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# MAXIM

## Nonvolatile RAM Controller

MXD1210

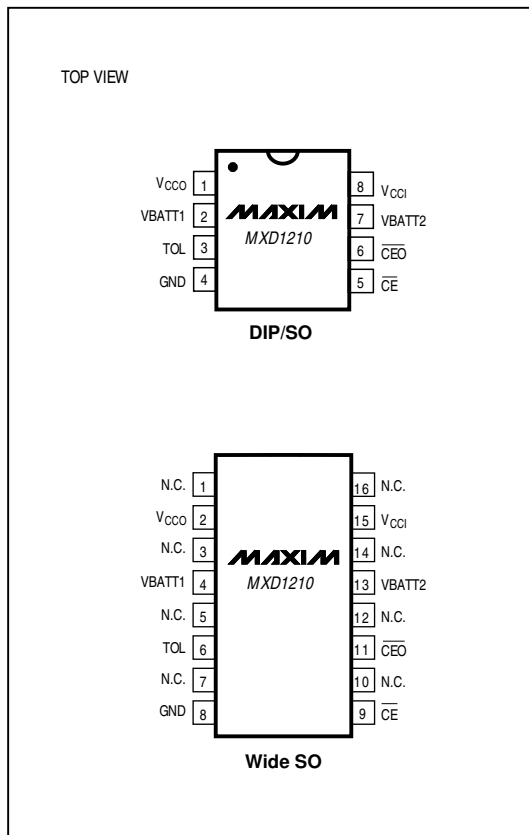
### General Description

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

### Pin Configurations



### Features

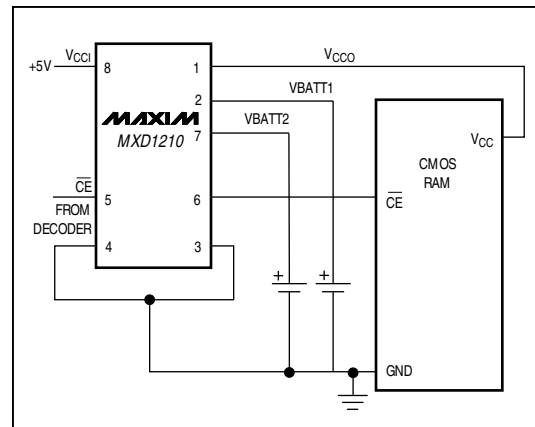
- ♦ Battery Backup
- ♦ Memory Write Protection
- ♦ 230μA Operating-Mode Quiescent Current
- ♦ 2nA Backup-Mode Quiescent Current
- ♦ Battery Freshness Seal
- ♦ Optional Redundant Battery
- ♦ Low Forward-Voltage Drop on V<sub>CC</sub> Supply Switch
- ♦ 5% or 10% Power-Fail Detection Options
- ♦ Tests Battery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

### 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



# Nonvolatile RAM Controller

## ABSOLUTE MAXIMUM RATINGS

V <sub>CC1</sub> to GND .....	-0.3V, +7V	Continuous Power Dissipation (T <sub>A</sub> = +70°C)
VBATT1 to GND.....	-0.3V, +7V	8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) ....
VBATT2 to GND.....	-0.3V, +7V	8-Pin SO (derate 5.88mW/°C above +70°C).....
V <sub>CC0</sub> to GND.....	-0.3V, V <sub>S</sub> + 0.3V	16-Pin Wide SO (derate 9.52mW/°C above +70°C).....
	(V <sub>S</sub> = greater of V <sub>CC1</sub> , VBATT1, VBATT2)	8-Pin CERDIP (derate 8.00mW/°C above +70°C).....
Digital Input and Output Voltages to GND.....	0.3V, V <sub>CC1</sub> + 0.3V	Operating Temperature Ranges
		MXD1210C_.....
		MXD1210E_.....
		MXD1210MJA.....
		Storage Temperature Range .....
		Lead Temperature (soldering, 10sec) .....

