Datasheet

NHR 9430 Regenerative 4-Quadrant AC Load

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NHR 9430 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:

- 6 Sizes – 12 to 96kW
- Single, Split or Three-Phase programmable
- 10 to 350VAC
- 30 to 880Hz
- DC operation to 10 to 400VDC
- Reactive power capability 2.6 x Real Power
- Sink power regenerated back to facility with >90% efficiency
- Power factor range: -1 to +1
- Crest factor range: 1.414 to 4.000
- High-resolution waveform digitizer
- 9" Touch-Panel user interface
- High power density/minimum rack space

PHYSICAL AND SAFETY:

MODEL	9430-12	9430-24	9430-36	9430-48	9430-72	9430-96
Physical						
Connectors	Terminal blocks	Terminal blocks and bus bars				
Form	Chassis	Single Cabinet			Double Cabinet	
Dimensions (HxWxD)	15¾ x 19 x 24"/ 400 x 483 x 610mm	49 x 23 x 30"/ 1245 x 584 x 762mm	61 x 23 x 30"/ 1549 x 584 x 762mm	78 x 23 x 30"/ 1981 x 584 x 762mm	78 x 46 x 30"/ 1981 x 1168 x 762mm	
Weight	155lbs/70kg	480lbs/218kg	640lbs/290kg	780lbs/353kg	1280lbs/581kg	1560lbs/708kg
Operating Temperature	0° - 35°C, Non-Condensing					

Safety			
UUT Prog. Limits	V Min/Max, I Max, W Min/Max, each with time delay values	Isolation	Facility to Chassis - 1kV, Facility to Output - 2kV, Output to Chassis - 1kVl
Physical	User Interlock, Emergency Stop and remote e-Stop connection	Watchdog	A continuous communication verification program controlled by a test executive
Internal Protection	Over-Voltage, Over-Current, Over-Power, Over-Temp.	Self Test	An automatic hardware check upon power-up
EMC	CE Mark		

Applications

The 9430 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 9430 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 9430 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 9430 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 9430 accurately duplicates real-world reactive electrical power flows.

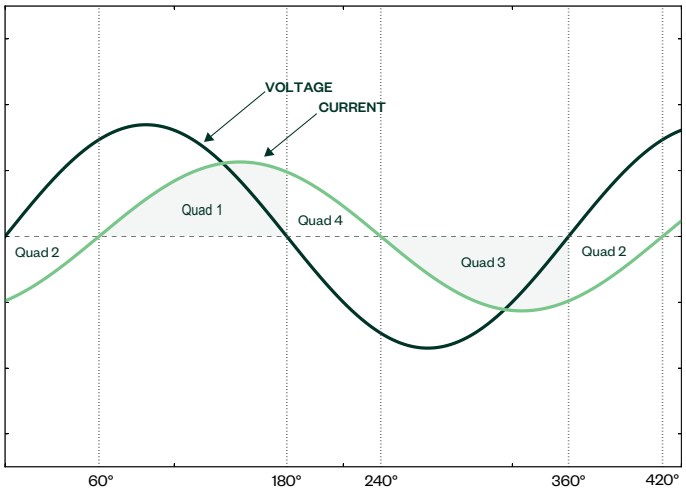


FIGURE 1

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

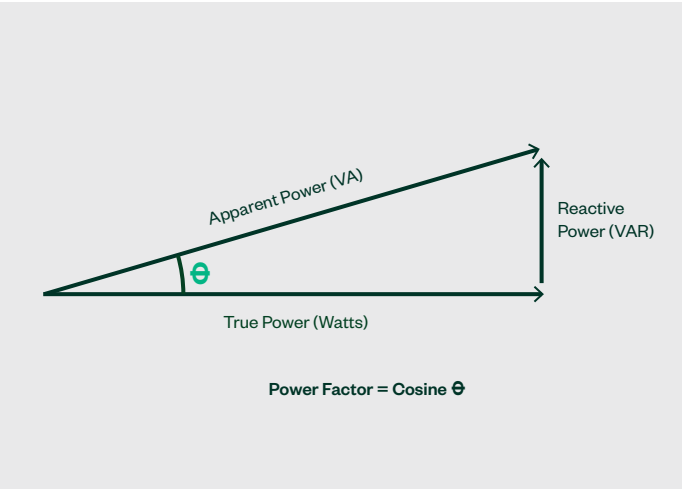


FIGURE 2

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 2.6 x true power (Watts.) All 9430 Loads are rated both for true power and apparent power. For instance, a 12kW Load is also rated for 31.5kVA.

