

## SolarEdge Recommended AC Wiring – Application Note

This note recommends the appropriate AC wire size for connecting the SolarEdge inverter AC output to the utility grid.

In some PV installations, the wiring between the inverter AC output and the utility grid connection point covers large distances. In these cases, wire size should be increased in-order to limit the voltage rise on this wire run.

An improper AC wire size can cause a large voltage drop on the used cables, and result in power dissipation over the wire (cable heating and decreased energy harvest), and increased inverter AC output voltage, which may halt the inverter (inverter voltage trip).

SolarEdge recommends a voltage drop that is no greater than 1% between the PV array and the inverter.



### Note

The electric installation must be according to the local electrical codes.

## Wire Resistance, Voltage Drop and Power Loss

### Wire Resistance

The potential losses and voltage drops over the wires are determined by the current, the wire material (typically copper or aluminum), the cross-section area of the wire and its length (ambient temperature is another factor of the resistance but will be omitted in order to simplify the calculations).

$$(1) R = \rho \cdot \frac{L}{A}$$

Where:

R – Wire resistance [ $\Omega$ ]

$\rho$  – Electrical resistivity factor =  $1.68 \cdot 10^{-8} [\Omega \cdot m]$  for copper or  $2.82 \cdot 10^{-8} [\Omega \cdot m]$  for Aluminum

L – Wire length [m]

A – Wire cross section [ $mm^2$ ]

### Voltage Drop

The voltage drop according to Ohm's Law:

$$(2) \Delta V = I \cdot R$$

$\Delta V$  – Voltage drop on the wire [V]

### Power Loss

$$(3) \Delta P = \Delta V \cdot I$$

I – Wire maximum current [A]

$\Delta P$  – Wire Power loss [W]

Power loss percentage:

$$(4) \Delta P\% = \frac{\Delta V \cdot I}{V \cdot I} \cdot 100 = \frac{\Delta V}{V} \cdot 100 = \Delta V\% = \frac{I \cdot R}{V} \cdot 100 = \frac{I \cdot \rho \cdot \frac{L}{A}}{V} \cdot 100 = \left(\rho \cdot \frac{I}{V}\right) \cdot \left(\frac{L}{A}\right) \cdot 100$$

Since  $P = I \cdot V$ , the equation can be reduced to:

$$(5) \Delta P\% = \left(\rho \cdot \frac{P}{V^2}\right) \cdot \left(\frac{L}{A}\right) \cdot 100$$

And also:

$$(6) \Delta P\% = \Delta V\%$$

$P$  - Inverter peak power - will be found in the datasheet

$V$  - Grid voltage

$L$  - Wire length - Distance between the inverter and the grid connection (practically it should be multiplied by 2 since you have a returning wire, and divided by 3 in a 3 phase system)

$A$  - Wire cross section [mm<sup>2</sup>]

$\rho$  - Copper resistivity factor

### Example:

Using the SE4000 single-phase inverter positioned 25m from the utility grid connection:

If choosing a copper wire with cross section area of 10mm<sup>2</sup> -

Using equation (1), the resistance is:

$$R = 1.68 \cdot 10^{-8} \cdot \frac{2 \cdot 25}{10 \cdot 10^{-6}} = 0.084 \Omega$$

The inverter maximum current can be found in its datasheet ( $I_{max} = 22A$ )

Using equation (2), the voltage drop is:

$$\Delta V = R \cdot I = 0.084 \cdot 22 = 1.84V$$

Assuming grid voltage is 230V,

$$\Delta V\% = \frac{1.84}{230} = 0.8\% < 1\%$$

If the voltage drop on the wire exceeds SolarEdge recommendation (1%), use a larger cross section wire.

Using equation (3), the calculated power loss is:

$$\Delta P = \Delta V \cdot I = 1.84 \cdot 22 = 40.5W$$

## Minimal Wire Cross Section

To calculate the minimal required wire cross section, use the following equation:

$$(7) A_{min} = \frac{P \cdot \rho \cdot L}{V \cdot \Delta V_{max}}$$

$P$  - Inverter peak power - can be found in the datasheet

$L$  - Distance between the inverter and the grid connection (For single and three-phase systems, the number should be multiplied by 2 or divided by 3 respectively)

$V$  - Grid voltage

$\Delta V_{max}$  - Maximum allowed voltage drop on the wire - it is recommended that this value is no greater than 1% of the grid voltage

$\rho$  - Copper/Aluminum resistivity factor

The selected wire cross section should be greater than the minimal number calculated according to equation (7).



### Note

Do not connect wires with cross section larger than 16mm<sup>2</sup> directly to the inverter input terminal blocks - use external wiring box to transition between wire gauges.