



NH Research Introduction & Product Overview

*Test solutions for today's technologies
& tomorrow's innovations*



Enabling Electrification

NHR enables electrification by accelerating innovation, validation & functional test of today's & tomorrow's technologies

Backed by over 50 years of experience in power conversion and power supply test systems we provide world-class test instruments and systems. Our solutions provide the performance, simplicity, and safety that engineers and researchers desire.

- Best-in-class performance
- Reduced testing time
- Ease of use
- Improved safety
- Modular & scalable solutions
- Energy savings



Our Products

NHR's product portfolio ranges from power instruments to complete test system solutions.

- AC & DC Electronic Loads
- Battery Test & Battery Emulation Systems
- Grid Simulators
- AC & DC Power Sources
- Bi-directional Sources

Our Value



Simplified Testing

- Easy set up, intuitive GUI & simple variable-based inputs
- Reduce test development time & increase engineering productivity
- Multiple ways to control instrument including third-party software
- Built-in measurements & features eliminate additional test equipment



Flexible & Scalable Configuration

- Flexible voltage & current combinations for optimized testing
- Scalable power, multi-channel capability & wide operating envelopes
- Highly modular configuration of power to address specific test requirements
- Address evolving test needs



Bi-directional AC & DC

- Bi-directional test solutions to emulate today's real world conditions
- Battery emulation & grid simulation are crucial for validating an entire product or system
- Accepts back EMF & eliminates safety hazards
- Speed up development time, reduce complexity & costs



Regenerative AC & DC

- Energy is recycled for re-use back into your test system or facility
- Typically > 90% energy efficiency
- Reduced heat dissipation in the work space improves work conditions & increases productivity
- Reduce energy usage & operating costs



Speed & Accuracy

- Fast transient response times to meet today's technologies & tomorrow's innovations
- Accurate data & high performance test solutions
- Reduce testing time & risk of error
- Provides confidence in today's & tomorrow's testing



Integrated Safety

- Safety features designed into all products
- Integrated safety relays & isolated inputs
- No hidden costs or additional safety accessories required
- Eliminate safety risks & confidently push the boundaries of test

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Bi-directional DC Source

Battery Test Systems

Battery Emulation

Regenerative DC Electronic Loads

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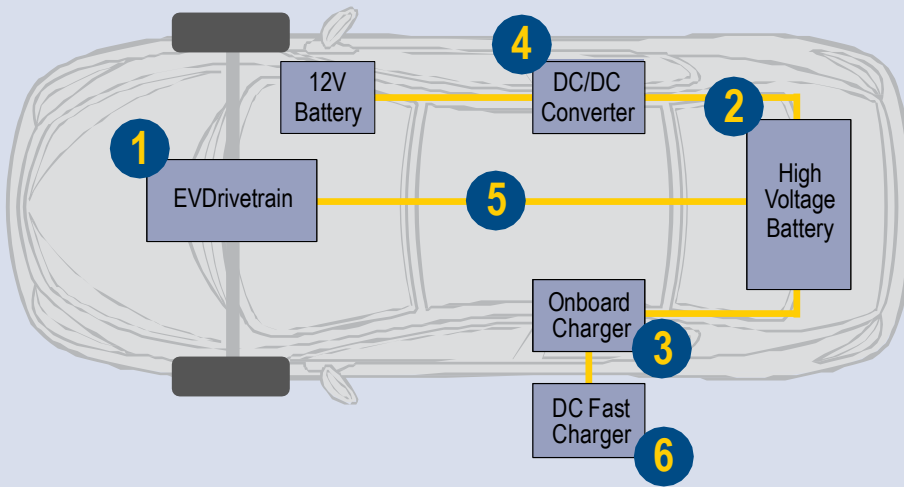
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Worldwide Service & Customer Support | 19



Automotive | Electric Vehicles

EV Test Solutions for Powertrain, Battery, DC Fast Charger & Power Electronics



Complete EV Test Solutions

- 1 Powertrain
- 2 High Voltage Battery Test
- 3 Onboard Charger & EVSE
- 4 DC/DC Converter
- 5 In-vehicle Power Electronics
- 6 DC Fast Charger

