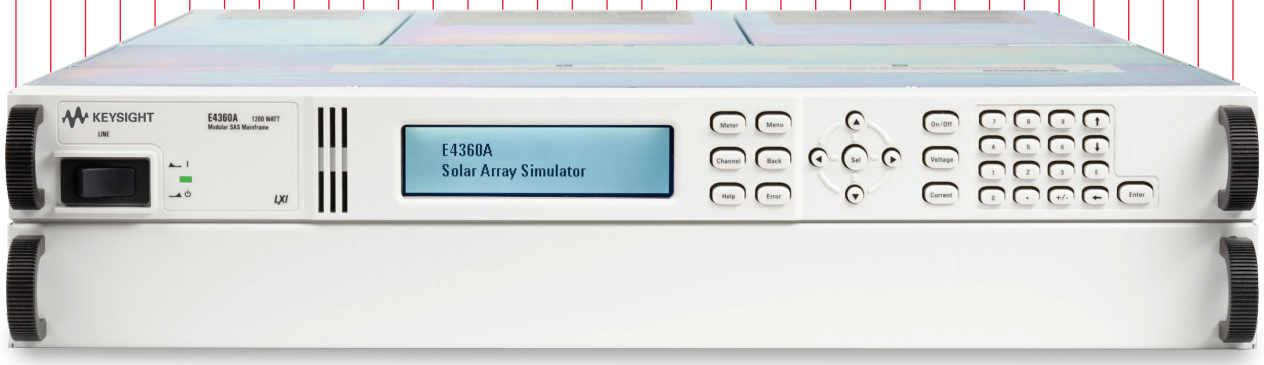
Keysight E4360

Modular Solar Array Simulators

Models: E4360-62A, E4366-68A

Data Sheet



KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights

- Accurate simulation of any type of solar array
- Small size: up to 2 outputs in 2U of rack space
- High output power – up to 600 W per output
- Fast I-V curve change and fast recovery switching time
- Easy to simulate environmental conditions
- LAN, USB, and GPIB interfaces standard
- Fully compliant to LXI Class C specifications
- Custom turn-key system or individual instruments available

Solar Array Simulation

Satellite test applications

Solar panels consisting of multiple solar cells provide power to satellites. They have unique I-V characteristics. Since the output power varies with environmental conditions (temperature, irradiation) and operational conditions (eclipse, spin), a specialized power supply such as the solar array simulator (SAS) must be used for making accurate tests and veryifying the satellite power system.

Residential photovoltaic (PV) test applications

Solar panels are also used in residential power systems to provide power to homes. Each solar panel output can be connected to a microinverter that converts the DC solar panel output into AC for use in the home. To test microinverters, a solar array simulator is used to verify that the microinverter will track the maximum power point under various environmental conditions (such as sunny conditions, cloudy conditions, shadowing, and different temperatures) and to ensure that the microinverter is reliable and efficient.

As the trend moves toward higher power solar panels and more efficient inverters, there is a need for a specialized DC power source that is reliable, repeatable, scalable, cost effective, and available off the shelf.

Satellite manufacturers need to verify the design of the power bus regulator on the ground. Microinverter and DC power optimizer designers need to verify accuracy and efficiency of the device to gain competitive advantage in the marketplace.

Keysight Solar Array Simulator

The Keysight Technologies, Inc. E4360 Modular Solar Array Simulator (SAS) is a dual output programmable dc power source that simulates the output characteristics of a solar array. The E4360 SAS is primarily a current source with very low output capacitance and is capable of quickly simulating the I-V curve of different arrays under different conditions (ex. temperature, age etc.). It provides up to 2 outputs and up to 1200 W in a small 2U-high mainframe.

Whether you build your own test system requiring instrument only or if you want a full turn-key system with all the instruments and software integrated and installed – Keysight gives you the flexibility you need. The E4360 SAS is readily available as an off-the-shelf instrument and also is available from Keysight integrated into a full turn-key solar array simulator system configured to your exact specification.

Multiple simulation modes

The E4360 SAS provides three operating modes, Simulator (SAS), Table and Fixed modes. To accurately simulate the I-V cure of a solar array, use SAS or table modes. When a standard power supply is needed, use fixed mode.

1. SAS mode

The E4360 SAS internally generates a 4,096 I-V point table. An internal algorithm is used to approximate an I-V curve. This can be done via the I/O interfaces or from the front panel where a PC is not needed. These four input parameters are needed to establish a curve in this mode:

- V_{oc} - open circuit voltage
- I_{sc} - short circuit current
- I_{mp} - current at the peak power point on the curve
- V_{mp} - voltage at the peak power point on the curve

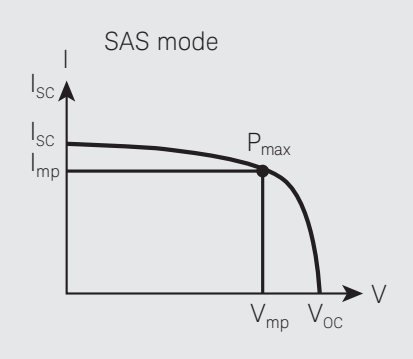


Figure 1. Power supply output characteristic in SAS mode

2. Table mode

The I-V curve is determined by a user-defined table of points. A table can have a minimum of 3 points, up to a maximum of 4000 points. A point corresponds to a specific value of I and V. As many as 30 tables may be stored in each of the E4360 SAS built-in volatile and non-volatile memory. The tables (I-V curve) stored in this non-volatile memory will be retained when the power is turned off, while those stored in volatile memory will be erased after power is removed.

