Solar Cells Characteristics Tester

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Abstract

The equipment is used for testing the electrical characteristics of solar cells that were connected to be a solar panel, which can be found anywhere of solar power plant. This device was built from power switch devices for sinking the high current of the solar panel. The processor is a controller, which controls the quantity of the current, which flow through the switching devices and collect the characteristic of the solar panel. The tester can measure the current, voltage, temperature, and light intensity, which are main factors that affect the electrical characteristics of solar cells. 12 bits resolution signal converter is used to change the measuring levels so we can change measuring levels to 4096 levels, and these data are stored in the memory. The equipment can also calculate the maximum power of the solar system panel.

1. INTRODUCTION

A solar cell is an electrical energy source that is in constant use throughout the world, very reliable, does not make pollution, and has been developing efficiency continually. It is made from a semiconductor, such as Si, CdS, etc. It consists of at least a P-N junction of two dissimilar materials that act as a potential barrier across which carrier flow is excited by incident photons. When sunlight, which consists of photon, reaches the solar panel, the photon will go through the semiconductor into the P-N junction, which is a depletion region and has an electrical field. The photon will excite the atoms to create hole-electron pairs near the junction, and these pairs of hole-electron will be accelerated to move by the electrical field when the solar cells are connected to a circuit and current flows in the circuit.

When a module faces to the sun, a voltage can be measured between the positive and negative terminals. No current is flowing because no appliance has been connected yet, so this measurement is called the *open voltage circuit* or V_{OC}. If an appliance is connected between the two terminals, a current will flow from the module. The module now has a voltage less than V_{OC}. By adding more loads, more current flows and the voltage gets lower. From the highest current, the terminals of a module can be connected directly to each other. The voltage is now zero and the current is maximum value. By shorting the terminals, the maximum current is measured and is called the *short circuit current* or I_{SC}. The measurements of current against voltage can be plotted on a graph. Joining the point on the graph together produced a line called an *I-V curve* (see figure 1). For suitable load, a solar cell can produce the maximum power that can be found from the result of voltage multiplied by current at suitable load.

The output current depends on 7 factors as follows:

1. The amount of sunlight reaching the cells,
2. The temperature of the cells, (or of the junction)
3. The number of cells in module,
4. The area of each cell,
5. The type of semiconductor,
6. The state of working, and
7. The effect of system losses, such as from cables.

The amount of sunlight reaching the cells at any moment is referred to light intensity. The light intensity reaching the ground varies throughout the day with the movement of the sun and the clouds. Light intensity is often measured in unit of watt per square meter (W/m^2).

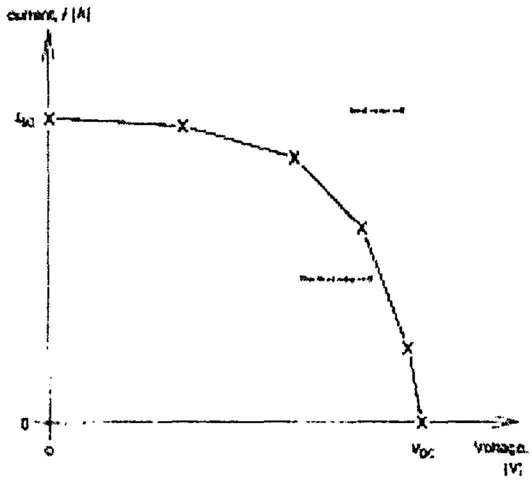

Figure 1. Comparison of practical and idealsolar cells

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As light shines on the solar cells, they warm up and the electrical output of the module changes because inside a solar cell is the P-N junction which the current flow through the P-N junction is

$$I_j = I_0\left(e^{qV/kT} - 1\right) \qquad (1)$$

where

I_j = current through the junction

V = voltage across junction

I_0 = reverse saturation current

k = Boltzmann's constant

q = Magnitude of electron charge