Example Applications



DC Fast Charger Test

- Battery emulation
- High power wireless



Powertrain Test

- Motor drive performance
- Dynamometer, alternator
- Battery emulation
- Start - stop testing



Battery Test

- Drive cycle & performance
- Charge/discharge
- BMS development



Power Conversion

- DC to DC converter
- EVSE, onboard charger
- In-vehicle electronics
- Bi-directional onboard charger

Aerospace | Defense

ATE Friendly & Next Generation Power Test Solutions from R&D to Sustainment



Complete Avionics Test Solutions

- 1 Batteries, capacitors
- 2 Propulsion system
- 3 AC-DC, DC-DC converters
- 4 AC generators
- 5 Auxiliary loads, switches, electric actuators, etc.

Example Applications



Traditional ATE

- Power supply
- Power conversion
- Chargers



Solar PV & Grid Tied

- DG, V2G, ESS, micro-grid simulation
- PV emulation, PV inverter test



Avionics, Tanks, Ships

- Propulsion systems, drive train
- Motor emulator
- Inverter test
- High voltage battery test
- DC fast charger, charger

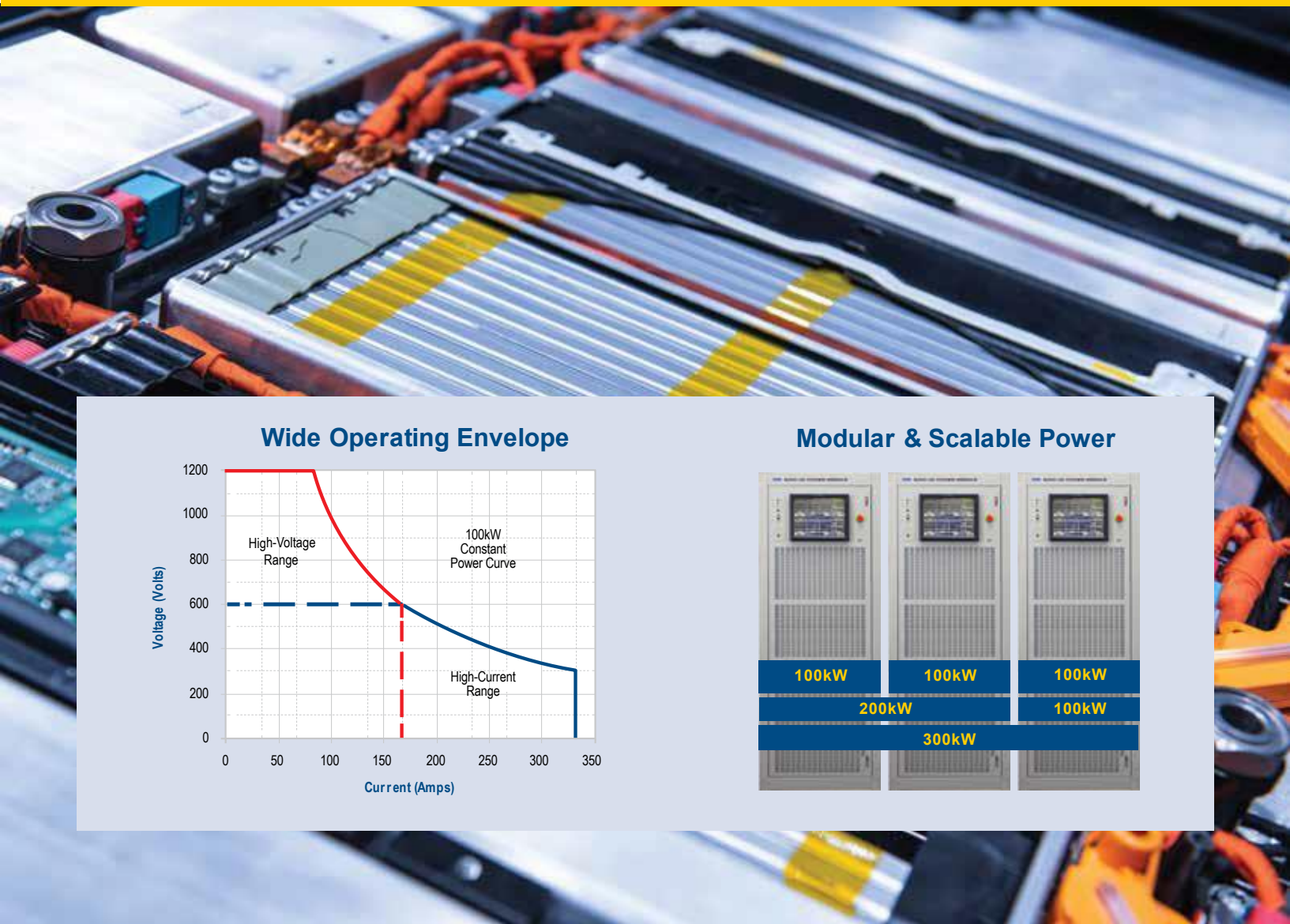


Radar, Electronic Warfare

- Power electronics test

Battery Test | Energy Storage

Test Solutions for All Battery Chemistries, Fuel-cells, Supercapacitors & Energy Storage Devices