Additionally, current and voltage offsets can be applied to the selected table to simulate a change in the operating conditions of the solar array.

3. Fixed mode

This is the default mode when the unit is powered on. The unit has the rectangular I-V characteristics of a standard power supply.

Fast I-V curve changes

The E4360 offers fast curve changes to enable better simulation of solar arrays under various environmental conditions, like eclipse and spin. The resolution of the I-V curve can be set to optimize the I-V curve for resolution or fast curve change. In simulation (SAS) mode and table mode, you can select high resolution which uses a 4,096 point table to generate a smoother I-V curve within 350 msec. For fast I-V curve generation, you can select the 256 point table that quickly generates an I-V curve within 30 msec. All the E4360 SAS in the system can be synchronized to change their I-V curves at the same time using the hardware trigger, such that I-V curves can be changed on up to 100 outputs within 30 msec or 350 msec based on resolution setting.

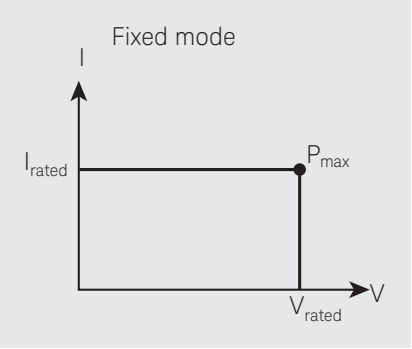


Figure 2. Power supply output characteristic in Fixed mode

Performance Specifications for Keysight E4361A and E4362A SAS Modules

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 40 °C and are applicable for Fixed, Simulator, and Table modes

			E4361A	E4362A	E4362A-J01	E4362A-J02
Output ratings (Simulator and table mode)		Maximum power	510 W	600 W	594 W	594 W
		Maximum open circuit voltage (V_{oc})	65 V	130 V	117 V	120 V
		Maximum voltage point (V_{mp})	60 V	120 V	108 V	110 V
	Line voltage: 200 V/230 V/240 V	Maximum short circuit current (I_{sc})	8.5 A	5.0 A	5.5 A	5.4 A
		Maximum circuit point (I_{mp})[1]	8.5 A	5.0 A	5.5 A	5.4 A
	Line voltage: 100 V/120 V[4]	Maximum short Circuit current (I_{sc})	4.25 A	2.5 A	2.75 A	2.7 A
		Maximum current point (I_{mp})[1]	4.25 A	2.5 A	2.75 A	2.7 A
Output ratings (Fixed mode)	**Minimum impedance (ΔV/ΔVl)[1]**		0.25 Ω	1 Ω	1 Ω	1 Ω
	Voltage		0 - 60 V	0 - 120 V	0 - 108 V	0 - 110 V
	Line voltage: 200 V/230 V/240 V	Current	0 - 8.5 A	0 - 5.0 A	0 - 5.5 A	0 - 5.4 A
	Line voltage: 100 V/120 V[4]	Current	0 - 4.25 A	0 - 2.5 A	0 - 2.75 A	0 - 2.7 A
Current derating factor (from 40 to 55 °C)			0.11 A/°C	0.069 A/°C	0.069 A/°C	0.068 A/°C
Output voltage ripple & noise (from 20 Hz to 20 MHz with a resistive load, outputs ungrounded, or either output grounded)		Simulator/table mode	20 mV_{rms}	24 mV_{rms}	24 mV_{rms}	24 mV_{rms}
			125 mV_{p-p}	195 mV_{p-p}	195 mV_{p-p}	195 mV_{p-p}
		Fixed mode (constant voltage)	24 mV_{rms}	30 mV_{rms}	30 mV_{rms}	30 mV_{rms}
			150 mV_{p-p}	150 mV_{p-p}	150 mV_{p-p}	150 mV_{p-p}
Programming accuracy[2,3] (@ 23 ±5 °C)		Fixed mode voltage	0.075% + 25 mV	0.075% + 50 mV	0.075% + 50 mV	0.075% + 50 mV
		Fixed mode current	0.2% + 20 mA	0.2% + 10 mA	0.2% + 11 mA	0.2% + 11 mA
Readback accuracy[3] (from front panel or over GPIB with respect to actual output @ 23 ±5 °C)		Voltage	0.08% + 25 mV	0.08% + 50 mV	0.08% + 50 mV	0.08% + 50 mV
		+Current	0.20% + 20 mA	0.20% + 10 mA	0.20% + 11 mA	0.20% + 11 mA
		–Current	0.35% + 48 mA	0.35% + 24 mA	0.35% + 26 mA	0.35% + 26 mA
Load regulation – fixed mode (change in output voltage or current for any load change within ratings)		Constant voltage	2 mV	2 mV	2 mV	2 mV
		Constant current	1 mA	1 mA	1 mA	1 mA
Line regulation – fixed mode (change in output voltage or current for any line voltage change within ratings)		Constant voltage	2 mV	2 mV	2 mV	2 mV
		Constant current	1 mA	1 mA	1 mA	1 mA

1. There is no maximum impedance restriction. The programmed value for Imp can be less than or equal to I_{sc}.
2. In Simulator mode, the output current is related to the readback output voltage by an internal algorithm. In Table mode, the output current is related to the readback output voltage by interpolation between points that are entered by the user.
3. The unit may go out of specification when subjected to RF fields of 3 volts/meter in the frequency range of 26 MHz to 1 GHz.
4. There is no current derating when only one output module is installed in the mainframe.