scienlab

Energy storage test systems

Efficient solutions for reproducible measuring results

Testing energy storage devices

From cell sample to battery system tests

Highlights of the Scienlab test systems

Energy regeneration capabilities
All battery test and formation systems have high regeneration capabilities allowing highly efficient, cost-effective, and environmentally-friendly operation. More than 90 % of the energy is fed back into the mains. With a standard VDA cycle test on a 70 Ah cell with 100 test channels, savings amount to more than 60,000 € p.a. compared to non-regenerating systems.

Using the module as a cell test system and the pack as a module test system
Scienlab's test systems for battery modules (0 – 80 V) have been designed in such a way that they can also be used for analyzing battery cells (0 – 6 V). Test systems for battery packs (0 – 1000 V) also are able to test battery modules (0 – 80 V) – both with a constant measurement precision. There is no need for subsequent alterations or the purchase of new systems. This saves time and money and makes it possible for the user to react flexibly to (future) test requirements.

Synchronized recording of measurement data
All the (measurement) data recorded by the test system has a common time stamp: All analog, digital and CAN signals are synchronized and displayed in a millisecond pattern and then visualized in the ESD software. This facilitates effective and reliable analysis of battery behavior.

Impedance spectroscopy in every channel
Upon customer request Scienlab realizes a separate electrochemical impedance spectroscopy (EIS) in every test channel within the systems. The user thus benefits from a high degree of operating comfort and saves on testing time because there is no need for external equipment or rewiring of the device under test (DUT).

Modern energy storage devices have to meet high quality and market demands: power and energy density, safety, durability and, last but not least, costs have to be optimized in order to survive on the market. For this reason, comprehensive tests must be carried out during the research and development, production, and quality assurance phases to ensure successful battery development and production.

The Scienlab solution

Flexible solutions for a variety of test requirements
Scienlab offers innovative and flexible solutions for the characterization, verification and validation of all types of energy storage devices: from customer-specific stand-alone solutions through integrated test systems to ready-for-use test laboratories. Battery cells, modules and packs including battery management systems (BMS) for mobile, industrial and stationary use can be tested comprehensively and reliably using Scienlab test systems. Working together with the top-class PC software EnergyStorageDiscover (ESD) customer-specific performance, function, ageing and environmental tests as well as standardized and standard-compliant tests (e.g. ISO, DIN EN, SAE) can easily be carried out.

The Scienlab scope of services

Scienlab offers excellently designed complete solutions from one single source: from planning through organization to the implementation of ready-for-use test benches. In addition to precise and reliable battery test systems, Scienlab's scope of service includes:

- Integration of temperature and climatic chambers
- Conditioning of the device under test
- Contacting systems for user-friendly DUT connection
- Integration of customer chargers
- Development and realization of comprehensive safety concepts
- Scienlab Test Bench Guard for monitoring of the entire test bench
- Scienlab Measurement & Control Modules for the recording of voltage, temperature and for the provision of all analog and digital inputs and outputs
- Commissioning, maintenance, calibration support etc. by the Scienlab Service & Support Center

Scienlab test bench for characterization and development of battery cells and modules

The Scienlab energy storage test systems

The outstanding characteristics of Scienlab test systems include precise measuring technology, extremely reliable power electronics for reproducible results and regeneration capabilities that ensure first-class energy- and cost-efficiency. The modular concept offers maximal flexibility and individuality in terms of the layout of the systems and the test environment as a whole. This enables rapid and cost-efficient adaptation at any time to meet future requirements. Furthermore, the compact and robust hardware ensures a long operating life as well as low maintenance and service expenses.

The Scienlab control and test software EnergyStorage-Discover

The state-of-the-art Scienlab EnergyStorageDiscover (ESD) software allows all the components of the test bench to be controlled and monitored effectively. ESD ensures that both predefined standard tests and individual test procedures can be carried out conveniently and simply. Furthermore, characteristic key data can be determined immediately during the test procedure, and the results are also reproducible. The user benefits from the intuitive operation, the powerful visualization of extensive measurement data volumes, and the export function to all common file formats.

