Photovoltaic / Solar Array Simulation Solution

PV8921A, PV8922A Photovoltaic Array Simulators
DG9000A Advanced / Multi-Input Photovoltaic Inverter Test Software

Whether your inverter has one or twelve inputs / MPPTs, Keysight's Photovoltaic / Solar Inverter Test Solution can help you go beyond the test standards to maximize performance and bankability.

New PV8900 Series achieves 2000 V, 20 kW in a 3U high package
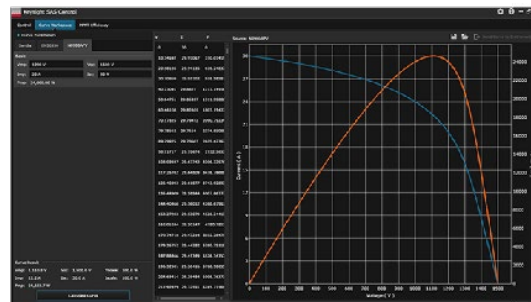

Figure 1. PV8900 PV simulators
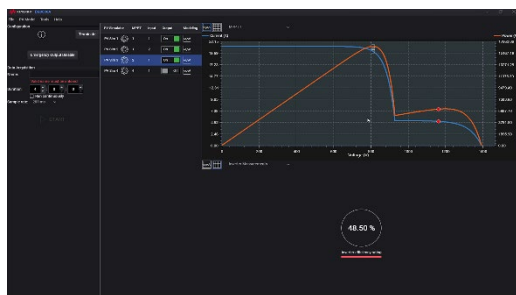

Figure 2. DG9000A PV model (curve) workspace

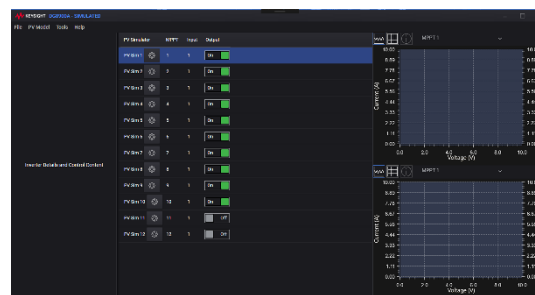Figure 3. DG9000A MPPT efficiency

Figure 4. DG9000A multiple control

KEYSIGHT TECHNOLOGIES

Maximize the performance of your inverter

Figure 5. PV8922A Photovoltaic Array Simulator

If you are designing or manufacturing photovoltaic solar inverters from one to twelve inputs and up to 2000 V per input, Keysight's Photovoltaic / Solar Inverter Test Solution can help you develop, verify, and maximize the performance and bankability of your inverter. The solution enables you to optimize maximum power point tracking (MPPT) algorithms and circuits.

The explosive growth in the solar power generation industry has increased competition and intensified the need for solar inverter test and measurement solutions. With the PV8900 Series and DG9000A software you can simultaneously control and test from one to twelve PV inverter inputs / MPPTS, enabling you to go beyond the test standards, optimizing your inverters to beat the competition.

To keep solar power at grid parity with competing methods of power generation, performance and power conversion efficiency are increasingly important. Small increments in power production have a dramatic effect on the profitability of solar power generation.

You need to ensure your solar inverters are capable of converting the maximum power that is available from the solar array. Developing and verifying the performance of inverter MPPT algorithms and circuits is challenging. MPPT algorithms are complex, and under-the-sun testing with a comprehensive set of temperature and irradiance conditions is extremely difficult, expensive, and time consuming, if even possible at all.

As inverters increase in power, the size of the test array would become unmanageable. As they increase in number of inputs on a single inverter, the complexity of test changes exponentially. The only practical test method is to use a laboratory test solution that can simulate from one to many real-world solar array strings.

Want a turn-key system delivered?

Contact Keysight
www.keysight.com/find/contactus

Quickly create, visualize, and execute photovoltaic / solar I-V curves

Keysight's PV simulation solution consists of the PV8900 Series PV simulator hardware and the DG9000 advance/multi-input PV inverter test software.

