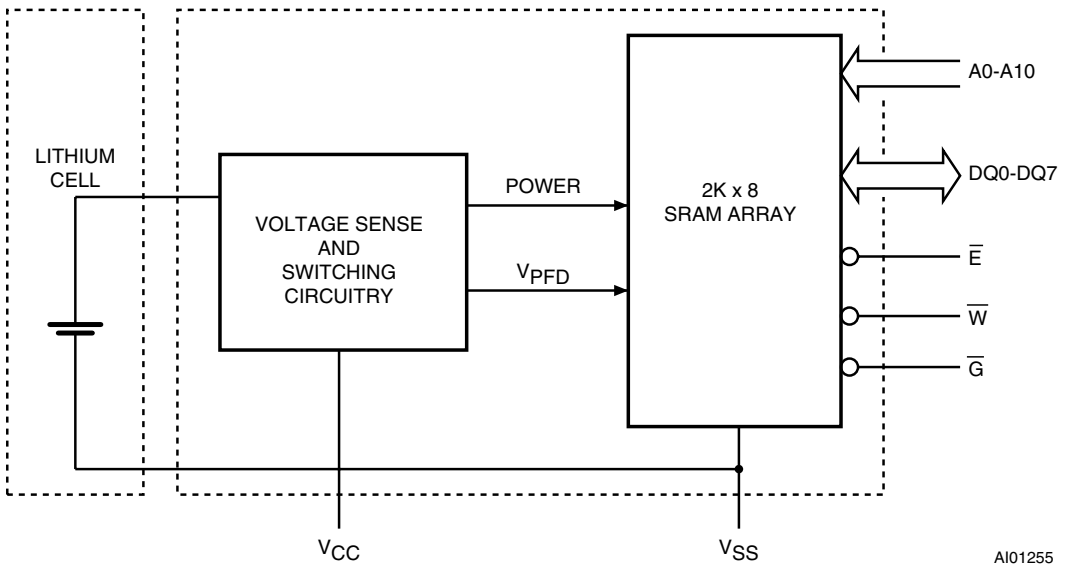


Figure 3. Block diagram



2 Operation modes

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_{CC} 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_{CC}. As V_{CC} falls below approximately 3V, the control circuitry connects the battery which maintains data operation until valid power returns.

Table 2. Operating modes

Mode	V_{CC}	$\overline{E}$	$\overline{G}$	$\overline{W}$	DQ0-DQ7	Power
Deselect	4.75 to 5.5V or 4.5 to 5.5V	V_{IH}	X	X	High Z	Standby
WRITE		V_{IL}	X	V_{IL}	D_{IN}	Active
READ		V_{IL}	V_{IL}	V_{IH}	D_{OUT}	Active
READ		V_{IL}	V_{IH}	V_{IH}	High Z	Active
Deselect	V_{SO} to V_{PFD}(min)(1)	X	X	X	High Z	CMOS standby
Deselect	$\leq V_{SO}$(1)	X	X	X	High Z	Battery back-up mode

1. See *Table 10 on page 16* for details.

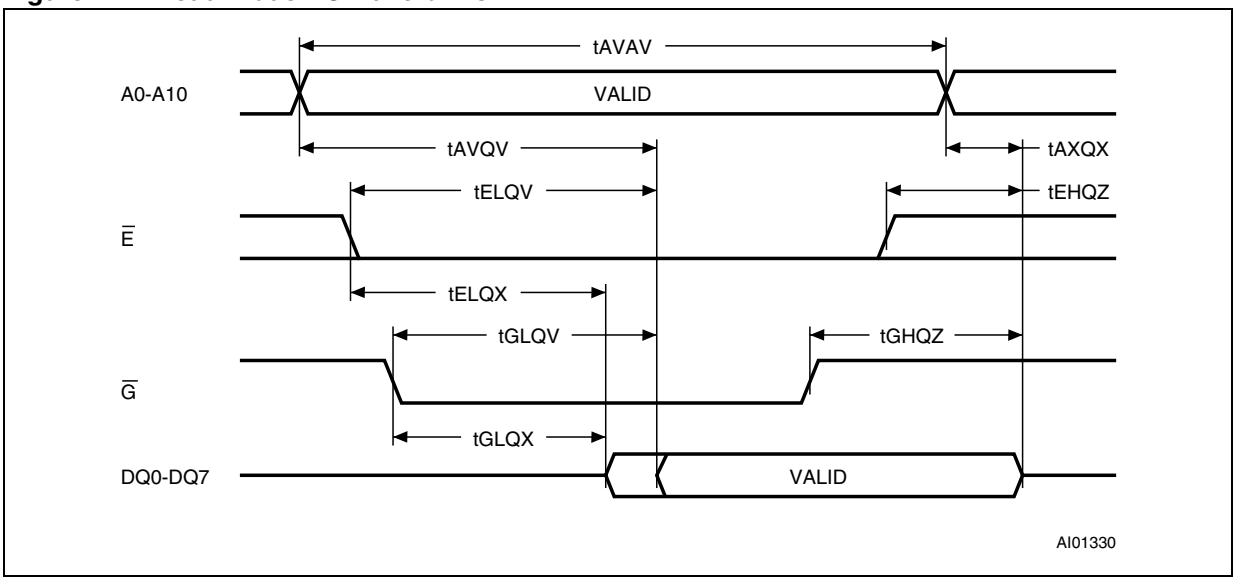
Note: X = V_{IH} or V_{IL}; V_{SO} = Battery back-up switchover voltage.

