

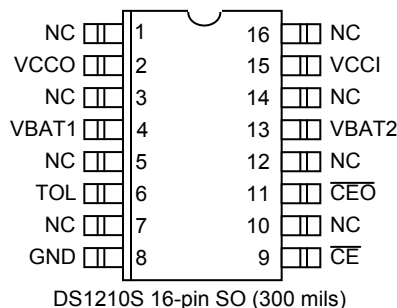
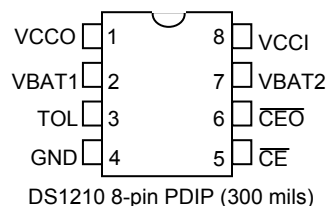


## DS1210 Nonvolatile Controller Chip

### FEATURES

- Converts CMOS RAMs into Nonvolatile Memories
- Unconditionally Write Protects when  $V_{CC}$  is Out-of-Tolerance
- Automatically Switches to Battery when Power-Fail Occurs
- Space-Saving 8-Pin PDIP or 16-Pin SO Packages
- Consumes <100nA of Battery Current
- Tests Battery Condition on Power up
- Provides for Redundant Batteries
- Optional 5% or 10% Power-Fail Detection
- Low Forward Voltage Drop on the  $V_{CC}$  Switch
- Optional Industrial (N) Temperature Range of -40°C to +85°C

### PIN ASSIGNMENT



### PIN DESCRIPTION

|                  |                          |
|------------------|--------------------------|
| $V_{CCO}$        | - RAM Supply             |
| $V_{BAT1}$       | - + Battery 1            |
| TOL              | - Power Supply Tolerance |
| GND              | - Ground                 |
| $\overline{CE}$  | - Chip Enable Input      |
| $\overline{CEO}$ | - Chip Enable Output     |
| $V_{BAT2}$       | - + Battery 2            |
| $V_{CCI}$        | - + Supply               |
| NC               | - No Connect             |

### DESCRIPTION

The DS1210 Nonvolatile Controller Chip is a CMOS circuit which solves the application problem of converting CMOS RAM into nonvolatile memory. Incoming power is monitored for an out-of-tolerance condition. When such a condition is detected, chip enable is inhibited to accomplish write protection and the battery is switched on to supply the RAM with uninterrupted power. Special circuitry uses a low-leakage CMOS process which affords precise voltage detection at extremely low battery consumption. The 8-pin DIP package keeps PC board real estate requirements to a minimum. By combining the DS1210 Nonvolatile Controller Chip with a CMOS memory and batteries, nonvolatile RAM operation can be achieved.

## OPERATION

The DS1210 nonvolatile controller performs five circuit functions required to battery back up a RAM. First, a switch is provided to direct power from the battery or the incoming supply ( $V_{CCI}$ ) depending on which is greater. This switch has a voltage drop of less than 0.3V.

The second function which the nonvolatile controller provides is power-fail detection. The DS1210 constantly monitors the incoming supply. When the supply goes out of tolerance, a precision comparator detects power-fail and inhibits chip enable ( $\overline{CEO}$ ).

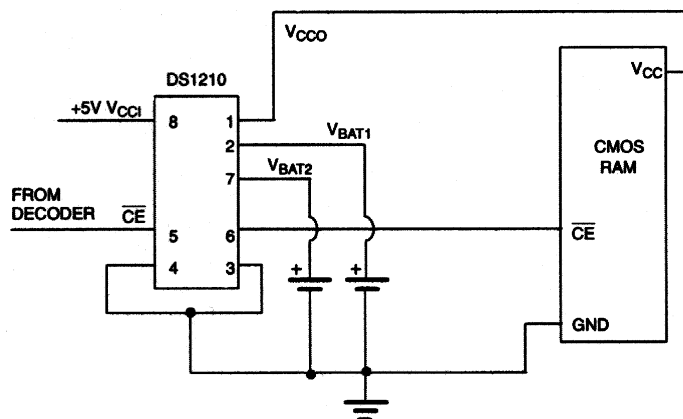
The third function of write protection is accomplished by holding the  $\overline{CEO}$  output signal to within 0.2 volts of the  $V_{CCI}$  or battery supply. If  $\overline{CE}$  input is low at the time power-fail detection occurs, the  $\overline{CEO}$  output is kept in its present state until  $\overline{CE}$  is returned high. The delay of write protection until the current memory cycle is completed prevents the corruption of data. Power-fail detection occurs in the range of 4.75 volts to 4.5 volts with the tolerance (TOL) pin grounded. If TOL is connected to  $V_{CCO}$ , then power-fail detection occurs in the range of 4.5 volts to 4.25 volts. During nominal supply conditions  $\overline{CEO}$  will follow  $\overline{CE}$  with a maximum propagation delay of 20ns.

