SL1200A Series
Scienlab Regenerative AC Emulator

Low Voltage & High Voltage as Single & Dual Range

KEYSIGHT

OPERATING INSTRUCTIONS

Content

Notices

Copyright Notice

Edition

Edition 3.1, January 2024 (Original Operating Instructions)

Published by

Keysight Technologies Deutschland GmbH

Suttner-Nobel-Allee 21

44803 Bochum, Germany

Technology Licenses

The hardware and / or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

U.S. Government Rights

The Software is “commercial computer software,” as defined by Federal Acquisition Regulation (“FAR”) 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement (“DFARS”) 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at www.keysight.com/find/sweula. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS

and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR OF ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT SHALL CONTROL.

Safety Information

⚠ DANGER A DANGER notice indicates a (extremely) hazardous situation which, if not avoided, will result in death or serious injury.
Do not proceed beyond a DANGER notice until the indicated conditions are fully understood and met.

⚠ WARNING A WARNING notice indicates a hazardous situation which, if not avoided, could result in death or serious injury.
Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

⚠ CAUTION A CAUTION notice indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

NOTICE A NOTICE indicates to pay attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data.
Do not proceed beyond a NOTICE until the indicated conditions are fully understood and met.

NOTE A NOTE refers exclusively to application notes without any security relevance.

Safety and Regulatory Notices

Using the system can cause danger and damage for life and limb of the operators or third parties, to the system itself or to other material assets. In addition to the manufacturer´s countermeasures, the operator must also take appropriate countermeasures against danger due to residual energy. The personnel must be briefed about these dangers and the necessary countermeasures during instruction.

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or instructions elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assume no liability for the customer´s failure to comply with these requirements. Please read the also Chapter 1, Section Intended use.

⚠ DANGER Danger to life in case of misuse at the outputs.
The Scienlab Regenerative AC Emulator does not have its own insulation guard.

- If the system emulates an electrical isolation against PE at the output, the local installation regulations and guidelines must be observed.
- This would be in the case of the emulation of an IT network in AC mode, or generally in DC mode.

⚠ DANGER Danger to life due to high voltages.
Some components are still supplied with voltage after switching off (wiring color orange).

- Before installation and upkeep, turn off and lock out all external voltage supplies.
- Only disconnect or establish electrical connections in a voltage-free condition.
- For models SL1214A and SL1215A, ensure model is in correct voltage range for application before enabling system output.

⚠ DANGER Danger to life due to missing covers!
In case of misapplication, missing protective cover can lead to severe injury, burns or death in the event of shock and arc flash.

- Do not remove cover under load and not operate without cover in place.
- After installation and upkeep, the previously removed protective cover must be replaced.

⚠ DANGER

Depending on the set output voltage and current, the system sometimes releases large amounts of energy at the output.

Touching the connection bars inside the system or the DUT terminals can occur life-threatening body currents.

- Never touch, connect, or disconnect the connecting lines to the DUT during active operation.
- Danger of arcing.

⚠ DANGER

Residual voltage after switch-off.

In case of connected DUT, the output terminals can still carry voltages even after switch-off of the system!

- Measure the voltage at the outputs to ensure that they are voltage-free.

⚠ DANGER

Danger to life due to charging or discharging batteries.

Batteries are sensitive to overloading/underloading and might explode or start burning. This can lead to danger for life and limb.

- Therefore, a battery must be monitored by a battery management system (BMS).

NOTICE

EMC interferences possible!

The Scienlab Regenerative AC Emulator has an increased interference emission level according to CISPR 11 at a rated input power of >20 kW. This can result in interference with third party sensitive radio services in a distance up to 30 m.

- For a rated input power of >20 kW, keep a distance min. 30 m to third party sensitive radio services.

NOTICE

Hearing protection due to noise exposure in the operating area!

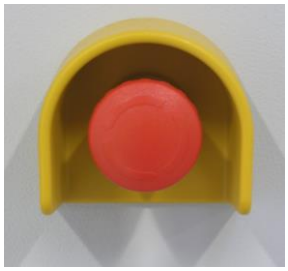
- Noise level <85 dB(A) at a distance of 1 m from the front
- It is recommended to wear hearing protection during operation.

Safety and monitoring devices

The system has monitoring devices that switch-off the system in case of emergency. If additional systems are connected to the SL1200A Scienlab Regenerative AC Emulator, it is recommended that the systems are integrated into a higher-level safety device.

Main switch

- On the front side
- I ON: power supply switched on
- O OFF: power supply switched off, communication with the system is maintained
- Trip: when emergency stop is triggered → system switches off, main switch in position Trip
- **Note:** In the O OFF position, the main switch can be locked using a padlock



Emergency stop push button

- On the front side
- Press: forces local emergency stop of the system (Responds: see safety relay)
- Turn counterclockwise: unlocks
- Functional test of the emergency stop button: monthly

Key switch Test Release

- On the front side
- Used for enabling/disabling test
- OFF: test release withdrawn (output contactors and power stage are blocked)
- ON: test release given; test may be started (e.g., acknowledged by software)

Transformer circuit breaker for 24 V power supply (=EIN-1Q3)
(illustration similar)

- Behind the front panel (detachable)
- Circuit breaker for the circuit of 24 V power supply (logic path) tapped upstream of the main switch
- O OFF: Circuit breaker has triggered → system is inactive; all power and communication connections (logic path) are inactive, switch on via main switch not possible.
- I ON: system can be switched on via main switch

Transformer circuit breaker for Measurement & Control Unit (MCU) (=EIN-1Q2) (illustration similar)

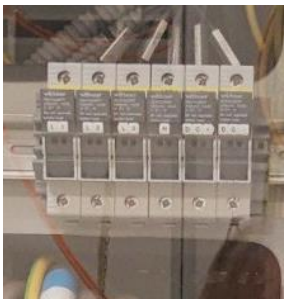
- Behind the front panel (detachable)
- Circuit breaker for the circuit of MCU (logic path) tapped upstream of the main switch

Fuses behind the front panel (detachable)

- Fuses for:
  - =CV2-1F1: 24 V control voltage
  - =CV3-1F1: 12 V Ethernet switch
  - =RPS1/3/5-1F1: power stages 1, 3 and 5
  - =RPS2/4/6-1F1: power stages 2, 4 and 6 (only for SL1203A, SL1213A, or SL1215A systems)

Fuse for the circuit between PE and output side neutral point (N')

- Behind the front panel (detachable)
- =ACO-1F1: Fuse for the circuit between PE and output side neutral point (N') active in the emulated grounded grid.
  - The fuse detects output-side earth faults (see Getting Started document)
- 0 OFF: Fuse has triggered → System is inactive
- I ON: Logic path MSE is active, main switch can be activated



Fuses inside the Output Box on the rear side of the system

- Fuses for:
  - =ACO-2F1: AC Sense L1'
  - =ACO-2F2: AC Sense L2'
  - =ACO-2F3: AC Sense L3'
  - =ACO-2F4: AC Sense N'
  - =DCO-2F1: DC+ Sense (optional)
  - =DCO-2F2: DC- Sense (optional)

Surge protection (=EIN-1F1)

- Inside the Input Box on the rear side
- Responds in the event of overvoltage (e. g. due to lightning)
- Reaction: Feedback signal is detected → undervoltage monitoring reacts → the main switch cannot be activated (falls back to position Trip)
- Consequence: Surge protection inlets must be changed (see Chapter 6 Section Tripping of the Surge Protection), feedback contact is reset

Safety relay

- Inside the system
- Responds when the local emergency stop switch or external emergency stop input via the higher-level safety device are triggered (2-pin each)
- AC supply of the power stages is interrupted, undervoltage monitoring triggers, main switch on “Trip” → system is switched off; power stage enable is withdrawn; 230 V auxiliary voltage and 24 V control voltage are maintained (logic path)
- Increased Safety function (optional)
  When the circuit breaker (1Q3) is switched on (main switch OFF), the safety relay checks all safety-relevant switching components. If an error is detected, the system cannot be switched on via the main switch.

Housing ground/functional earth

- On the rear side of the system
- Connection and coupling of housing ground
- Connection for EMC-compliant design

Display Soft Front Panel power stage

- On the front side
- Display is activated when power stage is active/in operation
- No settings needed

Signal lamp (default setting)

- On the top of the system
- Signals are fixed defined by the measurement and control unit (MCU)
- Connection via plug
- red: failure signal
  yellow: active signal (in operation/output relays closed)
  green: standby/ready signal

NOTE If the status of the configurable buses is different, several lights can be lit simultaneously.

Safety symbols

Protective earth-ground terminal

Housing ground/Functional earth

Danger, risk of electric shock

Caution, refer to accompanying description

Regulatory markings

The CE mark is a combination of CE, ICES and ISM marks.

This CE mark shows that the product complies with all the relevant European Legal Directives.

ICES-NMB-001 indicates that this ISM device complies with the Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.

The UK Conformity Mark is a mark owned by the UK Government. Affixing it to the product declares that all applicable directives and regulations have been fully complied with.

This mark, also called the "cTUVus mark", is used to demonstrate compliance with Canadian national standards issued by the Standards Council of Canada (SCC) and U.S. national standards.

This symbol is a South Korean Class A EMC Declaration. This is a Class A instrument suitable for professional use and in electromagnetic environment outside of the home.

This product is marked with the ACMA RCM mark for compliance in Australia/New Zealand. A copy of the Manufacturer´s Australia Declaration of Conformity for this instrument can be obtained by contacting your local Keysight Technologies Sales Representative.

This symbol indicates the product is recyclable.

The China RoHS mark indicates that toxic substance within the product stay inside at least 40 years before expiring.

ccr.keysight@keysight.com Contact address for questions to conformity of the product.

User Information

This Operating Instructions

- describes how to transport, install, connect, commission, operate and upkeep the system,
- provides important notes on safe and efficient handling of the system.

This Operating Instructions is part of the SL1200A Series Scienlab Regenerative AC Emulator and should always be kept at the system´s place of use.

