



# NH Research (NHR)

## Introduction & Product Overview

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

*Your Partner in Test*



# 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
- Ease of use
- Modular & scalable solutions
- Reduced testing time
- Improved safety
- Energy savings



## Our Products

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

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



# Our Value



## Simplified Testing

- Easy set up, intuitive GUI and 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

# Table of Contents

## Industry Overview | 5 – 8

- Electric Vehicles . . . . . 5
- Aerospace & Defense . . . . . 6
- Energy Storage & Battery Test . . . . . 7
- Renewable Energy & Microgrid . . . . . 8

## Product Overview | 9 – 19

### NHR 9200 & 9300 Series | 9 – 11

*Bi-directional DC Source*

*Battery Test Systems*

*Battery Emulation*

*Regenerative DC Electronic Loads*

- 9200 Series - Low to Medium Voltage . . . . . 10
- 9300 Series - Medium to High Voltage . . . . . 11

### AC Loads | 12 – 13

- 9430 Regenerative 4-Quadrant AC Load . . . . . 12
- 4600 Series 2-Quadrant AC Load . . . . . 13

### AC Sources/Grid Simulator | 14 – 15

- 9410 Regenerative AC Grid Simulator . . . . . 14
- 9420 AC Power Source . . . . . 15

### DC Electronic Loads | 16 – 17

- 4300 Series Modular DC Load - up to 120 V, 500 V . . . . 16
- 4700 Series Benchtop DC Load - up to 120 V . . . . . 17
- 4760 Series Benchtop DC Load - up to 600 V . . . . . 17

### DC Regenerative Loads

*Regenerative DC Electronic Loads (9 – 11)*

### Energy Test System Software Solutions | 18

- Enerchron® Test Executive Software . . . . . 18

### Power Supply Test Systems | 19

- EmPower® Software . . . . . 19
- 5600 - Universal Tester . . . . . 19
- 5710 - Engineering Characterization Test System . . . . 19
- S600 - Multi-channel Test System . . . . . 19

## Worldwide Service & Customer Support | 20

# Automotive | Electric Vehicles

EV test solutions for powertrain, battery test, DC fast charger & power electronics