The fourth function the DS1210 performs is a battery status warning so that potential data loss is avoided. Each time that the circuit is powered up the battery voltage is checked with a precision comparator. If the battery voltage is less than 2.0 volts, the second memory cycle is inhibited. Battery status can, therefore, be determined by performing a read cycle after power-up to any location in memory, verifying that memory location content. A subsequent write cycle can then be executed to the same memory location altering the data. If the next read cycle fails to verify the written data, then the batteries are less than 2.0V and data is in danger of being corrupted.

The fifth function of the nonvolatile controller provides for battery redundancy. In many applications, data integrity is paramount. In these applications it is often desirable to use two batteries to ensure reliability. The DS1210 controller provides an internal isolation switch which allows the connection of two batteries. During battery backup operation the battery with the highest voltage is selected for use. If one battery should fail, the other will take over the load. The switch to a redundant battery is transparent to circuit operation and to the user. A battery status warning will occur when the battery in use falls below 2.0 volts. A grounded  $V_{BAT2}$  pin will not activate a battery-fail warning. In applications where battery redundancy is not required, a single battery should be connected to the BAT1 pin, and the BAT2 battery pin must be grounded. The nonvolatile controller contains circuitry to turn off the battery backup. This is to maintain the battery(s) at its highest capacity until the equipment is powered up and valid data is written to the SRAM. While in the freshness seal mode the  $\overline{CEO}$  and  $V_{CCO}$  will be forced to  $V_{OL}$ . When the batteries are first attached to one or both of the  $V_{BAT}$  pins,  $V_{CCO}$  will not provide battery back-up until  $V_{CCI}$  exceeds  $V_{CCTP}$ , as set by the TOL pin, and then falls below  $V_{BAT}$ .

Figure 1 shows a typical application incorporating the DS1210 in a microprocessor-based system. Section A shows the connections necessary to write protect the RAM when  $V_{CC}$  is less than 4.75 volts and to back up the supply with batteries. Section B shows the use of the DS1210 to halt the processor when  $V_{CC}$  is less than 4.75 volts and to delay its restart on power-up to prevent spurious writes.

## SECTION A - BATTERY BACKUP Figure 1

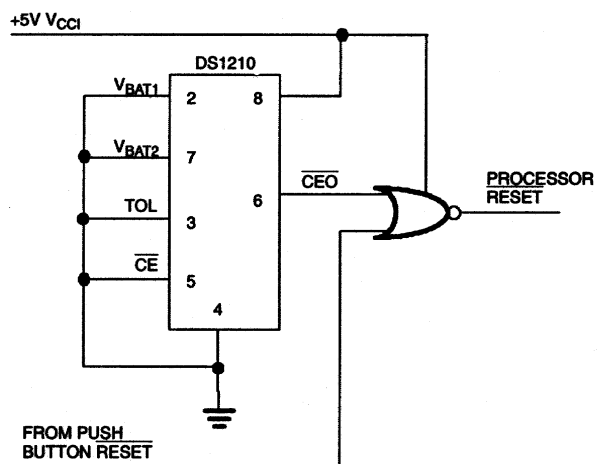


## BATTERY BACKUP CURRENT DRAIN EXAMPLE

### CONSUMPTION

|                  |              |
|------------------|--------------|
| DS1210 $I_{BAT}$ | 100 nA       |
| RAM $I_{CC02}$   | $10 \mu A$   |
| Total Drain      | $10.1 \mu A$ |