NOTICE The operating personal must read and understand the Operating Instructions and all other safety instruction before using this system.
These Operating Instructions must be readily accessible and available operator personnel.

Applicable documents

The following documents are also part of the system:

- Declaration of conformity
- Getting Started SL1200A Scienlab Regenerative AC Emulator
- Parameter and Message List
- Acceptance and calibration report

Action instructions

Steps to be performed by the operating personnel are given as a numbered list. The order of the steps must be followed. The systems response to the relevant steps are indicated by a check mark.

Example:

1 Step 1
2 Step 2

✓ System response to the steps.

Steps with no specific order are given as a bulleted list.

Example:

- Point 1
- Point 2

Links

Cross-references to other parts of this Operating Instructions or hyperlinks to websites are shown in red.

Note for the operator

If the SL1200A is integrated into an overall test bench with other systems, the operator should carry out a risk assessment.

NOTICE **Without prior connection to a higher-level safety system, misuse can result in life-threatening injuries.**

- Keysight recommend first connecting the system to the higher-level safety and emergency stop system of the test bench, before putting it into operation.
- The Keysight emergency stop system in the control cabinet may not be changed or adapted without the consent of Keysight.

Qualification of the personnel

This section provides an overview of the responsibilities and qualifications of the operating and service personnel.

Responsibility / Activity	Keysight Personnel	Operator personnel
Transport	X	X
Connection and assembly	X	X
Commissioning	X	--
Operation	X	X
Upkeep	X	X[1]
Replacement of system components	X	--
Troubleshooting	X	X
Disposal/recycling	X	X

Table 1: Responsibilities of personnel (X: permitted; --: not permitted)

Only personnel trained in electrical engineering, qualified, and instructed by Keysight may work on the system.

Contact KeysightCare – Technical support

Contact KeysightCare	
Keysight Technologies Technical Support	www.keysight.com/find/keysightcare-contact

[1] Inspection (preventive maintenance)

1 System Description

Intended use

The SL1200A Series Scienlab Regenerative AC Emulator is used for testing the power electronics of charging systems and other components that can be operated on any power grid, in particular

- 1-, 2- or 3-phase emulation of AC sources (Voltage Priority)
  - up to a voltage line-to-line 600 V_{rms}
    SL1201A, SL1202A, SL1203A, SL1214A LV range (low-voltage), SL1215A LV range (low-voltage), or
  - up to a voltage line-to-line 1200 V_{rms}
    SL1212A, SL1213A, SL1214A HV range (high-voltage), SL1215A HV range (high-voltage),
- 1-, 2- or 3-phase emulation of AC sink (Current Priority),
- 1-, 2- or 3-phase emulation of harmonics with order 0 to 50, as well as two interharmonics with freely specified frequency fx of up to 3750 Hz,
- optional: emulation of a DC source/sink (Voltage/Current Priority).

The SL1200A can be integrated in a comprehensive test solution for

- photovoltaic inverters (PV), battery energy storage inverters, and other types of grid-connected inverters,
- energy storage systems, in conjunction with the Scienlab Charging Discovery System (PHEV, EVSE, OBC).

The Scienlab Regenerative AC Emulator may only be operated in within the current, voltage and power ranges indicated in Section Technical data.

The system is built according to the applicable directives, the latest state of the art, and recognized safety regulations.

NOTICE **The system must only be used in accordance with its intended uses. This is a basic requirement for trouble-free and reliable operation. The system must be in safe condition before it is commissioned.**

Foreseeable misuse

The following in particular shall be deemed to be improper use:

- Any other use than that laid down in Section Intended use and further described in the operating instructions without the written consent of the manufacturer,
- Use, installation, operation, maintenance or repair of kind or manner other than described and by unqualified personnel,
- Use of non-approved, inappropriate accessories,

- Non-compliance with safety and operating instructions, occupational safety and accident prevention regulations or relevant statutory regulations,
- Failure to eliminate faults that may impair safety in a timely manner,
- Use of spare and accessory parts other than the original,
- Operation of the system with incomplete safety devices,
- Operation of the system in explosive areas.

Functional description

The SL1200A serves as a regenerative, bi-directional, 3-phase AC source/sink, with optional DC source/sink. The system can be parameterized in voltage- or current-controlled mode (Voltage Priority or Current Priority). Depending on the respective application, the system was given a compact design with integrated measuring and is available as LV variant (600 V, model SL1201A, SL1202A, SL1203A, SL1214A (LV range), SL1215A (LV range)) or HV variant (1200 V, model SL1212A, SL1213A, SL1214A (HV range), SL1215A (HV range)) variant.

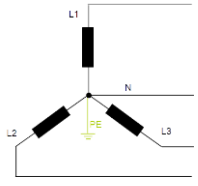
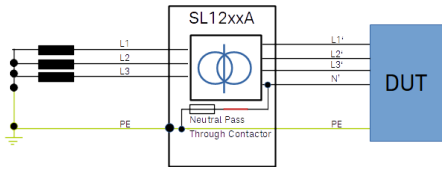
The SL1200A consists of up to six power stages (RPS – regenerative power system), there are three different types of power stages:

- Single range low voltage: 600 V AC, optional 500 V DC,
- Single range high voltage: 1200 V AC, optional 1000 V DC, and
- Dual range:
  - low voltage: 600 V AC, optional 500 V DC,
  - high voltage: 1200V AC, optional 1000 C DC.

The power stages can be parametrized and used individually or together with each other. Thus, various configurations are possible.

In AC mode, the SL1200A is operated with a sinusoidal AC voltage output and an adjustable fundamental frequency of 40 to 75 Hz (Voltage Priority). If the SL1200A is configured in Current Priority mode, the power stage synchronizes with the voltage measured at the terminals and regulates the specified (positive or negative) current. To emulate different output grid forms, the output side neutral point can be set to PE.

The following table shows examples for AC grid emulations[2].

Grid Form	Description Grid / Example AC mode	Connection SL12xxA to DUT
	PE reference Neutral Pass Through Contactor: closed TN/TT grid[3]	

[2] For 5-wire SL1200A models, neutral pass through contactor passes the 'N' phase from the Grid to the output 'N' of the SL1200A system instead of the 'PE' connection as shown below.
[3] TN/TT grid: The generated phases have a potential reference to grounding (PE).
IT grid: The generated phases are electrically isolated from grounding (PE).

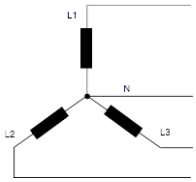
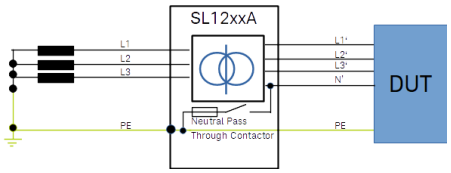
Grid Form	Description Grid / Example AC mode	Connection SL12xxA to DUT
	Without PE reference Neutral Pass Through Contactor: opened IT grid[3]	

Table 2: Examples for emulated AC grids

Equipped with an optional DC mode, the SL1200A can be operated as a DC voltage / DC current source. If, for example, a charging station is tested, the system can be used to emulate the HV battery in the vehicle (Voltage Priority). If, instead, the vehicle with a battery is tested, the SL1200A can emulate a DC charging station (Current Priority). If a battery is connected to the SL1200A, the battery must be monitored by a battery management system (BMS). The DC outputs are always electrically isolated against ground (PE).

To test the DUT to mains fluctuations, the SL1200A emulates electrical supply grids with different harmonics and interharmonics. Harmonics can be generated in Voltage Priority or Current Priority modes. The SL1200A can measure and control 50 harmonics and additionally control two free frequencies for interharmonics. The limits are based on the requirements of the standards EN61000-2-2 and EN61000-4-13 as well as UL2231-2.

The system features two separate current paths, the power path and the logic path. The main switch disconnects the output stages and the contactor circuit from the mains via the power path. In the event of an emergency stop, the main switch switches the output to a safe condition.

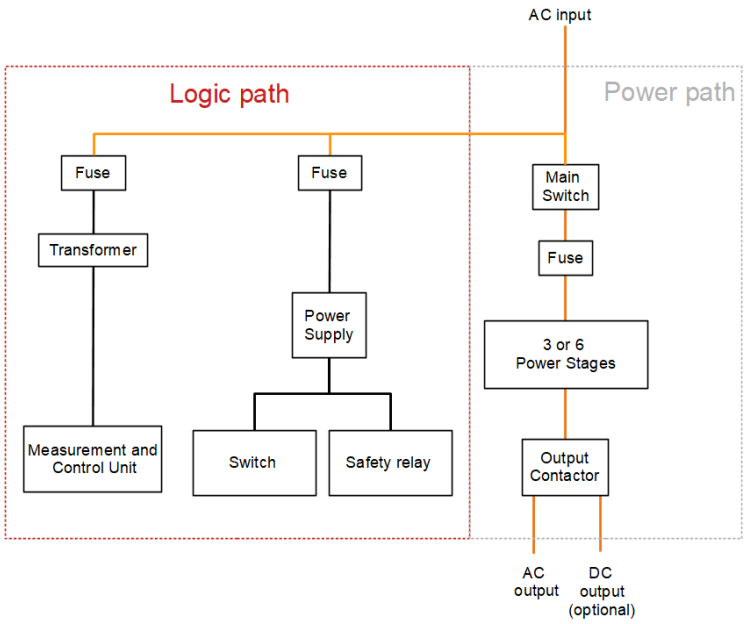


Figure 1: Two current paths of SL1200A

When the system is switched off via the main switch, some components are not switched off. All components connected in the logic chain (e. g. measurement and control unit (MCU), switch and safety relay) continue to be supplied with voltage (lines marked orange). This means that communication between the system and operating software is maintained even in the event of an emergency stop. When the logic path is switched off, the power path cannot be switched on.

Optionally, the system is equipped with an extended safety device (Increased Safety function, - ST2/SD2 option). Before the system can be switched on via the main switch, the safety relay checks all safety-relevant switching components of the system after the circuit breaker (1Q3) is switched on. The system can only be switched on via the main switch after a positive check.

