

Power Amplification for Real-Time Power Simulation

New, simple upgrade for Keysight SL1200A Series enables Real-Time PHIL power simulation

Available as
an upgrade to
all models!

SL1201A 600 V_{L-L}, 63 A, 30 kW / 42 kVA

SL1202A 600 V_{L-L}, 63 A, 45 kW / 66 kVA

SL1203A 600 V_{L-L}, 125 A, 90 kW / 130 kVA

SL1212A 1200 V_{L-L}, 32.5 A, 45 kW / 68 kVA

SL1213A 1200 V_{L-L}, 65 A, 90 kW / 135 kVA

SL1214A 600 / 1200 V_{L-L}, 65 / 32.5 A, 45 kW / 68 kVA

SL1215A 600 / 1200 V_{L-L}, 130 / 65 A, 90 kW / 135 kVA

≤ 21 μs
Delay
(typical)

SL1200A Software Front Panel (SFP)

SL1200A Grid Integration and Compliance Test Automation Suite

Figure 1. Rendition of SL1215A with high-speed interface for low-latency PHIL grid simulation (left), next to an actual SL1215A (right)



Important Note: This data sheet only covers characteristics of the new, low-latency PHIL grid simulation upgrade now available for all SL1200A Series Regenerative AC / Grid Emulators. For full specifications, please see the [SL1200A Regenerative AC / Grid Emulator Series data sheet](#).

Grid Modernization Requires Realistic Testing

As renewable generation, energy storage, electric vehicle charging, and other distributed energy resources (DERs) connect to the grid, engineers need test environments that can reproduce real-time, real-world grid behavior before equipment is deployed. Traditional grid test setups and power amplifiers can be limited in their ability to accurately reproduce dynamic grid conditions at the necessary speeds.

Keysight Real-Time PHIL helps engineering teams evaluate complex power scenarios with a Power Hardware-in-the-Loop approach. It combines real power hardware with simulated power behavior, such as in real-time grid emulation. By pairing Keysight's SL1200A Series Regenerative AC / Grid Emulators (power amplifier) with a high-speed real-time interface, the solution enables fast, more realistic validation of connected devices and control strategies, such as grid-tied inverters.

Keysight Real-Time PHIL Grid Simulation

Keysight's Real-Time PHIL solution is designed for engineers who need to test grid-connected equipment against fast-changing, realistic grid conditions. It supports real-time simulation workflows by combining high-power AC / DC output capability, low-latency control, high-speed measurement feedback, and flexible operation modes in one integrated grid emulation platform.

The result is a practical way to validate DERs, EV charging systems, energy storage systems, grid-edge controls, and other connected energy technologies before they are exposed to real grid events.

Why This Matters

Real-time grid simulation is increasingly important as grid-connected devices become more complex and as control interactions between DERs, inverters, EV chargers, and energy storage systems become harder to validate with static test methods. A low-latency PHIL approach helps engineers close the loop between simulated grid behavior and real power hardware so they can observe how devices respond to dynamic conditions in a controlled lab environment.

Keysight's approach helps reduce the gap between simulation and hardware validation by enabling real power exchange, fast command updates, and high-bandwidth measurement feedback in a scalable SL1200A-based platform.

Wide-Range of Use Cases

- Validate grid-forming and grid-following DER and inverter behavior under realistic dynamic grid conditions
- Evaluate EV charging and V2G interactions before deployment
- Test energy storage systems and grid-edge control strategies
- Reproduce short-duration grid events in a controlled lab environment
- Support real-time simulation workflows that require fast measurement and setpoint updates
- Explore advanced grid modernization scenarios without relying on field testing

