



NH Research (NHR) Product Overview

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

Your Partner in Test

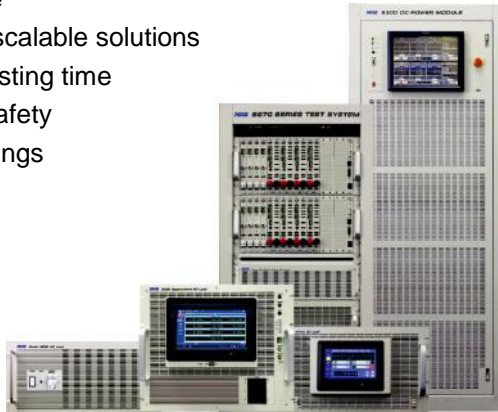


Enabling Electrification

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 test system solutions.

- ✓ Battery test systems & battery emulators
- ✓ Grid simulators
- ✓ Bi-directional sources
- ✓ AC & DC electronic loads
- ✓ 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 and 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 (p5-8)

Electric Vehicles (p5) , Aerospace & Defense (p6)
Energy Storage & Battery Test (p7), Renewable Energy & Microgrid (p8)

Product Overview (p9-19)

NHR 9200 & 9300 Series (p9-11)

Bi-directional DC Source

Battery Test Systems

Battery Emulation

Regenerative DC Electronic Loads

- 9200 Series – Low to Medium Voltage (p10)
- 9300 Series – Medium to High Voltage (p11)

AC Loads

- 9430 Regenerative 4-Quadrant AC Load (p12)
- 4600 Series 2-Quadrant AC Load (p13)

AC Sources/Grid Simulator

- 9410 Regenerative AC Grid Simulator (p14)
- 9420 AC Power Source (p15)

DC Electronic Loads

- 4300 Series Modular DC Load - up to 120 V, 500 V (p16)
- 4700 Series Benchtop DC Load - up to 120 V (p17)
- 4760 Series Benchtop DC Load - up to 600V (p17)

DC Regenerative Loads

See *NHR 9200, 9300 Series (p9-11)*

Energy Test System Software Solutions

- Enerchron® Test Executive Software (p18-19)

Worldwide Service & Customer Support (p20)

Automotive | Electric vehicles

EV test solutions for powertrain, battery test, DC fast charger & e-mobility

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

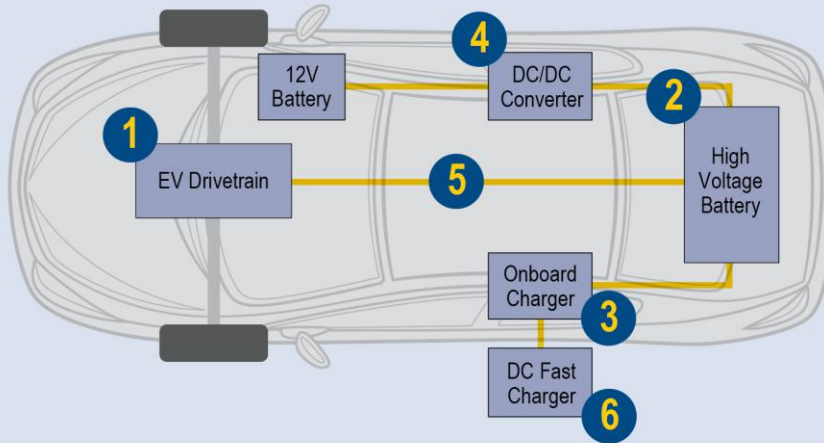


Power Conversion

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

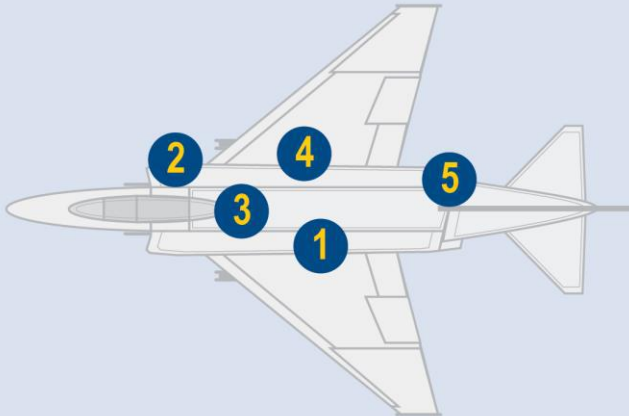
Complete EV Test Solutions

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



Aerospace & Defense

ATE-friendly and 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



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

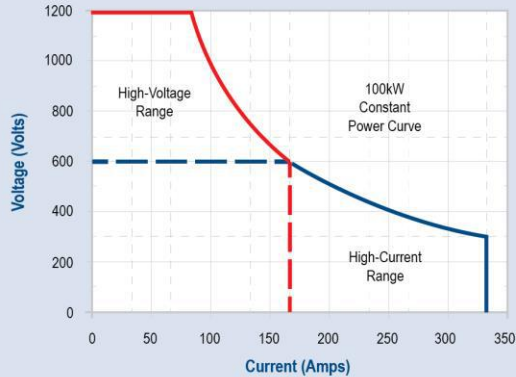
- DG, V2G, ESS, micro-grid simulation
- PV emulation, PV inverter test