Via the customer interface, the system can be configured as either a 1- to 3-phase AC source/sink or a DC source/sink (DC optional, -SDC option). Channel switchover between AC and DC operation may only be performed in load-free state. AC and DC operation use separate terminal blocks (DC terminals only on -SDC option) (see documentation Getting Started Guide).

Regenerative operation

Regenerative operation is automatic and requires no programming on the part of the user. Whenever the SL1200A system is sinking current, either by rapidly down programming the output, or by discharging an energy source such as a battery, the system will direct the excess power back to the AC mains. You cannot disable the regenerative operation.

During regenerative operation, the power factor of 0.99 is maintained. Sine-wave current distortion is less than 2% at full load. This ensures the quality of the AC signal that is returned to the AC mains.

When an AC mains dropout is sensed, galvanic relays disconnect the AC mains and the unit shuts down. To safeguard your device under test, the SL1200A system provides “anti-islanding” that senses that the grid is live before regenerating power back to the grid.

Refer to Chapter 3, Section AC Mains Considerations for additional information about unit shutdown and restart.

System arrangement

The SL1200A consists of two rack variants with three or six power stages; both rack variants are available as low-voltage and high-voltage, single or dual range. The low voltage variants SL1201A, SL1202A, SL1203A (single range) are designed with an output voltage of up to 600 V, an output current of up to 125 A, and an output power of up to 90 kW. The high-voltage variants SL1212A, SL1213A (single range), however, provide an output voltage of up to 1,200 V, an output current of up to 65 A, and an output power of up to

90 kW. The dual range voltage variants, SL1214A and SL1215A, can be switched to provide up to either 600 V at an output current up to 130 A, or 1200 V at an output current up to 65 A.

Communication to both a control computer and the parallel-connected systems is ensured by Ethernet interfaces.

Internal fans are responsible for cooling the interior of the system. These are integrated into each individual power stage. Ventilation slots for discharging the exhaust air are located at the rear of the system.

All essential connections are also located on the rear side of the system, as shown in the following image.

Depending on the specification and function, following models are available:

- STD – Standard Cabinet
- SDC – Standard Cabinet with DC power source
- ST2 – Standard Cabinet with Increased Safety
- SD2 – Standard Cabinet with DC power source and Increased Safety

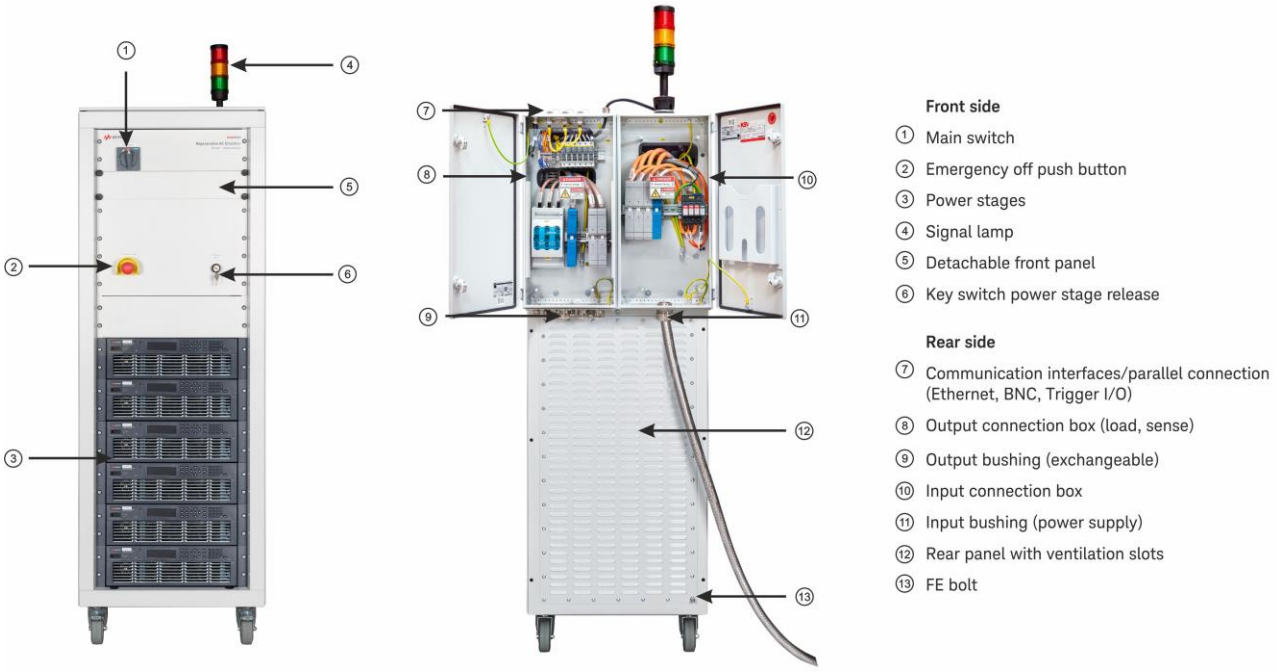


Figure 2: System arrangement Scienlab Regenerative AC Emulator (left front side, right rear side) (illustration similar)

Technical Data

System data and models

System data			
System designation	Scienlab Regenerative AC Emulator		
Model options	SL1200A series	-STD	Standard Cabinet
		-SDC	Standard Cabinet with DC power source
		-ST2	Standard Cabinet with Increased Safety
		-SD2	Standard Cabinet with DC power source and Increased Safety

Model number		Dimension rack (H x W x D)	Max. weight
SL1201A	AC power source, 30 kW, 600 V, 63 A	1265 x 605 x 1050 mm	350 kg
SL1202A	AC power source, 45 kW, 600 V, 63 A	1265 x 605 x 1050 mm	350 kg
SL1203A	AC power source, 90 kW, 600 V, 125 A	1665 x 605 x 1050 mm	500 kg
SL1212A	AC power source, 45 kW, 1200 V, 32.5 A	1265 x 605 x 1050 mm	350 kg
SL1213A	AC power source, 90 kW, 1200 V, 65 A	1665 x 605 x 1050 mm	500 kg
SL1214A (switchable)	AC power source, 45 kW, 600 V, 65 A or AC power source, 45 kW, 1200 V, 32.5 A	1265 x 605 x 1020 mm	350 kg
SL1215A (switchable)	AC power source, 90 kW, 600 V, 130 A or AC power source, 90 kW, 1200 V, 65 A	1665 x 605 x 1020 mm	500 kg

Height signal pillar	450 mm, variably positionable
Number of Units in Parallel	up to 9 systems
Overvoltage category	III
Contamination level	2
Systems heat dissipation	appr. 15% of output max. power
Protection class	IP20; Type 1 Enclosure (UL50E)
Operating conditions	
Operating temperature	0 °C to +40 °C
Storage temperature	-25 °C to +55 °C
Relative humidity	< 95% (non-condensing)
Noise level	<85 dB(A) at a distance of 1 m from the front
Maximum operating altitude	2.000 m AMSL
Communication interface	
To control PC, for parallel connection of various Scienlab Regenerative AC Emulators	Ethernet LAN

In the following, a distinction is made in the technical data between specifications and supplemental characteristics. Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 40 °C after a 30-minute warm-up period. Specifications apply at the output terminals, with the sense terminals connected to the output terminals (local sensing). Supplemental characteristics are not warranted but are descriptions of performance determined either by design or by type testing. Supplemental characteristics are typical unless otherwise noted.

AC and DC Input Rating

AC / DC Input Rating	30 kW power stage	45 kW power stage	90 kW power stage
Power supply	3~, PE, 380 to 480 V AC (±10 %), 50 or 60 Hz (±2 %)		
Input power	34.5 kVA / 45.5 kVA DC	51.75 kVA / 68 kVA DC	103.5 kVA / 137 kVA DC
AC mode	Input current In / Mains supply protection provided on site (values recommendation for EU; consider country-specific standards)		
@380 V grid	53 A / 63 A gG	79 A / 80 A gG	156 A / 160 A gG
@400 V grid	50 A / 63 A gG	75 A / 80 A gG	149 A / 160 A gG
@480 V grid	42 A / 63 A gG	63 A / 80 A gG	124 A / 125 A gG
DC mode (optional)	Input current In / Mains supply protection provided on site (values recommendation for EU; consider country-specific standards)		
@380 V grid	70 A / 80 A gG	105 A / 125 A gG	210 A / 224 A gG
@400 V grid	66 A / 80 A gG	99 A/ 125 A gG	198 A / 224 A gG
@480 V grid	55 A / 63 A gG	83 A/ 100 A gG	166 A / 200 A gG
Supplemental Characteristics			
Efficiency @ max. power	87.7%		

AC Output Rating – AC mode

AC Output Rating		SL1201A	SL1202A	SL1203A	SL1212A	SL1213A	SL1214A LV or HV range	SL1215A LV or HV range
Output cable length		10 m						
Specifications								
Voltage range (rms)[4]		0 to 600 V_{L-L}, 0 to 346 V_{L-N}			0 to 1200 V_{L-L}, 0 to 692 V_{L-N}		LV: 0 to 600 V_{L-L}, 0 to 346 V_{L-N} HV: 0 to 1200 V_{L-L}, 0 to 692 V_{L-N}	
Output phase		L1, L2, L3, N, PE						
~ Configuration		1-phase, 2-phase, 3-phase 1-phase@3xpower, connected outside in parallel						
Max. current (autoranging) rms[5]		63 A	63 A	125 A	32.5 A	65 A	LV: 65 A HV: 32.5 A	LV: 130 A HV: 65 A
Current @ max. voltage[5]		28.9 A	43.3 A	86.6 A	21.6 A	43.2 A	LV: 43.3 A HV: 21.6 A	LV: 86.6 A HV: 43.2 A
Max. current (parallel connection of the load lines at the output) rms[5]		189 A	189 A	375 A	97.5 A	195 A	LV: 195 A HV: 97.5 A	LV: 390 A HV: 195 A
Apparent power	max.	±42 kVA	±66 kVA	±130 kVA	±68 kVA	±135 kVA	LV: ±67.5 kVA HV: ±68 kVA	±135 kVA
	per phase	±14 kVA	±22 kVA	±43.3 kVA	±22.7 kVA	±45 kVA	LV: ±22.5 kVA HV: ±22.7 kVA	±45 kVA
Real power	max.[5]	±30 kW	±45 kW	±90 kW	±45 kW	±90 kW	±45 kW	±90 kW
	per phase	±10 kW	±15 kW	±30 kW	±15 kW	±30 kW	±15 kW	±30 kW
Fundamental frequency		40 to 75 Hz						

