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Datasheet

NHR 9530 Regenerative 4-Quadrant AC Load

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NHR 9530 Regenerative 4-Quadrant AC Load

Applications

ELECTRIC VEHICLES | GRID UTILITY | SOLAR INVERTER | SWITCH/ FUSE | UPS | VEHICLE TO GRID

BEST FOR:

- Testing 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.

KEY FEATURES:

- 100kW cabinet, expandable to 1.2MW
- Single, Split or Three-Phase programmable up to 200A per Ph
- 30 to 120Hz
- DC operation from 10 to 400VDC, AC operation up to 606VLL
- Reactive Power-capacity 2.1 X Real Power
- Sink power regenerated back to facility with >90% efficiency
- Power factor range: -1 to +1
- Crest factor range: 1.414 to 3.000
- High-resolution waveform digitizer
- 15” high brightness LCD touch panel
- High power density with small footprint.

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		

Applications

The 9530 is a current-regulated, 4-quadrant AC load with selectable phase inputs/outputs and a built-in waveform digitizing measurement system. In the sink mode, it sends power back to the facility mains rather than dissipated as heat. The 9530 has the capability of simulating almost any linear or non-linear load. Applications include testing of UPSs, AC sources, inverters, rectifiers, switches, circuit breakers and fuses.

4-Quadrant Operation

The most unique feature of the Model 9530 AC Load is its ability to operate in all 4-quadrants. This bi-directional capability significantly expands load simulation relative to 2-quadrant AC loads. More specifically, the 9530 allows creating the reverse current caused by inductive or capacitive loads (low power factors); namely sending power back to the UUT (source) during part of the AC cycle (Fig. 1). In this manner the 9530 accurately duplicates real-world reactive electrical power flows.

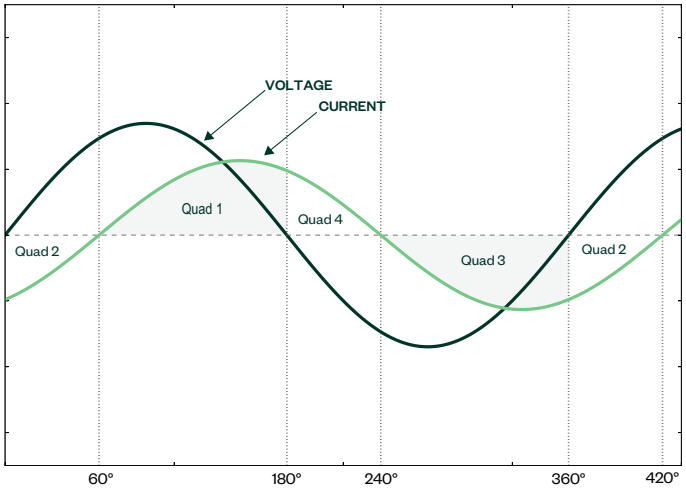

FIGURE 1

0. 5 PF Inductive Load waveform showing bi-directional power flows.

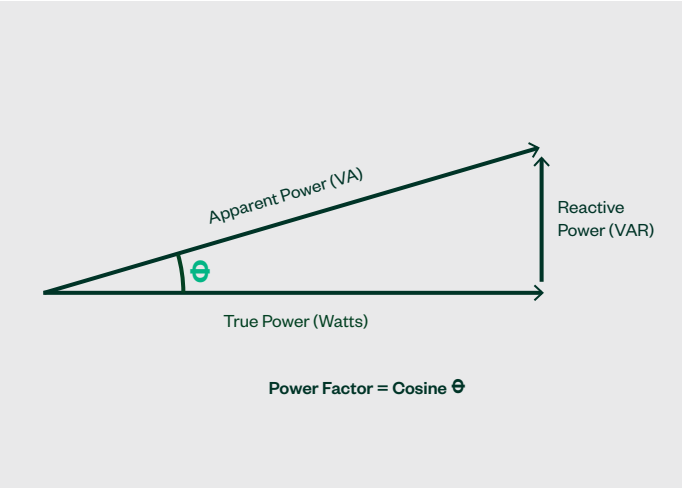

FIGURE 2

The Power Triangle.