Battery Test & Energy Storage

Test solutions for all battery chemistries, fuel-cells, supercapacitors & energy storage devices



Wide Operating Envelope



Modular & Scalable Power



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



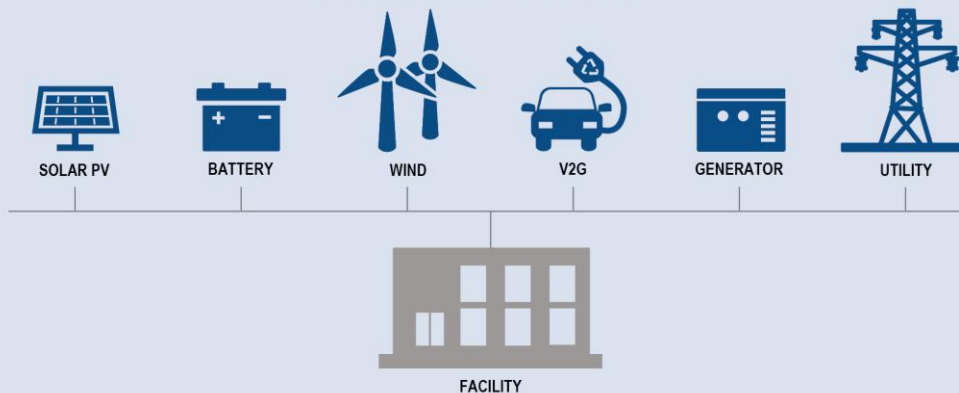
Power Conversion

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

Renewable Energy | Microgrid

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

Microgrid Test Solutions



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

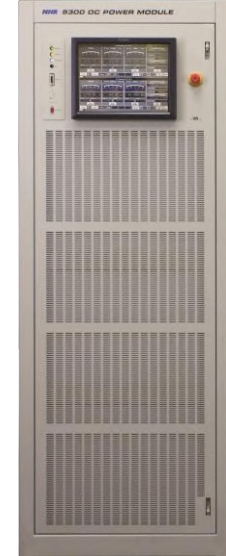
- AC-DC, DC-DC converter
- UPS - Power Distribution Unit

NHR 9200 & 9300 Series

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



9200 Series
12 kW up to 21 channels



9300 Series
100 kW up to 2.4 MW

9200 Series – Low to Medium Voltage



Modular, Regenerative, Bidirectional 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%
- ✓ 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 Electric 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 Bidirectional 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%
- ✓ 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 Electric 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



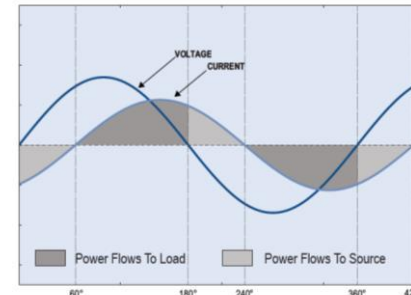
Applications:

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

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

4-Quadrant Operation



Inductive Load waveform showing bi-directional power flows.

4600 AC Load



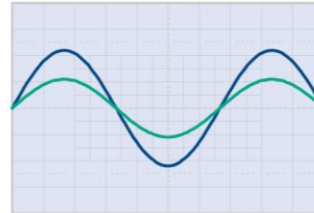
Programmable Power & Crest-Factor Control of AC Loading

- ✓ 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

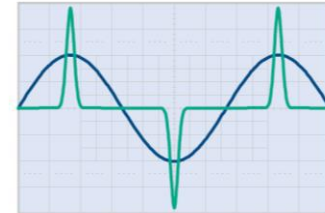
Applications:

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

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

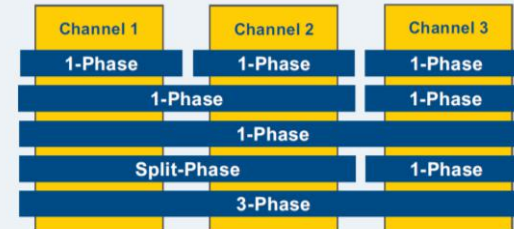
- ✓ 8 power ratings – scalable from 4 to 96 kW
- ✓ Dual AC voltage range – 175, 350 VAC at 30 to 100 Hz AC
- ✓ Dual DC voltage range – 200, 400 VDC
- ✓ Programmable 1, 2 or 3-Phase
- ✓ Regenerative discharge (load)
- ✓ High efficiency > 90%
- ✓ Mix AC & DC on separate output channels
- ✓ Built-in safety 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 IEC, EN, VDE, GB and similar grid-tied standards world-wide.