[4] regulation limited to rms voltages >45 V_{L-N} when regenerating (sinking) power in current controlled AC modes of operation
[5] Specification valid in single-phase mode

AC Output Rating		
Supplemental Characteristics		
Phase Angle Range	0 to 360 deg	
Voltage Slew Rate	500 V/ms[6]	
Phase Loss/Dropout[7]	≤50 µs	
Crest Factor	up to 3.6	
Leakage Current	test data can be provided on request	
Load regulation	0.25% FS	
Output THD (resistive load)	0.25%	
AC Output Programming	**Accuracy**	**Resolution**
Specifications		
Progr. voltage	0.2% FS[8]	0.1 Vrms
Progr. current	±0.2% ±0.4 A	0.1 Arms
Progr. frequency	±0.01% FS (FS = 75 Hz)	1 mHz
Supplemental Characteristics		
Phase Angle	1.5 deg	0.1 deg
Progr. Frequency Slew Rate	1.79E+308 Hz/s	
AC Measurement	**Accuracy**	**Resolution**
Specifications		
Voltage measurement	±0.15% ±0.25 Vrms	0.01 Vrms
Current measurement	±0.2% ±0.4 Arms	0.1 Arms
Frequency measurement	±0.01% FS	1 mHz
Supplemental Characteristics		
Peak Current Measurement	±0.5 A ±0.5% of reading (<100 Hz)	--
Phase angle measurement	<±2 deg	0.5 deg
Real Power Measurement	±0.2% ±0.1% FS	10 W
Apparent Power Measurement		10 VA
Reactive Power Measurement		10 VAr
Power Factor Measurement	± 0.1% FS	0.01
Energy Measurement	0.153% (working point Urms=230V, Irms=30A) (SL1201A, SL1202A, SL1214A LV Range) 0.213% (working point Urms=230V, Irms=30A) (SL1203A, SL1215A LV Range) 0.155% (working point Urms=230V, Irms=30A) (SL1212A, SL1214A HV Range) 0.185% (working point Urms=230V, Irms=30A) (SL1213A, SL1215A HV Range)	0.001 kWh (For cumulative energy measurements up to 1000 kWh)

[6] Full voltage dropouts at faster speeds (approx. 50 µs) can be achieved using Phase Loss/Dropout (see Getting Started Guide).
[7] Transition speed to any voltage to 0 V
[8] for an output voltage of 15 to 346 V_{L-N} / 26 to 600 V_{L-L} (SL1201A, SL1202A, SL1203A, SL1214A (LV range), SL1215A (LV range)), 15 to 692 V_{L-N} / 26 to 1200 V_{L-L} (SL1212A, SL1213A, SL1214A (HV range), SL1215A (HV range))

DC Output Rating - DC mode (optional)

DC Output Rating		SL1201A	SL1202A	SL1203A	SL1212A	SL1213A	SL1214A LV or HV range	SL1215A LV or HV range
Specifications								
Voltage		±500 V	±500 V	±500 V	±1000 V	±1000 V	LV: ±500 V; HV: ±1000 V	
Current[9]		±180 A	±180 A	±360 A	±90 A	±180 A	LV: ±180 A, HV: ±90 A	LV: ±360 A, HV: ±180 A
Current @ max. voltage[9]		±80 A	±120 A	±240 A	±60 A	±120 A	LV: ±120 A, HV: ±60 A	LV: ±240 A, HV: ±120 A
Power[9]		40 kW	60 kW	120 kW	60 kW	120 kW	60 kW	120 kW
Output phase		DC+, DC-						
Supplemental Characteristics								
Current rise time		<2 ms (10% to 90%)						
Voltage dynamic		500 V/ms (10% to 90%)						
Load regulation		0.25% FS						
DC Output Programming		**SL1201A**	**SL1202A**	**SL1203A**	**SL1212A**	**SL1213A**	**SL1214A LV or HV range**	**SL1215A LV or HV range**
Specifications								
Prog. voltage	accuracy	±0.03% ±75 mV			±0.03% ±150 mV		LV: ±0.03% ±75 mV; HV: ±0.03% ±150 mV	
	resolution	0.1 V						
Prog current	accuracy	±0.03% ±18 mA	±0.03% ±18 mA	±0.03% ±36 mA	±0.03% ±9 mA	±0.03% ±18 mA	LV: ±0.03% ±18 mA HV: ±0.03% ±9 mA	LV: ±0.03% ±36 mA HV: ±0.03% ±18 mA
	resolution	0.1 A						
DC Measurement								
Voltage measurement	accuracy	±0.03% ±75 mV			±0.03% ±150 mV		LV: ±0.03% ±75 mV, HV: ±0.03% ±150 mV	
	resolution	0.1 V						
Current measurement	accuracy	±0.03% ±18 mA	±0.03% ±18 mA	±0.03% ±36 mA	±0.03% 9 mA	±0.03% ±18 mA	LV: ±0.03% ±18 mA HV: ±0.03% 9 mA	LV: ±0.03% ±36 mA HV: ±0.03% ±18 mA
	resolution	0.1 A						

[9] Specification valid in single-phase mode

Harmonics (optional)

Harmonic Synthesis	
Supplemental Characteristics	
Progr. Harmonics and interharmonics	✓
Harmonics voltage injection	up to 50th
Individual voltage harmonic amplitude output accuracy, n=2 to 50	±0.5% ±0.25 V
Individual voltage harmonic phase angle output accuracy, n=2 to 50	0.1° x n ±1°
Harmonics current injection	up to 50th
Individual current harmonic amplitude output accuracy, n=2 to 50	±0.5% ±0.5 A
Individual current harmonic phase angle output accuracy, n=2 to 50	0.1° x n ±1°
Harmonic Measurements	
Supplemental Characteristics	
Voltage/Current THD Measurement	up to 50th
Individual Voltage Harmonic Amplitude Measurement, accuracy n = 2 to 50	±0.5% ±0.25 V
Individual Voltage Harmonic Phase Angle Measurement, accuracy n = 2 to 50	0.1° x n ±1°[10]
Individual Current Harmonic Amplitude Measurement, accuracy n = 2 to 50	±0.5% ±0.5 A
Individual Current Harmonic Phase Angle Measurement, accuracy n = 2 to 50	0.1° x n ±1°[10]
Frequency measurement bandwidth	20 kHz

[10] Measurement of Harmonic Phase Angle when in Current Priority mode requires current flow; 1 A minimum load per phase is recommended.

2 Transport and Installation

⚠ WARNING Risk by obstacles.
Supply disconnecting devices (main switch or emergency stop push button) may not be obscured and must be freely accessible.

- Make sure that the path to the supply disconnecting devices is freely accessible.

⚠ CAUTION Risk of injury!

- It is imperative that personal protective equipment (safety shoes and gloves) is worn when loading and transporting the system.
- The system has a weight of up to 500 kg and should be carefully carried out of the transport box by two persons.

NOTICE At the place of use, approx. 50 cm to the surrounding systems should be maintained so that the exhaust air can escape from the ventilator slots during operation.

NOTICE

- The system must not be thrown during transportation.
- The system must be set down on an even surface.
- The system will be installed in a dust free location.

NOTICE EMC interferences possible!
The Scienlab Regenerative AC Emulator has an increased interference emission level according to CISPR 11 at a rated input power of >20 kW. This can result in interference with third party sensitive radio services in a distance up to 30 m.

- For a rated input power of >20 kW, keep a distance min. 30 m to third party sensitive radio services.

NOTICE Transport and installation work on the system may only be carried out by specially trained personnel (see Qualification of the Personnel).

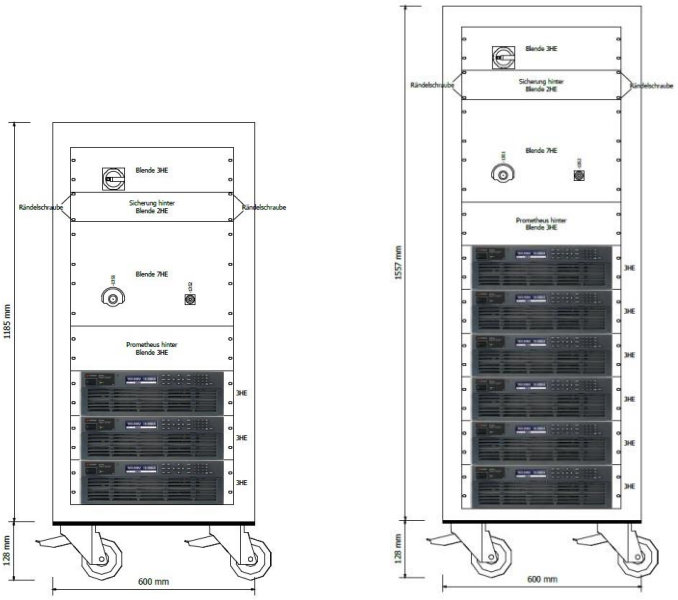


Figure 3: SL1200A with 30/45 kW (left) and 90 kW configuration (exemplary)

Means of transportation

The following means of transport are required for transporting the system:

- Forklift,
- Pallet jack,
- Transport rope for securing the cabinet,
- Anti-slip mats.

Before installation

The location of media connections ought to be observed before installation to ensure easy connection of the system to the building services.

The connections are located on the rear side of the system.