2.1 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.

Figure 4. Read mode AC waveforms



Note: WRITE Enable ($\overline{W}$) = High.

Table 3. Read mode AC characteristics

Symbol	Parameter[1]	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

1. Valid for ambient operating temperature: T_A = 0 to 70°C or –40 to 85°C; V_{CC} = 4.75 to 5.5V or 4.5 to 5.5V (except where noted).

2.2 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_{EHAX} from Chip Enable or t_{WHAX} from WRITE Enable prior to the initiation of another READ or WRITE cycle. Data-in must be valid t_{DVWH} prior to the end of WRITE and remain valid for t_{WHDX} 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_{WLQZ} after $\overline{W}$ falls.

Figure 5. Write enable controlled, write AC waveform

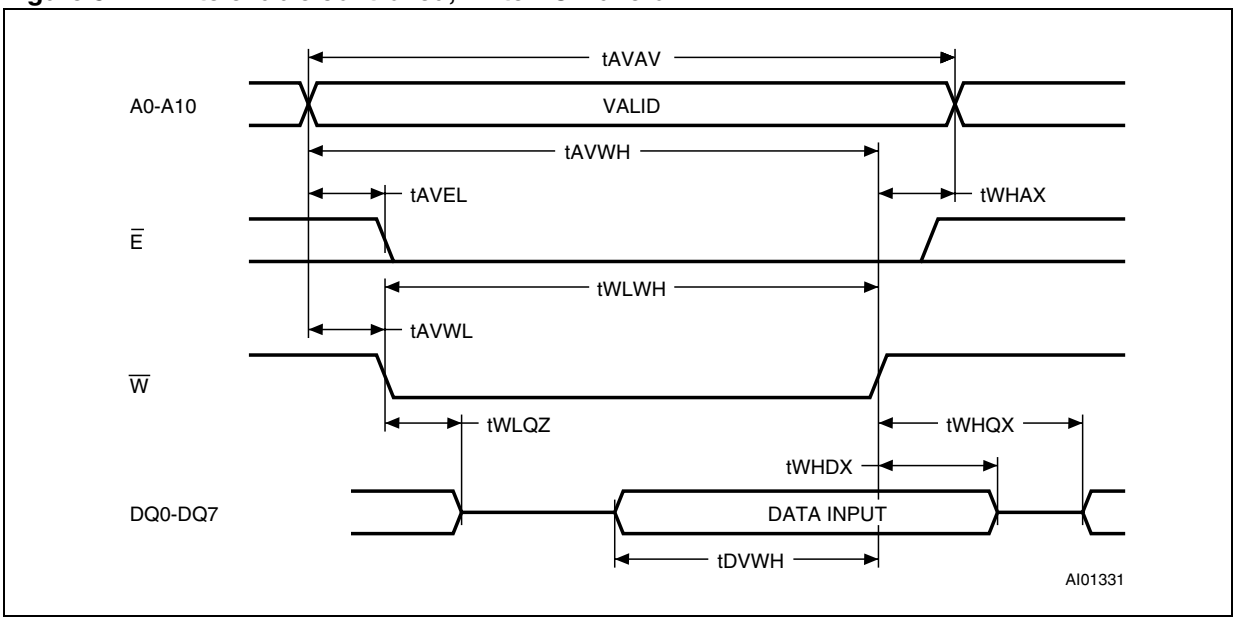


Figure 6. Chip enable controlled, write AC waveforms

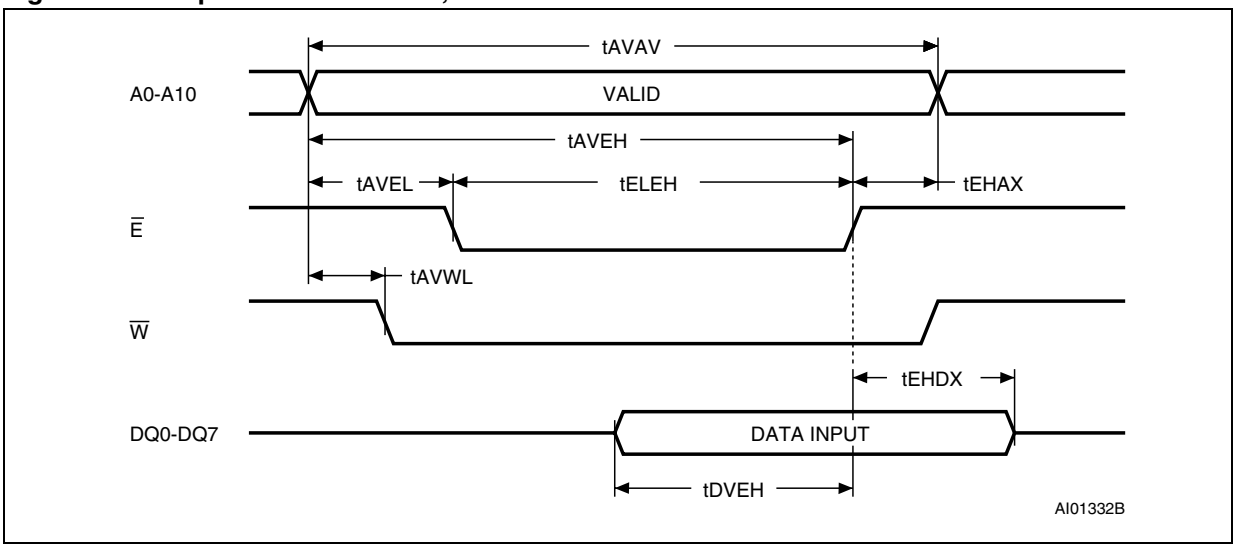


Table 4. Write mode AC characteristics

Symbol	Parameter[1][1]	M48Z02/M48Z12						Unit
		–70		–150		–200		
