

Keysight Technologies

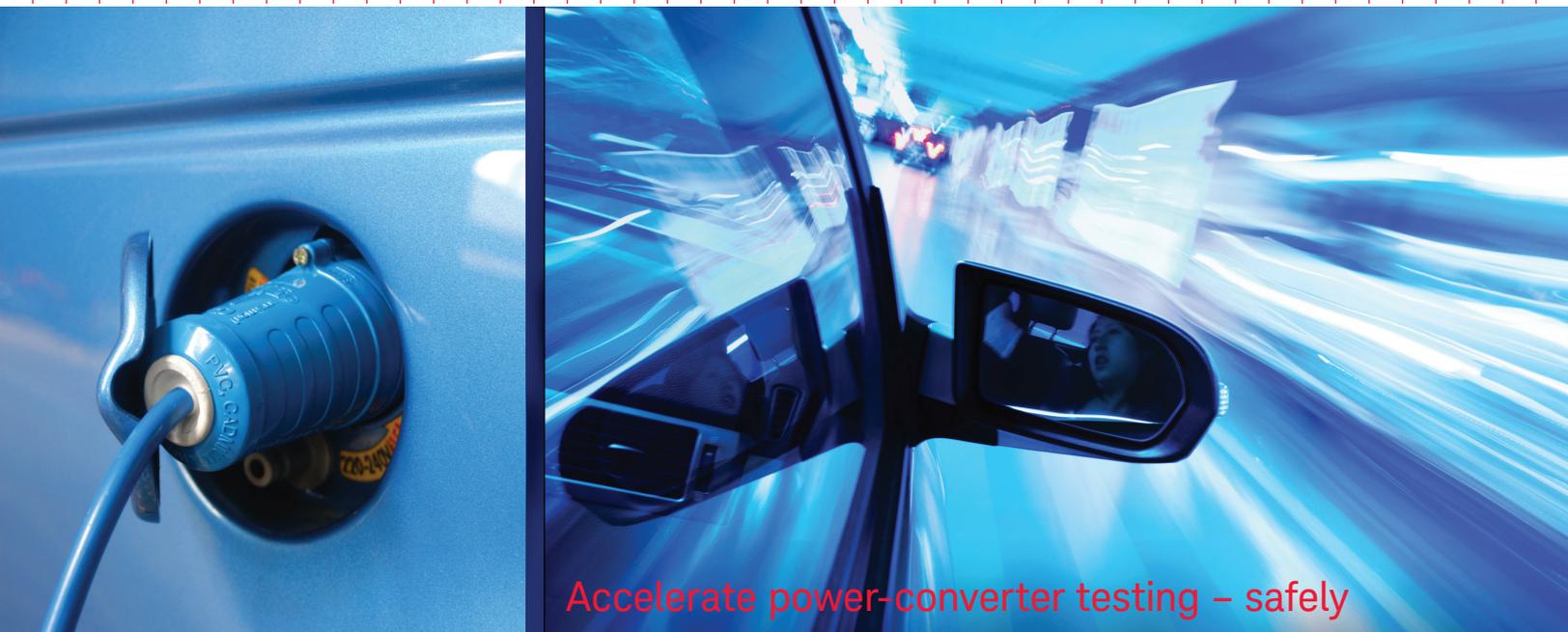
EV1003A Hybrid-Electric/Electric Vehicle Power-Converter Test Solution

RP7900 Series Regenerative Power System

SD1000 Safety Disconnect Solution

PA2200 Series IntegraVision Power Analyzer

Solution Brochure



Accelerate power-converter testing – safely

Only Keysight's power-converter test solution allows you to accelerate your test without having to worry about the safety of your people.



Introduction

The hybrid-electric and electric vehicle (HEV/EV) market has been growing rapidly. Increasing vehicle electrification in the automotive market brings with it new challenges in design and manufacturing. Probably the most noticeable change is the addition of high-voltage, high-power batteries to a platform that is traditionally 12 volts. Hybrid electric and full electric vehicle batteries are 300 volts and higher. These high voltages bring with them additional costs and risks.

Higher costs and risks for high-voltage, high-power components

Purchasing EV test equipment suitable to handle this new high-voltage, high-power environment can be in the range of 4-times more expensive than that of low-power equipment (e.g. 1 kW vs. 10 kW power sources), and many times even higher. Operating expenses will also increase, and at an even greater multiple. For example, the amount of electricity consumed by a 10 kW power source is 10X that of a 1 kW power source when sourcing full power. All this power creates an enormous amount of heat that needs to be mitigated by increasing your facility's cooling capability. Moreover, you now need to comply with high-voltage safety regulations, such as NFPA 79 in the United States. Extra equipment, such as a safety disconnect system, needs to be considered. This leads again to higher cost since you need to design, implement, and support this safety system. Finally, support and maintenance plans become much more complex, especially if you are deploying these systems worldwide.