Preparatory measures:

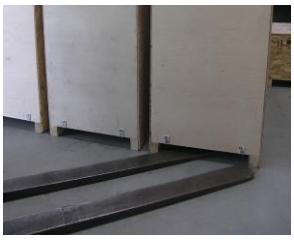
- define the exact place of installation and mark it,
- define the transportation route and remove potential obstacles,
- keep away unauthorized persons from the transportation route. Cordon off the respective areas.

Transporting and unpacking the system

The following steps ought to be respected when transporting and unpacking the system:

Visual check

- Before unpacking, a visual inspection of the packaging and the relevant transport indicators should be carried out.



Transport

- Means of transportation: Forklift, pallet jack
- Set the fork of the width between the transportation box base columns.
- Do carefully enter the forklift into between the base columns.
- Secure Transportation box with transport rope, if necessary.
- Do carefully raise the system only slightly, transport it as closely to the floor as possible and settle the system to the place of installation carefully.

Open the transport box

- Loosen the butterfly fasteners on the side and spring steel clips on the lid of the transport box.

Unpack the system

- Unfold the sides of the transport box and lay them down.
- Remove the transport protection.
- The front should be used as a ramp.
- Release the parking brake on the system.
- Roll the system out of the box.
- The system must be set up on a level surface and moved if necessary.

⚠ CAUTION The system has a weight of up to 500 kg and should be carefully carried out of the transport box by two persons.

Installing the system

The system should be installed in a freely accessible area so that the user has direct access to the supply disconnecting devices in case of an emergency.

Approx. 50 cm to the surrounding systems should be maintained so that the exhaust air can escape from the ventilator slots during operation.

Disposing of the packaging material

The packaging material (wood, foam, cardboard) must be disposed of separately. Observe the country-specific recommendations.

3 Connection and Assembly

DANGER **Danger to life due to high voltages.**
Some components are still supplied with voltage after switching off (wiring color orange).

- Before installation and upkeep, turn off and lock out all external voltage supplies.
- Only disconnect or establish electrical connections in a voltage-free condition.
- For models SL1214A and SL1215A, ensure model is in correct voltage range for application before enabling system output.

DANGER **Danger to life if the cover is missing!**
In case of misapplication, missing protective cover can lead to severe injury, burns or death in the event of shock and arc flash.

- Do not remove cover under load and not operate without cover in place.
- After installation and maintenance work, the previously removed protective cover must be replaced.

DANGER **Danger to life if PE connection is interrupted!**
If the PE connection within the system is interrupted, contact can result in large electric shocks.

- A recommendation for the cable cross section for the PE connection can be taken from the Reference Schematic.

WARNING **Danger caused by conductive foreign bodies within the system.**
A risk to life and limb of users or third parties exists if chips end up in the electronics during machining work.

- No conductive foreign bodies may fall into the system or be used in the system.

CAUTION **The safety rules set out in DIN VDE 0105-100:2015-10 must be observed in order to prevent electrical accidents:**

1 Disconnect from the mains.
2 Secure against reconnection.
3 Verify that the system is dead.
4 Carry out earthing and short-circuiting.
5 Provide protection from adjacent live parts.

NOTICE **Assembly, connection, and electrical work on the system may only be carried out by specialist staff and specially trained personnel** (see Qualification of the Operating Personnel).

All essential connection points are located on or in the input and output terminal box at the rear of the SL1200A Scienlab Regenerative AC Emulator.

Figure 4: Connections of the input and output box

Before connection and assembly, all system fuses must be switched off. To do this, remove the front panel, check fuses and switch them off if necessary.

Before commissioning the SL1200A, the following assembly work must be carried out:

- Electrical installation,
- DUT connection,
- Connecting signal lines and control lines.

Electrical installation

NOTE **All cables must be selected according to the maximum current and country-specific standards.**

⚠WARNING **Compliance to all regulations for the operation of and connection to the public grid of energy back-feeding equipment is required.**

- Connections must be made by a qualified electrician who knows about energy back-feeding equipment to ensure that all applicable safety requirements have been applied and all necessary conditions have been met. Knowledge about 3-phase mains circuits and all applicable safety standards and requirements is also required.
- Depending on the installation site, additional mains connection monitoring equipment may be necessary. The energy supplier must be consulted for further regulations and guidelines.

AC mains considerations

Keysight SL1200A Series models have a fully bi-directional three-phase AC input converter, which allows for seamless bi-directional power flow between the AC mains and DC output terminals. In a standard power supply, energy

only flows from the AC to the DC output terminals. In a regenerative power supply, energy also flows from the DC output terminals back to the AC mains whenever the system is sinking current, either from rapid downprogramming of the output or from discharging an energy source such as a battery. This return of energy back to the AC mains is called regenerative operation.

The AC input converter of the SL1200A system employs firmware algorithms to maintain high power factor and low total harmonic distortion across a wide range of operating conditions.

Follow all wiring instructions for the line connection provided in the installation guide.

Several internal protection functions are used to safeguard the system against abnormal line conditions while also preventing AC mains islanding. The following conditions cause the system to shut down:

- If the line voltage is greater than 120% of the highest nominal rating for two line cycles.
- If the line current is greater than 120% of the highest expected line current for about one second.
- If the line frequency shifts more than 2 Hz from the initial line frequency for more than two seconds.
- If a three-cycle line dropout occurs.

The system will automatically reboot if the fault condition is no longer present. The output will remain off after reboot until the operator reinstates the previous settings by a PC software, e.g., SL1200A Soft Front Panel. This behavior is consistent with safe operating procedures.

The following condition will force the output into a protection state and produce a power fail (PF) status flag:

- If the line voltage is less than 85% of the lowest nominal rating for more than one second.

The following condition will prevent the system from turning on:

- If the line frequency is outside the range of 46.5 Hz to 63.5 Hz.

In case of an AC mains power failure, the system will automatically disconnect from the line. This will occur with the system either sourcing or sinking current.

⚠WARNING Although the system already has grid monitoring and disconnects itself from the grid, if necessary, it may be that further steps are necessary. Please contact your local energy supplier for further regulations and guidelines.

Connecting the mains supply (input)

The description of connecting the mains supply is based on the standard version with terminals. Establish the connection in accordance with the pertinent standards and guidelines at the installation location and according to the Reference Schematic. Install supply lines and interfaces in the control cabinet.

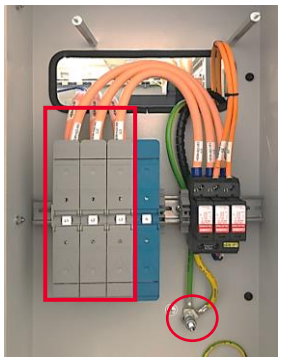
- Prevent tripping hazards due to loosely installed cables.
- Protect cable against damage.

The lines to the mains supply are routed via a terminal box (right-hand side) on the rear of the SL1200A. A clockwise rotating field must be ensured for the order L1, L2, L3. Further electrical details are listed in Chapter 1, Section Technical data.

NOTE To ensure that EMC limit values are adhered to, it is important that the shielding of the EMC cable gland fully surrounds the shielding of the cable.

EMC shield contact

- Cables are routed underneath the terminal box through the EMC screw connections into the system



Mains supply connection (illustration similar)

- Connection at the provided terminals acc. to the Reference Schematic
- Ensure a right-turning rotating field for L1, L2, L3
- N must not be connected (terminal without function)
- Separate bolt for PE
- Ring cable lug connections
- Tightening torque: see Site Preparation & Installation Guide

NOTE The system is equipped with 1 feed-through for multi-wire cables for mains supply (30 kW and 45 kW output stages).
The system has corresponding single feed-throughs for single-wire mains supply cables (90 kW output stages).

NOTE To ensure contact protection and avoid electronic interference, the protective screen must be refitted, and the terminal box door closed after installation of the lines for mains supply.

Housing ground/functional earth

As an additional protective measure, an earth connection has been attached to the SL1200A to reduce and systematically dissipate electromagnetic/electrical interference.

Housing ground/functional earth

- On the rear side of the system
- Connection and coupling of housing ground
- Connection for EMC-compliant design

Establish the connection in accordance with the pertinent standards and guidelines at the installation location and according to the Reference Schematic.

Connection of DUT (device under test) (output)

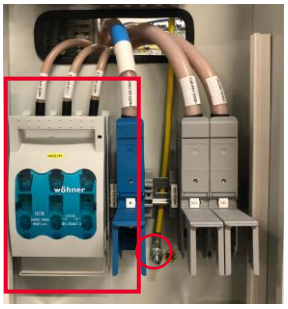
Connection of AC mode

NOTE **To ensure that EMC limit values are adhered to, it is important that the shielding of the EMC cable gland fully surrounds the shielding of the cable.**

Connecting load lines

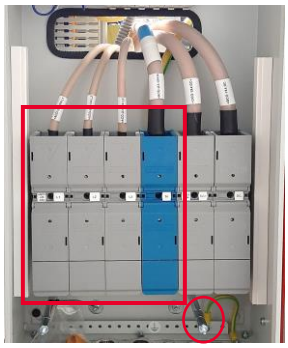
The cables to the load connections and to the voltage measurement of the DUT are routed via a cable gland plate underneath the output box of the SL1200A, and connected via the corresponding terminal strips. The cables must be connected to the DUT.

Refer to the enclosed Reference Schematic diagram for the detailed terminal assignment.



