

# Modular DC Electronic Loads

## MODEL 4350 DIGITIZING DC LOADS

- 2400 Watt, 16-slot full-rack mainframe
- 150/300/600W-500V load modules
- Three voltage and current ranges
- Front connected and front loading
- 2 isolated channels of 1MS/s digitizing capability with 16-bit precision per load
- 2 isolated digital inputs per load
- 20 MHz peak-peak noise measurement per load
- Supports both multi-output and multi-UUT parallel testing strategies
- MPPT Mode for solar panels
- LED driver test with precise V-I curves
- PC/LAN control with LabVIEW and other IVI-compliant languages



Model 4350 with 150, 300 & 600 W loads

### A COMPLETE TESTER WITHIN EACH LOAD

The Model 4350 Digitizing DC load combines an advanced electronic load with the latest digitizing circuits that record both voltage and current waveforms. Once digitized, that information can be quickly processed to calculate an exceptionally wide range of precision measurements. This technique typically eliminates separate, single-function measurement instruments such as a DMM, DSO, MUX and related cabling. In addition to greatly simplifying tester design, the tester-per-load functionality provides simultaneous testing on all loads, thereby significantly improving test speed and tester throughput.

### CONFIGURATION FLEXIBILITY

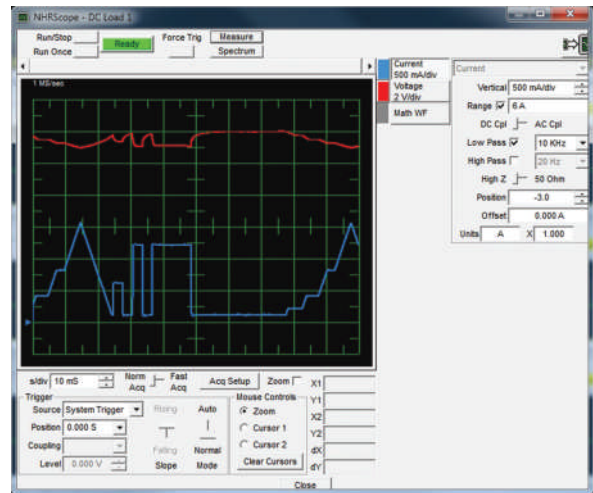
The 4300 16-slot mainframe and 4350 loads with three power levels lead the industry in configuration flexibility with 25 different combinations that can be created. Even more configuration flexibility can be gained through software combining like-loads to operate as a single virtual load. As an example, 4 of the 600 W loads can be software paralleled to behave as a virtual 2400 W load. These capabilities yield an almost limitless arrangement of load combinations ranging from sixteen 150-W modules to a single virtual 2400-W load. If test requirements dictate even higher power levels, additional mainframes or the NH Research Model 4700/4760 high-power loads can be integrated seamlessly into a complete loading test solution.

150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
150	150	150	150	150	150	150	150	150	150	300	300	600	600	600	600	600	600
150	150	150	150	300	300	600	600	600	600	600	600	600	600	600	600	600	600

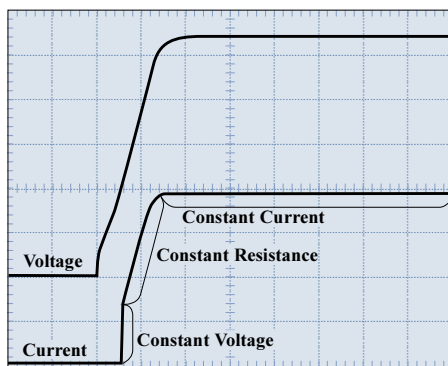
5 of the 25 possible load configurations

## COMPREHENSIVE MEASUREMENTS

Each load offers 20 standard measurements plus additional graphic waveform analysis tools that provide an almost limitless range of UUT transient performance information. The tools include a programmable sample window, 256k data-point memory and a unique graphic control and recording interface. Waveform transient measurements once only performed in the engineering laboratory are now executed at speeds that invite incorporation into production testing.



