RCD Selection for SolarEdge TerraMax™ Inverters - Application Note

This Application Note provides detailed information about capacitive discharge current, residual current, and the selection of Residual Current Devices (RCDs) for TerraMax™ inverters.T

Revision history

- Version 1.1, November 2024: Added general update.
- Version 1.0, October 2024: Initial release date.

PV System Residual Current Factors

In every PV installation, several elements contribute to the current leakage to protective earth (PE). These elements can be divided into two main types:

- Capacitive discharge current - Discharge current is generated mainly by the parasitic capacitance of the PV modules to PE. The module type, the environmental conditions (rain, humidity) and even the distance of the modules from the ground can affect the discharge current. Other factors that may contribute to the parasitic capacitance are the inverter's internal capacitance to PE and external protection elements such as lightning protection. During operation, the DC bus is connected to the alternating current grid via the inverter. Thus, a portion of the alternating voltage amplitude arrives at the DC bus. The fluctuating voltage constantly changes the charge state of the parasitic PV capacitor (i.e. capacitance to PE). This is associated with a displacement current, which is proportional to the capacitance and the applied voltage amplitude.
- Residual current - if there is a fault, such as defective insulation, where an energized cable comes into contact with a grounded person or object, an additional current flows, known as a residual current.

Residual Current Detection

SolarEdge TerraMax inverters incorporate a certified internal Residual Current Detection to protect against possible electrical shock in case of a malfunction of the PV array, cables, or inverter (DC). The inverter includes insulation and residual current monitoring according to IEC 62109-2 cl 4.8 and UL1741 section 31 to protect the DC side.

As the TerraMax system is defined as "Systems located in closed electrical operating areas," and as such, protection against shock hazard on the PV array or detection of sudden changes in residual current is not required. The TerraMax inverter indicates continuous residual current.
According to IEC 62109-2 The inverter shall disconnect within 0.3s and indicate a fault if the continuous residual current exceeds a maximum of 10 mA per kVA of rated continuous output power. According to the UL1741 the TerraMax inverters with DC rating of 250kw shall disconn,ect and indicate a fault if the current exceeds 4A and inverters with DC rating above 250kw shall disconnect and indicate a fault if the current exceeds 5A.

Residual Current limit according to IEC62109-2 section 4.8.3.5

Rated Continuous Output Power	Continuous Residential Current Limit	Time to Disconnect from the Grid
Above 30kVA	10mA/KVA	0.3s

Residual Current limit according to UL1741

Device DC Rating (kW)	Maximum Ground-Fault Current Detecting Setting (Amperes)
100 – 250	4
Above 250	5

Installation and Selection of an External RCD Device

Due to the size of the PV array connected to the inverter and resulting capacitive discharge currents, it is not recommended to use external RCDs on the AC side. Depending on the array oversizing rate the discharge currents are expected to be in a range of up to 3-4A. Therefore, the nominal rating of an external RCD would need to be at least 5A differential current (considering that an RCD does trip between 50-100% of nominal rating).

To achieve electric shock protection by automatic disconnection of supply, we do not consider an external RCD feasible. As a result, we recommend using fuses or circuit breakers to trip within the required time. This requires enough available fault current and low impedance fault current loops. In the case of ground-mounted systems, there are typically dedicated transformers, and the wiring is erected according to the site needs. This can be easily achieved when planned.