Product overview

Scienlab supplies a wide range of systems in terms of voltage, current, output (optionally expandable by parallel connection) and channel options. You are also welcome to have Scienlab put together a tailor-made solution for you.

Voltage range (in V)	0 – 6	0 – 20	5 – 60 0 - 60*	5 – 80 0 - 80*	50 – 600 0 – 600*	50 – 850 0 – 850*	50 – 1000 0 – 1000*
Current range (in A) Current measuring accuracy							
± 5 up to ± 0,03µA ± 0.05 % o. m. v.	up to 0.03 kW**	–	–	–	–	–	–
± 25 up to ± 5 mA ± 0.05 % o. m. v.	up to 0.15 kW	–	–	–	–	–	–
± 75 up to ± 25 mA ± 0.05 % o. m. v.	up to 0.45 kW	–	–	–	–	–	–
± 100 up to ± 20 mA ± 0.05 % o. m. v.	up to 0.6 kW	up to 2 kW	up to 6 kW	up to 8 kW	up to 22 kW	up to 22 kW	up to 44 kW
± 300 up to ± 60 mA ± 0.05 % o. m. v.	up to 1.8 kW	up to 6 kW	up to 18 kW	up to 24 kW	up to 180 kW	up to 255 kW	up to 300 kW
± 600 up to ± 120 mA ± 0.05 % o. m. v.	up to 3.6 kW	up to 12 kW	up to 36 kW	up to 48 kW	up to 360 kW	up to 360 kW	up to 360 kW
Voltage measuring accuracy	±1 mV, typ. 150 µV	± 4 mV ± 0.05 % o. m. v.	± 16 mV ± 0.05 % o. m. v.	± 16 mV ± 0.05 % o. m. v.	± 200 mV ± 0.05 % o. m. v.	± 200 mV ± 0.05 % o. m. v.	± 250 mV ± 0.05 % o. m. v.
Characteristics							
Regeneration capability	yes***	yes	yes	yes	yes	yes	yes
No. of channels	any	any	any	any	1	1	1
Channels for manual parallel connection	6	6	6	6	4	4	4
Channels for automatic parallel connection	2	2	2	2	2	2	2
Flow dynamics	typ. 0.8 ms	typ. 0.8 ms	typ. 0.8 ms	typ. 0.8 ms	typ. 1.6 ms	typ. 1.6 ms	typ. 1.6 ms
Cell test functionality	–	–	yes	yes	–	–	–
Voltage range	–	–	0 – 6 V	0 – 6 V	–	–	–
Voltage measuring accuracy	–	–	±1 mV, typ. 150 µV	±1 mV, typ. 150 µV	–	–	–
Module test functionality	–	–	–	–	yes	yes	yes
Voltage range	–	–	–	–	0 - 80 V	0 - 80 V	0 - 80 V
Voltage measuring accuracy	–	–	–	–	± 16 mV ± 0.05 % o. m. v.	± 16 mV ± 0.05 % o. m. v.	± 16 mV ± 0.05 % o. m. v.

o. m. v.: of measured value * Optional range ** Voltage range: -2 .. 8 V, -6 .. 6 V *** not for 5 A

Systems for cell formation

The challenge
For an energy storage device cell (e.g. lithium ion cell) to acquire the characteristics of an accumulator after mechanical production and to optimize the cell, it must be formatted by repeated and controlled charging and discharging.

The Scienlab solution
In order to format cells in a cost effective and efficient way, Scienlab offers various formation systems with an output voltage of 0 – 6 V and an output current of up to 100 A. The modular structure of the systems has a flexible configuration that enables it to fulfill a range of customer requirements. Battery cells can therefore be formatted selectively in small numbers within the framework of research and development, or in a fully automated process during large-scale production.

