# A low cost Lithium Ion battery management system for a multi-cell, high voltage battery pack

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## Summary

This paper provides an introduction to a novel approach for monitoring the health of Lithium Ion cells when arranged in a manner that creates significant series voltage as to preclude standard low voltage monitoring circuitry. By combining the low cost of commercial off-the-shelf battery monitoring technology with a novel method of optically isolating each device, a 4 wire, optically isolated network can be used to daisy chain a large number of monitoring devices without fear of large electrical voltages. Monitoring of individual cell voltage, temperature, current and state of charge as well as the ability to control cell balancing are all features of this system.

## Background

Traditional multi-cell battery management systems will normally consist of either a method of multiplexing the measurement of each cell or monitoring a small number of cells with a complex circuit that is then isolated from the rest of the pack. Standard battery management integrated circuits are usually limited from 1 to 4 cells and don't involve any sort of optical isolation. By multiplexing the measurement the cost of the electronics can be brought down but the amount of wiring is increased and the potential for high voltage shorts will increase as well. The potential for harm during troubleshooting is also increased as the entire pack voltage is present on the measurement board. By isolating the measurement boards to just a few cells the voltage potential is reduced but the circuit complexity is increased which in turn increases cost. Both of these methods have tradeoffs between complexity and price. By creating a new approach, the best of both worlds can be combined.

## Solution

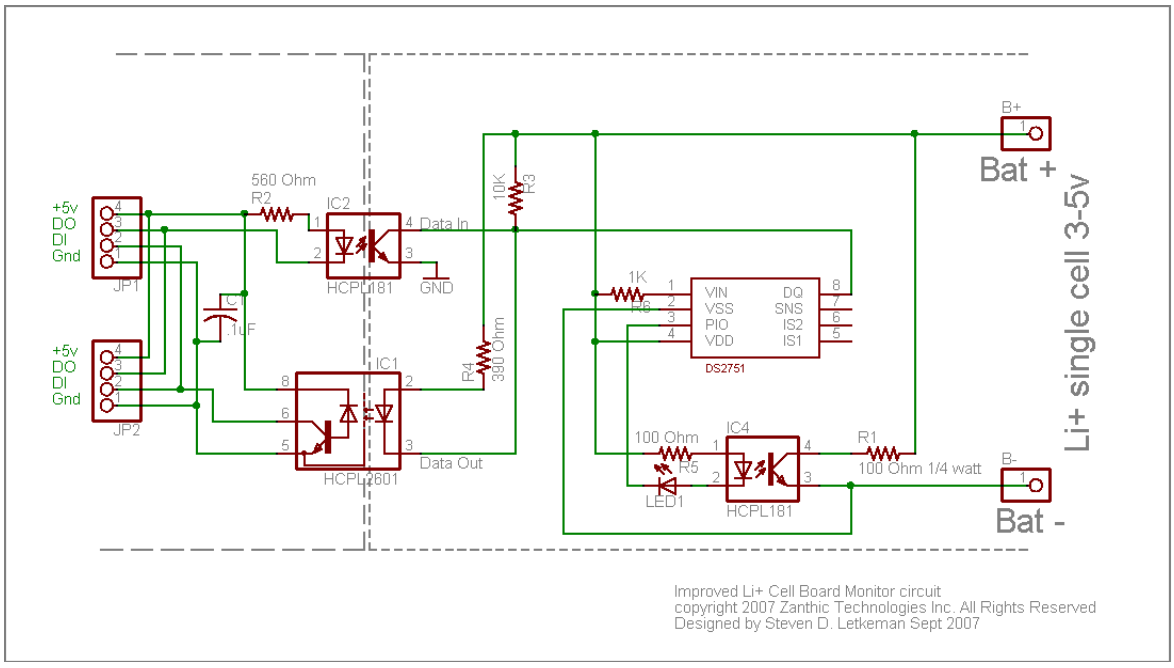
By combining the use of commercially available battery monitoring devices that incorporate the 1-wire® data communications method (such as the Maxim's DS2751 device) with a method of optically isolating the communications bus, a low cost, high performance battery management system can be created. 1-wire devices that are optically isolated would normally require the use of an expensive DC/DC system to provide power to the isolated side of the circuitry. By using the battery voltage on one side and the network power on the other side, this extra cost, size and complexity can be avoided.

The DS2751 features

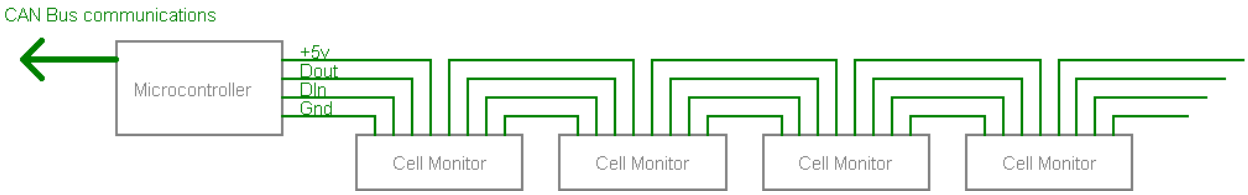
- Voltage measurement resolution of 4.88mV
- 12 bit current measurement
- Temperature measurement with .125C resolution
- Unique 64bit device address

## Schematic




The schematic diagram does not include the ability to monitor current flow as this could be implemented at a pack level but the DS2751 does have the capability to measure current flow locally. A microcontroller would be connected to the DO (Data Out) and DI (Data In) connections on the bus shown on the left of the schematic. Two connectors were used on each test board to allow for the easy "daisy chaining" of boards together. When driven low, DO will drive IC2 opto-coupler to pull the data line low that is connected to the 1-wire input on the DS2751. This will also drive the input of IC1 on and when the DS2751 drives it's 1-wire output low, IC1 will also be enabled which in turn will drive the DI input back to the controlling microcontroller. The digital output on the DS2751 can be used to drive an opto-isolator or FET device to enable the cell balancing circuit.




Any number of cell monitoring boards can be daisy chained together up to the drive limitations of the microcontroller output. A FET or some other driver circuit could be employed to increase the drive capability. The test board used a CAN (Controller Area Network) bus to communicate the resulting data to the test PC but other methods such as RS232 could be used as well.

## Firmware

Standard 1-wire functions do not function with the circuitry shown because of the timing changes due to the additional timing delays that the opto-isolators create. By using a powered opto-isolator for the returning signal, the delays can be reduced to the point where the DS2751 reacts as expected. Once the low level communication functions are in place, standard higher level functionality can be used to scan the network for all 1-wire devices, poll for their status and control the output for enabling the cell balancing.

## Conclusion

By combining the low cost of the DS2751 Lithium Ion battery management IC with a novel method of optically isolating the circuitry, a low cost, full featured method of multi-cell monitoring and management can be created. For more information on further developments of this circuitry and firmware, please contact Zanthic Technologies Inc.

## About Steve Letkeman/Zanthic Technologies Inc.

Steve Letkeman is the owner of Zanthic Technologies Inc., which was incorporated in 1996. Steve has over 13 years of CAN (Controller Area Network) experience and over 20 years working with embedded microcontrollers. His designs can be found in everything from automotive, agricultural, robotic, home automation to industrial automation equipment. Zanthic products have been shipped to over 35 countries around the world.

For more information, please see our contact page at www.zanthic.com

1-wire is a trademark of Dallas Semiconductor

## References


1. The DS2751 data sheet is available at: www .maxim-ic.com/quick_view2.cfm/qv_pk/3823