AC Coupled Systems with Conext™ XW+/SW: Solutions Guide

976-0240-01-01
Revision G

Safety Information

Important Information

This document contains important safety instructions that must be followed during installation procedures. Read and keep this Solutions Guide for future reference.

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

Schneider Electric

NOTICE
NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved. For more information, see Audience.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, ARC FLASH, AND FIRE

This document is in addition to, and incorporates by reference, the relevant product manuals for Conext XW+/SW Battery Inverters and PV inverters. Before reviewing this document, you must read the relevant product manuals. Unless specified, information on safety, specifications, installation and operation is as shown in the primary documentation received with the product. Ensure you are familiar with that information before proceeding.

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

Contents

Purpose

This Solutions Guide outlines how the Conext XW+/SW Battery inverters and PV inverters can be interconnected to form an AC-Coupled system.

Audience

This manual is intended for use by qualified personnel installing a system involving Schneider Electric Conext XW+/SW Battery Inverters and PV inverters.

The qualified personnel have training, knowledge, and experience in:

- Installing electrical equipment and PV systems (up to 1000 V).
- Applying all applicable installation codes.
- Analyzing and reducing the hazards involved in performing electrical work.
- Selecting and using Personal Protective Equipment (PPE).

Configuration, servicing, and maintenance must be performed by authorized service personnel only. Authorized service personnel meet the requirements for a qualified installer, plus they have received specific training from the manufacturer on servicing the Conext XW+/SW Battery Inverters and PV inverters.

This manual does not contain information regarding servicing or de-energization for servicing. Authorized service personnel must refer to the Installation and Owner's guides.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, ARC FLASH, AND FIRE

- This equipment must be serviced by authorized personnel only.
- Authorized service personnel must disconnect both AC and DC power from the inverters, perform lock-out and tag-out, and verify that all circuits are de-energized before attempting any maintenance, cleaning, or work on any circuits connected to the inverters. Putting the inverters in Standby mode will not reduce this risk.
- After all power is disconnected, wait at least ten minutes for internal capacitors to discharge to safe voltages before opening inverter doors or covers.
- To reduce the chance of short-circuits, authorized service personnel must use insulated tools when installing or working with equipment.

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

Prerequisite

It is strongly recommended to upgrade to the latest Conext XW+/SW firmware. To find the latest firmware, go to https://solar.schneider-electric.com/products/inverterchargers/ > your product > **DOWNLOADS > Firmware**.

⚠ CAUTION

RISK OF INJURY AND EQUIPMENT DAMAGE

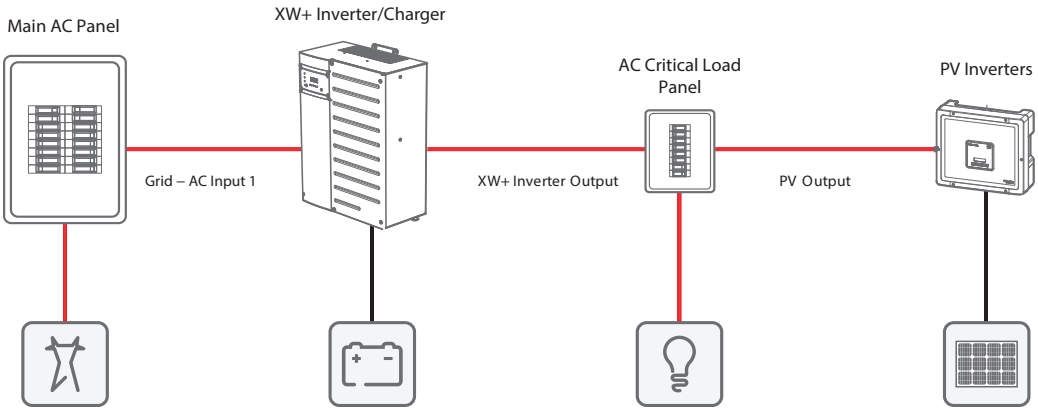
- To prevent battery damage in a micro-grid AC system, always use the latest firmware available for your inverter.
- If Li-ion batteries are used, ensure they are Listed or certified with a built-in battery management system (BMS).

Failure to follow these instructions can result in injury or equipment damage.

What is AC Coupling?

