

# Photovoltaic / Solar Array Simulation Solution

PV8921A Photovoltaic Array Simulator, 1500V, 30A, 20kW, 400/480 VAC  
PV8922A Photovoltaic Array Simulator, 2000V, 30A, 20kW, 400/480 VAC  
PV8931A Photovoltaic Array Simulator, 1500 V, 60 A, 30 kW, 400/480 VAC  
PV8932A Photovoltaic Array Simulator, 2000 V, 30 A, 30 kW, 400/480 VAC  
DG8901A Solar Array Simulator Control Pro Software  
DG9000A Advanced / Multi-Input Photovoltaic Inverter Test Software



Two New PV8900  
models achieve  
2000 V, 30 kW in a 5U  
high package

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.



Figure 1. PV8921A and PV8932A PV simulators

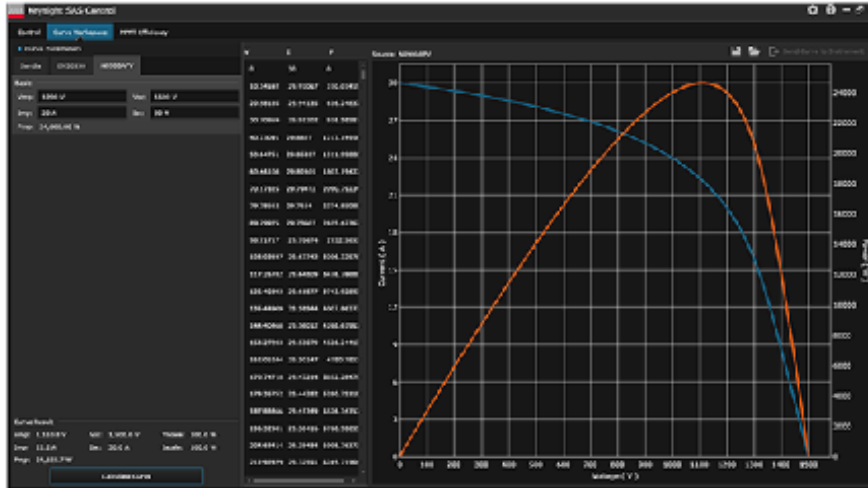


Figure 2. DG9000A PV model (curve) workspace

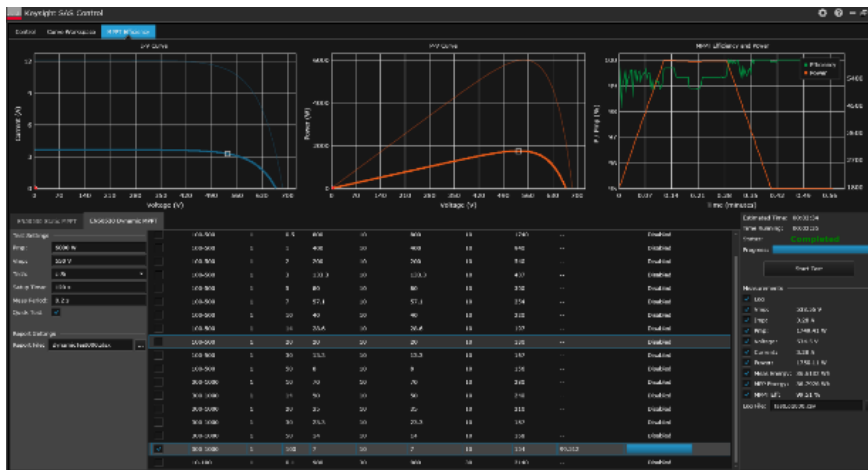


Figure 3. DG8901A dynamic EN50530 MPPT test

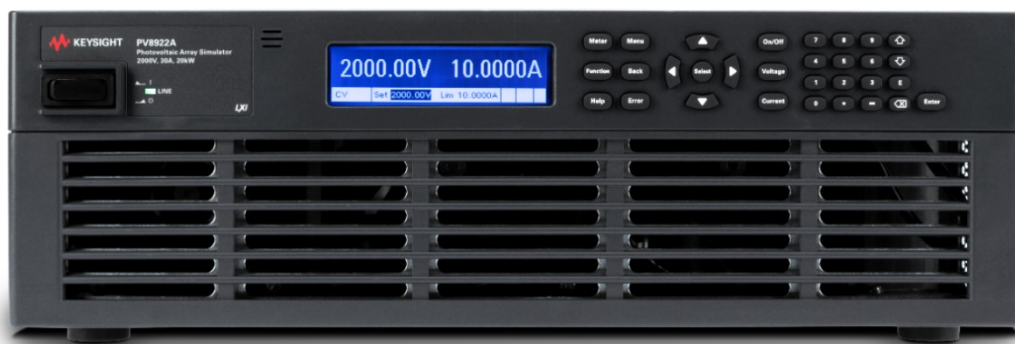


Figure 4. PV8922A Photovoltaic Array Simulator

## Maximize the performance of your inverter

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. With the DG8900 software you can quickly and easily test individual inputs to the European EN50530 (April 2010) standard to easily compare your results to your competitors.

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 PV inverter test system delivered?

Complete PV inverter test system with PV8900 and SL1200 grid emulator

Contact Keysight

