

SL1133A Scienlab Combined Battery Test Solution

Cell Level – Up to ± 1000 A, 24 Channels



Scienlab Combined Battery Test Solution – Cell Level

The SL1133A Scienlab Combined Battery Test Solution (CBTS) is an innovative, compact, and efficient solution for characterizing and testing battery cells. The space-saving combination of power electronics, test chamber and sophisticatedly developed cell holders 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 and sizes of cells can be tested. The defined fixtures accept a range of prismatic cells (and pouch cells using adapters), ensuring accurate measurement results.

In contrast to other systems which connect to cells by external wires, the integration of the electronics and the climate chamber into one system ensures the shortest connection length (lowest impedance) to the devices under test. Furthermore, a central connection point for all media (power, water, nitrogen, compressed air, and data communications) simplifies the installation, reduces maintenance costs, and ensures fast commissioning. To guarantee safe testing, the CBTS employs a safety concept that prevents possible dangers in test laboratories before they occur.

SL1133A Basic configurations

Max. current range ¹	±300 A	±400 A	±500 A
Test channels	12 or 24		

¹ Manual parallel connections of channels increase the maximum current range of the system. You can connect 2x 400 A channels for ±800 A, 3x 300 A channels for ±900 A, or 2x 500 A channels for ±1000 A maximum range.

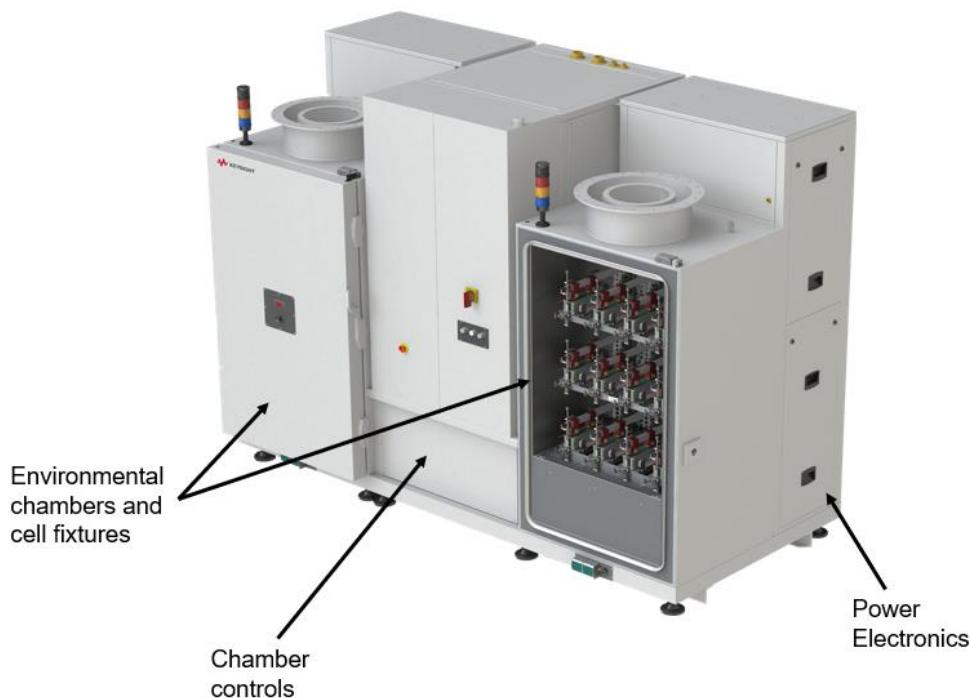


Figure 1. The SL1133A Cell Test Solution combines power electronics, environmental chambers, cell fixturing, and safety controls into a one physically integrated and specified test system.

Power electronics

All higher-power 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 AC mains during cell discharge. The system also offers automatic calibration to decrease ongoing service costs. Manual parallel connections of channels increase the maximum current range of the system. You can connect 2x 400 A channels for ± 800 A, 3x 300 A channels for ± 900 A, or 2x 500 A channels for ± 1000 A maximum range when you need to test large cells.

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. In the case of an emergency shutdown, contacts on the mains ensure that there is no voltage and all internal high voltage sources are automatically discharged.

The SL1132A has strong security for data acquisition and transmission. The Measurement and Control Unit (MCU) is an embedded system providing autonomous program sequence control and measurement data acquisition. This assures that a test will continue running even if communication with the system PC is lost. Communication among the elements of the test system (power electronics, chamber, cooling, system PC) is managed via Ethernet.