		Min	Max	Min	Max	Min	Max	
t_{AVAV}	WRITE cycle time	70		150		200		ns
t_{AVWL}	Address valid to WRITE enable low	0		0		0		ns
t_{AVEL}	Address valid to chip enable 1 low	0		0		0		ns
t_{WLWH}	WRITE enable pulse width	50		90		120		ns
t_{ELEH}	Chip enable low to chip enable 1 high	55		90		120		ns
t_{WHAX}	WRITE enable high to address transition	0		10		10		ns
t_{EHAX}	Chip enable high to address transition	0		10		10		ns
t_{DVWH}	Input valid to WRITE enable high	30		40		60		ns
t_{DVEH}	Input valid to Chip enable high	30		40		60		ns
t_{WHDX}	WRITE enable high to input transition	5		5		5		ns
t_{EHDX}	Chip enable high to input transition	5		5		5		ns
t_{WLQZ}	WRITE enable low to output Hi-Z		25		50		60	ns
t_{AVWH}	Address valid to WRITE enable high	60		120		140		ns
t_{AVEH}	Address valid to chip enable high	60		120		140		ns
t_{WHQX}	WRITE enable high to output transition	5		10		10		ns

1. Valid for ambient operating temperature: T_A = 0 to 70°C or –40 to 85°C; V_{CC} = 4.75 to 5.5V or 4.5 to 5.5V (except where noted).

