



Additional yield losses when oversizing the
max. input current or max. usable DC Power

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Business Unit Solar Energy

Additional yield losses when oversizing the current

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1 Introduction

All Fronius inverters with their flexible design offer the possibility their power to be oversized at least 50% and the limit of the oversizing is always stated on the datasheet (like in the example below).

		Symo GEN24 SC / GEN24 Plus SC								
		6.0			8.0			10.0		
		MPPT1	MPPT2	Total	MPPT1	MPPT2	Total	MPPT1	MPPT2	Total
Max. usable DC power	W	6,180	6,180	6,180	8,240	8,240	8,240	10,300	8,600	10,300
Max. PV generator output	W _{peak}	7,500	7,500	9,000	10,000	8,500	12,000	12,500	9,000	15,000

Oversizing refers that the PV array has a higher peak capacity than the inverter. One of the reasons to oversize the array is that in reality the theoretical peak power of the PV modules is often not achieved.

1.1 Oversizing of the max. input Current and max. usable DC Power

In practice the maximum MPP current of a PV array ($I_{mpp,pv\ array}$) can exceed the maximum input current of the inverter/MPPT ($I_{dc,max}$). Such a case is called current oversizing (I_{mpp} of the PV array $>$ $I_{dc,max}$ of the inverter/MPPT).

Current oversizing is similar to the power oversizing. When the PV array is oversized, the power limitation will be done by shifting the operating point which means higher voltage, lower current. So, the same case when there is current oversizing, in the case when the current flowing from the array ($I_{mpp,pv\ array}$) increases and it is higher than the inverter's maximum input current ($I_{dc,max}$), the DC current will be limited to the maximum input current of the inverter ($I_{dc,max}$) and there will be shifting of the operating point to a higher voltage, the voltage will increase.

In a case when there is PV array power oversizing and also current oversizing, the operating point is already shifted to a higher voltage value because of the Power limitation, it might not be necessary to shift it further because the current is already to a lower level (because of the power limitation) and at this point there are no additional losses.

The main point is if the power gets limited the current already gets limited and if the current is also oversized then this might not have an impact anymore.

Fronius inverters show high resilience concerning high power and high MPP current of the PV array.

2 When will there be additional yield losses?

An inverter is flagged if additional yield losses are possible. Yield losses may occur if the maximum input current of the MPPT is exceeded. Yield losses can occur if the maximum MPP Power (Maximum usable DC Power) at the MPPT is exceeded.

Additional yield losses when oversizing the current

As an example, let's take Symo GEN 24 10.0 Plus SC inverter (All of these explanations are valid for all of our inverters) and the PV array is oversized with additional 30%, so the inverter is connected with 13 kWp and it is a 10 kW inverter, so the *Inverter Ratio (IR)* = $\frac{\text{Installed Power}}{\text{Max.usable DC Power inverter}} * 100\% = \frac{13}{10} * 100\% = 130\%$.

This inverter has $I_{dc\ max}=28/14\ A$ respectively on each MPPT. In this example the PV modules have $I_{mpp, stc} = 14.72\ A$.

The PV array has 2 strings connected to the inverter, one string on MPPT1 and one string on MPPT2. It is visual that the string connected to MPPT2 has $I_{mpp, stc}(14.72\ A) > I_{dc\ max}(14\ A)$, so this means that there might be additional losses due to the current oversizing but doesn't necessarily mean that there will be. Let's have a look into this.

The current sizing ratio (SR_I) $\rightarrow SR_I = \frac{I_{mpp, stc}}{I_{dc, max}} = \frac{14.72\ A}{14\ A} * 100\% = 105.14\%$. When it comes to power and current oversizing Fronius has done additional analysis how this affects the performance of our inverters. It was analyzed how the PV arrays are performing also in the summer period when there might be higher temperature leading to voltage drop and higher irradiation which means that there might be full current ($I_{mpp, stc}$) and we defined a Δ buffer $\rightarrow \Delta=15\%$.