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<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>RECOMMENDED OPERATING CONDITIONS</b>						
Supply Voltage	V <sub>CC1</sub>	TOL = GND	4.75		5.50	V
		TOL = V <sub>CC0</sub>	4.50		5.50	
Input High Voltage	V <sub>IH</sub>		2.2			V
Input Low Voltage	V <sub>IL</sub>				0.8	V
Battery Voltage (Note 1)	VBATT1 VBATT2	1 or 2 batteries	2.0		4.0	V

## ELECTRICAL CHARACTERISTICS

(V<sub>CC1</sub> = +4.75V to +5.5V, TOL = GND; or V<sub>CC1</sub> = +4.5V to +5.5V, TOL = V<sub>CC0</sub>; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>; unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>NORMAL SUPPLY MODE, TOL = V<sub>CC0</sub></b>						
Supply Current	I <sub>CC1</sub>	V <sub>CC0</sub> , $\overline{CEO}$ open, VBATT1 = VBATT2 = 3V		0.23	0.5	mA
Output Supply Voltage	V <sub>CC0</sub>	I <sub>CC01</sub> = 80mA (Note 2)	MXD1210C	V <sub>CC1</sub> - 0.20		V
			MXD1210E	V <sub>CC1</sub> - 0.21		
			MXD1210M	V <sub>CC1</sub> - 0.25		
Output Supply Current	I <sub>CC0</sub>	V <sub>CC1</sub> - V <sub>CC0</sub> ≤ 0.2V (Note 2)	MXD1210C		80	mA
			MXD1210E	0.23	75	
			MXD1210M	0.23	65	
Input Leakage Current	I <sub>IL</sub>				±1.0	μA
Output Leakage Current	I <sub>OL</sub>				±1.0	μA
High-Level Output Voltage	V <sub>OH</sub>	I <sub>OH</sub> = -1mA	2.4			V
Low-Level Output Voltage	V <sub>OL</sub>	I <sub>OL</sub> = 4mA			0.4	V
V <sub>CC1</sub> Trip Point	V <sub>CC1TP</sub>	TOL = GND	4.50		4.74	V
		TOL = V <sub>CC0</sub>	4.25		4.49	

# Nonvolatile RAM Controller

MXD1210

## ELECTRICAL CHARACTERISTICS

( $V_{CC1} < V_{BATT}$ ; positive edge rate at  $V_{BATT1}$ ,  $V_{BATT2} > 0.1V/\mu s$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ ; unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>BATTERY-BACKUP MODE</b>						
Quiescent Current (Note 1)	$I_{BATT}$	$V_{CC0}$ , $\overline{CE0}$ open $V_{CC1} = 0V$	MXD1210C/E	2	100	nA
			MXD1210M		5	$\mu A$
Output Supply Current (Notes 3, 4)	$I_{CCO2}$	$V_{BATT} - V_{CC0} \leq 0.2V$			300	$\mu A$
$\overline{CE0}$ Output Voltage	$V_O$	Output open	$V_{BATT} - 0.2$			V

## ELECTRICAL CHARACTERISTICS

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

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

## $V_{CC}$ POWER TIMING CHARACTERISTICS

( $V_{CC1} = +4.75V$  to  $+5.5V$ ,  $TOL = GND$ ; or  $V_{CC1} = +4.5V$  to  $+5.5V$ ,  $TOL = V_{CC0}$ ;  $T_A = T_{MIN}$  to  $T_{MAX}$ ; unless otherwise noted.)

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

## TIMING CHARACTERISTICS

( $V_{CC1} < +4.75V$  to  $+5.5V$ ,  $TOL = GND$ ; or  $V_{CC1} < +4.5V$ ,  $TOL = V_{CC0}$ ;  $T_A = T_{MIN}$  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			$\mu s$
	$t_{FB}$	Tolerance to battery power	10			
$V_{CC}$ Slew-Rate Power-Up	$t_R$		0			$\mu s$
$\overline{CE}$ Pulse Width (Note 6)	$t_{CE}$				1.5	$\mu s$

**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:**  $\overline{CE0}$  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.

