

Keysight Technologies

# Scienlab Battery Test System

Pack Level 360 kW

SL1000A



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## Battery Test System | Pack Level

Systems with an output power range of 250 kW up to 360 kW

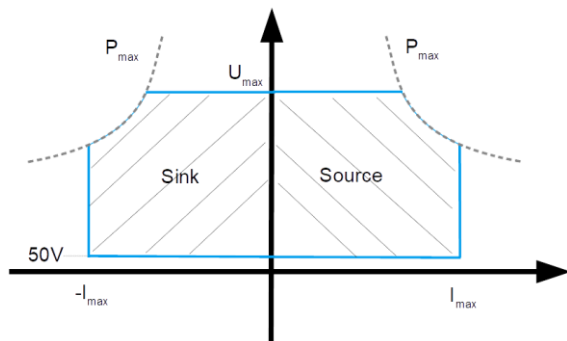
The Battery Test System (Pack-Level) is an electric system designed to provide sink and source for high voltage battery packs for automotive and industrial applications.

The following voltage, current and power options are available:

<b>Voltage</b>	50 – 600 V			
<b>Current Options</b>	600 A			
<b>Power Options</b>	250 kW	300 kW	330 kW	360 kW

<b>Voltage</b>	50 – 850 V				
<b>Current Options</b>	300 A	600 A			
<b>Power Options</b>	250 kW	250 kW	300 kW	330 kW	360 kW

<b>Voltage</b>	50 – 1000 V					
<b>Current Options</b>	300 A		600 A or 900 A			
<b>Power Options</b>	250 kW	300 kW	250 kW	300 kW	330 kW	360 kW



Maximum power within a voltage range of 50 V ...  $U_{max}$  (2-QS system)

### Control unit and power amplifier

- MCU – BT (Measurement and Control Unit)
- Embedded system for autonomous sequence control
- Communication-interface: Ethernet

### Analog acquisition of voltage and current data acquisition (4-wire measurement)

	600 V	850 V	1000 V
<b>Voltage accuracy</b>	±0.05% of measured value, ±200 mV (offset)		±0.05% of measured value, ±300 mV (offset)

	300 A	600 A	900 A
<b>Current accuracy</b>	±0.05% of measured value, ±60 mA (offset)	±0.05% of measured value, ±120 mA (offset)	±0.05% of measured value, ±180 mA (offset)
<b>Ripple</b>	±0.2% $FS_{eff} = 1,2 A_{eff}$	±0.2% $FS_{eff} = 2,4 A_{eff}$	±0.2% $FS_{eff} = 3,6 A_{eff}$

- Resolution: 32 bit
- Sample rate: maximum 20 kS/s (internally 625 kS/s)
- 3x temperature input: PT100 4-wire measurement, -50 °C ... 130 °C, ± 1K
- Control of external components (Test chamber, etc.; Ethernet protocol required)

### Current output characteristics

	300 A	600 A	900 A
<b>Rise and fall time</b>	< 1,6 ms typ., max. 2 ms, -90% to +90%		
	-270 A to 270 A	-540 A to 540 A	-810 A to 810 A

- No switching times within power stage or channel at transition from positive to negative current and vice versa.

### Intrinsic Safety

- Intrinsically safe against overheating, overcapacity, short circuit and idling
- Protection against reverse polarity by checking the polarity before output contactors are allowed to close
- No hardware protection against reverse polarity
- Monitoring of all internal voltages, currents and temperatures
- DC output contactors capable to disconnect DUT at full load current
- Mains side power contactors ensuring the absence of voltage
- Discharge of all internal high voltage sources upon emergency OFF

### System cabinet

	300 A	600 A	900 A
<b>Basic dimensions*</b>	2.48 m H x 3.6 m W x 0.8 m D		2.48 m H x 4,1 m W x 0.8 m D
<b>Weight approx.</b>	2400 kg	2400 kg	2900 kg

\* Height includes rollers. Width and depth without accessories such as switches, etc.

- Protection type IP 54
- Control cabinet color: RAL 7035
- Ambient temperature: 10°C – 40°C
- Air humidity: 30 – 75% relative humidity.
- Sound pressure level according to DIN EN 3744 <70 dB(A) measured at 1 m distance from front
- 2x 230 V-service-outlets accessible from the outside, door installation

### Documentation

- 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 taken into account by default and require explicit agreement and quotation.