Model 4350 Power Scope



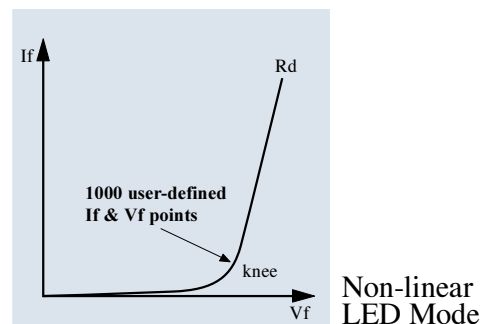
Power supply turn-on voltage & current waveforms in Auto Mode

## AUTO-MODE

The Auto-Mode feature provides the capability to more accurately set the load to what the UUT will actually see at turn on. In fact, many UUTs will not turn on into a CC load. By using Auto-Mode, the user can create a minimum voltage that the UUT must achieve before the load starts drawing any current, then it will transition into a CR mode while the voltage rises, and then finally into the CC mode. This simultaneous programmability of modes prevents an accidental over-power condition that could damage the UUT.

## LED DRIVER TEST

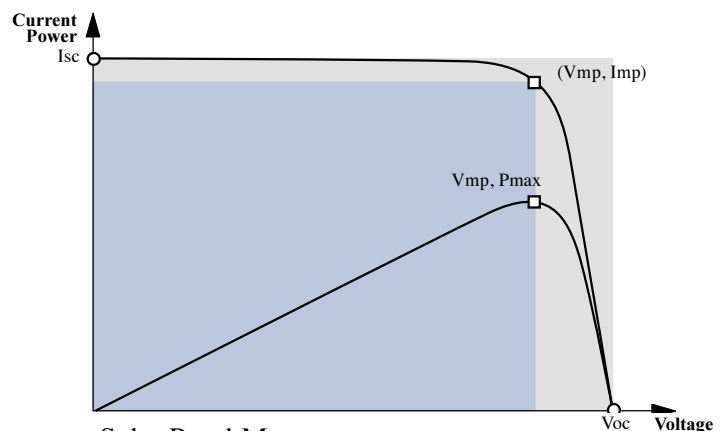
An advanced feature of the 4350 Loads is the user-defined Non-Linear LED Emulation Mode. Through this application, a precise V-I relationship, including knee, is created by the user to authentically emulate the LED. These V-I curves can be stored in memory and then called by the test program when needed.



Non-linear LED Mode

## SOLAR PANEL TEST WITH MPPT MODE

The 4350 Load is capable of testing solar panels by emulating an inverter or other charge controller through a special Maximum Power Point Tracking (MPPT) Mode. In this mode, as the voltage of the panel changes, the load changes the current drawn in order to maximize power transfer. In addition to the MPPT, the load will provide data for an Excel calculation and plotting of  $I_{sc}$ ,  $V_{oc}$ ,  $V_{mp}$ ,  $I_{mp}$ ,  $P_{max}$  and FF.



Solar Panel Measurements

## NEW MULTI-UUT PARALLEL TEST STRATEGY SUPPORT

The simultaneous testing of multiple UUTs such as chargers, adapters, and other high-volume, consumer power electronic devices is now a competitive reality. In fact, leading manufacturers have moved from 4 or 8 to 16 UUTs tested simultaneously. Having all the measurement capability within each load now makes this new multi-UUT parallel test strategy not only possible but relatively inexpensive. The distributed measurement architecture is also an advantage when testing the more traditional multi-output power supplies because it provides both channel-to-channel measurements and faster test speeds.

