NEW

Model 9410
Regenerative Grid Simulator

For The Testing of Grid-Tied Inverters, V2G, & Other AC Power Products

NH Research, Inc.

Key Features

- 8 models - 4kW/8kVA to 96kW/192kVA
- Output AC Voltage - 0 to 310, 400VRMS L-N
- Output Frequency - DC, 30 to 100Hz
- Output DC Voltage - 200, 400VDC
- Programmable 1, 2 or 3-Phase modes
- Full 4-quadrant operation
- High resolution waveform capture on all V & I
- Sink power regenerated back to facility
- 9" Touch-Panel user interface
- SCPI programming & NI LabVIEW drivers

Model 9410 *single Power Module front panel view*

Unique Power Modules Provide Exceptional Configuration Flexibility

The Power Modules that make up the Model 9410 Regenerative Grid Simulator are scalable from 4kW to 96kW and can be programmed to provide DC, single-phase, split-phase or 3-phase operation *(Fig. 1)*. With this control over both maximum power and phase configuration, the Model 9410 achieves a new standard for flexibility to test the widest range of inverters.

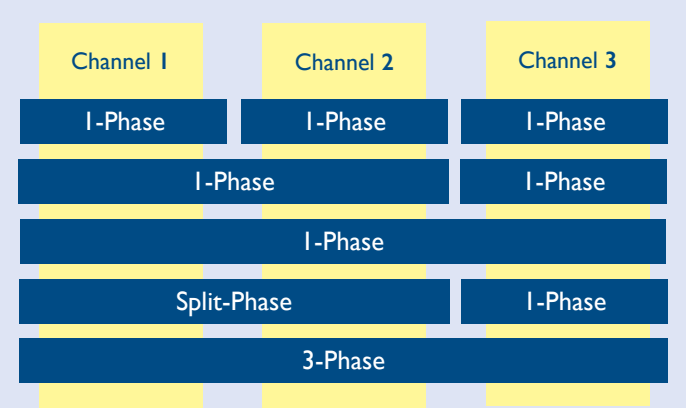


Figure 1 *- 3 channels with multiple configuration possibilities.*

Higher Power is a Field Upgrade

In addition to each Power Module being phase configurable, any Model 9410 can be expanded with additional 12kW Power Modules to provide more power. In this manner, a user can obtain just what is necessary for the current project knowing that if more power is needed in the future, it is a straightforward field upgrade.

More Reactive Power Capability Per kW

The Model 9410 Regenerative Grid Simulator is rated in both true power (kW) and apparent power (kVA) in order to optimally size the test system for the test requirements. The system is able to maintain full true power across a wide operating voltage range as well as maintain this true power level even when additional reactive power (kVARS) or reactive current harmonics are present *(Fig. 2)*. Sizing a traditional kVA-only rated system for true power must account for the worst-case power factor and the effects due to current harmonics. For example, a 45kVA-only rated system is able to provide 45kW when the power factor is unity (pf=1) but only able to provide only 30kW when there is an equal amount of reactive power (pf=0.7). In order to provide 45kW at a 0.7 power factor a 64kVA system is required. This sizing can be even more complicated when reactive current harmonics are considered. The Model 9410 simplifies this selection process by allowing the system to be specified in true power while still providing a higher VA rating to support reactive power needs. For example, A 9410-48 system is rated to provide up to 48kW of power and is able to maintain an apparent power of up to 96kVA, thereby meeting the needs for both true power and reactive power transfer requirements.

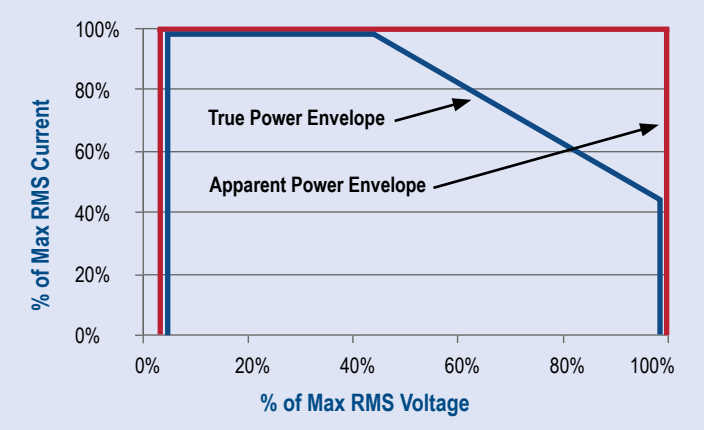


Figure 2 - Model 9410 Operating Envelopes.

