NEW

9300 Series
High-Voltage Battery Test System

Automated Charge/Discharge Cycling of Batteries & Other Energy Storage Components

NH Research

Key Features

- Wide Operating Envelope at 100kW per cabinet
  - High Voltage Range up to 1200V & 167A
  - High Current Range up to 333A & 600V
- Scalable to 1.2MW/4000A
- >90% efficiency of discharge power returned to AC mains
- Built-in digital measurements with charting & scope displays
- Current, Voltage & Mode transitions in <2 mSec
- Battery Emulation Mode
- Touch Panel, LabVIEW® & IVI Drivers
- Enerchron® Test Executive

Model 9300 *200kW Test System*

Application

The 9300 tester is a fast-acting, fully programmable, and bi-directional DC source (charge) that provides reversible current flow in order to act as a regenerative DC load (discharge). Both modes support any combination of constant power, constant voltage, and constant-current regulation limits. Products tested include batteries, fuel cells, ultra-capacitors, and other energy storage devices used in the automotive, aviation, heavy industrial, marine, grid storage, university research, and standards certification laboratory markets. The most frequent uses are for battery charge/discharge cycling, testing battery chargers and battery emulation.

An Operating Envelope that Delivers More Voltage & Current

Maximum voltage and current for a given kW rating is the typical place to start when evaluating power cyclers. The 9300 optimizes these two parameters through two ranges, one to provide up to 1200V and the other to provide up to 333A within a single 100kW cabinet (*Fig. 1*). More current and power is available through additional 100kW cabinets, which can be run synchronously in parallel up to 1.2MW/4000A. The exceptionally wide operating envelope combined with the ability to add additional 100kW cabinets, allows the test engineer to choose a power level that yields cost efficient testing of todays' products without risk of being caught without enough current or power to test future products. One can always add more cabinets in the field.

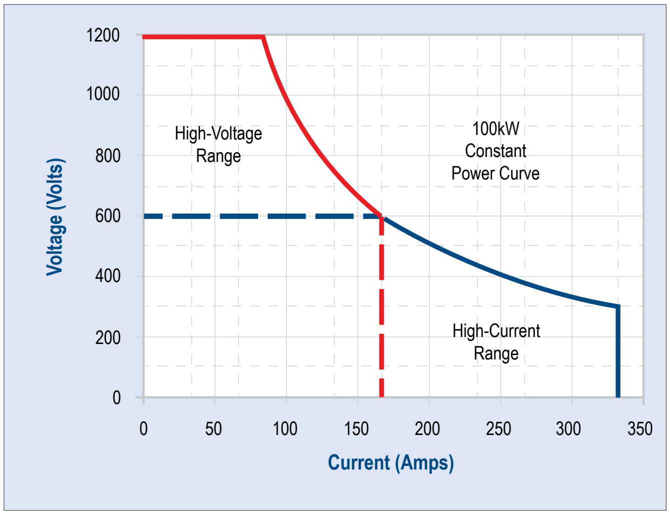


Figure 1 *- Wide Constant Power Operating Envelope*

Comprehensive Measurement Capability Built-In

A wide range of precision measurement information is provided by the 1-MS/S digitization of analog measurement signals within each cabinet. An example is the simultaneous measurements of voltage, current, amp-hours and watt-hours that are continuously available. The digitizer data may be accessed or downloaded to provide high-resolution, synchronized samples of voltage and current for advanced measurements such as battery condition. Additional measurement input channels are available through third-party data acquisition hardware that runs under Enerchron®. The resulting comprehensive measurement information minimizes or even eliminates the need for additional measurement instruments required for the test system (*Fig. 2*).