[www.keysight.com/find/contactus](http://www.keysight.com/find/contactus)



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

Keysight's PV simulation solution consists of the PV8900A Series PV simulator hardware and two software packages to choose from: the DG8900 SAS control/curve generation software 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 DG8900 SAS Control software allows the user to control one PV8900A (or one primary/secondary set) output as well as easily create, visualize, and download solar / photovoltaic I-V curves to the instrument using the Curve Workspace. Once a curve has been downloaded to an 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. The DG9000 software allows the user to control the output of from one to twelve PV8900A units (or primary/secondary combinations).



Figure 5. DG9000A MPPT efficiency

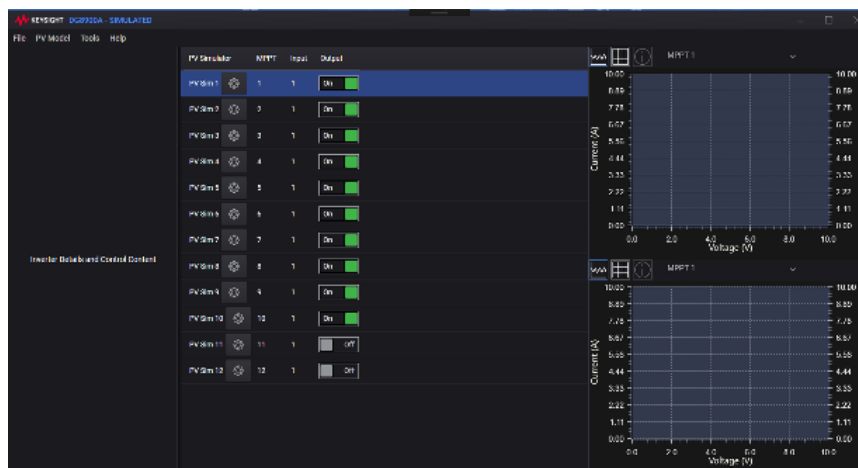


Figure 6. DG9000A multiple control

## DG8900 SAS Control Software

To easily compare your efficiency to your competitors and maximize your appeal to customers, the DG8900 SAS control software has automated static and dynamic EN50530 MPPT test. Simply input the test parameters, such as Pmp, Vmp, etc., click “Start Test” and the SAS Control App does the rest. Once the test is complete, SAS Control Pro creates a report formatted to the EN50530 standard as well as a log file with all of the measurements from the test.