Temperature chamber and DUT fixtures

The system offers homogeneous cooling/heating of the devices under test (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 to accommodate a wide variety of prismatic cells (and pouch cells using adapters), by adjusting the cell holders without needing to replace the fixture. 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 and wiring enable precise measurement results.



Figure 2. Left: Cell holders for 12 prismatic cells in each chamber.



Figure 3. Cell holders are easy to unload.

CBTS safety concept

The primary objective of the safety concept is to protect the operating staff in case of a hazardous situation inside the test chamber. This is achieved by continually monitoring the interior of the chamber using CO and H₂ sensors, in order to detect outgassing and incipient thermal events at very early stages. High concentrations and accumulation of slowly leaking gaseous substances is minimized by a continuous flushing of the chamber with compressed air. As soon as hazardous levels are detected by the sensors, N₂ flushing will be initiated to remove volatile substances inside the chamber. This procedure reduces the content of oxygen in the test chamber to minimize the likelihood of fire.

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

Redundant measurements

To prevent accidents due to overcurrent, overcharging, or overtemperature, the safety concept provides a redundant measurement of current, voltage and temperature. This is verified and evaluated in a higher-level, independent 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 (SL1070A).

Exhaust air channel

The test chamber is connected to the exhaust air channel of the building using a reusable one-way pressure relief flap to relieve any overpressure caused by outgassing substances. Furthermore, each chamber is equipped with an independent safety temperature limiter to avoid overheating of the DUTs.

Automated door lock

An automated door lock ensures the safety of the operating staff in two respects.

1. No active parts can be reached by the operating staff during a test.
2. The door cannot be opened during a test thus preventing the release of dangerous gases into the laboratory.

There is an additional function whereby the operating staff may request a time-limited deactivation of the door lock via the control room (the PC supervising the test system). This enables the exchange of DUTs during a test. However, the operator of the control room must check and verify whether the chamber may be opened safely based on the currently monitored safety parameters.

Electrochemical impedance spectroscopy

You can gain deeper insights into the characteristics of your cells with the optional electrochemical impedance spectroscopy (EIS) capability. SL1133A provides integrated electrochemical impedance spectroscopy measurements per test channel, independently programmable within a test sequence. Multisine/sine delivers faster results. Find out more [below](#).

SL1133A CBTS Technical Data

System options	300 A	400 A	500 A
Test channels	12 or 24		
Voltage range	6 V		
Current range	±300 A	±400 A	±500 A
	Manual parallel connections of channels increase the maximum current range of the system. You can connect 2x 400 A channels for ±800 A, 3x 300 A channels for ±900 A ¹ , or 2x 500 A channels for ±1000 A maximum range ² .		
Power range	1.8 kW	2.4 kW	3 kW
Voltage/current measurement			
Voltage accuracy ³	<1 mV		
Current accuracy ³	±0.05% of measured value, ±60 mA (offset)	±0.05% of measured value ±80 mA (offset)	±0.05% of measured value ±100 mA (offset)
Resolution	32 bits		
Sample rate	1 kHz		
Recommended re-calibration period	12 months		
Current output dynamics			
Current range (-90 to +90%)	-270 to +270 A	-360 to +360 A	-450 to +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.		
Temperature measurement			
Type and quantity	PT1000 (3 x per channel)		
Measurement range	-40 to +120 °C		
Measurement accuracy	±1 K		

¹ Permitted max. current with parallel connection of three channels for 900 A at max. chamber temperature of 80 °C for five minutes.

² Permitted max. current with parallel connection of two channels for 1000 A at max. chamber temperature of 80 °C for two minutes.

³ Measurement and programming accuracy.

System options	300 A	400 A	500A
System AC Power			
Efficiency	> 90%		
Reactive power compensation	$\cos(\Phi) > 0.98$		
Mains supplies	3 ~, PE, 400 VAC (+10%/-5%)/50 Hz (± 0.2 Hz)		
Pre-fuse on site	125 A gG	150 A gG	150 A gG

Supported cell types for DUT fixture

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)

System cabinet	300 A	400 A	500 A
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		

Environmental

Operating/storage temperature	10 to 40 °C
Humidity	30 to 75% rel. H.
Sound pressure level	73 dB(A) measured at 1 m distance from front side
Cooling water connection	
Max. heat transfer	10 kW
Intake	1½", $\vartheta_I = 14$ to 20 °C
Return	1½", ϑ_R max. 30 °C
Cooling water consumption	<6.5 m³/h for $\Delta T = 10$ K
Inlet pressure	2 to 4 bar
Pressure difference	2 bar

