

## Product Preview: KLP S-SERIES SOLAR EMULATOR

### DESCRIPTION

The KLP-S (standard) and KLP-ES (Ethernet) models provide a versatile, economical and rapid method of testing power inverters used to connect solar cells and solar panels to the electric grid. Inverter testing typically requires one or more solar cells, each of which must be tested over the full spectrum of solar illumination. In a single 1U package, the KEPCO KLP S-series is capable of emulating a wide variety of solar cells, eliminating the costly and time-consuming process of securing characterization samples. It further saves the necessity of purchasing a variable light source for emulation of illumination conditions. The KLP S-series is an indispensable tool in the testing and characterization of power inverters. With its scalability, flexibility and speed, the S-series will enable your products to get to market quickly, with the performance you need and all at a very affordable price.

Solar cells and solar panels are typically connected to the electrical grid via an inverter which operates at the Pmp (Maximum power point). Power inverters monitor the current and voltage (hence power) that the inverter draws from the solar cell. By varying its duty cycle, the inverter changes its operating point and re-computes the new power point. Continuing in this fashion the inverter increases and decreases the duty cycle until it finds the maximum power point. The inverter repeats this process continually so that it maintains operation at the Pmp, even when there are varying illumination conditions - cloud coverage, angle of sun, etc. The output of the solar cell is typically depicted by an I-V curve. This curve depends on four variables:

- **Voc** - Voltage Open Collector - The voltage of the cell when no current is drawn (maximum voltage).
- **Isc** - Current Short Circuit - The current from the cell when the output of the cell is short-circuited (maximum current).
- **Vmp** - Voltage Maximum Power - The cell voltage at the maximum power point.
- **Imp** - Current Maximum Power - The cell current at the maximum power point.

Kepeco's KLP S-series emulates the solar cell by inserting the values for Voc, Isc, Vmp and Imp into emulation equations that replicate the unique I-V curve as shown in Figure 1. The KLP then emulates solar cell behavior by supplying the appropriate output voltage for each value of current drawn by the inverter. It does this dynamically as the inverter searches for the Maximum Power point Pmp. By changing Voc, Isc, Vmp and Imp it is possible to emulate different illumination conditions for the same cell or the characteristics of a completely different cell or panel.

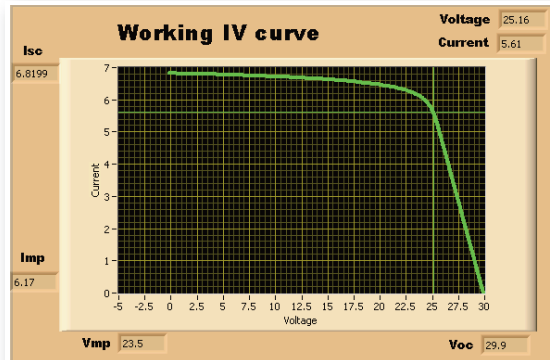


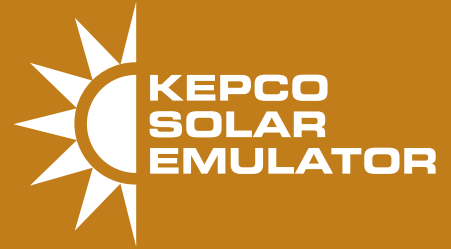
Figure 1 - Typical Solar Emulator I-V Curve

The KLP S-series works in concert with a proprietary KEPCO LabView driver program that produces a smart table of up to 1000 current/voltage pairs for each unique set of Voc, Isc, Vmp and Imp values. This table of current/voltage pairs corresponds to a unique I-V curve, and is downloaded to the KLP S-series.

The emulation of the solar cell is accomplished by the KLP output following the unique I-V curve. For each measurement of current, the KLP output is set to the corresponding voltage. After setting the voltage, the KLP again measures the current, looks up the current in the downloaded table and sets the output to the voltage corresponding to the current measured. The cycle repeats until the emulation is stopped. The smart table concentrates current/voltage pairs near the Pmp, allowing greater accuracy and resolution where it is needed and speeding up downloaded curve generation.