# Nonvolatile RAM Controller

## Pin Description

PIN		NAME	FUNCTION
8-PIN DIP/SO	16-PIN WIDE SO		
1	2	V <sub>CC0</sub>	Backed-up supply to RAM
2	4	VBATT1	Battery 1 positive connection
3	6	TOL	Tolerance select pin
4	8	GND	Ground
5	9	$\overline{\text{CE}}$	Chip-enable input
6	11	$\overline{\text{CEO}}$	Chip-enable output
7	13	VBATT2	Battery 2 positive connection
8	15	V <sub>CCI</sub>	5V power supply to chip
-	1, 3, 5, 7 10, 12, 14, 16	N.C.	No connect, not internally connected

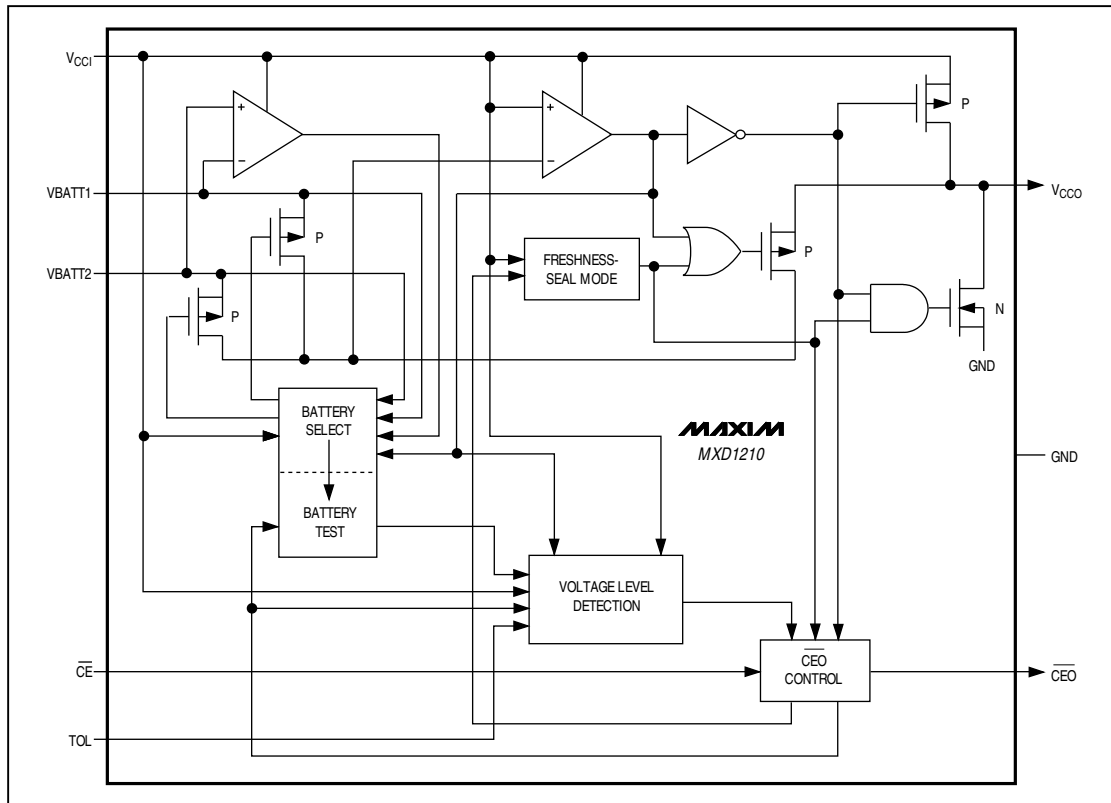


Figure 1. Block Diagram

# Nonvolatile RAM Controller

MXD1210

## 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 <sub>CCTP</sub> RANGE (V)
TOL = GND	4.75 to 4.50
TOL = V <sub>CCO</sub>	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 ( $\overline{CE0}$ ) to within 0.2V of V<sub>CC1</sub> or of the selected battery, whichever is greater. If the chip-enable input ( $\overline{CE}$ ) is low (active) when power failure is detected, then  $\overline{CE0}$  is held low until  $\overline{CE}$  is brought high, at which time  $\overline{CE0}$  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  $\leq 2.0V$ . Each time the MXD1210 is repowered (V<sub>CC1</sub> > V<sub>CCTP</sub>) 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<sub>CC1</sub> first exceeds V<sub>CCTP</sub>. 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/ $\mu$ s. 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<sub>CC</sub> is less than 4.75V, and to provide battery backup to the supply.

