White Paper

Prevent PV System Crosstalk and Maximize Site Safety with the SolarEdge DC-optimized Solution

Background

Electromagnetic interference, known as crosstalk, may occur in commercial rooftop PV installations using Power Line Communications (PLC) for inverter data transmissions. When crosstalk occurs, it can have adverse affects on the PV system's Rapid Shutdown (RSD) functionality, compromising site safety. To overcome this issue, traditional string inverters with third-party RSD devices require costly and complex solutions that grow BoS and labor expenses.

This document explains how SolarEdge's DC-optimized solution is designed to avoid the negative effects of crosstalk and when coupled with its fully integrated RSD functionality, can ensure BoS savings, reduced installation time, and less labor when compared to traditional string inverters.

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What is crosstalk?

Crosstalk refers to interference caused by the electromagnetic field of one communication signal affecting the signal in a nearby wire or cable. When the electromagnetic fields of both signals overlap, crosstalk is created as illustrated in Figure 1 below.

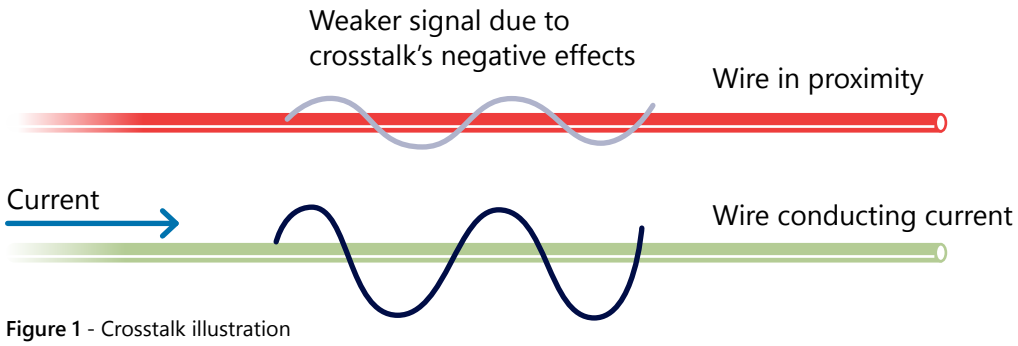

Figure 1 - Crosstalk illustration

Where does crosstalk occur in PV systems?

Crosstalk is a significant issue in structured cabling systems commonly found in commercial rooftop PV installations using Power Line Communication (PLC) for inverter data transmissions.

Rooftop PV plants include wires, junction boxes, and hardware devices that have electrical signals passing through them. The electromagnetic fields created by these signals are prone to Electromagnetic Interference (EMI) from other signal-generating sources. The resulting crosstalk can cause signal strength degradation and line noises.

For example, if two wires near each other carry different electrical signals, the signal currents will create magnetic fields that will induce a weaker signal in the neighboring wire.

Furthermore, commercial rooftop installations that comprise multiple strings for multiple inverters are often routed together in one conduit/solar raceway, further increasing the likelihood of crosstalk.

What is Rapid Shutdown?

PV system conductors may remain energized even after the inverter is turned off.

High DC voltages created by PV arrays pose risks to installers, maintenance personnel and firefighters. A growing number of PV safety codes and requirements have been issued worldwide to address and mitigate these risks.

Rapid Shutdown (RSD) is an important safety standard that is mandated by National Electrical Code (NEC) and widely adopted in North America*. It requires rooftop PV systems to have the ability to swiftly reduce voltage to non-lethal levels in the event of an emergency.

According to the NEC 2017 regulations (updated in NEC 2020), this requirement applies to voltage both inside and outside the PV array. RSD allows fast discharge of conductors to safe voltage levels, within 30 seconds. As a result, RSD significantly improves safety levels for emergency and maintenance personnel.

Additional RSD-related safety standards adopted in North America include UL1741 and UL3741.

How does crosstalk affect Rapid Shutdown operation?

Crosstalk can negatively affect Rapid Shutdown (RSD) in PV systems, compromising safety and putting people and property at risk.