### Key features and benefits

- Easily view and control your N8900APV Series PV Simulator from the Control tab
  - Perform simple functions, such as setting voltage, current, OVP, as well as turn the output on/off
  - Set the instrument mode: SAS or Power Supply
  - View the programmed I-V and power curves, maximum power point, and the active I-V and power points (SAS mode only)
- Quickly create and download photovoltaic I-V curves from the Curve Workspace tab
  - Create PV curves according to Sandia, EN50530, and Keysight's proprietary (N8900APV) models
  - Choose between Basic and Advanced curve generation
  - Graphically view the curve before sending it to the instrument
- Create static and dynamic EN50530 test reports with one click from the MPPT Efficiency tab (DG8901A upgrade required after 30-day free trial)
  - Automated test to the EN50530 standard
  - Automated reports formatted to the EN50530 standard
  - Full log file with all the measurements from the test

## 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.

## DG9000 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

- $I_{mp}$  – the current at the maximum power point
- $I_{sc}$  – the short-circuit current of the array
- $V_{mp}$  – the voltage at the maximum power point
- $V_{oc}$  – the open-circuit voltage of the array

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:

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 up to 30 kW autoranging, single-output programmable DC power. The autoranging output characteristic enable 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.

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 60 A at up to 30 kW. These supplies offer many system-ready features like multiple standard I/O interfaces to simplify and accelerate test-system development and compact 3U (20 kW) or 5U (30 kW) design to save rack space. If you need more power, you can easily parallel multiple units to create “one” power supply with up to 600 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.

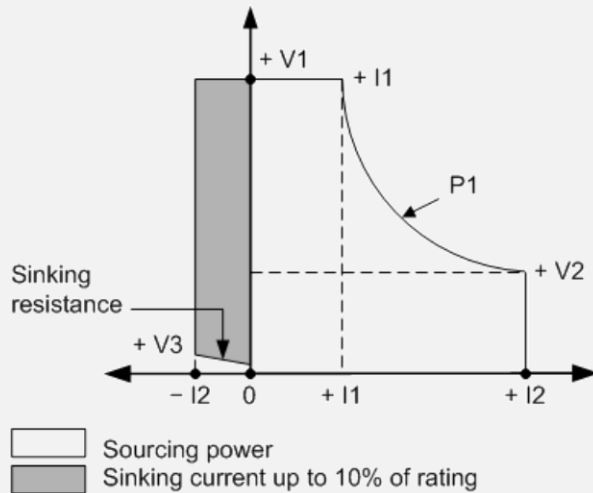


Figure 9. Autoranging output characteristic

Model	+V1	Model	+V1	Model	+V1	Model	+V1	Model
PV8921A	1500	666	15	13.3	30	3	20	500 mΩ
PV8922A	2000	666	15	10	30	3	20	500 mΩ
PV8931A	1500	500	10.5	20	60	6	30	175 mΩ
PV8932A	2000	1000	18	15	30	3	30	600 mΩ

## Advanced DC Power Supply

- 30 kW maximum output power
- Up to 2000 V and up to 60 A
- Easily parallel units to create “one” power supply with up to 600 kW of power
- Built-in voltage and current measurement
- High power density, 20 kW in only 3U, 30 kW in 5U
- Protection from over-voltage, over-current, and over-temperature
- LAN (LXI Core), USB, and GPIB



Figure 7. Autoranging output – like having many power supplies in one

## 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.

## 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 twenty 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.



## 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	PV8931A	PV8932A
DC output ratings	Voltage	1500 V	2000 V	1500 V	2000 V
	Current	30 A	30 A	60 A	30 A
	Power	20 kW	20 kW	30 kW	30 kW
Output voltage ripple and noise	CV p-p <sup>1</sup>	3 V	3 V	2.25 V	3 V
	CV rms <sup>2</sup>	400 mV	400 mV	300 mV	400 mV
Load regulation	Voltage <sup>3</sup>	100 mV	100 mV	75 mV	100 mV
	Current	4 mA	4 mA	8 mA	4 mA
Programming & Measurement accuracy <sup>4</sup>	Voltage	0.04%+150mV	0.04%+150mV	0.03%+100mV	0.03%+150mV
	Current	0.03%+3mA	0.03%+3mA	0.03%+6mA	0.03%+3mA
Transient response <sup>5</sup>					
Recovery time		300 µs	300 µs	300 µs	300 µs
Settling band		15 V	20 V	15 V	20 V

