

# App Note 3476: Adding Battery-Detection Functionality to the DS1312, DS1314, and DS1321 Controller ICs

*The DS1312, DS1314, and DS1321 are nonvolatile controller ICs that have a built-in battery-voltage monitor. The monitor measures the voltage of a lithium cell connected to the  $V_{BAT}$  pin and issues a warning when the battery voltage is low. The battery voltage is measured once during power-up and once every 24 hours thereafter. As long as a battery is attached to the  $V_{BAT}$  pin, the device operates properly. However, if the battery is removed and the  $V_{BAT}$  pin is left floating, erroneous battery-voltage measurements might be made, depending on the value of the floating  $V_{BAT}$  voltage. This application note describes how to add battery-detection functionality to the DS1312, DS1314, and DS1321 devices.*

## Battery-Voltage Monitor Description

The battery-voltage monitoring circuits of the DS1312, DS1314, and DS1321 were designed to measure the voltage of a lithium cell attached to the  $V_{BAT}$  pin. The intent was that a battery would always be connected to the  $V_{BAT}$  pin, except for a short battery-replacement period. Once during power-up and once every 24 hours after power-up, an internal 1.2Mohm resistor is used to measure the voltage of the lithium cell connected to the  $V_{BAT}$  pin. If no battery was attached to the  $V_{BAT}$  pin during power-up, then the battery warning pin,  $/BW$ , will be enabled as expected when  $V_{CCI}$  rises above  $V_{CCTP}$ . If, however, a battery was present during power-up and the initial battery voltage test, then later removed leaving the  $V_{BAT}$  pin floating, the next battery-voltage test 24 hours later might not detect a voltage below  $V_{BTP}$  on the  $V_{BAT}$  pin. Thus, no battery warning would be activated even though the battery had been removed.

## Battery-Presence Detection Circuit

Battery-detection functionality can be added by connecting a small (0.1 $\mu$ F to 1nF) capacitor from the  $V_{BAT}$  pin to ground. (See **Figure 1** for the placement of the capacitor, C1.) The capacitor prevents the internal voltage oscillation on the  $V_{BAT}$  pin caused by the removal of the lithium battery. By adding this capacitive load to the  $V_{BAT}$  pin, the internal voltage oscillations on the  $V_{BAT}$  pin are dampened, and the battery-voltage measuring circuit is then able to properly load the  $V_{BAT}$  pin and discharge the voltage below  $V_{BTP}$ , thus causing the low-battery warning alarm

to become enabled and setting the /BW pin high.

If an application using the DS1312, DS1314, or DS1321 will always have a voltage source connected to the  $V_{BAT}$  pin, whether that source is a lithium battery, other voltage source, or even a connection to ground, then this addition of the detection circuit is not necessary. Connecting the capacitor to the  $V_{BAT}$  pin adds additional leakage and shortens the life of the battery (depending on the size of the battery and capacitor chosen), and also introduces the issue of having to protect that battery from reverse charging current.

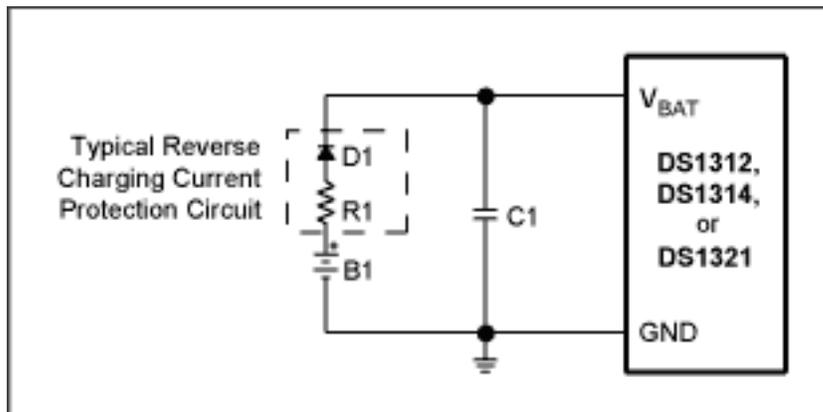


Figure 1. Battery-Presence Detection Circuit

## Protection-Circuitry Consideration

Adding a capacitor in parallel with the lithium battery requires additional components to protect the lithium cell from reverse charging current. When the DS1312, DS1314, and DS1321 leave battery backup mode, the  $V_{BAT}$  pin becomes a high-impedance input. Because only the lithium battery and capacitor are connected to  $V_{BAT}$ , there is an opportunity for the capacitor to reverse charge into the lithium cell, creating the need for the reverse charging current protection circuitry. Battery manufacturers recommend reverse charging current protection circuits so their products can meet UL conditions of acceptability. It is suggested that the engineer refer to the battery manufacturer's recommended reverse charging current protection circuit for that manufacturer's products. Typically, such a protection circuit consists of a resistor and diode (typically silicon) in series between the battery and any other connections. Figure 1 shows a typical reverse charging current protection circuit. The diode allows the battery to supply current to the application, but prevents current from feeding from the capacitor back into the battery. The resistor is in place to protect the battery in case the diode should fail, and to dampen any incoming current.

## Conclusion

The DS1312, DS1314, and DS1321 nonvolatile controllers offer a low-battery warning function by means of a battery-voltage measurement circuit. When the connection to the  $V_{BAT}$  pin is floating, the device has difficulty determining what voltage is present. The internal 1.2Mohm resistor on its own may not be enough to pull that unknown value below the  $V_{BAT}$  trip point,  $V_{BTP}$ . Adding a small capacitor to the  $V_{BAT}$  pin provides enough load to allow the built-in battery

measurement circuit to draw the floating voltage below VBTP and detect that there is no battery present.

Questions/comments/suggestions concerning this application note can be sent to:  
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### **More Information**

DS1312: [QuickView](#) -- [Full \(PDF\) Data Sheet](#)

DS1314: [QuickView](#) -- [Full \(PDF\) Data Sheet](#)

DS1321: [QuickView](#) -- [Full \(PDF\) Data Sheet](#)