PV Module Output at Any Irradiance and Cell Temperature

Short-circuit current, open-circuit and maximum-power voltage, current and power of a PV module at a given irradiance and cell temperature from its data sheet.

Method: Data-sheet translation of PV module characteristics to operating conditions

Input parameters

Unit system: SI

Parameter	Value	Unit
Rated power at STC	0.40000	kW
Open-circuit voltage at STC	49.500	V
Maximum-power voltage at STC	41.500	V
Short-circuit current at STC	10.200	A
Maximum-power current at STC	9.6400	A
Current temperature coefficient (per K)	5.0000e-04	
Voltage temperature coefficient (per K, negative)	-0.002800	
Power temperature coefficient (per K, negative)	-0.003500	
Cells in series	72.000	
Diode ideality factor	1.2000	
Irradiance on the module	0.80000	kW/m²
Cell temperature	50.000	°C

Calculated results

Parameter	Value	Unit
Short-circuit current	8.2620	A
Open-circuit voltage	45.498	V
Maximum-power voltage	38.058	V
Maximum-power current	7.8084	A
Maximum power (power-coefficient method)	0.29200	kW
Maximum power from the voltage and current estimates	0.29717	kW
Ratio to rated power	73.000	%

Notes for this case

• Currents scale with irradiance and α; voltages change with β and by N_s n kT/q ln(G/1000) with irradiance; power by the data-sheet γ. Low-light efficiency of real modules differs by a few per cent; use the maker's low-irradiance data where given.

Formula and method

$$I_{sc} = I_{sc,STC}\frac{G}{1000}[1+\alpha(T_c-25)],\quad V_{oc} = V_{oc,STC}[1+\beta(T_c-25)] + N_s n\frac{kT_c}{q}\ln\frac{G}{1000},\quad P = P_{STC}\frac{G}{1000}[1+\gamma(T_c-25)]$$

Variables

P_{STC}	Rated power at STC	W
V_{oc}	Open-circuit voltage at STC	V
V_{mp}	Maximum-power voltage at STC	V
I_{sc}	Short-circuit current at STC	A
I_{mp}	Maximum-power current at STC	A

α	Current temperature coefficient (per K)	-
β	Voltage temperature coefficient (per K, negative)	-
γ	Power temperature coefficient (per K, negative)	-
N_s	Cells in series	-
n	Diode ideality factor	-
G	Irradiance on the module	W/m²
T_c	Cell temperature	K
P	Maximum power (power-coefficient method)	W
$V_{mp}I_{mp}$	Maximum power from the voltage and current estimates	W
P/P_{STC}	Ratio to rated power	-

Method and standards

Module translation equations.

Assumptions and limits

- Crystalline silicon behaviour; series and shunt resistance effects lumped in the coefficients.

References

Data-sheet translation of PV module characteristics to operating conditions

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/solar-pv/pv-module-output-irradiance-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.