XW Pro AC Coupling Solutions Guide

990-6421

December 2020

Exclusion for Documentation

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Safety Information

Important Information

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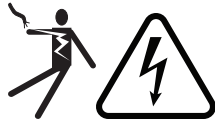
The addition of either symbol to a "Danger" or "Warning" safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

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.

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*.

Audience

This guide is intended for use by qualified personnel who plan to design an AC coupled installation using XW Pro battery inverters and PV inverters.

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

- Installing electrical equipment.

- Applying all applicable installation codes.

- Analyzing and reducing the hazards involved in performing electrical work.

- Installing and configuring batteries.

- 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 XW Pro battery inverters and PV inverters.

The qualified personnel must refer to *XW Pro Installation Guide (document number 990-91228 or 990-91403)* for full safety information.

⚡ ⚠ 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 XW Pro inverter/charger. 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.

About

Purpose

This Solutions Guide provides planning information and safety guidelines for designing an AC-coupled system beyond what is available in the Installation and Owner's guides.

Scope

This Solutions Guide applies to XW Pro battery inverters and compatible Schneider Electric or 3rd party PV inverters.

The information provided below does not modify, replace or waive any of the terms and conditions mentioned in the Installation and Owner's guides, including but not limited to the limited warranty.

This document also specifies typical XW Pro and PV inverter settings but the user must also consult the PV inverter manufacturer.

Related Documents

- *XW Pro Li-Ion Battery Solution Guide (document number 990-6359)*
- *XW Pro Installation Guide (document number 990-91228 or 990-91403)*
- XW Pro Multi-unit Design Guide (990-91373)

Contents

This manual is intended for use by qualified personnel

1 Introduction

What's in This Chapter?

Prerequisites

It is recommended to upgrade to the latest XW Pro and Conext Gateway firmware before configuring the equipment. Consult Conext Gateway Owner's Guide (975-0806-01-03) and XW Pro Owner's Guide (document number 990-91227 or 990-91402) for firmware upgrade instructions. 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 have an external battery management system (BMS).

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

Overview

When a PV inverter is connected to the AC output of a battery 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 and/or battery energy to the loads.

Figure 1 AC-Coupled System Diagram
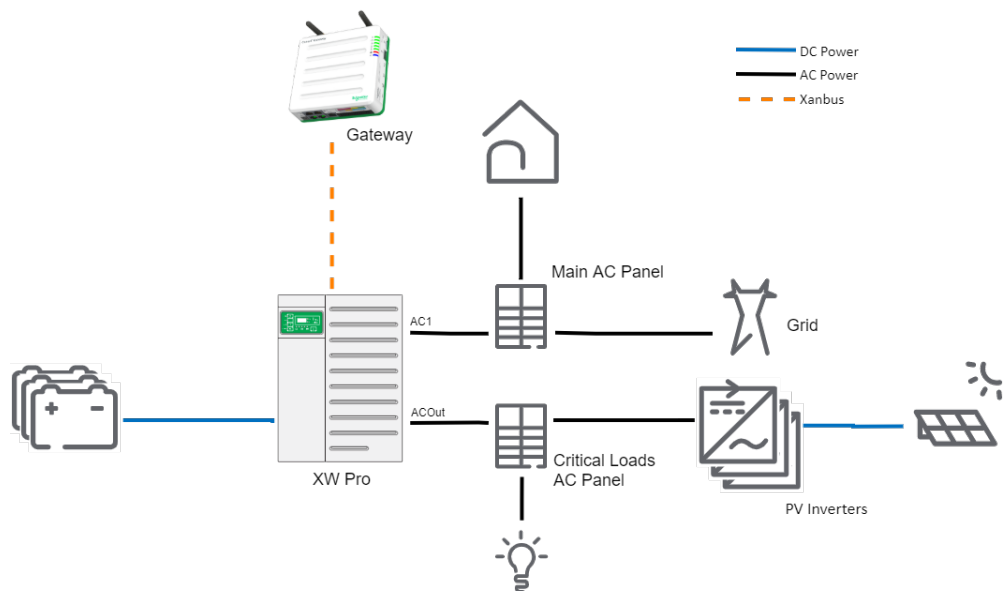
An example of AC Coupling with the XW Pro is shown in *Figure 1*. The PV system is connected to the grid through the internal relay located on the AC bus inside the XW Pro inverter. This allows power to be produced and supplied or "sold" back to the grid if it exceeds the power consumed by the critical loads. When the grid goes out of limits, the