MULTIPLE CONFIGURATION POSSIBILITIES



9410 & 9420 Series

Programmable 1, 2 or 3-phase configuration

9420 AC Power Source



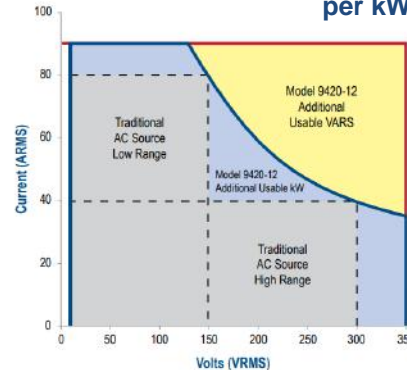
General Purpose AC Stimulus

- ✓ 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

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.

4300 Series Modular DC Load



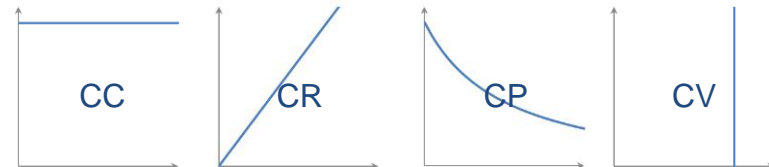
Mix & Match up to 16 Loads with Independent Measurement Capability in a Single 5U / 222.25mm Chassis

- ✓ 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



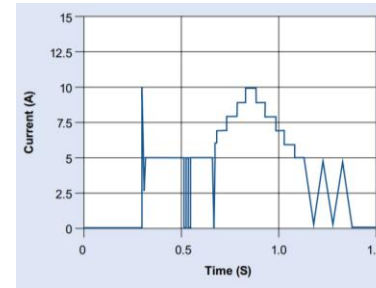
Fast-Transient, High-Current Linear Loads for Bench-Top or Automated Test Station Use

- ✓ 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



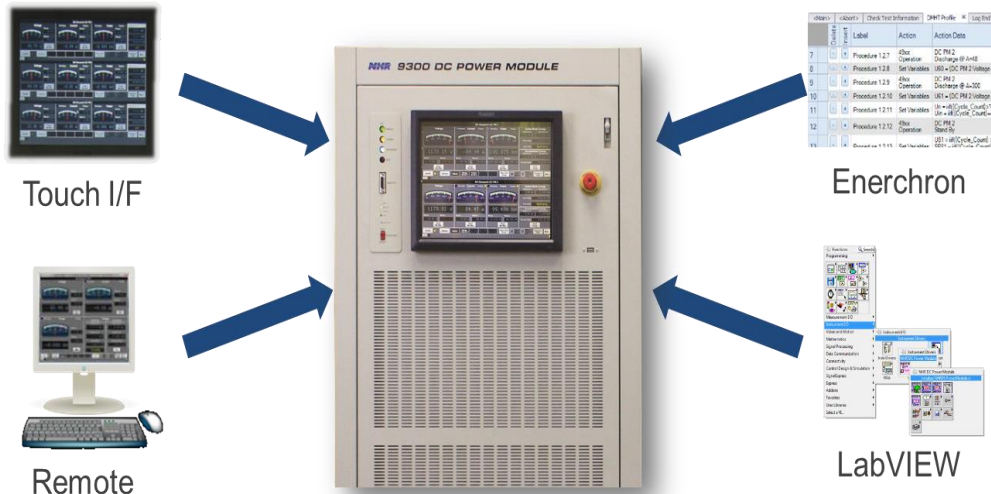
4300 & 4700 Series

Inrush simulation, step changes (20 μ 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



Instrument or System Solutions

Individual test instruments can be easily controlled within the system or integrated with third party tools.

- GUI & Automation
- Large, easy to use touch screen
- Real-time data visualization
- Intuitive manual & remote control
- Fully documented drivers such as SCPI, IVI-C / IVI
- COM and LabVIEW® drivers

Enerchron Test System Solutions

Dramatically Reduce Testing Time & Costs

Test System Solutions



Full integration of NHR & third-party tools required for test

Products Supported:

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

Enerchron Test Executive Software

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

Saves test development time

- Dynamic variable-based test sequences
 - Save key data & perform calculations
 - Dynamically control the test during test
 - Implementing drive/grid cycles is easy as 1-2-3
- Reduces operator error
- Third-party integration with tools (CAN, Modbus, LAN, RS232-485)

Eliminates duplication of test development efforts

- Programmable Re-mapping Capability
- Scalable, reusable test programs
- Test at any station or UUT

Saves engineering post processing time

- Capture & log key measurement points during test
- Perform calculations in test
- Results automatically logged to all data reports
- Configurable multiple-report engine saves required data

Worldwide Service & Customer Support

Need help?

Contact us for more info.



Contact Us



Technical Support



Training

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 and replacement parts to resolve problems quickly

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

Phone: 949-474-3900

Email: sales@nhresearch.com

Website: www.nhresearch.com

NHR Headquarters

16601 Hale Ave.

Irvine, CA 92606