## SECTION B - PROCESSOR RESET



## ABSOLUTE MAXIMUM RATINGS

|                                             |                                          |
|---------------------------------------------|------------------------------------------|
| Voltage Range on Any Pin Relative to Ground | -0.3V to +7.0V                           |
| Operating Temperature Range                 | 0°C to +70°C, -40°C to +85°C for N parts |
| Storage Temperature Range                   | -55°C to +125°C                          |
| Soldering Temperature (reflow, SO)          | +260°C                                   |
| Lead Temperature (soldering, 10s)           | +300°C                                   |

*This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.*

## PACKAGE THERMAL CHARACTERISTICS (Note 1)

PDIP

|                                                          |         |
|----------------------------------------------------------|---------|
| Junction-to-Ambient Thermal Resistance ( $\theta_{JA}$ ) | 110°C/W |
| Junction-to-Case Thermal Resistance ( $\theta_{JC}$ )    | 40°C/W  |

SO

|                                                          |        |
|----------------------------------------------------------|--------|
| Junction-to-Ambient Thermal Resistance ( $\theta_{JA}$ ) | 70°C/W |
| Junction-to-Case Thermal Resistance ( $\theta_{JC}$ )    | 23°C/W |

**Note 1:** Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board for the SO. For detailed information on package thermal considerations, refer to [www.maxim-ic.com/thermal-tutorial](http://www.maxim-ic.com/thermal-tutorial).

## RECOMMENDED OPERATING CONDITIONS

(Note 10)

| PARAMETER                      | SYMBOL                     | MIN  | TYP | MAX          | UNITS | NOTES |
|--------------------------------|----------------------------|------|-----|--------------|-------|-------|
| TOL = GND Supply Voltage       | $V_{CCI}$                  | 4.75 | 5.0 | 5.5          | V     | 2     |
| TOL = $V_{CCO}$ Supply Voltage | $V_{CCI}$                  | 4.5  | 5.0 | 5.5          | V     | 2     |
| Logic 1 Input                  | $V_{IH}$                   | 2.2  |     | $V_{CC}+0.3$ | V     | 2     |
| Logic 0 Input                  | $V_{IL}$                   | -0.3 |     | +0.8         | V     | 2     |
| Battery Input                  | $V_{BAT1}$ ,<br>$V_{BAT2}$ | 2.0  |     | 4.0          | V     | 2, 3  |

## DC ELECTRICAL CHARACTERISTICS

(Note 10;  $V_{CCI} = 4.75$  to  $5.5V$ , TOL = GND)  
( $V_{CCI} = 4.5$  to  $5.5V$ , TOL =  $V_{CCO}$ )

| PARAMETER                                              | SYMBOL     | MIN           | TYP  | MAX  | UNITS   | NOTES |
|--------------------------------------------------------|------------|---------------|------|------|---------|-------|
| Supply Current                                         | $I_{CCI}$  |               |      | 5    | mA      | 4     |
| Supply Voltage                                         | $V_{CCO}$  | $V_{CC}-0.2$  |      |      | V       | 2     |
| Supply Current                                         | $I_{CCO1}$ |               |      | 80   | mA      | 5     |
| Input Leakage                                          | $I_{IL}$   | -1.0          |      | +1.0 | $\mu A$ |       |
| Output Leakage                                         | $I_{LO}$   | -1.0          |      | +1.0 | $\mu A$ |       |
| $\overline{CEO}$ Output @ 2.4V                         | $I_{OH}$   | -1.0          |      |      | mA      | 6     |
| $\overline{CEO}$ Output @ 0.4V                         | $I_{OL}$   |               |      | 4.0  | mA      | 6     |
| $V_{CC}$ Trip Point (TOL=GND)                          | $V_{CCTP}$ | 4.50          | 4.62 | 4.74 | V       | 2     |
| $V_{CC}$ Trip Point (TOL= $V_{CCO}$ )                  | $V_{CCTP}$ | 4.25          | 4.37 | 4.49 | V       | 2     |
| $\overline{CEO}$ Output                                | $V_{OHL}$  | $V_{BAT}-0.2$ |      |      | V       | 8     |
| $V_{BAT1}$ or $V_{BAT2}$<br>Battery Current            | $I_{BAT}$  |               |      | 100  | nA      | 3, 4  |
| Battery Backup Current<br>@ $V_{CCO} = V_{BAT} - 0.3V$ | $I_{CCO2}$ |               |      | 50   | $\mu A$ | 7, 8  |