XW Pro switches to back-up and powers the critical load panel to support the loads. Thus, the XW Pro forms the grid to keep the PV inverters operating. The XW Pro 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 then reconnect after re-qualifying the grid formed by the XW Pro, according to its settings.

Surplus Power in Off-Grid/Backup Modes

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 Off-Grid/Back-Up Mode and Surplus Power
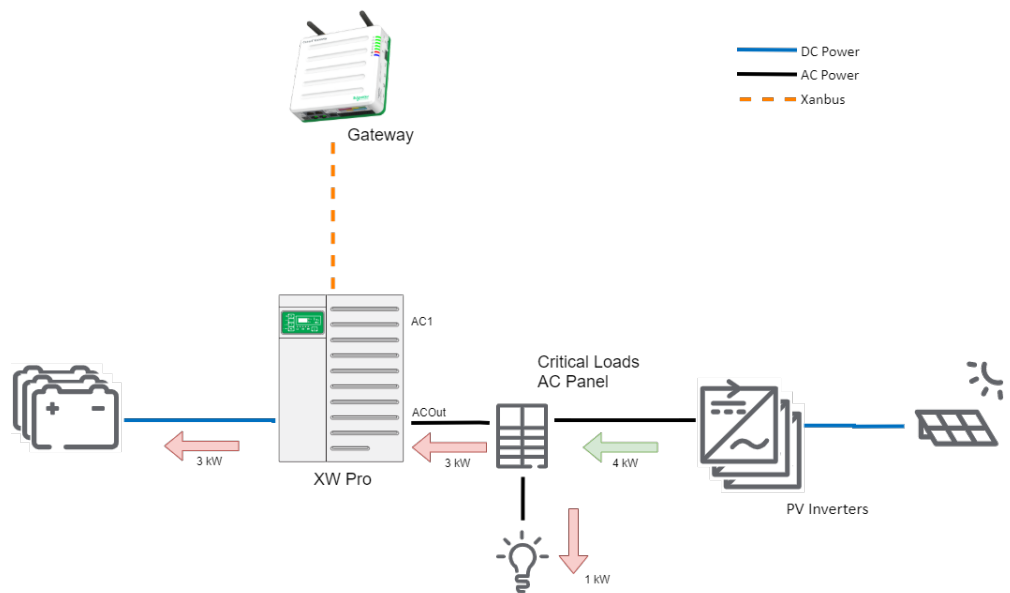
If there is more power being generated than can be consumed by the loads, the surplus power will flow to the XW Pro and will be converted to DC power which flows into the battery. Once the battery approaches full charge, power generation by the PV inverter must be curtailed to maintain the balance between generation and consumption. As the battery bank approaches full charge or its charge voltage, charge SOC, or current limits, XW Pro 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.

2 Planning and Installation

What's in This Chapter?

Supported Architectures

XW Pro 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 *"Operation with Legacy PV Inverters" on page 14* for more details).

Figure 3 and *Figure 4* show two supported AC-coupling architectures by XW Pro battery inverter:

- Critical loads are connected on the AC Out side of the XW Pro output (without external contactor)

- Critical loads are connected on the AC1 side of the XW Pro output (with external contactor)

For systems using Li-ion batteries, it is recommended to operate the XW Pro with `State of Charge Control` enabled for enhanced AC coupling performance and DC voltage regulation at high SOC. `State of Charge Control` can be used when a Conext Battery Monitor or a compatible battery listed in the *XW Pro Li-Ion Battery Solution Guide (document number 990-6359)* is connected to the system.

