First Solar Inverter Compatibility Guidance

This document provides guidance for the use of inverters with First Solar Series 4/4A and newer Series modules. For documentation purposes, system designers are required to notify First Solar of the specific inverter model intended for use throughout the First Solar System Design and Application (PD-2-303, "SDA") process.

This document is not intended for use with First Solar Series 2 or Series 3 modules. Inverters to be used with Series 2 and Series 3 must be approved by First Solar prior to procurement and installation.

Project Developer and/or System Designer shall verify compatibility of the chosen BOS components prior to equipment procurement and installation. Project Developer and/or System Designer is responsible for ensuring that the system design and installation complies with all applicable laws and codes.

Determination of Maximum System Voltage:

When connecting First Solar Series 4/4A or newer Series Modules in a series string, ensure that the system design voltage and inverter design specifications are not exceeded. In 1000VDC applications, this is typically ensured by limiting series strings to 10 modules or less and in 1500VDC applications, this is typically ensured by limiting series strings to 15 modules or less. General conditions assumed for calculating the maximum number of modules are -10°C cell temperature and 700W/m² irradiation.

The system designer may decide to connect various amounts of modules in series for a specific system based on local climatic conditions and has to ensure that modules are not subjected to voltages in excess of the module rating. Exeeding the maximum voltage module rating may void the First Solar Module Warranty.

The following computation should be considered while calculating the maximum number of modules in series.

The open circuit voltage of a module at low temperature is given by:

$$V_{OC_{module}}^{MAX} = \left(V_{OC_{STC}} \cdot [1 + c_1 \cdot \{T_{module}^{MIN} - 25°C\}^3 + c_2 \cdot \{T_{module}^{MIN} - 25°C\}^2 + c_3 \cdot \{T_{module}^{MIN} - 25°C\}] \cdot [a \cdot \ln(G_{POA}) + b]\right) \quad \textbf{(1)}$$

The open circuit voltage of the system at low temperature is found by multiplying the module V_{OC} by the number of modules connected in series:

$$V_{OC_{system}}^{MAX} = V_{OC_{module}}^{MAX} \cdot n_{MCIS} \quad \textbf{(2)}$$

Where:

V_{OCSTC}	Rated value of a module's V_{OC} (from datasheet)
c_1 = 3.229e^{-8} °C^{-3}	3rd-order polynomial coefficient of module V_{OC} at low temperature
c_2 = -1.345e^{-6} °C^{-2}	2nd-order polynomial coefficient of module V_{OC} at low temperature
c_3 = -2.788e^{-3} °C^{-1}	1st-order polynomial coefficient of module V_{OC} at low temperature
T_{module}^{MIN}	Minimum expected module temperature, in units of °C
a = 0.0436	LN Factor (Logarithmic regression)
G_{POA}	Irradiance in module Plane of Array, in units of W/m^2
b = 0.7001	Ordinate shift ((Logarithmic regression)
n_{MCIS}	Number of modules connected in series

Maximum Power Point Window:

The Maximum Power Point (MPP) voltage of a module array must be considered for compatibility with the specified MPP window of the inverter. Similar to the maximum open circuit voltage, the MPP voltage of the array is dependent on ambient conditions, and the system should be designed to ensure that the MPP voltage of the array remains within the MPP window for expected operating conditions during the lifetime of the system.

The following computation should be considered while calculating the proper MPP window:

$$\mathbf{V_{mpp\_min}} = \left(\boldsymbol{V_{mppSTC}} * \left(\mathbf{1} - \boldsymbol{tol_{Vmpp}}\right) * \left(\mathbf{1} - \left(\boldsymbol{t_{syst}} * \boldsymbol{dg}\right)\right) * \left(\mathbf{1} + \boldsymbol{T_{K_{Pmpp}}} * \left(\boldsymbol{T_{Mod_{max}}} - \mathbf{25°}\boldsymbol{C}\right) * n_{MCIS}\right)\right) \quad \textbf{(3)}$$

$$\mathbf{V_{mpp\_max}} = \left(\left(\boldsymbol{V_{mppSTC}} * \left(\mathbf{1} + \boldsymbol{tol_{Vmpp}}\right) * \left(\mathbf{1} + \boldsymbol{T_{K_{Pmpp}}} * \left(\boldsymbol{T_{Mod_{max}}} - \mathbf{25°}\boldsymbol{C}\right) * n_{MCIS}\right)\right) \quad \textbf{(4)}$$

Parameter:

V_{mppSTC}	Data sheet value
tol_{Vmpp}	Vmpp tolerance according to data sheet
t_{syst}	Expected inverter or system lifetime in years (typically a system is designed for 25 years)
dg	Degradation guidance Vmpp -0.3%/year
T_{KVmpp}	Temperature Coefficient of V_{mpp}
T_{Modmax}	Module temperature (typically 70°C)
n_{MCIS}	Number of modules connected in series

This document provides only general guidance and is not intended to be exhaustive. The calculations above are not intended to make any representations or warranties of inverter performance, but only to verify compatibility. In order to make this guidance most useful, it is recommended to use worst case climate conditions to calculate the compatibility. The system designer remains fully responsible for the design as well as for the selection of a suitable inverter. The modules always need to be installed, operated and serviced as described in the First Solar User Guide (PD-5-200, "*User Guide*"). Finally, the system designer remains responsible for ensuring that the system design and installation complies with all applicable laws and codes.

Please do not hesitate to contact First Solar if you have any questions: technicalsupport@firstsolar.com