



Measuring individual cells in high voltage battery packs

using National Instrument's CompactRIO and WireFlow's WF 3169

Abstract

This application note demonstrates how the CompactRIO Industrial Controllers from National Instruments can be used to do voltage measurements on every cell in high voltage battery stacks of several kilovolts. The solution is to use the WF 3169 Battery Stack Monitor Modules from WireFlow along with a well-defined voltage isolation strategy.

Problem

The challenge of measuring a battery stack is that the voltmeter used to measure the voltage over each cell must withstand a high common-mode voltage relative the ground of the series connected battery stack. The rated working isolation voltage of the voltmeter must be larger than the total battery pack voltage.

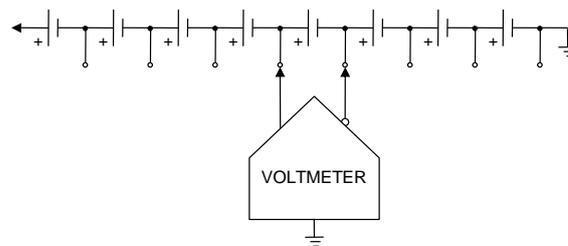


Figure 1. Voltmeter on multiple cells

Solution

The WF 3169 module from WireFlow is a 24-channel battery monitoring device that includes an ADC and a high voltage input multiplexer. The module can measure up to 24 series-connected cells with a max voltage of 5V per cell. The module measurement circuitry is galvanically isolated from the other modules in the system and provides up to 1000 VDC channel-to-earth rated working voltage, making the module ideal for accurately monitoring large battery stacks. By using several WF 3169 modules connected in series it is possible to monitor every cell in a long string of series-connected cells.

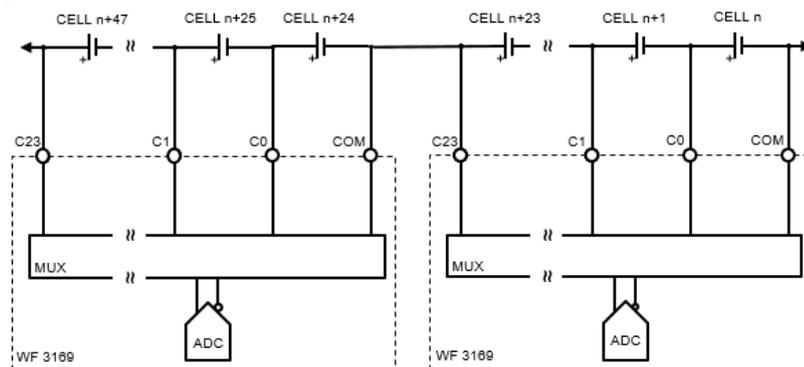


Figure 2. Using multiple WF 3169

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The WF 3169 modules are mounted in a CompactRIO chassis. If there is a need to also measure currents, temperatures etc., other measurement modules can be inserted into the same CompactRIO chassis together with the WF 3169 modules.

There are CompactRIO chassis with room for 4 or 8 modules. The size of the chassis, however, does not limit how many WF 3169 that can be used. The series connected WF 3169 modules can extend over several chassis without problem.



Figure 3. The WF 3169 Battery Stack Monitor Module

A normal setup is to connect the battery's negative terminal to ground potential as well as the CompactRIO chassis ground. This works fine for battery packs with a total voltage up to 1000 V, which is the specified isolation voltage of the WF 3169 module. If the battery pack being used has a total voltage above 1000V, then a slightly more complex voltage isolation method is required. The recommended strategy is to use multiple 8-slot CompactRIO chassis equipped with WF 3169 modules. Each such CompactRIO chassis can handle voltages of up to 960 Volts. This because 8 modules x 24 channels give in total 192 cell measurements channels per chassis. Max voltage per cell measurement is 5V. This means that each chassis can measure voltages up to max $192 \times 5 = 960 \text{ V}$ and has an isolation voltage of 1000 V.

The first chassis is to be grounded together with the BAT- pole as described earlier. The other chassis must each be galvanically isolated from ground. This can be done by placing the chassis in an isolated plastic box to avoid any metal parts to get in contact with ground. The ethernet interface must be isolated with a network isolator, such as the 2313915 isolator from Phoenix Contact that has an isolation of 4 kV. The DC supply for the CompactRIO must also be chosen with care, to make sure that it is galvanically isolated with the required isolation voltage.

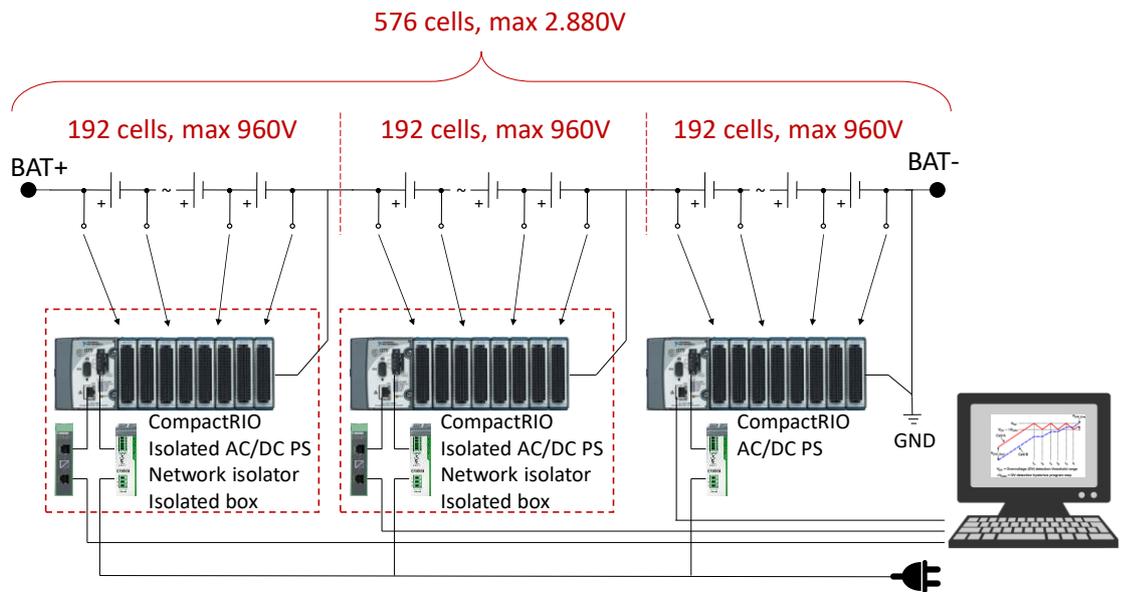


Figure 4. Setup with isolated CompactRIO chassis to enable measurements above 1000 volts