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Keywords: NV SRAM, module, lithium, battery monitor

## APPLICATION NOTE 3254

# Battery Monitoring in NV SRAM Modules

Jun 28, 2004

*Abstract: As a prerequisite to this article, it is recommended that application note 505, "[Lithium Coin-Cell Batteries: Predicting an Application Lifetime](#)" be reviewed to gain a better understanding of the general behavior of lithium coin-cell batteries.*

*Maxim offers a variety of products that incorporate lithium coin-cell batteries. In some applications, the ability to monitor the battery status is desired to prevent any accidental loss of data when the battery is approaching its useful end-of-life. Battery monitoring is an integral function of the DS1330, DS1345, and DS1350 NV SRAM PowerCap Modules.*

*This battery monitoring feature is also featured for sorting in our [Parametric Search of memory products](#).*

## Which Applications Might Require Battery Monitoring?

In field installations requiring very long service lifetimes or those where the environment may introduce some uncertainty in the overall reliability of the battery back-up system, some ability to periodically check the remaining battery capacity is beneficial.

Installations such as servers or RAID applications that are designed to be 'always-on' rely on the NV SRAM to preserve mission-critical data should a power outage occur. Reliable and expedient system recovery after power restoration is therefore a fundamental necessity, and may warrant some additional overhead in the system architecture.

## How Does the Battery Monitoring Circuit Work?

As outlined in application note 505, there are several characteristics of lithium coin-cell batteries that must be understood to accurately predict the service lifetime of the battery. With the flat voltage characteristics of lithium batteries over time, and faced with the environmental variables that an NV SRAM module might be exposed to during the system's life cycle, use of simple open-circuit voltage (OCV) monitoring is not a sufficient gauge of the remaining battery capacity.

**Figure 1** shows the typical voltage characteristics observed with a lithium coin-cell battery under a fixed 100kΩ load. Maxim has designed a battery monitoring circuit that utilizes the characteristics of lithium batteries under exposure to a known load to determine if the cell remains a viable power source for battery back-up. As this load exposure also requires consumption of some small amount of the battery

capacity, the frequency of this exposure was also of concern during the design definition.

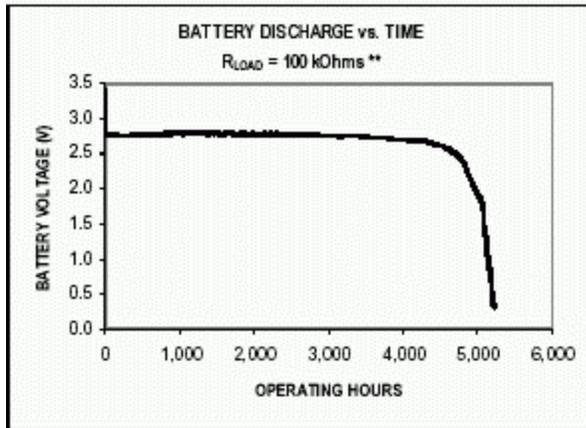


Figure 1. Battery discharge plot.

\*\*load selected to accelerate battery discharge for purposes of the graph.

At power-up, and again approximately every 24 hours, an internal 1M $\Omega$  test resistor is connected across the battery terminals for one second and the battery voltage is sampled. During that one second period, should the battery voltage ( $V_{BAT}$ ) fall below a factory-programmed battery warning trip-point (~2.6V), the battery warning output (active-low BW) will be asserted. (see **Figure 2**) Once asserted, battery testing will be performed approximately every 5 seconds to detect battery removal, and active-low BW will remain active until the weak battery is physically removed and replaced with a fresh cell. Once a fresh cell has been attached, the first passing test result will deassert the active-low BW output and the test interval will return to 24 hours. (See **Figure 3**.) 'Active-low BW is an open-drain output driver.

Battery replacement, in the case of the PowerCap products, should generally be performed when system power is on so that the internal memory content is not corrupted. Normal memory write/read operations are not inhibited while active-low BW is active, but preservation of the data during a power loss cannot be assured. Due to the 5 second test interval, it is required that the battery be removed for more than one test interval, or about 7 seconds, prior to attaching a new battery.

The battery is retested after each power-up, even if active-low BW had been active at power-down.