## Common Characteristics

Characteristic		PV8921A / PV8922A	PV8931A / PV8932A
AC input ratings	Phase and range	3 phase; 380 – 480 VAC ±10%	
	Frequency	50 / 60 Hz	
	Input VA	23 kVA	34 kVA
	Connections	L1, L2, L3, N, PE	
	Power factor <sup>6</sup>	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)	126 lbs. (57.2 kg)
Dimensions	See Outline Diagrams		

<sup>1</sup> From 20 Hz to 20 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded

<sup>2</sup> From 20 Hz to 10 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded

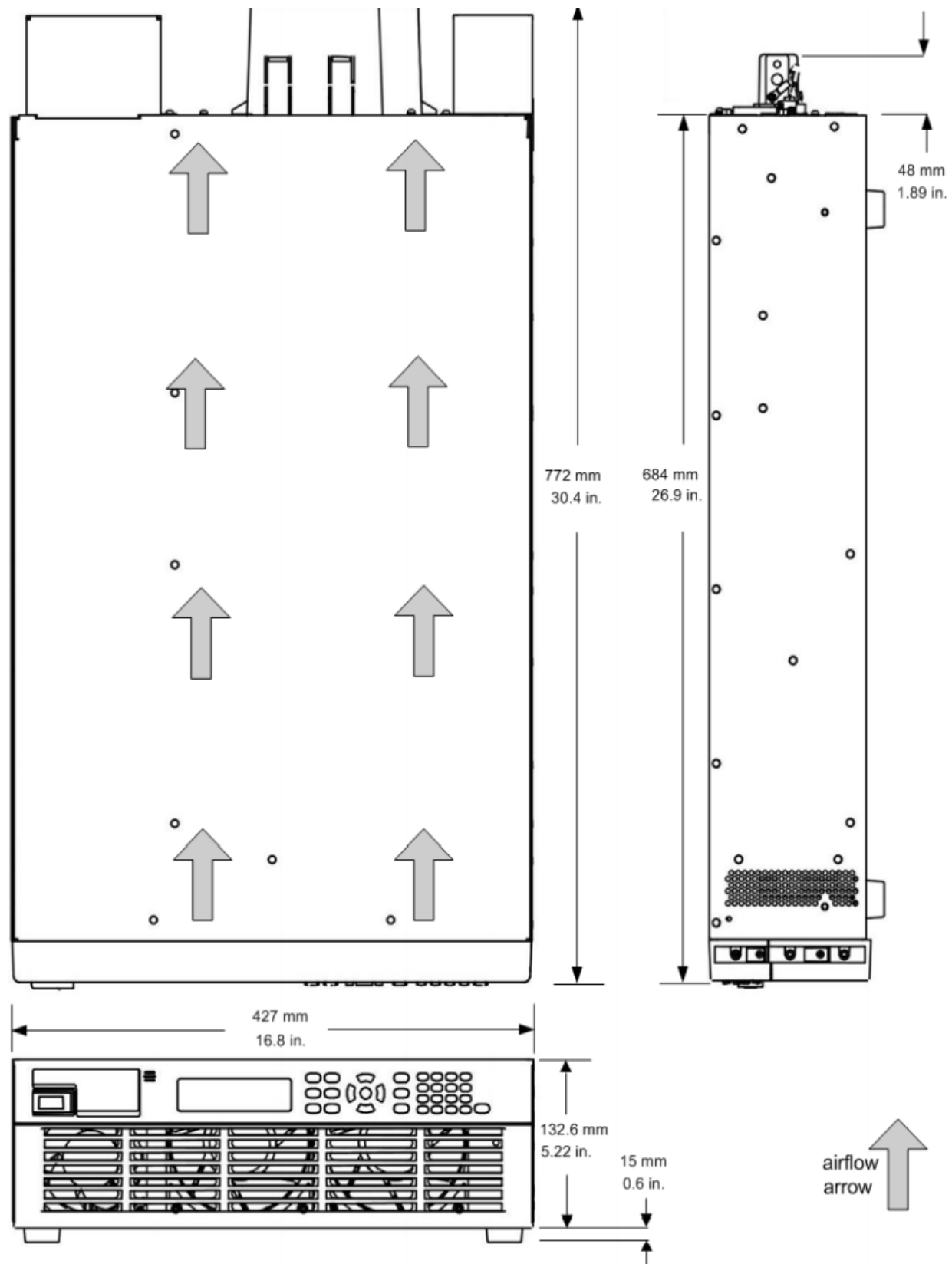
<sup>3</sup> Also applies when remote sensing with a ≤1 V drop per load lead