HIVAR® Design Provides Reactive Loading without Derating True Power

This advanced design feature provides for testing high reactive load input power without the customary reduction of true power (Watts) normally required with conventional loads. The HiVAR design provides testing sources with reactive power (VARs) as large as 2.1 x true power (Watts.) All 9530 Loads are rated both for true power and apparent power. For instance, a 100kW Load is also rated for 210kVA.

Several Emulation Modes

To provide testing under the broadest range of loading conditions, the 9530 Load will operate in several Emulation Modes. Constant Current (CC) Mode provides current to be drawn constantly, making it suitable for linear, non-linear and regulation loading. Constant Resistance (CR) Mode allows the load to emulate a power resistor with a unity power factor. Constant Power (CP) Mode emulates a load such as a switching power supply. Constant Apparent Power (CS) Mode expressed as VA, is a vector quantity where there is both real power and reactive power (Fig. 2).

User-Defined Waveforms

In addition to programmable power and crest factors, one of the tools used by the 9530 AC Load for creating non-linear waveforms is a graphics editor. This editor allows starting with a straight line or modifying a generated waveform based on current, power and crest factor. The graphical editor includes an auto-check feature to ensure the settings are compatible with each other and within the capabilities of the 9530. It also supports waveform smoothing, symmetrical and asymmetrical waveform manipulation. With this graphics editor, waveforms can be quickly created to duplicate waveform distortions or transient events such as spikes, dropouts or any other anomaly that can be drawn as a single cycle (Fig. 3).