Example Applications



Battery Test

- EV/ESS battery module/pack
- Charge/discharge
- BMS development
- Battery characterization
- Life-cycle
- Fuel cell test (module, stack)



Battery Emulation

- EV powertrain
- Avionics propulsion systems
- DC fast charger
- Smart Grid simulation
- Solar PV emulation



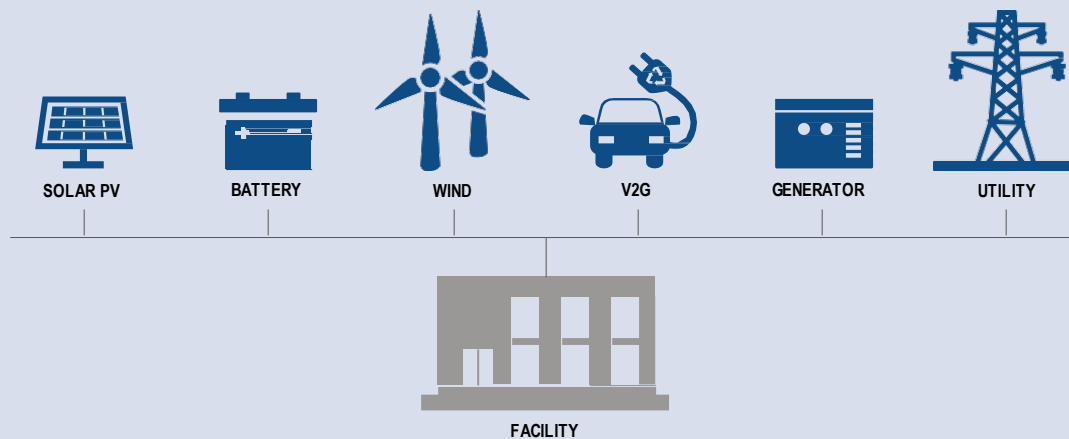
Power Conversion

- Grid-tied inverters
- DC-DC converters
- PDU & UPS

Renewable Energy | Smart Grid

Renewable Energy Test Solutions for Solar PV, Grid-tied Technologies & Energy Storage Systems

Microgrid Test Solutions



Example Applications



Grid-tied Technologies

- Distributed generation (DG)
- ESS
- High power wireless
- EV load testing



Grid Simulation

- ESS
- Microgrid



Solar PV

- Solar PV emulation
- Battery emulation
- PV Inverter



Energy Storage System

- Battery, fuel cell test



Power Conversion

- AC-DC, DC-DC converter
- UPS - Power Distribution Unit

NH Research 9200 & 9300 Series



- **Bi-directional DC Source**
- **Battery Test System**
- **Battery Emulation**
- **Regenerative DC Load**



9200 Series Low to Medium Voltage



Modular, Regenerative, Bi-directional DC Source for Automated Characterization, Battery Cycling & Battery Emulation