**CAPACITANCE**(T<sub>A</sub> = +25°C)

| PARAMETER          | SYMBOL           | MIN | TYP | MAX | UNITS | NOTES |
|--------------------|------------------|-----|-----|-----|-------|-------|
| Input Capacitance  | C <sub>IN</sub>  |     |     | 5   | pF    |       |
| Output Capacitance | C <sub>OUT</sub> |     |     | 7   | pF    |       |

**AC ELECTRICAL CHARACTERISTICS**(Note 10; V<sub>CCI</sub> = 4.75V to 5.5V, TOL = GND)(V<sub>CCI</sub> = 4.5V to 5.5V, TOL = V<sub>CCO</sub>)

| PARAMETER                                 | SYMBOL          | MIN | TYP | MAX | UNITS | NOTES |
|-------------------------------------------|-----------------|-----|-----|-----|-------|-------|
| $\overline{\text{CE}}$ Propagation Delay  | t <sub>PD</sub> | 5   | 10  | 20  | ns    | 6     |
| $\overline{\text{CE}}$ High to Power-Fail | t <sub>PF</sub> |     |     | 0   | ns    |       |

**AC ELECTRICAL CHARACTERISTICS**(Note 10; V<sub>CCI</sub> = 4.75V, TOL = GND)(V<sub>CCI</sub> < 4.5, TOL = V<sub>CCO</sub>)

|                                      |                  |     |    |     |    |   |
|--------------------------------------|------------------|-----|----|-----|----|---|
| Recovery at Power Up                 | t <sub>REC</sub> | 2   | 80 | 125 | ms |   |
| V <sub>CC</sub> Slew Rate Power-Down | t <sub>F</sub>   | 300 |    |     | μs |   |
| V <sub>CC</sub> Slew Rate Power-Down | t <sub>FB</sub>  | 10  |    |     | μs |   |
| V <sub>CC</sub> Slew Rate Power-Up   | t <sub>R</sub>   | 0   |    |     | μs |   |
| $\overline{\text{CE}}$ Pulse Width   | t <sub>CE</sub>  |     |    | 1.5 | μs | 9 |

**NOTES:**

2. All voltages are referenced to ground.

3. Only one battery input is required. Unused battery inputs must be grounded.

4. Measured with V<sub>CCO</sub> and  $\overline{\text{CEO}}$  open.5. I<sub>CC01</sub> is the maximum average load which the DS1210 can supply to the memories.

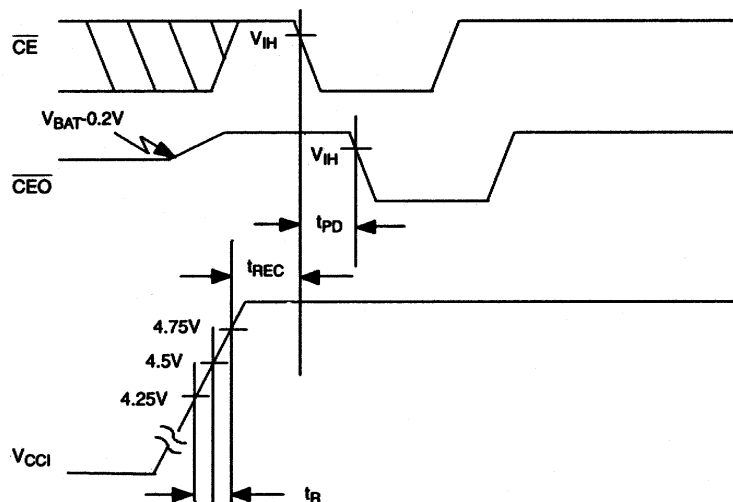
6. Measured with a load as shown in Figure 2.