The PV simulators are autoranging, programmable DC power sources that simulate the output characteristics of a photovoltaic array under different environmental conditions (temperature, irradiance, age, cell technology, etc.) enabling you to quickly and comprehensively test inverter MPPT algorithms and inverter efficiency. The DG9000 software allows the user to control the output of from one to twelve PV8900A units (or primary/secondary combinations) as well as easily create, visualize, and download solar / photovoltaic I-V curves to the instrument using the PV Model Workspace. Once a curve has been downloaded to a PV8900A, the user can enable the output and watch as their PV inverter searches for the maximum power point, gaining insight into their MPPT algorithm.
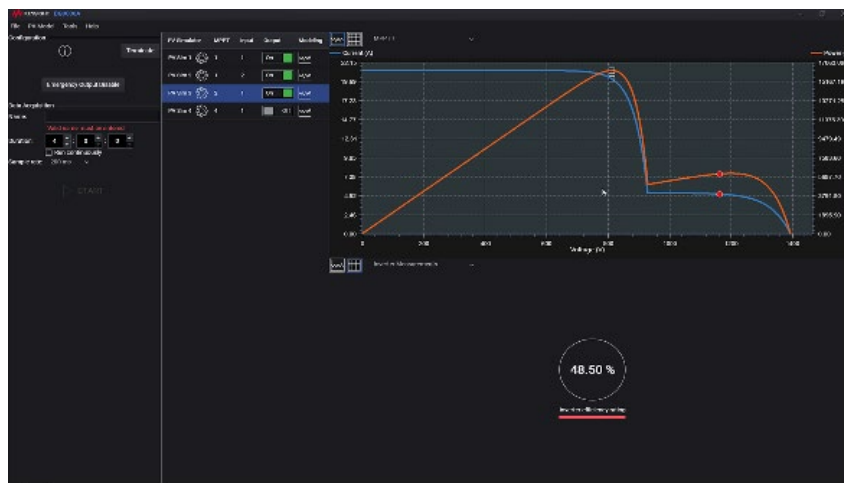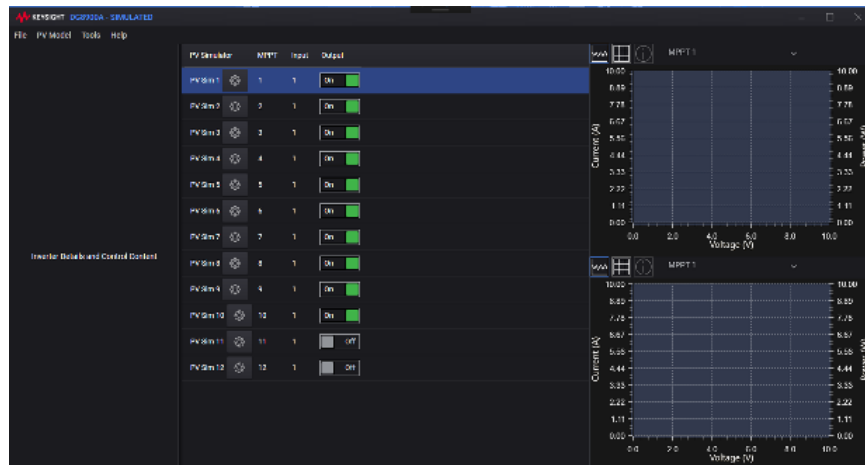

Figure 6. DG9000A MPPT efficiency

Figure 7. DG9000A multiple control

DG9000 Advanced / Multi-Input PV Inverter Test Software: Beyond the Standards

Existing test standards don't address the testing of innovative multiple-input designs, missing 99% of the possible test points, and this leads to inaccurate representations of energy conversion.

The DG9000 software helps you avoid this scenario with testing that accounts for real-world operation of multi-input inverter designs. Going beyond outdated standards, it enables quick and easy analysis that covers more operating points. Broad coverage helps you pinpoint problems and correct them before they reach your customers.

The DG9000 helps you innovate in testing with a solution that combines extensive test data with informative analysis. We're filling in the gaps the standards haven't yet addressed, covering more of the missing 99% and enabling testing of PV inverters that have up to 12 inputs.

Key features and benefits

- Intelligent user interface with single point of control, configuration, management, and I-V curve generation for up to 12 separate SAS channels

- Swap between / view MPPT operation on up to 12 separate I-V curves; software automatically calculates combined I-V curves from multiple separate SAS channels connected in parallel

- Synchronized dynamic I-V curve scaling across separate SAS channels

- Test data dashboard aggregates/displays time-synchronized real-time measurements of voltage, current, power, and MPPT efficiency for up to 12 independent MPPTs and/or 12 separate PV inputs

- Synchronized time-stamped data logging of all theoretical (programmed) and actual (measured) operating characteristics

Use multiple simulation modes to create SAS characteristics

The PV8900 has two solar array simulation (SAS) operating modes: curve mode where the PV array simulator quickly creates the curve mathematically and table mode where you can enter the precise I-V curve with up to 1024 points.

With a 2000 V output and 2000 V isolation voltage, the PV array simulators are ready for emerging solar power plant technologies and allow testing to higher solar inverter input voltages.