Connection of AC LV load lines (SL1201A, SL1202A, SL1203A)

- Connection according to Reference Schematic of the SL1200A
- From left to right: L1, L2, L3, N
- Separate bolt for PE
- Ring cable lug connections
- **Tightening torque: see Site Preparation & Installation Guide**



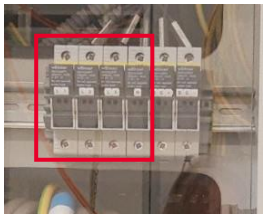
Connection of AC HV load lines (SL1212A, SL1213A)

- Connection according to Reference Schematic of the SL1200A
- From left to right: L1, L2, L3, N
- Separate bolt for PE
- Ring cable lug connections
- **Tightening torque: see Site Preparation & Installation Guide**

Connection of AC LV/HV load lines (SL1214A, SL1215A)

- Connection according to Reference Schematic of the SL1200A
- From left to right: L1, L2, L3, N
- Separate bolt for PE
- Ring cable lug connections
- **Tightening torque: see Site Preparation & Installation Guide**

Connecting sense lines



Connection of sense lines, AC HV + LV

- Connect to the fuses according to Reference Schematic
- Measure DUT voltage Usense
- From left to right: L1, L2, L3, N
- Wire end ferrules

Additional DC mode connection (optional)

The function in DC mode can be added in addition to the AC operating mode. The cables to the load connections and to the voltage measurement of the DUT are routed via a replaceable cable gland plate underneath the output box of the SL1200A, and connected via the corresponding terminal strips.

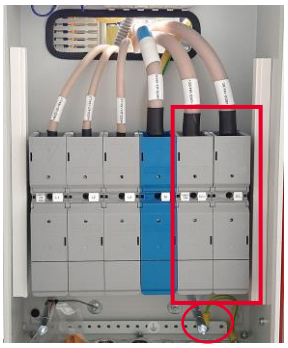
The cables must be connected to the DUT.

Refer to the enclosed Reference Schematic for the detailed terminal assignment.

Connecting load lines

Connection of DC LV load lines (SL1201 – SL1203)

- Connect to the DC+/DC- terminal strip according to Reference Schematic
- From left to right: DC+/DC-
- Separate bolt for PE
- Ring cable lug connections
- **Tightening torque: see Site Preparation & Installation Guide**



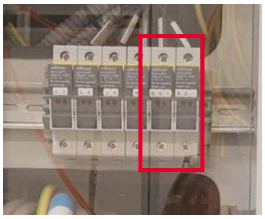
Connection of DC HV load lines (SL1212, SL1213)

- Connection according to Reference Schematic
- From left to right: DC+/DC-
- Separate bolt for PE
- Ring cable lug connections
- **Tightening torque: see Site Preparation & Installation Guide**

Connection of DC LV/HV load lines (SL1214A, SL1215A)

- Connection according to Reference Schematic
- From left to right: DC+/DC-
- Separate bolt for PE
- Ring cable lug connections
- **Tightening torque: see Site Preparation & Installation Guide**

Connecting sense lines



Connection of DC sense lines, HV + LV

- Connect to the fuses according to Reference Schematic
- Measure DUT voltage Usense
- From left to right: DC+/DC-
- Wire end ferrules connections

Using an emulator adapter with a Scienlab Charging Discovery System

If the SL1200A Scienlab Regenerative AC Emulator is used together with a Scienlab Charging Discovery System (CDS: SL1040A-ST2 or SL1047A) for charging technology application, instead of load and sense lines, an emulator adapter is connected to the Scienlab Regenerative AC Emulator, which is permanently installed with the output box and no connection inside the outbox is needed.

Connecting an emulator adapter

In case the emulator adapter is included individually as a component of the in the scope of delivery, the following installation description must be observed.

⚠ DANGER

Danger to life due to high voltages.
Some components are still supplied with voltage after switching off (wiring color orange).

- Before installation and upkeep, turn off and lock out all external voltage supplies.
- Only disconnect or establish electrical connections in a voltage-free condition.
- For models SL1214A and SL1215A, ensure model is in correct voltage range for application before enabling system output.

⚠ DANGER

Danger to life if the cover is missing!
In case of misapplication, missing protective cover can lead to severe injury, burns or death in the event of shock and arc flash.

- Do not remove cover under load and not operate without cover in place.
- After installation and maintenance work, the previously removed protective cover must be replaced.

NOTICE

In case the emulator adapter must be installed to the SL1200A before commissioning:

- Replace the supplied fuses in the connection area of the AC load lines before commissioning.
- Replace the bottom flange plate with the corresponding bottom flange plate for the emulator adapter.
- Replace the connections as described follows.

Emulator adapter

- Example: DC emulator adapter
- DC+, DC-, PE, Pilot1 + 2, LV_PL3 + 4

Labeling the emulator adapter line	Connection to
AC emulator adapter for AC charging	
AC (L1, L2, L3, N)	see Section Connection of AC mode load lines
Pilot 1, Pilot 2	Pin 13b + 14b of Connection emergency stop to CDS (see Table 4 Pin assignment Release and Emergency stop In/Out)
LV_PL3, LV_PL4	Pin 17b + 18b of Connection external release to SL1200A (see Table 4 Pin assignment Release and Emergency stop In/Out)
PE	see Section Connection of AC mode load lines
AC/DC emulator adapter for AC and DC charging (additional connections to AC charging)	
DC+/DC-	See Section Additional DC mode connection

Table 3: Connection of emulator adapter

Parallel connection

NOTICE

Observe identical cable lengths for parallel connection!
To avoid voltage losses to the DUT, the cable lengths between the SL1200A and the defined connection point of the parallel connection (e. g. at the RPT box as in Figure 5) must always be the same.

NOTE

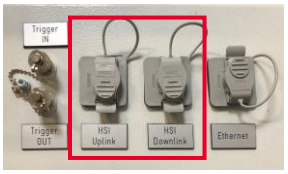
Only systems with identical output voltage & power ratings may be connected in parallel. For example, the following are valid combinations:

- **Up to 9 systems with any combination of models SL1202A, SL1214A in LV range**
- **Up to 9 systems with any combination of models SL1203A SL1215A in LV range**
- **Up to 9 systems with any combination of models SL1212A, SL1214A in HV range**
- **Up to 9 systems with any combination of models SL1213A, SL1215A in HV range**

To connect up to 9 Scienlab Regenerative AC Emulators systems in parallel, the interfaces HSI Uplink and HSI Downlink on the top of the output box are used. For connection, use the RJ45 connectors included in the scope of delivery.

NOTE

For connection, use the RJ45 connectors from Phoenix Contact included in the scope of delivery (type VS-08-RJ45, IP67). For connection the RJ45 connectors, please refer to the supplied assembly instructions.



HSI Uplink / HSI Downlink

- On the top of the Output Box on the rear side
- Ethernet connection ports (use RJ45 connectors)
- For parallel connection director/follower systems (see Figure 5)

The following Figure 5 shows an example for a parallel connection via Remote Power Terminal (RPT).

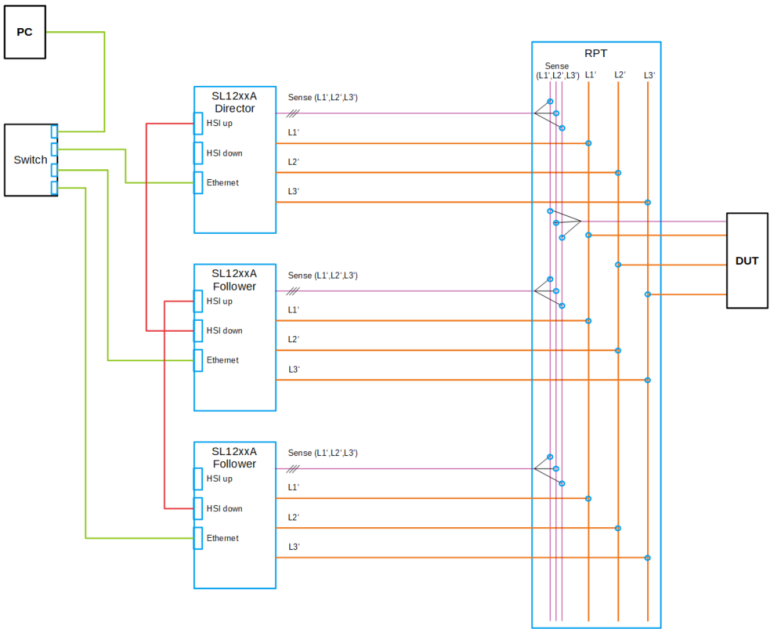


Figure 5: Schematic for parallel connection (connection via remote power terminal (RPT) as an example)

The load and sense lines must be connected in parallel as well.

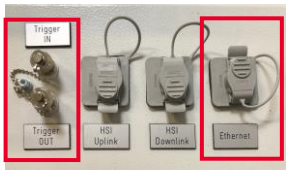
For more information please refer to the help file of the PC software SL1200A Regenerative AC Emulator Soft Front Panel on keysight.com.

Connecting signal and control lines

Communication interfaces

Additional signal and control connections can be found the roof of the output box, on the rear side of the system. Here are communication interfaces (RJ45 sockets) for the connection of an operating computer (Ethernet connection port). For connection, use the RJ45 connectors included in the scope of delivery. Furthermore, there are interfaces (BNC sockets) for trigger input and trigger output signals.

NOTE **For connection, use the RJ45 connectors from Phoenix Contact included in the scope of delivery (type VS-08-RJ45, IP67). For connection the RJ45 connectors, please refer to the supplied assembly instructions.**



Ethernet Interface

- On the top of the Output Box on the rear side
- Communication interface to the operating PC
- Use RJ45 connectors

Trigger In / Out, BNC sockets

- On the top of the Output Box on the rear side
- Freely usable interface (e. g. for external oscilloscope)
- Input: reaction to trigger signals
- Output: sending a trigger signal on specified events

The pin assignment depends on the corresponding system configuration and can be taken from the Reference Schematic.

Connecting higher-level safety technology

If the system is integrated into an overall test bench with other systems, the operator should carry out a risk assessment.

NOTICE

Without prior connection to a higher-level safety system, misuse can result in life-threatening injuries.

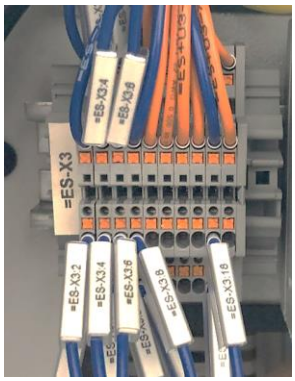
- Keysight recommend first connecting the system to the higher-level safety and emergency stop system of the test bench, before putting it into operation.
- The Keysight emergency stop system in the control cabinet may not be changed or adapted without the consent of Keysight.

