

Keysight Technologies  
**Scienlab Battery Test System**  
Module Level

SL1001A    SL1006A



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## Battery Test System | Module Level

### Systems up to 68 kW per channel

The Battery Test System (Module Level) is an electric system which is designed to provide sink and source for battery modules for automotive and industrial applications.

The following voltage, current and power options per channel are available:

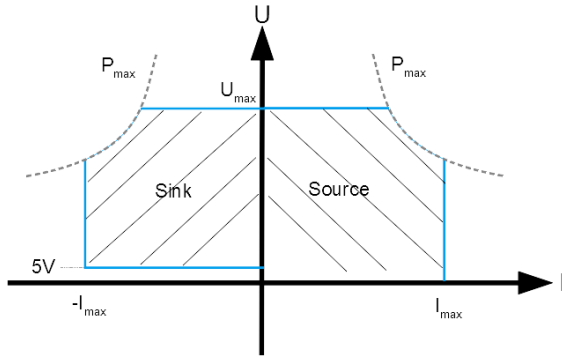
|                        |          |       |      |       |       |
|------------------------|----------|-------|------|-------|-------|
| <b>Voltage range</b>   | 0 – 20 V |       |      |       |       |
| <b>Current options</b> | 100 A    | 300 A |      | 600 A |       |
| <b>Power options</b>   | 2 kW     | 3 kW  | 6 kW | 6 kW  | 12 kW |

|                        |                      |       |       |       |       |
|------------------------|----------------------|-------|-------|-------|-------|
| <b>Voltage range</b>   | 0 – 60 V* / 5 – 60 V |       |       |       |       |
| <b>Current options</b> | 100 A                | 300 A |       | 600 A |       |
| <b>Power options</b>   | 6 kW                 | 9 kW  | 15 kW | 18 kW | 36 kW |

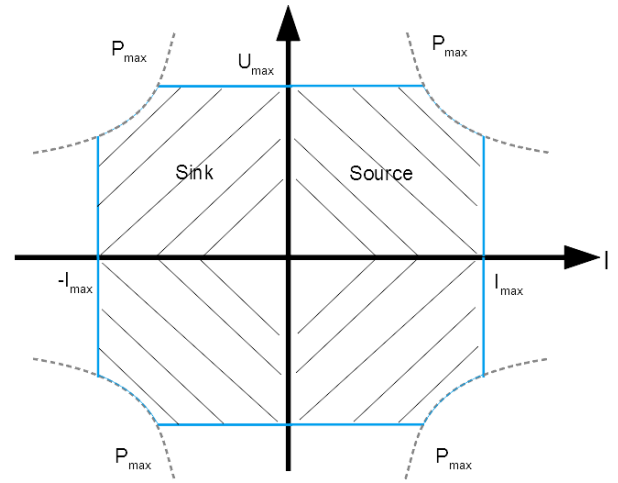
|                        |                      |  |       |       |  |
|------------------------|----------------------|--|-------|-------|--|
| <b>Voltage range</b>   | 0 – 90 V* / 5 – 90 V |  |       |       |  |
| <b>Current options</b> | 300 A                |  | 600 A |       |  |
| <b>Power options</b>   | 24 kW                |  | 24 kW | 48 kW |  |

|                        |                      |  |  |  |  |
|------------------------|----------------------|--|--|--|--|
| <b>Voltage range</b>   | 0 – 300* / 5 – 300 V |  |  |  |  |
| <b>Current Options</b> | 750 A                |  |  |  |  |
| <b>Power Options</b>   | 68 kW                |  |  |  |  |

\* Additional voltage range of 0 – 6 V available with 4QS option (SL1001A-T01).



Maximum power of 5 V ...  $U_{max}$  (2 quadrant system)



Maximum power of 0 V ...  $U_{max}$  (4 quadrant system)

### Control unit and power amplifier

Test Bench Control System (TBCS) – Linux real-time PC

- Embedded system for autonomous sequence control
- Measurement data acquisition
- Communication interface: Ethernet

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

|                         | 20 V  | 60 V   | 90 V   | 300 V  |
|-------------------------|---|--|--|--|
| <b>Voltage accuracy</b> | ± 0.05% of measured value,<br>± 4 mV (offset) | ± 0.05% of measured value,<br>± 12 mV (offset) | ± 0.05% of measured value,<br>± 18 mV (offset) | ± 0.05% of measured value,<br>± 60 mV (offset) |

|                         | 100 A  | 300 A  | 600 A   | 750 A   |
|-------------------------|--|--|---|---|
| <b>Current accuracy</b> | ± 0.05% of measured value,<br>± 20 mA (offset) | ± 0.05% of measured value,<br>± 60 mA (offset) | ± 0.05% of measured value,<br>± 120 mA (offset) | ± 0.05% of measured value,<br>± 150 mA (offset) |
| <b>Ripple</b>           | ± 0.2% FS <sub>eff</sub>                       |  |   |   |