When a PV inverter is connected to the AC output terminal of a battery-based inverter, the system is referred to as an AC-Coupled system. In this configuration, the PV inverter is exposed to the AC output voltage of the battery-based inverter, which is responsible for grid forming during off-grid/backup operation. The PV inverter injects power to the critical load panel and the AC output of the battery-based inverter. The inverters are thus “AC-coupled” with each other and are able to share PV solar energy to the required loads.

Figure 1 AC-Coupled System Diagram



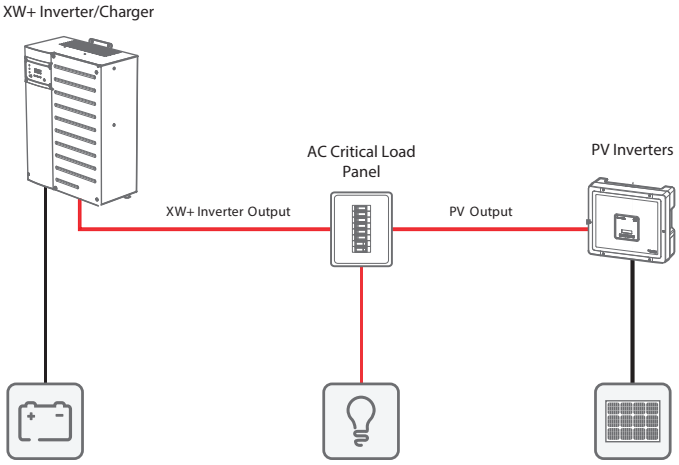
An example of AC Coupling with the Conext XW+ is shown in *Figure 1*. The PV system is connected to the grid through the internal relay located on the AC bus inside the Conext XW+ inverter. This allows power to be produced and supplied or “sold” back to the grid if it exceeds the power consumed by the critical loads.

When the grid goes out of limits, the Conext XW+ switches to back-up and powers the critical load panel to support the loads. Thus, the Conext XW+ forms the grid to keep the PV inverters operating. The Conext XW+ switch over to back-up is almost instantaneous. In some cases, the PV inverter does not detect the transition and continues to operate without interruption. If the PV inverter detects the switch over, it will disconnect and will wait 5 minutes before producing power.

Surplus Power in Off-Grid/Backup Mode

The most critical element of AC coupling is the use of the surplus power that the PV system produces when operating in off-grid or backup mode. The surplus power is the power that is not used by the loads. For instance, if the PV inverter produces 4 kW and the load is 1 kW, there is a surplus of 3 kW.

Figure 2 Grid Forming and Surplus Power



If there is more power being generated than can be consumed by the loads, the surplus power will flow to the Conext XW+ and will be converted to DC power which flows into the battery. Once the battery reaches full charge, power generation by the PV inverter must be curtailed to maintain the balance between generation and consumption. As the battery bank reaches full charge, Conext XW+ curtails PV inverter generation by raising the AC output frequency, causing compatible PV inverters to reduce their power output. This is called Frequency Shift power curtailment.

NOTICE
RISK OF EQUIPMENT DAMAGE Follow all instructions related to AC Coupled PV sizing, battery sizing, and charge settings in the following sections of this document. **Failure to follow these instructions can result in equipment damage.**

AC Coupling System Design

There are several important considerations when designing an AC coupled system with the XW+/SW inverter:

- PV Inverter Compatibility
- Battery Inverter/PV Inverter Sizing
- Lithium Ion (Li-ion) Battery Compatibility
- AC Coupling in Generator-Based Systems

PV Inverter Compatibility

NOTICE

RISK OF INCOMPATIBLE EQUIPMENT

- Ensure that the PV inverter warranty covers off-grid applications, specifically AC coupling with a battery-based inverter.
- Ensure that the PV inverter is capable of operating when it is AC-Coupled with the battery-based inverter which forms the local grid. PV inverters with an impedance sensing anti-islanding scheme are not compatible with the inverter/charger.

Failure to follow these instructions can result in equipment damage.

Anti-Islanding

PV inverters feature protection mechanisms that detect when a grid fails so that the inverter can cease generating power. This feature helps to protect against unintentionally supplying power to a dead grid that might be under service. Some legacy implementations of anti-islanding protection on PV inverters use a grid impedance check as a mechanism to detect a failed grid. Battery inverters typically have higher output impedance compared to the grid, and this impedance might render the system incompatible.