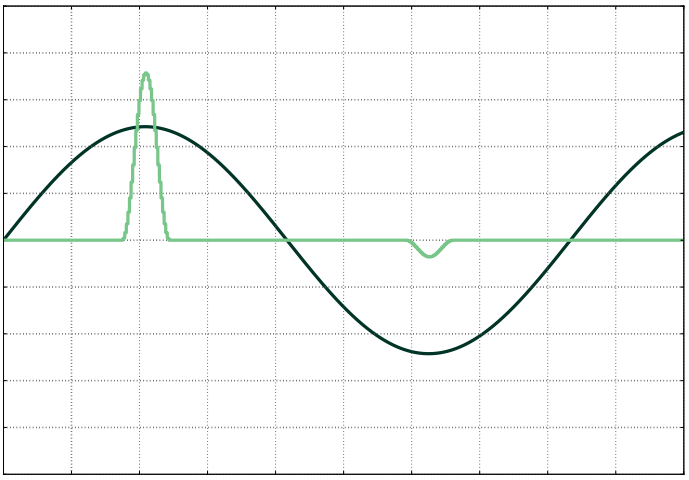

FIGURE 3
User-Defined Asymmetrical Current

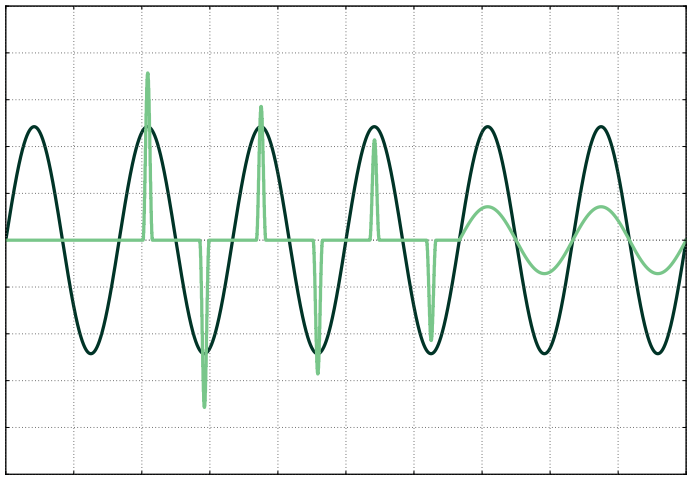

FIGURE 4
Start-Up Inrush Current Macro

Macros

A second powerful user-defined waveform tool are Macros. These are a pre-programmed sequence of settings where each new setting is effective for a sub-cycle, any number of cycles or for a fixed amount of time. This sequence is entered using a menu-driven, programming-free interface. The sequence is then downloaded to the AC Load where it is executed at high speeds to provide precise control of any phase. Macros can be stored for use on other test programs (Fig. 4).

Regenerative Return of Load Power to Facility Line

The 9530 Load returns greater than 90% of power to the facility thereby providing significant electrical savings. It certain continuous loading testing, it has been shown that the load will recover its purchase cost in 2 - 3 years. Even for intermittent load usage, the savings from regenerative return to the facility is substantial and worth evaluating. Additional benefits are a more comfortable work environment, less air conditioning required and an elimination of facility power upgrades.

Built-In Digital Measurement

Model 9530 Loads include a digital measurement system that features a high-resolution waveform digitizer. This provides the power analysis tools typically found in test systems that include digital multi-meters, oscilloscopes, and power analyzers. Having such a comprehensive measurement system built into the 9530 eliminates the integration complexity, prolonged start-up time, extra cabinet space and cost for those additional measurement instruments often required. The user is ready to begin testing the day the 9530 is delivered.

The types of measurements are broad and include almost any type of voltage, current, power and timing. In a 3-phase 9530, all three channels of voltage and current measurements are digitized simultaneously at 125kSamples/sec to be displayed, recorded or further processed to yield a custom measurement. Specialized measurements such as abnormal grid detection thresholds, disconnection timing, power ramp-up timing, and generated harmonic current limits are possible.

Waveform Capture			
Data Channels	6 ch (3 phases of voltage & current)	Memory	64k samples for each of 6 ch
Bandwidth	DC to 50kHz	Accuracy/Resolution	0.5% Range/0.005% Range
Sample Rate	to 125 kSample/sec	Aperture	1 cycle to 64 sec
Aperture Measurements	13 total including AC/DC Voltage, Current, True Power		
Background Measurements	35 total including AC/DC Voltage, Current, True Pwr, Apparent Pwr, Freq., Pwr Factor, Crest Factor, Energy, Phase Angle, Pk V, Pk I, Pk Pwr		
Custom Current Waveforms			
Standard	Sine, n-step Sine, Triangle, Clipped Sine, Notched Sine, Arbitrary (User Def.)	User Defined	Graphical wave shape editor or downloaded Excel table
Control			
User Interface	Built-In Touch Panel and/or external PC w/ Windows software tools including GUI	Drivers	Ni-Compliant LabVIEW Drivers, Enerchron (opt.)
External System Communication	LAN (Ethernet) supporting SCPI or VXI-II		

The Power of Choice: Flexible Control Options

There are multiple ways to control the 9530 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.