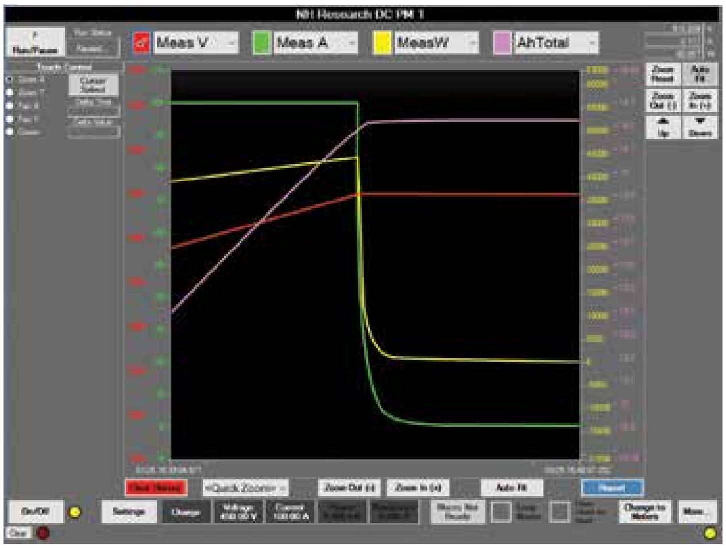


Figure 2 *- Chart Recorder*

Multiple Safety Features to Protect the Unit-Under-Test, Tester & Operator

9300 performance is monitored continuously. Items such as measurement ambiguities, under/over-range conditions, heat-sink temperature limits, and grid frequency limits will trigger an appropriate warning message to the controlling device. Operator setting errors & UUT malfunctions are caught through programmable safety limits (*Fig. 3*), which will disconnect the UUT from the tester. Each tester also provides a separate interlock input that can be connected to an external test fixture. The tester will open its output contactors thereby isolating it if the interlock input is triggered. And finally, the user can abort testing and disconnect the UUT through an emergency manual or remote power-off switch.

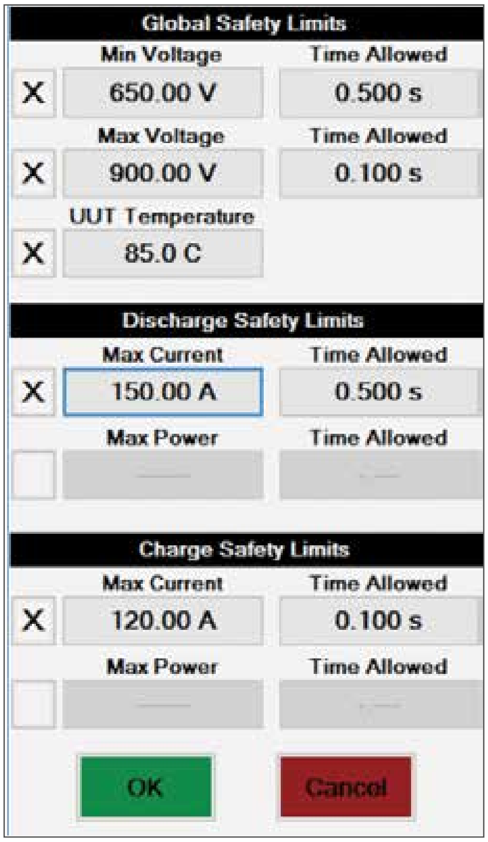


Figure 3 *- Operator setting errors & UUT malfunctions are caught through programmable safety limits*

Three Control Choices

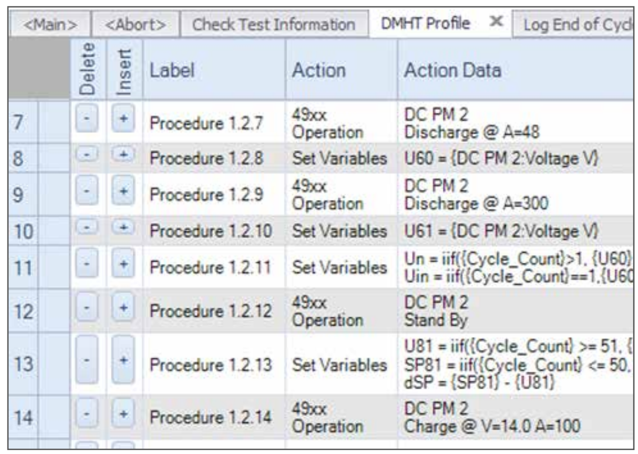
The basic 9300 has a Touch-Panel that controls and displays voltage, current, power along with other settings, limits and test status. The Touch-Panel provides the ability to create, run, monitor, chart and report UUT charge/discharge profiles without writing any code. This makes the 9300 ideal for engineering development and trouble-shooting UUTs.