Maximal efficiency
A high level of efficiency is of paramount importance, particularly in large-scale cell production, where a high number of formation channels is continuously in use. In order to achieve efficient and cost-effective operation, Scienlab's systems have a recovery capability of typically > 94 %. The compact size of the formation systems allows the operation of many channels in a very small space – for space-saving on-site operation.

High measuring precision
During cell formation the precise recording of the charge is extremely important since it is necessary for determining the state of charge (SOC) or charge balance. To achieve this, Scienlab systems offer a high level of current measuring accuracy of up to 5 mA. Furthermore, they are also fitted with a stable, differential sense-voltage sensor with a measuring precision of up to 1 mV. This ensures that the relevant parameters can be recorded accurately. These measurements allow important characteristics such as internal resistance and charge balance to be determined and the cell to be characterized accurately.

Active safety
For safety reasons, two basic measurements need to be continuously monitored during the formation process: cell voltage and temperature. The Scienlab solutions thus have two active safety mechanisms. Firstly, the sensing wires for voltage measurement are fitted with wire-break detection which prevents the cells being overcharged unintentionally. Secondly, each formation channel has a temperature sensor which monitors the temperature of the cells. If the measurements exceed certain thresholds the relevant channel is automatically switched off and the user is informed by an error message.

Scienlab formation system with 6 channels

Test systems for the development of cell samples

The challenge

Ongoing research is dedicated to identifying new material combinations for innovative new battery solutions with the goal of optimizing power and energy density, safety, durability and costs of energy storage devices. Cell samples are set up and characterized to achieve this.

The Scienlab solution

Scienlab has developed a special solution for this task:

- Voltage range: -2 .. 8 V, -6 .. 6 V
- Output current: up to 5 A
- Parallel connection: 2 channels to increase the current to max. 10 A
- Control modes: current, voltage, power, resistance
- Optional impedance spectroscopy in every channel

High measuring precision

The successful characterization and development of cell prototypes demands precise control and extremely accurate measuring technology. These requirements are being met by Scienlab systems with a voltage measuring accuracy of 1 mV and a current measuring accuracy of 0.03 µA, realized by the automatic switchover of measuring range. Furthermore, temperature measurement is integrated in each channel.

Reference electrodes

Reference electrodes are integrated to analyze the electrode process. Here, it is not only important to precisely record this potential compared to the anode and cathode potentials, but also to actively integrate the reference electrode during the measuring phase. Thus Scienlab systems make it possible to select the voltage measurement between anode/cathode, reference electrode/cathode or reference electrode/anode as the actual value for every control mode. This allows active control of the reference electrode potential during cyclic voltammetry for example.

Ergonomic structure

A large number of channels are necessary particularly when a large number of cells are being tested (e.g. button cells), and these demand extensive wiring. Scienlab enables a convenient and ergonomic adaption of cell samples – without the annoying tangled cables. Depending on the customer application the load and measurement outputs for each channel are easily accessible on the front plate and can be switched to a system connector on the back of the test system. In addition, the compact system design saves on space requirements: a 96-channel system requires just 0.8 x 0.8 m^2 for example.

Scienlab test system as desktop unit for testing up to 12 cell samples

Test systems for battery cells

The challenge

The cell is the basis of every energy storage device and has a direct influence on the quality of the battery modules and packs. Therefore, it is essential to characterize the cells during an early development phase. Depending on the intended use of the cell (e.g. stationary or mobile), various tests need to be carried out on the cell characteristics to evaluate its performance capability.

The Scienlab solution

For this task, Scienlab has developed extremely reliable test systems for precise and reproducible measurement results. This ensures that electrical properties can be accurately recorded with high current dynamics at the same time (-90 % - 90 %: 0.8 ms typ.).
With the Scienlab test software ESD, not only the test systems but also the components in the test environment (e.g. temperature or climate chambers) can be conveniently controlled and monitored. Particularly the parameters relevant for cell characterization such as internal resistance, efficiency, capacity, cyclical life span and calendar life, reaction to temperature changes and mechanical resistance can be analyzed.

