

Wels, 01/12/2016

## RECOMMENDATION ON THE SYSTEM DESIGN OF THE FRONIUS ECO

### Fronius International GmbH

hereby confirms that, for system designs containing the inverters

#### / Fronius ECO 25.0-3-S and Fronius ECO 27.0-3-S,

the minimum temperature limit can be raised from -10 °C to 0 °C, without voiding the manufacturer's warranty conditions, provided that:

- / the Fronius ECO is installed in one of the listed countries within the attached country list,
- / the installation location is less than 1000 m above sea level and
- / the PV-Modules are not installed on PV-Tracking Systems.

Based on extensive analyses of simulation models as well as analyses of installed systems lasting several years, Fronius International GmbH has determined that a cell temperature of -10 °C and a simultaneous insolation of 1000 W/m<sup>2</sup> will not occur under the aforementioned conditions. Therefore, when the strings and voltage limits are correctly configured in accordance with the operating instructions, no system voltages above 1000 V DC will occur, even with the adapted temperature limits.

Furthermore, the investigations carried out by Fronius International GmbH have shown that a cell temperature of +70 °C can only occur with poorly ventilated solar modules and with an ambient temperature above 30 °C. Fronius International GmbH therefore recommends that the maximum temperature be reduced from 70 °C to 60 °C, provided that

- / the Fronius ECO is installed in one of the listed countries within the attached country list and
- / the solar modules installed are adequately ventilated.

However, if the MPP\_Min voltage of 580 V is undercut in a range of 5 percent, a temporary performance restriction of max. 1-3 percent is to be expected. This restriction has only a very slight impact on the annual energy yield (<0.25%).

### Fronius International GmbH

Solar Energy Division  
Froniusplatz 1  
A-4600 Wels



Thomas Mühlberger  
Head of Solution Management



SHIFTING THE LIMITS

## ATTACHMENT “COUNTRY LIST”

- / Austria
- / Belgium
- / Denmark (without Greenland)
- / Germany
- / Great Britain
- / Hungary
- / Ireland
- / Luxembourg
- / Netherland
- / Switzerland

## ATTACHMENT “RECOMMENDATION ON THE SYSTEM DESIGN OF THE FRONIUS ECO”

When designing a photovoltaic system, the module temperature limits established on the market are  $-10\text{ }^{\circ}\text{C}$  and  $+70\text{ }^{\circ}\text{C}$

Investigations carried out by Fronius have shown that these limits can be modified without this giving rise to adverse effects or risks during system operation.

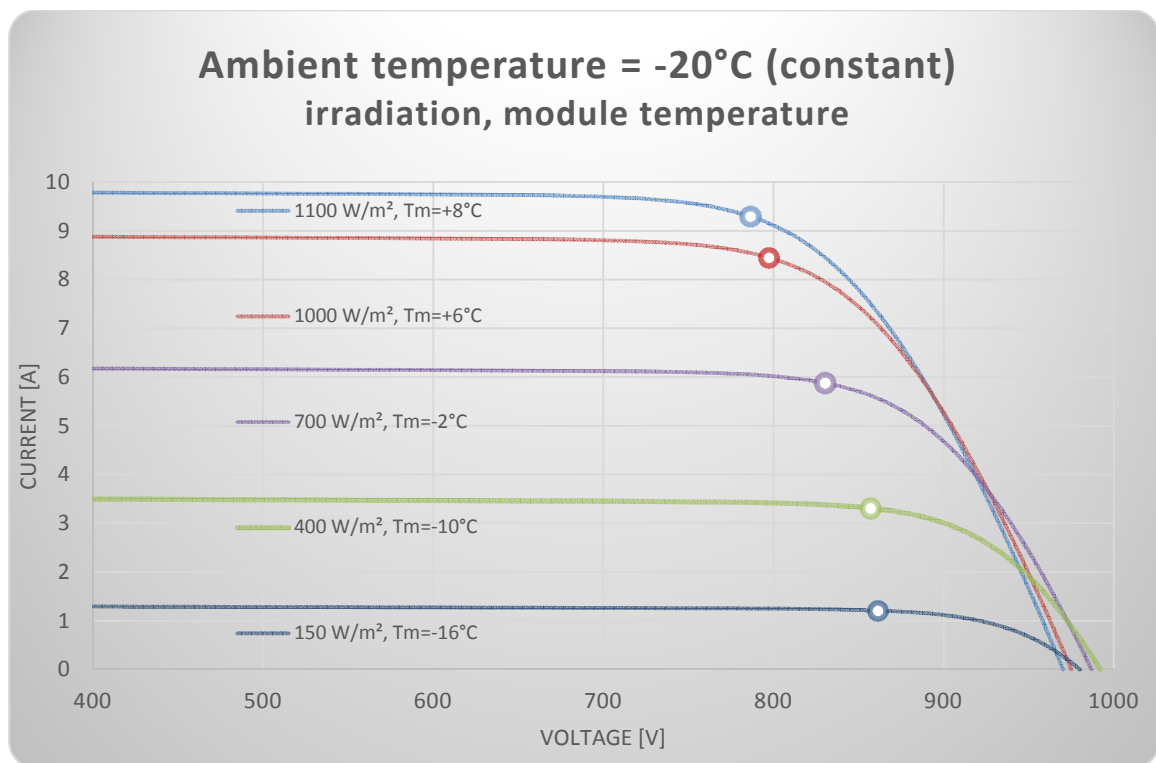
These limits can be adjusted where necessary, depending on the environmental conditions of the system (insolation at site, site temperatures, alignment, installation type, etc.).