In curve mode, the output I-V characteristic follows an exponential model of the solar array/module. The characteristic is created from four input parameters:

I_{mp} – the current at the maximum power point $\qquad$ V_{mp} – the voltage at the maximum power point

I_{sc} – the short-circuit current of the array $\qquad$ V_{oc} – the open-circuit voltage of the array

In table mode, the SAS characteristic curve is created from up to 1024 user-specified voltage/current points to match specific I-V curves. An intuitive PC-based software application makes creating and downloading SAS characteristic curves fast and straight-forward.

Your PV Array Simulator is Also an Advanced, Autoranging System DC Power Supply

The Keysight Technologies PV8900 Series PV array simulator provides 20 kW autoranging, single-output programmable DC power for ATE applications. The autoranging output characteristic enables unprecedented flexibility by offering a wide range of voltage and current combinations at full power. Power supplies with "rectangular," or traditional, output characteristics provide full power at only one voltage and current combination. Just one does the job of multiple power supplies. It's like having many power supplies in one!

The PV8900 Series provides stable output power, built-in voltage and current measurements, and autoranging output voltage and current from up to 2000V, up to 30 A at up to 20 kW. These supplies offer many system-ready features like multiple standard I/O interfaces to simplify and accelerate test-system development and compact 3U design to save rack space. If you need more power, you can easily parallel multiple units to create "one" power supply with up to 200 kW of total output power. The built-in primary/secondary control enables programming as if it's just one big power supply; no need to program each supply individually.

Autoranging output – does the job of multiple power supplies

The PV8900 PV array simulators' autoranging output characteristic makes it much more flexible than rectangular, or traditional, output characteristic power supplies because they expand the power curve, giving you more voltage and current combinations in one power supply. It's like having many rectangular power supplies in one.

For example, the 2000 V, 30 A, 20 kW model is capable of 2000 V and 10 A at 20 kW as well as 667 V and 30 A at 20 kW. If it were a rectangular output, the specifications would be 2000 V, 10 A, 20 kW. At 667 V it would only be able to output 6.7 kW, not the 20 kW of autoranging output. Figures 9 below shows the details of the PV8900's output.

Easy front-panel operation

Using the front panel controls, you have complete access to all of the PV8900 Series PV array simulator features via the extensive menu system (Note: SAS table points cannot be programmed from the front panel). You can enter your settings via the keypad. You can also set protection settings, power-on states, and other features. The output voltage, current, and power can be displayed simultaneously, and annunciators at the bottom of the display show PV array simulator status and operating modes. You can lock the front panel controls to protect against accidental parameter changes.

Advanced DC Power Supply

- 20 kW maximum output power

- Up to 2000 V and up to 30 A

- Easily parallel units to create "one" power supply with up to 200 kW of power

- Built-in voltage and current measurement

- High power density, 20 kW in only 3U (5.25 inch/13.34 cm)

- Protection from over-voltage, over-current, and over-temperature

- LAN (LXI Core), USB, and GPIB

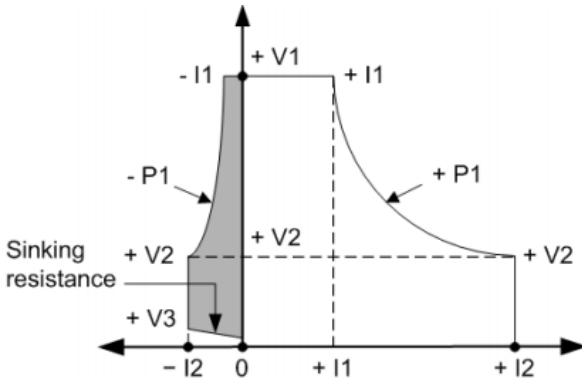Figure 8. Autoranging output – like having many power supplies in one

Autoranging Output

Figure 9. Autoranging output characteristic

Model	+V1	+V2	+V3	+I1	-I1	+I2	-I2	+P1	-P1	Sinking resistance
PV8921A	1500 V	666 V	6 V	13.3 A	1.33 A	30 A	3 A	20 kW	2 kW	333 mΩ
PV8922A	2000 V	666V	6 V	10 A	1 A	30 A	3 A	20 kW	2 kW	333 mΩ

Device protection

To safeguard your device, the PV8900 Series PV array simulator provides over-temperature, over-current and over-voltage protection to shut down the power supply output when a fault condition occurs.

Need more power? We've got you covered.

