Parameters

Cristhian Michael

1. Values

- **Max Power**: The maximum power output that a solar panel can generate under standard test conditions.
- **Open-Circuit Voltage**: The voltage measured across the terminals of a solar panel when no current is flowing.
- **Short-Circuit Current**: The current measured when the terminals of a solar panel are shorted.
- **Optimal Operating Voltage**: The voltage at which the solar panel produces its maximum power output.
- **Optimal Operating Current**: The current at which the solar panel produces its maximum power output.

$$P_{max} = V_{max} * I_{max}$$

Equation 1: Maximum power formula.

Example 1

The following figure is from the data sheet of a solar panel, and it will be used to verify where its values come from.

Electrical Characteristics STC : AM1.5 1000W/m² 25°C NOCT : AM1.5

Module Type	LR5-54HTH-420M		LR5-54HTH-425M	
Testing Condition	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	420	314	425	318
Open Circuit Voltage (Voc/V)	38.73	36.36	38.93	36.55
Short Circuit Current (Isc/A)	14.00	11.31	14.07	11.36
Voltage at Maximum Power (Vmp/V)	32.44	29.60	32.64	29.78
Current at Maximum Power (Imp/A)	12.95	10.60	13.03	10.67
Module Efficiency(%)	21.5		21.8	

Figure 1: Row Spacing representation.

By multiplying the maximum current I by the maximum voltage V, you can calculate the maximum power P that a solar panel can produce

$$P_{max} = 32.44 * 12.95 = 420W$$

Equation 2: Max power verification.

The following figure illustrates how temperature impacts the performance of a solar panel, specifically showing how increasing temperatures reduce voltage while slightly increasing current, ultimately decreasing the panel's overall power output. This visual representation highlights the importance of considering temperature effects in solar panel efficiency.

Temperature Ratings (STC)

Temperature Coefficient of Isc	+0.050%/°C
Temperature Coefficient of Voc	-0.230%/°C
Temperature Coefficient of Pmax	-0.290%/°C

Figure 2: Temperature ratings.

Considering that the actual temperature is 31℃, there is a 6°C difference from standard conditions. This increase in temperature leads to a noticeable decrease in the solar panel's output power.

$$P_{new} = P_{max} - (P_{max} * \% * N)$$
$$P_{new} = 420 - (420 * 0.29\% * 6) = 412.7W$$

Equation 3: Maximum power at different temperature.

The same process is applied to calculate the new voltage and current, depending on the temperature. By adjusting for temperature differences using the appropriate formulas, you can determine how both voltage and current change with temperature variations.

$$V_{new} = V_{max} + \% * (T_{new} - T)$$
$$V_{new} = 32.44 - 0.23 * (31 - 25) = 31.06V$$

Equation 4: Maximum voltage at different temperature.

$$I_{new} = I_{max} + \% * (T_{new} - T)$$
$$I_{new} = 12.95 + 0.05 * (31 - 25) = 13.25A$$

Equation 5: Maximum current at different temperature.

Understanding the effects of temperature changes on a solar panel is crucial for predicting its performance in various locations with different climates. This knowledge allows for better system design and optimization, ensuring maximum efficiency and energy output under varying temperature conditions.