

SL1200A Series

Scienlab Regenerative AC / Grid Emulator, 3-phase (3 Φ)

SL1201A 346V_{L-N} / 600 V_{L-L}, 63 A, 30 kW / 42 kVA
SL1202A 346V_{L-N} / 600 V_{L-L}, 63 A, 45 kW / 66 kVA
SL1203A 346V_{L-N} / 600 V_{L-L}, 125 A, 90 kW / 130 kVA
SL1212A 692 V_{L-N} / 1200 V_{L-L}, 32.5 A, 45 kW / 68 kVA
SL1213A 692 V_{L-N} / 1200 V_{L-L}, 65 A, 90 kW / 135 kVA

SL1200A Software Front Panel (SFP)
KS8400B PathWave Test Automation
SL1220A AC / Grid Test Sequencing Plugin



SL1213A 90 kW / 135 kVA

Introduction

Today's energy/grid infrastructure is changing and growing rapidly. Variable renewable energy (VRE) and inverter-based distributed energy resources (DERs) in the form of solar, wind, and battery storage are the dominant theme in global grid modernization initiatives. Within the automotive industry, the electrification of vehicles is expected to create significant demand on the grid for charging, while also expanding the opportunity for energy storage through vehicle-to-grid (V2G) power applications.

As the energy mix intensifies, so does the challenge of managing the way we produce, distribute, and consume electricity. "Smart" inverters with grid support functionality have emerged as a key enabler to overcoming such challenges. As a result, inverter manufacturers are required to adhere to a specific set of grid compliance/interconnection standards that necessitate the need for extensive test. To test, grid emulation equipment is required.

DERs are also moving to higher output voltages to reduce losses and costs, moving from 600 to 800 VAC, and potentially up to 1000 VAC in the future (IEC-LV directive allows up to 1000 VAC). The goal of higher voltages combined with the requirement to provide grid support functions, such as high-voltage ride-through (HVRT), creates the need to test to even higher than the 1000 VAC limit.

To achieve the high voltages needed to test new inverter/control designs, inverter engineers often must either connect multiple power supplies in series or use an external transformer. This leads to costly, complex test setups with an inability to easily expand, along with reduced performance, wasted space, and other additional downsides.

Achieve high voltage without addition of large, expensive transformer

The SL1200A series was designed to handle all your AC / grid test needs up to 1200 VAC, from 30 kW / 66 kVA to 810 kW / 1.2 MVA¹ without the need for a transformer. Two voltage ranges are available: 600 VAC and 1200 VAC. The 600 VAC models are ideal for low voltage inverter test as well as EV and EVSE charging test applications. The 1200 VAC models allow for (HVRT) testing at the IEC LV-AC limit without the need for a large, complex test setup.



Reduce system costs, complexity and space with direct output up to 1200 VAC.

No transformer!

Decrease your time to market with easy-to-use software for automating grid conformance standard test.



¹ Parallel up to nine (9) to achieve up to 810 kW / 1.2 MVA (± 1.08 MWDC).

Key features of the SL1200A three-phase AC emulator

- High-Power AC (1, 2, or 3 Φ) and DC² power source
- Up to 1200 V_{L-L} (± 1000 V_{DC}) is achieved at full specifications without a transformer.
- Up to 1125 Arms (± 3240 A_{DC}); up to 810 kW / 1.2 MVA with simple connection of nine units in parallel.
- Test to standards, such as IEC 61000, UL 1741 SB, IEEE 1547-2018 / 1547.1-2020, GB/T 37408, etc.
- 100% regenerative, bidirectional power solution with CV and CC modes, standard on all models.
- Get up and running immediately with intuitive soft front panel (SFP) and test sequencing software³.
- A complete, one-vendor solution of hardware, software, consulting, and support services worldwide for all grid-edge applications, such as EVSE / EV charging test, solar / PV inverter test, battery energy storage system test.

Harmonics and Interharmonics

The SL1200A series has the capability of injecting and measuring even and odd harmonics and interharmonics up to the 50th order. With programming accuracy of 0.01% and measurement accuracy of ± 0.05 Hz, harmonics and interharmonics can be injected as well as measured accurately, eliminating the need for an external power analyzer in most cases. A Software Front Panel (SFP) is included standard, making creation and measurement of harmonics for the SL1200A quick and easy.