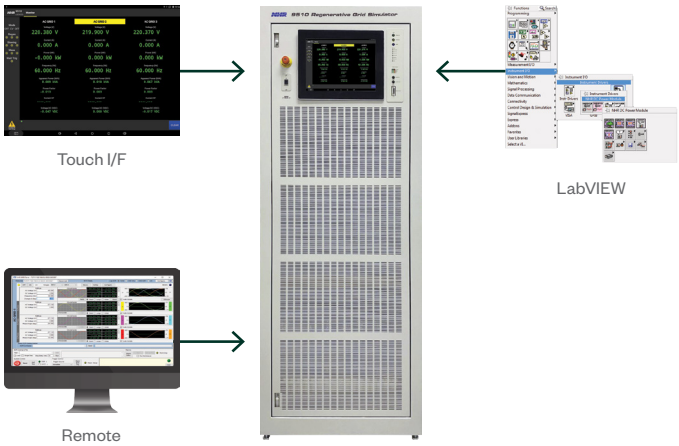

FIGURE 8
Flexible Control Options

NHR 9530 Regenerative 4-Quadrant AC Load Specifications

Model Number	9530-100	9530-200	9530-400	9530-500	9530-1000	9530-1200
AC Output Programmability						
Phases/Output Channels	Single, Split or 3-Phase					
Input Voltage (LR,HR)	10 - 175, 350VRMS L-N (30Hz - 120Hz)					
Current Limit Set Ranges[1] (per Φ)	50, 200A (3Φ)	X2	X4	X5	X10	X12
Current Limit Set Max[1] (per Source)	150, 600A (1Φ)	X2	X4	X5	X10	X12
Power Limit Set Max[2] (1, Split, 3Φ)	100, 67, 100kW	X2	X4	X5	X10	X12
Maximum Apparent Power[5]	210kVA	X2	X4	X5	X10	X12

Normal Mode (CC/CP/CS)		Resistance Mode (CR/CC/CP)	
Crest Factor[4]	1.414 - 3.0 (up to 2x MAX ARMS)	Constant Resistance	0.5ohm to 1000Ω
Power Factor	-1.0 - +1.0	Resolution	10mΩ
Slew Rate	10%-90% Range in < 500µs	Result. Current[1]	Vin/Rset

DC Loading Programmability						
Input Voltage	10 - 200, 400VDC					
DC Loading Modes	Constant Voltage (CV), Constant Current (CC), Constant Power (CP), Constant Resistance (CR), in any combination					
Current Limit Set Ranges[7]	50 - 200A	X2	X4	X5	X10	X12
Power Limit Set Max[3]	100kW	X2	X4	X5	X10	X12

Measurements (Accuracies apply when the settings and/or measurements are greater than 10% of Range and input voltage is above 50VRMS.)						
	Range	Accuracy				Resolution
Voltage Range (LR, HR)	424, 707V Pk					
AC RMS / DC Avg.		±(0.1% Rdg + 0.1% F. S.)				0.005% Rng
Frequency	30-120Hz	1% (Sinusoidal Voltage)				0.01Hz
Current per Phase (LR, HR)	167, 500A Pk	X2	X4	X5	X10	X12
AC Current	Model Dependent	±(0.1% Rdg + 0.1% Rng) @<100Hz, ±(0.2% Rdg + 0.2% Rng) @>100Hz				0.005% Rng
DC Current	Model Dependent	±(0.1% Rdg + 0.1% Rng)				0.005% Rng
Power (kW, kVA)	V Rng x C Rng	±(0.2% Rdg + 0.2% Rng)				0.005% Rng
Energy (AH, kWH, kVAH)	Time dependent	0.3% Reading + 0.3% Rng				0.005% Rng
Additional Measurement	Energy (Ah, kWh, kVAh), AC Crest Factor, AC Power Factor, True Power (P), Reactive Power (Q), Waveform Capture					

Input Power						
Voltage/Frequency	Universal Input - 380 to 480VAC ±10% (L-L, 3-Phase, 50/60Hz) / 49 - 51Hz or 59.3 - 60.5Hz		Power Factor		Unity PF > 99% measured at full power when loading 480VRMS (L-L) / 60Hz	
Efficiency[6]	92% @ 480V Facility Input measured at full power when loading 480VRMS (L-L) / 60Hz		Cooling		Air Cooled 35°C Max Ambient, reduced power from 35 to 50°C	
Current/phase @ 380, 400, 480V	168, 144, 134A	X2	X4	X5	X10	X12

[1] Programming Accuracies for Current are ±(0.1% Set+0.15% F.S.) @ < 100Hz & ±(0.2% Set+0.25% F.S.) @ > 100Hz. [2] Programming Accuracies for Power are ±(0.2% Set+0.25% F.S.). [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 at 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.

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