Keysight's Solution

Keysight is partnering with industry leaders in the HEV/EV market to help them transition their EV tests smoothly into the world of high-voltage, high-power test. Keysight has designed a solution specifically to address the safety, regulatory, and environmental issues mentioned above. This solution is the only commercial-off-the-shelf (COTS) regenerative power system with highly integrated safety features that protect your devices under test and your people. The regenerative capabilities enable the energy consumed to be put back onto the grid cleanly, saving costs from energy consumption and cooling, while not interfering with the grid. Keysight's solution and worldwide support give you the confidence to deploy high-voltage, high-power solutions to meet the fast paced, high-growth demands of the HEV/EV market.

After reviewing this brochure, please do not hesitate to contact Keysight to learn more.

Key features of the EV1003A Power Converter Test Solution

Deliver safe and effective testing of EV/HEV components

Safeguard your people and your devices under test

- Handle faults and ensure output is secured (i.e., disconnected) with redundant safety disconnect system
 - Responds rapidly by disconnecting within 15 ms after a fault occurs
 - Includes four disconnection points (relays) with two each on the positive and negative sides
- Rely on sensing that ensures the grid is live before regenerating power back to the grid (“anti-islanding”)
- Get an extra layer of safety with control of external AC contactors to disconnect all three phases
- Protect your device under test with over-voltage, over-current, and over-temperature (OVP, OCP, and OT)
 - Supports remote inhibit, which is triggered by external inputs such as contact closure or low TTL line



Utilize a compact solution that serves as a power source and an electronic load, just like a battery

- Get sourcing and sinking (electronic load) up to 950 V, up to 40 A, and up to 10 kW
- Operate in two-quadrant mode as power source and regenerative electronic load
- Replace the capabilities of multiple power supplies with auto-ranging output
- Create up to 100 kW power or loading through easy parallel connection of up to 10 units
- More accurately emulate high-voltage, high-power battery (up to 50 Ω) with programmable resistance (model dependent)
- Leverage features rarely found in 10 kW power sources: list mode, best-in-class measurement accuracy
- Reduce footprint with compact size: up to 10 kW of sourcing and loading in 3U
 - Compare to typical 6 kW load at 4U and typical 12 kW load at 6U

Reduce costs for cooling and electricity with an eco-friendly design

- Count on conversion efficiency that returns more than 85% of power to the grid during regeneration
- Minimize interference with other electronics with clean power being returned to the grid
 - Performs regeneration with less than 3% total harmonic distortion (typical) at full load
- Shrink overall energy consumption: Less heat from dissipation means less air conditioning when sinking (DC to AC)
 - Lessens electricity use with >85% efficiency when sourcing (AC to DC) and sinking/regenerating (DC to AC)

Solution Components

RP7900 Regenerative Power System

The RP7900 Series Regenerative Power System is the core of the solution. It provides the battery emulation capabilities for vehicle electrification tests, such as 2-quadrant (source/sink) operation and programmable output resistance. It also provides the added benefit of regenerating >85% of power back to the grid.



This is an abbreviated list of specifications and characteristics. For the full list of specifications and characteristics, please see Specifications and Characteristics section in the Keysight RP7900 Series Operating and Service Guide, literature number RP7900-90001 <http://literature.cdn.keysight.com/litweb/pdf/RP7900-90901.pdf>

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 40°C after a 30-minute warm-up period. Specifications apply at the output terminals, with the sense terminals connected to the output terminals (local sensing).

Specification	RP7951A/RP7961A	RP7952A/RP7962A	RP7953A/RP7963A
DC ratings			
Voltage source	0 to 500 V	0 to 500 V	0 to 950 V
Current source and sink	0 to ±20 A	0 to ±40 A	0 to ±20 A
Power	5 kW	10 kW	10 kW
Output ripple & noise ¹			
CV peak-to-peak	500 mV	500 mV	1000 mV
Load regulation			
Voltage	30 mV	30 mV	60 mV
Current	9 mA	17 mA	9 mA
Voltage programming accuracy ²	0.03% + 60 mV	0.03% + 60 mV	0.03% + 120 mV
Voltage measurement accuracy ²	0.03% + 80 mV	0.03% + 80 mV	0.03% + 160 mV
Current programming & measurement accuracy ²	0.1% + 12 mA	0.1% + 24 mA	0.1% + 12 mA
Transient response ³			
Recovery time	500 μs	500 μs	500 μs
Settling band	1.25 V	1.25 V	2.375 V

1. From 20 Hz to 20 MHz with resistive load, terminals ungrounded, or either terminal grounded
2. At 25°C ±5°C after a 30 minute warm-up; measurement NPLC=1; valid for 1 year, see Calibration Interval
3. Time to recover to within the settling band following a step change from 50% to 100% of full load

Safety Disconnect System

The safety disconnect solution was designed to work exclusively with the RP7900 Series. In less than 15 ms the safety disconnect will remove the output voltage in order safeguard your DUT and your people in response to a fault. Faults can be generated by the RP7900 or a user (emergency switch).