### AFE (Active Front End)

- Bidirectional power supply
- Reactive power compensation  $\cos(\phi) > 0.98$
- Efficiency  $> 90\%$
- HV EMC filter
- 2 kHz filter
- Proven respect of limits for power-related disturbances within the low voltage grid as per EN61000-6-4

### Resonance converter

- All-pole potential separation of the power stages to the supply network

### Mains supplies

- 3, PE 400 V 50 Hz,
- Functional Earth (FE)
- Wire feedthrough via EMC screw joint on the roof

	250 kW	300 kW	330 kW	360 kW
<b>Pre-fuse on site</b>	2x 224 A gG	2x 315 A gG	2x 315 A gG	2x 315 A gG

### Cooling of power electronics

- Water/water heat exchanger including internal water cycle to prevent condensation
- Limiting water amount within cabinet
- Supervision of water temperature and internal controller
- Metal-coated coolant hoses

### Cooling of cabinet interior

- Water/air heat exchanger
- Supervision of the inner room temperature and the heat exchanger
- No waste air emitted into laboratory environment
- Roof mounting

### Cooling Water

	250 kW	300 kW	330 kW	360 kW
<b>Heat transfer</b>	25 kW	30 kW	33 kW	36 kW
<b>Flow rate</b>	0.39 l/s resp. 1.43 m <sup>3</sup> /h	0.47 l/s resp. 7.7 m <sup>3</sup> /h	0.52 l/s resp. 1.89 m <sup>3</sup> /h	0.57 l/s resp. 2.0 m <sup>3</sup> /h
	$\vartheta_I = 15\text{ °C}, \vartheta_o = 30\text{ °C}, \Delta\vartheta = 15\text{ K}$			
	Intake: 1", $\vartheta_I = 6\text{ °C} - 20\text{ °C}$ ; Return: 1", max. $\vartheta_R = 30\text{ °C}$			

- max. inlet pressure 6 bar, without pressure impact, pressure difference > 1,5...3,0 bar

### Safety

- Emergency stop switch / main switch (red/yellow) for all-pole disconnection
- Dual-channel fast stop (black push button)
- External fast stop input for Test Bench Guard integration
- Key switch for output contactor interlock
- Door hinge mounted on the right side
- Door handles: Comfort handles with safety lock
- Parametrizable limits for the protection of the DUT
- Insulation monitoring device (Bender ISOMETER® iso685-D-B)
- Evaluation of the insulation resistance via interface
- Insulation monitoring device can be switched off

**Note:** While the monitoring device is off user must ensure that the DUT's insulation monitoring device is active and linked to the emergency chain. The user is responsible for the safety of the test bench.

- Signal light with magnetic mounting
- Red: Error; Yellow: Active, Green: Ready
- Display elements: moving coil meter to display the output terminal voltage Measuring point: on DUT side of output contactors  
Display area: 0 – 1000 V respectively 0 – 1250 V for 1000 V Systems, installation point: door

#### **Interface to supervisory system (terminal block)**

- Release AC input contactor
- Release DC output contactor
- Status signal: output contactor open/closed
- Alarm: violation of the limit values
- Alarm: internal error
- Output: fast-stop
- Release system
- Input: fast-stop

## System Options

### Output Configuration Option Class

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

#### **SL1000A-501 Automatic parallel switch enable for two systems – 300 A**

- Parallel operation of two amplifiers automatically controllable within the test sequence
- Parallel operation of system 1 + 2 with DUT 1 or DUT 2

**Note:** The power leads between the test system and the DUT must be designed for 600 A output. 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.

#### **SL1000A-502 Automatic parallel switch enable for two systems – 600 A**

- Parallel operation of two amplifiers automatically controllable within the test sequence
- Parallel operation of system 1 + 2 with DUT 1 or DUT 2

**Note:** The power leads between the test system and the DUT must be designed for 1200 A output. 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.



### **SL1000A-503 Second DC output 300 A**

- Switch to another power outlet including sense-wires
- Switching programmable within test sequence
- Redundant trip limits for containment in test running are dynamically adjustable in ESD
- Additional display element for DC output voltage

### **SL1000A-503 Second DC output 600 A**

- Switch to another power outlet including sense-wires
- Switching programmable within test sequence
- Redundant trip limits for containment in test running are dynamically adjustable in ESD
- Additional display element for DC output voltage

## **Additional Current Range Option Class**

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

### **SL1000A-401 Additional Current Range 30 A**

- Measuring range  $\pm 30$  A, accuracy  $\pm 0.05\%$ ,  $\pm 6$  mA (offset)
- Current range selection programmable within the test sequence
- Tester must be disabled to switch the measurement range

**Note:** Combination of 30 A and 100 A (SL1000A-401 and SL1000A-402) is not possible.

### **SL1000A-402 Additional Current Range 100 A**

- Measuring range  $\pm 100$  A, accuracy  $\pm 0.05\%$ ,  $\pm 20$  mA (offset)
- Current range selection programmable within the test sequence
- Tester must be disabled to switch the measurement range

**Note:** Combination of 30 A and 100 A (SL1000A-401 and SL1000A-402) is not possible.

### **SL1000A-403 Additional Current Range, second output – 30 A**

- Measuring range  $\pm 30$  A, accuracy  $\pm 0,05\%$ ,  $\pm 6$  mA (offset)
- Current range selection programmable within the test sequence
- Tester must be disabled to switch the measurement range