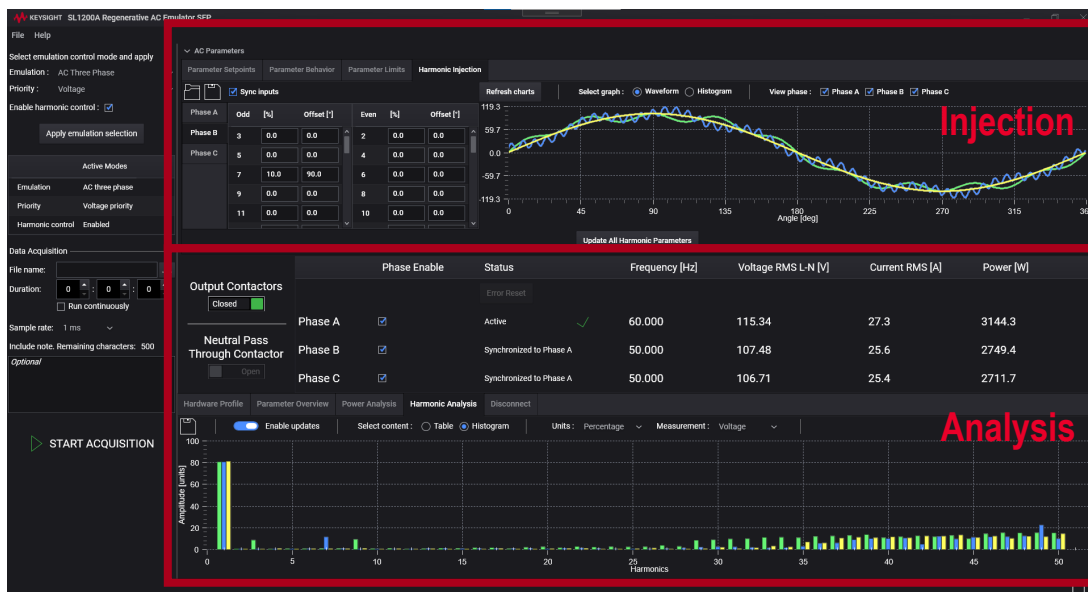


Figure 1. SL1200A Software Front Panel – Harmonics injection and analysis tab.

² For DC operation, option SDC hardware is required.

³ SL1200A SFP is included free; KS8400B and SL1220A Test Sequencer require licenses after free trial.

Simplified Test Automation of Standards

KS8400B PathWave Test Automation provides powerful, flexible, and extensible test sequencing and test plan creation with additional capabilities that optimize your test software development and overall performance. The SL1220A AC / Grid Test Sequencer plugin provides a SL1200A test control library with pre-programmed grid transients for the KS8400B, from which test sequences can easily be developed to automate standards, such as:

| | | | | |
|------------|---------------|------------|---------------|----------|
| IEEE 1547 | AS/NZS 4777.2 | GB/T 37408 | VDE-AR-N 4105 | CEI 0-16 |
| UL 1741 SB | G98/G99 | GB/T 36547 | VDE-AR-N 4110 | CEI 0-21 |

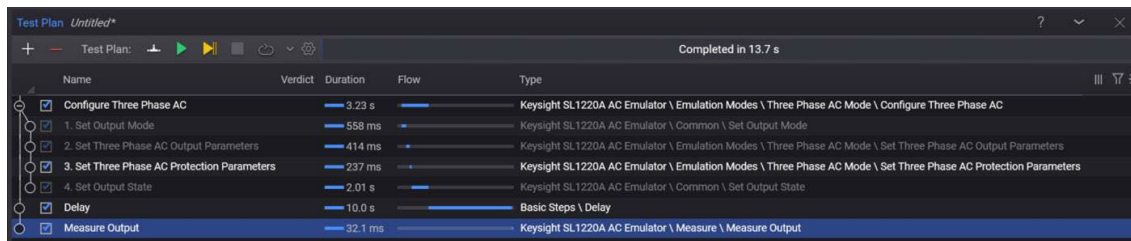


Figure 2. SL1220A Plugin running a test sequence.

Balancing Real Power and Reactive Power Capability

Grid test standards require the grid emulator to source or load reactive power; power factor (PF) < 1. For example, IEEE 1547.1-2020 states the need for PF = 0.9. This makes maximum Apparent Power a key specification of a grid emulator. However, most standards tests are performed at PF = 1 making maximum Real Power an even more important specification. The ideal grid emulator provides as much real power (power density) as possible, with sufficient apparent power to provide for sourcing / loading with power factors < 1.

