Technical Information

Connection and Grounding of PV Inverters

1 Content

An SMA product (PV, hybrid, battery or Sunny Island inverter) is part of a PV system in which each component, if connected incorrectly, can affect the system in an undesirable way. This may prevent the intended safety elements, such as surge arrestors on the AC and DC sides and fuses, from functioning as required, or the overvoltage category specified for the product may not be maintained. The correct grounding structure of a PV system is therefore of crucial importance to ensure the long-lasting operation of a PV system.

This document does not replace any regional, state, provincial, federal or national laws, regulations or standards that apply to the installation, electrical safety and use of the product. SMA Solar Technology AG assumes no responsibility for the compliance or non-compliance with such laws or codes in connection with the installation of the product.

2 Grounding system with main grounding busbar

If a PV system includes multiple inverters, each one must be individually connected to the main grounding busbar to ensure proper grounding. Never connect the grounding cables of inverters in series.

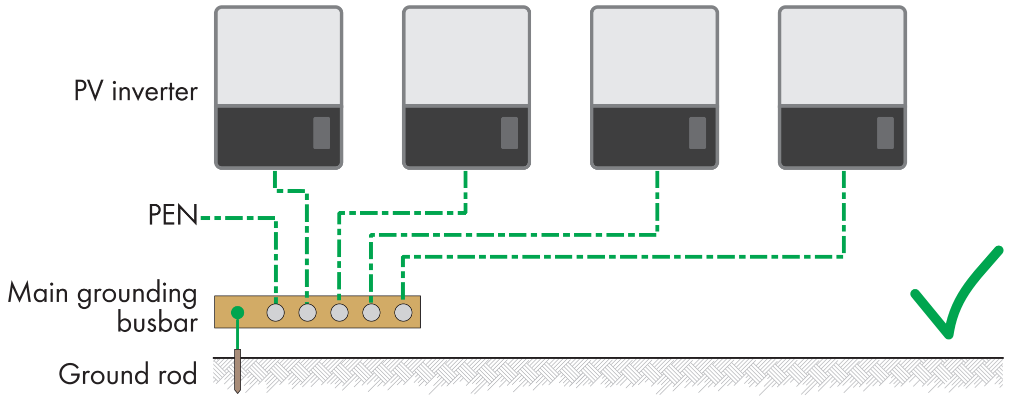

Figure 1: Example of a grounding arrangement on the AC side.

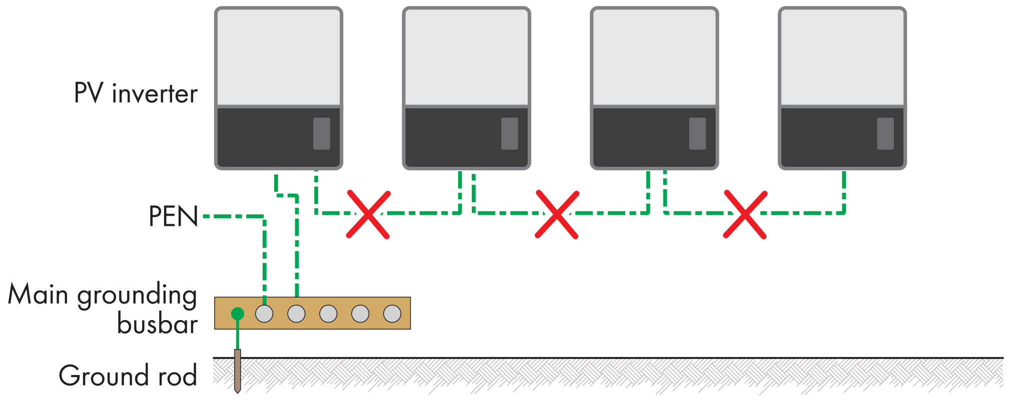

Figure 2: Example of a faulty grounding arrangement of inverters.

3 Cable Resistances

To avoid unnecessary line losses in the system, the line resistance of the lines/cables used must be taken into account. The conductor resistance is largely determined by the conductor cross-section, line length, and conductor material. SMA Solar Technology AG recommends that the line resistance does not exceed 100 mΩ. When planning PV systems, always observe the specified cable cross-sections in the relevant valid manual for the products used. The cross-sections specified there may be larger than those in the following table.