<sup>4</sup> Percent of value + offset; at 25°C ±5°C after a 30 minutewarm-up; measurement NPLC=1; valid for 1 year

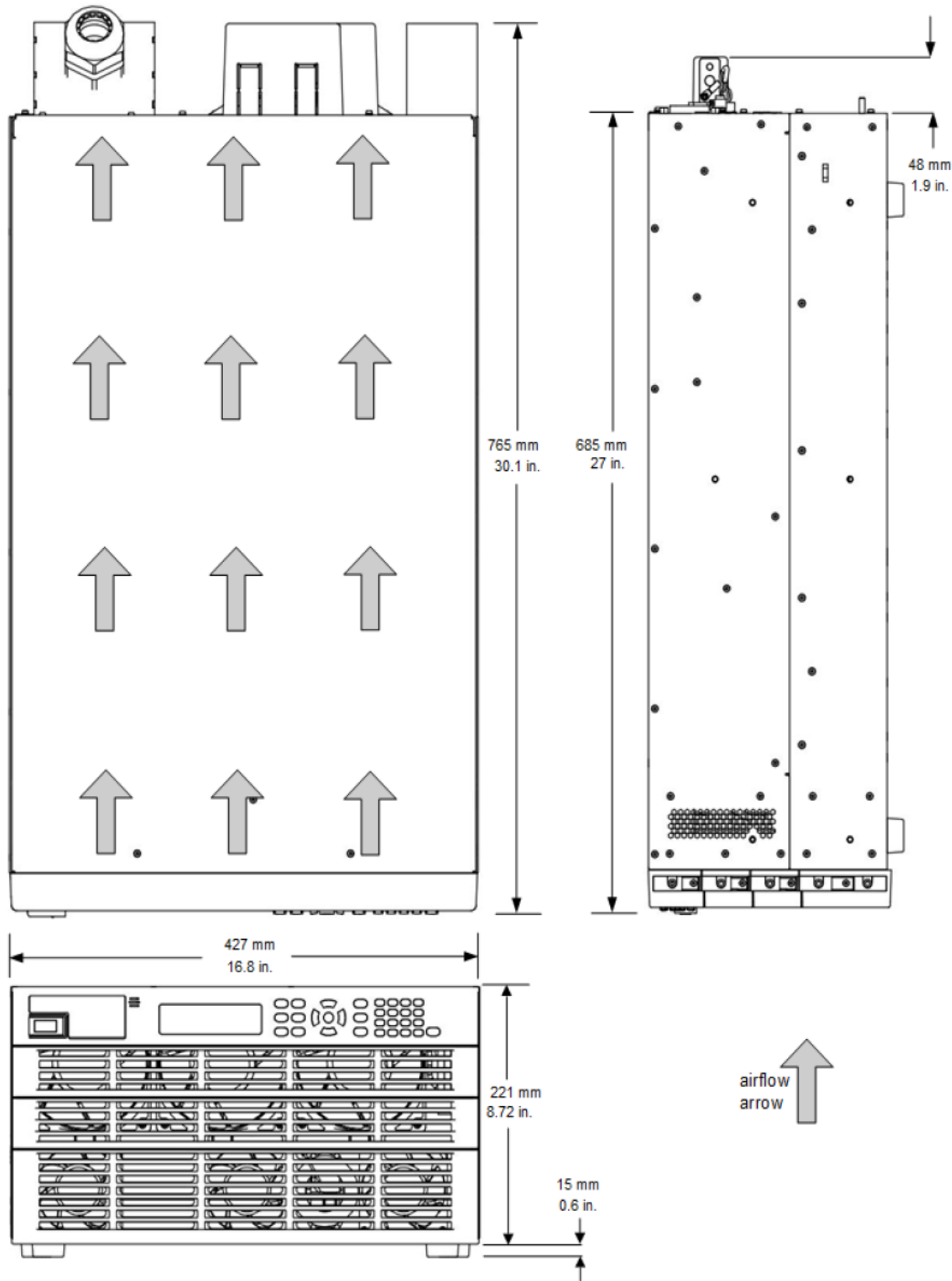
<sup>5</sup> Time to recover to within the settling band following a step change from 40% to 90% and 90% to 40% of full load at Comp 0, with a 40 µs current rise and fall time

