9300 Series High-Voltage Battery Test System



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

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 2.4MW/8000A
- >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

Application

The 9300 tester is a fast-acting, fully programmable, and bidirectional 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 2.4MW/8000A. 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.



Model 9300 200kW Test System

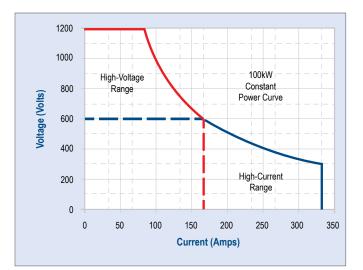


Figure 1 - Wide Constant Power Operating Envelope

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 watthours 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*).

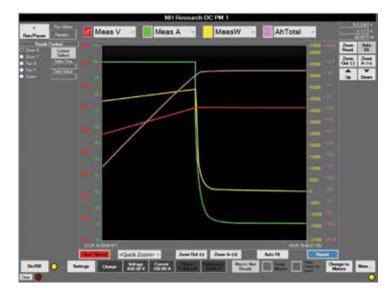


Figure 2 - Chart Recorder

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, heatsink 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.

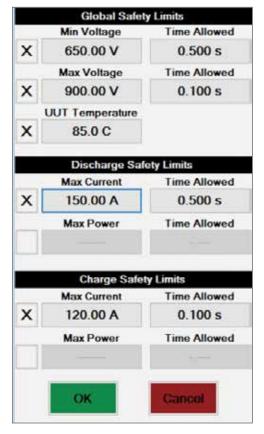


Figure 3 - Operator setting errors & UUT malfunctions are caught through programmable safety limits

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.

<main></main>		<abo< th=""><th>ort></th><th>Check Test I</th><th>nformation</th><th>DMHT Profile × Log End of Cyd</th></abo<>	ort>	Check Test I	nformation	DMHT Profile × Log End of Cyd				
	Delete	Insert	Label Procedure 1.2.7		Action	Action Data				
7	6	+			49xx Operation	DC PM 2 Discharge @ A=48				
8		•	Proc	edure 1.2.8	Set Variable	s U60 = {DC PM 2:Voltage V}				
9		•	Proc	edure 1.2.9	49xx Operation	DC PM 2 Discharge @ A=300				
10	6		Proc	edure 1.2.10	Set Variable	s U61 = {DC PM 2:Voltage V}				
11	2	+	Proc	edure 1.2.11	Set Variable	Un = iif({Cycle_Count}>1, {U60} Uin = iif({Cycle_Count}==1,{U60}				
12		Ð	Proc	edure 1.2.12	49xx Operation	DC PM 2 Stand By				
13		+	Proc	edure 1.2.13	Set Variable	U81 = iif({Cycle_Count} >= 51, { SP81 = iif({Cycle_Count} >= 50, dSP = {SP81} - {U81}				
14	6	Procedure 1.2.1			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	9300-120	
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 Capabilit	у												
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	0.025% Set + 0.025% Range												
Current Accuracy	0.1% Set + 0.1% Range												
Slew Rate	Same polarity 10 - 90% < 2mS Low Range, < 3mS High Range												
Current Change Time	< 5mS												
Current Reverse Time	< 10mS												
Parallelability	Synchronou	is control for	up to 12 char	nnels (1.2MV	V)								
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 day	1mS - 7 days											
Test Meas. (4-wire)		Ra	nge			Accuracy				Resolution			
Voltage, DC Avg.	0 - 600V/0 -	1200V			0.025% Reading + 0.025% Range				0.005% Range				
Current, DC Avg. Amp Hr	0 - 333A/0 - 167A				0.1% Reading + 0.1% Range				0.005% Range				
Power, Watt Hr	I Range x V Range				0.12% Reading + 0.12% Range				0.005% Range				
Time	1mS - 1 Yr				0.1% Reading				0.005% Range				
Temperature	0 - 150 °C												
Control													
Local User Interface	Touch-Pane	el with graphi	c meters & co	ontrols plus N	lacro screen:	S							
Ext. Sys. Communication	LAN (Ether	net)											
Drivers (Win XP, Win 7)	LabVIEW, I	VI-COM, IVI-	ъС										
Analog Current Monitor	0 to +10V cl	narge/0 to -10	OV discharge										
Analog Voltage Monitor	0 to +10V fu	Ill scale volta	ge										
Safety													
Isolation AC Input	1000VDC M	1000VDC Mains to Chassis & UUT - / 1500VDC Mains to UUT +											
Isolation UUT Input	1000VDC U	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 - 60H	Hz, 380VAC/2	200A or 480V	/AC/160A. Ou	tput Power r	educed to 90	W below 36	0VAC input					
Calibration													
Method	Semi-Auton	natic with sta	ndard lab equ	uipment, Full	y-Automatic v	vith HP3458A	& NHR Cali	brator					
Higher power models are		to 0200 240	0 at 2 41414/										

* Higher power models are available up to 9300-2400 at 2.4MW.

Specifications apply after 30 minute warm-up. Refer to Users Manual for additional product specifications.