Cable length	Recommended minimum cable cross-section for copper conductors
Up to 20 m	Device-dependent (depending on individual components)

Cable length	Recommended minimum cable cross-section for copper conductors
Up to 40 m	10 mm²
40 m to 90 m	≥ 16 mm²
From 90 m	≥ 25 mm²

For aluminum conductors, refer to the conversion tables.

Information: According to product standard IEC/UL 62109-1 (Section 7.3.6.3.5, Table 11), the cross-section of the outer grounding conductor for line conductor cross-sections up to 16 mm² must be the same as the cross-section of the line conductors. For larger cross-sections of the line conductors up to 35 mm², the grounding conductor must be at least 16 mm². For cross-sections larger than 35 mm², the grounding conductor must have at least half the cross-section of the line conductors.

4 Equipotential grounding

If components are used in the PV system that require equipotential bonding (e.g., mounting rack, metal conduits or cable channels, module frame, etc.), these must be connected with a grounding busbar intended for this purpose.

For this additional grounding connection (e.g., use of a grounding electrode), some inverters have additional connection points for grounding conductors inside or outside the enclosure.

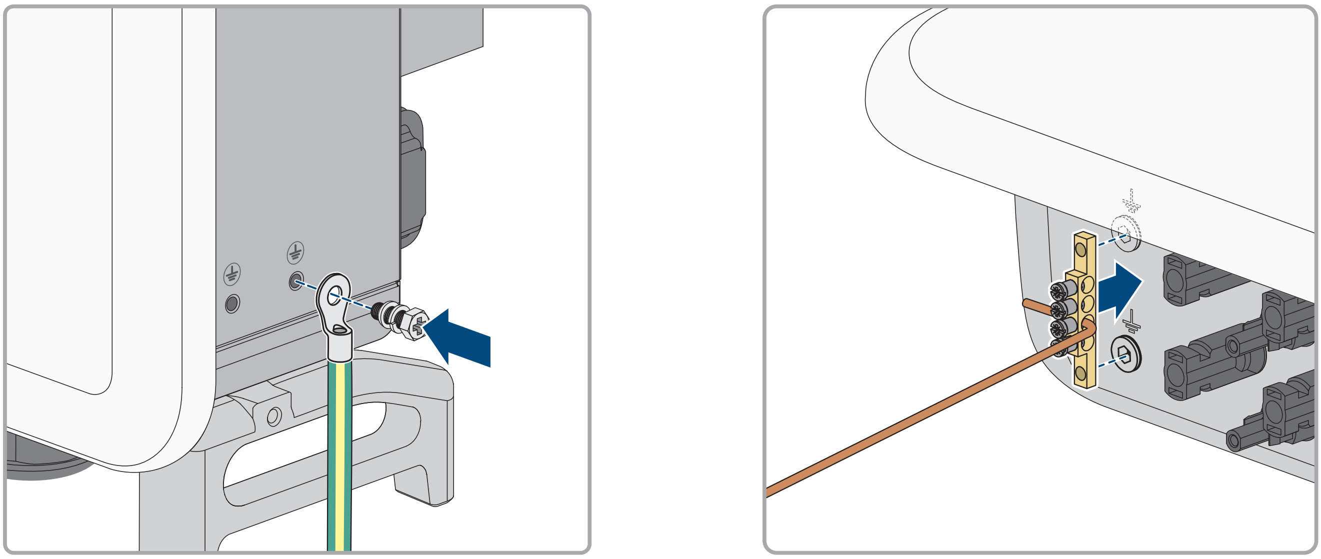

Figure 3: Example connection of a separate grounding

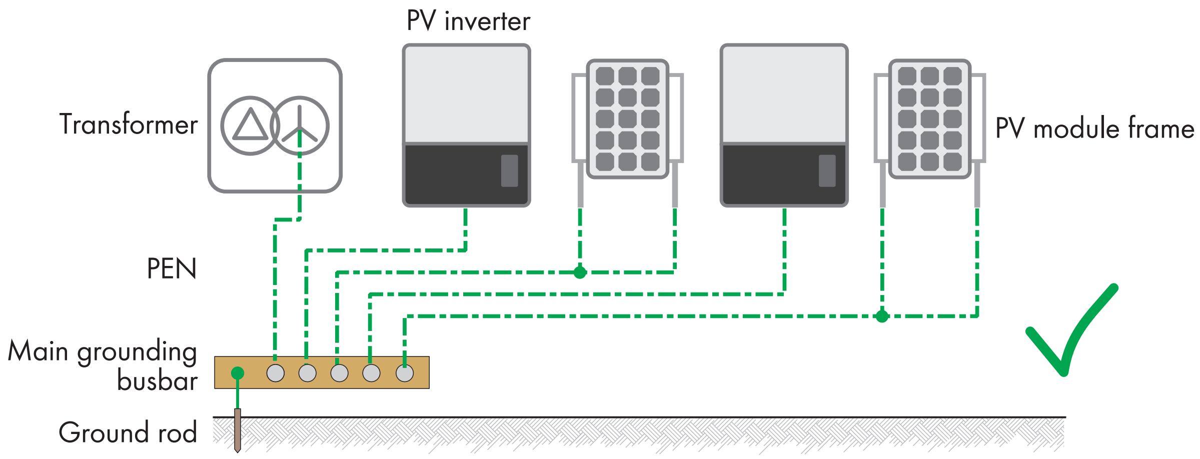

Figure 4: Example of a grounding arrangement on the AC and DC side

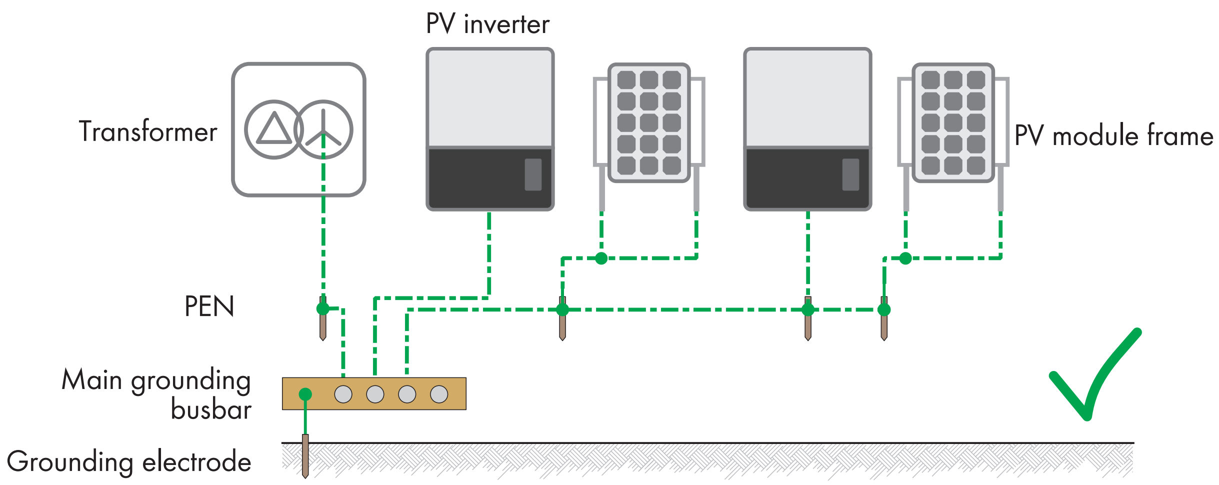

Figure 5: Example of combining individual grounding electrodes

If several grounding electrodes are already installed, connect each grounding electrode to the main grounding bar to ensure equipotential bonding for the entire PV system.

