

Keysight Technologies

# Scienlab Combined Battery Test Solution (CBTS)

Cell Level

SL 1133A



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## Battery Test System | Cell Level

The Scienlab Combined Battery Test Solution (CBTS) is an innovative, flexible and efficient solution for characterizing and testing battery cells. The space-saving combination of power electronics, test chamber and a sophisticatedly developed DUT holder not only enables the testing of large quantities of cells in the smallest space but is also flexible in use. Thanks to the adaptable DUT fixtures, different types of Batteries can be tested. The defined fixtures ensure accurate measurement results.

In contrast to other systems connected externally by wires, the integration of the electronic and the climate chamber into one system ensures shortest connection length (lowest impedance) to the device under test. Furthermore, a central connection point for all media (power, water, nitrogen, compressed air and communication) simplifies the installation and maintenance and ensures fast commissioning. Service costs are reduced in this way. To guarantee safe testing, the CBTS employs a safety concept that prevents possible dangers in test laboratories before they occur.

## Power Electronics

All Scienlab battery test systems from Keysight have high regeneration capabilities, allowing efficient, cost-effective, and environmentally-friendly operation. Thanks to the bi-directional power supply, more than 90 % of the energy is fed back into the mains. The system also offers automatic calibration; service costs are eliminated. A manual parallel connection of up to 3 channels (only with 300 A option) increases the current to maximum to 900 A for additional flexibility.

The CBTS is protected against overheating, overcapacity, short circuit and idling. It also has reverse polarity protection and monitors all internal voltages, currents and temperatures. Power contactors on the mains ensure that there is no voltage. In an emergency OFF, all internal high-voltage sources are automatically discharged. The CBTS relies on security for data acquisition and transmission. The Measurement and Control Unit (MCU) is an embedded system for autonomous program sequence control and measurement data acquisition. Communication to the test environment is ensured via Ethernet.

## Temperature Chamber & DUT Fixtures

The system offers homogeneous cooling/heating of the DUTs through optimal air flow. The air is guided from the back wall of the test chamber to the front and drawn in at the front part of the test chamber floor.

The DUT fixture is designed for a wide variety of cell formats without converting the device. An easy manual parallel test channel connection is also possible. Thanks to a quick-release technology, set-up times are reduced to a minimum. The defined DUT fixtures enable precise measurement results.

## CBTS Safety Concept

The safety concept is designed to avoid an explosive mixture in the chamber. The lower explosion limit (LEL) of hydrogen in air (4.1 vol %) is as the basis for calculating the chamber volume. The available chamber volume is calculated by the chamber inner dimensions minus the volume of cells and fixtures.

The primary safety concept objective is protecting the operating staff in case of a hazardous situation inside the test chamber. This is achieved by monitoring the chamber interior with CO and H<sub>2</sub> sensors to detect outgassing and incipient fires at a very early stage. The concentration of slowly leaking gaseous substances is kept low by a continuous flushing of the chamber with compressed air. As soon as an accident is detected by the sensors, N<sub>2</sub> flushing is immediately initiated to remove the volatile substances from the chamber. This procedure reduces the content of oxygen in the test chamber to minimize the likelihood of fire in the test chamber.

The chamber is connected to the exhaust air channel of the building via a reversible pressure relief flap for relieving any overpressure caused by outgassing substances. Furthermore, each chamber is equipped with an independent safety temperature limiter to avoid an overheating of the devices under tests (DUTs).

An automated door lock ensures the safety of the operating staff in two respects. No live parts can be reached by the operating staff while a test is running; an inadvertent opening of the door in case of an emergency releasing dangerous gases into the laboratory is prevented. An additional function enables the exchange of DUTs during a test, since it is possible for the operating staff to request a time-limited deactivation of the door lock via the control room. In this case the control room checks whether the chamber may be opened safely, based on the current monitored safety parameters.

To prevent accidents due to overcurrent, overcharging or overtemperature, the safety concept provides a redundant measurement of current, voltage and temperature. That is verified and evaluated in a higher-level safety PLC. As soon as a critical operating state is detected, the concerned test channel will be switched off. The provided safety equipment is monitored by a Scienlab Test Bench Guard (SL/TBG)