## 21ST CENTURY GRAPHIC USER INTERFACE

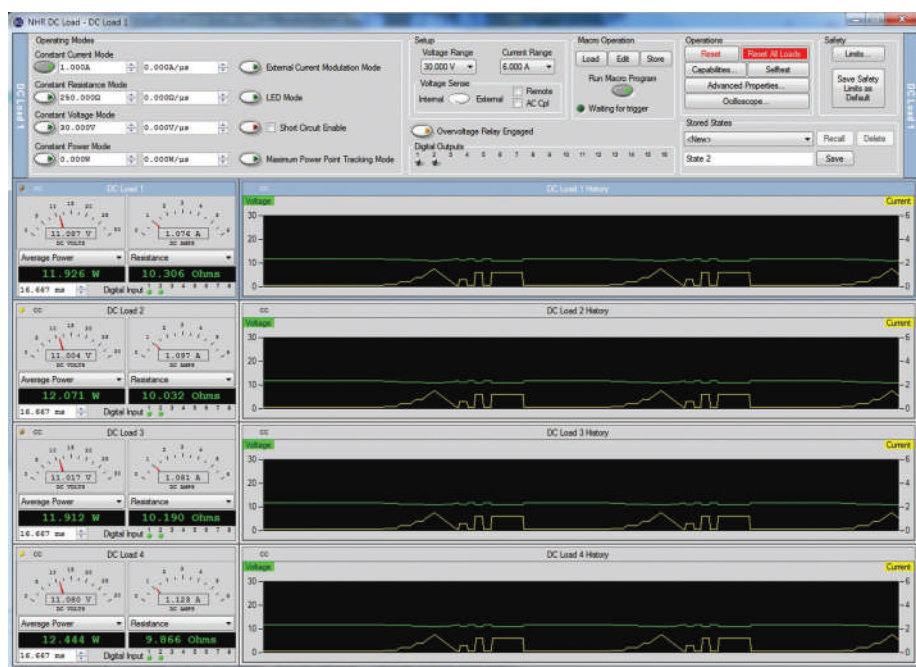
The several-decades-old manual instrument interface consisting of tiny knobs and 3-line LCD, while perhaps acceptable for a single load in a bench-top application, is simply inadequate for the control and reporting information generated by a multi-load/measurement system. That voluminous information is now logically organized on a single screen with drop down menus to select various performance options together with graphic oscilloscope-like panels to view and extract waveform measurements on up to 16 channels in each mainframe. Additional higher power NHR load models would also integrate into this single soft panel.

## PC CONTROL

The Model 4350 Load can be used within the NHR 5600, 5700 and S450 Automated Functional Test Systems that include the emPower™ Test Executive. The load can also be used within a customer's test system where it would be controlled through a LAN (Ethernet) interface, and is compatible with programming environments such as LabVIEW, LabWindows/CVI and other IVI-conforming languages.

## MACRO MODE

The Macro Mode provides programming a sequence of up to 1000 settings including the slew rate and time between settings. It also allows for mixing load modes within the same Macro. With this flexibility, the user is able to more accurately synthesize a wide range of complex waveforms that replicate the real-world conditions the UUT will encounter. This sequence may be synchronized to other load modules for parallel operation and may also be run in a single burst or continuous mode.



## FRONT CONNECTED AND FRONT LOADING

The Model 4350 has input connections on the front panel, which allows shorter cable lengths to the test fixture and UUT. In turn, this results in less cable-induced inductance and potential dynamic instability. Removal of a load is as easy as unfastening 4 front-panel screws and then sliding out the load. This facilitates faster load module reconfiguration, test fixture change-over and load repair when necessary.

