



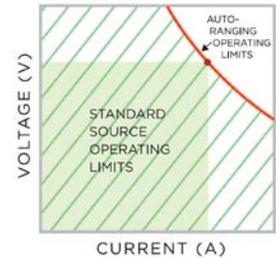
Application Note

Intepro Systems PSI 9000 Series of DC Sources for Photovoltaic Solar Array Simulation.

Overview

Solar panels are made of many photovoltaic cells grouped together within a panel, solar arrays are panels grouped together to increase the power output level. The output power curve is affected by various weather conditions such as irradiation, temperature, rain, clouds and shade conditions. The output is non-linear and the type of photovoltaic cell used within the panel also affects the output curve. With the use of the PV Table function in the PSI 9000 series the DC source can accurately emulate the non-linear I-V curve of the panel or array. Use the manufactures published I-V data of the solar panel to accurately emulate the specific band and model of the panel you're planning to use.

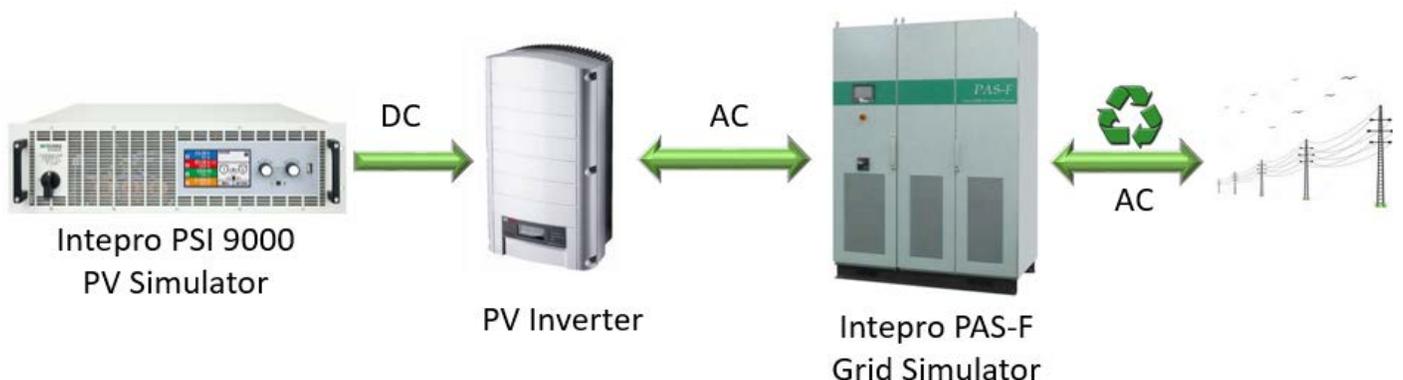
PSI 9000 series are designed for simulating static and dynamic irradiance levels. Curves are based on industry leading 16,400 data points and adjustable to 1% increments. Another advantage the PSI 9000 series is [Auto-Ranging](#) output that extends the voltage and current combinations within the power envelope. This is important to truly emulating a PV panel and can reduce the amount of power supplies needed to do your testing.



Important characteristics of a solar photovoltaic cell

- Short-circuit current (**ISC**), which is proportional to the irradiance
- Open circuit voltage (**UOC**), which almost reaches its maximum value even in low light situations
- The maximum power point (**MPP**), at which the solar panel can provide the maximum output power

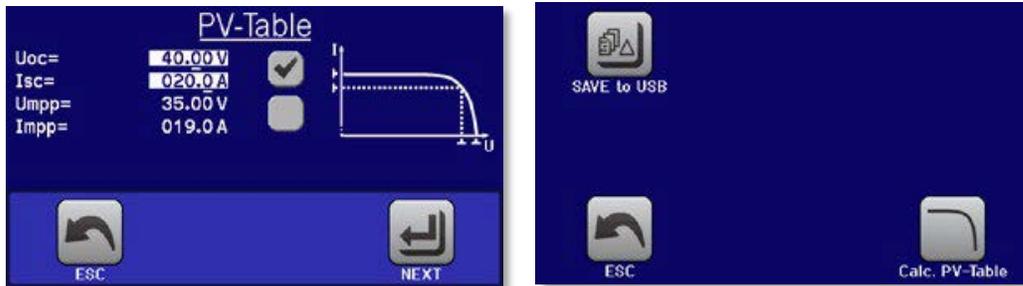
This testing is very important for qualifying the PV inverter because a PV inverter will need to operate under wide variations of power levels coming from the solar array. Part of this testing includes wide input range verification, safe shut down and hold up time to insure the PV inverter does not impact the grid in a negative way.



Benefits of using a solar array simulator for testing and qualification

- Able to simulate all weather conditions in a very short period of time
- Functional test, durability, safety, overpower and compliance testing
- No need to have a large solar array, temperature controlled room and external lighting

Use the PV table function in the PSI 9000 series to set up your simulation values



This table function uses the standard XY generator to let the power supply simulate solar panels or solar cells with certain characteristics. The device calculates an IU table from four typical values. While the function is running, the user can adjust a parameter “Irradiance” between 0% (darkness) and 100% (bright light) in 1% steps to simulate different light situations.

