19-0154; Rev 1; 3/96

MAXIM

Nonvolatile RAM Controller

General Description

The MXD1210 nonvolatile RAM controller is a very low-power CMOS circuit that converts standard (volatile) CMOS RAM into nonvolatile memory. It also continually monitors the power supply to provide RAM write protection when power to the RAM is in a marginal (out-of-tolerance) condition. When the power supply begins to fail, the RAM is write protected, and the device switches to battery-backup mode.

Applications

µP Systems

Computers

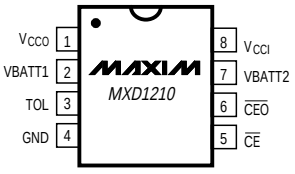
Embedded Systems

Features

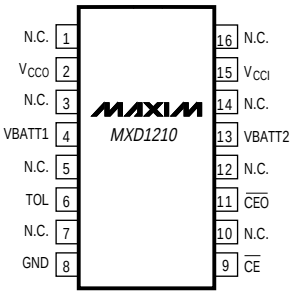
- ♦ **Battery Backup**
- ♦ **Memory Write Protection**
- ♦ **230µA Operating-Mode Quiescent Current**
- ♦ **2nA Backup-Mode Quiescent Current**
- ♦ **Battery Freshness Seal**
- ♦ **Optional Redundant Battery**
- ♦ **Low Forward-Voltage Drop on V_{CC} Supply Switch**
- ♦ **5% or 10% Power-Fail Detection Options**
- ♦ **Tests Battery Condition During Power-Up**
- ♦ **8-Pin SO Available**

Pin Configurations

TOP VIEW



DIP/SO



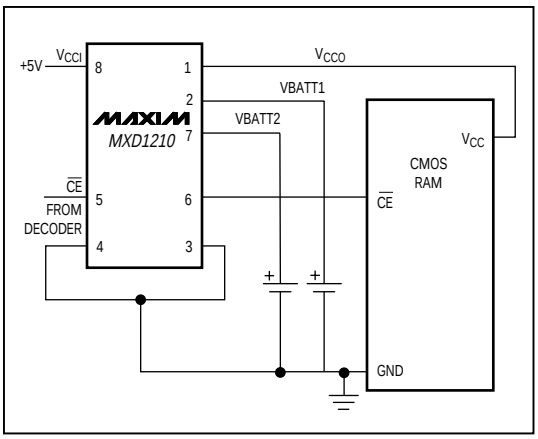
Wide SO

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MXD1210CPA	0°C to +70°C	8 Plastic DIP
MXD1210CSA	0°C to +70°C	8 SO
MXD1210CWE	0°C to +70°C	16 Wide SO
MXD1210C/D	0°C to +70°C	Dice*
MXD1210EPA	-40°C to +85°C	8 Plastic DIP
MXD1210ESA	-40°C to +85°C	8 SO
MXD1210EWE	-40°C to +85°C	16 Wide SO
MXD1210MJA	-55°C to +125°C	8 CERDIP

**Contact factory for dice specifications.*

Typical Operating Circuit



ABSOLUTE MAXIMUM RATINGS

V_{CCI} to GND .....-0.3V, +7V
VBATT1 to GND..... -0.3V, +7V
VBATT2 to GND..... -0.3V, +7V
V_{CCO} to GND..... -0.3V, V_S + 0.3V
(V_S = greater of V_{CCI}, VBATT1, VBATT2)
Digital Input and Output Voltages to GND..... 0.3V, V_{CCI} + 0.3V

Continuous Power Dissipation (T_A = +70°C)
8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
8-Pin SO (derate 5.88mW/°C above +70°C).....471mW
16-Pin Wide SO (derate 9.52mW/°C above +70°C).....762mW
8-Pin CERDIP (derate 8.00mW/°C above +70°C).....640mW
Operating Temperature Ranges
MXD1210C_ _ ..... 0°C to +70°C
MXD1210E_ _ ..... -40°C to +85°C
MXD1210MJA..... -55°C to +125°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RECOMMENDED OPERATING CONDITIONS						
Supply Voltage	V_{CCI}	TOL = GND	4.75		5.50	V
		TOL = V_{CCO}	4.50		5.50	
Input High Voltage	V_{IH}		2.2			V
Input Low Voltage	V_{IL}				0.8	V
Battery Voltage (Note 1)	VBATT1 VBATT2	1 or 2 batteries	2.0		4.0	V

