Programmable power supplies and electronic loads

EA Elektro-Automatik (EA) offers CANopen-capable power supplies and electronic loads deployed e.g. while recycling of batteries and for fuel cell testing.

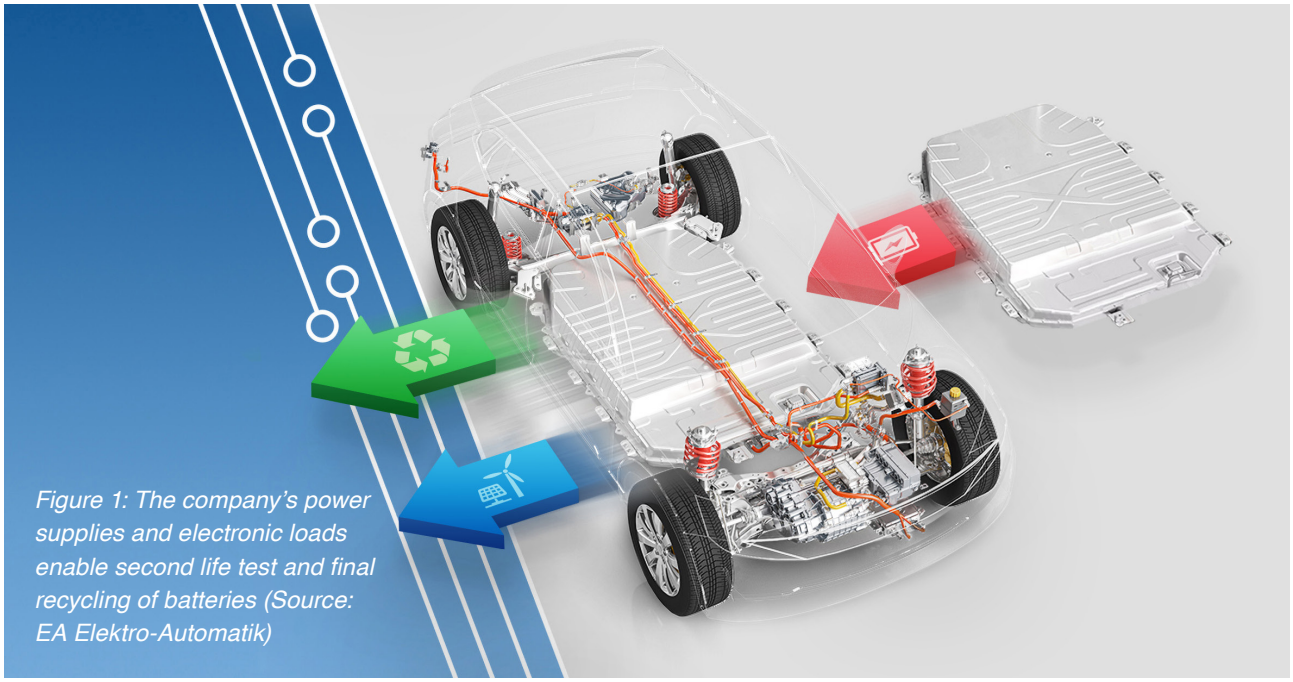

Figure 1: The company's power supplies and electronic loads enable second life test and final recycling of batteries (Source: EA Elektro-Automatik)

With increasing operating time, the lithium-ion batteries used in electric vehicles become less effective and need to be replaced. The old batteries then begin a second life or are finally recycled. EA has developed a range of products for initial battery production, recharging, second life test, and final recycling.

The batteries' second-life use

If the storage capacity of the lithium-ion battery systems is no longer sufficient for use in e-vehicles, residual capacities may well be available for second-life use. Potential applications of second-life batteries range from home storage, emergency power supplies, and energy storage for solar power or wind energy.

With the 30-kW EA-PSB 10000 bidirectional (charge/discharge) power supply, the batteries are tested for their remaining capacity by charging them to almost 100 % and then discharging them again. The DC power supply takes the energy from the connected battery during the discharge process and converts it into AC voltage with an efficiency of up to 96 %. This is then fed back into the local power grid. In a four-unit rack package, the power supplies offer a power density of up to 1,92 MW, thus, enabling for mass testing. Additional time savings are possible due to the device's capability to seamlessly switch between operation as source and sink. The true auto-ranging feature guarantees the maximum possible charge and complete discharge of the batteries through high load currents also at voltages below 2 V_{DC}.

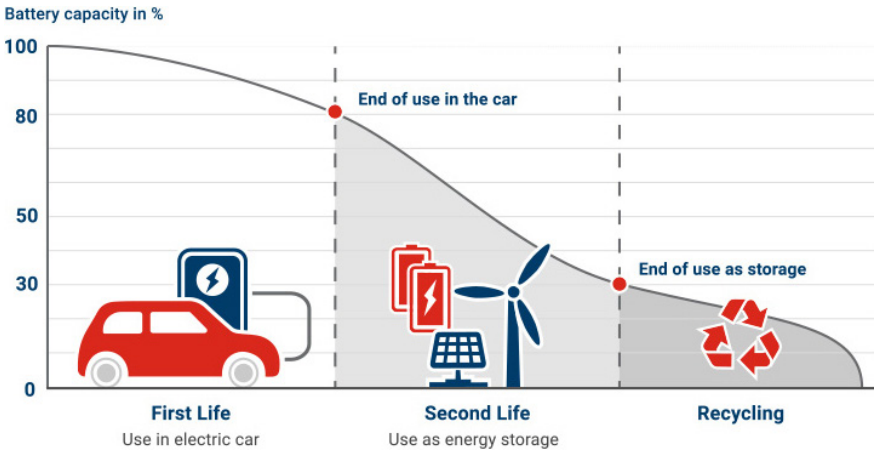

Figure 2: Battery lifecycle (Source: EA Elektro-Automatik)

