



Datasheet

NHR 9510 High-Power System for Grid Simulation



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NHR 9510 High-Power System for Grid Simulation

Applications



ELECTRIC VEHICLES



DC FAST CHARGER



SATELLITE OR SPACE



ENERGY STORAGE



POWERTRAIN



FUEL CELL SYSTEMS



SOLAR PV



TEST LABS

BEST FOR:

- Test solution for engineering development, compliance verification and manufacturing for all utility grid-tied products.
- Distributed Energy Resources, Energy Storage Systems, Solar PV, and Vehicle to Grid test, evaluation, and certification.

KEY FEATURES:

- Regenerative AC/DC Grid Simulator and Power Amplifier
- Optimized for PHIL applications
- 100kW Power Modules
- Modular and Scalable AC Power from 100kW to 1.2MW
 - Same unit can act as master or parallel auxiliary unit
 - Field expandable for future increased power demands
- Fully isolated design:
 - Facility to output and channel to channel
 - High voltage remote sense up to 866VL-L
- Widest True-Power Operating Envelope with wide range of power factors and range of voltage (290V to 606VL-L with full power)
- Provides extra current for different voltage grid tied products
- AC Load option: 3 separate channels can be configured as Regenerative AC/DC Grid Simulator or 4-Q AC Load
- High power density with small footprint
- Multiple phase and DC capability covers all utility source and load requirements
 - Programmable three-phase, split-phase, or single phase
- Independent voltage and current measurement range for enhancing measurement accuracy
- Powerful waveform synthesizer combined with high-resolution digitizer covers extensive test and evaluation requirements.
- Programmable Output Impedance
- Ideal for regulation testing standards: UL 1741SA, IEEE 1547, IEC 62116, IEC 61000-4-11(pre-compliance), 4-13, 4-14, 4-28, etc.

PHYSICAL AND SAFETY:

| MODEL | | 9510 | |
|------------------------|--|-----------------------|---|
| Physical | | | |
| Connectors | 2 x 1-2" stud terms. per ch. (6 Tot.) + Grnd. | Cabinet Weight | 1200lbs/545kg (100kW cabinet) |
| Cabinet Dim. (HxWxD) | 78" x 28" x 39"/1980mm x 712mm x 990mm | Operating Temperature | 5 - 35°C (up to 95% RH non-condensing) |
| Safety | | | |
| Isolation | Facility to Chassis: 500V, Output to Chassis: 500V, Facility to Output Iso.: 500V | Module Protection | Self-protecting: over-voltage, over-current, over-power, and over-temp. |
| Physical | Emergency Stop and external Inter-Lock | Watchdog Timer | Continuously monitors control comms. |
| Program. Safety Limits | Min/Max Voltage, Current (per direction), and Power (per direction) with separate limits and time delay values | | |

The Industry Leading Solution for Testing and Verification of High Power Grid-tied Applications

The 9510 Regenerative Grid Simulator is the industry leading solution for testing and verification of high power grid-tied applications in compliance with regulatory testing standards, worldwide. The 9510 has a built-in power amplifier mode for Power Hardware in the Loop (PHIL) applications providing further testing and simulation capability ideal for research labs. Modular and scalable power is available in 100kW modules up to 1.2MW. Programmable frequency is between 30Hz and 120Hz. The output can be AC, DC or AC+DC and the AC can be single, split or 3-Phase. With this wide range of power, frequency and phase configuration options, the 9510 provides the ultimate flexibility to test the broadest selection of grid-tied products.

Amplifier Mode for Power Hardware in the Loop (PHIL) with Low Latency

The 9510 is externally controllable via a low latency, per-phase analog input. This feature amplifies control signals from real-time simulation systems for power hardware in the loop testing. The dual range output ensures the maximum flexibility and accuracy in PHIL simulations.