ELECTRICAL CHARACTERISTICS

(V_{CCI} = +4.75V to +5.5V, TOL = GND; or V_{CCI} = +4.5V to +5.5V, TOL = V_{CCO}; T_A = T_{MIN} to T_{MAX}; unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
NORMAL SUPPLY MODE, TOL = V_{CCO}							
Supply Current	I_{CCI}	V_{CCO}, $\overline{CEO}$ open, VBATT1 = VBATT2 = 3V			0.23	0.5	mA
Output Supply Voltage	V_{CCO}	I_{CCO1} = 80mA (Note 2)	MXD1210C	V_{CCI} - 0.20			V
			MXD1210E	V_{CCI} - 0.21			
			MXD1210M	V_{CCI} - 0.25			
Output Supply Current	I_{CCO}	V_{CCI} - V_{CCO} ≤ 0.2V (Note 2)	MXD1210C			80	mA
			MXD1210E		0.23	75	
			MXD1210M		0.23	65	
Input Leakage Current	I_{IL}					±1.0	µA
Output Leakage Current	I_{OL}					±1.0	µA
High-Level Output Voltage	V_{OH}	I_{OH} = -1mA		2.4			V
Low-Level Output Voltage	V_{OL}	I_{OL} = 4mA				0.4	V
V_{CCI} Trip Point	V_{CCTP}	TOL = GND		4.50		4.74	V
		TOL = V_{CCO}		4.25		4.49	

ELECTRICAL CHARACTERISTICS

(V_{CCI} < VBATT; positive edge rate at VBATT1, VBATT2 > 0.1V/µs, $T_A = T_{MIN}$ to T_{MAX}; unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
BATTERY-BACKUP MODE							
Quiescent Current (Note 1)	I_{BATT}	V_{CCO}, $\overline{CEO}$ open V_{CCI} = 0V	MXD1210C/E		2	100	nA
			MXD1210M			5	µA
Output Supply Current (Notes 3, 4)	I_{CCO2}	VBATT - $V_{CCO} \le 0.2V$				300	µA
$\overline{CEO}$ Output Voltage	V_O	Output open		VBATT - 0.2			V

ELECTRICAL CHARACTERISTICS

($T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT/OUTPUT CAPACITANCE (Note 5)						
Input Capacitance	C_{IN}				5	pF
Output Capacitance	C_{OUT}				7	pF

V_{CC} POWER TIMING CHARACTERISTICS

(V_{CCI} = +4.75V to +5.5V, TOL = GND; or V_{CCI} = +4.5V to +5.5V, TOL = V_{CCO}; $T_A = T_{MIN}$ to T_{MAX}; unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
$\overline{CE}$ Propagation Delay	t_{PD}	R_L = 1kΩ, C_L = 50pF	MXD1210C	5	10	20	ns
			MXD1210E	5	10	22	
			MXD1210M	5	10	25	
$\overline{CE}$ High to Power-Fail (Note 5)	t_{PF}				0		ns

TIMING CHARACTERISTICS

(V_{CCI} < +4.75V to +5.5V, TOL = GND; or V_{CCI} < +4.5V , TOL = V_{CCO}; $T_A = T_{MIN}$ to T_{MAX}; unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Recovery at Power-Up	t_{REC}		2	5	20	ms
V_{CC} Slew-Rate Power-Down	t_F	To out-of-tolerance condition	300			µs
	t_{FB}	Tolerance to battery power	10			
V_{CC} Slew-Rate Power-Up	t_R		0			µs
$\overline{CE}$ Pulse Width (Note 6)	t_{CE}				1.5	µs

Note 1: Only one battery input is required. Unused battery inputs must be grounded.
Note 2: I_{CCO1} is the maximum average load current the MXD1210 can supply to the memories.
Note 3: I_{CCO2} is the maximum average load current the MXD1210 can supply to the memories in battery-backup mode.
Note 4: $\overline{CEO}$ can sustain leakage current only in battery-backup mode.
Note 5: Guaranteed by design.
Note 6: t_{CE} max must be met to ensure data integrity on power loss.