2.3 Data retention mode

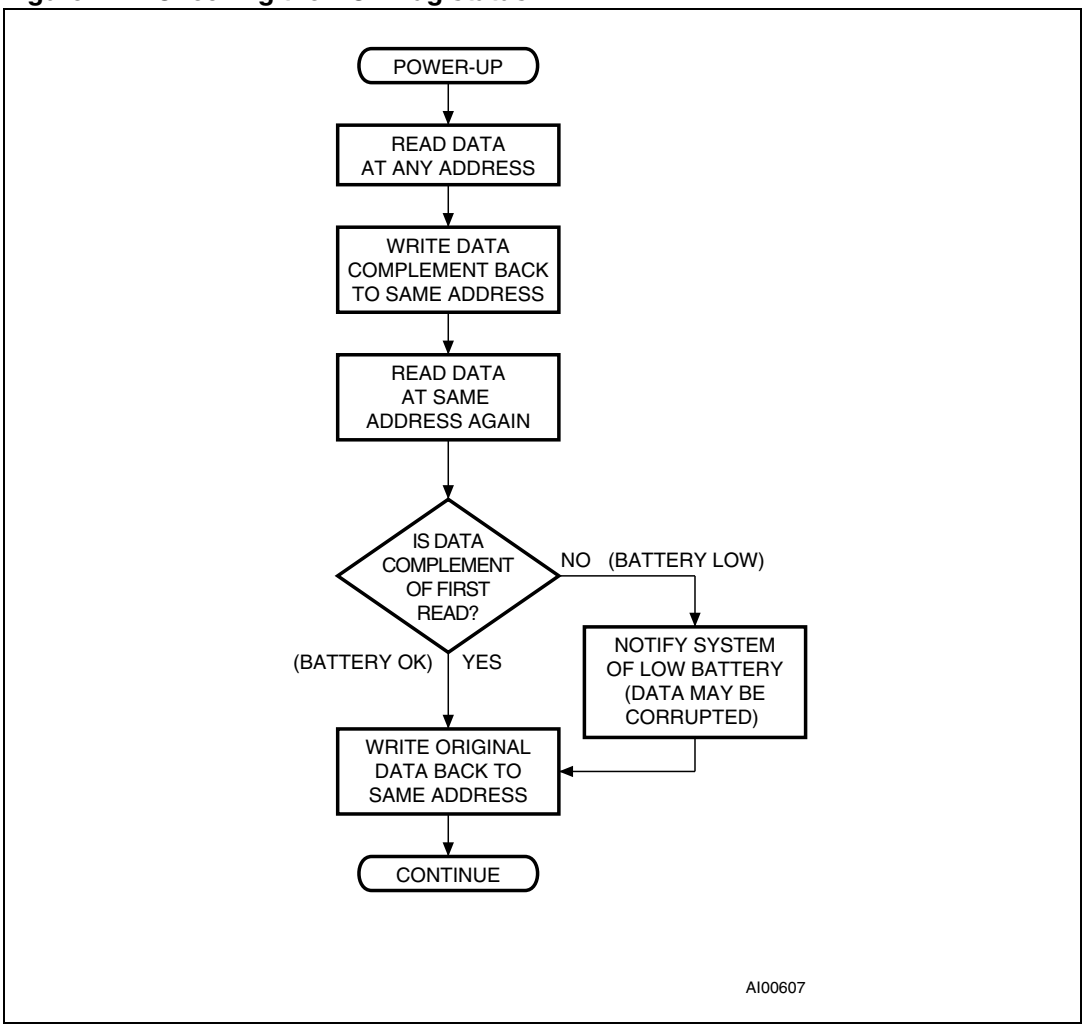
With valid V_{CC} applied, the M48Z02/12 operates as a conventional BYTEWIDE™ static RAM. Should the supply voltage decay, the RAM will automatically power-fail deselect, write protecting itself when V_{CC} falls within the V_{PFD} (max), V_{PFD} (min) window. All outputs become high impedance, and all 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 ($\overline{BOK}$) flag will be set. The $\overline{BOK}$ flag can be checked after power up. If the $\overline{BOK}$ 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 7 on page 11* illustrates how a $\overline{BOK}$ check routine could be structured.

For more information on a Battery Storage Life refer to the Application Note AN1012.