## Example Applications



### DC Fast Charger Test

- Battery emulation
- V2L, V2G
- High power wireless



### Powertrain Test

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



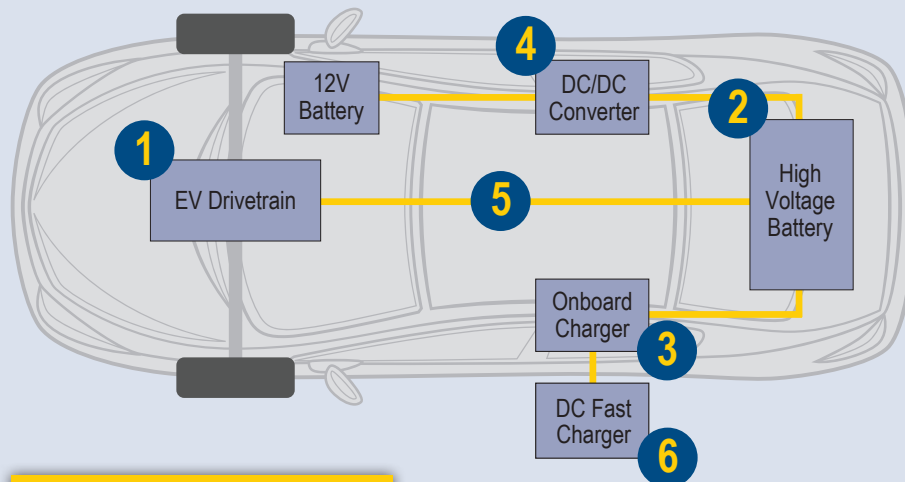
### Battery Test

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



### Power Conversion

- DC to DC converter
- EVSE, Onboard charger
- In-vehicle electronics



## Complete EV Test Solutions

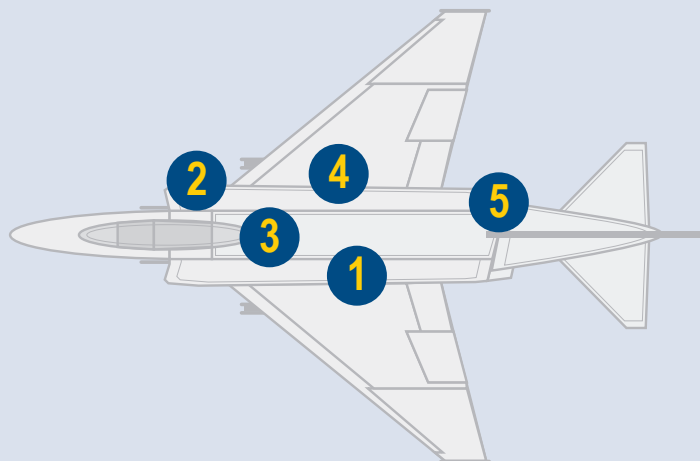
- 1 Powertrain
- 2 High Voltage Battery Test
- 3 Onboard Charger & EVSE
- 4 DC/DC Converter
- 5 In-vehicle Power Electronics
- 6 DC Fast Charger

[Learn More](#)



# 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.

[Learn More](#)

## Example Applications



### Traditional ATE

- Power supply
- Power conversion
- Chargers



### 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



### Solar PV & Grid Tied

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

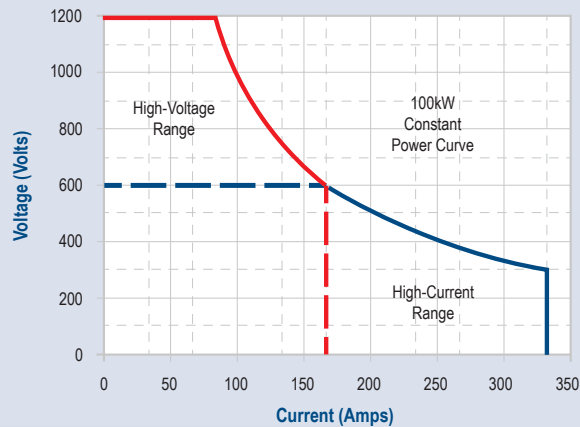
- EV powertrain
- Avionics propulsion systems
- DC fast charger
- Micro-grid simulation
- Solar PV emulation



### Power Conversion

- Grid-tied inverters
- DC-DC converters
- Power Distribution Units
- UPS

## Wide Operating Envelope



[Learn More](#)

## Modular & Scalable Power

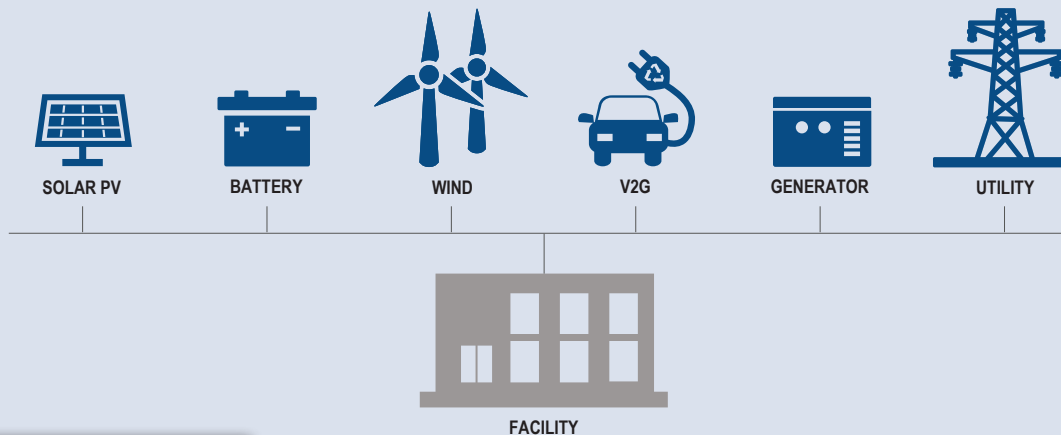




# Renewable Energy | Microgrid

Renewable energy test solutions for solar PV, grid-tied technologies & energy storage systems