PV systems comprised of inverters and RSD devices (refer to Figure 2 below) use PLC to constantly communicate with the inverter, periodically generating 'Keep Alive' signals to all system components. If the 'Keep Alive' signal strength is compromised by crosstalk, then Rapid Shutdown initiation may be affected with severe implications i.e. increased risk of safety hazards that may result (in rare cases) in PV plant fires.

To avoid this scenario, PV systems with traditional string inverters and third-party RSD transmitters recommend design rules and guidelines that are costly. These recommendations include:

- Separation of cables associated with different inverters into different conduits and trays
- Separate conduits and trays as far as possible

By following these guidelines, crosstalk can be avoided but additional BoS and labor costs are incurred as well as longer installation times at the rooftop PV plant.

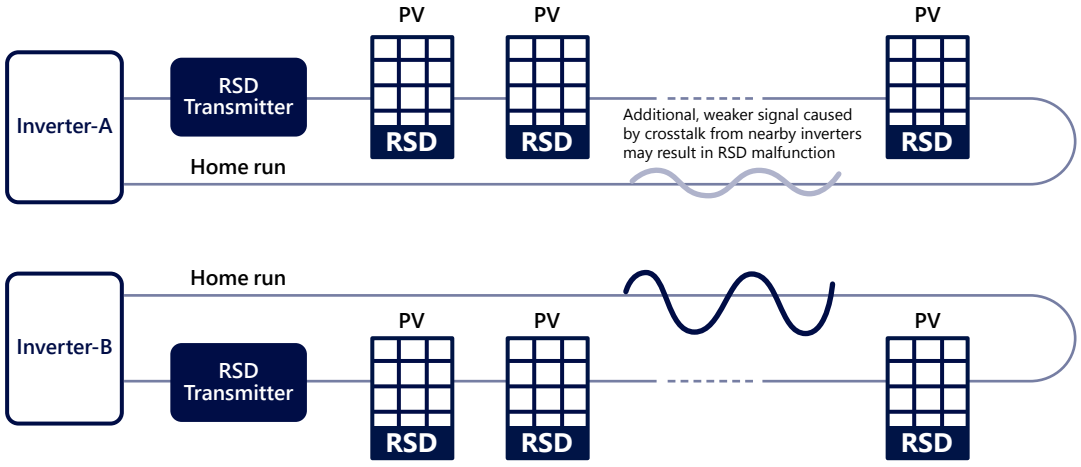

Figure 2 - Crosstalk and RSD in PV systems – applicable for inverters with third-party RSD devices

* The NEC section 690.12 requirements were first introduced in NEC 2014, 2017, and updated in NEC 2020. SolarEdge inverters installed in North America have complied with these requirements since they came into effect.

Avoid crosstalk effects by design with SolarEdge's fully integrated RSD functionality

The SolarEdge PV system is based on Module-Level Power Electronics (MLPE) technology and consists of intelligent solar inverters and Power Optimizers. RSD operation is fully integrated into all SolarEdge inverters and consequently eliminates the need to install costly external devices, and the need to take costly design measures explained previously. This results in BoS savings, reduced installation time, and less labor.

The ability of SolarEdge PV systems to avoid crosstalk effects is inherent in the system design. This is achieved by implementing a "pairing" process that uses a robust communication protocol to pair the inverter and Power Optimizers. During this process, Power Optimizers get a unique inverter ID, ignoring messages from nearby inverters. This implies that each Power Optimizer will communicate only with the inverter with a specific ID, avoiding crosstalk effects and ensuring successful completion of the RSD process. The safety of the PV system is therefore not compromised by crosstalk, and PV plant stakeholders can enjoy peace of mind.

In addition, when RSD is triggered or communication between the inverter and Power Optimizers is interrupted for any reason, the Power Optimizers immediately enter safety mode thereby ensuring touch-safe levels of PV array voltage.

