



Electric Flight Test Solutions

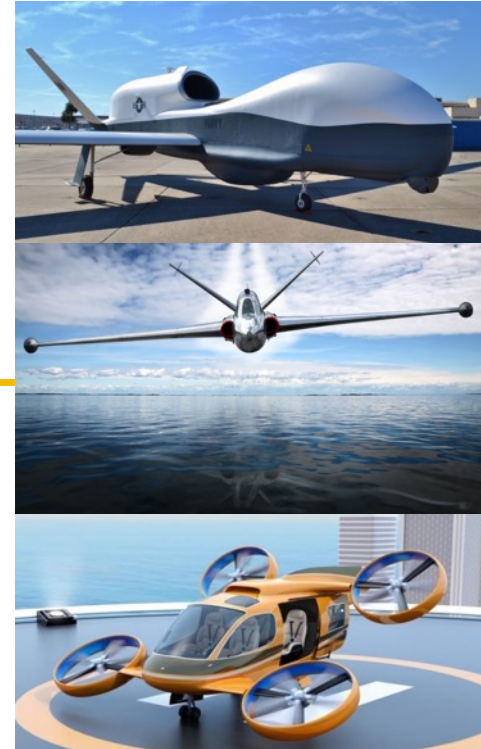
*Full & Hybrid-Electric Planes, E-VTOL,
Flying Taxis, Drones*

Components & systems:

Batteries, electric propulsion & power electronics

NH Research (NHR)

Enabling Electrification

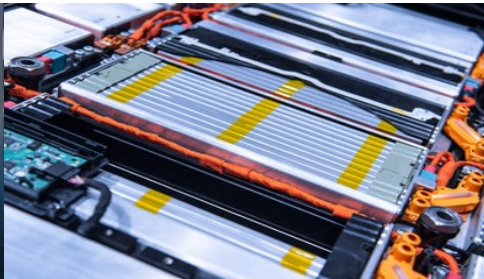


Enabling Electrification

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

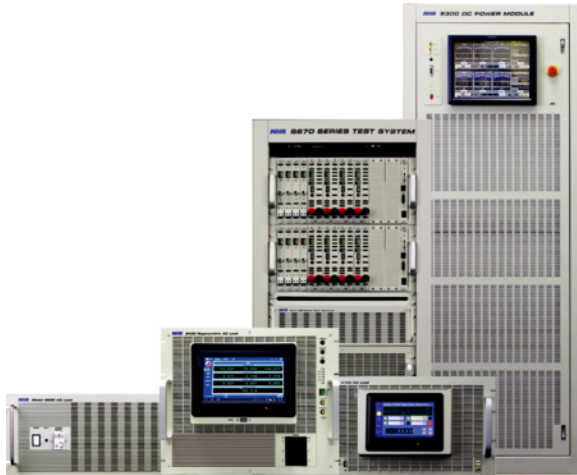
Backed by over 50 years of experience

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



World-Class Test Solutions

**Flexible, Modular Hardware
AND Software**



Product Portfolio

- ✓ Battery/Fuel Cell Test Systems
- ✓ Bi-directional DC Source
- ✓ Grid Simulators
- ✓ AC & DC Electronic Loads
- ✓ AC & DC Power Sources
- ✓ Power Supply Test Systems

...Your Partner in Test

Electric Flight



Commercial Airplanes



Military & Defense



eVTOL



Drones



Flying Taxis



Batteries, Fuel Cell, Propulsion

...and more!

“The Grid” Revolutionizes Electric Aircraft

Advanced, High Power R&D Lab



NHR 9300 Series



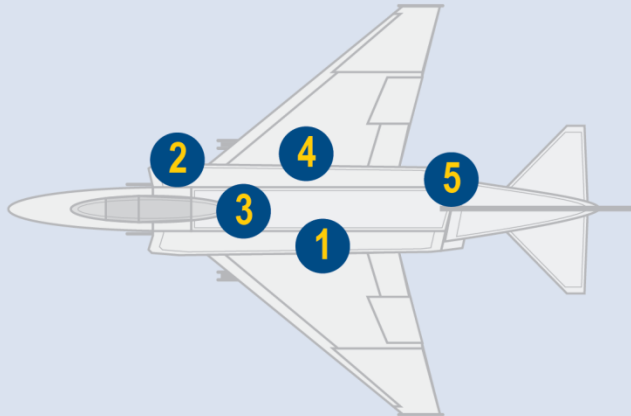
Collins Aerospace “The Grid”

NHR provides high voltage DC power farm

[Read the Press Release](#)

Aerospace & Defense

ATE-friendly and next generation power test solutions from R&D to sustainment



Complete Avionics Test Solutions

- ❶ Batteries, capacitors
- ❷ Propulsion system
- ❸ AC-DC, DC-DC converters
- ❹ AC generators
- ❺ Auxiliary loads, switches, electric actuators, etc.

Electric Flight Test Solutions

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

Electric Flight Power Test Solutions

High Voltage
Battery

Propulsion

Primary/Secondary
PDU

DC-DC
Converters

Electric
Actuators

Inverter



Example: e-VTOL (Electric Vertical Take-off and Landing)

High Voltage Battery Tester

NHR's 9300 and 9200 Battery Test Systems enable scalable power and flexible configurations for life-cycle, drive cycle & performance testing.

9300 Series - 100kW modules up to 2.4 MW, Dual range (600 V, 1200V)

9200 Series - 12kW modules parallel up to 21 channels

- Modular & scalable power
- Fast response times
- Built-in safety isolation relays and contactors
- Easy third-party integration & data management
- Optional test system software available



High Voltage Battery



Full-Electric Propulsion

NHR's 9300/9200 battery emulators can be used to emulate a high voltage battery and the DC Buss, ideal for electric propulsion testing.