This is an abbreviated list of characteristics. For the full list of characteristics, please see "Appendix A" in the Keysight RP7900 Series Operating and Service Guide, literature number RP7900-90001
<http://literature.cdn.keysight.com/litweb/pdf/RP7900-90901.pdf>

Supplemental characteristics are not warranted but are descriptions of performance determined either by design or by type testing. All supplemental characteristics are typical unless otherwise noted.

Characteristic		Keysight SD1000A
Power relay ratings		500 VDC; 60 ADC
Relay life (typical)		1,000,000 cycles
Regulatory compliance	EMC	Complies with European EMC Directive for test and measurement products Complies with Australian standard and carries C-Tick mark This ISM device complies with Canadian ICES-001 Cet appareil ISM est conforme à la norme NMB-001 du Canada
	Safety	Complies with European Low Voltage Directive and carries the CE-marking. Conforms to US and Canadian safety regulations. Declarations of Conformity for this product may be downloaded from the Web. Go to http://regulations.corporate.keysight.com and click on Declarations of Conformity
Environmental	Operating environment	2.5 MHz (-3 dB)
	Temperature range	0°C to 55°C (Maximum continuous power available is derated at 1% of rating per degree C from 40°C to 55°C)
	Relative humidity	95% or less (non-condensing)
	Altitude	Up to 2000 meters
	Storage temperature	-30°C to 70°C
Output terminal isolation		No output terminal may be more than ±950 VDC from any other terminal or chassis ground.
AC Input	Nominal rating	Single phase; 100-240 VAC input, 50-60 Hz
	Input Range	86-264 VAC; 47-63 Hz
	Power consumption	150 W
Typical weight		33 lbs (15 kg)

PA2200 Series IntegraVision Power Analyzer

The IntegraVision Power Analyzer makes EV test for AC and DC power measurements simple. Easily measure power on any of the vehicles power converters, such as AC-to-DC power conversion efficiency of the on-board charger.

This is an abbreviated list of specifications and characteristics. For the full list of specifications and characteristics, please see the IntegraVision PA2200 Series Data Sheet, literature number 5992-0324EN

<http://literature.cdn.keysight.com/litweb/pdf/5992-0324EN.pdf>



Basic accuracy (50/60 Hz)		0.05% of reading	
Best power accuracy (50/60 Hz)		0.1% of reading	
Power channels (voltage and current)	PA2201A	2 Channels	
	PA2203A	4 Channels	
Voltage measurement bandwidth (-3 dB)		2.5 MHz (-3 dB)	
Current measurement bandwidth (2 A or 50 A Input)		100 kHz (-3 dB)	
Current measurement bandwidth (external input)		2.5 MHz (-3 dB)	
Maximum voltage		1000 _{Vrms} (2000 V peak)	
Maximum current	Direct input	2 _{Arms} (6 A peak) or 50 _{Arms} (100 A peak)	
	External transducer	10 _{Vrms} (30 V peak)	
Record size		Maximum 1.5 M points on each waveform simultaneously	
Digitizing speed		Maximum 5 M samples/second at 16 bits on each waveform simultaneously	
Display size and type		12.1- inch capacitive multi-touch/gesture enabled display	
Power channels (voltage and current)			
Voltage	Connector safety	Banana Plug	
	Maximum voltage	1000 _{Vrms} , 2000 Vpeak	
	Input impedance	2 MΩ 12.5 pF	
	Ranges	5 V, 10 V, 20 V, 50 V, 100 V, 200 V, 500 V, 1000 V	
Current	Directly connected	Connector	Pluggable Terminal Block, Phoenix Contact PN: 1967469
		Maximum current	2 _{Arms} , 6 A peak or 50 _{Arms} , 100 A peak
		Input impedance	2 A input: 60 mΩ + 0.10 μH 50 A input: 6 mΩ + 0.06 μH
		Ranges	2 A input: 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA, 1 A, 2 A 50 A input: 200 mA, 500 mA, 1 A, 2 A, 5 A, 10 A, 20 A, 50
	External transducer	Connector	Isolated BNC
		Maximum current	10 _{Vrms} , 30 V peak
		Input impedance	100 kΩ 100 pF
		Ranges	50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V
Crest factor		3 at full-scale (Unless in conflict with maximum input ratings) Maximum Crest Factor of 30 at 10% of full scale	
Current input protection		Internal current shunt measurement paths are not fused. Current limit protection (fuse or breaker) and appropriate wire sizing should be provided by the user. Currents in excess of 140% of the rated rms currents may cause permanent damage to the current measurement shunts. An internal protection mechanism is provided for the 2A shunt to avoid damage due to mis-wiring, but it should not be relied upon in situations where higher than 2 _{Arms} currents are expected.	
Isolation		Voltage and current terminals are isolated from earth ground to 1000 V CAT II rating. Voltage is isolated from current with 1000 V CAT II rating	

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