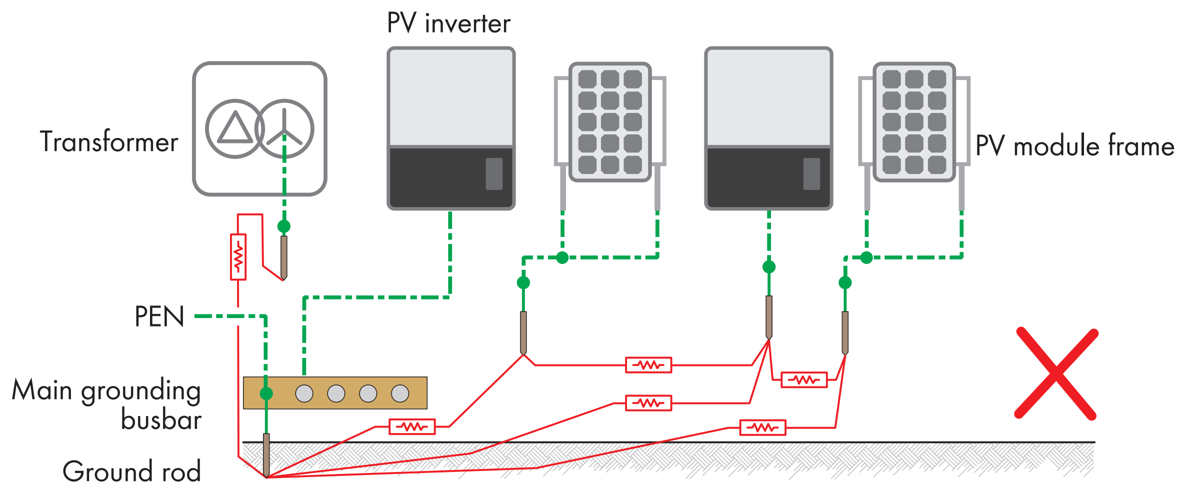

Figure 6: Example of an incorrect installation in systems with a mains transformer or multiple inverters and/or grounding electrodes

5 Connection of equipment grounding

For optimal grounding of all components involved and effective equipotential bonding, a direct connection of the respective equipment grounding terminals on the devices to the main grounding busbar is preferable. Equipotential bonding via routes that are implemented via the housing parts of the devices installed in the system should be avoided as far as possible, as they are significantly weaker in terms of functionality than direct connections to the main grounding busbar.

If an external ground connection on the inverter enclosure is used for equipment grounding, this ground connection should also be connected to the main grounding busbar.

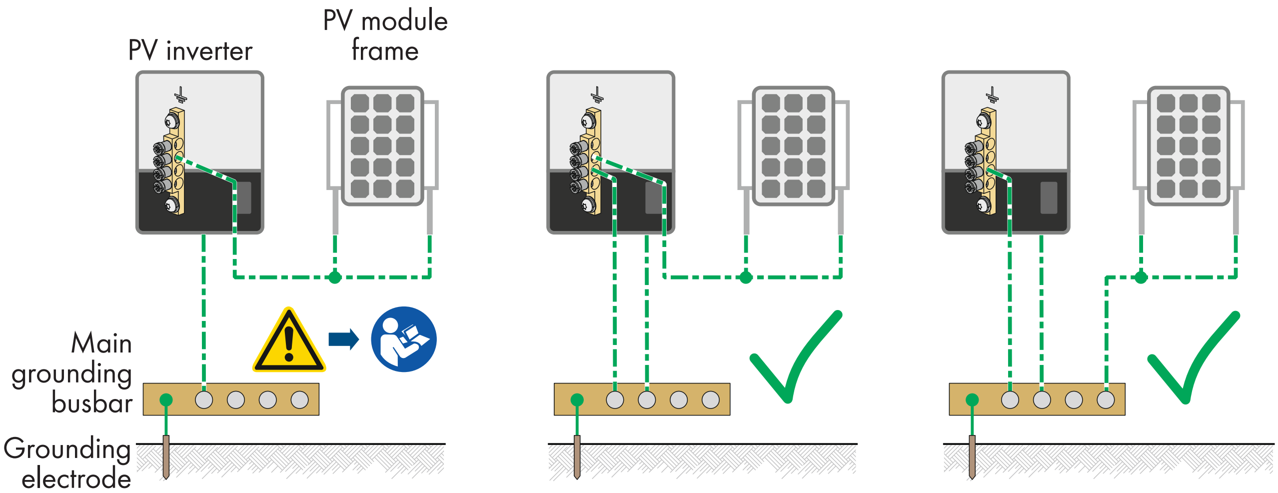

Figure 7: Connection example for equipotential bonding

6 Overvoltage category

A low-impedance ground connection is required so that the devices can fulfill their specified overvoltage category. The standard only takes into account residual currents that occur when defining the necessary minimum cross-sections, for example.