9300 Series - 100kW modules up to 2.4 MW, Dual range (600 V, 1200V)

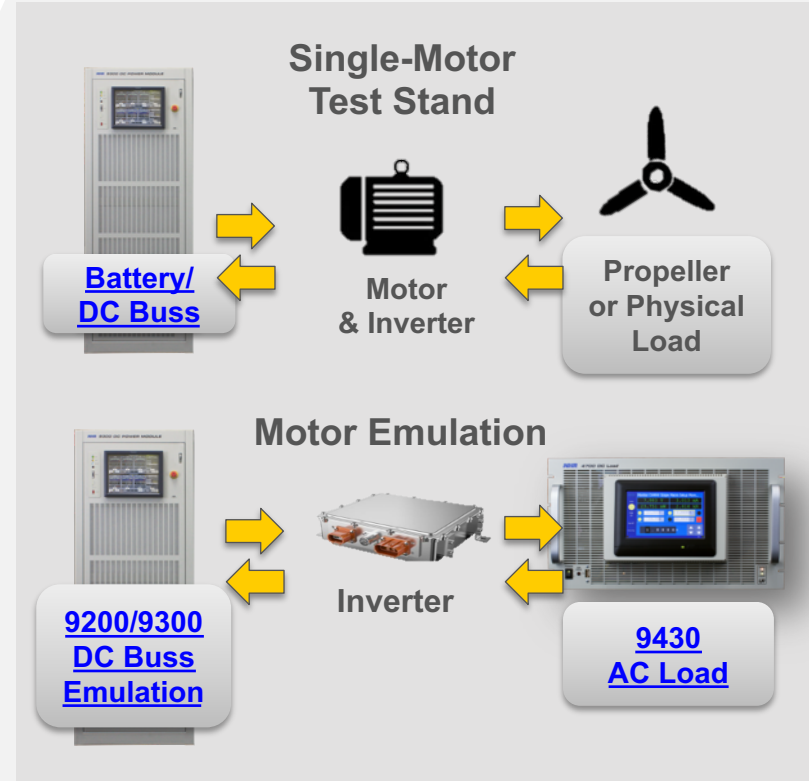
9200 Series - 12kW modules parallel up to 21 channels

- Accepts back EMF ensures accuracy & prevents safety hazards
- Battery emulation sinks & sources to maintain voltage regulation
- Built-in safety isolation relays & contactors
- Easy third-party integration & data management
- Optional test system software available



Propulsion
System

Full Electric Propulsion





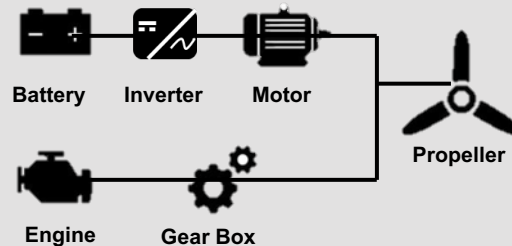
Parallel Hybrid Electric
Electric motor provides rotation and supports the combustion engine for peak performance.

Propulsion System

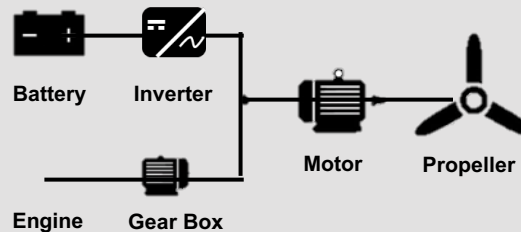
Serial Hybrid Electric
Combustion engine used to generate electrical energy to charge a battery or run the electric motor