7. I<sub>CC02</sub> is the maximum average load current which the DS1210 can supply to the memories in the battery backup mode.8. t<sub>CE</sub> max must be met to ensure data integrity on power loss.9.  $\overline{\text{CEO}}$  can only sustain leakage current in the battery backup mode.

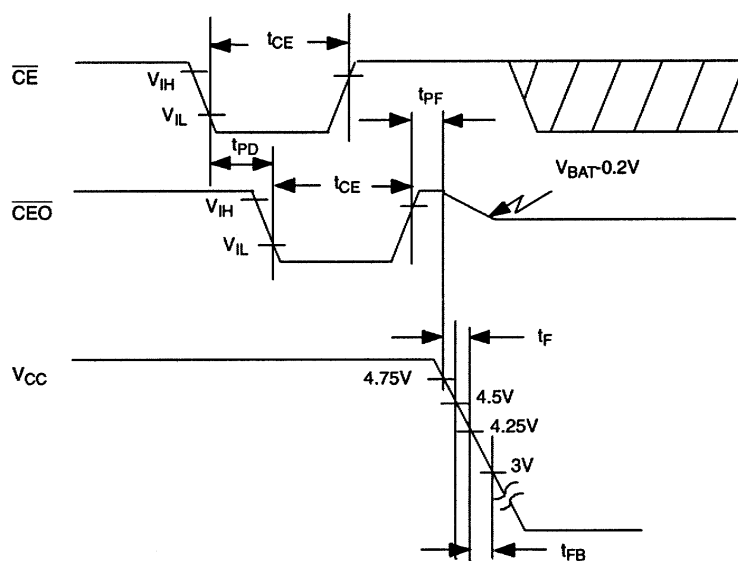
10. All AC and DC electrical characteristics are valid for the full temperature range. For commercial products, this range is 0 to +70°C. For industrial products (N), this range is -40°C to +85°C.

11. DS1210 is recognized by Underwriters Laboratories (UL) under file E99151.

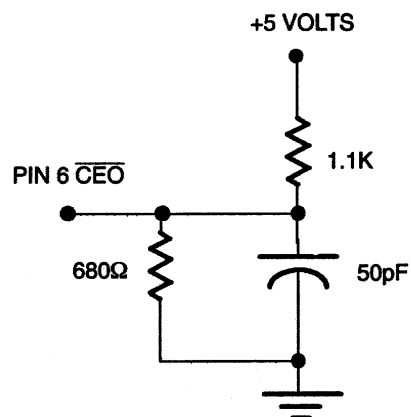
## TIMING DIAGRAM: POWER-UP



## TIMING DIAGRAM: POWER-DOWN



## OUTPUT LOAD Figure 2



## ORDERING INFORMATION

| PART      | TEMP RANGE     | PIN-PACKAGE |
|-----------|----------------|-------------|
| DS1210+   | 0°C to +70°C   | 8 PDIP      |
| DS1210N+  | -40°C to +85°C | 8 PDIP      |
| DS1210S+  | 0°C to +70°C   | 16 SO       |
| DS1210SN+ | -40°C to +85°C | 16 SO       |

+Denotes a lead(Pb)-free/RoHS-compliant package.

## PACKAGE INFORMATION

For the latest package outline information and land patterns (footprints), go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages). Note that a “+”, “#”, or “-” in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO.             | LAND PATTERN NO.        |
|--------------|--------------|-------------------------|-------------------------|
| 8 PDIP       | P8+4         | <a href="#">21-0043</a> | —                       |
| 16 SO        | W16+2        | <a href="#">21-0042</a> | <a href="#">90-0107</a> |

**REVISION HISTORY**

| <b>REVISION<br/>DATE</b> | <b>DESCRIPTION</b>                                                                                                                                                                                                                                                                                | <b>PAGES<br/>CHANGED</b> |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 6/12                     | Added lead temperature and soldering temperature information to the <i>Absolute Maximum Ratings</i> section; changed “Pin 3” to “TOL” in multiple places; added the <i>Package Thermal Characteristics</i> section; added the <i>Ordering Information</i> and <i>Package Information</i> sections | 1, 2, 4, 5, 8            |