Environmental

Compressed air connection	
Connection	Male thread R ½"
Max. consumption	8.7 Nm³/h
Pressure	6 to 10 bar
Temperature	2 to 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
GN2 connection	
Connection	Male thread R ¾"
Max. consumption	48 Nm³/h
Inlet pressure	3 to 5 bar
Temperature	2 to 50 °C

Temperature chamber

Test room dimensions (H x W x D)	1200 x 850 x 620 mm, 663 liters
Max. cell dimensions (H x W x D)	100 x 60 x 400 mm
Max. floor loading	Approx. 180 kg
Temperature range	-33 to +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 2x 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 Reusable one-way pressure relief valve, flanged connection DN500 (EN 1092-1) Signal light (Colors Red, Green, blue) Gas monitoring sensors including sampling device
Additional Features	Additional feedthrough Ø 50 mm, Schuko socket and Ethernet.

Documentation

Supplied documents:

- Operating instructions in English
- CE Declaration of Conformity
- Acceptance and calibration protocol

System design and realization according to the common basic safety and health demands of EU directives. Special customer requirements need an individual discussion and quote.

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 (for example), paralleling other pairs of channels is 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 selections

SL1133A-EIS Electrochemical impedance spectroscopy

Description	Integrated electrochemical impedance spectroscopy (EIS) per test-channel, independently programmable within a test sequence.
Measuring method	Galvanostatic and potentiostatic
Measure range	0.01 m Ω to 1 Ω
Excitation amplitude	Not specified
Magnitude error term ka	± 100 $\mu\Omega$
Inductive error term ki	± 20 nH
Relative error term kr	1%
Absolute error Phi	2 degrees
AC current amplitude	500 mA
Frequency range	1 mHz to 10 kHz
SL1133A-RID RFID option	
Description	Tracking of DUT location and its status via RFID. This option needs an initial registration set, which can be requested separately.

Software to Control Cell Test Systems

Keysight provides cell test system software that starts with Scienlab Energy Storage Discover to control your individual cell test systems such as the SL1133A and extends to PathWave Lab Operations for Battery Test to manage and coordinate your entire battery testing laboratory with multiple systems used to test cells, modules, and battery packs.

SL1091A Scienlab Energy Storage Discover (ESD)

Scienlab Energy Storage Discover (ESD) is the intuitive test-software environment for developing, performing, and analyzing tests for an individual test system.



Figure 4. Scienlab Energy Storage Discover controls individual test systems.

- Central controlling component for all Keysight Scienlab-brand energy storage test environments.
- Comprehensive overview, user-friendly operation, easy-to-learn.
- Powerful visualization of tests and results.
- Several ESD offline versions support creating test programs.
- Available simulation environment for offline test.
- Ethernet communication with the battery test system.
- Easy integration with external control and monitoring software via optional standardized remote-interface.
- Holistic vehicle emulation from the perspective of battery cell, module and pack levels.
- Support for Windows 7 and 10. Single software license per workstation.
- Integration of external components into the test environment and process, such as environmental chambers, cooling and heating equipment, or optional Scienlab-brand Measurement and Control Modules.

Find out more about Scienlab Energy Storage Discover [here](#).

EP1150A PathWave Lab Operations for Battery Test

PathWave Lab Operations for Battery Test enables efficient planning and coordination of your entire battery test laboratory. It manages all resources, including test facilities, test systems, and your test objects or devices under test (DUTs). PathWave Lab Operations for Battery Test provides an integrated, web-based lab management platform that helps you modernize your test workflows, eliminating legacy paper-based processes, and increasing data integrity and traceability.

This powerful set of tools helps you to improve test throughput for all the cells and batteries you need to test, to fulfill the testing requirements for your projects on-schedule, and to optimize test asset utilization.