Always check with the PV Inverter manufacturer to verify that the anti-islanding mechanism is compatible with AC-coupled systems using battery-based inverters.

Frequency-Watt

The Conext XW+/SW inverters use Frequency Shift to regulate battery charge current coming from AC coupled PV. PV inverters used in AC coupled systems are recommended to have frequency-Watt controls. Legacy inverters without frequency-Watt controls can be used with some limitations. See *Battery Charge Control Using Frequency Shift on page 10* for more information about the required features and configurations.

Battery Inverter/PV Inverter Sizing

Because battery charge management through Frequency Shift is not instantaneous, the power rating of AC coupled PV inverters must be sized taking into account the battery charge power and the battery-based inverter ratings. Charging power is calculated as minimum battery voltage times the recommended charging current. Regardless of the system size, the maximum allowable rating of any AC Coupled PV inverter(s) is the lesser of:

a. the maximum allowable charging power of the battery

b. 125% of the continuous charge power rating of the Conext XW+/SW inverters

Note: For the Conext XW+, the Max Chg Rate setting only regulates charge from the AC1 or AC2 port, but not the AC OUT port used for AC Coupling. This parameter cannot be used to regulate or reduce the battery charge current from AC coupled PV inverters. Charge regulation using Frequency Shift is initiated when the battery reaches the bulk voltage. Therefore, it is critical that the battery is rated to accept charging from the full rated power of AC coupled PV inverters during the bulk charge stage.

Always refer to the battery manufacturer for recommended charge settings to configure your Conext XW+/SW. For specific settings of AC coupled PV inverters, refer to the PV inverter manufacturer.

Lithium Ion (Li-ion) Battery Compatibility

NOTICE

RISK OF EQUIPMENT DAMAGE

- Always check your manufacturer's recommended applications. Not all Li-ion batteries may be used in offgrid or backup power applications.
- Always follow PV and battery sizing guidelines.
- Ensure Li-ion batteries can accommodate the high inrush current from the initial connection of battery-based inverters. A pre-charge circuit may be required. Conext XW+ has 26 mF capacitance and the Conext SW has 16 mF capacitance. Check with your battery manufacturer to confirm compatibility.

Failure to follow these instructions can result in equipment damage.

NOTICE

RISK OF EQUIPMENT DAMAGE

- Check with your manufacturer to confirm the rated charge power of any Li-ion battery packs connected in parallel. Due to possible variations in current sharing between parallel connected battery packs, the rated charge power may not be proportionate to the number of battery packs in parallel.
- Ensure that the rating of any AC coupled PV inverter is less than the rated charge power of the Li-ion battery packs.

Failure to follow these instructions can result in equipment damage.

For AC coupled systems with Conext XW+/SW inverters, ensure the Li-ion battery packs are sized so that the continuous rated charge power of the battery is equal to or greater than the maximum power available from the AC Coupled PV inverter. Refer to the Battery Inverter/PV Inverter Sizing section for more details on the sizing requirements.

When the maximum charge voltage is exceeded, the battery-based inverter will start ramping up frequency and the PV inverter will curtail accordingly, however, the overall control response time may not be fast enough to prevent exposure to a transient charge power in certain conditions. For example, a sudden drop in loads or a transfer to backup power operation when there are no loads present can cause the batteries to be exposed to a short duration charge power up to the PV inverter power rating.

Due to the sensitivity of Li-ion batteries, it is highly recommended to include an over-voltage protection relay to disconnect the AC coupled PV inverter in the event that the voltage reaches or exceeds the battery's maximum operating voltage. The disconnect relay should be installed at the critical load panel or other appropriate location, and connected in series with the output of the PV inverters. The relay can be triggered by the 12 Volt Aux port of the Conext XW+, set up to trigger on high battery cutout (HBCO). Select a relay with a coil drive specification that does not exceed 80% of the 250mA XW Aux output rating. HBCO needs to be set to an acceptable level, not exceeding the safe operating voltage of the Li-ion battery (see the manufacturer’s specifications). Example relays include the SquareD™ 30A power relay (PN:8501CDO16V51), and the Automation Direct™ 40A power relay (PN:AD-PR40-2C-12D). With Li-ion batteries, it is also recommended to set the charge voltage setting of the battery-based inverter to 98% of the manufacturer's specified charge voltage. Refer to the Owner's Guide of the battery-based inverter for more information on these settings.