Quickly create a primary/secondary setup for even more total output power. The PV array simulators give you the flexibility to easily connect in parallel up to ten identical units for greater output current and power. The units can also be configured to look like "one" big power supply. Series operation is not recommended.

Figure 10. Parallel up to 10 x PV8900 (up to 200 kW)

Performance specifications

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 40°C after a 30-minute warm-up. Specifications apply at the output terminals, with local sensing.
See PV8900-90901 for complete specifications.

Specification		PV8921A	PV8922A
DC output ratings	Voltage	1500 V	2000 V
	Current	30 A	30 A
	Power	20 kW	20 kW
Output voltage ripple and noise	CV p-p[1]	3 V	3 V
	CV rms[2]	400 mV	400 mV
Load regulation	Voltage[3]	100 mV	100 mV
	Current	4 mA	4 mA
Programming & Measurement accuracy[4]	Voltage	0.04% + 150 mV	0.04% + 150 mV
	Current	0.03% + 3 mA	0.03% + 3 mA
Transient response[5]			
Recovery time		300 µs	300 µs
Settling band		20 V	20 V

Common Characteristics

Characteristic		PV8921A and PV8922A
AC input ratings	Phase and range	3 phase; 380 – 480 VAC ±10%
	Frequency	50 / 60 Hz
	Input VA	23 kVA
	Power factor[6]	0.99
Output terminal isolation		No output terminal may be more than ±2000 VDC from any other terminal or chassis ground.
Typical Weight		82 lbs. (37.3 kg)

[1] From 20 Hz to 20 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded
[2] From 20 Hz to 10 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded
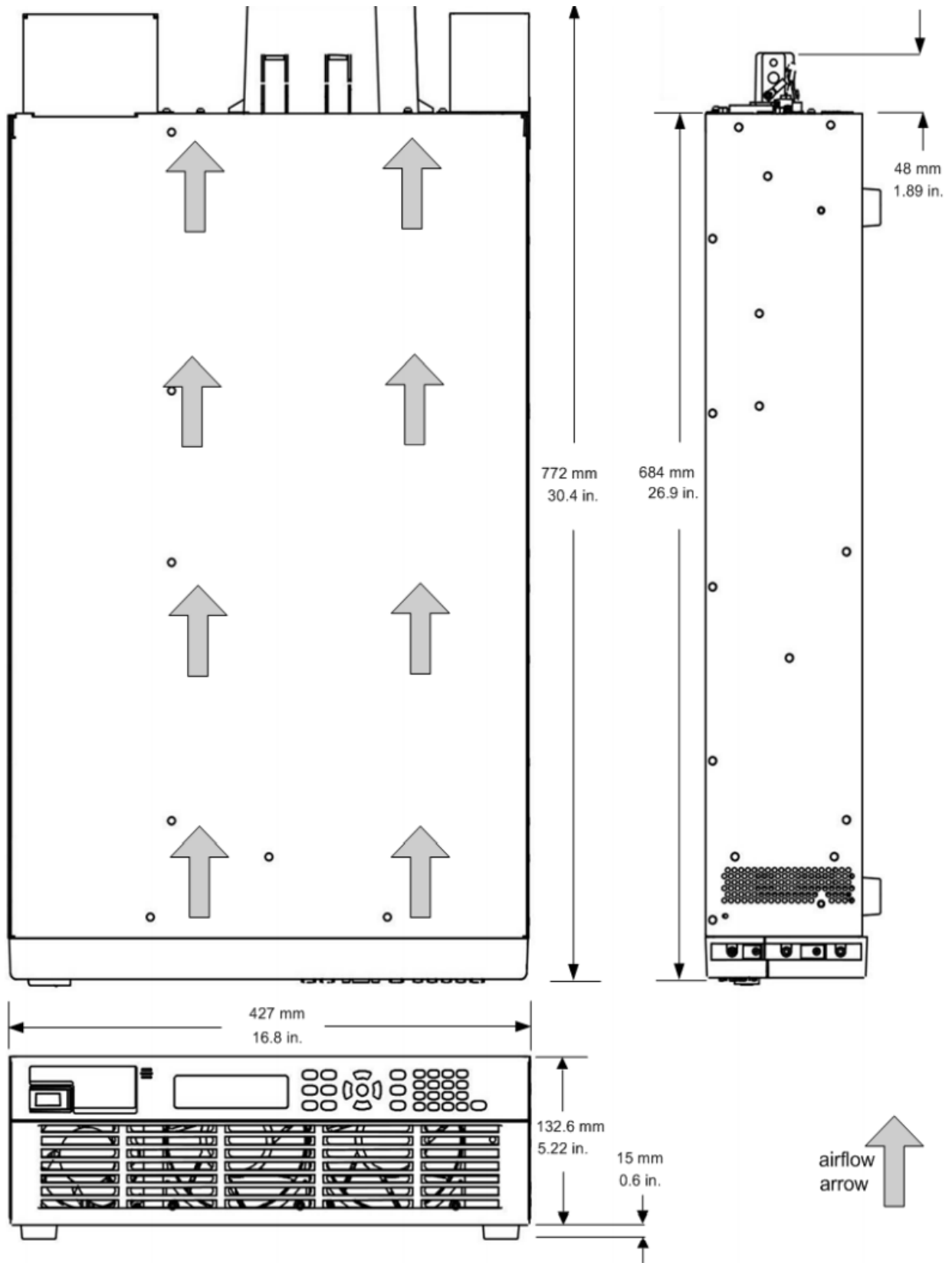[3] Also applies when remote sensing with a ≤1 V drop per load lead
[4] Percent of value + offset; at 25°C ±5°C after a 30 minutewarm-up; measurement NPLC=1; valid for 1 year
[5] Time to recover to within the settling band following a step change from 40% to 90% and 90% to 40% of full load at Comp 0, with a 40 µs current rise and fall time
[6] At nominal input and rated power