## Microgrid Test Solutions



[Learn More](#)

## Example Test Applications



### Grid-tied Technologies

- Distributed generation (DG)
- V2G, 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



# NHR 9200 & 9300 Series

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Bi-directional DC Source



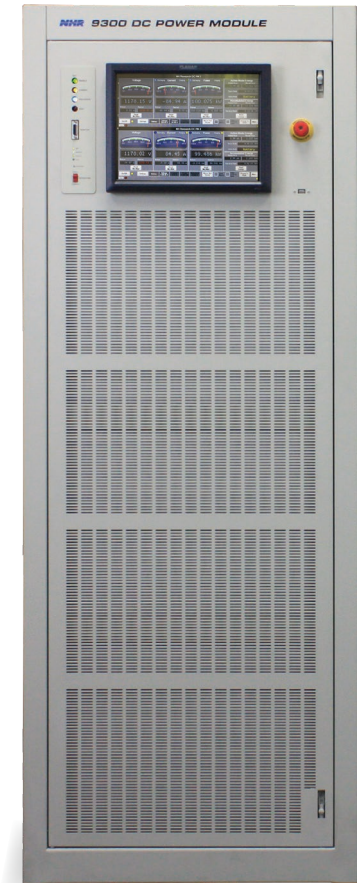
Battery Test System



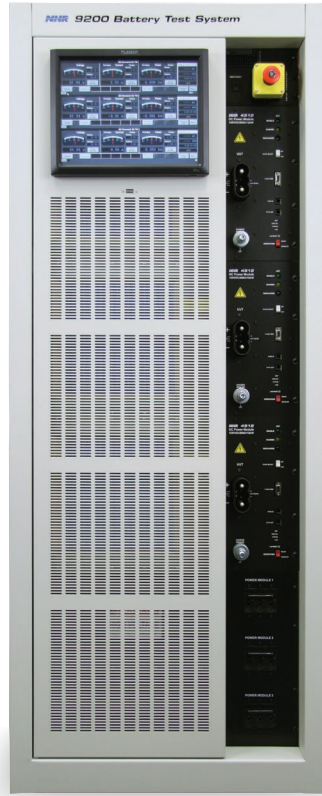
Battery Emulation



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, 120, 240 & 600 V
- Up to three 12 kW modules/cabinet, scalable to 144 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

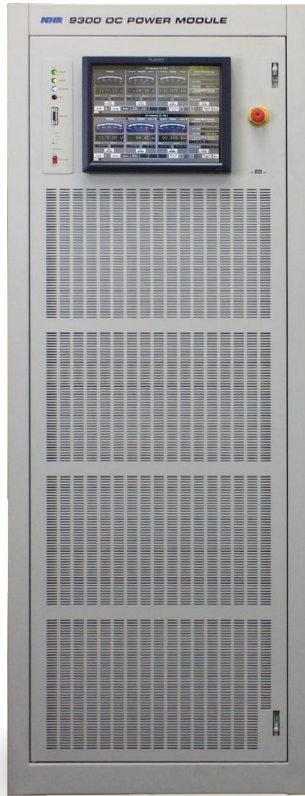
## Battery Test:

- EV/ESS 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)
- Microgrid, 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/ESS 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)
- Microgrid, ESS, PV Emulation