It is also clear from the definition of power factor,

$$PF = \text{Real Power (kW)} / \text{Apparent Power (kVA)},$$

the maximum Apparent Power of a grid emulator can't be provided at PF = 1 (see left graph in Figure 3). Keysight can provide graphs, such as Figure 3 below, to show the relationship between voltage, current, PF, kVA, and kW, enabling a clear understanding of the capabilities of the SL1200A.

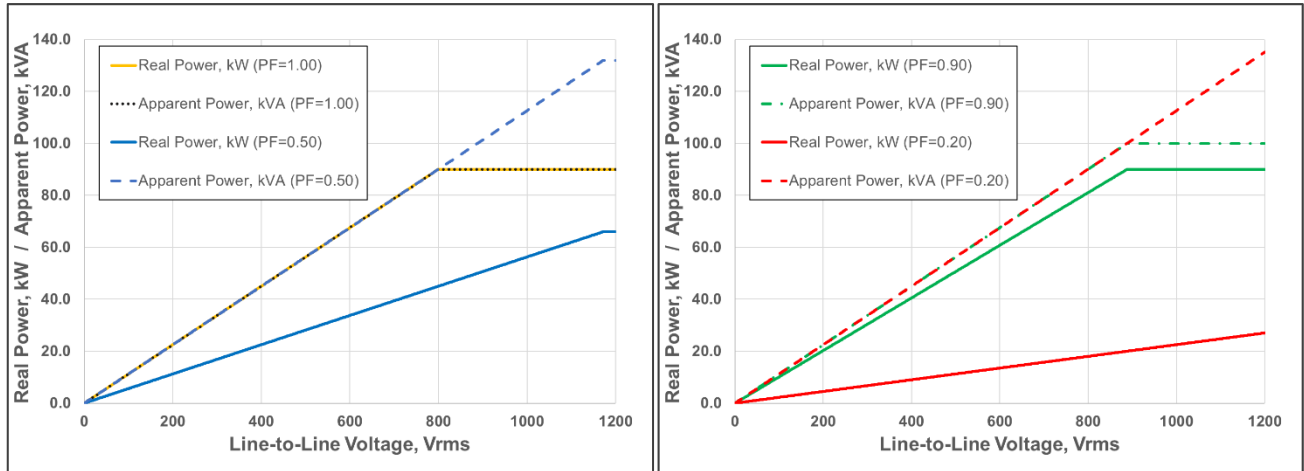


Figure 3. Operating voltage vs. real and apparent power by power factor for one (1) SL1213A4.

Test Flexibility: High-Power DC Operation and Paralleling

Paralleling (and de-paralleling)

Up to nine (9) SL1200As of the same model number can be arranged in parallel to achieve higher power up to 810 kW / 1.2 MVA (1.08 MW_{DC} with Option SDC) using a simple output combiner box and one cable for communication between the director and each follower. SL1200A units can be easily paralleled and “de-paralleled” as many times as necessary to meet the needs of your current application. Adding DC operation provides even more flexibility.

High-Power DC operation up to ± 1.08 MW with paralleling and option SDC

Option SDC provides the additional hardware necessary to operate the SL1200A as a high-power, regenerative (bidirectional, 4-quadrant) DC power supply / electronic load up to ± 1.08 MW! In today’s ever-changing energy market, having AC and DC in one solution provides an extraordinary level of flexibility and futureproofing. There are many applications, such as AC and DC charging test, where AC and DC operation in the same system saves costs and space.

SL1200A Regenerative AC Emulator Soft Front Panel (SFP)

The SL1200A Series of Regenerative AC Emulators are controlled using a user-friendly software front panel. All functions of the SL1200A are configured through the SFP's intuitive user interface as well as firmware updates.