# MODEL 4350 DIGITIZING DC ELECTRONIC LOAD SPECIFICATIONS

<b>OVERVIEW</b> Power Slots (16 per Mainframe) Maximum Current Maximum Voltage Voltage & Current Measurements Other Measurements	150 W 1 30 A 500 V Overshoot, Undershoot, AC RMS, AC+DC RMS, Positive Peak, Negative Peak, Peak-Peak, High-Frequency Peak - Peak (Noise), Rise Time, Fall Time, Settling Time, Hold-Up Time Average Power, Peak Power, Resistance, Trigger-In Time, DIN State and Time	300 W 2 60 A 500 V 0 - 0.66, 6.0, 60 A 0.06% S + 0.06% R 0.0015% R 0 - 30, 120, 500 V 0.05% S + 0.05% R 0.0015% R 0 - 40, 200 W 0.05% S + 0.05% R 0.0015% R 150 mΩ - 35 kΩ 2 % S Any combination of the above 4 Modes Creates V-I curves that emulate specific LEDs Emulates inverter or other charge controller with MPPT 0 - 0.66, 3.0, 30 A 0.066, 0.3, 6 A/μS 10 μS to 60 S 1 % ±10 μS <10 μS 30 - 45 A 75 mΩ Any combination of CC, CV, CR, CP and Slew Single Burst or Continuous 1000 50 μS - 60 Sec 25 μS - 60 Sec 10 μS 1% +/- 10 μS System Trigger	600 W 4 120 A 500 V 0 - 0.66, 12, 120 A 0.06% S + 0.06% R 0.0015% R 0 - 30, 120, 500 V 0.05% S + 0.05% R 0.0015% R 0-40, 800 W 0.05% S + 0.05% R 0.0015% R 38 mΩ - 8.7 kΩ 2 % S 0 - 0.66, 12, 120 A 0.066, 1.2, 24 A/μS 10 μS to 60 S 1 % ±10 μS <10 μS 120 - 180 A 19 mΩ DC - 500 kHz DC - 100 kHz	Accuracy Analog Time Digitizing Rate Record Length Trigger Power Range Accuracy Resolution Resistance Range Accuracy Resolution High Frequency Pk-Pk Noise Range Bandwidth Accuracy Resolution DIN Timing Range Accuracy Resolution	1% R (1/sample rate) +0.05 % Rdg 1 MS/s 256K points System Trigger, DINS, Voltage IR x VR 1 Accuracy + V Accuracy 0.0015% R IR x VR 1 Accuracy + V Accuracy 0.0015% R IR x VR 1 Accuracy + V Accuracy 0.0015% R 0 - Inf 1 Accuracy + V Accuracy 0.0015% R 0 - Inf 1 Accuracy + V Accuracy 0.0015% R 0 - Inf 1 Accuracy + V Accuracy 0.0015% R 0 - 0.25, 2.5 VAC 10 Hz - 20 MHz 3% R @1 MHz 0.0015% R 100μS to 168 hours 100μS to 168 hours 100 nano S 100μS to 168 hours 0.05% Rdg ± 100 μS 100 nano S 100μS to 168 hours 0.05% Rdg ± 100 μS 100 nano S
<b>PROGRAMMABLE FEATURES</b> Constant Current Mode Ranges Accuracy (Set) Resolution Constant Voltage Mode Ranges Accuracy Resolution Constant Power Mode Range Accuracy Resolution Constant Resistance Range Accuracy (V & I > 10% R) Auto Mode LED Driver Mode Solar PV Panel with MPPT Mode Slew Rate Range Maximum Rise & Fall Time Range Accuracy Resolution Short Circuit Current Resistance Macro Modes Repetition Settings Total Period Delay Resolution Accuracy Triggering	150 mΩ - 35 kΩ 2 % S Any combination of the above 4 Modes Creates V-I curves that emulate specific LEDs Emulates inverter or other charge controller with MPPT 0 - 0.66, 3.0, 30 A 0.066, 0.3, 6 A/μS 10 μS to 60 S 1 % ±10 μS <10 μS 30 - 45 A 75 mΩ Any combination of CC, CV, CR, CP and Slew Single Burst or Continuous 1000 50 μS - 60 Sec 25 μS - 60 Sec 10 μS 1% +/- 10 μS System Trigger	600 W 4 120 A 500 V 0 - 0.66, 12, 120 A 0.06% S + 0.06% R 0.0015% R 0 - 30, 120, 500 V 0.05% S + 0.05% R 0.0015% R 0-40, 800 W 0.05% S + 