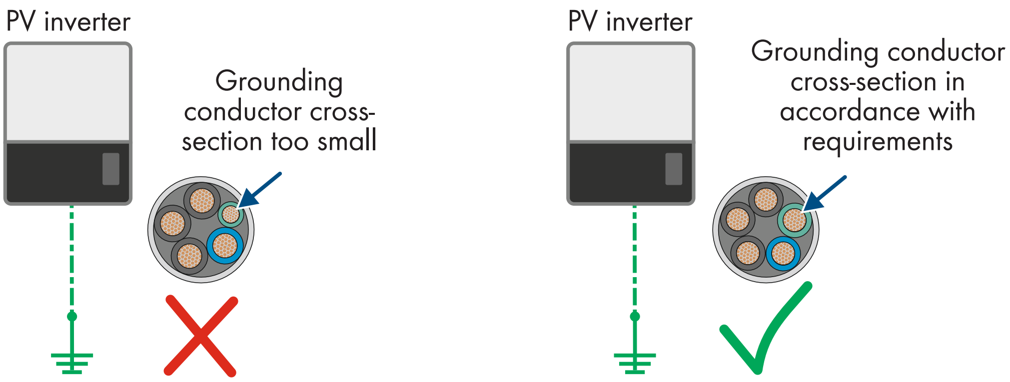

Figure 8: Observe AC supply line cross-sections (see Section 3, page 2)

The products from SMA Solar Technology AG are designed so that the specified connectable cable cross-sections cover the entire operating range of the product and its electrical safety. In certain cases, installation standards may specify smaller cross-sections for specific operating states, but the cross-section range limits specified by SMA Solar Technology AG always apply. These limits must not be exceeded or fallen short of.

7 Compliance with the connection regulations of the devices used

The installation line of the inverter defines the permissible cable connection options at the respective connection points of the device. Any other use is not permitted and may compromise the safe operation of the device.

Observe the installation specifications, such as line cross-section, line type, stripping specifications, and tightening torques.

Figure 9: Observe the maximum number of conductors per grounding terminal

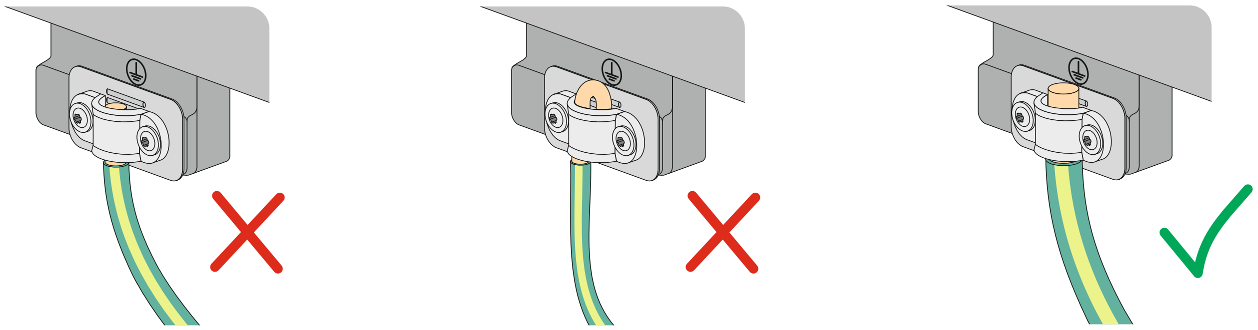

Figure 10: Observe minimum conductor cross-section and insulation stripping length

8 Information on grounding in YNyn transformers

For medium-voltage transformers of the YNyn type (star-star connection with outgoing neutral conductors on both the primary and secondary sides), both neutral conductors must be grounded separately from each other, each with its own grounding electrode.