AC Coupling in Generator-Based Systems

NOTICE

RISK OF DAMAGE TO THE GENERATOR

Never connect a generator to the AC Input terminal of a battery inverter configured for AC coupling. The inverter will not be able to regulate the current being backfed into the AC input and may backfeed AC current into the generator.

Failure to follow these instructions can result in equipment damage.

NOTICE

RISK OF DAMAGE TO THE INVERTER

Always check the recommendations of your equipment manufacturer when designing systems with PV inverters that are AC-Coupled with a generator. Some PV inverters are susceptible to failure when AC-Coupled with a generator.

Failure to follow these instructions can result in equipment damage.

In systems consisting of a generator as the secondary source of AC power, it is undesirable to allow the PV inverter to come online when the generator is forming the grid (that is, the battery inverter is in bypass mode and/or charging from a generator). In conditions where PV

generation exceeds AC load and battery charging consumption, excess PV power could flow to the generator with potentially damaging effects.

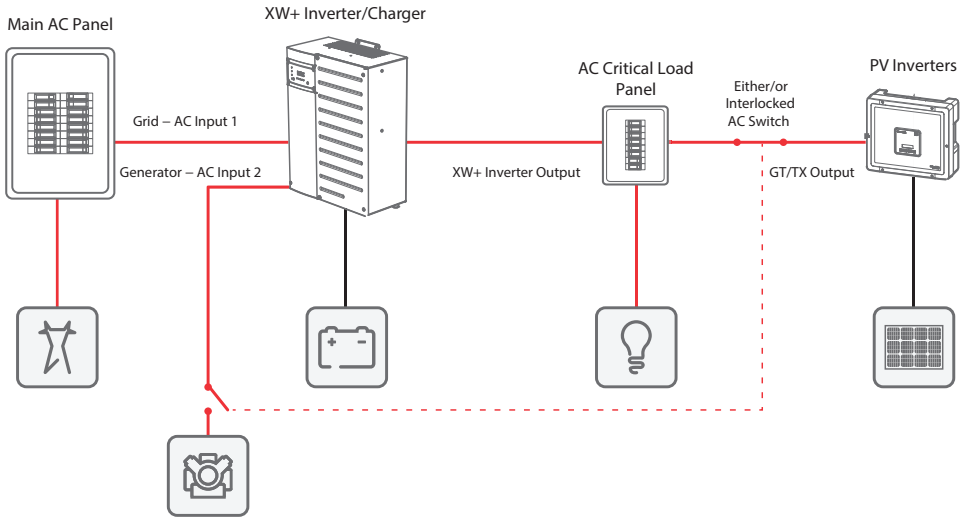
While running a generator in an AC-Coupled system, the generator will provide AC power to the battery-based inverter and the PV inverter. The PV inverter will detect this and begin to inject energy to the system. Generators and other AC sources are not designed to accept backfed power, so there must be a way to disallow the concurrent operation of the AC source and PV inverters on the system. This can be done manually or through the use of interlocked AC transfer contactors.

In all cases, while the generator is running, the PV inverter must be disconnected from the circuit. PV harvest is only possible when the generator is not running and is disconnected, and the Conext XW+/SW is inverting.

It is possible to use a disconnect switch to automatically disconnect the PV inverters when the generator is operating. To do this, a pair of interlocked disconnect switches can be installed. One is placed between the generator output and the AC input of the battery-based inverter, and a second one between the PV inverter and critical load panel.

Note: The power metering on the Conext XW+ may not work as expected when it is in voltage source invert mode and power is flowing back into the batteries.

Figure 3 AC-Coupled System with Generator



Battery Charge Control Using Frequency Shift

The Conext XW+ regulates the battery charge using Frequency Shift. This technique exploits the active power reduction versus frequency feature of PV Inverters (frequency-Watt). This is a key feature of modern smart inverters, but may be absent in older legacy PV inverters. See *Lithium Ion (Li-ion) Battery Compatibility on page 8*.

