Solar PV String Sizing: Modules per String

Most and fewest PV modules in a string for an inverter, from module Voc and Vmp, their temperature coefficients and the coldest and hottest cell temperatures.

Method: IEC 61215 / IEC 60904-3 standard test conditions; Module temperature coefficients from the data sheet

Input parameters

Unit system: SI

Parameter	Value	Unit
Module open-circuit voltage at STC	49.500	V
Module maximum-power voltage at STC	41.500	V
Temperature coefficient of Voc, per °C	-0.27000	%
Temperature coefficient of Vmp (or Pmax), per °C	-0.35000	%
Coldest cell temperature (lowest site ambient at sunrise)	5.0000	°C
Hottest cell temperature in operation	70.000	°C
Inverter maximum DC input voltage	1,100.0	V
Inverter lowest MPPT voltage	200.00	V
Inverter highest MPPT voltage	1,000.0	V

Calculated results

Parameter	Value	Unit
Module Voc at the coldest temperature	52.173	V
Module Vmp at the hottest temperature	34.964	V
Module Vmp at the coldest temperature	44.405	V
Most modules per string (inverter maximum voltage)	21.000	
Most modules per string to stay inside the MPPT range	22.000	
Fewest modules per string (MPPT lowest voltage when hot)	6.0000	

Notes for this case

- Choose a string length between the fewest and the smaller of the two maxima; check string current against the inverter input current too.

Formula and method

$$V_{oc,cold} = V_{oc}\left[1 + \beta_{oc}(T_{min} - 25\,°\mathrm{C})\right]$$

$$V_{mp,hot} = V_{mp}\left[1 + \beta_{mp}(T_{max} - 25\,°\mathrm{C})\right]$$

$$N_{max} = \left\lfloor \frac{V_{max}}{V_{oc,cold}} \right\rfloor, \quad N_{MPP,max} = \left\lfloor \frac{V_{MPP,max}}{V_{mp,cold}} \right\rfloor, \quad N_{min} = \left\lceil \frac{V_{MPP,min}}{V_{mp,hot}} \right\rceil$$

Variables

V_{oc}	Module open-circuit voltage at STC	V
V_{mp}	Module maximum-power voltage at STC	V
β_{oc}	Temperature coefficient of Voc, per °C	-
β_{mp}	Temperature coefficient of Vmp (or Pmax), per °C	-
T_{min}	Coldest cell temperature (lowest site ambient at sunrise)	K
T_{max}	Hottest cell temperature in operation	K

V_{max}	Inverter maximum DC input voltage	V
$V_{MPP,min}$	Inverter lowest MPPT voltage	V
$V_{MPP,max}$	Inverter highest MPPT voltage	V
$V_{oc,cold}$	Module Voc at the coldest temperature	V
$V_{mp,hot}$	Module Vmp at the hottest temperature	V
$V_{mp,cold}$	Module Vmp at the coldest temperature	V
N_{max}	Most modules per string (inverter maximum voltage)	-
$N_{MPP,max}$	Most modules per string to stay inside the MPPT range	-
N_{min}	Fewest modules per string (MPPT lowest voltage when hot)	-

Method and standards

Module voltages are corrected linearly from standard test conditions (25 °C cell) with the data-sheet coefficients. The string must stay below the inverter maximum at the coldest Voc, and inside the MPPT window at the hottest and coldest Vmp.

Assumptions and limits

- Linear temperature coefficients; irradiance effects on Voc not included.
- Cell temperature at the hottest case estimated by you.
- Use the Vmp coefficient where the data sheet gives it. The Pmax coefficient is usually larger in magnitude: it makes N_min conservative but N_MPP,max less so.
- The page warns when even one module exceeds the inverter maximum, and when the inverter maximum is below its MPPT high voltage.

References

• IEC 61215 / IEC 60904-3 standard test conditions
• Module temperature coefficients from the data sheet

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

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/solar-pv-string-sizing

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Reopens the calculator with the inputs of this report.