### Maximum open circuit voltage $V_{oc}$

The maximum open circuit voltage that occurs is dependent on the minimum ambient temperature ( $T_a$ ).

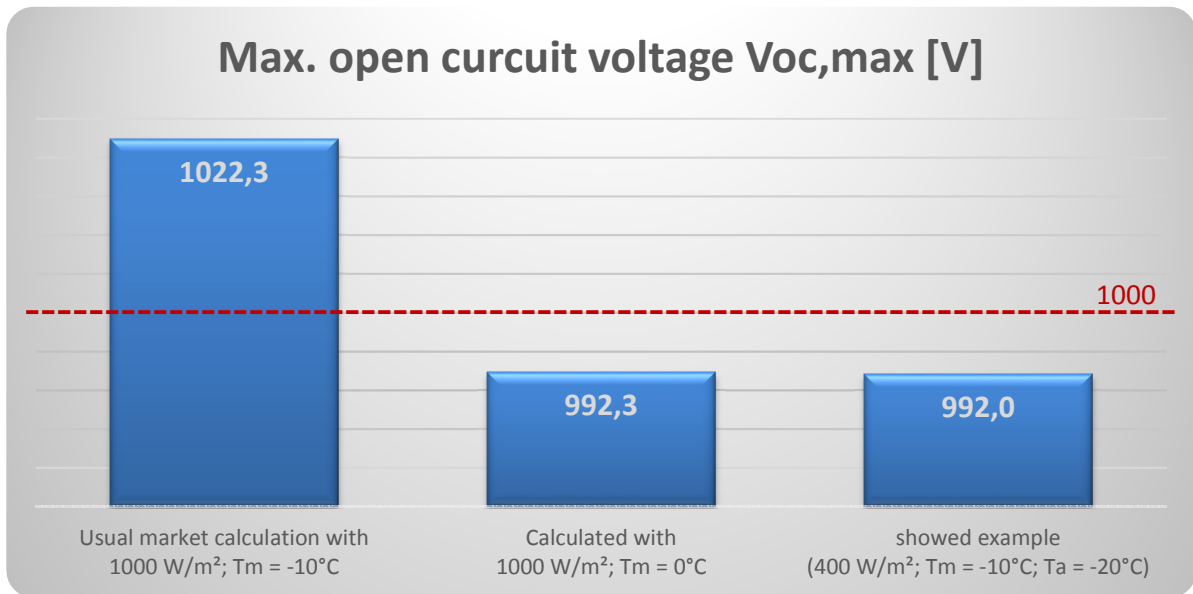
In many cases, the minimum module temperature  $T_m$  can be increased from  $-10\text{ }^{\circ}\text{C}$  to  $0\text{ }^{\circ}\text{C}$  in the system design. This is permitted if the actual maximum DC voltage occurring ( $V_{oc,max,real}$ ) is below the calculated value for the maximum open circuit voltage at  $1000\text{ W/m}^2$  and  $0\text{ }^{\circ}\text{C}$  ( $V_{oc,max}$ ).

