1.0 Introduction

Most Conext Core XC Series Grid-Tied Photovoltaic Inverters communicate using Modbus/RS485 connections to a monitoring and control system that is located in the same photovoltaic (PV) box as the inverter. This arrangement provides isolation for the inverter electronics.

Occasionally the inverter communication lines are routed outside of the boundary of a PV box and connected to devices such as array boxes. If fiber optic cables are used to carry the signals between the boxes, isolation can be maintained. If copper wiring is used to carry the signals, however, the wiring may conduct power surges (from lightning or ground differentials between nodes) back into the inverter.

This Application Note explains the communication cabling requirements for Conext Core XC Series inverters at sites where the inverter is connected to devices outside of the PV box via copper wiring. It also provides recommendations for the type of surge protection and describes how to wire the surge protection devices.

1.1 Related Documents

- Conext Core XC Series Installation and Planning Manual (document number 990-4613)
2.0 Safety

In the Conext Core XC Series, the Modbus/RS485 circuits are to be connected only to external Modbus/RS485 circuits that are Safety Extra-Low Voltage (SELV). SELV is a common designation that refers to a circuit in which the voltages within the circuit and from the circuit to ground have values that are not a shock hazard, under both normal and single fault conditions. This is achieved by the design of the circuits, and by maintaining protective separation (fault-tolerant insulation and isolation) between the SELV circuits and all hazardous voltage circuits, both within the inverter and in the installation.

**DANGER**

**HAZARD OF ELECTRIC SHOCK**

Connect only to Safety Extra Low Voltage (SELV) circuits.

The circuits provided for use with external communications and control equipment are designed to provide isolation from neighboring hazardous circuits within the inverter. The communications and control circuits within the Conext Core XC Series are floating from ground and are classified as SELV. They must be connected only to other SELV circuits in a manner which maintains all the circuits within SELV limits and prevents ground loops. Separate conduit entries must be provided for the communications and control circuits and the PV circuits and all AC circuits.

Physical and electrical separation of the communications and control circuits from non-SELV electrical circuits must be maintained both within the inverter and external to the inverters.

**Failure to follow these instructions will result in death or serious injury.**

3.0 Surge Protection Design

The surge protection system described in this Application Note is intended for connecting Conext Core XC Series inverters to a Modbus/RS485 network that may contain other devices including, but not limited to, supervisory control and data acquisition (SCADA) systems, other inverters, combiner boxes, and so on.

**NOTICE**

**EQUIPMENT DAMAGE**

The protection needs of devices other than Conext Core XC Series inverters on a Modbus/RS485 network that uses copper wiring must be considered individually.

**Failure to follow these instructions may result in equipment damage.**

The recommended surge protection design is shown in Figure 1.
Figure 1 Conext Core XC Series communication system, showing surge protection design.
3.1 Inverter Connections

The Modbus/RS485 connectors in the Conext Core XC Series are located at S43 and S44 on the communications (CMX) board on the left wall of the DC cabinet, (see Figure 2).

![Modbus/RS485 connectors](S43 and S44)

**Figure 2** Modbus/RS485 connectors

The details of the Modbus connections are shown in Figure 3.

![Modbus connection details](1.png)

**Figure 3** Modbus connection details

The shield of the RJ45 male connector must be connected to the cable shield (drain). Do not connect the RJ45 connector shield to the signal common.
3.2 System Cable Shield and Signal Common Grounding

**NOTICE**

**RISK OF EQUIPMENT DAMAGE**

The signal common and the cable shield must each be connected directly to protective ground and at one point only for the entire bus. **Failure to follow these instructions may result in equipment damage.**

The signal common must be connected directly to the protective ground and must be connected at one point only for the entire bus. In general, this connection point is on the master device or on its tap.

The cable shield must be connected directly to the protective ground and must be connected at one point only for the entire bus. The shield drain wire must not be used as a signal common.

In the system diagram shown in Figure 1 on page 3, the preferred point of connection of the cable shield and signal common to the protective grounding is at the SCADA device.

3.3 Surge Protector

To achieve the highest level of surge protection, install the surge protector near the point where the copper wiring exits the PV box and minimize the length of wiring between the surge protector and the Conext Core XC Series inverter that is being protected on the Modbus/RS485 network.

The surge protector must be connected so that the Line Side faces the unprotected environment (outdoor cabling), as shown in Figure 4.

![Surge protector connections](image)

**Figure 4** Surge protector connections

The following surge protectors have been tested and are approved for operation with Conext Core XC Series inverters when configured as shown in Figure 1 on page 3:

- B&B Electronics Model HESP4DR: DIN Rail Mounted Data Line Surge Suppressor
- B&B Electronics Model 485HESP: RS485 High-Energy Surge Protector (panel mounted)

These devices offer three stage surge protection of 6 kV as per IEC 61000-4-5.
3.3.1 Connection Details

The surge protector must be connected as follows:

- **Equipment Side**: To inverter
- **Line side**: To outdoor environment

**Grounding**

The grounding cable should be kept as short as possible and the ground should be close to the inverter to minimize noise.

The cable shields from the two cables must be connected to provide continuity. Do not connect the cable shield to the surge protector ground.

Figure 5 shows a typical surge protector wiring (B&B Electronics Model HESP4DR).

![Surge protector wiring example](image)

**Figure 5** Surge protector wiring example
3.4 Common Mode Choke

Communication lines may have common mode noise if a ground potential difference exists between different nodes of the RS485 network. When the communication quality is affected, a common mode choke can be used to reduce the noise impact. Figure 6 shows a typical common mode choke.

![Common mode choke diagram](image)

**Figure 6** Common mode choke

Loss of data due to an increase in the common mode voltage can also be more significant if multiple surge arresters are used on one RS485 network (for example, between the PV box and the array boxes). Common mode chokes can reduce these effects.

3.4.1 Guidelines

It is not possible to specify a single common mode choke device that will ensure proper performance for every scenario because the magnitude and effect of the common mode noise varies depending on the particular details of an installation.

The following sections provide general guidelines for the use of a common mode choke.

**Placement Within the System**

Place the common mode choke between the Line Side of the surge protector and the cable coming from the outdoor environment (see Figure 5). This reduces the possibility of loss of communication between the inverters and the rest of the nodes on the Modbus/RS485 chain.

**Winding**

Wind the entire communication cable, including the shield, through the core of the common mode choke.

**Core Type and Turns**

The core type and the number of turns depend on the details of a particular installation. For example, in a test setup the Fair-Rite part number 2643803802 core was found to be effective for link distances from 0 m to 330 m.
3.5 Cabling

A 1.5 pair cable that is suitable for an EIA-485/Modbus/RS485 application is illustrated in Figure 7. The illustrated cable is Belden 3106A Multi-Conductor - EIA Industrial RS485 PLTC/CM.

![Cable example](image)

**Figure 7** Cable example

To properly select a cable, the system designer must consider factors such as local codes, environmental conditions (such as temperature), location (such as cable tray vs direct burial), and the requirements for other equipment connected on the Modbus/RS485 network. Many cables meet the recommendations of the EIA-485 standard, including the shielded Cat 5 cable used in Ethernet network installations.

For more information please refer to the Modbus and EIA-485 standards (see “Related Documents” on page 1).