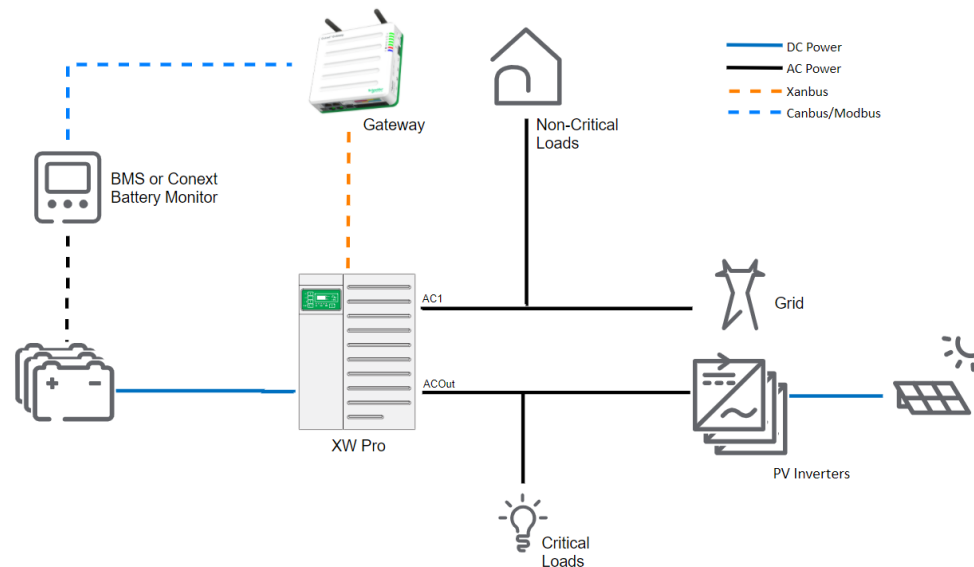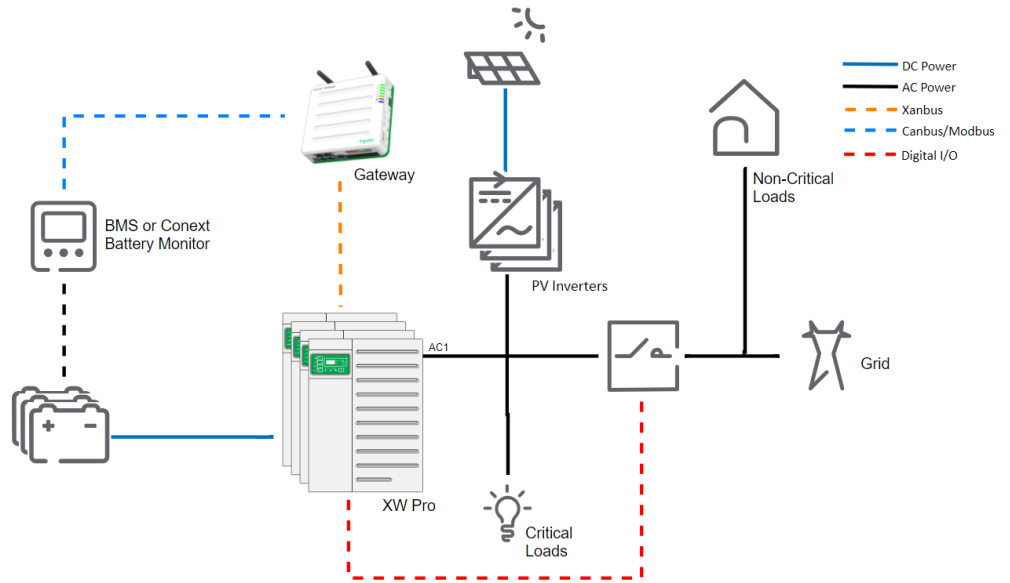*Figure 3 AC-coupled system without external contactor*

Figure 4 AC-coupled system with external contactor

Sizing

The XW Pro can be connected in various configurations from just a single unit to multiple units in parallel, or in a three-phase configuration. Regardless of the system configuration however, the maximum continuous allowable rating of AC-coupled PV inverter(s) is the lesser of:

- 125% of maximum allowable charge power of the battery (calculated as rated continuous charge current times rated charge voltage).