0.05% R 0.0015% R 38 mΩ - 8.7 kΩ 2 % S 0 - 0.66, 12, 120 A 0.066, 1.2, 24 A/μS 10 μS to 60 S 1 % ±10 μS <10 μS 120 - 180 A 19 mΩ DC - 500 kHz DC - 100 kHz	<b>SYSTEM CONTROL</b> Communications Drivers Logic-level Input Signals Open-Collector Output Signals <b>SAFETY</b> Load Protection UUT Protection Isolation Self Test Watchdog	LAN (Ethernet), 100BaseT RJ45 8 pin connector LabVIEW, IVI-COM, IVI-C Reset, Trigger, Start, Stop, Interlock Trigger, Start, Stop, Pass, Fail, Ready, DC Present Over-voltage, over-current, over-power, over-temperature, reverse voltage Over-voltage, under-voltage, over-current, over-power, loss of communication shutdown ±1000 VDC from AC power input to load or chassis ground, ±600 VDC from load to chassis ground Power-up test of input, output, control and protection mechanisms Continuous performance monitoring for measurement ambiguities, over/under-current ranges, and heat sink temperature limits	
<b>MEASUREMENT INSTRUMENTATION</b> Current Range (±) Accuracy Resolution DC Voltage Range (±) Frequency Accuracy Resolution Waveform Bandwidth Voltage Current	0 - 0.66, 3.0, 30 A 0.05% Rdg + 0.05% R 0.0015% R 0 - 30, 120, 600 V DC - 500 kHz 0.02% Rdg + 0.04% R 0.003% R DC - 500 kHz DC - 100 kHz	0 - 0.66, 6.0, 60 A 0.05% Rdg + 0.05% R 0.0015% R 0 - 30, 120, 600 V DC - 500 kHz 0.02% Rdg + 0.04% R 0.003% R DC - 500 kHz DC - 100 kHz	0 - 0.66, 12, 120 A 0.05% Rdg + 0.05% R 0.0015% R 0 - 30, 120, 600 V DC - 500 kHz 0.02% Rdg + 0.04% R 0.003% R DC - 500 kHz DC - 100 kHz	<b>PHYSICAL</b> Mainframe Size Weight Operating Temperature Input Power	Height: 8 3/4" (222 mm), Width: 19" (483 mm), Depth: 22" (559 mm) 86 lbs (39 kg) fully loaded 0 - 35° C at full power and 100% duty cycle 90 - 264 VAC , 47 - 63 Hz
<b>ADDITIONAL FEATURES</b> Over-Voltage Power Supply External Analog Input External Current Monitor Digital Inputs (DINS) per Load Digital Outputs (DOUTs) per Load Digital Outputs per Mainframe Calibration	Programmable power supply to test UUT for over-voltage protection, relay connected and 5 A limited 0 - 10 V signal input to modulate current 0 - 10 V output signal corresponding to 100% of Range Current 2 isolated, logic level 2 isolated, ±100 VDC, 300 mA 12 isolated, ±100 VDC, 300 mA Closed cover, all adjustments are done in software and stored in on-board flash memory	0 - 0.66, 12, 120 A 0.05% Rdg + 0.05% R 0.0015% R 0 - 30, 120, 600 V DC - 500 kHz 0.02% Rdg + 0.04% R 0.003% R DC - 500 kHz DC - 100 kHz	0 - 0.66, 12, 120 A 0.05% Rdg + 0.05% R 0.0015% R 0 - 30, 120, 600 V DC - 500 kHz 0.02% Rdg + 0.04% R 0.003% R DC - 500 kHz DC - 100 kHz	<b>PHYSICAL</b> Mainframe Size Weight Operating Temperature Input Power	Height: 8 3/4" (222 mm), Width: 19" (483 mm), Depth: 22" (559 mm) 86 lbs (39 kg) fully loaded 0 - 35° C at full power and 100% duty cycle 90 - 264 VAC , 47 - 63 Hz

R = Range, S = Set Point, Rdg = Readings • Specifications apply at 25±5 °C after a 10 minute warm up and are subject to change without notice. Accuracies apply when settings and/or measurements >10% of Range