- Module options to fit your voltage needs - 40 or 120V
- Up to two 12 kW modules/cabinet, scalable to 252 kW
- Mix, match & parallel modules & cabinets
- Regenerative discharge (load)
- High efficiency > 87%
- Sub millisecond current transients for simulating ultra-fast step changes seen in Battery Test, Interruptible Current
- Devices, EV Powertrain Testing & more.
- Very low noise
- Built-in safety features including pre-charge circuit, isolation relays, etc.
- CAN, BMS, DAQ options

Battery Test:

- EV/Battery Module/Pack Test
- Start - Stop Test
- Battery Characterization
- Cycling, Life-cycle
- Charge, Discharge
- Fuel Cell Test – Cell, Module, Stack

Battery Emulation:

- EV Powertrain, Avionics Propulsion Systems
- DC Charger
- Power Conversion: DC/DC Converters, Inverters
- On-board Charger, UPS, Power Distribution Unit (PDU)
- Smart Grid, ESS, PV Emulation

9300 Series Medium to High Voltage



High Voltage, Regenerative Bi-directional DC Source for Automated Characterization, Battery Cycling & Battery Emulation

- Dual voltage range – 600 V & 1200 V
- Modular 100 kW per cabinet
- Scalable up to 2.4 MW
- Regenerative discharge (load)
- High efficiency > 90%
- Sub millisecond current transients for simulating ultra-fast step changes seen in Battery Test, Interruptible Current
- Devices, EV Powertrain Testing & more.
- Very low noise
- Built-in safety features including pre-charge circuit, isolation relays, etc.
- CAN, BMS, DAQ options

Battery Test:

- EV/Battery Module/Pack Test
- Battery Characterization
- Cycling, Life-cycle
- Charge, Discharge
- Fuel Cell Test-Module, Stack

Battery Emulation:

- EV Powertrain, Avionics Propulsion Systems
- DC Fast Charger
- Power Conversion: DC/DC Converters, Inverters
- On-board Charger, UPS, Power Distribution Unit (PDU)
- Smart Grid, ESS, PV Emulation

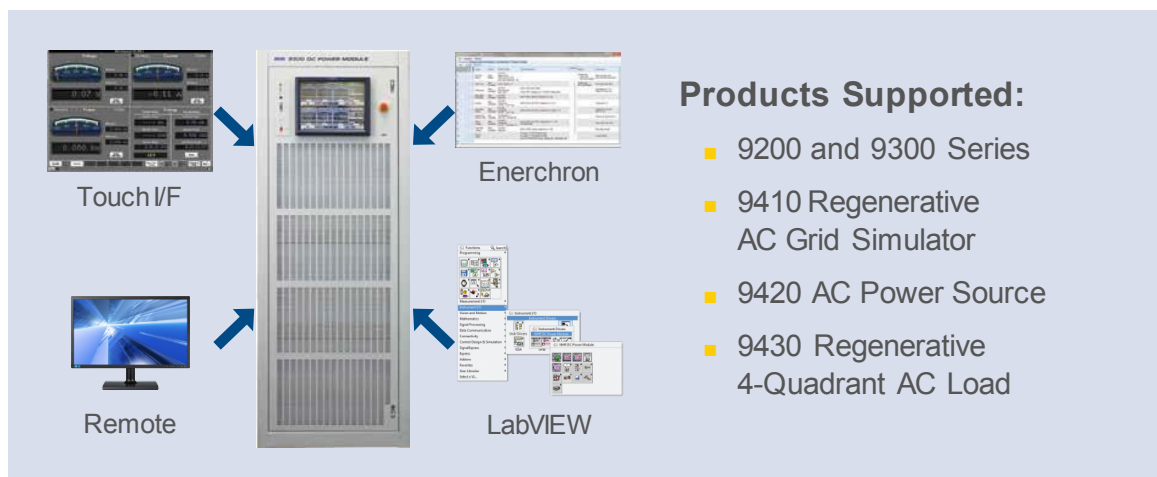
The Power of Choice (NHR Advantage)