Pin Description

PIN		NAME	FUNCTION
8-PIN DIP/SO	16-PIN WIDE SO		
1	2	V_{CCO}	Backed-up supply to RAM
2	4	VBATT1	Battery 1 positive connection
3	6	TOL	Tolerance select pin
4	8	GND	Ground
5	9	$\overline{CE}$	Chip-enable input
6	11	$\overline{CEO}$	Chip-enable output
7	13	VBATT2	Battery 2 positive connection
8	15	V_{CCI}	5V power supply to chip
–	1, 3, 5, 7 10, 12, 14, 16	N.C.	No connect, not internally connected

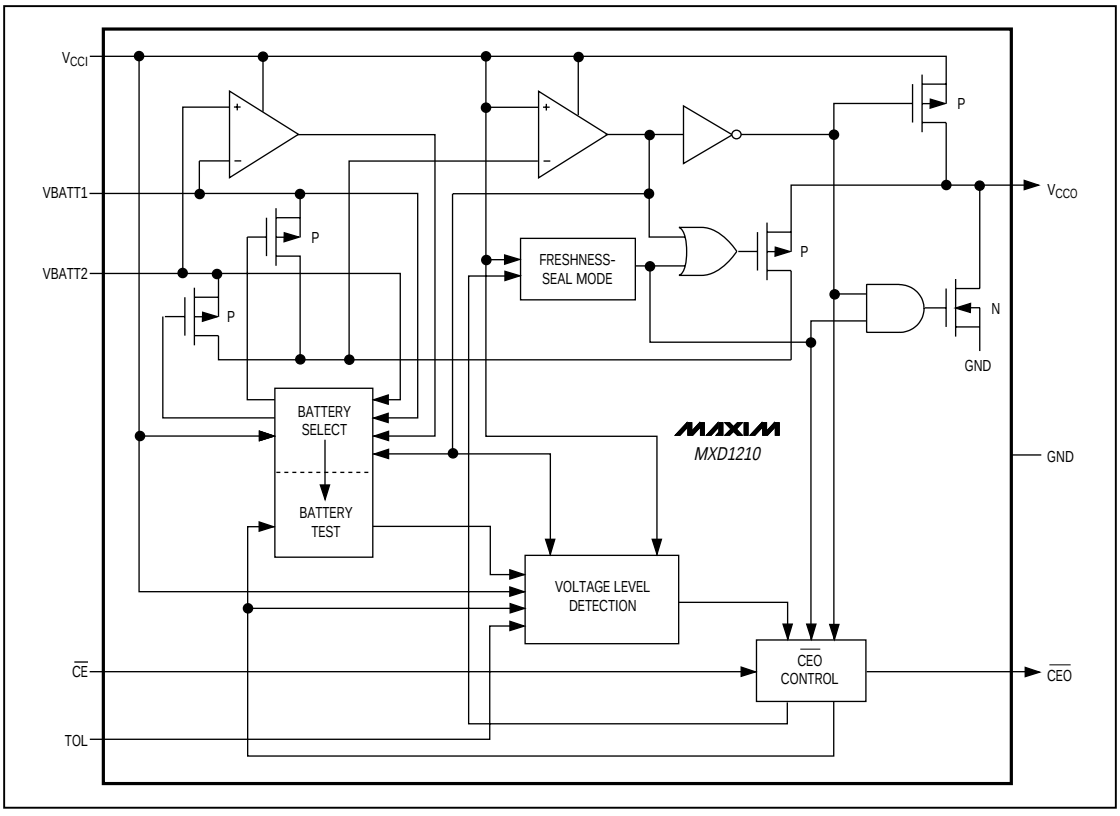


Figure 1. Block Diagram

Detailed Description

Main Functions

The MXD1210 executes five main functions to perform reliable RAM operation and battery backup (see *Typical Operating Circuit* and Figure 1):

1. RAM Power-Supply Switch: The switch directs power to the RAM from the incoming supply or from the selected battery, whichever is at the greater voltage. The switch control uses the same criterion to direct power to MXD1210 internal circuitry.
2. Power-Failure Detection: The write-protection function is enabled when a power failure is detected. The power-failure detection range depends on the state of the TOL pin as follows:

CONDITION	V_{CCTP} RANGE (V)
TOL = GND	4.75 to 4.50
TOL = V_{CCO}	4.50 to 4.25

   Power-failure detection is independent of the battery-backup function and precedes it sequentially as the power-supply voltage drops during a typical power failure.
3. Write Protection: This holds the chip-enable output ($\overline{CEO}$) to within 0.2V of V_{CCI} or of the selected battery, whichever is greater. If the chip-enable input ($\overline{CE}$) is low (active) when power failure is detected, then $\overline{CEO}$ is held low until $\overline{CE}$ is brought high, at which time $\overline{CEO}$ is gated high for the duration of the power failure. The preceding sequence completes the current RD/WR cycle, preventing data corruption if the RAM access is a WR cycle.
4. Battery Redundancy: A second battery is optional. When two batteries are connected, the stronger battery is selected to provide RAM backup and to power the MXD1210. The battery-selection circuitry remains active while in the battery-backup mode, selecting the stronger battery and isolating the weaker one. The battery-selection activity is transparent to the user and the system. If only one battery is connected, the second battery input should be grounded.
5. Battery-Status Warning: This notifies the system when the stronger of the two batteries measures ≤ 2.0V. Each time the MXD1210 is repowered ($V_{CCI} > V_{CCTP}$) after detecting a power failure, the battery voltage is measured. If the battery in use is low, following the MXD1210 recovery period, the device issues a warning to the system by inhibiting the second memory cycle. The sequence is as follows:

First access: read memory location n, loc(n) = x

Second access: write memory location n,

loc (n) = complement (x)

Third access: read memory location n, loc (n) = ?

If the third access (read) is complement (x), then the battery is good; otherwise, the battery is not good. Return to loc(n) = x following the test sequence.

Freshness-Seal Mode

The freshness-seal mode relates to battery longevity during storage rather than directly to battery backup. This mode is activated when the first battery is connected, and is defeated when the voltage at V_{CCI} first exceeds V_{CCTP}. In the freshness-seal mode, both batteries are isolated from the system; that is, no current is drained from either battery, and the RAM is not powered by either battery. This means that batteries can be installed and the system can be held in inventory without battery discharge. The positive edge rate at VBATT1 and VBATT2 should exceed 0.1V/µs. The batteries will maintain their full shelf-life while installed in the system.

Battery Backup

The *Typical Operating Circuit* shows the MXD1210 connected in order to write protect the RAM when V_{CC} is less than 4.75V, and to provide battery backup to the supply.

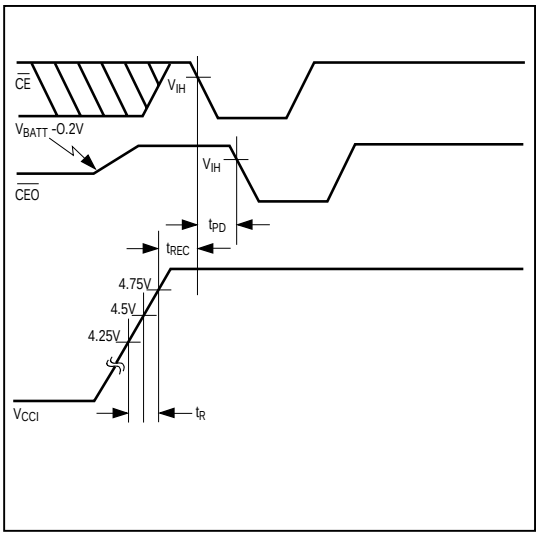


Figure 2. Power-Up Timing Diagram

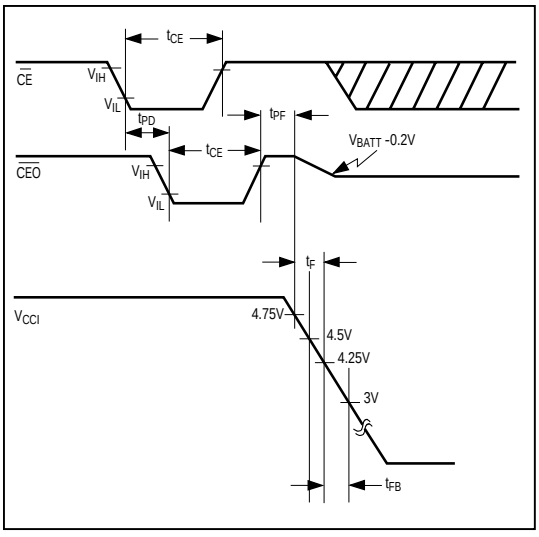
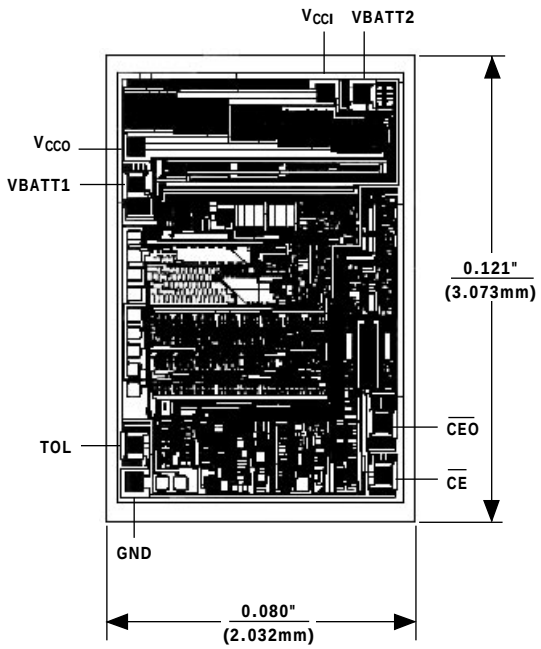