## Technical Data

| General system properties   |                |       |       |
|-----------------------------|----------------|-------|-------|
| Efficiency                  | > 90 %         |       |       |
| Reactive power compensation | cos (Φ) > 0.98 |       |       |
| Resolution                  | 32 bit         |       |       |
| Sample rate                 | 1 kS/s         |       |       |
| System Options              | 300 A          | 400 A | 500 A |
| Test channels               | 12 or 24       |       |       |

|                                |   |   |  |
|--------------------------------|---|---|--|
| Voltage Range                  | 6 V   |   |  |
| Current Options                | 300 A   | 400 A                                       | 500 A  |
| Power Options                  | 1.8 kW  | 2.4 kW                                      | 3 kW   |
| <b>Measurement Accuracy</b>    | <b>300 A</b>  | <b>400 A</b>                                | <b>500 A</b>                                 |
| Voltage accuracy               | < 1 mV  |   |  |
| Current accuracy               | ± 0.05 % of measured value, ± 60 mA (offset)  | ± 0.05 % of measured value ± 80 mA (offset) | ± 0.05 % of measured value ± 100 mA (offset) |
| <b>Current output dynamics</b> | <b>300 A</b>  | <b>400 A</b>                                | <b>500 A</b>                                 |
| Current Range (-90 % – +90 %)  | - 270 A – + 270 A   | - 360 A – + 360 A                           | - 450 A – + 450 A                            |
| Rise and fall time             | < 3 ms typ.   |   |  |
| Switching time                 | No switching times within power stage or channel at transition from positive to negative current and vice versa |   |  |
| <b>Temperature Measurement</b> |   |   |  |
| Type & Quantity                | PT1000 (3 x per channel)  |   |  |
| Measurement range              | - 40 °C – 120 °C  |   |  |
| Measurement accuracy           | ± 1 K   |   |  |
| <b>System cabinet</b>          | <b>300 A</b>  | <b>400 A</b>                                | <b>500 A</b>                                 |
| Weight approx.                 | 2500 kg   | 2700 kg                                     | 2900 kg                                      |
| Dimensions (H x W x D)*        | 2.60 m x 3.20 m x 1.56 m  |   |  |
| Ambient temperature            | 10 °C – 40 °C   |   |  |
| Humidity                       | 30 % – 75 % rel. H.   |   |  |
| Sound pressure level           | 73 dB(A) measured at 1 m distance from front side   |   |  |
| <b>Electrical connection</b>   | <b>300 A</b>  | <b>400 A</b>                                | <b>500 A</b>                                 |
| Mains supplies                 | 3 ~, PE, 400 VAC (+ 10 %) / 50 Hz   |   |  |
| Pre-fuse on site               | 125 A gG  | 150 A gG                                    | 150 A gG                                     |

| <b>Cooling water connection</b>  |  |
|----------------------------------|--|
| Max. heat transfer               | 10 kW  |
| Intake                           | 1½", $\vartheta_1 = 14\text{ °C} - 20\text{ °C}$ |
| Return                           | 1½", $\vartheta_0$ max. 30 °C                    |
| Cooling water consumption        | < 6.5 m³/h for $\Delta T = 10\text{ K}$          |
| Inlet pressure                   | 2 – 4 bar  |
| Pressure difference              | 2 bar  |
| <b>Compressed air connection</b> |  |
| Connection                       | Male thread R ½"                                 |
| Max. consumption                 | 8.7 Nm³/h  |
| Pressure                         | 6 – 10 bar                                       |
| Temperature                      | 2 °C – 35 °C                                     |
| Quality                          | ISO 8573-1                                       |
| Solid impurities                 | Class 2: Particle size < 1 µm                    |
| Max. oil content                 | ≤ 0.01 mg/m³ (liquid and gaseous)                |
| Moisture content                 | Class 6 (vaporous)                               |
| Max. dew point                   | - 40 °C  |
| <b>GN2 connection</b>            |  |
| Connection                       | Male thread R ¾"                                 |
| Max. consumption                 | 48 Nm³/h   |
| Inlet pressure                   | 3 – 5 bar  |
| Temperature                      | 2 °C – 50 °C                                     |

| <b>Temperature chamber</b>                       |  |
|--|--|
| Test room dimensions                             | 1200 mm x 850 mm x 650 mm (H x W x D), 663 liters  |
| Max. cell dimensions                             | 100 mm x 60 mm x 400 mm (H x W x D)  |
| Max. floor loading                               | 180 kg (approx.)   |
| Temperature range                                | - 33 °C – 80 °C  |
| Heating rate                                     | 3 K/min (empty chamber); 2 K/min (with 232 kg of DUTs)   |
| Cooling rate                                     | 2 K/min (empty chamber); 1 K/min (with 232 kg of DUTs)   |
| Heat Compensation                                | 2 kW @ 25 °C; 1.1 kW @ - 33 °C   |
| Safety Features                                  | Emergency stop switch (red/yellow) for all-pole disconnection  |
|  | 2 x fast stop push button (black) to stop each chamber separately  |
|  | Electromechanical door locking system  |
|  | Continuous small flushing volume with compressed air   |
|  | Optional: Nitrogen flushing in the event of an accident  |
|  | Reversible pressure relief valve, flanged connection DN500 (EN 1092-1)   |
|  | Signal light (Colors Red, Green, blue)   |
| Gas monitoring sensors including sampling device |  |
| Additional Features                              | Additional throughfeed Ø 50 mm, Schuko socket and Ethernet   |
| <b>Supported cell types of DUT Fixture</b>       |  |
| DIN91252:2016-11 Table 1                         | PHEV1, PHEV2, HEV1, HEV2, BEV1, BEV2, BEV3, BEV4   |
| DIN91252:2016-11 Table 5                         | PHEV1, PHEV2, HEV, BEV1, BEV2 (max. current rating 400 A)  |
| Other cell types                                 | Max. overall dimensions: 100 mm x 60 mm x 400 mm (H x W x D)   |
| <b>Documentation</b>                             |  |
| Supplied Documents                               | Operating instructions in English  |
|  | CE Certificate of Conformity   |
|  | Acceptance and calibration protocol  |
|  | System design and realization according to applicable safety and regulatory requirements (such as EU Directives). Special customer standards are not considered by default and require explicit agreement and quotation. |