Enerchron Test Executive Software

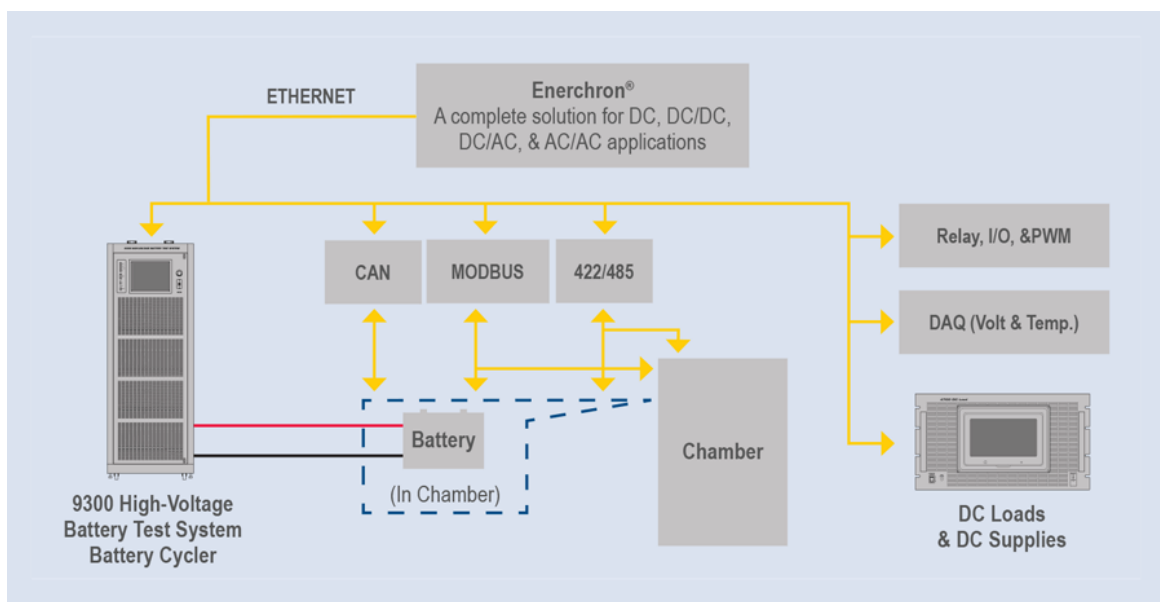
Test executive with advanced test creation, execution and reporting capabilities for battery cycling and other energy product testing. Write your own software, work with your favorite integrator.

- Powerful, flexible, intuitive test sequence editor
- Reduces test development time with simple graphical sequence programming so engineers can focus on UUT
- Unique variable-based programming
- Save key data & perform calculations
- Dynamically control the test during test
- Import or create drive cycles
- Implementing drive/grid cycles is easy as 1-2-3
- Programmable remapping capability
- Integrate with third-party communication tools

Flexible Data Control Options



Test System Solutions

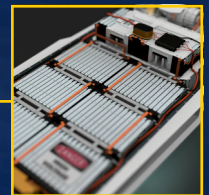


NH Research 9410 & 9420 Series



Regenerative
AC Grid Simulator

AC Power Sources



9410 Regenerative Grid Simulator



Testing of PV Inverters, Grid-Tied Technologies
AC Power & Frequency Conversion Products

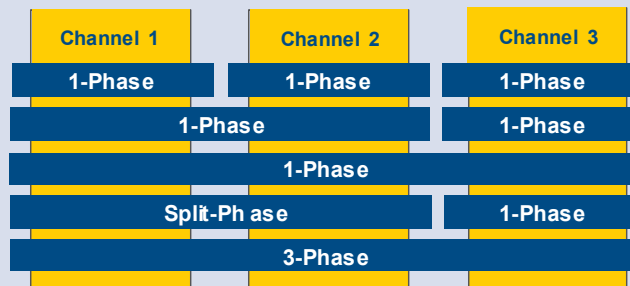
- 8 power ratings – scalable from 12 to 96 kW
- Dual AC voltage range – 175, 350 VAC at 30 to 100 Hz AC
- Dual DC voltage range – 200, 400 VDC
- Programmable 1, 2 or 3-Phase
- Regenerative discharge (load)
- High efficiency > 90%
- Mix AC & DC on separate output channels
- Built-in safety isolation relays

Applications:

- Grid Simulation: Smart Grid Systems
- ESS
- On-board Chargers, Grid-aware Chargers
- Grid Utility Test
- PV/Grid Tied Inverter Test
- UPS, Power Distribution Unit (PDU) Test

Compliant with UL1741, IEEE1547 and similar grid-tied standards world-wide.