Modular configuration

The cell test systems are modular and can be compiled flexibly. This makes it possible to adapt to changing requirements at any time. Various current classes are available (100 A, 150 A, 200 A, 300 A, 600 A). Each system can have any number of power stages, which is why the system can be made up of several channels, depending on requirements. Several channels can be connected in parallel for increased current and power requirements.

Cost reduction through energy efficiency

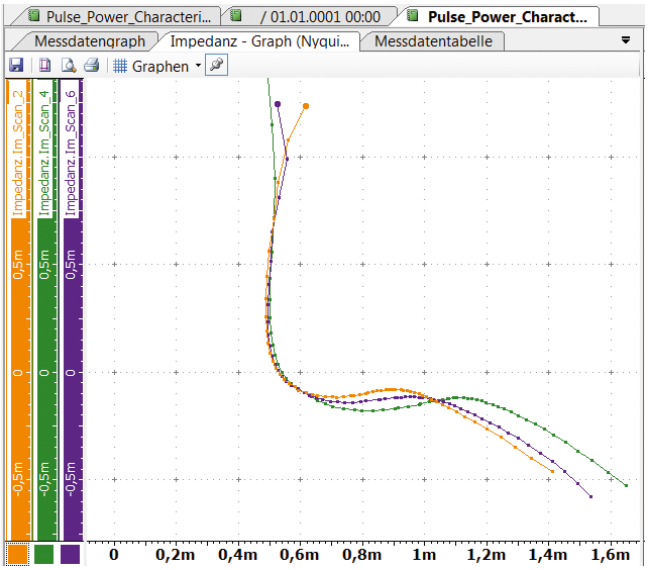
When analyzing total costs (TCO) it cannot be denied that the costs of operating a test laboratory are significant. In terms of endurance tests with lots of channels, Scienlab's efficient systems with their regeneration capabilities can significantly reduce costs. All the channels in one system are supplied internally through a common intermediate circuit. The energy recovered during the discharging procedure in one test channel can be used to charge another test channel. The energy required is taken from the mains supply network while any energy not required is fed back to the mains. This means energy is used extremely efficiently: the energy drawn from the mains typically makes up just 10 % of the system output. A further advantage is that no additional cooling system is needed, making the system more compact and significantly reducing space requirements.

Comprehensive measuring technology and options

Reliable and precise measuring technology is essential for characterizing cells. For this reason, Scienlab systems have:

- Voltage measuring accuracy: up to 150 µV
- Current measuring accuracy: up to 0.05 % of the measured value + 6 mA
- 3 temperature sensors in each channel
- CAN connections in every channel for the recording, processing, storing and sending of messages
- Optional: use of the source type "constant power loss" from the temperature measurement for thermal testing (e.g. determination of thermal resistance)
- Optional: integrated electrochemical impedance spectroscopy (EIS) per channel for convenient frequency testing – can be programmed directly into the test processes without changing the contacting of the DUT

Contacting of a battery cell in the climate chamber



Example of an impedance graph visualized in Scienlab ESD software

Test systems for battery modules

The challenge

When battery cells are connected to modules, two products are created. Firstly, battery systems for 12 V or 48 V on-board power supplies, or rechargeable batteries for power tool applications, including all system functions, such as BMS. Secondly, a module is being developed that can be used as a component in a HV battery system for electric cars; these have a voltage of up to 60 V or higher. It may also be necessary to re-measure a single cell, if the results of the module test require this.

The Scienlab solution

Both types of battery modules have to pass similar tests:
They must be tested in terms of their electrical and thermal characteristics under different climatic conditions and with the integration of all battery system components. The test systems from Scienlab offer development engineers the best possible support in carrying out this task.