Figure 7. Checking the $\overline{BOK}$ flag status

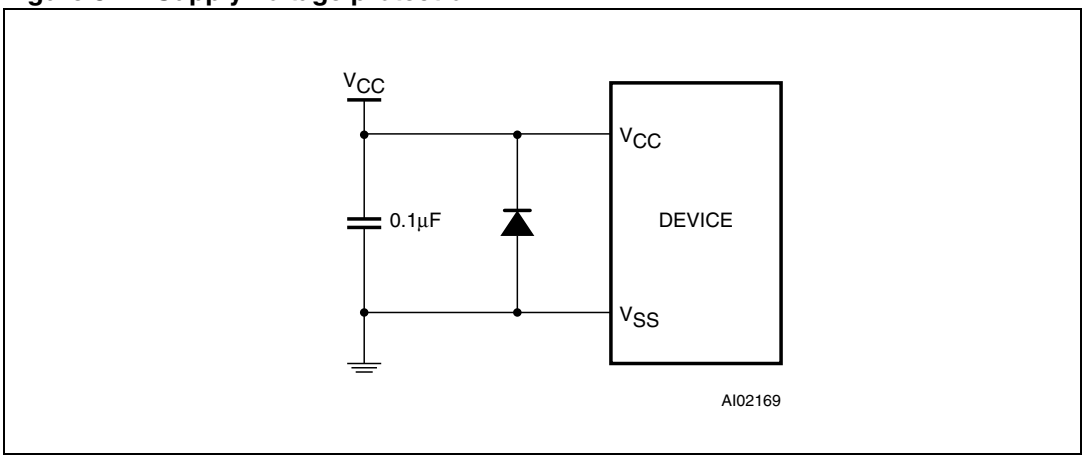


2.4 V_{CC} noise and negative going transients

I_{CC} 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 0.1µF (as shown in *Figure 8 on page 12*) 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, STMicroelectronics recommends connecting 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 8. Supply voltage protection



3 Maximum rating

Stressing the device above the rating listed in the “Absolute Maximum Ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

Table 5. Absolute maximum ratings

Symbol	Parameter		Value	Unit
T_A	Ambient operating temperature	Grade 1	0 to 70	°C
T_{STG}	Storage temperature (V_{CC} off, oscillator off)		–40 to 85	°C
T_{SLD}(1)	Lead solder temperature for 10 seconds		260	°C
V_{IO}	Input or output voltages		–0.3 to 7	V
V_{CC}	Supply voltage		–0.3 to 7	V
I_O	Output current		20	mA
P_D	Power dissipation		1	W

1. 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 –0.3V are not allowed on any pin while in the battery back-up mode.*

4 DC and AC parameters

This section summarizes the operating and measurement conditions, as well as the DC and AC characteristics of the device. The parameters in the following DC and AC Characteristic tables are derived from tests performed under the Measurement Conditions listed in *Table 6: Operating and AC measurement conditions*. Designers should check that the operating conditions in their projects match the measurement conditions when using the quoted parameters.

Table 6. Operating and AC measurement conditions

Parameter		M48Z02	M48Z12	Unit
Supply voltage (V_{CC})		4.75 to 5.5	4.5 to 5.5	V
Ambient operating temperature (T_A)	Grade 1	0 to 70	0 to 70	°C
Load capacitance (C_L)		100	100	pF
Input rise and fall times		≤ 5	≤ 5	ns
Input pulse voltages		0 to 3	0 to 3	V
Input and output timing ref. voltages		1.5	1.5	V

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

Figure 9. AC testing load circuit

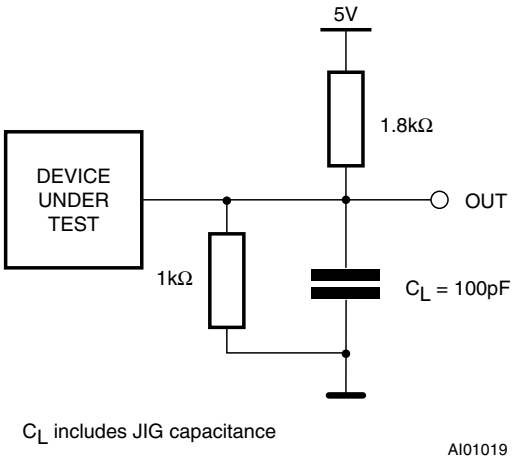


Table 7. Capacitance

Symbol	Parameter[1][2]	Min	Max	Unit
C_{IN}	Input capacitance		10	pF
C_{IO}[3]	Input / output capacitance		10	pF

