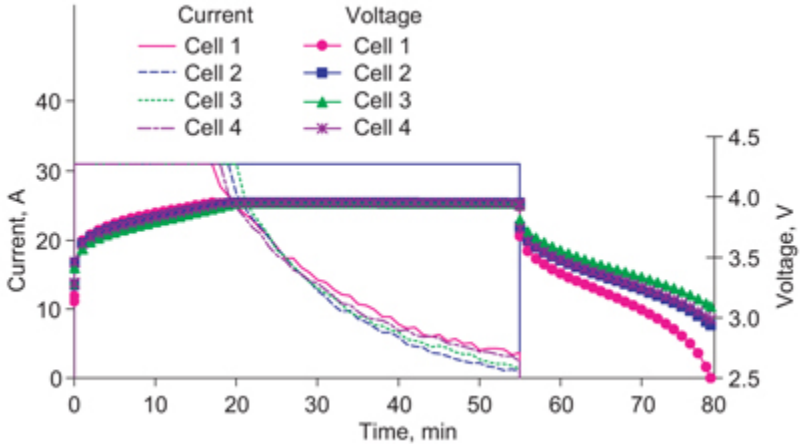
# Lithium-Ion Cell Charge-Control Unit Developed

A lithium-ion (Li-ion) cell charge-control unit was developed as part of a Liion cell verification program (ref. 1). This unit manages the complex charging scheme that is required when Li-ion cells are charged in series. It enables researchers to test cells together as a pack, while allowing each cell to charge individually. This allows the inherent cell-to-cell variations to be addressed on a series string of cells and reduces test costs substantially in comparison to individual cell testing.

Life-test data of Li-ion cells is critical in order to establish their performance capabilities for NASA missions and exploration goals. NASA missions that fly in low Earth orbit require more than 30,000 cycles to meet many mission requirements, and Li-ion batteries are relatively new to this type of application. They require a more complex charging scheme than is typically required of the alkaline cells that they may replace, and they require that strict voltage cutoff levels be established and followed to ensure safe, long operation.

So that this requirement could be addressed on the laboratory test level, a method was needed to manage the current through each cell once it reached its cutoff voltage limit. In response to these requirements, a team of researchers at the NASA Glenn Research Center developed a Li-ion cell charge-control unit. The unit allows multiple Li-ion battery cells in a series-connected pack to charge independently of each other when they are being charged from a single current source. The unit serves the dual purpose of (1) ensuring that individual cells are charged at full current up to their voltage limit and are then held at that voltage while allowing the current to taper so that the cell can continue to gain additional capacity without becoming overcharged and (2) allowing cells that are at lower states of charge to continue to be charged at full current until they reach their voltage limit.




*Charge control of four Li-ion cells during low-Earth-orbit cycling.*

Long description of figure. Graph of current versus time and voltage for four lithium-ion cells being charged at 30 amperes using a main current supply in conjunction with the lithium-ion cell charge-control

unit. As the voltage of each cell reaches its limit of 3.95 volts, the current through each individual cell begins to decrease. The lithium-ion cell charge-control unit maintains each cell at a voltage of 3.95 volts until the end of the charge period. The cells are then discharged.

The unit consists of electronic circuits and thermal management devices housed in a common package. It also contains isolated annunciators to signal when each cell is actively being bypassed. These annunciators can be used by external charge managers or can be connected in series to signal that all cells have reached maximum charge. The charge-control circuitry is self-powered by each of the battery cells being regulated, eliminating the need for an external power source or controller to drive the circuitry. A 110-V alternating-current source of electricity is required to power the thermal management portion of the system, and a small direct-current voltage source is needed to activate the annunciator signal, if desired.

The Li-ion cell charge-control unit can address the unique charging requirements of Li-ion cells on an individual cell basis while reducing the number of channels required to test the cells, resulting in substantial cost savings to the testing program. The charge-control unit was coinvented at Glenn by NASA and QSS Group, Inc., researchers, and the work was performed under the NASA Aerospace Flight Battery Systems program funded through the Energetics Project of NASA's Office of Aerospace Technology.

# Reference


1. McKissock, Barbara I.: Lithium-Ion Batteries Being Evaluated for Low-Earth-Orbit Applicatons. Research & Technology 2004, NASA/TM--2005-213419, 2005, pp. 93-94. http://www.grc.nasa.gov/WWW/RT/2004/RP/RPC-mckissock.html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