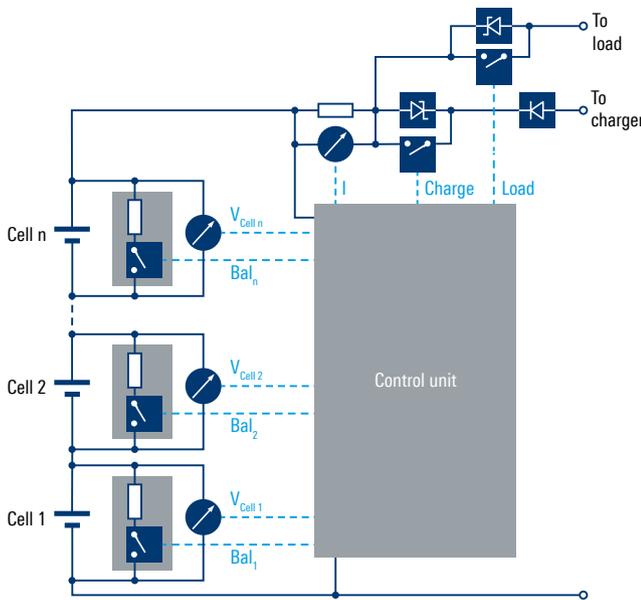


TESTING BATTERY MANAGEMENT SYSTEMS WITH ROHDE & SCHWARZ POWER SUPPLIES

Exemplary schematic of a battery pack with battery management system (BMS)



Your task

It is crucial to simulate, measure and test the rechargeable batteries used in battery-powered devices and vehicles. Overcharging and deep discharging reduce the lifetime of rechargeable batteries. Defects could lead to overheating of a battery and even cause a fire.

Larger batteries are typically built by connecting multiple cells in series and parallel. Since the same charge and discharge current flows through all cells, individual differences in battery capacity, self-discharging, etc. would lead to differing states of charge (SoC) over time and consequently limit the capacity and lifetime of the battery.

Battery management systems (BMS) actively monitor, control and manage various battery cell parameters. The tasks of a BMS are

- ▶ Determining the SoC of each cell
- ▶ Supervising the integrity and derating of each cell (state of health, SoH)
- ▶ Detecting faults and exceptional conditions and preventing hazards such as overheating and fire
- ▶ Balancing the SoC between the cells
- ▶ Thermal and energy management

Balancing can be implemented in a passive way by selectively loading the cells having the highest charge during the charging process or by using switch-mode regulators to actively transfer energy from the cells with the highest state of charge to those with the lowest state of charge.

Since BMSs play a crucial role in battery life and fail safety, they have to be tested thoroughly. The tests have to simulate all conditions that could possibly occur in operation.

Rohde & Schwarz solution

The R&S®NGL200 and R&S®NGM200 DC power supplies from Rohde & Schwarz are versatile devices with all the functions required for testing and validating battery management systems.

The R&S®NGL200 and R&S®NGM200 support two-quadrant operation as source and sink. Source currents up to 6 A and sink currents up to 3 A are possible. All outputs are fully isolated against ground. They can be connected in series to emulate battery packs on a single cell level up to a maximum voltage of 250 V against ground. The adjustable output impedance can be set between $-50 \text{ m}\Omega$ and $100 \text{ }\Omega$. Current and voltage measurements at the power supply output deliver high-resolution values.

All functions can be fully remote controlled with command processing times of less than 6 ms. In addition, the R&S®NGM200 power supply series features an optional battery simulation mode that allows realistic simulation of different predefined or user-defined cell types. Open-circuit voltage and internal resistance depending on the state of charge are defined for each cell type in an ASCII file.

These features allow the cell properties to be simulated and varied over time with high precision and high time resolution. For small and medium-sized batteries, the cell current can be drawn directly out of the power supplies. For larger batteries like those used in automotive applications, it is not necessary for the charging and discharging currents to physically flow for the BMS tests. Current measurement results, e.g. voltages across shunt resistors, are simulated to the BMS, and the power supplies establish the cell voltages and deliver the balancing currents.

The R&S®NGL202 and R&S®NGM202 with their two channels per unit and compact form factor allow flexible configuration and space-saving setups for testing a BMS. A 19" rackmount kit and backplane connections provide easy and rugged integration into racks.

Beyond the R&S®NGM-K106 battery simulation option, the R&S®NGM200 power supply series provides enhanced measurement accuracy and fast logging of current and voltage up to a sample rate of 500 000 values per second. The battery simulation option can run profiles stored in ASCII files; these profiles describe the open-circuit voltage and internal resistance versus state of charge. Profiles for common battery types are available in the power supply. The fast logging function can capture narrow spikes and glitches in current and voltage for troubleshooting purposes.

Summary

The R&S®NGL200 and R&S®NGM200 power supplies from Rohde & Schwarz can advantageously simulate battery cells when testing battery management systems. In many cases, they can replace far more expensive dedicated battery simulators.



Arrangement with eight R&S®NGM202 two-channel power supplies for simulation of up to sixteen battery cells as used in a 48 V system

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