Hybrid Electric Propulsion

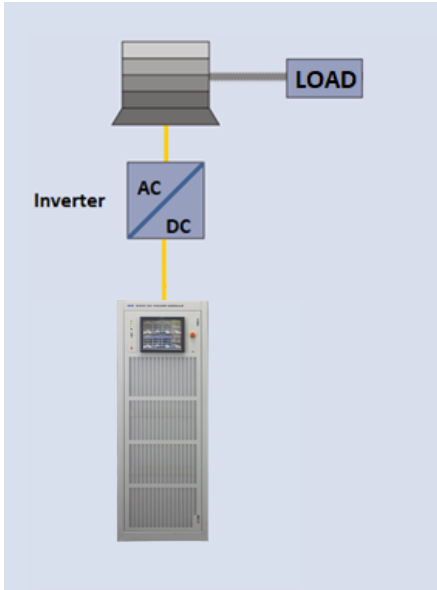
Parallel Hybrid Electric



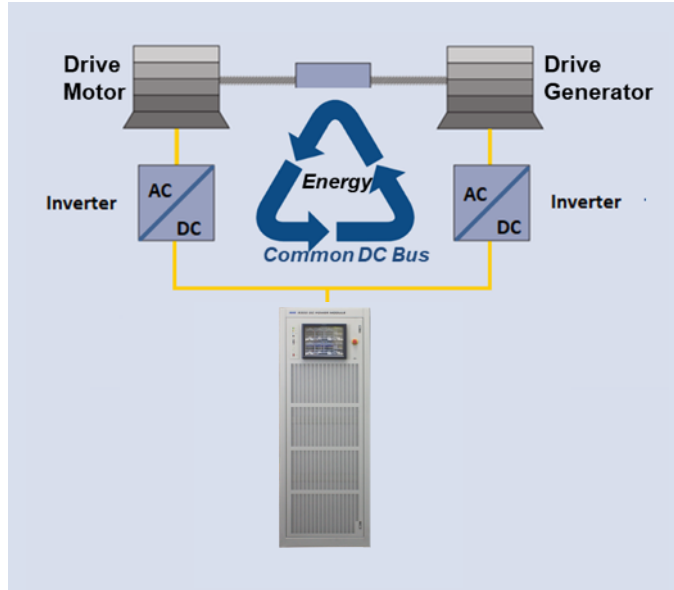
Serial Hybrid Electric



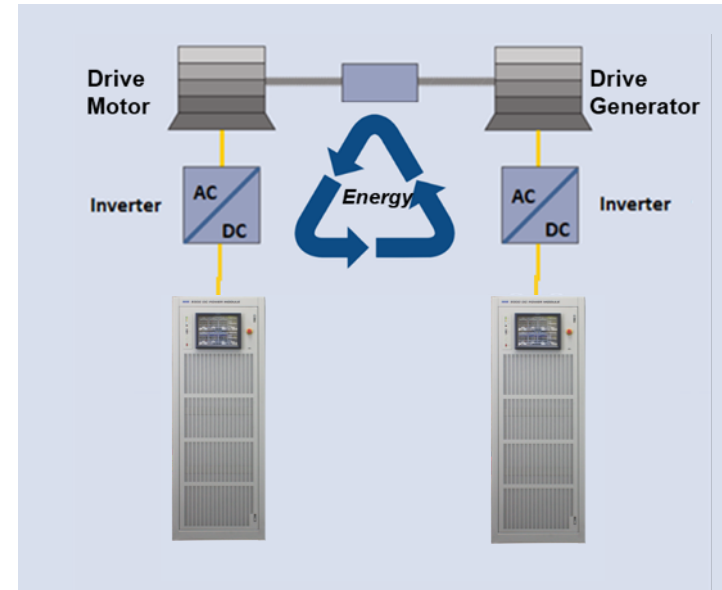
Electric Propulsion Test Approaches



Single-ended DC Bus



Common DC Bus



Isolated DC Bus

The **NHR Approach** accepts back EMF and prevents safety hazards. Isolated input and output paths eliminates single points of failure.

Power Distribution Units

NHR provides safe solutions for testing PDUs which route multiple high power sources and loads throughout the aircraft.

- Modular power configuration & flexibility
- Fast transient capabilities
- Built-in safety isolation relays and contactors

Bi-directional DC Source for Battery Emulation

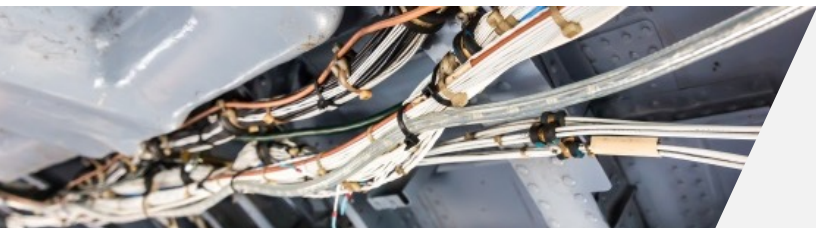
- **9300 Series** - 100kW modules up to 2.4 MW
- **9200 Series** - 12kW modules

DC Load for transient load inrush simulation

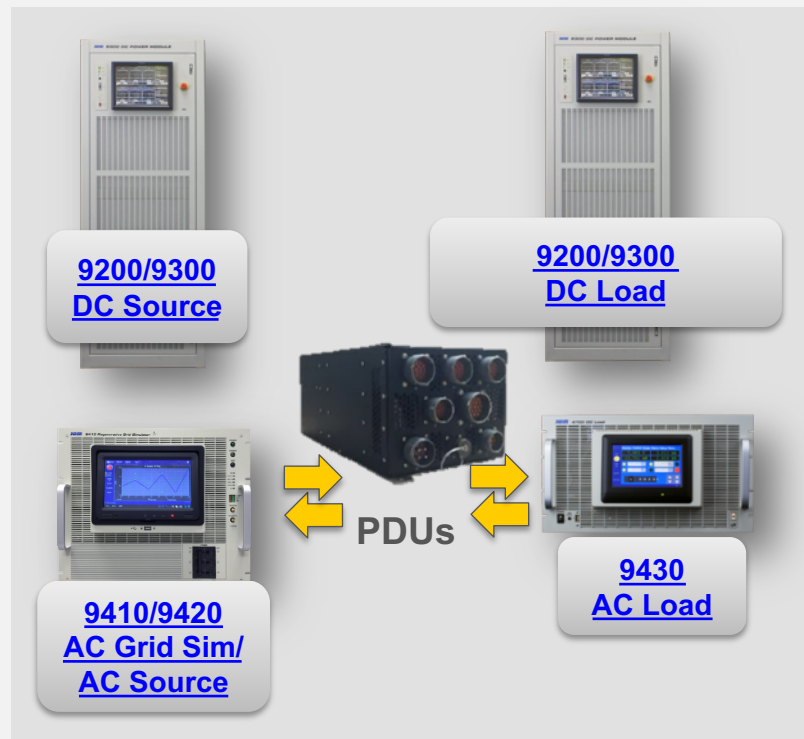
- **9200/9300 Series** - Regenerative > 90%

AC Sources/ Loads

- **9410** Grid Sim/ **9420** AC Source
- **9430** Regenerative 4 Quadrant Load



Primary & Secondary Power Distribution Units



Aircraft Electrical Power Systems

NHR's DC loads are ideal for multi-channel load testing while NHR's 9300/9200 bi-directional DC source can be used to emulate the PDU power source.