This means $\rightarrow SR_{I- THRESHOLD} = IR - \Delta = 130\% - 15\% = 115\%$. As long as the SR_I is lower than $SR_{I- THRESHOLD}$ there will not be any additional yield losses because of the current oversizing. If the SR_I is higher than the $SR_{I- THRESHOLD}$ than there might be additional yield losses.

	$SR_{I- THRESHOLD} < SR_I < SR_{I- THRESHOLD}$
Additional yield losses	$yes < SR_I < no$

If the Power Ratio of a MPPT (Power Ratio_{MPPT} (PR_{MPPT})) is higher than the Inverter Ratio (IR) (especially with multi-MPPT inverters) and more power is connected to this MPPT, this can lead to an additional yield loss during operation. If the MPPT Power is oversized by the inverter is not oversized this can cause losses.

$$PR_{MPPT} = \frac{\text{Installed Power on MPPT}}{\text{Max.usable DC Power on MPPT}} * 100\%$$

	$IR < PR_{MPPT} \leq IR$
Additional yield losses	$yes < PR_{MPPT} \leq no$

Additional yield losses when oversizing the current

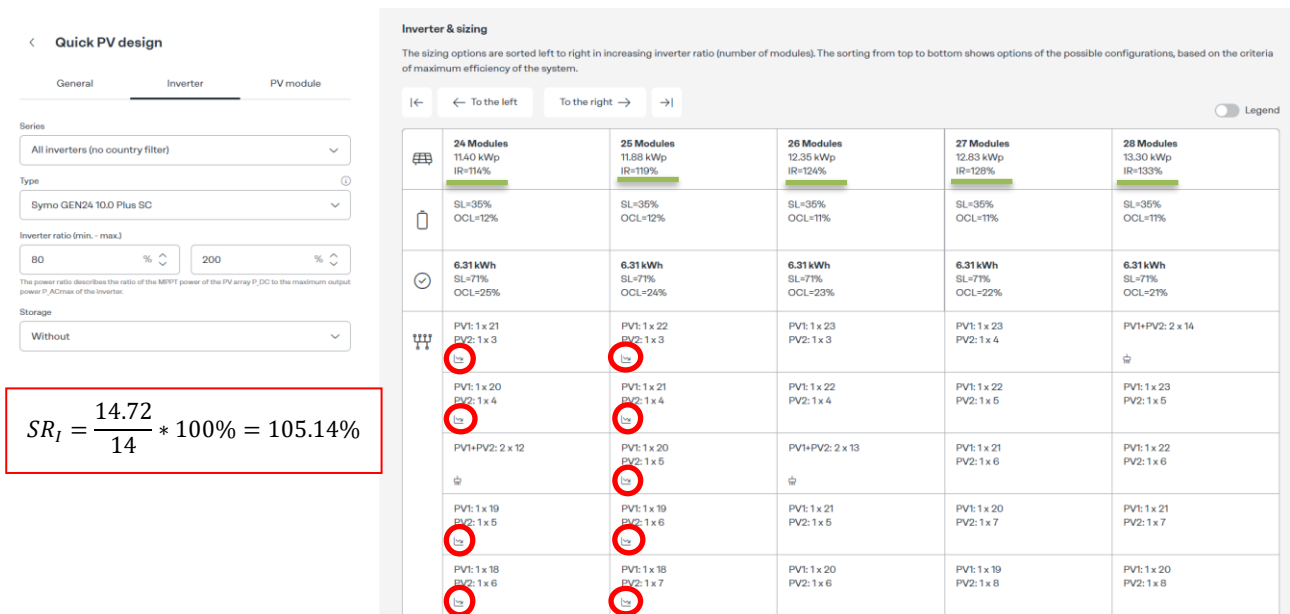


Figure 1: Example from Solar Creator and signalization where there are additional yield losses.

In the figure 1 it is presented example from the Solar Creator where with red is circled the sign for additional yield losses → . This sign indicates which system can have minor additional yield losses and on which MPPT and the losses are due to maximum input current oversizing on one MPPT.