Analyses have shown that, with constant ambient temperatures (in the example,  $T_a=-20\text{ }^{\circ}\text{C}$ ), the maximum open circuit voltage ( $V_{oc,max}$ ) occurs at approx.  $400\text{ W/m}^2$  (with a module temperature of  $T_m=-10\text{ }^{\circ}\text{C}$ ) (see Figure 1). With lower insolation values, the module temperatures fall and the MPP voltage may increase, but the open circuit voltage will be lower.



**Figure 1: Characteristics  $T_a=-20\text{ }^{\circ}\text{C}$  (source: internal analysis - Fronius International GmbH)**

The maximum open circuit voltage that occurs, calculated at  $1000\text{ W/m}^2$  and  $T_m=0\text{ }^{\circ}\text{C}$ , is just above the maximum open circuit voltage in Figure 1, while the maximum open circuit voltage calculated at  $1000\text{ W/m}^2$  and  $T_m=-10\text{ }^{\circ}\text{C}$  is significantly higher than  $1000\text{ V}$  (see Figure 2).

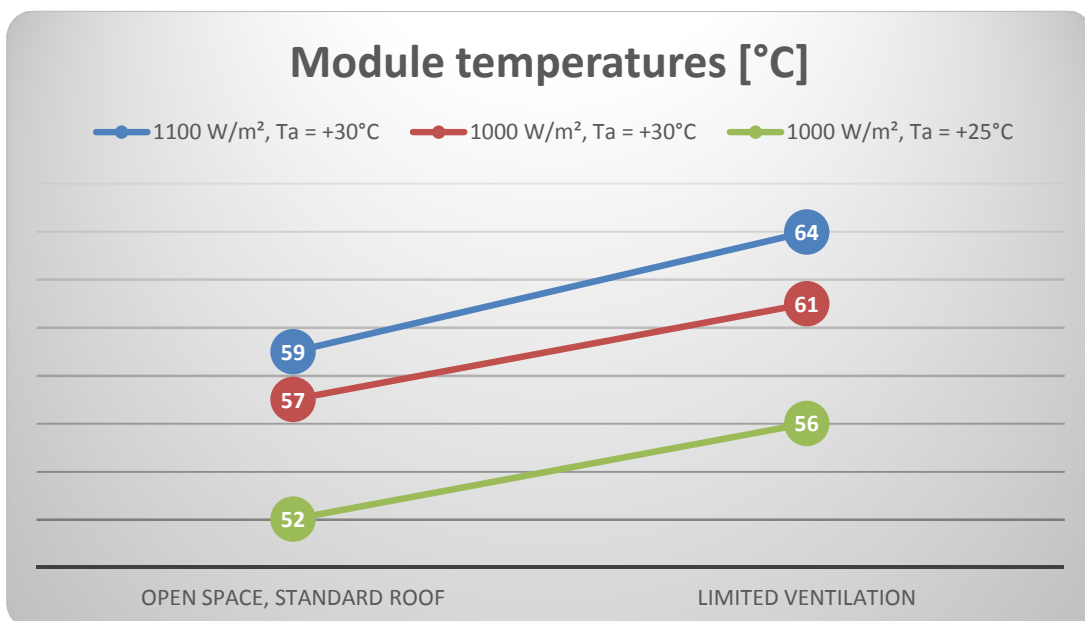


**Figure 2: Max. open circuit voltage (source: internal analysis - Fronius International GmbH)**

Consequently, under these conditions, calculation using an adapted minimum module temperature of T<sub>m</sub>=0 °C is permitted.

### Minimum DC voltage U<sub>dc,min</sub>

The minimum MPP voltage that occurs is dependent on the maximum ambient temperature (T<sub>a</sub>). Analyses of the module temperatures occurring have shown that, in systems installed in open spaces or on a well-ventilated roof, these temperatures lie below T<sub>m</sub>=+60 °C, even with insolation of 1100 W/m<sup>2</sup> and an ambient temperature of T<sub>a</sub>=+30 °C (see Figure 3).



**Figure 3: Module temperatures (source: internal analysis - Fronius International GmbH)**

Consequently, under these conditions, calculation using an adapted maximum module temperature of T<sub>m</sub>=+60 °C is possible.