DC Load for transient & accessory load inrush simulation

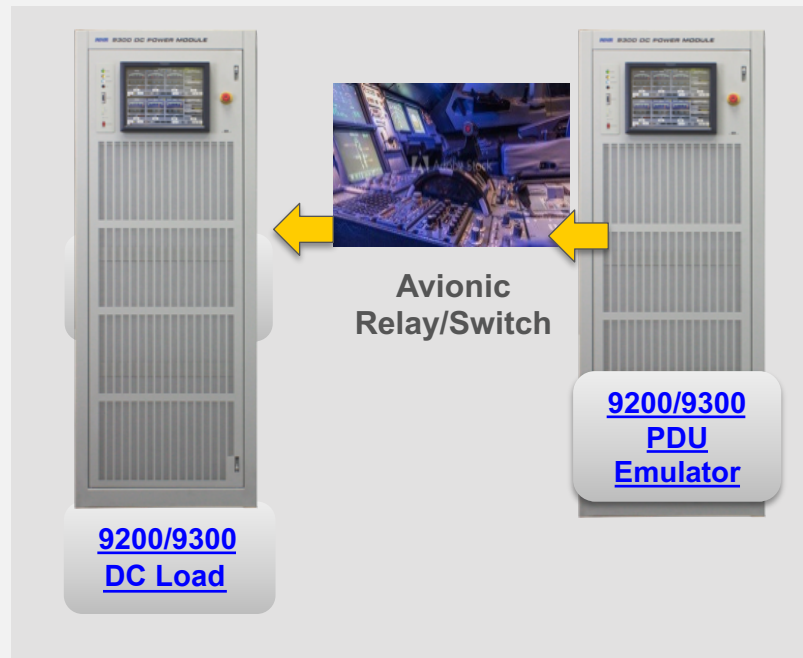
OR

Bi-directional DC Source for Battery Emulation

- **9300 Series** - 100kW modules up to 2.4 MW
Dual range (600 V, 1200V)
- **9200 Series** - 12kW modules
Parallel up to 21 channels



Power Electronics, Cockpit Control Power, etc.



Battery Test/Emulation Solutions

Flexible, Modular Hardware AND Software



Benefits

- ✓ **Modular, Configurable Power**
- ✓ **Scalable Solutions**
- ✓ **Fast response times**
- ✓ **Reduced testing time**
- ✓ **Battery Emulation Mode**
- ✓ **Improved safety**
- ✓ **Energy savings**

Test Solutions for Today's Products & Tomorrow's Innovations

NHR's 9200 Battery Test System



- Lower power, **12kW** modular design
- Configured to meet your application
 - 40V** – Start/Stop, military, & starter/generator
 - 120V** – Battery modules & 48V systems
 - 600V** – APM, OBC, and EV electronics

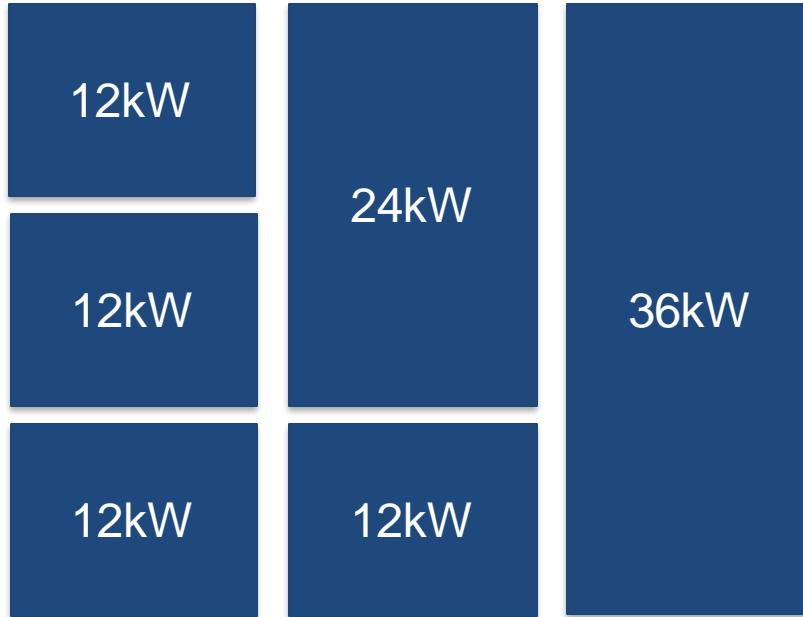
NHR 9300 High Voltage Battery Test System



- Battery Module/Pack Level Testing
- Dual Voltage Range Design **600V, 1200V**
- Modular **100kW** per Cabinet Design
Configurable from **100kW up to 2.4MW**
- Regenerative > 90% Energy Efficiency
- Fast Transient Speeds

Meet power demands of today & tomorrow

Modular & Scalable Power



Flexible Configuration:

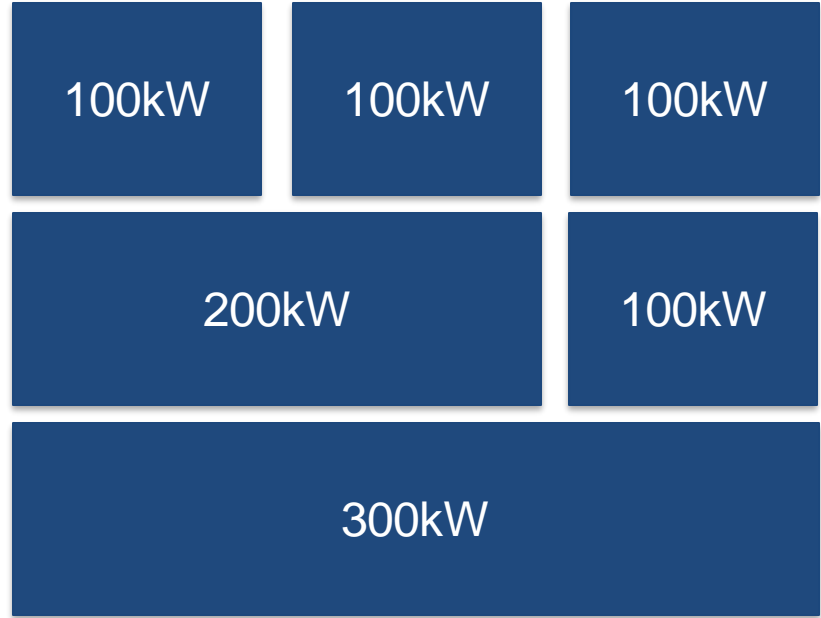
- 3 x 12 kW Modules can be used independently
- Parallel two modules to make 24kW channel
- Parallel three modules to make 36 kW channel
- Channels can sink/source independently and simultaneously!