# 9430 Regenerative 4-Quadrant AC Load



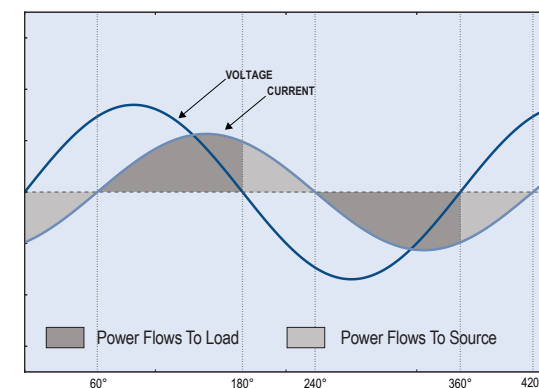
## Linear & Non-Linear AC Loading in Several Emulation Modes

- 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%
- 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.*



# 4600 AC Load



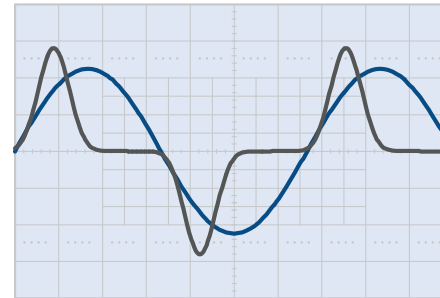
## Applications:

- UUT Reliability Testing, UPS Testing, V2G
- Grid Utility Test, Inverter Test
- Linear & Non-linear Loading, Inductive & Capacitive Loading Requirements
- True Short Circuit Test

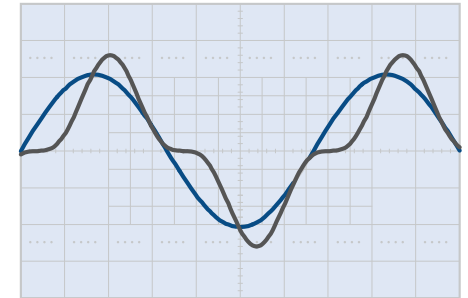
## Programmable Power & Crest-Factor Control of AC Loading

- 6 power ratings – 3 to 36 kW
- Programmable 1 & 3-phase
- User-defined waveforms
- PC control using LabVIEW & IVI drivers
- 100-step macro per cycle loading changes
- CC, CR, CV, CP, SC, UPF & CNL emulation modes

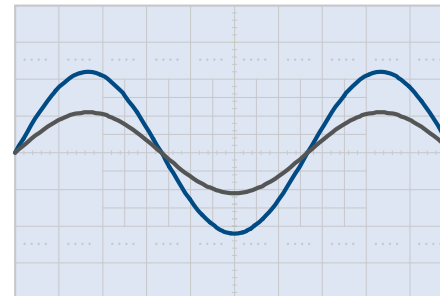
### Leading Power Factor



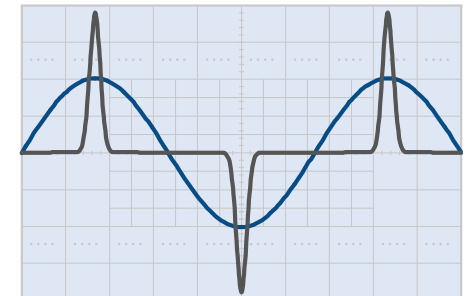
### Lagging Power Factor



### Utility Power Factor



### High Crest Factor



*The 4600 can simulate a resistor, constant load (CC or CP), or non-linear rectified loading and shifting rectified loading (capacitive or inductive).*