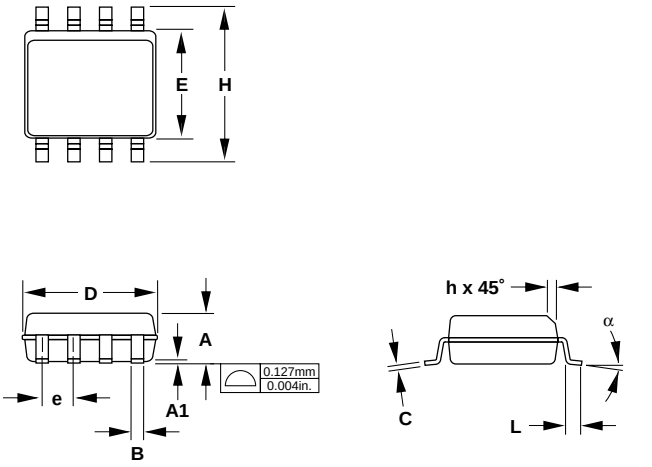
Figure 3. Power-Down Timing Diagram

Chip Topography



TRANSISTOR COUNT: 1436;
LEAVE SUBSTRATE UNCONNECTED.

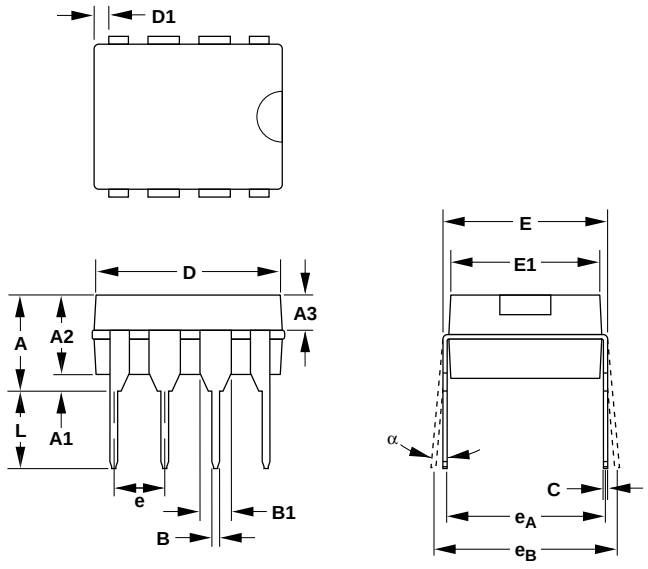
Package Information



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
D	0.189	0.197	4.80	5.00
E	0.150	0.157	3.80	4.00
e	0.050 BSC		1.27 BSC	
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27
α	0°	8°	0°	8°

21-325A

8-PIN PLASTIC SMALL-OUTLINE PACKAGE



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
A1	0.015	–	0.38	–
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.050	0.065	1.27	1.65
C	0.008	0.012	0.20	0.30
D	0.348	0.390	8.84	9.91
D1	0.005	0.035	0.13	0.89
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
e_A	0.300 BSC		7.62 BSC	
e_B	–	0.400	–	10.16
L	0.115	0.150	2.92	3.81
α	0°	15°	0°	15°

21-324A

8-PIN PLASTIC DUAL-IN-LINE PACKAGE