The second control choice is the Enerchron® Test Executive, described below, which would be run on an external PC. This is the best choice for more extensive and longer term tests where substantial data collection is necessary.

The third option is where the user can utilize their own system controller and test software to communicate to the 9300 through LabVIEW or another IVI-compliant programming language. This works well in instances where the customer has already written test programs and doesn't want to replicate that work.

Enerchron® Test Executive

Enerchron® is a high-level, PC software application for organizing, deploying, executing, and reporting on automated testing of energy storage devices. Enerchron® elevates the 9300 from an instrument into a system by providing the capability to integrate other instruments such as a temperature chamber and data acquisition modules. A key structural element of this software package is the use of variables instead of hard-coded values. With this capability, test sequences may be written which import industry standard drive cycles or user-specific test routines that are then scaled to the UUT (*Fig. 4*). The UUT test data may further be processed using standard formulas to provide calculated results without a secondary processing step.



	Delete	Insert	Label	Action	Action Data
7	-	+	Procedure 1.2.7	49xx Operation	DC PM 2 Discharge @ A=48
8	-	+	Procedure 1.2.8	Set Variables	U60 = {DC PM 2:Voltage V}
9	-	+	Procedure 1.2.9	49xx Operation	DC PM 2 Discharge @ A=300
10	-	+	Procedure 1.2.10	Set Variables	U61 = {DC PM 2:Voltage V}
11	-	+	Procedure 1.2.11	Set Variables	Un = iif({Cycle_Count}>1, {U60} Uin = iif({Cycle_Count}==1,{U6C
12	-	+	Procedure 1.2.12	49xx Operation	DC PM 2 Stand By
13	-	+	Procedure 1.2.13	Set Variables	U81 = iif({Cycle_Count} >= 51, { SP81 = iif({Cycle_Count} <= 50, dSP = {SP81} - {U81}
14	-	+	Procedure 1.2.14	49xx Operation	DC PM 2 Charge @ V=14.0 A=100

Figure 4 *- Enerchron Test Sequence Editor*

Regenerative Design Yields Recovering Tester Cost in as Little as 2 Years

With the highly efficient design of the 9300, well over 90% of the energy that normally ends up as waste heat during battery discharge testing can be recovered by converting it back to useable facility power. The savings attainable can provide payback of the entire system within a few years depending upon the tester use (*Fig. 5*). Additional advantages of this regenerative load feature are a cooler work environment, less risk of insufficient air conditioning capacity, elimination of elaborate water cooling systems plus the community goodwill created through being recognized as a "green" neighbor investing to minimize our carbon footprint.

REGENERATIVE LOAD SAVINGS

Assumptions:

- 100kW Load @ 50% Duty Cycle 24/7/52 Hrs
- 90% Regen Efficiency
- $0.176/kWh electrical cost (Irvine, CA actuals)

Calculation:

100kW x 0.5 DC X 0.9 Eff x 24 x 7 x 52 x $0.176 = $69,189/Yr

Conclusion:

Regenerative battery power cyclers in continuous use generate electrical savings sufficient to pay for equipment in as little as 2 years.