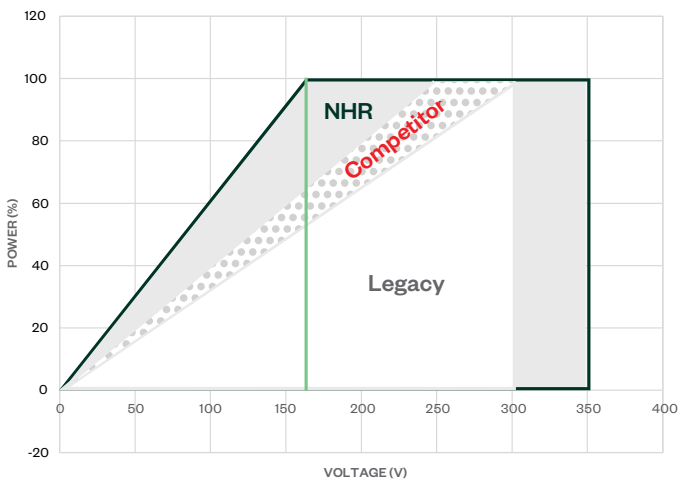


FIGURE 1
Max Power Delivered at 166VAC L-N

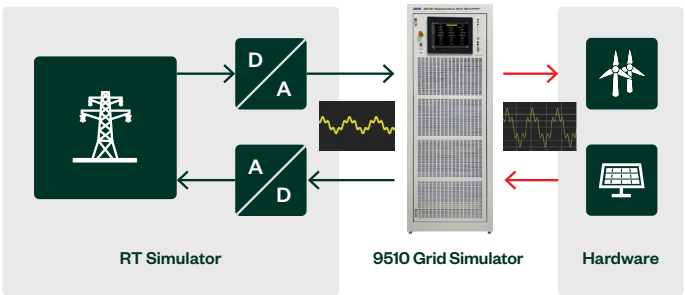


FIGURE 2
Modular and Scalable Power up to 1.2MW

Low Voltage Ride-Through (LVRT) and Area Electrical Power System (EPS) Disturbance Simulation

The 9510 Grid Simulator is able to directly simulate common power line disturbances, such as LVRT test patterns (Fig. 2 and 3), through a combination of macros and user-definable wave shapes. Macros are pre-programmed sequences of settings which are entered through a user-friendly menu, downloaded to the grid simulator, and are executed to provide precise control of the output(s). This method is used to generate LVRT test patterns, sub-cycle, and multi-cycle changes to the output covering nearly every need.

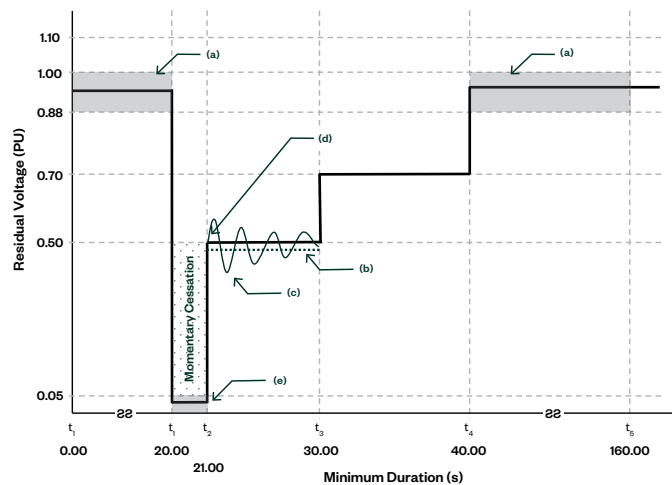


FIGURE 3
LVRT as per 1547.1:2020 Section 5.4.4

Waveforms

User-definable wave shapes extend this capability by permitting the generation of outputs including transient anomalies, voltage harmonics, or any other irregularity which can be drawn as a single cycle (Fig. 4 - 6). These wave shapes can be played continuously or switched in through the macro programming interface.