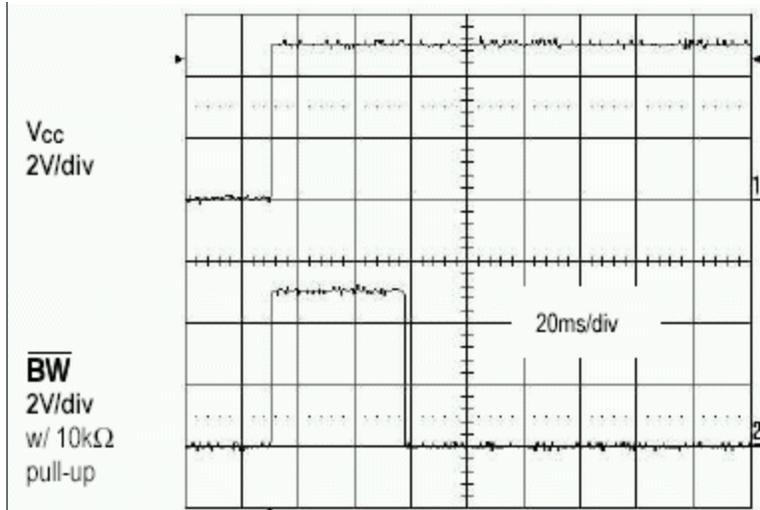


Figure 2. Power-on battery test fails ( $V_{BAT} = 2.55V$ ).

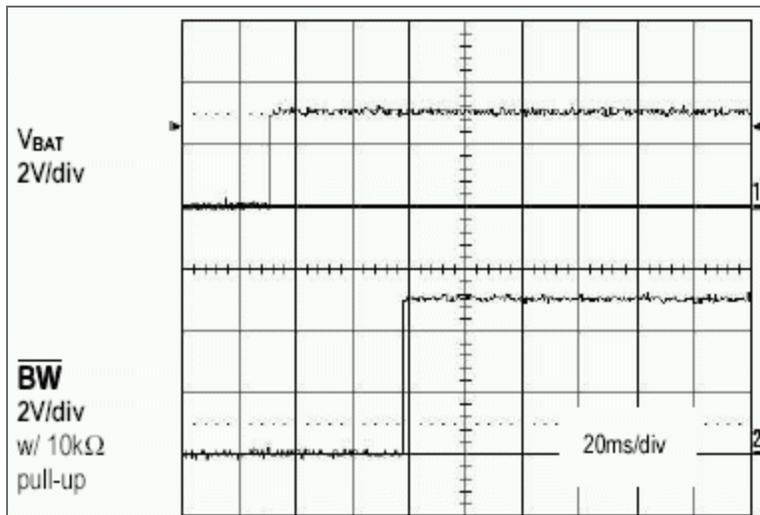


Figure 3. Battery test passes with fresh cell ( $V_{BAT} = 3.15V$ ).

Based upon the characteristics of the end-of-life voltage profile on the primary batteries used, the occurrence of a valid active-low BW signal should provide the user roughly 500 hours (~3 weeks) advanced notice of an impending battery failure.

## How Should the Battery Warning Output be Monitored?

The active-low BW output is an open-drain device, and requires an external pullup resistor (~3kΩ–10kΩ) to VCC to achieve a Logic 1 output state. When asserted, the active-low BW pin can sink up to 10mA. It is recommended to connect this pin to a available interrupt or I/O input on the user's microprocessor device. Due to the battery monitoring periodicity, check the active-low BW state at least once every 24 hours if not tied directly to a microprocessor hardware interrupt.

## What Corrective Action Should be Taken when a Battery Warning is Observed?

Depending upon the system, corrective action could potentially range anywhere from illumination of a panel indicator or sending warning messages to the operator to something more elaborate as an automated service dispatch function using external communications ports and a predetermined error protocol. In any case, the relative safety of many days of prior warning should allow the user sufficient reaction time to execute a controlled procedure for battery replacement without experiencing data loss. Questions/comments/suggestions concerning this application note can be sent to:

[MixedSignal.Apps@maximintegrated.com](mailto:MixedSignal.Apps@maximintegrated.com).

Related Parts		
<a href="#">DS1312</a>	Nonvolatile Controller with Lithium Battery Monitor	<a href="#">Free Samples</a>
<a href="#">DS1314</a>	3V Nonvolatile Controller with Lithium Battery Monitor	<a href="#">Free Samples</a>
<a href="#">DS1321</a>	Flexible Nonvolatile Controller with Lithium Battery	<a href="#">Free Samples</a>
<a href="#">DS1323</a>	3.3V Flexible Nonvolatile Controller with Lithium Battery Monitor	
<a href="#">DS1330AB</a>	256k Nonvolatile SRAM with Battery Monitor	<a href="#">Free Samples</a>
<a href="#">DS1330W</a>	3.3V 256k Nonvolatile SRAM with Battery Monitor	<a href="#">Free Samples</a>
<a href="#">DS1330Y</a>	256k Nonvolatile SRAM with Battery Monitor	<a href="#">Free Samples</a>
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<a href="#">DS1345Y</a>	1024k Nonvolatile SRAM with Battery Monitor	<a href="#">Free Samples</a>
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<a href="#">DS1350Y</a>	4096k Nonvolatile SRAM with Battery Monitor	<a href="#">Free Samples</a>

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