You Control Size to Maximize Use In Test!

Modularity: Future Proof & Maximize Use



**Covers All Power Levels
from 100kW to 2.4MW**

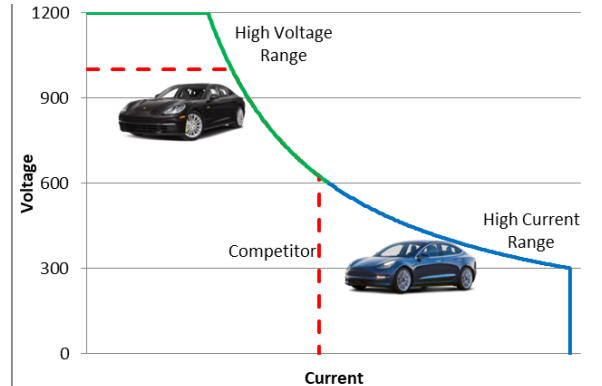
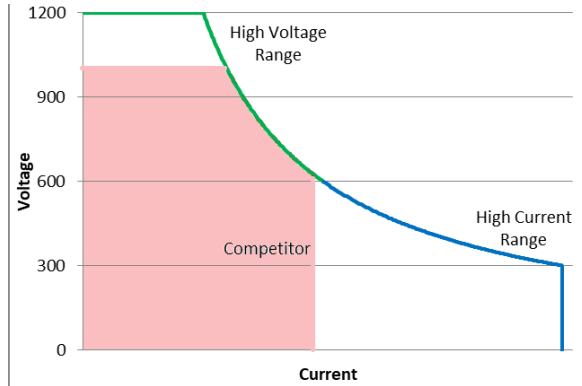


You Control Size to Maximize Use In Test!

Widest Operating Envelope

Dual Range - 9300 Series Battery Pack Test System

NHR is the Market Leader



High voltage range - ideal for modern high voltage EVs and energy storage with full power up to 1,200 VDC

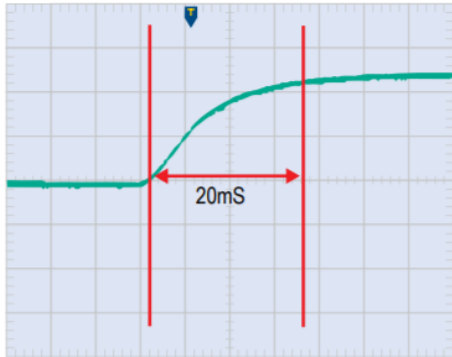
High current range is ideal for 300-600V EVs and energy storage

Test Solutions for Today's Products & Tomorrow's Innovations

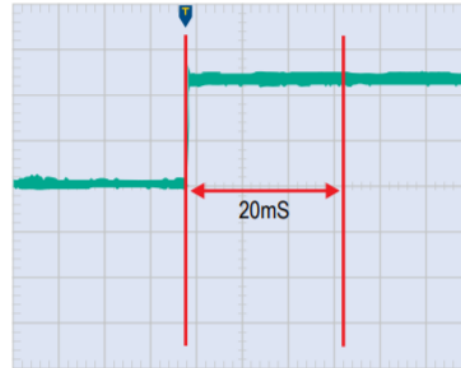
Fast Response Times

Electrification is increasing in speed and performance.

- Test solutions need to keep up
- Fast hardware performance & software command response