# 9410 Regenerative Grid Simulator



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

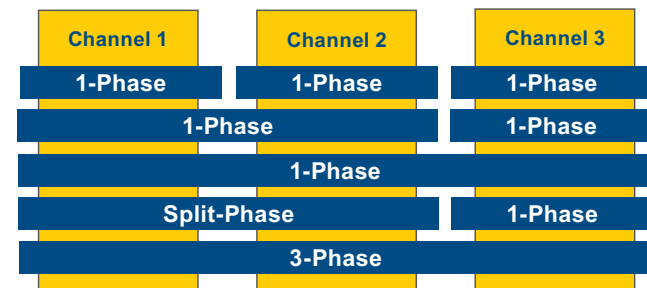
- 8 power ratings – scalable from 4 to 96 kW
- Dual AC voltage range – 175, 350 VAC at 30 to 100 Hz AC
- Dual DC voltage range – 200, 400 VDC
- Programmable 1, 2 or 3-Phase
- Regenerative discharge (load)
- High efficiency > 90%
- Mix AC & DC on separate output channels
- Built-in safety isolation relays

## Applications:

- Grid Simulation: Microgrid systems
- V2G, 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



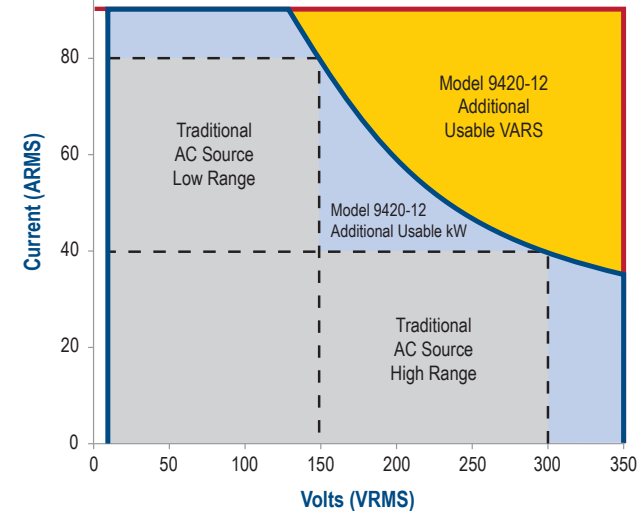
## Applications:

- 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

## General Purpose AC Stimulus

- 7 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

## 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.*

# 4300 Series Modular DC Load



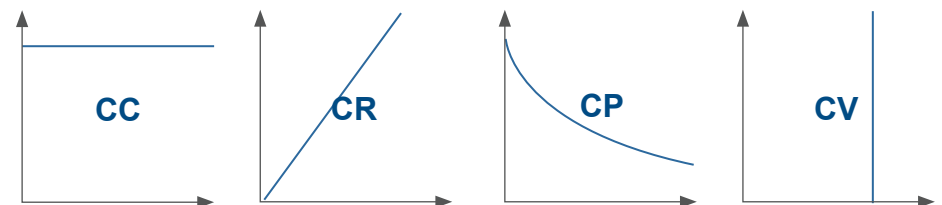
Mix & Match up to 16 Loads with Independent Measurement Capability in a Single 5U / 8 3/4" Chassis

- Voltage rating – 120 V or 500 V
- 3 Power ratings – 150, 300 & 600 W
- Advanced built-in scope measurements, waveform capture & analysis
- Drastically reduces muxing channel count
- High functionality reduces ATE footprint
- Power Analyzer & OVP source available
- Mix & match loads for maximum configuration flexibility
- Isolated digital inputs & outputs for test fixture support
- PC/LAN control with LabVIEW & IVI drivers

## Applications:

- ATE Testing: Radar Power Emulation, Aviation, Power Supply, Solar Panel
- Power Devices: Chargers, Adapters, DC Supplies, LED Drivers, Telecom Rectifiers
- Fuel Cell Test, Super Capacitor Test
- Power Conversion
- EV Subsystem Test: OBC, V2G, APM, DC/DC Converter
- Highly Modular, Flexible & Compact Test Requirements

## Precision in Digitally Controlled DC Loading



## 4300 & 4700 Series:

- High accuracy in both set & measurement
- Ultra-fast slew-rate controls for all loading modes
- Fast transients, sub-millisecond pulse