Hundreds of Precision Measurements

The Model 9410 includes a built-in measurement system which provides the power analysis tools typically found in digital multi-meters, oscilloscopes, and power analyzers. Having such a comprehensive measurement system eliminates the integration complexity, start-up time, extra cabinet space and cost for the additional measurement instruments normally required. The user is ready to begin testing the day the Grid Simulator is delivered.

The types of measurements are practically limitless. In a 3-Phase Power Module, all six channels of V & I measurements are digitized simultaneously at 1KS/s to be displayed, recorded or further analyzed. Specialized measurements such as abnormal grid detection thresholds, disconnection timing, power ramp-up timing, and generated harmonic current limits are possible. The number of such specialized measurements is limited only by the users' capability to create additional measurement algorithms.

User Defined Waveshapes

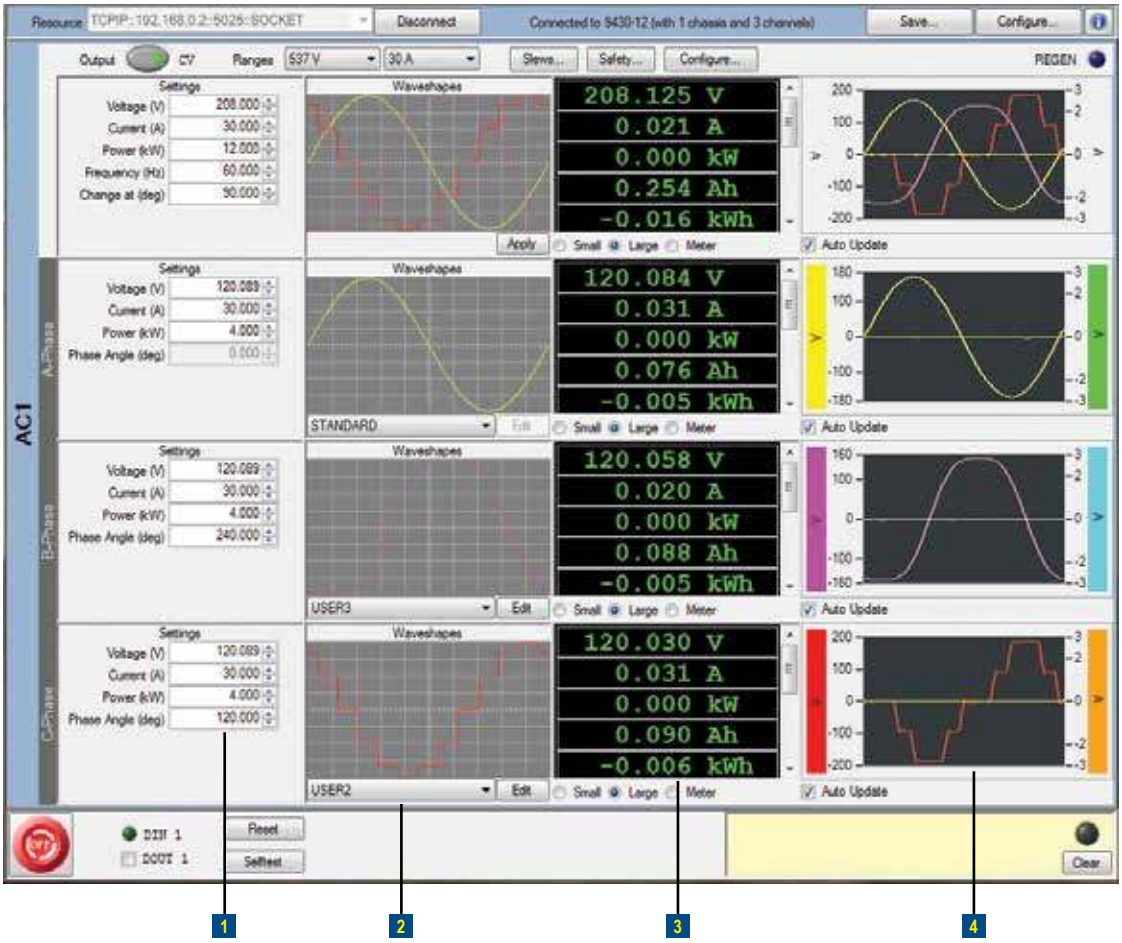
In addition to several standard waveshapes, the Model 9410 has the ability to generate custom voltage waveshapes. These waveshapes can be created by two different methods. First would be through downloading a table of numbers that correspond to the desired value of each point over the entire cycle. A second method of creating custom waveshapes is through a NH Research designed graphical waveshape editor. This provides actual manipulation of the waveshape and allows adding asymmetrical inflections, transient anomalies, harmonics, and any other wave shape that can be drawn as a single-cycle.