## System Options

### Parallel Switch Enable Selection

**Note:** The selection of any option in this section adds approximately 50 kg to the system weight.

| SL1133A-P02 2 Channel parallel switch |   |
|---------------------------------------|---|
| Description                           | Manually controllable parallel operation of two channels  |
|                                       | Parallel operation of channel 1 + 2 with DUT 1 or DUT 2 (exemplary), parallelization of other channels also possible.   |
| Notes                                 | The power leads between the test system and the DUT must be designed for double output current. Connecting two systems in parallel has no effect on the voltage accuracy. The offset of the current accuracy is multiplied by two. The error of the measured value [%] is not affected. |

| SL1133A-P03 3 Channel parallel switch |  |
|---------------------------------------|--|
| Description                           | Manually controllable parallel operation of three channels   |
|                                       | Parallel operation of channel 1 - 3 with DUT 1, DUT 2 or DUT 3   |
|                                       | Parallel operation of channel 5 - 7 with DUT 5, DUT 6 or DUT 7   |
|                                       | Parallel operation of channel 9 - 11 with DUT 9, DUT 10 or DUT 11  |
| Notes                                 | Only available for 300 A current option in combination with 24 channels. The power leads between the test system and the DUT must be designed for triple output current. The offset of the current accuracy is multiplied by three. The error of the measured value [%] is not affected. |



## Additional Function Selection

| <b>SL1133A-EIS Electrochemical Impedance Spectroscopy (EIS)</b> |   |
|---|---|
| Description   | Integrated electrochemical impedance spectroscopy per test-channel, independent programmable within test sequence                   |
| Measurement method  | Potentiostatic & galvanostatic  |
| Absolute Error $ \Phi $   | 2 degrees   |
| Absolute Error $ Z $  | 5 $\mu\text{Ohm}$   |
| Relative Error $ Z $  | 1 %   |
| Frequency band  | 1 mHz – 10 kHz  |
| <b>SL1133A-RID RFID Option</b>                                  |   |
| Description   | Tracking of DUT location and its status via RFID. This option needs an initial registration set, which can be requested separately. |

## Service Options

Service features depend on the customer facilities, expertise, and overall scope of the project. For that reason, it is not possible to give exact service efforts without knowing the requirements and goals of the customer. Keysight offers the following services to ensure a successful project execution and to reduce the ramp-up time for our customers.

### **HS0003A-100 Project Management**

By ordering the Project Management Service, an experienced project manager is dedicated to your project and acts as direct communication interface from Keysight to the customers Project Management Team.

The project manager takes over the responsibility:

- To observe internal project progress and secure that project schedule/ project milestones are kept.
- That any unscheduled project events are immediately communicated and discussed with the customer.
- To provide complete and accurate project documentation to the customer.

### **R9001A-201 Installation Service**

The scope of the offered Installation Service depends on the customer facility. Share all relevant information and requirements that require installation such as connection to the local grid and water supply with your local field engineer so that the scope of service personnel and material costs for installation can be calculated.

**Note:** Installation can be executed by the customer.

## R9001A-202 Start-up Assistance Service

Keysight offer a Start-up Assistance Service to guide the customer during first usage of the test bench after installation. Start-up assistance service is recommended for each test bench project. It includes:

- Local presence of experienced test bench engineer during first usage of the test bench.
- Consulting of customer personnel with regards to intended usage of the test bench (e.g. initial test with customer specimen)
- Review of executed hardware installation of Keysight products.
- Review and consulting to software settings of operation software if ordered
- Travel expanses

**Note:** Start-up Assistance Service is offered on a daily base. Keysight recommends at least two days of Start-up Assistance Service for each test bench project.

## HS0002A - Productivity Support Service

The Productivity Support Service is offered to support, consult and train the customer's operation personnel to reduce the ramp-up time for initial usage of a new test bench and for any unexpected system behavior during the test bench life cycle. Productivity Support Service is executed remotely (phone/Internet) or on site (on request). It includes:

- Direct access to an experienced system specialist via Phone/Internet.
- Support for failure analysis and trouble shoot
- Software and programming support & consulting

**Note:** Keysight recommends at least two days of Productivity Support Service for each test bench project.

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