The SL1200A provides the option to exchange permanently defined external signals with the superordinate control and safety computer. The terminals for all safety-relevant input/output signals are located in the output box on the rear side of the system. The lines to the terminals are routed via the flange plate into the output box.

The signals are the following:

- External emergency stop,
- External release output contactor,
- Feedback signals neutral path through, AC connectors, DC connectors (increased safety) (optional).

The Reference Schematic defines all available incoming and outgoing signals and the associated terminals.



Connection of external safety signals (illustration similar)

- External test release signal (2-pin)
  OFF: test release withdrawn (output contactors and power stage are blocked)
  ON: test release given, test may be started (e.g. acknowledged by software
- Emergency stop In/Out (2-pin)
- Jumpers have to be removed for connecting external release or emergency stop in/out.
- Connection via the flange plate of the output box according to Reference Schematic
- Option: connection Increased Safety Out

The internal emergency stop chain is designed redundant (2 channels). The following table shows a short description of each connection terminal -X3:

Pin assignment	Description
Channel 1:1b – 3b Channel 2: 2b – 5b	Connection terminals for first external emergency stop push button (2 channels, ex works pre-equipped with jumper)
Channel 1: 4b – 7b Channel 2: 6b – 8b	Connection terminals for second external emergency stop button (2 channels; ex works pre-equipped with jumper)
Channel 1: 9b-10b Channel 2: 11b-12b	Feedback from internal emergency stop push button (2 channels; when using a Scienlab Test Bench Guard for example)
Channel 1: 13b – 14b Channel 2: 15b – 16b	Feedback system status emergency stop (from both the internal and external emergency stop), conditions are as follows: • if the safety relay is off (logic path is off), the feedback contacts of the safety relay are open, • if the safety relay is on and an emergency stop (external or internal) is triggered, the feedback contacts of the safety relay are closed, • if the safety relay is on and an emergency stop (internal or external) is pressed, the feedback contacts of the safety relay are open
17b – 18b	Connection terminals for external release (when using a Scienlab Test Bench Guard for example) (pre-equipped with jumper)
19b – 20b	Feedback from internal key release switch
21b – 26b (optional)	21 – 22: neutral path through 23 - 24: feedback AC contactor (L1') 25 – 26: feedback AC contactor (L2') 27 – 28: feedback AC contactor (L3') 29 – 30: feedback AC contactor (N') 31 – 32: feedback DC contactor (DC+) 33 – 34: feedback DC contactors DC-)

Table 4: Pin assignment Release and Emergency stop In/Out (see Reference Schematic)

The figure below shows the overview of the emergency/safety contact:

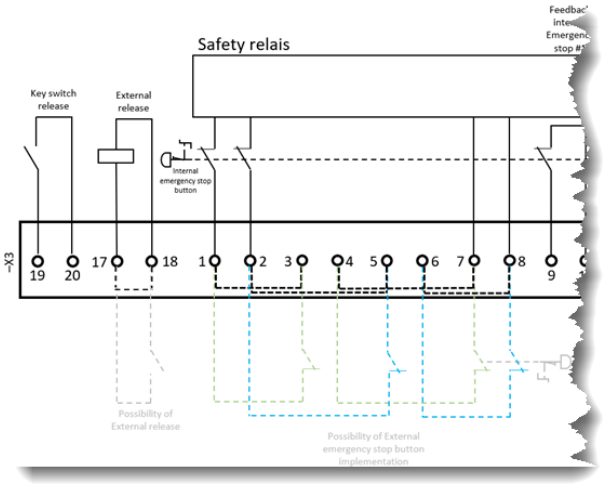


Figure 6: Overview of emergency concept of Scienlab Regenerative AC Emulator (extracted detail terminal -X3)

Connecting signal lamp

The signal lamp is connected to the system with a plug. The socket is located on the roof of the system.

Socket for connecting signal lamp

- Connection socket on the roof of the system
- System checks correct connection of the signal lamp after switching on

4 Commissioning

DANGER

Danger to life in case of misuse at the outputs.
The Scienlab Regenerative AC Emulator does not have its own insulation guard.

- If the system emulates an electrical isolation against PE at the output, the local installation regulations and guidelines must be observed.
- This would be in the case of the emulation of an IT network in AC mode, or generally in DC mode.

WARNING

Danger when changing the location of the system!
The system is movable due to the rollers. When the system is connected, there is a risk of lines being torn off if the system is moved.

- The system must be secured with the parking brake before startup.
- Disconnect the system from the supply voltage when moving it.

CAUTION

Electrical malfunction through moisture condensation!
In case of high fluctuations of temperature, condensate water can be formed. Thus, possible insulation sections cannot be maintained, and the electronics are damaged.

- Before switching on the system, the Scienlab Regenerative AC Emulator acclimatize to the ambient temperature in the operating area (generally between 5 °C and 40 °C) for at least 24 hours.

NOTICE

Hearing protection due to noise exposure in the operating area!

- Noise level <85 dB(A) at a distance of 1 m from the front
- It is recommended to wear hearing protection during operation.

NOTICE

The system may only be switched on and put into operation by specialist staff and specially trained personnel (see Section Qualification of the Operating Personnel).

The following cabling must be completed before commissioning as described in Chapter 3:

- Electrical installations are complete (see Chapter 3 Section Electrical Installation),
- Load and measuring lines are connected with the DUT (see Chapter 3 Section Connection of DUT),

- Signal and control lines are connected (see Chapter 3 Section Connecting Signal Lines and Control Lines),
- All connections and cabling between SL1200A, control computer / Hardware-in-the-Loop (HiL) platform and higher-level safety technology, if available, have been checked,
- the device under test is in a protected environment, in accordance with the safety guidelines, especially regarding protection earthing,
- all necessary enable signals are provided,
- PC software and firmware, available via Keysight Homepage (Software/Firmware), are installed.

Procedure for switching on/off

The SL1200A has got a power path and a logic path.

The system is switched on as follows:

- Turn the circuit breakers switch to I (ON) to activate the logic path,

Transformer circuit breaker for 24 V power supply (=EIN-1Q3) (illustration similar)

- Behind the front panel (detachable)
- Circuit breaker for the circuit of 24 V power supply (logic path) tapped upstream of the main switch
- O OFF: Circuit breaker has triggered → system is inactive; all power and communication connections (logic path) are inactive, switch on via main switch not possible.
- I ON: system can be switched on via main switch.

Transformer circuit breaker for Measurement & Control Unit (MCU) (=EIN-1Q2) (illustration similar)

- Behind the front panel (detachable)
- Circuit breaker for the circuit of MCU (logic path) tapped upstream of the main switch.

- Check that all fuses behind the front panel are switched on,
- Turn the main switch to I (ON) to activate the power path,

Main switch

- On the front side
- I ON: power supply switched on
- O OFF: power supply switched off, communication with the system is maintained
- Trip: when emergency stop is triggered → system switches off, main switch in position Trip
- **Note:** In the O OFF position, the main switch can be locked using a padlock

✓ The SL1200A is switched on and the logic path and power path are active.

The system is shut down as follows:

- Turn the main switch to 0 (OFF).

✓ The SL1200A is in standby/ready mode, the power path is inactive, the logic path is still active.

- Turn both circuit breakers switch to 0 (OFF).

✓ The SL1200A is completely switched off.

Performing initial commissioning

The following activities must be carried out for initial commissioning:

1 Switch on the fuses behind the panel on the front side,
2 Switch on both circuit breaker behind the panel on the front side,
3 Power stages are switched on (ex works setting),
4 Release emergency stop push button,
5 Perform visual and functional check of additional safety equipment (see Section Safety and Monitoring Equipment, page 9 ff.)
6 External emergency off function is released, if applicable (pre-equipped with jumper/bridge)

✓ The logic path of the SL1200A is active and communication with the system is established.

7 Main switch should start in position I (ON)
→ the system starts up,
→ when the power stages are ready to use, the green light on the power stages light up permanently,
8 Release key switch set to ON (position right),
9 External release function is released, if applicable (pre-equipped with jumper/bridge).

✓ Provided the ambient conditions are right, the SL1200A is operational after a start-up period of 2 minutes, after a warm-up period of 30 minutes, the system meets the specifications (see Chapter 1, Section Technical Data).

Recommissioning

After prolonged storage, the same steps as performed for initial commissioning are required, see Section Performing Initial Commissioning.

5 Action in an Emergency

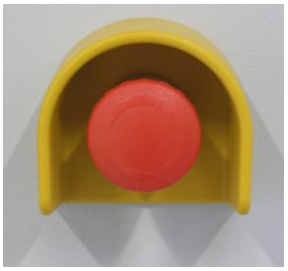
NOTICE **In the event of an emergency, the system may only be switched on and recommissioned by specially trained personnel** (see Qualification of the Operating Personnel).

In case of emergency, please carry out the described steps and inform the local KeysightCare department:

Contact KeysightCare	
Keysight Technologies Technical Support	www.keysight.com/find/keysightcare-contact

Control elements for switch-off

The following control elements are installed on the system for switching off and shutting down the system in an emergency:



Emergency stop push button

- On the front side
- Press: forces local emergency stop of the system (Responds: see safety relay)
- Turn counter-clockwise: unlocks

Main switch

- On the front side
- I ON: power supply switched on
- O OFF: power supply switched off, communication with the system is maintained
- Trip: when emergency stop is triggered → system switches off, main switch in position Trip
- **Note:** In the O OFF position, the main switch can be locked using a padlock

Transformer circuit breaker for 24 V power supply (=EIN-1Q3)
(illustration similar)

- Behind the front panel (detachable)
- Circuit breaker for the circuit of 24 V power supply (logic path) tapped upstream of the main switch
- O OFF: Circuit breaker has triggered → system is inactive; all power and communication connections (logic path) are inactive, switch on via main switch not possible.
- I ON: system can be switched on via main switch

Transformer circuit breaker for Measurement & Control Unit (MCU) (=EIN-1Q2) (illustration similar)

- Behind the front panel (detachable)
- Circuit breaker for the circuit of MCU (logic path) tapped upstream of the main switch

Switching off in an emergency

In an emergency, the supply of electrical energy must be switched off for the whole system or part of the installation if there is a risk of electric shock or any other risk caused by electricity.