Figure 5 *- Regenerative Load Savings Calculation*

Model 9300 High-Voltage Battery Test System

Model Number	9300-100	9300-200	9300-300	9300-400	9300-500	9300-600	9300-700	9300-800	9300-900	9300-1000	9300-1100	9300-1200
Rating	100kW	200kW	300kW	400kW	500kW	600kW	700kW	800kW	900kW	1000kW	1100kW	1200kW
Max Current @ 600V	333A	666A	999A	1332A	1665A	1998A	2331A	2664A	2997A	3330A	3663A	3996A
Current @ 1200V	±167A	±334A	±501A	±668A	±835A	±1002A	±1169A	±1336A	±1503A	±1670A	±1837A	±2001A

Programming Capability	
Operating States	Charge (Source), Discharge (Load), Standby, Battery Emulation
Charge/Discharge Modes	Constant-Voltage (CV), Current (CC), Power (CP), Series Resistance (CR)
Charging Envelope	0 - 600V/±333A, 0 -1200V/±167A
Discharging Envelope	30 - 600V/±333A, 60 - 1200V/±167A
Voltage Accuracy	0.1% Set + 0.1% Range
Current Accuracy	0.2% Set + 0.2% Range
Slew Rate	Same polarity 10 - 90% < 2mS Low Range, < 3mS High Range
Current Change Time	< 5mS
Current Reverse Time	< 10mS
Parallelability	Synchronous control for up to 12 channels (1.2MW)
Macro Test Profiles	
Development Source	Touch-Panel, Import from Excel or User's System Controller
Max. Steps	1000
Min.Time Delay	50μS
Max. Step Delay	1mS - 7 days

Test Meas. (4-wire)	Range	Accuracy*	Resolution
Voltage, DC Avg.	0 - 600V/0 - 1200V	0.05% Set + 0.05% Range	0.005% Range
Current, DC Avg. Amp Hr	0 - 333A/0 - 167A	0.1% Set + 0.1% Range	0.005% Range
Power, Watt Hr	I Range x V Range	0.12% Set + 0.12% Range	0.005% Range
Time	1mS - 1 Yr	0.1% Set	0.005% Range
Temperature	0 - 150 °C		

Control	
Local User Interface	Touch-Panel with graphic meters & controls plus Macro screens
Ext. Sys. Communication	LAN (Ethernet)
Drivers (Win XP, Win 7)	LabVIEW, IVI-COM, IVI-C
Analog Current Monitor	0 to +10V charge/0 to -10V discharge
Analog Voltage Monitor	0 to +10V full scale voltage
Safety	
Isolation AC Input	1000VDC Mains to Chassis & UUT - / 1500VDC Mains to UUT +
Isolation UUT Input	1000VDC UUT - to Chassis / 1500VDC UUT + to Chassis
Prog. Safety Limits	V Min/Max, I Max, W Min/Max
Internal Protections	Over-Voltage, Over-Current, Over-Power, Over-Temperature
Interlocks	External input, emergency stop & rear service door
Self-Test	Power-up Self-Test reports errors about status of input, output, control & protection mechanisms
Watchdog Timer	Continuously monitors control communications
Physical (Single 100kW Cabinet)	
Connectors	Main power through buss bars
Cabinet Dim. (HxWxD)	78 x 28 x 39"/1981 x 711 x 991mm
Cabinet Weight	1200lbs/544kg
Operating Temperature	0 - 35°C full power
Input Power	3ø, 50 - 60Hz, 380VAC/200A or 480VAC/160A. Output Power reduced to 90kW below 360VAC input
Calibration	
Method	Semi-Automatic with standard lab equipment, Fully-Automatic with HP3458A & NHR Calibrator

* Accuracies apply when the measurement is greater than 10% of range & less than 1000V. Specifications apply at 25°C ± 5°C after 10 minute warm-up.

NH Research

16601 Hale Avenue, Irvine, California 92606
Tel: (949) 474-3900
Email: sales@nhresearch.com

www.nhresearch.com

© Copyright 2017, NH Research Incorporated. Pub 11-15-17 JC
All rights reserved. Specifications subject to change without notice.