# Nonvolatile RAM Controller

**MXD1210**

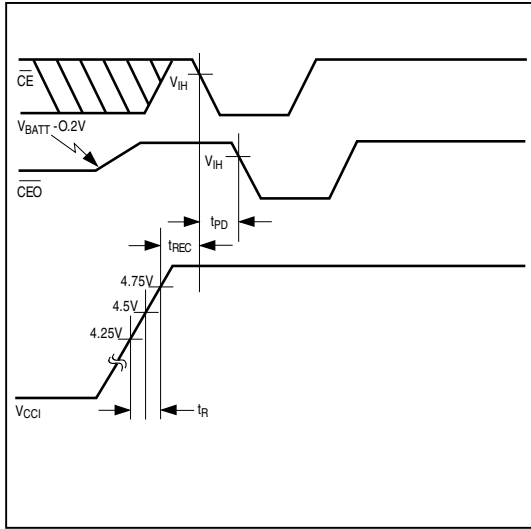


Figure 2. Power-Up Timing Diagram

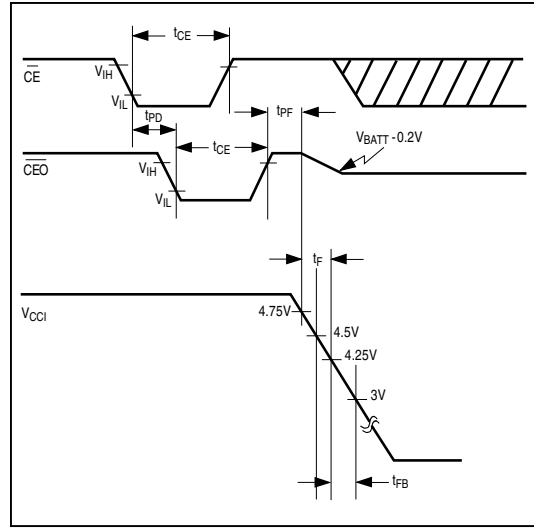
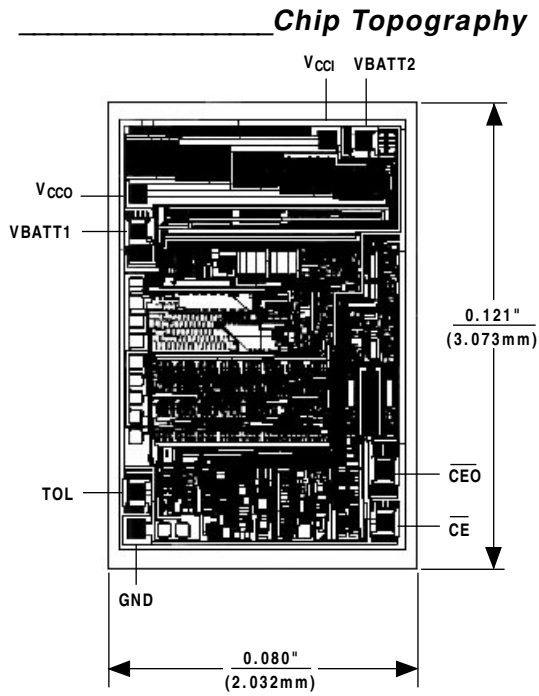