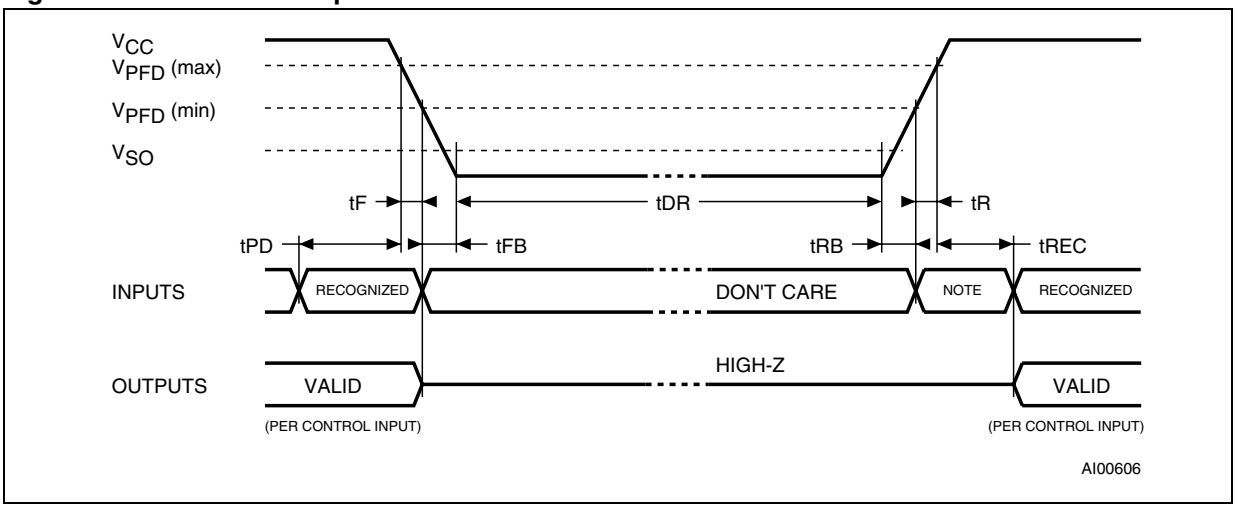
1. Effective capacitance measured with power supply at 5V. Sampled only, not 100% tested.
2. At 25°C, f = 1MHz.
3. Outputs deselected.

Table 8. DC characteristics

Symbol	Parameter	Test condition(1)	Min	Max	Unit
I_{LI}	Input leakage current	$0V \le V_{IN} \le V_{CC}$		±1	µA
I_{LO}(2)	Output leakage current	$0V \le V_{OUT} \le V_{CC}$		±1	µA
I_{CC}	Supply current	Outputs open		80	mA
I_{CC1}	Supply current (standby) TTL	$\overline{E} = V_{IH}$		3	mA
I_{CC2}	Supply current (standby) CMOS	$\overline{E} = V_{CC} - 0.2V$		3	mA
V_{IL}	Input low voltage		–0.3	0.8	V
V_{IH}	Input high voltage		2.2	V_{CC} + 0.3	V
V_{OL}	Output low voltage	I_{OL} = 2.1mA		0.4	V
V_{OH}	Output high voltage	I_{OH} = –1mA	2.4		V

1. Valid for ambient operating temperature: T_A = 0 to 70°C; V_{CC} = 4.75 to 5.5V or 4.5 to 5.5V (except where noted).
2. Outputs deselected.

Figure 10. Power down/up mode AC waveforms



Note: Inputs may or may not be recognized at this time. Caution should be taken to keep $\overline{E}$ high as V_{CC} rises past V_{PFD} (min). Some systems may perform inadvertent WRITE cycles after V_{CC} rises above V_{PFD} (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 is running.

Table 9. Power down/up AC characteristics

Symbol	Parameter[1]	Min	Max	Unit
t_{PD}	$\overline{E}$ or $\overline{W}$ at V_{IH} before power down	0		µs
t_F[2]	V_{PFD} (max) to V_{PFD} (min) V_{CC} fall time	300		µs
t_{FB}[3]	V_{PFD} (min) to V_{SS} V_{CC} fall time	10		µs
t_R	V_{PFD} (min) to V_{PFD} (max) V_{CC} rise time	0		µs
t_{RB}	V_{SS} to V_{PFD} (min) V_{CC} rise time	1		µs
t_{REC}	$\overline{E}$ or $\overline{W}$ at V_{IH} after power up	2		ms

1. Valid for ambient operating temperature: T_A = 0 to 70°C; V_{CC} = 4.75 to 5.5V or 4.5 to 5.5V (except where noted).
2. V_{PFD} (max) to V_{PFD} (min) fall time of less than tF may result in deselection/write protection not occurring until 200µs after V_{CC} passes V_{PFD} (min).
3. V_{PFD} (min) to V_{SS} fall time of less than t_{FB} may cause corruption of RAM data.