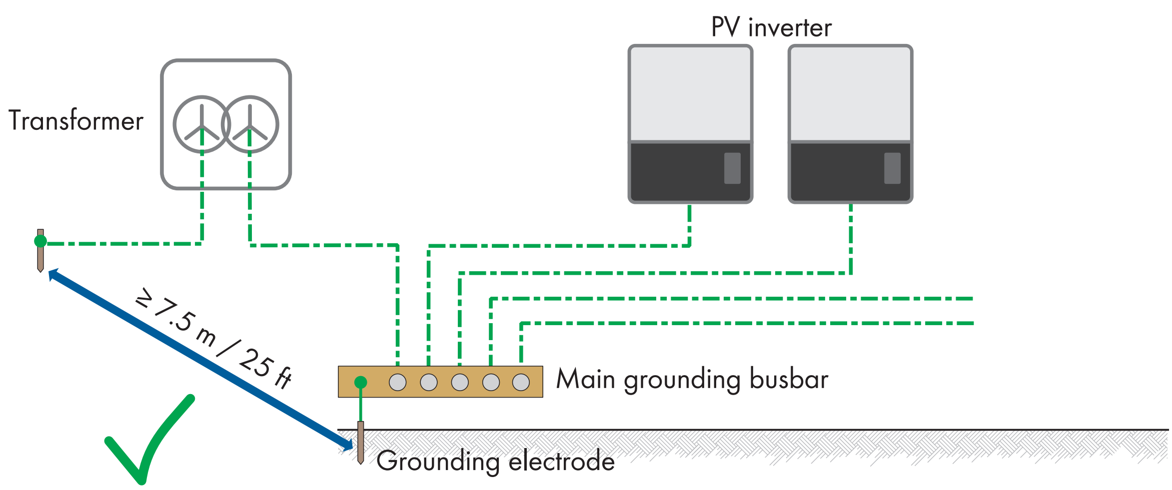

Figure 11: Separate grounding of the neutral point for YNyn transformers

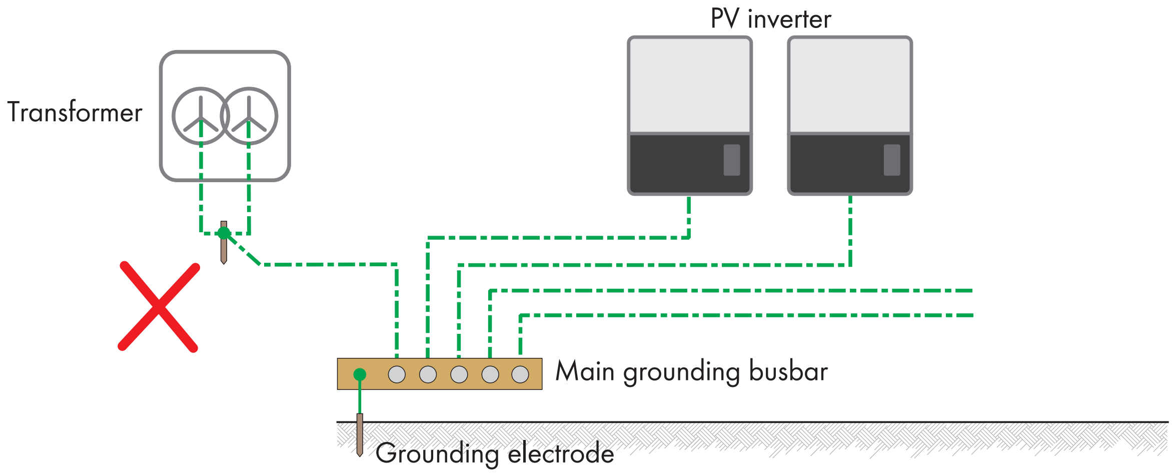

Figure 12: Incorrect grounding in YNyn transformers

Common grounding of the two neutral conductors of the transformer results in a partial coupling so that overvoltages can be transmitted via the neutral conductor.

In case of common grounding of the two neutral conductors, approx. 25% of the zero currents are transmitted. This leads to equalizing currents in the case of failure, which influence the voltage potential to ground and can lead to the destruction of devices in the system.