Module grounding and Ground Fault Detection in Spain

Technical Note

Grid-Tie inverters

TN_Grounding-01-01
Rev A

Module grounding

Certain modules must be grounded to ensure their optimum performance. There are two effects that can be corrected with grounding techniques: charge accumulation in the cells surface and TCO corrosion.

- Positive grounding. High voltages present in certain cells technologies may produce a static charge on their surface. This static charge accumulation produces a reversible reduction in the module efficiency. The objective of the positive grounding is to cancel the charge by driving the voltage in the PV+ terminal of the string close to or below the ground voltage.
- Negative grounding. Positively-charged sodium ions may react with infiltrated moisture and produce electrochemical corrosion in the Transparent Conductive Oxide (TCO) layer, one of the electrodes of the module. This creates permanent damage to the module. To reduce this effect, the potential of the PV- terminal must be kept at or close to ground potential in order to drive the positively charged sodium ions towards the negative pole.

The grounding may be done with different schemes:

a) Direct grounding: one of the terminals of the string is connected to ground, either directly or via a fuse. The connection ensures that the voltage in the grounded terminal is at the same value as the ground. The fuse may prevent potential fire hazards due to ground fault currents reaching dangerous levels.
b) Current-limited grounding: a resistor is placed between the desired terminal of the string and ground, limiting the maximum leakage current. The value of this resistor is usually between 100k and 500k Ohms and depends on the size of the string. As the number of strings increases higher polarization currents are required to achieve appropriate performance of the modules.

Direct grounding and current-limited grounding can be used for either positive or negative grounding. Both are commonly recommended by various silicon and thin film module manufacturers to obtain their rated module performance.

Ground Fault Detector

Local regulations generally impose certain requirements on the implemented grounding scheme. In North America the negative string is usually grounded, while in other countries, i.e. Spain, the terminals of the modules can not be grounded (even though their frames must be grounded for safety reasons using a ground rod separated from the electrical ground). In many regulations, an ungrounded system requires a Ground Fault Detector (GFD) to warn against potentially dangerous leakage current from the array to ground. One type of ground fault detector

continuously monitors the impedance from the PV string terminals to ground and signals when the resistance between the terminals and ground decreases below a certain limit. This limit is usually around 100kOhms, to take into account normal leakages within the modules, connectors, etc. Another type of GFD monitors the current from the PV array and signals when the leakage (residual) current exceeds a value determined by regulations (for example 300mA for VDE 0126-1-1 in Germany). In some cases the intent of the protection is to prevent fire hazards, and in other cases shock hazards.

Any GFD device incorporated into the inverter or into the system must not be disconnected. To do so may lead to an incorrect, unsafe and/or even illegal installation that could result in fire, personal injury, or loss of life.

GFD and grounding in Spain

The grounding scheme required to obtain the best performance with certain modules is incompatible with the GFD because when one of the terminals is connected to ground, the GFD will detect the leakage or lower impedance to ground and signal a fault to the inverter.

Legal limits for GFD vary depending on local regulations and on inverter topology. For instance,

- in the US PV modules are solidly grounded through a 1A to 5A fuse
- in Spain there is no limit set; but GFD is mandatory
- in Germany, non-isolated inverters isolation must be above 500kOhms before connection and a maximum of 150mA leakage during 40 ms is allowed after that.

Some regulatory requirements permit to accommodate the polarization needs using passive polarization. This is the situation in Spain, were the limit is set by the GFD. This is usually below 100k, and in such cases is low enough to accommodate the polarization requirements using passive polarization.

The following table shows the ground resistance setpoint for each GFD used in Xantrex central inverters:

Xantrex Inverter	GFD Device Installed	Resistance setpoint	Recommended polarization resistor
GT100E	Proat FAC3/X/600	80kOhms	=100kOhms
GT100E	Proat FAC3/900/X	80kOhms	=100kOhms
GT100E	Bender IRDH275-4	Adjustable 1kOhm – 1MOhm	= 125% R setpoint and = 100 kOhm
GT500E	Proat FAC3/1000/X	80kOhms	=100kOhms

The sensitivity of the Proat GFDs may be reduced if a lower polarization resistance is needed. For the exact procedure contact Proat, the manufacturer of the GFD device:

PROAT SL, Tel: +34 935 790 610, Pere III, local 5, 08100 Mollet del Vallés, Barcelona, http://www.proat.es/

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