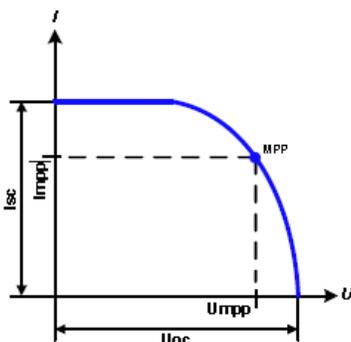
The following parameters can be set for the PV table function:

Value	Range	Description
Uoc	Umpp...Nominal device voltage	Open circuit voltage at no load
Isc	Impp...Nominal device current	Short-circuit current at max. load and low voltage
Umpp	0 V...Uoc	DC output voltage at the MPP
Impp	0 A...Isc	DC output current at the MPP

The voltage of the MPP (here: UMPP) lies typically 20% below UOC, the current of the MPP (here: IMPP) lies typically 5% below ISC. In case there are no definite values for the simulated solar cell available, Impp and Umpp can be set to this rule of thumb. The device limits the IMPP value to ISC as upper limit, the same applies for UMPP and UOC.

PV table function setting

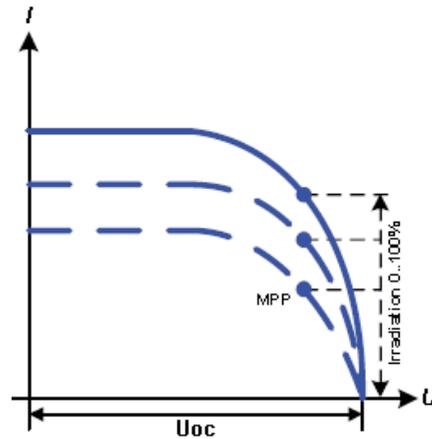
In the PV table function, which is based upon the XY generator with IU characteristics, the MPP is defined by the two adjustable parameters Umpp and Impp. These parameters are usually stated in data sheets of solar panels and have to be entered here.



Adjust all four parameters on screen to the desired values. Whether the calculated IU and P curves, which result from those values, make sense or not can be verified with a tool (Excel table or small software), which is either included with the device on CD or can be obtained upon request. The tool visualizes the curves as calculated from the adjusted values.

While the simulation is running, the user can see from the actual values (voltage, current, power) of the DC output, where the operating point of the power supply resp. of the simulated solar panel is. The adjustable value Irradiance (0%...100% in 1% steps, see screenshot below) helps to simulate different light situations from darkness (no power output) to the minimal amount of light that

Varying this parameter shifts the MPP and the PV curve along the Y axis. Also see diagram to the right. The value Irradiance is here used as a factor for the current I_{mpp} . The curve itself is not permanently re-calculated.



How to configure the PV table



1. In the function generator menu tap on **XY-Table**, then **PV-Table** and then **Calc. PV-Table**.
2. Adjust the four parameters as required for the simulation.
3. Do not forget to adjust the global limits for voltage and power in the next screen which you can access



with touch area **NEXT**. The voltage (U) setting should be at least as high as U_{oc} , or higher.



4. After setting the values for the required signal generation, tap on touch area **LOAD**.

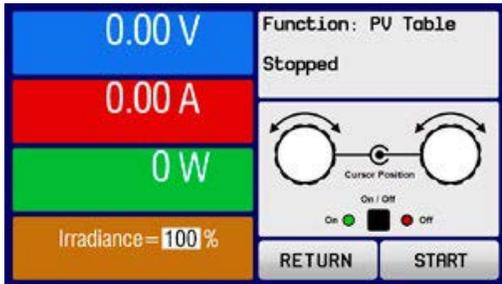
While loading, the IU function is calculated and sent to the internal XY generator. After this, the function is ready to run.

TIP: The function can be saved to USB flash drive as table, as well as read via any of the digital interfaces. In remote control, the function can't be loaded or controlled.



Intepro Systems PSI 9000 Series with PV Table Function for PV Solar Array Simulation

From the screen where the XY function generator is controlled manually (start/stop), you can go back to the first screen of PV table function and use the formerly locked touch area to save the table to USB drive. In order to do so, follow the on-screen instructions. The table can be used to analyze the values or to visualize it in Excel or similar tools.



How to work with the PV table function

1. With an appropriate load connected, for example a solar inverter, start the function.
2. Adjust value **Irradiance** with any rotary knob between 100% (default) and 0%, in order to reproduce different light situations for the simulated panel. The actual values on the display indicate the working point and can show whether the simulation has arrived at the MPP or not.
3. Stop the function run anytime.

Note: The PSI 9000 Series can also be used to test PV DC/DC converters (wide input range) that are used to condition the power from the solar array to the inverter.

<http://www.inteproate.com/products/dc-sources/psi-auto-ranging-programmable-power-supply/>