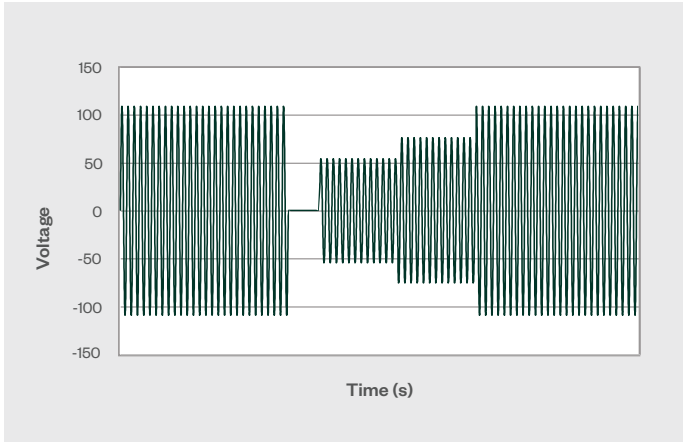


FIGURE 4
Low Voltage Ride-Through Profile

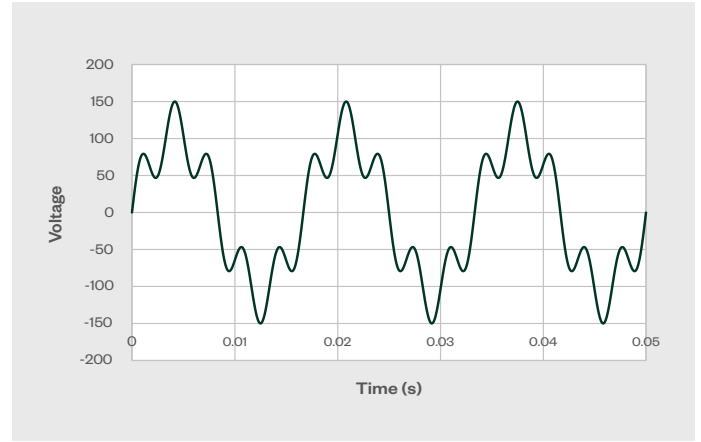


FIGURE 5
Distorted Waveform with Harmonics

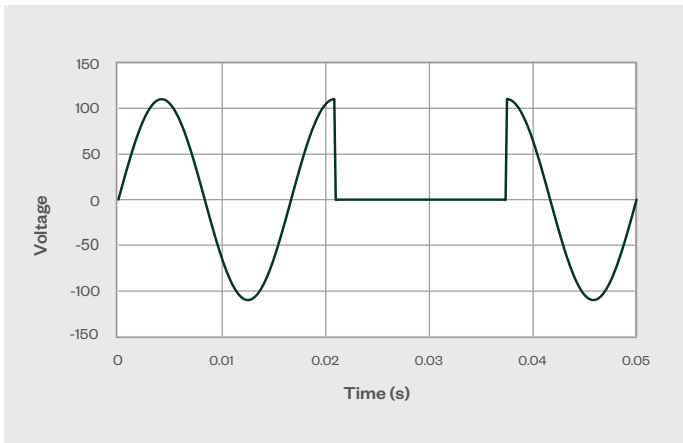


FIGURE 6
Sub-cycle Transient

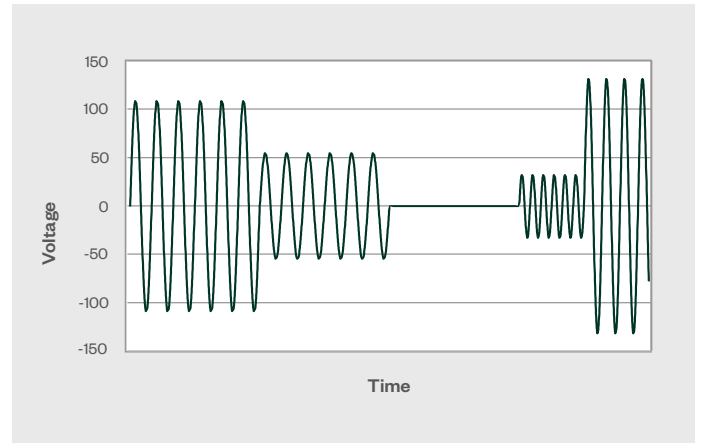


FIGURE 7
Voltage/Frequency Variation

The Power of Choice: Flexible Control Options

There are multiple ways to control the 9510 High Voltage Grid Simulator.