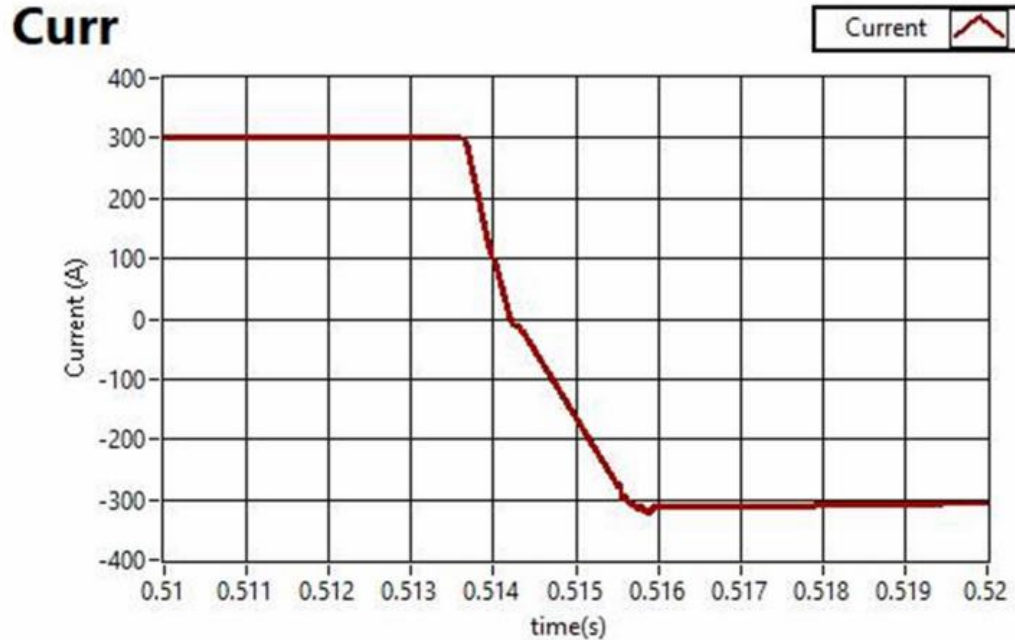


Slow rise-time of typical DC supply



Sub-millisecond rise-time of NHR

Transient Response



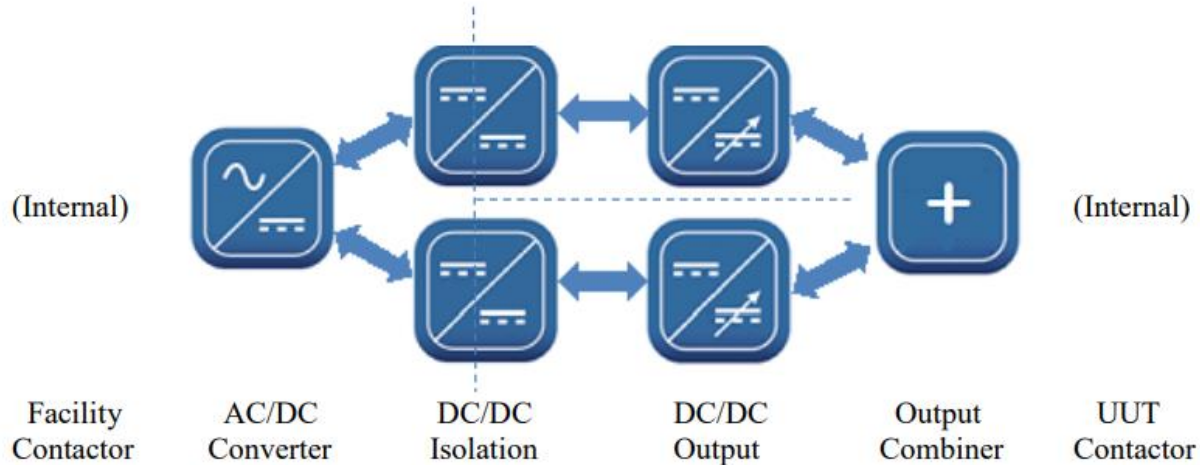
Faster speeds to meet real world transients

Theory of Operation

Internal Isolation and Power Conversion

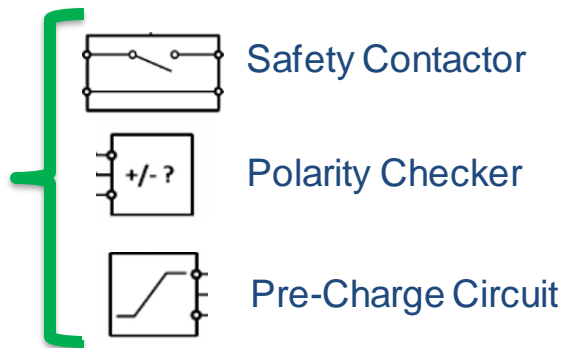
2.2 System Diagram & Theory of Operation

The 9300 uses multiple power stages to manage the DC testing output. Isolation regions are shown as blue dashed line.



NHR Integrated Safety Features

NHR Battery Cycler



All Included

Plus Additional Multiple Layers of Safety

Global Safety Limits		
	Min Voltage	Time Allowed
X	650.00 V	0.500 s
	Max Voltage	Time Allowed
X	900.00 V	0.100 s
	UUT Temperature	
X	85.0 C	

Discharge Safety Limits		
	Max Current	Time Allowed
X	150.00 A	0.500 s
	Max Power	Time Allowed

Charge Safety Limits		
	Max Current	Time Allowed
X	120.00 A	0.100 s
	Max Power	Time Allowed

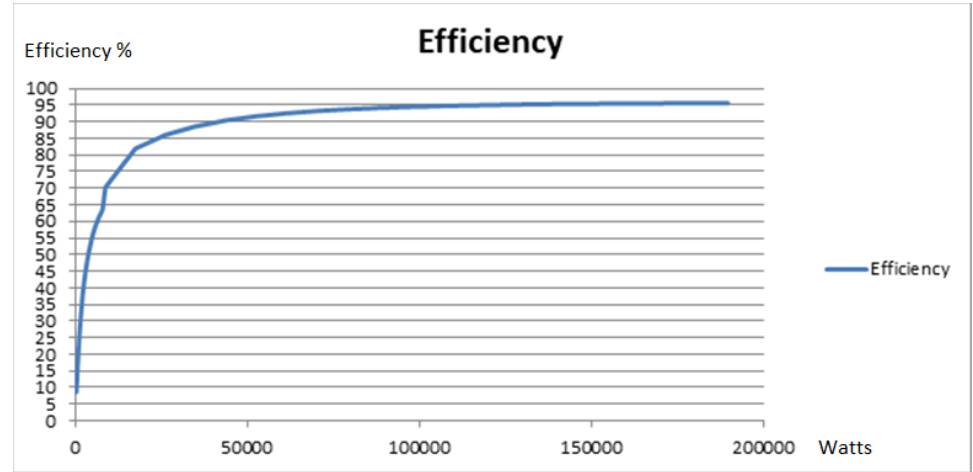
OK Cancel

Programmable Safety Limits

Environmental Factors

NHR Battery Cycler

- SiC Design
- Internal Galvanic Isolation
- > 90% Regenerative (95% above 50% Full Load)
- Regen Power roughly .9995 pf
- 60dB Noise when idle, 70dB when at Full Power