Measuring equipment

The module voltage and current are recorded using extremely precise measuring equipment, with highly dynamic power electronic outputs. Furthermore, communication with the BMS is also a matter of course: BMS values can be written or used as a variable during the test processes. This makes it possible for the BMS to directly control the output source. This way, dynamic thresholds can be conveniently traced. It is also possible to switch between the supply terminals, and to control analog and digital inputs and outputs. Since these measurement values are synchronized in the test processes, they can also be used to replace a BMS inclusive load balance.

Cell test capability

If, in addition to characterization and testing of modules, there is also the need to measure cells in the range of up to 6 V, Scienlab makes this possible with the optional function "cell test capability". In this mode, cells can be tested with the same level of measuring accuracy as is defined for cells in Scienlab's test systems. The extended application scope thus increases the number of possible test cases for a comparatively low price.

Integration of external chargers

When testing battery packs, e. g. for power tools, the original charger must be integrated into the testing process. This allows the charging process to be observed and the interaction between the battery pack and the charger to be investigated if necessary. For this application, the Scienlab module test systems have optional inputs for connection of the charger. Switching between the external charger and the internal power electronics can be carried out conveniently during the test phase. The electrical variables are measured using exactly the same measuring technology. The results are also recorded in the results file.

Scienlab battery test system

Test systems for battery packs

The challenge

Since an energy storage pack is a highly complex high-current and high-voltage system with BMS, cooling system and electrical and mechanical components, stringent demands are made of the test environment. In order to meet the demands and to develop an optimal energy storage pack the test bench also must meet high requirements.

The Scienlab solution

Scienlab offers complete solutions for all relevant characterizations needed to optimize durability, range and efficiency. Even before the first field application the system behavior is analyzed by realistic and reproducible emulation of the electrical and climatic conditions of the future application (e.g. driving and load profiles). In addition to the test system and the device under test further components which are relevant for the battery test are implemented in the test bench such as BMS, cooling system, temperature or climate chambers.

Real-time-capable complete solutions

In order to test complex battery packs, it is of paramount importance that all system-relevant variables are controlled and recorded synchronously. These not only include the battery voltage, current and temperature, but particularly all the signals related to the BMS. It is necessary to react to specific CAN messages within 1 ms, as well as to regulate recorded operational cycles in the test environment in real time. Scienlab test systems for battery packs offer a complete real time solution for this. In addition to highly dynamic and precise electronic power output signals, all analog and digital inputs and outputs are provided conveniently for the user through the Scienlab Measurement & Control Modules.

Scienlab test bench for validation of battery packs

This system makes it possible to quickly react to CAN signals within milliseconds as well as to manipulate the BMS via XCP. Thanks to the state-of-the-art ESD software from Scienlab all components in the test environment can be controlled and measured in real time; these measurements are then used directly as variables in further test processes. Data evaluation is possible directly during the test without a further and complex postprocess.

Module test capability

If, in addition to validation of battery packs, there is also the need to test modules in the range of up to 80 V, Scienlab makes this possible with the optional function "module test capability". In this mode, modules can be tested with the same level of measuring accuracy as is defined in Scienlab's test systems for modules. The extended application scope thus increases the number of possible test cases for a comparatively low price.

24/7

The availability of a test system has a significant influence on the effective costs. If a system is shut down for maintenance or repairs, this can cost a lot of time and money, particularly if it results in the development phase of a product being extended. Reliable systems that can operate without interruption (24 hours a day, seven days a week) are thus of vital importance – a fact that is always at the forefront of all development work on test systems at Scienlab.

The systems thus have a long service life and are extremely robust and reliable. In addition, they require almost no maintenance: only the filter in the water-cooled systems needs to be cleaned and the measurement technology must be calibrated annually.