Several Emulation Modes

To provide testing under the broadest range of loading conditions, the 9430 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). Constant RL (CRL) Mode emulates a resistive load with an inductive component such as a motor.

User-Defined Waveforms

In addition to programmable power and crest factors, one of the tools used by the 9430 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 9430. 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).

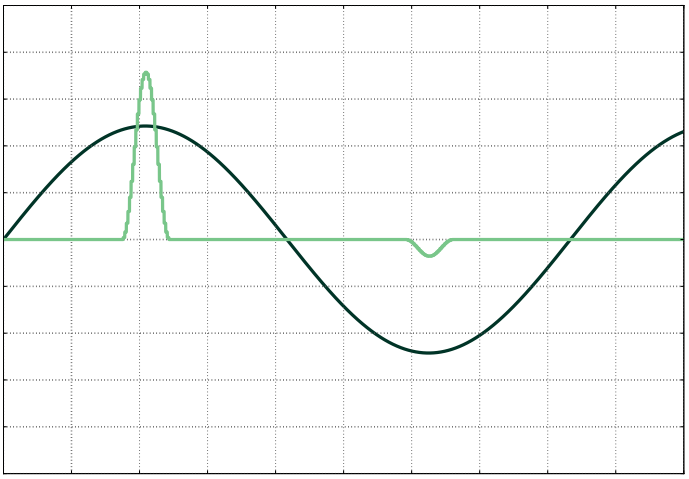


FIGURE 3

User-Defined Asymmetrical Current

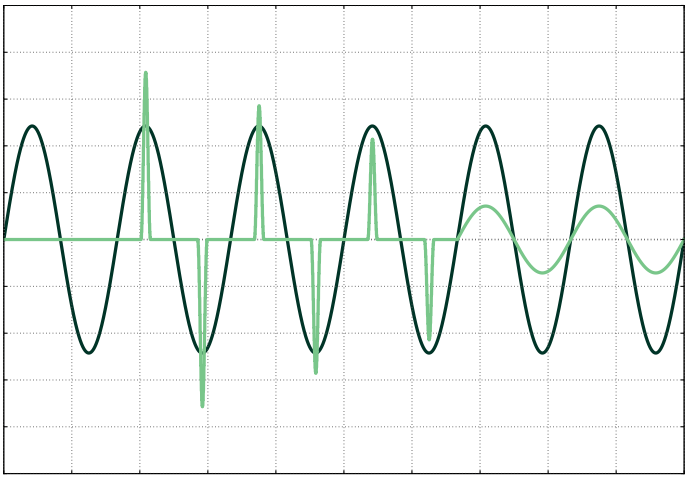


FIGURE 4

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 9430 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.

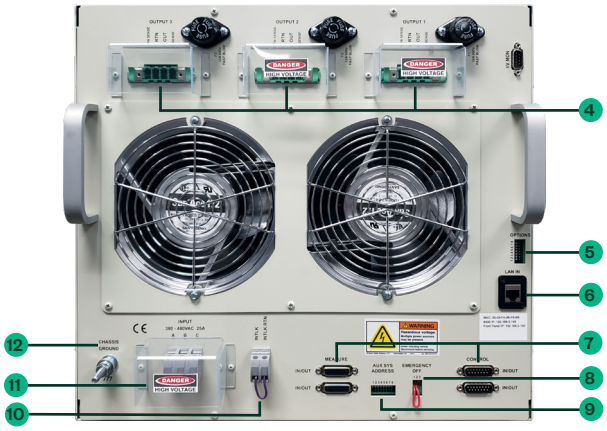
Built-In Digital Measurement

Model 9430 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 9430 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 9430 is delivered.

The types of measurements are broad and include almost any type of voltage, current, power and timing. In a 3-phase 9430, all six 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		

Physical Connections and Controls



1. Touch Panel Based Control and Display
2. Status Lights and Trigger
3. Circuit Breakers
4. Output Power Connectors and External Sense
5. Options Switch
6. LAN (Ethernet) Port
7. Parallel Connections
8. Remote Emergency Off
9. Auxiliary Configuration
10. Safety Interlock
11. Input AC Power Terminal
12. Chassis Ground