KEPCO supplies a set of sample I-V curves with its LabView driver program. In addition, the user can modify any or all of the Voc, Isc, Vmp and Imp values to emulate different solar cells as well as illumination conditions. While the emulation is running, the KLP S-series continually monitors its output current and correspondingly modifies its voltage setpoint, so that its output follows the programmed I-V curve.

An added benefit of the KLP S-series is the fact that in addition to the ability to use the LabView program to perform solar cell emulation, they may be operated as standard KLP 1200 watt instrument power supplies without reconfiguring. Another benefit of the S-series is that, like all KLP models, they automatically use the hyperbolic power limit expanding the range of the I-V curves to utilize the 1200 Watts at the Pmp point, allowing the S-series to emulate a wider variety of I-V curves with a single model with little set-up modification. Only seven models are required for Voc up to 600V maximum, Isc up to 120A maximum (see Figure 2). Master-slave configurations allow increased current capability.



### FEATURES AND BENEFITS

#### SCALABILITY -

Emulates voltages as high as 600 volts. Master-Slave operation for increased current capability.

#### FLEXIBILITY -

KEPCO KLP S/SE-series allows operation as a standard KLP Instrument power supply with no modifications or reconfiguring as well as a Solar Cell Emulator.

#### PROVEN TECHNOLOGY -

Built on the technology of the KLP and KLP LXI standard products.

#### WIDE SELECTION OPTIONS -

Models available from 0-10V/150A to 0-600V /4A @ 1200 Watts.

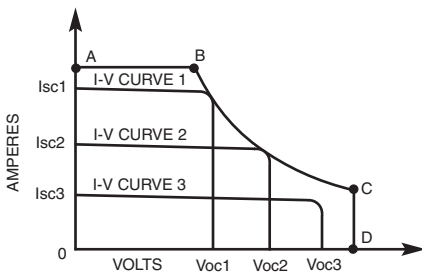
#### LOW COST -

Pricing comparable to standard 1200 Watt 1U instrument grade power supplies.

#### ROI -

Ability to emulate virtually any solar cell, instantly; dual Solar Cell Emulator and Instrument Power Supply functions allow multiple applications from the same investment; and lowest emulator cost offers excellent return for your development dollar.

The operating region of each KLP model is defined by points A, B, C and D. From point B to point C the operating region is defined by 1200W maximum. Only seven models are required for up to 600V maximum.



MODEL (1)	A	B	C	D
KLP 10-150	150A	8V	120A	10V
KLP 20-120	120A	10V	60A	20V
KLP 36-60	60A	20V	33.3A	36V
KLP 75-33	33.3A	36V	16A	75V
KLP 150-16	16A	75V	8A	150V
KLP 300-8	8A	150V	4A	300V
KLP 600-4	4A	300V	2A	600V

(1) Applies to all KLP models.

- A - Rated Current
- B - Maximum Voltage at Rated Current
- C - Maximum Current at Rated Voltage
- D - Rated Voltage

Figure 2 - KLP Hyperbolic Power Limit Allows Wide Variety of I-V Curves with Single Model

## OPERATION

The LabView program displays a Solar Emulator panel (Figure 3) used to conduct the Solar Cell testing. The Voc, Isc, Vmp and Imp values for four I-V curves are listed above the Working I-V Curve display. An adjacent Selector selects one curve for download. A Preview display to the right shows all four curves when the Preview button is clicked. When the Download to Unit button (under the Preview display) is clicked, then the selected curve is downloaded and displayed as a dashed line in the Working I-V Curve display to show it is waiting to be executed.

When the Execute Waiting Curve is clicked, the emulation starts and the Working I-V curve changes from a dashed line to a solid line. A cursor formed by the intersection of vertical and horizontal lines is green while the emulation is working and red when it is stopped. Realtime values for voltage setpoint and measured current appear in the windows above and to the right of the Working I-V Curve display, while the values for Voc, Isc, Vmp and Imp are shown at the left and bottom of Working I-V curve display. The Stop Emulation button stops the emulation, and the Stop VI button closes the panel window and exits the application.