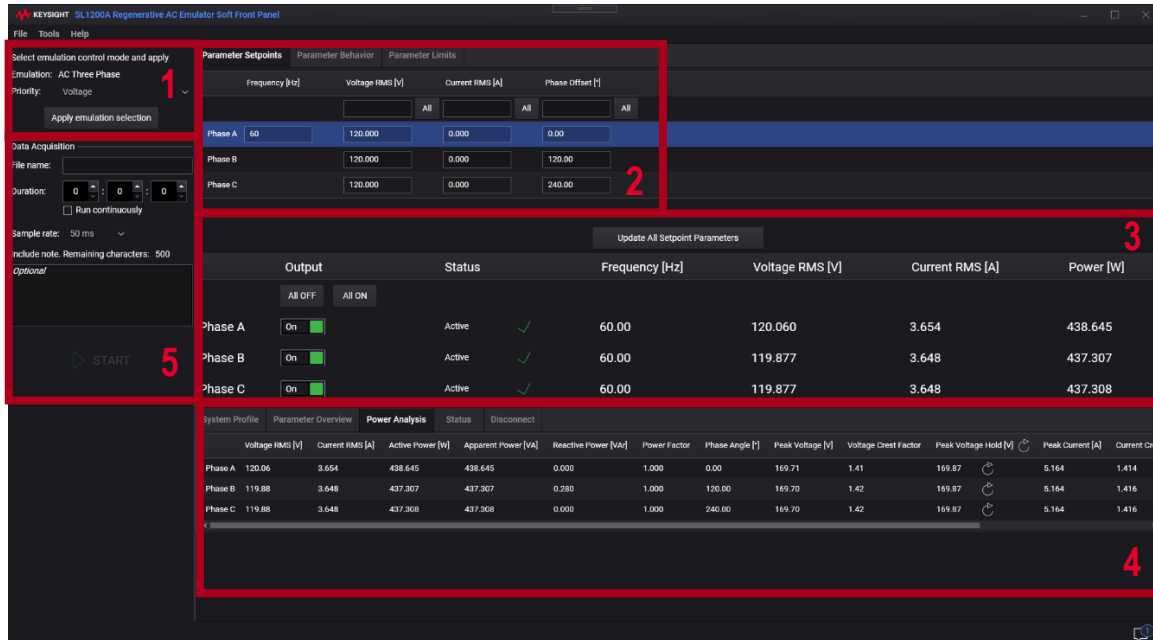


Figure 4. The SL1200A was designed for usability.

SFP functionality areas

1. Emulator configuration: Set emulation mode (1, 2, 3 Φ , or DC) and priority (voltage or current)
2. Control parameters: Setpoints, behavior, and limits
3. On/Off control and measurements: Turn output/phases on/off control and basic measurements (f, Vrms, Irms, and P)
4. Information tabs: System Profile, Parameter Overview, Power Analysis, Harmonic Analysis, Status, and Disconnect
5. Data acquisition: Create a file name, set duration and sample rate, enter notes, and click Start to begin capturing data.

Complete Solutions for Automotive and Energy Applications

When paired with Keysight's energy test solutions, the SL1200A Series provides a complete solution for PV Inverter, Energy Storage System inverter, and Charging (EV and EVSE) test.

Keysight's Photovoltaic / Solar Inverter Test Solutions

Whether your inverter has one or twelve inputs / MPPTs, Keysight's Photovoltaic / Solar Inverter Test Solution can help you go beyond the test standards to maximize performance and bankability.



Figure 5. SL1202A AC Emulator with PV8900A Solar Array Simulators and DG9000A PV software.

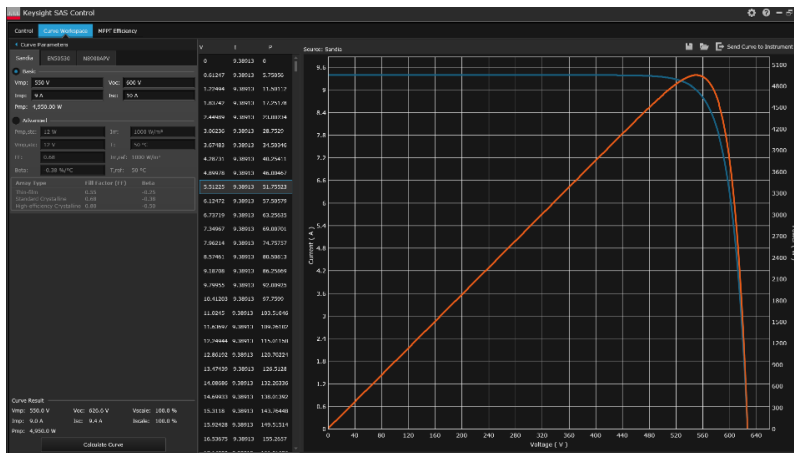


Figure 6. PV8900 Series (left) with DG9000A Software (right).

Learn more about the DG9000A and PV8900A Solar Array Simulator solutions at [keysight.com](https://www.keysight.com).