Figure 3. Power-Down Timing Diagram

# Nonvolatile RAM Controller

**MXD1210**



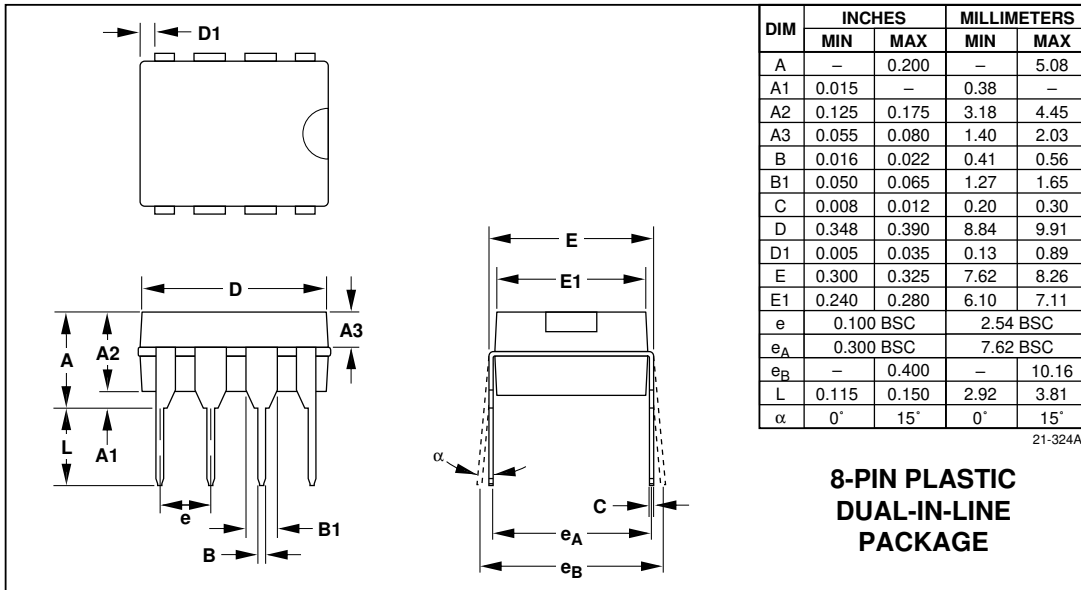
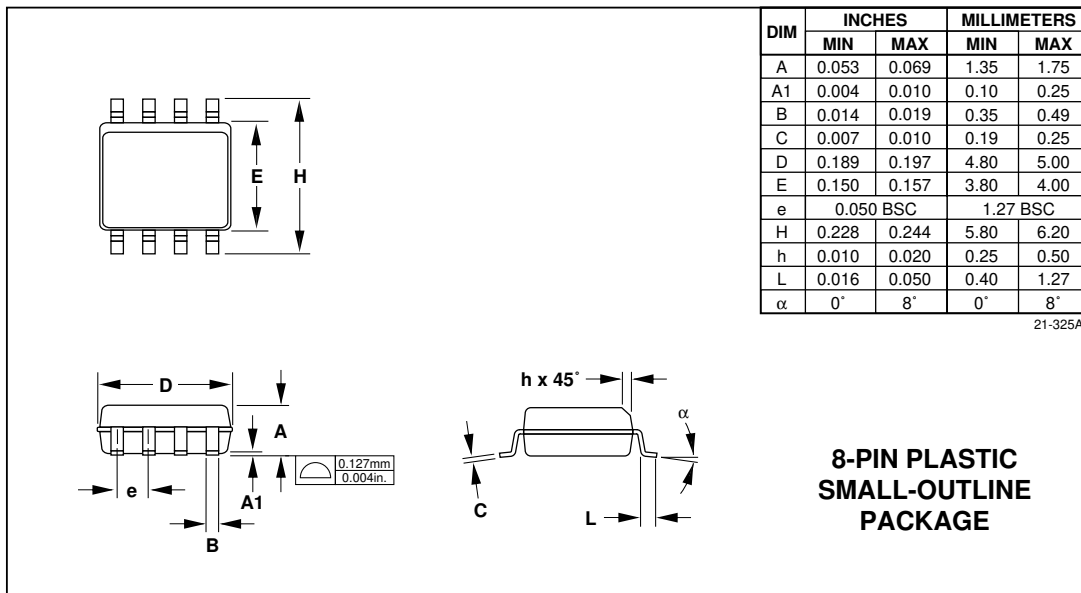
TRANSISTOR COUNT: 1436;  
LEAVE SUBSTRATE UNCONNECTED.



# Nonvolatile RAM Controller

MXD1210

## Package Information



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