- Fully programmable using NI standard tools such as LabVIEW and VeriStand. These include SCPI, OS-independent LabVIEW VIs for Windows applications.
- An integrated Touch-Panel provides a simple manual control interface and allows basic tests to be run within minutes of powering up the tester.
- For more complex test programs, a remote soft-panel interface on the user's PC or laptop provides additional control features such as wave-shape editors, waveform captures and test program step controls using Macros.
- Analog interface for Power Hardware in the Loop (PHIL)

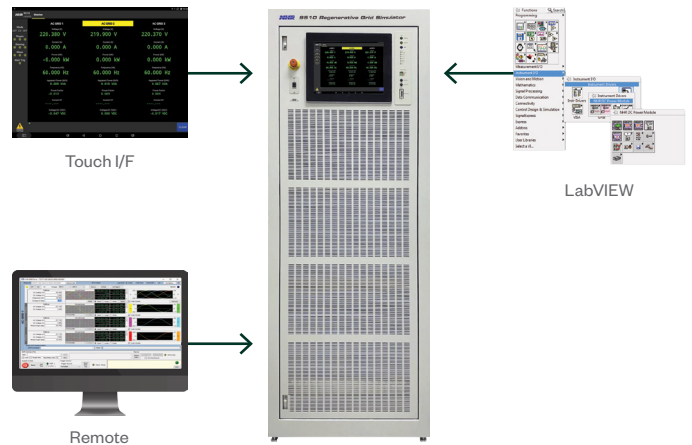


FIGURE 8
Flexible Control Options

Protection and Safety

The 9510 has built-in safety features to prevent serious failures and protect the operator, UUT, and the facility. Internal hardware contactors isolate the power module from the device under test and the facility power. Protection features cover grid-side (line in), internal (9510), output (UUT) failures, and detection of unintentional Islanding conditions. Interlock and eStop are provided for rapid shutdown.