Operation with Smart PV Inverters

NOTICE

RISK OF INCOMPATIBLE EQUIPMENT

- Ensure that the PV inverter warranty covers off-grid applications, specifically AC coupling with a battery-based inverter.
- Ensure that the PV inverter is capable of operating when it is AC-Coupled with the battery-based inverter which forms the local grid. PV inverters with an impedance sensing anti-islanding scheme are not compatible with the inverter/charger.

Failure to follow these instructions can result in equipment damage.

With smart PV inverters, surplus power is regulated using Frequency Shift according to the battery charge settings. When the battery reaches the bulk charge voltage, the battery-inverter frequency is ramped up linearly and the PV inverter responds by curtailing power according to its frequency-Watt settings. Depending on the grid code requirements of the installation and the settings of the PV inverter, power curtailment down to zero may not be possible. As a result, PV inverters may trip off during the final stages of the charge cycle, especially if there is significant surplus PV power. After a reconnect delay (typically 5 minutes), the PV inverter reconnects. This mode of operation is acceptable for grid-tied applications with less frequent outages.

Optimal charge management can be achieved by adjusting PV inverter settings to allow power curtailment to zero, which is a capability of many smart PV inverters. This allows improved charging in the Constant Voltage Absorption stage where the charge current continues to reduce towards zero. In grid-tied applications, follow the grid code requirements for all PV inverter settings unless approval is obtained from the utility. Contact the manufacturer for information on the available settings for AC coupling with battery-based inverters.

Note: Frequency-Watt power curtailment to zero may require special settings that are typically used in off-grid applications, where compliance with grid code requirements is not required.

Operation with Legacy PV Inverters

When AC coupling with legacy PV inverters without frequency-Watt capability, the battery-based inverter will have reduced ability to regulate the battery charge. When surplus power charges the batteries and the battery voltage reaches the bulk charge voltage, the battery-based inverter frequency is ramped up and the PV inverter will cease producing power and disconnect. When battery voltage drops below the charging voltage due to loss of PV back-feed power, its output frequency returns to normal (50 or 60 Hz). This return to normal frequency causes the PV Inverter to initiate its reconnect delay timer (usually 5 minutes), and come online. Depending on the available array power and loads, any surplus power will be used to charge the batteries and the cycle will repeat. It is recommended to set the Absorb Time limit to the minimum value to help reduce cycling.

Where possible, it is generally recommended to install smart PV inverters with frequency-Watt capability for AC coupled systems. However, operation with legacy PV inverters can be considered for grid-tied applications with less frequent outages.

Installation Notes

AC Breaker Requirement

Each PV inverter that is connected to the AC Output (load) of the Conext XW+ requires its own AC breaker. Although there is room to add breakers for the PV inverters directly into the Conext XW+ Power Distribution Panel, it is easier to install the breakers for AC coupled PV inverters in the critical load panel. If installing the PV inverter breakers in the Power Distribution Panel, refer to the *Conext XW+ Installation Guide (document part number: 975-0239-01-01)*. The sub-panel may also contain load breakers.

To install an AC-Coupled system:

1. Install one or more battery inverters according to the procedures outlined in their respective Installation Guides.
2. Install one or more PV inverters according to their Installation Guides, with the following exception: instead of connecting the PV inverter's AC output to the main AC panel, connect it to the Conext XW+ AC critical load panel.

Configuration Settings

NOTICE
RISK OF BATTERY DAMAGE Ensure that the AC Coupling feature is enabled on the battery inverters. If disabled, the battery may be exposed to overcharging. **Failure to follow these instructions can result in battery damage.**

Conext XW+ Configuration Settings

Note: For Conext XW+ configuration settings, see the *Conext XW+ Owner's Guide (document part number: 975-0240-01-01).*

Verify that AC Coupling (`AC_COUPLING`) is enabled. The default is Disabled.

- Using the System Control Panel (SCP):
  - On the Conext XW+ device screen, go to **Advanced Features** > **Adv Features** > **AC_COUPLING [Enabled]**.
  - In AC Coupling, the Conext XW+ maximum battery charge current is 140Adc (nonadjustable). The Max Chge Rate parameter is only used to regulate the charge from the AC1 and AC2 ports.
  - Fstop is hard coded to 52/62. If operating in an off-grid application or if permitted by the utility, set the PV inverter upper frequency limit for zero power to less than 52/62 and adjust the high frequency anti-islanding limits to 53/63 or less. The Conext XW+ will bump frequency to 54/64 if V_{batt} is greater than V_{bulk} + 4V.