NHR 9430 Regenerative 4-Quadrant AC Load Specifications

MODEL NUMBER	9430-12	9430-24	9430-36	9430-48	9430-72	9430-96
AC Output Programmability						
Phases/Output Channels	Single, Split or 3-Phase					
Input Voltage (LR,HR)	10 - 175, 350VRMS L-N (30Hz - 880Hz)					
Current Limit Set Ranges[1] (per Φ)	6, 30A (3Φ)	12, 60A (3Φ)	18, 90A (3Φ)	24, 120A (3Φ)	36, 180A (3Φ)	48, 240A (3Φ)
Current Limit Set Max[1] (per Source)	18, 90A (1Φ)	36, 180A (1Φ)	54, 270A (1Φ)	72, 360A (1Φ)	108, 540A (1Φ)	144, 720A (1Φ)
Power Limit Set Max[2] (1, Split, 3Φ)	12, 8, 12kW	24, 16, 24kW	36, 24, 36kW	48, 36, 48kW	72, 48, 72kW	96, 64, 96kW
Maximum Apparent Power[2]	31.5kVA	63kVA	94.5kVA	126kVA	189kVA	252kVA

Normal Mode (CC/CP/CS)		Resistance Mode (CR/CC/CP)		RL Mode (Series CR & CL)	
Crest Factor	1.414 - 4.0 (up to 3x MAX ARMS)	Constant Resistance	-4Ω to -1000Ω/ 1.5Ω to 1000Ω	Constant Series-RL	1.5Ω to 1000Ω/0H to 1H
Power Factor	-1.0 - +1.0	Resolution	10mΩ	Resolution	10mΩ/1μH
Slew Rate	10%-90% Range in < 500μs	Result. Current[1]	Vin/Rset	Result. Current	$Vin/\sqrt{R2 + (2\pi fL)2}$

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[1]	0 - 18, 90A	0 - 36, 180A	0 - 54, 270A	0 - 72, 360A	0 - 108, 540A	0 - 144, 720A
Power Limit Set Max[2]	0 - 12kW	0 - 24kW	0 - 36kW	0 - 48kW	0 - 72kW	0-96kW

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)	260, 520V Pk					
AC RMS	260, 520V Pk	±(0.1% Rdg + 0.06% Rng) @<100Hz, ±(0.2% Rdg + 0.12% Rng) @>100Hz				0.005% Rng
DC	260, 520V Pk	±(0.1% Rdg + 0.1% Rng)				0.005% Rng
Peak Voltage	260, 520V Pk	±(0.5% Rdg + 0.2% Rng) @<100Hz, ±(1.0% Rdg + 0.4% Rng) @>100Hz				0.005% Rng
Frequency	30-1000Hz	0.1% (Sinusoidal Voltage)				0.01Hz
Current per Phase (LR, HR)	20, 100A Pk	40, 200A Pk	60, 300A Pk	80, 400A Pk	120, 600A Pk	160, 800A Pk
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	±(0.2% Rdg + 0.1% Rng)				0.005% Rng
Peak Current	Model Dependent	±(0.5% Rdg + 0.2% Rng) @<100Hz, ±(1.0% Rdg + 0.4% Rng) @>100Hz				0.005% Rng
Power (kW, kVA)	V Rng x C Rng	±(0.2% Rdg + 0.1% Rng) @<100Hz, ±(0.2% Rdg + 0.2% Rng) @>100Hz				0.005% Rng
Energy (AH, kWH, kVAH)	Time dependent	0.3% Reading + 0.3% Rng				0.005% Rng
Power Factor	-1.0 to +1.0	±(0.25% Rdg + 0.25% Rng)				0.005% Rng
Crest Factor		±(0.6% Rdg + 0.6% Reading Pk)				0.005% Rng
Phase Angle (ΦX-ΦA)	0 to 360°	+-2 deg @ < 100Hz, 6 deg @ < 400Hz, 15 deg @ < 880Hz				1 deg

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	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	22, 20, 17A	44, 40, 34A	66, 60, 51A	88, 80, 68A	132, 120, 102A	176, 160, 136A

[1] Programming Accuracies for Current are ±(0.2% Set+0.2% Range) @ < 100Hz & ±(0.4% Set+0.4% Range) @ > 100Hz. [2] Programming Accuracies for Power are ±(0.4% Set+0.4% Range) @ < 100Hz and ±(0.8% Set+0.8% Range) @ > 100Hz. [3] Programming Accuracies for RL Mode are +-(1% * ILoad +300mA) @ < 100Hz & +-(1% * ILoad +600mA) @ > 100Hz.

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