Table 10. Power down/up trip points DC characteristics

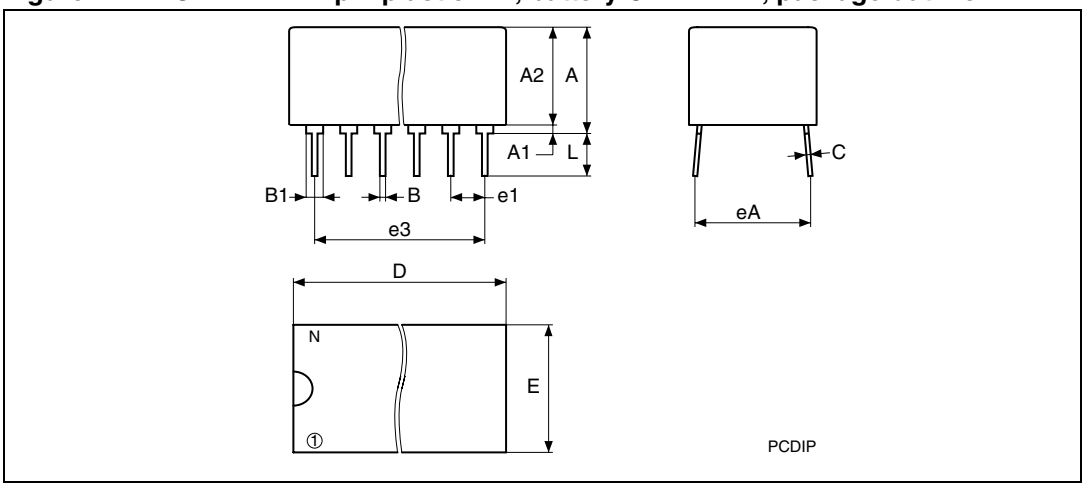
Symbol	Parameter[1][2]		Min	Typ	Max	Unit
V_{PFD}	Power-fail deselect voltage	M48Z02	4.5	4.6	4.75	V
		M48Z12	4.2	4.3	4.5	V
V_{SO}	Battery back-up switchover voltage			3.0		V
t_{DR}[3]	Expected data retention time		10			YEARS

1. All voltages referenced to V_{SS}.
2. Valid for ambient operating temperature: T_A = 0 to 70°C; V_{CC} = 4.75 to 5.5V or 4.5 to 5.5V (except where noted).
3. At 25°C, V_{CC} = 0V.

5 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

Figure 11. PCDIP24 – 24-pin plastic DIP, battery CAPHAT™, package outline



Note: Drawing is not to scale.

Table 11. PCDIP24 – 24-pin plastic DIP, battery CAPHAT™, package mechanical data

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		

6 Part numbering

Table 12. Ordering information scheme

Example: M48Z 02 –70 PC 1

Device type

M48Z

Supply voltage and write protect voltage

02 = V_{CC} = 4.75 to 5.5V; V_{PFD} = 4.5 to 4.75V

12 = V_{CC} = 4.5 to 5.5V; V_{PFD} = 4.2 to 4.5V

Speed

–70 = 70ns (M48Z02/12)

–150 = 150ns (M48Z02/12)

–200 = 200ns (M48Z02/12)

Package

PC = PCDIP24

Temperature range

1 = 0 to 70°C

Shipping method

blank = ECOPACK package, tubes

For a list of available options (e.g., Speed, Package) or for further information on any aspect of this device, please contact the ST sales office nearest you.

7 Revision history

Table 13. Document revision history

Date	Revision	Changes
May-1999	1.0	First issue
09-Jul-2001	2.0	Reformatted; temperature information added to tables (*Table 5*, *6*, *7*, *8*, *3*, *4*, *9*, *10*); Figure updated (*Figure 10*)
17-Dec-2001	2.1	Remove references to “clock” in document
20-May-2002	2.2	Updated V_{CC} noise and negative going transients text
01-Apr-2003	3.0	v2.2 template applied; test condition updated (*Table 10*)
22-Apr-2003	3.1	Fix error in ordering information (*Table 12*)
12-Dec-2005	4.0	Update template, Lead-free text, and remove references to ‘crystal’ and footnote (*Table 8*, *12*)
02-Nov-2007	5	Reformatted document; added lead-free second level interconnect information to cover page and *Section 5: Package mechanical data*; updated *Table 5*, *6*, *8*, *9*, *10*, *12*.

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