- Resolution: 32 Bit
- Sample Rate: max. 20 kS/s (internally 625 kS/s)
- 3x temperature input: PT100 4-wire measurement, -50°C – 130°C, ± 1K per test channel
- control of external components:
  - e.g. temperature chamber, conditioning unit (Ethernet protocol required)
  - Additional protocol implementation possible if component not yet supported

### Current output characteristics

|                           | 100 A                                  | 300 A           | 600 A           | 750 A           |
|---------------------------|--|-----------------|-----------------|-----------------|
| <b>Rise and fall time</b> | < 800 µs typ., max. 1 ms, -90% to +90% |                 |                 |                 |
|                           | -90 A to 90 A                          | -270 A to 270 A | -540 A to 540 A | -675 A to 675 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 can be closed
- 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
- Discharge of all internal high voltage sources upon emergency OFF

### Manual parallel operation

- Manual parallel operation of up to six output stages possible
- Output contacts including sense circuit have to be interconnected by the customer
- Master/Slave definition via control software Energy Storage Discover (ESD)

## System cabinet

- Basic dimensions (HxD): 2.6 m x 0.8 m\*
- Width depends on the amount of test channels:

| Number of channels |                | 1       | 2       | 4       | 5     | 6       | 8     | 10    | 12    | 16    |
|--------------------|----------------|---------|---------|---------|-------|---------|-------|-------|-------|-------|
| 20 V               | 100 A<br>2 kW  | 0.8 m   | 0.8 m   | 0.8 m   | -     | 0.8 m   | 0.8 m | -     | 0.8 m | -     |
|                    | 300 A<br>3 kW  | 0.8 m   | 0.8 m   | 0.8 m   | -     | 1.6 m   | -     | -     | -     | -     |
|                    | 300 A<br>6 kW  | 0.8 m   | 0.8 m   | 1.6 m   | -     | 1.6 m   | -     | -     | -     | -     |
|                    | 600 A<br>6 kW  | 0.8 m   | 0.8 m   | 1.6 m   | -     | 1.6 m   | -     | -     | -     | -     |
|                    | 600 A<br>12 kW | 0.8 m   | 0.8 m   | 1.6 m   | -     | 2.4 m   | -     | -     | -     | -     |
| 60 V               | 100 A<br>6 kW  | 0.8 m   | 0.8 m   | 0.8 m   | -     | 0.8 m   | 0.8 m | -     | 0.8 m | 0.8 m |
|                    | 300 A<br>9 kW  | 0.8 m   | 0.8 m   | 1.6 m   | -     | 2.7 m   | 3.5 m | 3.5 m | -     | -     |
|                    | 300 A<br>15 kW | 0.8 m   | 1.1 m   | 1.9 m   | -     | 2.7 m   | 3.5 m | 3.5 m |       |       |
|                    | 300 A<br>18 kW | 0.8 m   | 1.1 m   | 1.9 m   | -     | 2.7 m   | 3.5 m | 3.5 m |       |       |
|                    | 600 A<br>18 kW | 0.8 m   | 1.1 m   | 1.9 m   | -     | 2.7 m   | -     | -     | -     | -     |
|                    | 600 A<br>36 kW | 0.8 m   | 1.6 m   | 2.4 m** | -     | -       | -     | -     | -     | -     |
| 90 V               | 300 A<br>24 kW | 0.8 m   | 0.8 m** | 1.6 m** | -     | 2.4 m** | -     | -     | -     | -     |
|                    | 600 A<br>24 kW | 0.8 m   | 1.1 m** | 1.9 m** | 2.4 m | 2.7 m** | -     | -     | -     | -     |
|                    | 600 A<br>48 kW | 0.8 m** | 1.6 m** | 3.2 m** | -     | -       | -     | -     | -     | -     |
| 300 V              | 750 A<br>68 kW | -       | 2.4 m   | -       | -     | -       | -     | -     | -     | -     |

\* Hight includes rollers. Dimensions without extra accessories like the excess of switches, etc.

\*\* For cooling reasons, a simultaneity factor of 0.8 must not be exceeded during long-term operation.

- Protection type IP 54
- Control cabinet color: RAL 7035
- Ambient temperature: 10°C – 40°C
- Air humidity: 30 – 75% rel. H.
- Sound pressure level according to DIN EN 3744 <70 dB(A) measured at 1 m distance from front

### **AFE (Active Front End)**

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

### **Transformer**

- Common potential separation of all output stages
- Output stages themselves not potential separated

### **Mains supply**

- 3, N, PE 400V 50 Hz
- Functional Earth (FE)

### **Safety**

- Emergency stop switch / main switch (red/yellow) for all-pole disconnection
- Fast stop push button (black)
- 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® IR425-D4-1)

**Note:** While the monitoring device is switched off it must be ensured that the insulation monitoring device of the DUT 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

### **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. Before delivery, all test systems are subjected to a performance test with a minimal duration of 30 minutes (respectively 20 minutes in case of the 300 V system).