# 4700 & 4760 Series DC Load - Bench Top



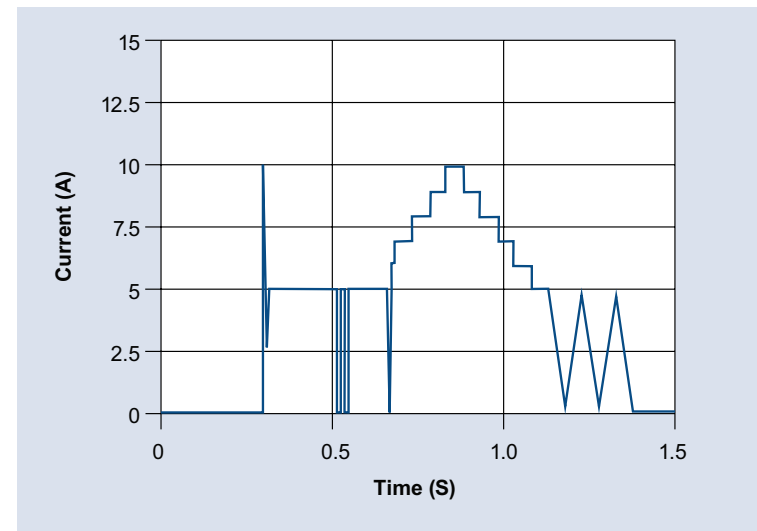
Fast-Transient, High-Current Linear Loads for Bench-Top or Automated Test Station Use

- 8 power ratings
  - 4700 Series - 1 kW / 200 A / 120 V to 36 kW / 7200 A / 120 V
  - 4760 Series - 1 kW / 50 A / 600 V to 36 kW / 1800 A / 600 V
- High accuracy 1 kW low power range
- Built-in advanced measurements, waveform capture & analysis
- PC control using LabVIEW & IVI drivers
- Optional touch-panel graphical user interface

## Applications:

- ATE Testing: Radar Power Emulation, Aviation, Power Supply, Solar Panel
- Power Devices: Chargers, Adapters, DC Supplies, LED Drivers, Telecom Rectifiers
- Fuel Cell Test, Super Capacitor Test
- Power Conversion
- EV Subsystem Test: OBC, V2G, APM, DC/DC Converter
- Ideal for Fast Transients, Ultra-low Voltage Loading (down to .01 VDC)

## High-Speed / Real World Transient Simulation



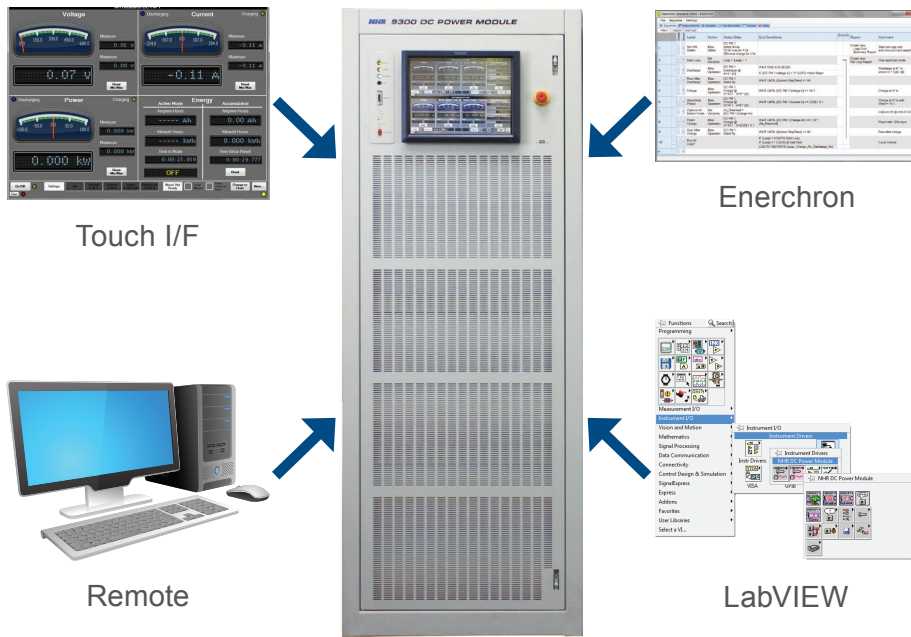
### 4300 & 4700 Series

Inrush simulation, step changes (20 $\mu$ S), noise simulation

# The Power of Choice (NHR Advantage)

*Write your own software - Enerchron Test Executive - Work with your favorite Integrator*