NHR 9510 Regenerative Grid Simulator Specifications

| MODEL NUMBER | 9510-100 | 9510-200 | 9510-300 | 9510-400 | 9510-500 | 9510-1000 | 9510-1200 | |
|---|--|---|---------------------|-------------------------|---------------------------------|---|-------------|-------------|
| Description | 100kW | Only 100kW cabinet can support parallel expansion up to 1.2 MW ³ | | | | | | |
| AC Output Ratings | | | | | | | | |
| Operating Modes | 4-Quadrant with Programmable Voltage (CV), Power Amplifier (PHIL), Optional AC Load | | | | | | | |
| Output Configurations | 3 independent set per channel 3 x 1Φ(AC or DC), 2Φ + 1Φ(AC or DC), or 3Φ AC outputs | | | | | | | |
| Power, Max (1Φ or 3Φ) | 100kW/210kVA ⁵ | X2 | X3 | X4 | X5 | X10 | X12 | |
| Current Ranges (RMS per Φ) ⁷ | 50, 200A | X2 | X3 | X4 | X5 | X10 | X12 | |
| Current Ranges (RMS 1Φ Mode) | 150, 600A | X2 | X3 | X4 | X5 | X10 | X12 | |
| Frequency | 30 - 120Hz (10mHz resolution) ⁴ | | | Load Regulation | | ± 0.02% F.S. | | |
| Voltage Ranges | 10 - 175, 10 - 350VRMS L-N (Split Phase 10-125, 20-250V Max) | | | Slew Rate | | 1V/μS (10% to 90% measured at 90 degree turn-on into no load or light resistive load) | | |
| Voltage Control Accuracy | ± 0.15% F.S. (Max Measurement PK) | | | Waveforms | | Sine, n-Step Sine, Triangle, Clipped-Sine, Arbitrary (user defined) | | |
| Programming Resolution | 0.01V | | | Phase Angle Control | | 0 to 359 degrees / 0.1 degree resolution | | |
| Distortion (THD) ² | 0.45% (Typ.) 0.65% (Max) <70Hz no load to full load ; 0.6% (Typ.) 0.85% (Max) >70Hz no load to resistive load | | | | | | | |
| DC Output Ratings | | | | | | | | |
| Operating Modes | DC Constant Voltage (CV), Optional DC Load | | | | | | | |
| Avg. Power (1ch or 3ch) ³ | 100kW | 200kW | 300kW | 400kW | 500kW | 1000kW | 1200kW | |
| Current Ranges (Per Ch.) | 50, 200A | 100, 400A | 150, 600A | 200, 800A | 250, 1000A | 500, 2000A | 600, 2400A | |
| Current Ranges (1 Ch.) | 150, 600A | 300, 1200A | 450, 2400A | 600, 2400A | 750, 3000A | 1500, 6000A | 1800, 7200A | |
| Voltage Ranges | 10 - 200, 10 - 400VDC | | | Ripple | | < 800mV RMS (into resistive load) | | |
| Power Amplifier Mode (PHIL) | | | | | | | | |
| Control Method ¹ | Analog Input ±10V PK-PK amplified to ±247.5V PK-PK (low range) and ±495V PK-PK (high range) | | | Latency (input-output) | | 50 uS typical | | |
| AC & DC Measurements | | | | | | | | |
| Measure Peak Voltage | 424V/707V Pk. | | RMS or DC Meas.Acc. | | 0.1% + 0.1% F.S. (AC RMS or DC) | | Resolution | 0.005% F.S. |
| Meas. Pk. Current (per Ch.) | 167, 500A Pk. | | RMS or DC Meas.Acc. | | 0.1% + 0.1% F.S. (AC RMS or DC) | | Resolution | 0.005% F.S. |
| Peak Power | V Range x I Range | | Accuracy | | 0.2% + 0.2% F.S. (kW or kVA) | | Resolution | 0.005% F.S. |
| Additional Measurements | Energy (Ah, kWh, kVAh), AC Crest Factor, AC Power Factor, True Power (P), Reactive Power (Q), Waveform Capture | | | | | | | |
| Waveform Digitizer | | | | | | | | |
| Data Acquisition | Output Voltage AND Current | | Memory Depth | 64k Samp. (V & I per Φ) | | Accuracy | 0.5% Range | |
| Sample Rate | 125 k Samples / sec | | Aperture Time | 1 cycle to 64s | | | | |
| Control | | | | | | | | |
| Local User Interface | Built-in Touch-Panel & PC-Based software tools including GUI | | | Analog Current Monitor | | [-10V, +10V] corresponds to ±Full Measurement Scale | | |
| External System Comm | LAN (Ethernet) supporting SCPI | | | Analog Voltage Monitor | | [-10V, +10V] corresponds to ±Full Measurement Scale | | |
| Drivers | NI-Compliant LabVIEW Drivers | | | | | | | |
| Input Power (Single 100kW Cabinet) | | | | | | | | |
| Voltage | Universal Input - 380V to 480V ± 10% (L-L, 3 Phase, 50/60Hz). Output Power reduced to 90kW below 360VAC input. | | | | | | | |
| Efficiency/Power Factor | Efficiency: > 90% typical (up to 94% at full pwr.), Pwr. Factor: > 0.95 typical (> 0.99 at full pwr.) ⁶ | | | Current per Φ | | 168A@380V, 144A@400V, 134A@480V | | |

¹ Refer to the gain / frequency graph, ² THD is tested based on output 480VL-L (277 VL-N) with resistive load, ³ Instant PK power per channel will be 100kW (300kW per system) and it will be derated as frequency lower than 50Hz. See derating curve in manual, ⁴ Load option might require a stiff source when doing high CF, ⁵ The Max VA setting will be derated when system use in 1-phase (150kVA > 60Hz, 120kVA above 30Hz), ⁶ near 93% at 480VLL/100kW, ⁷ Per cabinet per channel, the maximum hardware allowed peak current is 400A. Max peak current might be further derated in the situation of multiple system in parallel.