Besides the controlled switching off of the SL1200A, it is also possible to switch it off immediately in an emergency.

The following steps result in the immediate switching off or shutdown of the SL1200A:

- Press the emergency stop push button on the SL1200A, or
- Emergency stop via external signal of the higher-level safety equipment, if necessary

✓ The power supply of the power path is switched off.

NOTICE

Before switching the system on again after an emergency switch-off:

- Determine the cause for the emergency switch-off.
- Eliminate the causes.
- Observe the note on switching the system back on.

NOTICE

Switching the system back on!
If the main switch is set to “Trip” due to activation of the emergency stop (undervoltage triggering)

1 Before switching the system on again, set the main switch to “OFF”.
2 Only then set the main switch to “ON” to switch back on.

6 Troubleshooting and Fault Elimination

⚠ CAUTION **The safety rules set out in DIN VDE 0105-100:2015-10 must be observed in order to prevent electrical accidents:**

1 Disconnect from the mains.
2 Secure against reconnection.
3 Verify that the system is dead.
4 Carry out earthing and short-circuiting.
5 Provide protection from adjacent live parts.

NOTICE **Troubleshooting and fault elimination may only be carried out by specially trained personnel** (see Qualification of the Operating Personnel).

The following overview provides information about faults, their causes and remedies.

If an overload or a fault current interruption occurs or if a fault condition exists:

- Notify trained service personnel.
- If necessary, notify KeysightCare.

Contact KeysightCare	
Keysight Technologies Technical Support	www.keysight.com/find/keysightcare-contact

Fault message via the PC software

If the signal lamp or PC software SL1200A Regenerative AC Emulator Soft Front Panel (SFP) report an error, the error description can be read out via the PC software.

NOTE In parallel operation (up to 9 systems), in the event of a fault, the director and all follower up to the system with the fault switch into failure status (signal lamp red light). All other systems switch to the standby/ready status (signal lamp green light).

System cannot be switched on

The system does not switch on:

Possible causes	Remedy
No supply voltage present	Switch on the building supply voltage
Emergency stop push button pressed	Release emergency stop push button

Possible causes	Remedy
Signal via higher-level emergency stop/release	Check laboratory safety technology
Circuit breakers not switched on	Remove front panel, switch to ON
Fuse has tripped	Switch fuse on after opening the panel; reattach panel afterwards
Not properly wired external emergency/release in/out	Check wiring inside the SL1200A
Connectivity problem	Check cabling
Option Increased Safety is available: connectors defect	Contact KeysightCare

Table 5: Possible cause and remedy

Test cannot be started

Possible causes	Remedy
Signal lamp not properly connected	Check correct connection of plug
Key switch Release switch is set to OFF	Turn key switch to ON
External Release not properly connected	Check connection

Table 6: Possible cause and remedy

System switches off by itself

Possible causes	Remedy
In the event of a voltage drop, the undervoltage release is activated	If the main switch is set to “Trip” 1 Before switching the system on again, set the main switch to “OFF”. 2 Only then set the main switch to “ON” to switch back on.
External or internal emergency stop switch is pressed	1 Unlock emergency-stop push button, If the main switch is set to “Trip” 2 Before switching the system on again, set the main switch to “OFF”. 3 Only then set the main switch to “ON” to switch back on.
Output-side earth faults -> fuse (=ACO-1F1) between PE and N‘ tripped	Check and eliminate output-side earth fault

Table 7: Possible cause and remedy

Tripping of the surge protection

DANGER

Danger to life due to high voltages.
Some components are still supplied with voltage after switching off (wiring color orange).

- Before installation and upkeep, turn off and lock out all external voltage supplies.
- Only disconnect or establish electrical connections in a voltage-free condition.
- For models SL1214A and SL1215A, ensure model is in correct voltage range for application before enabling system output.

DANGER

Danger to life due to missing covers!
In case of misapplication, missing protective cover can lead to severe injury, burns or death in the event of shock and arc flash.

- Do not remove cover under load and not operate without cover in place.
- After installation and upkeep, the previously removed protective cover must be replaced.

If the surge protection trips, the plugs must be replaced. Please contact KeysightCare in advance.

Replace the defective plug as follows:

1 Switch off the system and lock out all external voltage supplies.
2 Check that the electrical inputs are in a voltage-free condition.
3 Open the right door of the Input Box on the rear side of the system.
4 Remove the protective cover.
5 Exchange the defect surge protection plugs.
6 Replace the previously removed protective cover and close the door of the Input Box.
7 Reset the main switch.

✓ After a renewed commissioning (see Chapter 4, Section Performing initial commissioning) the system is ready for operation.

Surge protection

- Inside the Input Box on the rear side
- Responds in the event of overvoltage (e. g. due to lightning)
- Reaction: Feedback signal is detected → undervoltage monitoring reacts → the main switch cannot be activated (falls back to position Trip
- Consequence: Surge protection inlets must be changed; feedback contact is reset

NOTICE

Switching the system back on!
If the main switch is set to “Trip” due to activation of the emergency stop (undervoltage triggering)

1 Before switching the system on again, set the main switch to “OFF”.
2 Only then set the main switch to “ON” to switch back on.

7 Upkeep and Inspection

NOTICE **Upkeep and inspection of the system may only be carried out by specially trained personnel** (see Section Qualification of the Personnel).

The SL1200A Scienlab Regenerative AC Emulator is largely maintenance free. A proper upkeep helps to ensure trouble-free and safe operation of the system. It consists of preventive maintenance and, if necessary, corrective maintenance[11].

Unless otherwise agreed, preventive maintenance is carried out by the operator of the system. It includes regular visual and functional inspections. The steps involved are described below.

If defects are detected during the inspection that require repair, this is carried out as corrective maintenance by the manufacturer. For this purpose, please contact KeysightCare:

Contact KeysightCare	
Keysight Technologies Technical Support	www.keysight.com/find/keysightcare-contact

General instructions for upkeep

⚠ DANGER **Danger to life due to high voltages.**
Some components are still supplied with voltage after switching off (wiring color orange).

- Before installation and upkeep, turn off and lock out all external voltage supplies.
- Only disconnect or establish electrical connections in a voltage-free condition.
- For models SL1214A and SL1215A, ensure model is in correct voltage range for application before enabling system output.

⚠ DANGER **Danger to life due to missing protective covers!**
Missing protective covers may result in serious injury, burns, or death from electric shock in case of misuse.

- Do not remove protective covers under load or without switching off the system first.
- Replace the protective covers following the assembly and upkeep work.

⚠ DANGER **Residual voltage after switch-off.**
In case of connected DUT, the output terminals can still carry voltages even after switch-off of the system!

- Measure the voltage at the outputs to ensure that they are voltage-free.

[11] cf. DIN EN 13306, IEC 60050

⚠ CAUTION **The safety rules set out in DIN VDE 0105-100:2015-10 must be observed in order to prevent electrical accidents:**

1 Disconnect from the mains.
2 Secure against reconnection.
3 Verify that the system is dead.
4 Carry out earthing and short-circuiting.
5 Provide protection from adjacent live parts.

NOTICE Some of the described inspection work depends to a large extent on the use and ambient conditions. The inspection intervals must be adapted to the actual requirements on a case-by-case basis.

Carrying out inspection work

System inspection should be carried out in compliance with the general safety notes as follows:

1 Switch off system by using the main switch 0 (OFF),
2 Secure against being switched on again,
3 Open front panel and switch off both circuit breaker,
4 Disconnect system from mains supply and communication,
5 Measure the voltage at the output and terminals to ensure that they are de-energized,
6 Carry out inspection in accordance with the following tables:

Inspection	Test interval
General visual check of the components and wiring system	annually, before each commissioning
Cleaning the system (see section Cleaning the system)	

Table 8: Inspection works voltage-free

7 Switch on both circuit breaker and close the front panel,
8 Switch on the system at the main switch I (ON),

Inspection	Test interval
Functional check of the emergency off device	monthly
Option Increased Safety: Functional check of circuit breaker (1Q3)	monthly recommended
Check for available software and firmware updates	Twice a year
Visual inspection of signal lamp	Annually

Inspection	Test interval
Check noise generation of the fan of power stages	Annually

Table 9: Inspection works when switched on

9 If defects were found during inspection, contact the KeysightCare; check the display elements after completing the correction of defects.

Cleaning the system

Only use a dry, clean and lint-free cleaning cloth to clean the surface of the system. Do not use any abrasive or flammable cleaning agents.

Cleaning must be carried out in consideration of the above-mentioned safety notes as follows:

1 Switch off system by using the main switch 0 (OFF),
2 Disconnect system from mains supply and communication,
3 Measure the voltage at the output and terminals to ensure that they are de-energized,
4 Wipe the housing, display modules and front panels with a dry, clean and lint-free cleaning cloth.

8 Decommissioning

Temporary decommissioning

1 Switch off system and attached module assemblies, see Chapter 4,Section Procedure for switching on/off,
2 Carrying out inspection and cleaning the system, see Chapter 7,Section Carrying out Inspection Work.

NOTICE After a temporary decommissioning, commissioning must be performed again, see Chapter 4 Commissioning.

Storage conditions

The ambient conditions as per the Technical Data in Chapter 1 must be observed for short- and medium-term storage (up to 2 years).

Dismantling, final decommissioning

1 Switch off system,
2 Disconnect the power supply to the system and roll up supply cables and fix them securely on the system.
3 Disconnect all further lines (signal and control lines, load and measuring lines) and roll up the cables.

Disassemble and decommission the system by performing the steps in reverse order. All system parts must be disposed of professionally.

Edition 3.1, January 2024
www.keysight.com