**Note:** Combination of 30 A and 100 A (SL1000A-403 and SL1000A-404) is not possible.

### SL1000A-404 Additional Current Range, second output – 100 A

- Measuring range  $\pm 100$  A, accuracy  $\pm 0.05\%$ ,  $\pm 20$  mA (offset)
- Current range selection programmable within the test sequence
- Tester must be disabled to switch the measurement range

**Note:** Combination of 30 A and 100 A (SL1000A-403 and SL1000A-404) is not possible.

## DC Emulator Option including Communication Interface

### SL1000A-D00 DC Emulator including Ethernet

Enhancement of the Battery Test System to be used as a DC emulator

- Key switch to select operation mode
- System boots in either Battery Test mode or DC Emulator mode

#### Control unit

- MCU – DCE (Measurement and Control Unit)
- Real time-computer to control the electrical output variables
- Communication-interface: Ethernet
- Including RLC-battery-simulation model

#### Documentation

- Ethernet interface description in English

#### Output characteristics

	600 V	850 V	1000 V
<b>Voltage accuracy</b>	$\pm 0.05\%$ of measured value, $\pm 200$ mV (offset)		$\pm 0.05\%$ of measured value, $\pm 300$ mV (offset)

- voltage ripple:  $300 \text{ mV}_{\text{eff}}$  typ.,  $500 \text{ mV}_{\text{eff, max.}}$  at measuring range of 500 kHz

	300 A	600 A	900 A
<b>Current accuracy</b>	±0.05% of measured value, ±60 mA (offset)	±0.05% of measured value, ±120 mA (offset)	±0.05% of measured value, ±180 mA (offset)
<b>Output capacity</b>	1600 µF	3200 µF	3200 µF

### Voltage output dynamics

- Rise time (10% → 90%): typ. 5 ms, max. 10 ms
- Load stability: <80V (typically <40V) @ 400V,

300 A	600 A	900 A
0 → 250A <1ms, 500 µF load	0 → 500A <1ms, 500 µF load	0 → 750A <1ms, 500 µF load

### Explanation of load stability

- @ 400 V → output voltage of 400 V
- 0 → 250 A, < 1 ms → current rise from 0 to 250 A in less than 1 ms
- 500 µF → load capacity of typical device under test
- typically 40 V → average overvoltage of 40 V
- <80 V → maximal 80 V overvoltage

### Safety

- Shut-down mode for fast stop: U = 0 V or I = 0 A selectable
- Fast stop delay adjustable between 0...30s

**Note:** The system weight increases by 50 to 75 kg.

### SL1000A-D01 Additional EtherCat interface

An EtherCat interface is added to control the system in DC Emulator mode, including interface specification.

### SL1000A-D02 Additional CAN interface

A CAN interface is added to control the system in DC Emulator mode, including interface specification.

### SL1000A-D03 Emulator Control

Inhouse-Software to control the Battery Tester while in DC Emulator mode.

**Note:** Mandatory if DC Emulator option is chosen.

### Electrochemical Impedance Spectroscopy (EIS)

#### SL1000A-001 Electrochemical Impedance Spectroscopy (EIS)

Integrated electrochemical impedance spectroscopy per test-channel, independent programmable within test sequence

- Sinusoidal current up to 10 A
- Absolute Error  $|\Phi| = 2$  degrees
- Measurement method: galvanostatic, 4-wire-measurement
- Relative Error  $|Z| = 1 \%$
- Absolute Error  $|Z| = 500 \mu\text{Ohm}$

	600 V	850 V	1000 V
<b>Frequency band</b>	100 mHz – 2 kHz		100 mHz – 1 kHz

### Cabinet Base Option Class

#### SL1000A-701 Base stand

Battery Tester is placed on top of 15 cm high base stand (reduces cabinet height to 238 cm)

#### SL1000A-702 Rollers

Battery Tester is placed on top of heavy-duty rollers and can be moved flexible

### TestBenchGuard-ready Tester Hardware Options

#### SL1079A-BP1 BPT – Redundant Measurement Current/Voltage Measurement enable

Redundant DUT current and voltage measurement

- Interface to the test bench guard
- CAN-Interface (not suitable for DUT BMS-CAN)

**Note:** Only in combination with the test bench guard option redundant current / voltage measurement

## SL1079A-BP2 BPT – BMS CAN connection

- Hardware Interface of the DUT BMS-CAN to the Test Bench Guard

## Service Options

Service features depends on the facilities, expertise of the customer, 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 reduce the ramp-up time for our customers.

### HS0003A-100 Project Management Service

Keysight recommends Project Management Service for each test bench project. 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 ensure 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's facility. Share all relevant information and requirements regarding test bench components that require installation, such as connection to the local grid and the local 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

The Start-up Assistance Service is offered 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 expenses

**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 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 trouble shoot
- Software and programming support & consulting

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

Learn more at: [www.keysight.com](http://www.keysight.com)

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: [www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)