Key Solution Advantages for PHIL Applications

- **Regenerative Operation**
Return absorbed energy back to the facility instead of dissipating it as heat, enabling efficient, long-duration testing of inverters, energy storage systems, EV chargers, and motor drives.
- **True Four-Quadrant Operation**
Seamlessly source and absorb power to support realistic evaluation of bidirectional technologies, including battery systems, V2G equipment, regenerative drives, and grid-support functions.
- **AC and DC Capability**
Validate AC grids, DC buses, batteries, and hybrid power architectures using a common platform, reducing test setup complexity and maximizing lab flexibility.
- **High-Fidelity Dynamic Performance**
High bandwidth, fast slew rates, and high-speed measurements enable accurate reproduction of transient events, grid disturbances, and converter interactions.
- **Low-Latency PHIL Operation**
High-speed actuation and measurement paths help preserve synchronization between simulation and hardware, supporting accurate closed-loop testing.
- **Aurora-Based Digital Connectivity**
Aurora over SFP provides a high-speed, deterministic digital communication path between the simulator and power interface. Compared with traditional analog interface architectures, digital communication can reduce signal-conditioning requirements, simplify scaling and calibration, and help maintain consistent performance in demanding PHIL environments.
- **Scalable Power Architecture**
Scale from a single rack to >1MW test setups

Conclusion

Keysight Real-Time PHIL adds low-latency Power Hardware-in-the-Loop capability to the long list of capabilities of the SL1200A Series Regenerative AC / Grid Emulator platform. With $\leq 21 \mu\text{s}$ actuation and measurement delay, high-speed real-time interface support, scalable AC / DC power capability, and high-fidelity dynamic response, the solution helps engineers validate complex grid behavior fast and with greater confidence. At the same time, remaining a versatile AC / grid and DC instrument.

Solution Characteristics

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 and apply at the DUT in compliance to the specified load line length, with local sensing.

Characteristic	Value
System Characteristics	
Power / Size	90 kW AC, 120 kW DC per rack
Scalable up to	Up to 1.35 MW AC, 1.8 MW DC
Aurora via Software Front Panel (SFP)	Yes
Setpoint Update Rate	1 Msps
General CV Stimulus Characteristics	
CV Actuation Delay (from HIL → V _{OC})	21 μs
CV Rise Time (10% - 90%, open-circuit)	6 μs
CV Amplifier Bandwidth (-3 dB -45°)	60 kHz 7 kHz
Full-Scale Voltage Bandwidth	1.2 kHz
Max Voltage Slew Rate (resistive load)	15 V / μs
General CC Stimulus Characteristics	
CC Actuation Delay (from HIL → I _{SC})	21.5 μs
CC Rise Time (10% - 90%, short-circuit)	9 μs
CC Amplifier Bandwidth (-3 dB -45°)	45 kHz 6 kHz
Measurement Characteristics	
Measurement Sample Rate	1 Msps
Voltage Meas Delay BW (V _{OC} to HIL)	19.5 μs ≥ 100 kHz
Current Meas Delay BW (I _{SC} to HIL)	23.5 μs ≥ 55 kHz
AC-Specific Stimulus Characteristics	
Max Output Voltage (RMS, L-L)	Low Range: 1.275 p.u. (612 V _{RMS}) High Range: 2.55 p.u. (1,224 V _{RMS})
Surge Current (RMS, relative to full load @ 480 V _{RMS} L-L)	1.4 p.u.
Instantaneous Peak Current (@ 480 V _{RMS} L-L nominal)	2.0 p.u.
Instantaneous Peak Power	2.3 p.u.
Worst-Case Voltage Slew Rate (@ 480 V _{RMS} L-L, full resistive load)	1.8 V/μs
CV Output Impedance ¹	1% @ 60 Hz, 35% @ 2 kHz
CC Output Admittance ²	1.7% @ 60 Hz, 42% @ 2 kHz
DC-Specific Stimulus Characteristics	
CV Output Impedance ³	140 μH / N
CC Output Impedance ³	8.5 μF · N

¹ $|Z_{OUT}| / R_{LNom}$ where $R_{LNom} = V_{Nom}^2 / P_{Nom}$ (applies to low range only; impedance in high range is 4X)

² $R_{LNom} / |Z_{OUT}|$ where $R_{LNom} = V_{Nom}^2 / P_{Nom}$

³ N represents the number of 20 kW power stages on a given bus; Final value not covered by the referenced PHIL data sheet

Ordering Information

If you already own an SL1200A Regenerative AC / Grid Emulator please contact your local Keysight representative to inquire about on-site upgrade services for your specific model.

If you do not yet own an SL1200A, please refer to the [SL1200A Series data sheet](#) to choose the model that meets your grid simulation / power amplification needs. Ordering information is located towards the end of the document. When you contact your Keysight sales representative, let them know you'd like to add PHIL capabilities to your order.



Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

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