Final battery recycling

After a certain operating time, batteries can only be finally recycled. For this purpose, they are disassembled into their individual parts, which can be further used. This process must be managed properly to ensure safety and prevent ignition. Lithium-ion batteries and lithium-ion polymer batteries must be completely discharged, which can be achieved with the 30-kW EA-ELR 10000 regenerative electronic load. The electronic load series can achieve up to 1,92 MW in rack systems. The residual battery charge can be extracted in a short time period and fed into the grid with an efficiency of up to 96 %. In this way, grid regeneration reduces operating costs, protects the environment, and lowers heat generation. In most cases, this makes external cooling systems unnecessary. Optionally, the EA-ELR 10000 is available in a sealed enclosure with a 90-% efficient water cooling.

Test and simulation of fuel cells

Use cases for fuel cells include power generation for commercial vehicles (e.g. forklifts, delivery vehicles, trucks and buses), backup power generation systems, and

Interfaces for automated test

The PSB 10000 supplies and the ELR 10000 loads have USB and Ethernet as standard interfaces and offer plug-and-play interface slots for CAN, CANopen, EIA-232, Modbus TCP, etc. The digital interface modules can be installed by the user and can be swapped out with a screwdriver. Via the galvanically-isolated CAN(open) interface, the instruments can be connected e.g. to industrial automation or automotive control systems.

EA's instruments are able to test fuel cells and to simulate fuel cell outputs at different voltages (Source: EA Elektro-Automatik)

The implementation of the CAN-based higher-layer protocol CANopen accords to the CiA 301 CANopen application layer and communication profile. The NMT (network management) server functionality is implemented. A respective CANopen EDS (electronic data sheet) file is shipped with the instruments. The devices support bit-rates up to 1 Mbit/s as well as the auto-baud function enabling to detect the bit-rate currently used in the CANopen network. The interface is accessible via a 9-pin Dsub connector. The interface's configuration is possible via a setup menu on the device.

other power sources. Fuel cell engineers have to conduct characterization (resistance), performance, and durability tests to adhere to required specifications. The performance is indicated via polarization (voltage and current) curves. A durability test is performed in operating conditions, where the stack is subjected to a continuous series of charge/discharge cycles. EA's regenerative loads enable to test fuel cell resistance, performance, and lifetime. The bidirectional laboratory power supplies are able to simulate the characteristics of different fuel cells.

With 30 kW of input power, the EA-ELR 10000 electronic loads connected in parallel can reach up to 1,92 MW for mass testing. Features include a built-in arbitrary waveform generator, function generator, and true auto-ranging function. Unlike other loads that need a separate AC instrument, the ELR load, with its built-in waveform generator, can perform the perturbation test to determine fuel cell resistance. The auto-ranging function enables to work with voltages of 0 V_{DC} to 60 V_{DC} up to 0 V_{DC} to 2 000 V_{DC}. Current outputs can reach up to 1 000 A. Due to the regenerative mode of operation, the energy can be fed back into the grid with an efficiency of up to 96 %. This saves power and eliminates the need for additional cooling systems.

The 30-kW EA-PSB 10000 power supply offers the same features and also provides an internal X-Y generator to simulate the fuel cell output at various voltages. The supply can add ripple and noise onto its output to determine how well a fuel-cell powered device can perform under different conditions.

Polarization and power-density curves of a fuel cell stack is a common indication for the cell performance. These curves are assessed under the optimal operating conditions (temperature, humidity, electrocatalysis, and ion-exchange membrane) of a fuel cell stack. The curve measurements can be obtained by programming a DC load in different current or resistance profiles. Load series ELR 9000 3U, ELR 9000 HP, and ELR 10000 4U enable such dynamic testing.

Figure 3: Via the CANopen interface the instruments can be connected e.g. to industrial automation applications (Source: EA Elektro-Automatik)

Market for fuel cells is growing

"In response to the demand for clean energy, the market for fuel cells is growing at a compound annual growth rate of 26,4 % and is projected to reach 848 million US $ by 2025. Uses for fuel cells include power generation for commercial vehicles such as buses and forklifts, backup power generation systems, and for other power sources. To ensure the design and manufacturing of quality fuel cells, EA Elektro-Automatik offers its EA PSB 10000 2-quadrant power supplies and EA ELR 10000 series electronic loads. Both the EA PSB power supplies and the EA ELR loads sink up to 30 kW and feed the energy back to the grid to enable testing of any size fuel cell stack," said Markus Schyboll, CEO of EA Elektro-Automatik.

HMI and software features

To interact with the supplies and the loads a 5-inch multicolor touchscreen display is available as a human machine interface (HMI). Via the display operators can control, setup, and program the device. Programmed and measured values can be shown in a chosen language. Using the EA Power Control software, the user can operate up to 20 devices remotely via a PC. Additional functions include sequencing and logging of data, a function generator, as well as automated remote maintenance with updates. Simulations of photovoltaic arrays is possible as well. ◀

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