<sup>6</sup> At nominal input and rated power

Outline diagram (PV8921A, PV8922A)



Outline diagram (PV8931A, PV8932A)



## Available PV8900A models

Model #	Max voltage (V)	Current (A) @ max voltage <sup>7</sup>	Voltage (V) @ max current <sup>7</sup>	Max current (A)	Max power (W)	AC input voltage (VAC)
PV8921A	1500	13.33	666	30	20000	400/480
PV8922A	2000	10	666	30	20000	400/480
PV8931A	1500	20	500	60	30000	400/480
PV8932A	2000	15	1000	30	30000	400/480

## 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

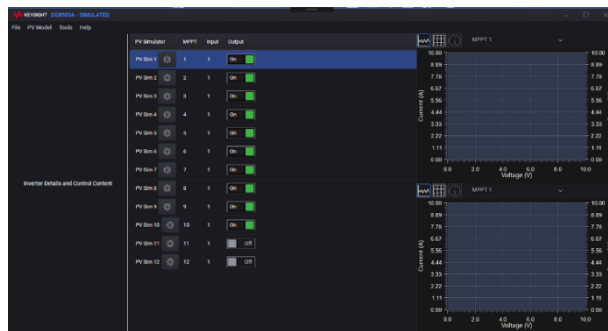


Figure 10. DG9000 multiple control

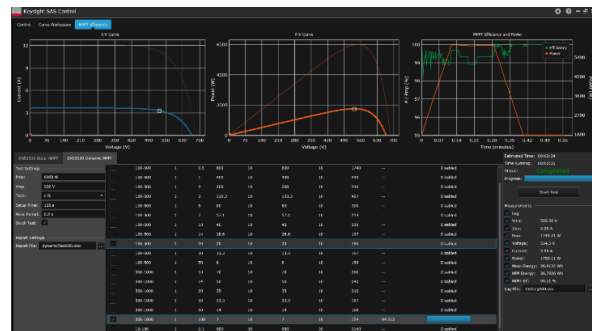


Figure 11. DG8901 performing EN50530 MPPT

<sup>7</sup> 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.

## DG8901A SAS Control Software

Available for download at <http://www.keysight.com/find/SasControlSoftware>

Model number	Description
DG8901A	License for SAS Control Pro, enables automated static and dynamic EN50530 test

Learn more at: [www.keysight.com](http://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](http://www.keysight.com/find/contactus)