## System Options

### Output Configuration Option Class

#### SL1001A-501 Automatic parallel switch enabling for two channels

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

**Note:** The power leads between the test system and the DUT must be designed for double the output current. Connecting two channels 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.

#### SL1001A-502 Automatic parallel switch enabling for two channels – 750 A

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

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

### Additional Current Range Option Class

#### SL1001A-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:** Only available for 300 A and 600 A output current.

#### SL1001A-402 Additional current range 150 A

- Measuring range  $\pm 150$  A, accuracy  $\pm 0.05$  %,  $\pm 30$  mA (offset)
- Current range selection programmable within the test sequence
- Tester must be disabled to switch the measurement range

**Note:** Only available for 750 A output current.



## Cell Test Option Class

### SL1001A-T01 Cell Test Option 6 V

- measuring range 0 – 6 V (4QS)
- Voltage accuracy:  $\pm 1$  mV (typ. 150  $\mu$ V)
- voltage range selection programmable within the test sequence

**Note:** This option is only available for 4 QS systems and always included in test systems with a voltage range of up to 20 V.

## Electrochemical Impedance Spectroscopy

### SL1001A-001 Electrochemical Impedance Spectroscopy (EIS) per channel

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

|                             | 100 A                             | 300 A           | 600 A |
|-----------------------------|-----------------------------------|-----------------|-------|
| <b>Sinusoidal current</b>   | Up to 5 A                         |                 |       |
| <b>Frequency band</b>       | 100 mHz – 2 kHz                   | 100 mHz – 5 kHz |       |
| <b>Absolute error  Phi </b> | 2°                                |                 |       |
| <b>Absolute error  Z </b>   | $\pm 200 \mu\Omega$               |                 |       |
| <b>Relative error  Z </b>   | 2 %                               | 1 %             |       |
| <b>Measurement Method</b>   | Galvanostatic, 4-wire-measurement |                 |       |

**Note:** Not available in combination with 300 V option

## Cabinet Base Option Class

### SL1001A-701 Base Stand

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

### SL1001A-702 Rollers

Battery Tester is placed on top of high rollers and can be moved flexible.

## System Cooling Option Class

### SL1001A-K02 Air Cooling with compressor

- Roof fan IP54 for compression refrigeration
- Monitoring of interior temperature

**Note:** Only available for 20 V systems with up to 6 kW or up to 6 channels.

### SL1001A-K03 Water Cooling

- Water/Air heat exchanger
- Heat transfer: max. 10% of total output power\*
- Intake:  $\frac{3}{4}$  ", 6 °C – 20 °C
- Return:  $\frac{3}{4}$  ", max. 30 °C
- Max. inlet pressure: 6 bar, without pressure impact, pressure difference > 1 bar

\*e.g. total output power = 96 kW, max. heat transfer = 9.6 kW

## Test Bench Guard-ready Tester Hardware Options

### SL1079A-CM1 Manual Parallel Connection

- Support of manual parallel connection of up to two Battery Test channels by the TBG
- Monitoring the current and voltage limit values of the respective master of the redundant measurement in parallel operation
- Sum formation of the individual flows of the redundant measurement to the correct monitoring of the current limits in parallel operation

### SL1079A-CM2 Automated Parallel Connection of two channels

- Up to 3 automated parallel connections of 2 channels each
- Detection of the automatic parallel connection of two channels of each Battery Test Bench about the state of the cross-contact
- Automatic monitoring of the current and voltage limits of the respective Master of the redundant measurement in parallel operation
- Automatic totals of the individual flows of the redundant measurement for the correct monitoring of the current limits in parallel operation
- Integration of standard input signals "status cross-contact channel x"

**Note:** Not available for 100 A Systems. Requires "option automatic parallel connection" in the Battery test system as well as option "option integration redundant current and voltage measurement". The power leads between the test system and the DUT must be designed for double the output current. Connecting two channels 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.

### **SL1079A-CM3 Redundant Current / Voltage Measurement – up to 6 channels**

Redundant DUT current and voltage measurement

- CAN Bus with 500 kBaud
- Data rate 16 2/3 Hz per measuring signal (connection via CAN-Bus controller)
- Measurement accuracy  $\pm 1\%$  from measurement range of current and voltage

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

### **SL1079A-CM4 BMS CAN Connection – selectable per channel**

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

## **Service**

Service features depends highly 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 is offering the following services to secure a successful project execution and to reduce the ramp-up time for our customers.

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

Project Management is highly recommended 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 secure that project schedule/ project milestones are kept.
- That any unscheduled occasions with relevance for the project 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 strongly depends on the individual facility of the customer. Please share all relevant information and requirements with regards to test bench components that require installation such as connection to the local grid and to the local water supply with your local field engineer that scope of service personnel and material costs for installation can be calculated.

**Note:** Installation can also 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 highly 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 to consider 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 customers operation personnel on the one hand to reduce the ramp-up time for initial usage of a new test bench, on the other hand with regards to any unexpected system behavior during the test bench life cycle. Productivity Support Service is executed via remote (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 considering 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)