Keysight's charging test solutions

Keysight's Scienlab Charging Discovery System Series (CDS) is a breakthrough solution for holistic test of all AC and DC charging interfaces of electric vehicles (EV) and electric vehicle supply equipment (EVSE).



Figure 7. AC charging test with SL1201A AC Emulator and SL1040A Charging Discovery System test.



Figure 8. (from left to right) SL1040A EMC, SL1040A Portable, and SL1047A High-Power.

Learn more about the SL1040A EMC and Portable Series and the SL1047A High-Power Series at [keysight.com](https://www.keysight.com).

Specifications

Unless otherwise noted, specifications are warranted over the ambient temperature range of 10 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).

| | SL1201A | SL1202A | SL1203A | SL1212A | SL1213A |
|--|--|--|--|---|---|
| Operating modes | AC, AC + DC offset DC ⁴ , DC + AC ripple | | | | |
| Output connections | L1, L2, L3, N, PE DC+, DC-, PE | | | | |
| AC output ratings | | | | | |
| Output phase | 1, 2, or 3 (3-phase selectable, 1-phase @ max power ⁵) | | | | |
| Max. real power ⁶ Per phase ⁵ | 30 kW 10 kW | 45 kW 15 kW | 90 kW 30 kW | 45 kW 15 kW | 90 kW 30 kW |
| Max. apparent power ⁷ Per phase ⁷ | 42 kVA 14 kVA | 66 kVA 22 kVA | 130 kVA 43.3 kVA | 68 kVA 22.7 kVA | 135 kVA 45 kVA |
| Voltage (rms) | | | | | |
| Range | 0 to 600 V _{L-L} 0 to 346 V _{L-N} | 0 to 600 V _{L-L} 0 to 346 V _{L-N} | 0 to 600 V _{L-L} 0 to 346 V _{L-N} | 0 to 1200 V _{L-L} 0 to 692 V _{L-N} | 0 to 1200 V _{L-L} 0 to 692 V _{L-N} |
| Prog. accuracy | 0.25% FS | | | | |
| Prog. resolution | 0.1 Vrms | | | | |
| Current (rms) | | | | | |
| Max. current (3-phase) rms | 63 A | 63 A | 125 A | 32.5 A | 65 A |
| Current @ Max. voltage | 28.9 A | 43.3 A | 86.6 A | 21.6 A | 43.2 A |
| Max. current (1-phase) rms | 189 A | 189 A | 375 A | 97.5 A | 195 A |
| Frequency | | | | | |
| Range ⁸ | 40 to 75 Hz | | | | |
| Prog. accuracy | ±0.01% | | | | |
| Prog. resolution | 0.001 Hz | | | | |

⁴ DC operation requires Option SDC.

⁵ In 1-phase mode all three phases are used in parallel to achieve the max power specification.

⁶ Parallel up to 810 kW / 1.2 MVA (Contact Keysight for solutions > 810 kW / 1.2 MVA).

⁷ Max power spec. available in single-phase mode.

⁸ Fundamental frequency up to 75 Hz with full specifications.

Specifications (Continued)

| | SL1201A | SL1202A | SL1203A | SL1212A | SL1213A |
|--------------------------------------|--|------------------------|------------------------|------------------------|------------------------|
| DC output ratings⁹ | | | | | |
| Voltage range | ±500 V | ±500 V | ±500 V | ±1000 V | ±1000 V |
| Current | ±180 A | ±180 A | ±360 A | ±90 A | ±180 A |
| Current @ Max. voltage | ±80 A | ±120 A | ±240 A | ±60 A | ±120 A |
| Power | 40 kW | 60 kW | 120 kW | 60 kW | 120 kW |
| Measurement (AC) | Vrms, Vpk, Vinst, Arms, Apk, Ainst, W, VAR, VA, Hz, PF, kWh, phase angle, crest factor | | | | |
| Voltage accuracy | 0.15% + 0.25 Vrms | | | | |
| Voltage resolution | 0.01 Vrms | | | | |
| Current accuracy | 0.2% + 0.4 Arms | | | | |
| Current resolution | 0.1 Arms | | | | |
| Freq. accuracy | ±0.04 Hz | | | | |
| Freq. resolution | 0.01 Hz | | | | |
| Measurement (DC) | | | | | |
| Voltage accuracy | 0.03% +75 mV | 0.03% +75 mV | 0.03% +75 mV | 0.03% +150 mV | 0.03% +150 mV |
| Voltage resolution | 0.1 V | | | | |
| Current accuracy | 0.03% +18 mA | 0.03% +18 mA | 0.03% +36 mA | 0.03% +9 mA | 0.03% +18 mA |
| Current resolution | 0.1 A | | | | |
| Physical specifications | | | | | |
| Dimensions (L x W x H) | 1.05 x 0.6 x 1.36 m | 1.05 x 0.6 x 1.36 m | 1.05 x 0.6 x 1.76 m | 1.05 x 0.6 x 1.36 m | 1.05 x 0.6 x 1.76 m |
| Weight | ~400 kg | ~400 kg | ~700 kg | ~400 kg | ~700 kg |