The output voltage amplitude and frequency are independently programmable so that the basic wave shape can be used with other voltages and frequencies. Additionally, each test channel/phase can use its own separate wave shape allowing the most versatility in creating a simulated grid condition.

More Ranges for Improved Voltage & Current Accuracy

Model 9410 provide a selectable high/low range for both voltage and current. This separate range control significantly improves set-point and measurement accuracy especially when compared to single-range or dual-range, voltage-only control. A 9410 test channel can be set to operate and measure in the optimum range for both voltage and current. Through this capability, the tester can be programmed in any combination of these ranges thereby providing four effective ranges including low-voltage/low-current, low-voltage/high-current, high-voltage/low-current and high-voltage/high-current.

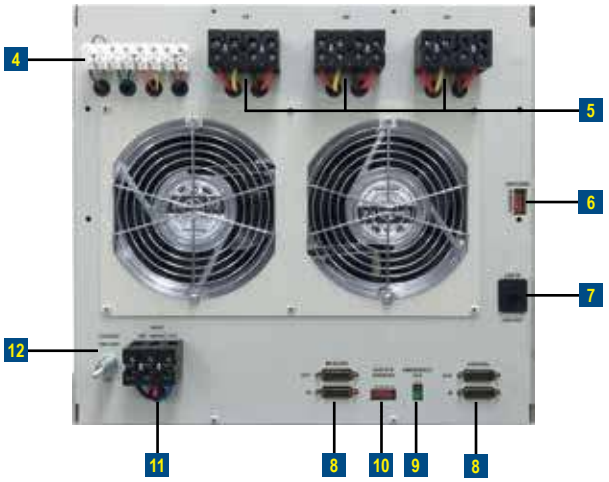
Soft Panel



1. Operation settings
2. Waveshape editor & program representation
3. Actual measurements
4. Internal scope display

***Figure 3** - This shows a grid where one phase is likely a UPS operating (square-ish sine wave), one phase is sinusoidal, and one is a clipped sine (sagging voltage at peak current).*