Easy Programmable Control

GUI & Automation



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

- 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
- Program friendly - make changes during test

You Control How to Use System

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

Flexible Data Control Options



Touch I/F



Remote



	<Main>	<Abort>	Check Test Information	DMT Profile	Log End of
	Delete	Insert	Label	Action	Action Date
7			Procedure 1.2.7	49box Operation	DC PM 2 Discharge @ A=48
8			Procedure 1.2.8	Set Variables	US0 = [DC PM 2/Voltage V]
9			Procedure 1.2.9	49box Operation	DC PM 2 Discharge @ A=300
10			Procedure 1.2.10	Set Variables	US1 = [DC PM 2/Voltage V]
11			Procedure 1.2.11	Set Variables	US = int([Cycle_Count]*1, 0) US = int([Cycle_Count]*1, 0)
12			Procedure 1.2.12	49box Operation	DC PM 2 Stand By
13			Procedure 1.2.13	Set Variables	US1 = int([Cycle_Count]*1, 0) US1 = int([Cycle_Count]*1, 0)

Enerchron



LabVIEW

9400 Series Regenerative Loads & Sources

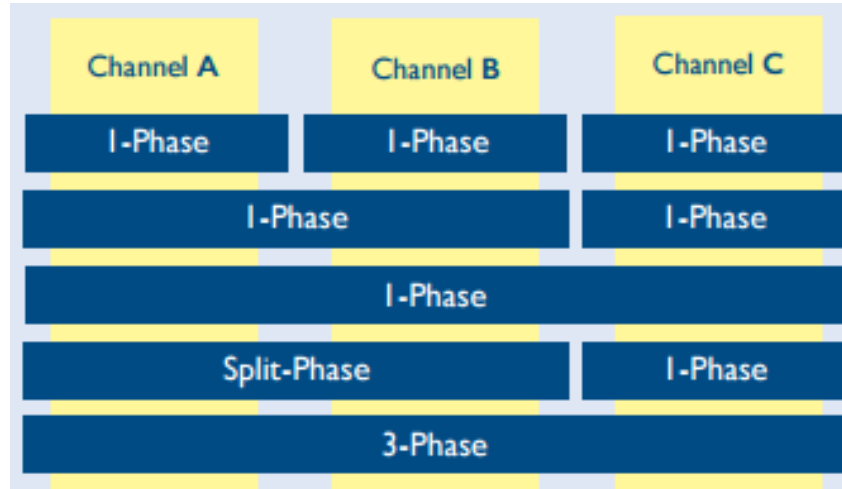


- [9410 – Grid Simulator](#)
- [9430 – AC 4 Quadrant Load](#)

Key Features

- ✓ Scalable from 4 to 96 kW
- ✓ 8 power ratings
- ✓ Multiple Ranges 175 & 350Vrms(l-n)
- ✓ Up to 880Hz
- ✓ Regenerative > 90% energy efficiency
- ✓ Programmable 1, 2 or 3-Phase mode
- ✓ Mix AC & DC on separate outputs
- ✓ Built-in safety isolation relays

Flexible Operating Output Modes



**1- ϕ , split- ϕ , 3- ϕ , & DC operating modes
are selected through software**

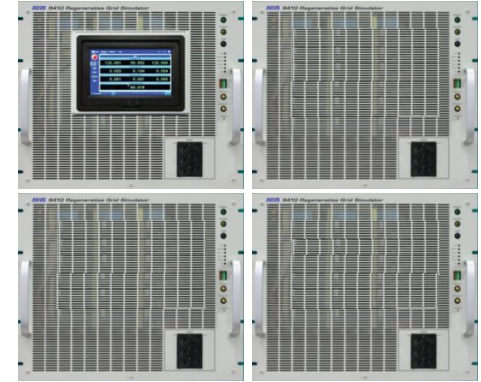
Expandable Power Through Modular Design



Channel 1	Channel 2	Channel 3
I-Phase	I-Phase	I-Phase
I-Phase		I-Phase
I-Phase		
Split-Phase		I-Phase
3-Phase		



Channel 1	Channel 2	Channel 3
I-Phase	I-Phase	I-Phase
I-Phase		I-Phase
I-Phase		
Split-Phase		I-Phase
3-Phase		