## KLP S/SE MODEL TABLE

MODEL (1)	RATED VOLTAGE RANGE (2)	MAXIMUM CURRENT FOR RATED VOLTAGE	MINIMUM PROGRAMMABLE CURRENT	RATED CURRENT RANGE (2)	MAXIMUM VOLTAGE FOR RATED CURRENT	RIPPLE AND NOISE p-p (3)	EFFICIENCY @115V a-c
KLP 10-150-	0-10V	120A@10V	1.9A	0-150A	8V@150A	75mV	80%
KLP 20-120-	0-20V	60A@20V	1.5A	0-120A	10V@120A	75mV	82%
KLP 36-60-	0-36V	33.3A@36V	0.8A	0-60A	20V@60A	125mV	83%
KLP 75-33-	0-75V	16A@75V	0.4A	0-33.3A	36V@33.3A	125mV	84%
KLP 150-16-	0-150V	8A@150V	0.2A	0-16A	75V@16A	125mV	86%
KLP 300-8-	0-300V	4A@300V	0.1A	0-8A	150V@8A	300mV	87%
KLP 600-4-	0-600V	2A@600V	0.05A	0-4A	300V@4A	400mV	88%

(1) Specifications listed apply to both standard and ethernet enabled models as well as all options indicated by letter suffix.

(2) The maximum current and voltage are constrained by the 1200 Watt power limitation.

(3) Bandwidth: 20MHZ; low frequency ripple may be higher at loads less than 30 Watts.

Specifications shown in the model table are identical to the standard KLP models. Refer to the Kepco website at [www.kepcopower.com/klp.htm](http://www.kepcopower.com/klp.htm) for detailed KLP specifications. The table below shows the S-series specifications that differ from the standard models.

## KLP S/SE SPECIFICATIONS

SPECIFICATION	RATING/DESCRIPTION	CONDITION
Points in Downloaded Table	1000	Maximum
RAM Storage	Stores tables for four I-V curves	
Curve Download Time	200 milliseconds	When idle
	300 milliseconds	When executing measure and set mode
Measure Then Set Update Rate	20 milliseconds	

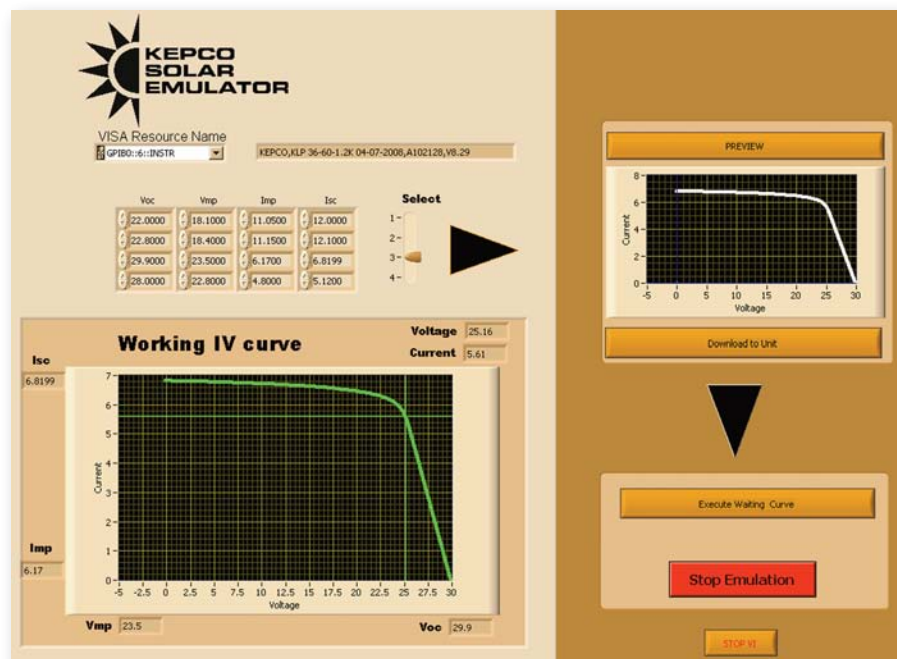


Figure 3 - LabView Solar Emulator Panel

**For more information on the standard Kepco Series KLP power supplies visit [www.kepcopower.com/klp.htm](http://www.kepcopower.com/klp.htm)**