Physical Connections & Controls



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

Model 9410 Regenerative Grid Simulator Specifications

Model Number	9410-4	9410-8	9410-12	9410-24	9410-36	9410-48	9410-72	9410-96
AC Output Ratings								
Phases/Output Channels	1	1 or 2	1, 2, or 3					
Power, Max (1ϕ or 3ϕ)	4kW/8kVA	8kW/16kVA	12kW/24kVA	24kW/48kVA	36kW/72kVA	48kW/96kVA	72kW/144kVA	96kW/192kVA
Current Ranges (RMS per ϕ)	6, 30A/ϕ	6, 30A/ϕ	6, 30A/ϕ	12, 60A/ϕ	18, 90A/ϕ	24, 120A/ϕ	36,180A/ϕ	48, 240A/ϕ
Current Ranges (RMS 1ϕ)	6, 30A	12, 60A	18, 90A	36, 180A	54, 270A	72, 360A	108, 540A	144, 720A
Peak Current	3 X Max RMS							
Frequency	30 – 100Hz							
Voltage Ranges, L-N	155, 310V, 400V Option							
Accuracy	0.2% Set + 0.2% Rng							
Resolution	0.005% Rng							
Distortion (THD)	<1% @ 50/60Hz (Full power into resistive load at 480VRMS (L-L))							
Response Rate	1V/µS (10% to 90% measured at 90 degree turn-on into resistive load)							
Custom Waveforms	Sine, n-Step Sine, Triangle, Clipped-Sine, Arbitrary (user defined)							
Phase Angle Control	0 to 359 degrees / 1 degree resolution							
DC Output Ratings								
Power Max (1ch or 3ch)	4kW	8kW	12kW	24kW	36kW	48kW	72kW	96kW
Current Ranges (Per Ch.)	6, 30A/CH	6, 30A/CH	6, 30A/CH	12, 60A/CH	18, 90A/CH	24, 120A/CH	36, 180A/CH	48, 240A/CH
Current Ranges (Per System)	6, 30A	12, 60A	18, 90A	36, 180A	54, 270A	72, 360A	108, 540A	144, 720A
Voltage Ranges	200, 400VDC							
Accuracy	0.2% Set + 0.2% Rng							
Ripple	< 800mV RMS							
AC & DC Measurements								
Peak Voltage	250, 500V							
Accuracy (AC RMS)	0.1% Rdg + 0.06% Rng.							
Accuracy (DC)	0.1% Rdg + 0.1% Rng.							
Accuracy (Peak)	0.5% Rdg + 0.2% Rng.							
Resolution	0.005% Rng							
Peak Current (per Ch.)	20, 100A	20, 100A	20, 100A	40, 200A	60, 300A	80, 400A	120, 600A	180, 800A
Accuracy (AC RMS)	0.2% Rdg + 0.06% Rng.							
Accuracy (DC)	0.2% Rdg + 0.06% Rng.							
Accuracy (Peak)	0.5% Rdg + 0.2% Rng.							
Resolution	0.005% Rng							
Peak Power	V range x I Range							
Accuracy (kW or kVA)	0.3% Rdg + 0.025% Rng.							
Resolution	0.005% Rng							
Additional Measurements	Energy (Ah, kWh, kVAh), AC Crest Factor, AC Power Factor, Waveform Capture							
Waveform Digitizer								
Data Acquisition	Output Voltage and Current							
Sample Rate	125kSamples / sec							
Memory Depth	64kSamples							
Aperture Time	1 cycle to 64s							
Accuracy/Resolution	0.5% Rng / 0.05%							
Control								
Local User Interface	Built-in Touch-Panel and PC-Based software tools including graphical user interface							
External System Comm	LAN (Ethernet) supporting SCPI or VX-11							
Drivers	NI-Certified LabVIEW Drivers, IVI-C, IVI-COM							
Safety								
Module Protection	Self-protecting for over-voltage, over-current, over-power, and over-temperature							
Physical	Emergency Stop and remote E-Stop connection							
Programmable Limits	Min/Max Voltage, Current (per direction), and Power (per direction) with separate limits and time delay values							
Software Watchdog	Programmable							
Physical								
Connectors	Terminal Block			Bus Bars				
Form	Chassis			Single Cabinet			Double Cabinet	
Dimensions (WxDxH)	19"x24"x15¾"			23"x30"x43"	23"x30"x78"	23"x30"x78"	46"x30"x78"	
Weight	105 lbs	120 lbs	135 lbs	370 lbs	505 lbs	855 lbs	1340 lbs	1610 lbs
Operating Temp	35°C							
Isolation	Facility to Chassis – 1,000V, Output to Chassis – 500 V, Facility to Output Internal Isolation – 2,000 V							
Input Power								
Voltage	Universal Input – 380V to 480V ± 10% (L-L, 3 Phase, 50/60Hz)							
Efficiency/Power Factor	> 85% / > 0.95							
Current per ϕ @ 380 V	9A	17A	25A	49A	73A	97A	144A	192A
Current per ϕ @ 400 V	9A	17A	24A	47A	69A	92A	137A	183A
Current per ϕ @ 480 V	8A	14A	20A	39A	58A	77A	114A	152A

Ordering Information	Model	kW Rating	Options
Grid Emulator P/N	9410	-12	-HV

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