Table 1 Conext XW+ AC Coupling Configuration Settings

Mode	Recommended Setting
Search	Disabled
Grid Support	Enabled[1]
Grid Sell	Disabled[2]
AC Coupling[3]	Enabled

Conext SW Configuration Settings

Note: For Conext SW configuration settings, see the *Conext SW Installation Guides (document part numbers: 975-0636-01-01, 975-0638-01-01)*.

Verify that AC Coupling (`AcCouple`) is enabled. The default is Disabled.

[1] For grid-connected systems.

[2] For off-grid system with an AC generator.

[3] AC Coupling feature must be set only on the Conext XW+ and Conext SW. It can be found in the Conext XW+ and SW Advanced Features menu.

- Using the SCP, on the Conext SW device screen, go to **Advanced Features > Adv Features > AcCouple [Enabled]**.

Table 2 Conext SW AC Coupling Configuration Settings

Mode	Recommended Setting
Search	Disabled
AC Support	Enabled[1]
AC Coupling[3]	Enabled

Note: For PV inverters and grid code settings that only allow partial curtailment, there is a possibility of PV inverter cycling at the end of the absorption charge cycle. If this occurs, the Conext XW+/SW Absorb Time limit can be reduced to trigger an earlier transition to Float, where the PV inverters will remain disconnected until the batteries need to be re-charged (triggered by the `ReCharge Volts` parameter).

NOTICE
RISK OF EQUIPMENT DAMAGE For PV inverters and grid code settings that only allow partial curtailment, reduce the Conext XW+/SW Absorb Time limit. **Failure to follow these instructions can result in battery damage.**

When setting the frequency, use the same start frequency as the PV inverter (i.e. 50.2 or 60.2 Hz). Then set the maximum frequency 0.1 Hz lower than the frequency corresponding to zero power production on the PV inverter. In this example, the setting would be 51.2 or 61.2 Hz.

To access off-grid mode, see the respective product manuals for the PV Inverters. Example inverter PV settings:

- Set the frequency for start of power reduction. We recommend using VDEAR-N 4105 default for start (50.2 Hz), but any other setting can be used. For 60 Hz systems, use 60.2 Hz.
- Set the frequency when PV inverter power output will be zero. We suggest at least 1 Hz higher, 51.2 (or 61.2) Hz.
- Set the high frequency disconnect on the PV inverter about 0.3 Hz higher or 51.5 (or 61.5) Hz.

For further assistance, contact Schneider Electric technical support at solar.schneider-electric.com.

Exclusion for Documentation

UNLESS SPECIFICALLY AGREED TO IN WRITING, SELLER

(A) MAKES NO WARRANTY AS TO THE ACCURACY, SUFFICIENCY OR SUITABILITY OF ANY TECHNICAL OR OTHER INFORMATION PROVIDED IN ITS MANUALS OR OTHER DOCUMENTATION;

(B) ASSUMES NO RESPONSIBILITY OR LIABILITY FOR LOSSES, DAMAGES, COSTS OR EXPENSES, WHETHER SPECIAL, DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL, WHICH MIGHT ARISE OUT OF THE USE OF SUCH INFORMATION. THE USE OF ANY SUCH INFORMATION WILL BE ENTIRELY AT THE USER'S RISK; AND

(C) REMINDS YOU THAT IF THIS MANUAL IS IN ANY LANGUAGE OTHER THAN ENGLISH, ALTHOUGH STEPS HAVE BEEN TAKEN TO MAINTAIN THE ACCURACY OF THE TRANSLATION, THE ACCURACY CANNOT BE GUARANTEED. APPROVED CONTENT IS CONTAINED WITH THE ENGLISH LANGUAGE VERSION WHICH IS POSTED AT http://solar.schneider-electric.com/.

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Contact Information

For country-specific details, please contact your local Schneider Electric Sales Representative or visit the Schneider Electric Solar Business website at: http://solar.schneider-electric.com/