Multiple Configuration Possibilities



9410 & 9420 Series

Programmable 1, 2 or 3-phase configuration

9420 AC Power Source



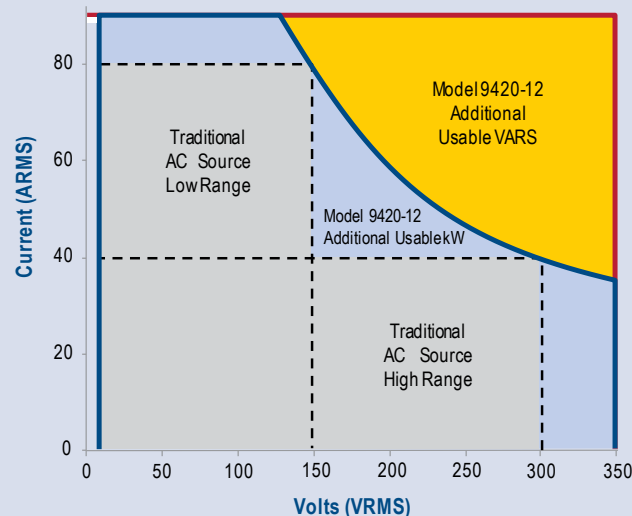
General Purpose AC Stimulus

- 8 power ratings – scalable from 8 to 96 kW
- Dual range – 175, 350 VAC at 30 to 880 Hz AC
- Dual range – 200, 400 VDC
- Programmable 1, 2 or 3-Phase
- Ultra-low current Energy Star measurement ranges
- DC output & bi-directional DC operating option
- Mix AC & DC on separate output channels
- Built-in safety isolation relays

Applications:

- ATE Applications: Regulatory Test
- Power-line Disturbance
- Power Conversion: AC/DC Converter Test
- Charger, UPS, Power Distribution Unit Test
- Data Center/Service
- Energy Star - Low Current Range

HIVAR® Offers 2 x Reactive Power Capability per kW

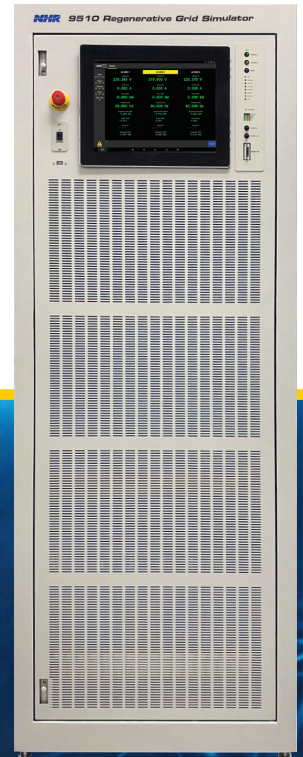


The 9420 12kW in single-phase mode has an extended operating envelope with more useable true power.

NH Research 9430 & 9510 Series

- Regenerative 4-Quadrant
AC Load

- Regenerative Grid Simulator



9430 Regenerative 4-Quadrant AC Load



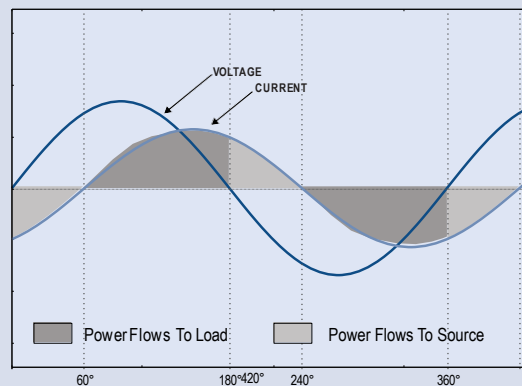
Linear & Non-Linear AC Loading in Several Emulation Modes