3 How high are the losses?

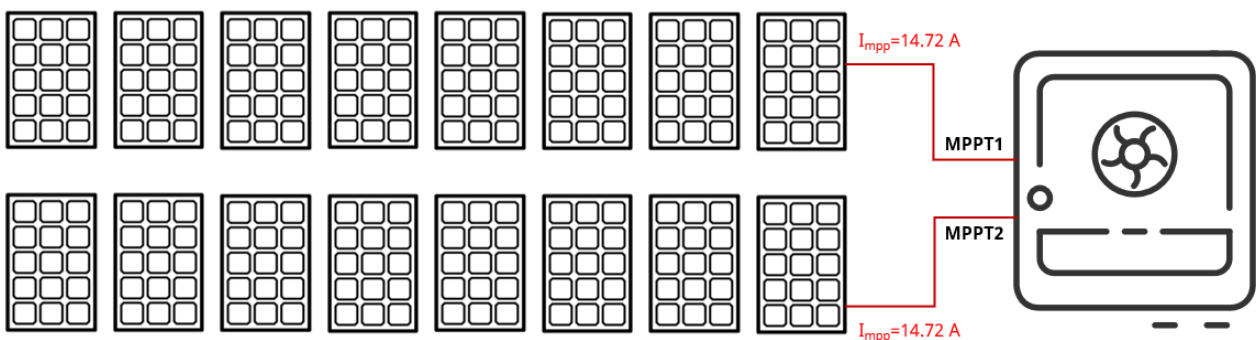


Figure 2: Example of Symo GEN24 10.0 Plus SC connected to modules with higher I_{mpp}

In figure 2 is presented an example of Symo GEN24 10.0 SC Plus connected with 2 strings with $I_{mpp} = 14.72 \text{ A}$ each. One string is connected to MPPT1 which has $I_{dc \text{ max}} = 28 \text{ A}$ and the other string is connected to MPPT2 which has $I_{dc \text{ max}} = 14 \text{ A}$. In this case, on MPPT2 the PV generator DC current is oversized by 5% than the maximum input current of the inverter's MPPT2 ($I_{dc \text{ max}} = 14 \text{ A}$) and the $SR_I = 105.14\%$.

Additional yield losses when oversizing the current

But even on a very sunny site with ideal weather conditions this design **reduces the annual yield by less than 0.2%**. (Please check out in our official website the whitepaper “Economic system design with Fronius GEN24 SC Plus and high current PV-modules”, where you can find the analysis of the annual yield.)

This example refers to a system without power oversizing.

With the power oversizing $IR \geq SR_1 + \Delta \geq 105\% + 15\% \geq 120\%$ we might not have even this 0.2% additional yield losses due to the current oversizing.

In reality the overall performance of the PV generator varies throughout the day with varying Irradiance, Temperature, also other factors as position of the sun, season and orientation of the roof. Direct irradiation on the PV generator of more than 900 W/m² occurs relatively rarely, correspondingly the maximum input current of the inverter ($I_{dc,max}$) is hardly ever exceeded. Even on PV systems that have oversized array this happens on very rare occasions only.

4 Reminder

The $I_{sc,pv}$ is the maximum short circuit current (I_{sc} at STC) and it is an important current used in designing the maximum string current. According to IEC 60364-7-712 $I_{sc,pv} = I_{sc,max} \geq I_{sc}(STC) \times 1,25$.

The PV generator’s I_{sc} must not exceed the value ($I_{sc,pv}$) of the inverter’s maximum power point tracker.

The maximum short circuit current is always stated in our datasheet for each of the MPPTs.

		Symo GEN24 SC / GEN24 Plus SC					
		6.0		8.0		10.0	
Max. array short circuit current ($I_{sc,pv}$) ¹	A	40	20	40	20	40	20

¹ $I_{sc,pv} = I_{sc,max} \geq I_{sc}(STC) \times 1,25$ according to e.g. IEC 60364-7-712, NEC 2020, AS/NZS 5033:2021.