How the MHGP's PPC Works

MHGP's PPC is different from the traditional power source. With a PV cell inside the PPC, it works same as the PV cell. Below is a general summary of how PV cells work, taken from the PVeducation.org and other reference websites.

I-V Characterization

PV cells can be modeled as a current source in parallel with a diode. When there is no light present to generate any current, the PV cell behaves like a diode. As the intensity of incident light increases, current is generated by the PV cell, as illustrated in Figure 1. The I-V curve of an illuminated PV cell has the shape shown in Figure 2 as the voltage across the measuring load is swept from zero to VOC, and many performance parameters for the cell can be determined from this data, as described in the sections below.

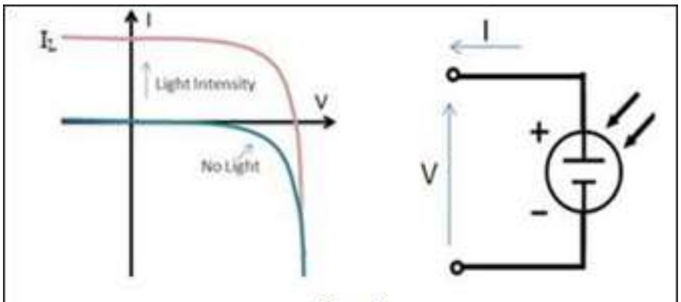

Fig. 1

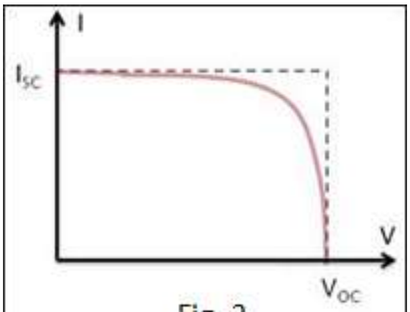

Fig. 2

Short Circuit Current (I_{SC})

The short circuit current I_{SC} corresponds to the short circuit condition when the impedance is low and is calculated when the voltage equals 0. I^{SC} occurs at the beginning of the forward-bias sweep and is the maximum current value in the power quadrant. For an ideal cell, this maximum current value is the total current produced in the solar cell by photon excitation.

Open Circuit Voltage (V_{OC})

The open circuit voltage (VOC) occurs when there is no current passing through the cell. VOC is also the maximum voltage difference across the cell for a forward-bias sweep in the power quadrant.

Maximum Power (P_{MAX}), Current at P_{MAX} (I_{MAX}), Voltage at P_{MAX} (V_{MAX})

The power produced by the cell in Watts can be easily calculated along the I-V sweep by the equation P=IV. At the I_{SC} and V_{OC} points, the power will be zero and the maximum value for power will occur between the two. The voltage and current at this maximum power point are denoted as V_{MAX} and I_{MAX} respectively.

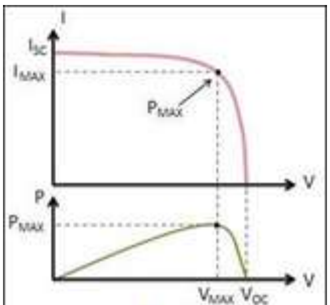

Fig. 3

Obtaining the I-V Curve

From the above information, we know that PV cells are very different than traditional power sources. PV cells can operate from 0V to Voc. What decides the PV cell operating voltage is the load resistance.

As we can see from the IV curve above (Fig.2), the higher the voltage, the lower the current. Using the equation “V = IR”, this means that load resistance (R) gets higher as we sweep from Isc to Voc. Therefore, placing a variable resistor as the load for PV cell allows us to adjust where the cell operates on the IV curve, and thus create an IV curve. In order to find the maximum power point (P= V*I), we multiple the current and voltage at each point along the IV curve. The location with the highest measured P is the maximum power point.

The simplest way to measure the I-V curve of a module is to use a variable resistor R as it is shown in Fig. 4. The value of R will be varied in steps from zero to infinity in order to capture the points of the I-V curve from short circuit to open circuit, by measuring the voltage and the current in each step. This method is only applicable to low-power modules since resistors for higher power are hardly available. Load resistors are not recommended for photovoltaic module characterization because Isc is never exactly reached and the reverse bias characteristics cannot be determined. However, the use of load resistors to evaluate the performance of a solar module can provide an inexpensive way of approximating its performance. As below, the load resistor is increased manually in steps. In each step, the voltage and the current (actually the voltage across a shunt resistor) are sensed using a pair of handed digital multimeter.

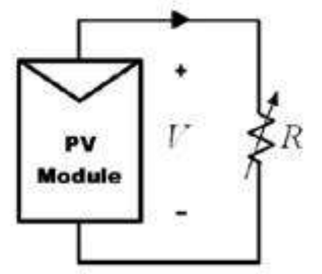

Fig. 4 Variable Resistor Scheme

Load Resistance vs Input Laser Power

Optimal load resistance will vary based on input laser power. As an example, as laser power drops, the PPC’s voltage levels remain largely unchanged, while its current will drop approximately linearly with laser power. So, as current drops with lower laser power, the optimal load resistance will increase, as shown in the “Optimal Load Resistance” chart within the PPC test report.

Actual Application

In an actual application, the load resistance might vary during operation within a certain range. Therefore, the PV cell may not always operate at its max power point. Adding a DC/DC converter in the circuit can ensure the output voltage from the PPC (PV cell) stays stable, which may be needed for the circuit.

2017.12.18

References:

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