BoS comparison analysis – 500kW rooftop installation

SolarEdge DC-Optimized Solution Based on a fully integrated RSD solution with inverters and Power Optimizers	**Traditional String Inverter Solution** Based on string inverters with third-party RSDs
Components and equipment	
• 1105 x 450W modules => 497.25kW DC • 553 x P1101 Power Optimizers • 8 strings of 32 modules, 25 strings of 34 modules • 3 x 120kW inverters and 1 x SE80KUS inverter => 440kW AC	• 1105 x 450W modules => 497.25kW DC • 553 RSD Devices • 65 strings of 17 modules • 4 x 80kW inverters and 2 x 60 kW inverters => 440kW AC
Electrical design	
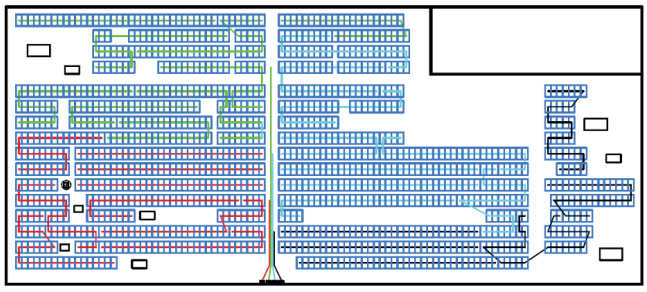	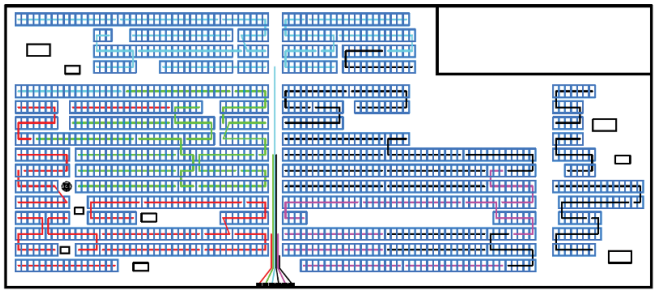
Figure 3 - SolarEdge DC-optimized design – fully integrated RSD solution with string inverters and Power Optimizers	**Figure 4** - traditional string solution's electrical design with string inverters and third-party RSDs

SolarEdge DC-Optimized Solution Based on a fully integrated RSD solution with inverters and Power Optimizers	Traditional String Inverter Solution Based on string inverters with third-party RSDs
Solution summary	
The SolarEdge solution requires only four inverters (compared to six with the competing solution) because SolarEdge inverters have a larger capacity (120kW) with longer string lengths. This results in four inverter groupings and separate cable trays are not required.	Inverter stringing is performed using cable trays to ensure the strings are separated from each other, mitigating crosstalk. It's relatively straightforward to mitigate the crosstalk inside the PV array by keeping the strings separated. However, when running the strings through the cable trays, down the middle towards the inverter, there is greater potential for crosstalk. Based on the third-party RSD manufacturer's design guidelines and restrictions, each inverter needs to be separated into its own cable tray to mitigate crosstalk. Consequently, six cable trays in total would be required, with the lines through the middle of Figure 4 above representing their length (resulting in additional wiring and labor costs).

BoS savings summary (including materials and labor costs)

SolarEdge design BoS savings	Cost of adding cable trays + labor (required by the competing solution)	Total SolarEdge BoS savings
2.2 c/W	0.6 c/W	2.8 c/W = $13,906 for the entire 500kW project

Summary

With its industry-leading, fully integrated RSD solution and crosstalk-free functionality, SolarEdge DC-optimized systems can enable BoS savings when compared to typical solutions using third-party RSD devices, as well as design and installation flexibility. Furthermore, they eliminate the need for additional components, wiring, conduits, and cable trays, which may add additional points of failure to the system.

In comparison, PV systems comprised of inverters with third-party RSD devices require significant changes in the rooftop PV plant design to mitigate the risk of crosstalk. These changes can be costly and complex, requiring the running of separate conduits/steel pipes, installation of more cable trays for cable separation, and additional installation space.