⁹ DC mode requires Option SDC.

Supplemental Characteristics

| | SL1201A | SL1202A | SL1203A | SL1212A | SL1213A |
|---|--|---------|---------|---------|---------|
| Voltage | | | | | |
| Load regulation | 0.25% FS | | | | |
| Slew rate | 3 V / μ s (open circuit) | | | | |
| Crest factor | Up to 3.6 | | | | |
| THD (linear load) | 0.25% (at fundamental) | | | | |
| Phase angle | | | | | |
| Range | 0 to 360 deg | | | | |
| Meas. accuracy | < \pm 2 deg | | | | |
| Meas. resolution | 0.5 deg | | | | |
| Prog. setpoint accuracy | 1.5 deg | | | | |
| Prog. setpoint res. | 0.1 deg | | | | |
| Peak current | | | | | |
| Meas. accuracy (AC) < 100 Hz | 0.5% + 0.5 A | | | | |
| AC input ratings (source and regen. operation) | | | | | |
| Voltage | 380 to 480 VAC \pm 10%, 50 or 60 Hz | | | | |
| Connections ¹⁰ | L1, L2, L3, N, PE | | | | |
| Current (option STD) | 53.7 A | 80.5 A | 161 A | 80.5 A | 161 A |
| Current (option SDC) | 72 A | 108 A | 216 A | 108 A | 216 A |
| Efficiency | 85% (in both source and load/regeneration operation) | | | | |
| Power factor | 0.99 | | | | |

¹⁰ All SL1200 models require all five wires, include Neutral to operate

Supplemental Characteristics (Continued)

| | SL1201A | SL1202A | SL1203A | SL1212A | SL1213A |
|-------------------------------------|---------|---------|-------------------------------------|---------|---------|
| Harmonics and interharmonics | | | | | |
| Injection and measurement, voltage | | | 2 nd to 50 th | | |
| Injection and measurement, current | | | 2 nd to 50 th | | |
| THD voltage meas. | | | 2 nd to 50 th | | |
| THD current meas. | | | 2 nd to 50 th | | |
| Current meas. acc. | | | 0.5% + 0.5 A | | |
| Voltage meas. acc. | | | 0.5% + 0.25 V | | |
| Freq. meas. acc. | | | ±0.05 Hz | | |
| Freq. meas. res. | | | 0.01 Hz | | |
| Freq. meas. bandwidth | | | 20 kHz | | |
| Output ratings (DC) | | | | | |
| Voltage rise time (10 to 90%) | | | 500 V / ms | | |
| Current rise time (10 to 90%) | | | < 2 ms | | |

Input / Output Connections

All SL1200A models have input and output connections that are easy to access and connect. The image below shows the connection cabinets on the rear-top of the system. The left cabinet is for the AC and DC output connections providing power to the device under test. The right cabinet is for the AC input connections providing power to the SL1200A system.



Figure 9. Rear connection cabinets (may differ slightly from actual product).

How to Order

Each model in the SL1200A Regenerative AC Emulator Series has two options available: STD and SDC. Test automation software is also available.

SL12xxA-STD standard system

This is the standard system. It supports AC and “AC + DC” modes.

SL12xxA-SDC standard system with DC hardware

This is the standard system with the hardware necessary to switch from AC-mode to DC-mode.

SL1200A Soft Front Panel

The SL1200A SFP is available for free download at www.keysight.com/find/SL1200software. A license is not required.

KS8400B PathWave Test Automation and SL1220A Plugin

The SL1220A plugin runs within KS8400B. A license for KS8400B is required to use the SL1220A plugin. A license is also required for SL1220A. Free trials are available for both. The KS8400B and SL1220A software can be downloaded for free at www.keysight.com/find/tap.

Learn more at: 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