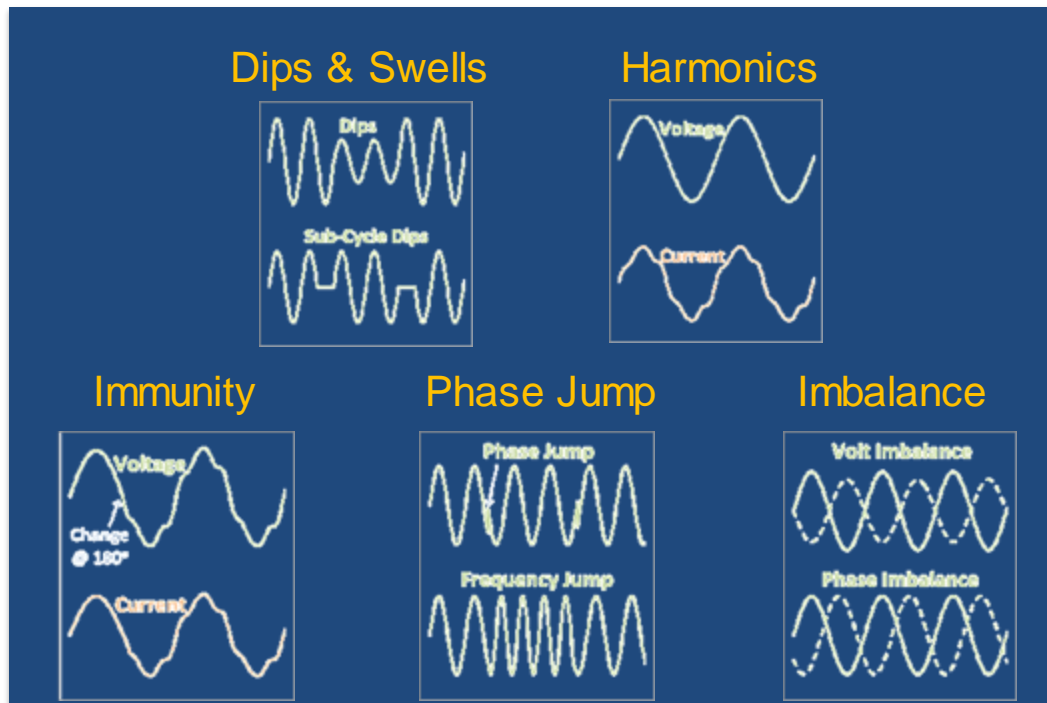


Channel 1	Channel 2	Channel 3
I-Phase	I-Phase	I-Phase
I-Phase		I-Phase
I-Phase		
Split-Phase		I-Phase
3-Phase		

9410 Regenerative Grid Simulator



**NHR 9410
Grid Simulator**



The Right Tool for Simulating AC Voltage Disturbances

9400 Series Regenerative Loads & Sources

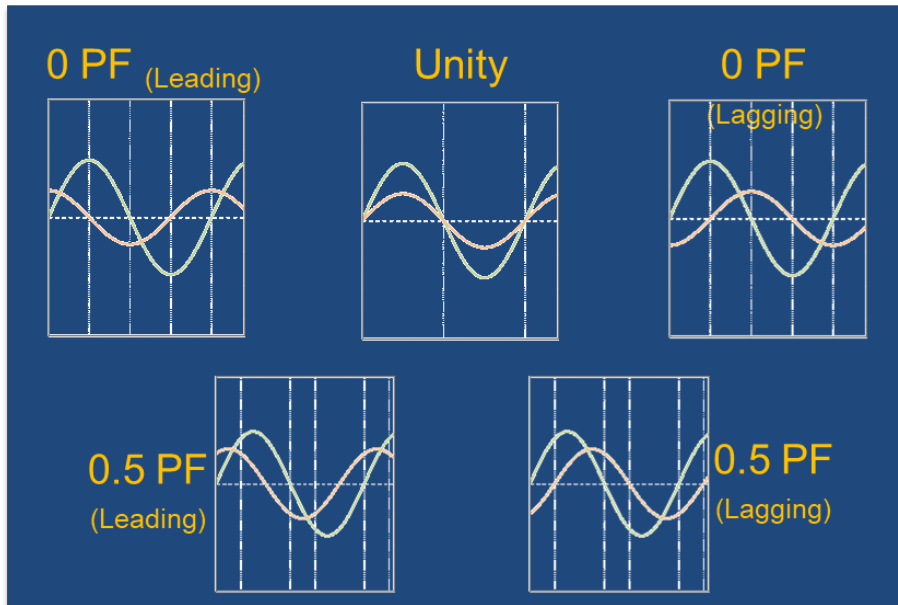


- [9410 – Grid Simulator](#)
- **9420 – AC Source HVAR**
- [9430 – AC 4 Quadrant Load](#)

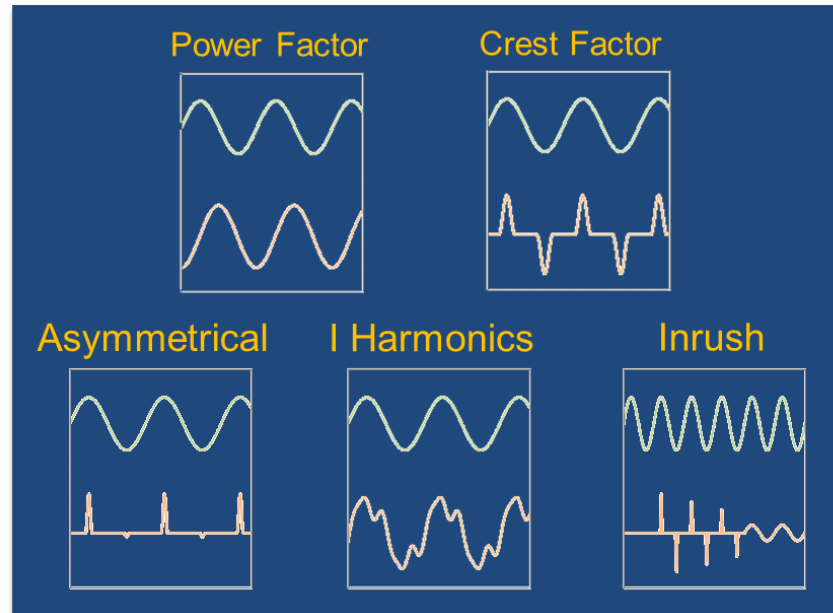
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9430 Regenerative 4-Quadrant Loading



**Simulate Any Power
Factor/Current Control**



**Simulate Any Combination
of Load Profiles**

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- **We help you achieve your goals.**
- ✓ **Expertise** – application, product design, engineering specialists on stand-by
- ✓ **Access** – rapid response times by phone, email, and site-visits
- ✓ **Support** – technical experts, training, diagnostic/calibration tools, and replacement parts to resolve problems quickly



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Technical Support



Training

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

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Technical Support



Training

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