- 8 power ratings – 4 to 96 kW
- Programmable 1, 2 or 3-Phase
- AC voltage range – 10 to 350 VAC
- Frequencies – 30 to 880 Hz
- DC voltage range – 10 to 400 VDC
- Reactive power capability 2.6 x real power
- High efficiency > 90%
- Slewable power factor range: -1 to +1
- Crest factor range: 1.414 to 4.000

Applications:

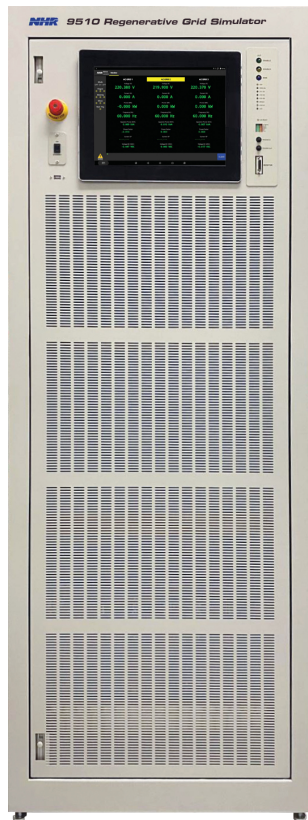
- Full Line Disturbances at Any Power Factor
- Grid Utility Test, Inverter Test, UPS Test
- EV Load Testing
- Switch, Fuse Test
- Linear & Non-linear Loading, Inductive & Capacitive Loading Requirements.

4-Quadrant Operation



Inductive Load waveform showing bi-directional power flows.

9510 Regenerative Grid Simulator

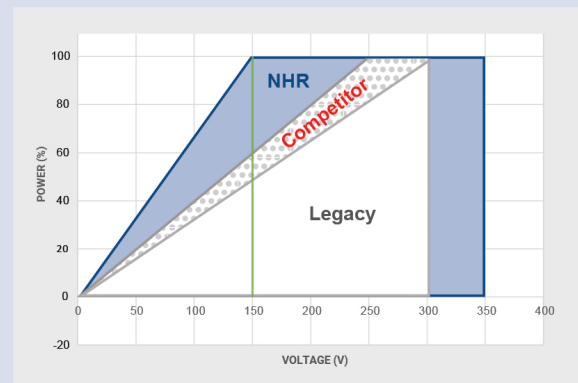


Regenerative AC/DC Grid Simulator & Power Amplifier optimized for PHIL applications

- Modular & scalable AC power from 100kW to 1.2MW
- AC Load option: Modules can be configured as Regenerative
- AC/DC Grid Simulator or 4-Quadrant AC Load
- Widest True-Power Operating Envelope (Voltage & Current)
- Galvanic Isolation – output, channel to channel UUT
- Highest power density with small footprint
- Multiple phase & DC capability covers all utility source and load requirements
- Programmable three-phase, split-phase, or single phase
- Powerful waveform synthesizer combined with high-resolution digitizer covers extensive test & evaluation requirements.
- Ideal for Regulation Testing Standards: UL 1741SA, IEEE 1547, IEC 62116, IEC 61000-4-11 (pre-compliance), 4-13, 4-14, 4-28, etc.

Applications:

- Full Line Disturbances at Any Power Factor
- Grid Utility Test, Inverter Test, UPS Test
- EV Load Testing
- Switch, Fuse Test
- Linear & Non-linear Loading, Inductive & Capacitive Loading Requirements.



9510 Maxpower Delivered at 150VAC L-N

Worldwide Service & Customer Support

Need help? Contact us for more info.



Contact Us



Technical Support



Training

*“At NHR, we consider every customer a **partner**.”*

We help you achieve your goals.

- **Expertise** – application, product design, engineering specialists on stand-by
- **Access** – rapid response times by phone, email & site-visits
- **Support** – technical experts, training, diagnostic tools, calibration tools & replacement parts to resolve problems quickly

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Enabling Electrification

Your Partner in Test