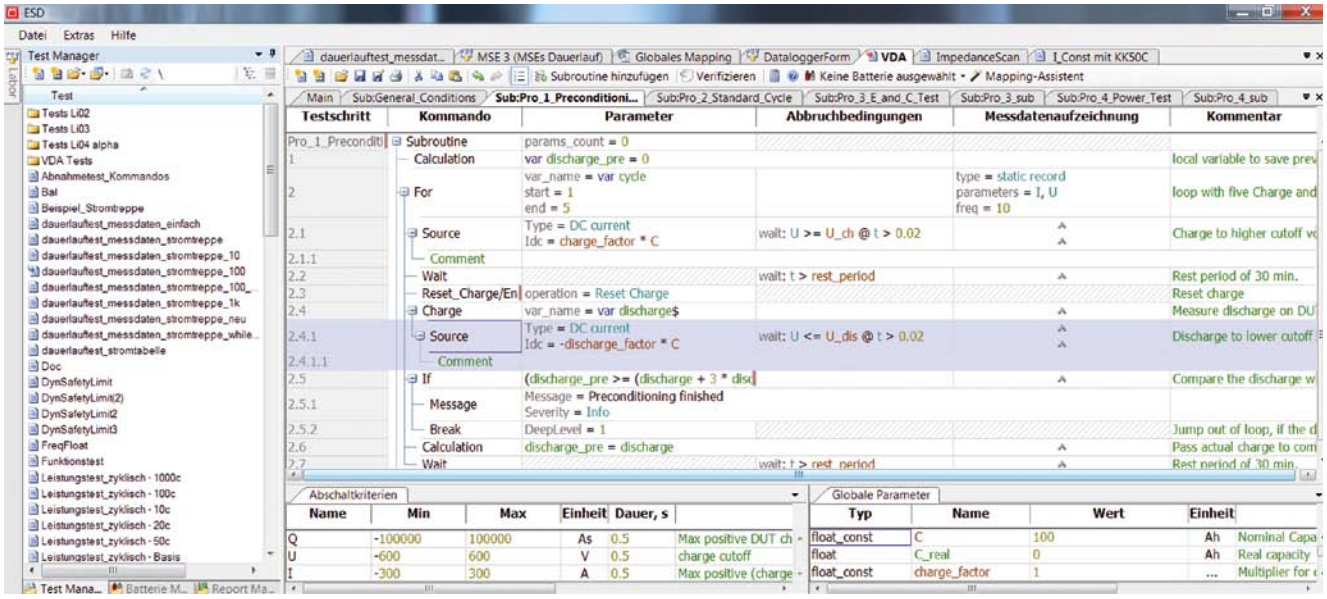
EOL-test

In addition to laboratory use, test systems are required for end-of-line testing in energy storage device production. Here, the focus is not so much on finding a flexible solution, but rather on a reduced, tailor-made solution with minimal investment costs. In this field, Scienlab offers a reliable EOL system that meets production line test requirements.

Scienlab Measurement & Control Module

EnergyStorageDiscover

Effective control, testing and evaluation: Software for energy storage tests



Scienlab test and control software ESD

Extensive tests are necessary for successful development and production of batteries. The Scienlab software application EnergyStorageDiscover (ESD) offers the users a wide range of different options as well as an intuitive operating concept and also provides meaningful and reproducible test results. The software is being continuously further developed and adapted to new requirements based on continuous exchange of information and experiences with Scienlab customers. ESD allows timesynchronous control of all Scienlab battery test systems for cells, modules and packs as well as all test environment components and also permits validation of all energy storage types. Test scenarios can be individually created, edited, controlled and monitored.

Highlights

- Maximum transparency and user friendliness due to intuitive operation and short familiarization
- Self-explanatory programming of simple and complex tests
- Clear structuring of test sequences thanks to (sub-)routines and their management in libraries
- Display of measurements at runtime and changes of the test program as well as integration of calculated variables and calculation results in further test procedure possible at any time
- Monitoring of test environment via overall and detail views for each channel
- User-friendly evaluation without post-processing
- Transparent visualization of measurement data and simple analysis using tables and graphs during the entire test
- Safety of device under test, test bench and test bench operator due to redundant monitoring of individually defined limit values as well as automatic shut-down of the test systems if the upper or lower limit values are exceeded
- Standardized remote interface allows integration of test benches into a higher-level control and monitoring system

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