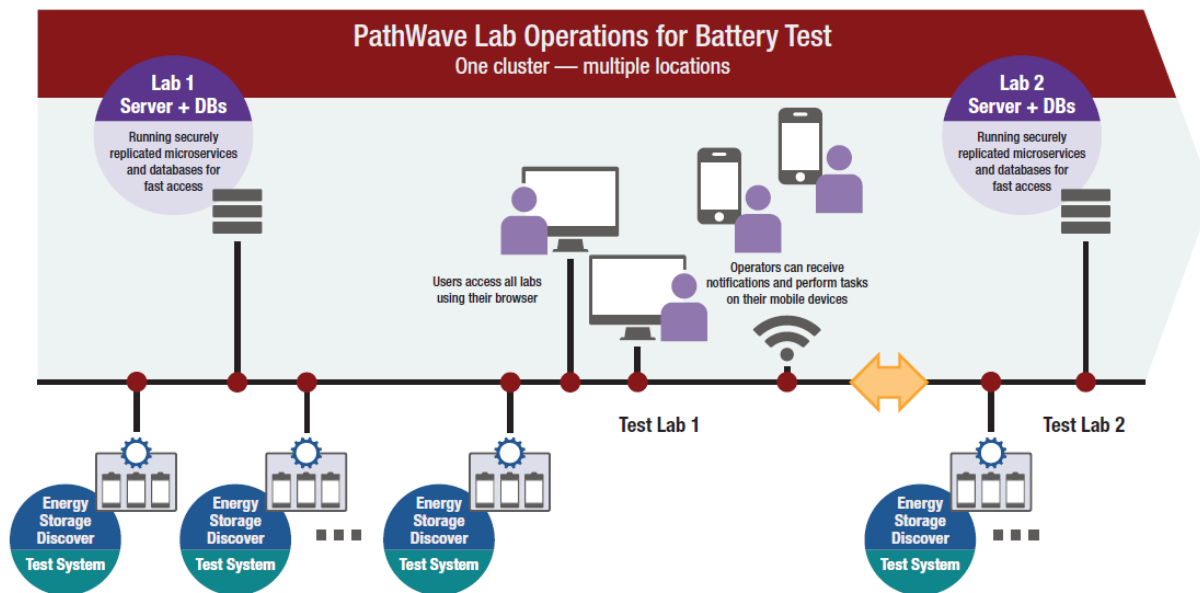


Figure 5. PathWave Lab Operations for Battery Test manages multiple test systems in a laboratory.

- Easily register and track test objects in your lab.
- Quickly analyze your data and statistics.
- Organize your test lab workflow, documents, lab orders, and tasks.
- Plan and optimize your test capacities and sequences.
- Share and control test plans, results, data, and other documents. Collaboration and discussion among lab staff become easy and productive.
- Remotely control your lab and its devices anywhere, anytime.
- Manage and route notifications to your preferred device or email service.
- Automated, networked, and scalable for any size of testing lab – up to thousands of channels.

Find out more about PathWave Lab Operations for Battery Test [here](#).

Project Management, Consulting and Installation Services

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

PS-XPM-100-SL Project management services

Keysight recommends project management services for each test bench project. By ordering the project management services, an experienced project manager is dedicated to your project and acts as a direct communication interface from Keysight to the customer's project management team. The project manager takes over the responsibility:

- To develop and manage the project plan.
- To track project progress and milestones.
- Communication project status regularly and ensure any unscheduled project events or project deviations are communicated and promptly discussed with the customer project team.
- To provide complete and accurate project documentation to the customer.

PS-XINS-100-SL Project installation services

These services provide installation expertise to manage, deliver and coordinate local facilities installation for the test bench. Specific installation efforts depend on the customer's individual facility, the locally available power and cooling and the test bench being delivered.

PS-XENG-100-SL Project engineering services

Project engineering services provide specialized engineering services during project development and implementation. The customer's project team will have access to engineering expertise to aid in various tasks specific to their project including but not limited to – safety matrix and test bench guard, facilities and lab layout, special power requirements, etc.

PS-XCOM-100-SL Project commissioning services

Project commissioning services for the test solution provide an experienced test bench engineer to validate and complete the test bench setup in readiness for the customer's initial usage. It includes validating specific hardware and software configurations per the project requirements and any specific consulting agreed to beforehand, given the test bench's customer-specific usage.

PS-S40-03 Productivity assistance

Productivity assistance is offered to support, consult, and train your operational 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 Assistance is executed either 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 troubleshooting.
- Software and programming support and consulting.

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

Extend the Capabilities of Your Test Solution

Battery module and battery pack testing

As your testing needs move beyond testing of single cells, Keysight provides test solutions for battery modules and battery packs. You can select battery test systems that address the range from small coin cells to large EV packs. Keysight offers integrated systems that include power electronics, fixturing and contacting, independent and redundant safety systems, environmental chambers, battery cooling and heating, and interfaces to your BMS, ECU, and other control systems. Or you can select Keysight system components and combine them with other components (e.g. chambers, cooling) you have chosen, and have Keysight provide a fully integrated, customized test solution. And all your test systems at all levels (cell, module, pack) are controlled with the same Energy Storage Discover software to provide a consistent user interface and data management.

Keysight offers systems and solutions with capabilities up to 1000 V and 1200 A for development, characterization, product validation, and durability testing.

Contact Keysight to explore how we can create a solution for your battery testing needs.



Figure 6. SL1700A Scienlab Battery Test System – Pack Level Series

For more information on Keysight Technologies' products, applications, or services, please visit: www.keysight.com