## Flexible Data Control Options



## Products Supported:

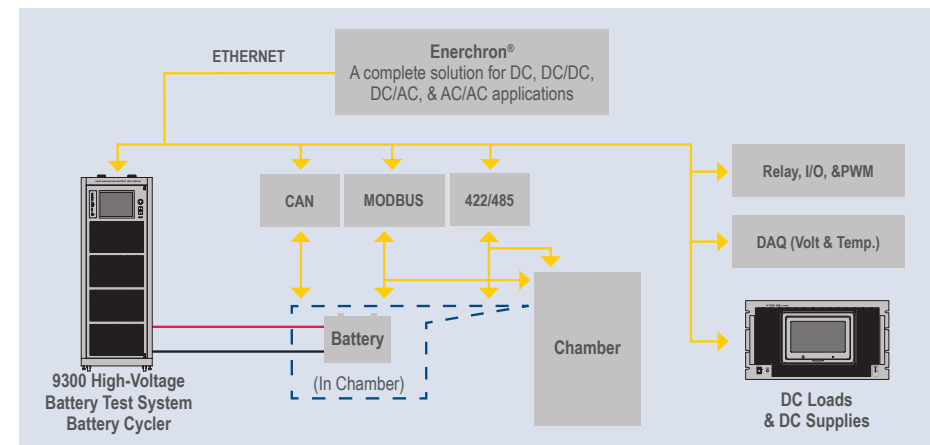
- 9200 Series, 9300 Series
- 4312, 4350, 4700, 4760 Series DC Loads
- 9410 Regenerative AC Grid Simulator
- 9420 AC Power Source
- 9430 Regenerative 4-Quadrant AC Load

## Enerchron Test Executive Software

Test Executive with Advanced Test Creation, Execution, & Reporting Capabilities for Battery Cycling & Other Energy Product Testing

- Powerful test sequencer editor that is flexible & intuitive
- 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

## Test System Solutions



# Power Supply Test Systems



## emPower™ Test Executive Software

Simplified Test Creation, Execution & Reporting for Power Supply Functional Tests

- Ideal for matrix & high volume testing
- Zero post-development using automatic report generator
- Sequencer with built in features
- Reduces software development time & risk
- Easy data entry environment
- Complete library of design verification test routines
- Speeds up test & increases productivity

## 5600 - Universal Test System (AC-DC, DC-DC)

Universal tester for testing power supplies with DC outputs

- Maximum configuration flexibility with multi-bay capacity
- Digitizer replaces several single-function instruments 2 waveform digitizers, 2 x 16, 100 Mhz multiplexer
- Expandable input measurement channels
- Common interface panel

## 5710 - Engineering Characterization Test System (AC-DC, DC-DC)

Characterization/Design Verification, Power Supplies/ATE Testing

- Tektronix MDO-Series Mixed Signal Oscilloscope
- Unlimited voltage, current & timing measurements
- Library of design verification test routines reduces program development time
- Wide configuration flexibility

## S600 - Multi-Channel Power Supply Test System (AC-DC)

High Speed, Parallel Testing of High Volume Power Conversion Devices

- Configurable up to 16 devices in parallel at different outputs
- Easy configuration through front-loading, card-based instruments
- Built-in waveform digitizers on all instruments
- Time-synchronized multi-output UUT testing
- Space savings

# 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

## Contact us for more info:

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