Outline diagrams

772 mm
30.4 in.

684 mm
26.9 in.

48 mm
1.89 in.

427 mm
16.8 in.

132.6 mm
5.22 in.

15 mm
0.6 in.

airflow
arrow

Available PV8900A models

Model #	Max voltage (V)	Current (A) @ max voltage[1]	Voltage (V) @ max current[1]	Max current (A)	Max power (W)	AC input voltage (VAC)
PV8921A	1500	13.3	666.7	30	20000	400/480
PV8922A	2000	10.0	666.7	30	20000	400/480

Figure 11. PV8922A

DG9000A Advanced / Multi-Input Photovoltaic Inverter Test Software

Available for download at http://www.keysight.com/find/DG9000Adownload

Product/Model #	Description
DG9104A	License to control up to 4 PV simulators in DG9000A software
DG9108A	License to control up to 8 PV simulators in DG9000A software
DG9112A	License to control up to 12 PV simulators in DG9000A software

[1] The PV8900 Series PV array simulators can be used as autoranging power supplies. The "Current @ max voltage" and "Voltage @ max current" are listed to show the full range of voltage and current combinations possible due to the autoranging capability.
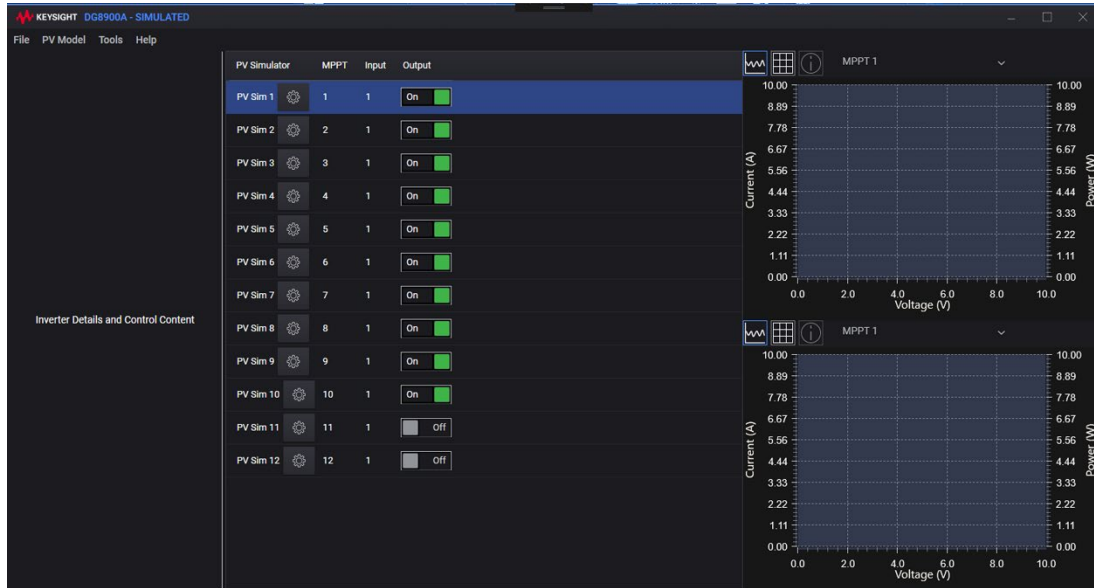
Figure 12. DG9000A multiple control

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

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