- 125% of continuous rating of XW Pro inverter(s).

For example, if battery inverter is rated for 6.8 kW of continuous power at 40°C and battery pack is rated for 3.75 kW at 40°C, then the PV inverter must be no more than 125% of lesser of two which is 4.68 kW at 40°C.

In three phase configurations utilizing XW Pro battery inverters, it is recommended to use three-phase PV inverters, such as the Schneider Electric CL series, in order to provide balanced power on the three phases.

AC Coupling with a Generator

| NOTICE |
| --- |
| **RISK OF DAMAGE TO THE GENERATOR OR PV INVERTER** |
| In an AC-coupled system, never connect a generator to the AC2 (GEN) port of XW Pro without an interlocked contactor to prevent parallel operation of the generator and PV inverters. XW Pro will not be able to regulate power being pushed by PV inverters into the AC2 (GEN) port and may backfeed AC power into the generator. |
| **Failure to follow these instructions can result in equipment damage.** |

While running a generator in an AC-coupled system, the generator provides AC power to XW Pro and PV inverters. The PV inverter detects this (it recognizes the generator as

regular grid) and begins to inject power into the system. However, generators are not designed to accept backfed power, so the concurrent operation of the AC source and PV inverters must be disallowed. While the generator is running, the PV inverter must be disconnected from the circuit and therefore PV harvest is only possible when the generator is not running and XW Pro is grid-forming. This can be done with an interlocked contactor whose coil is driven by the generator output. Normally-open contacts are placed between the generator output and the AC2 (GEN) port of the XW Pro, and normally-closed contacts placed between the PV inverters and the load panel.

Figure 5 AC-coupled system with a generator
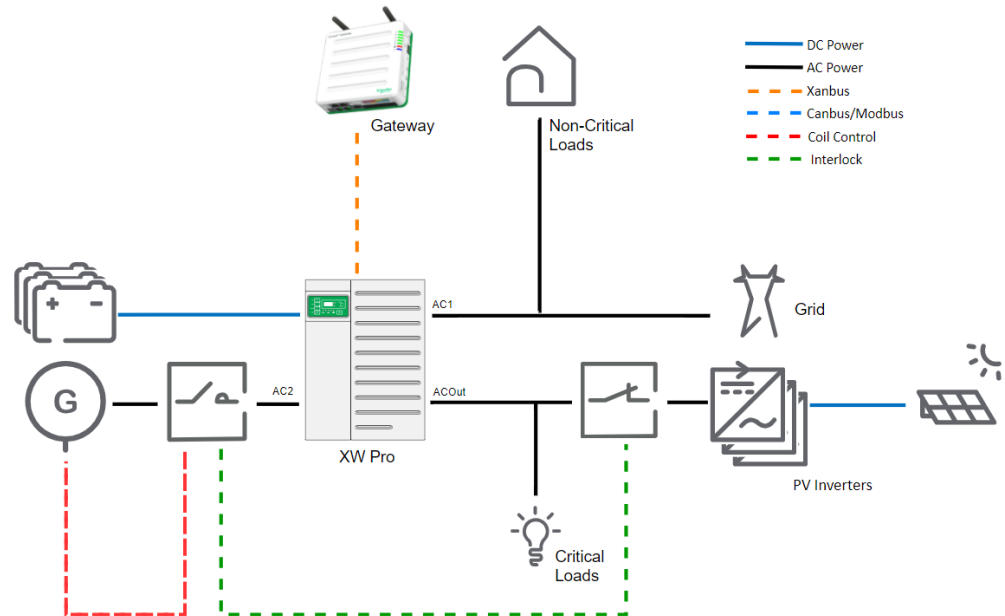
Recommended contactor part number is LC1D188G7.

Note: The power metering on the XW Pro may not work as expected when it is in grid forming (invert mode) and power is flowing back into the batteries.

Operation with Legacy PV Inverters

For AC-coupled systems with legacy PV inverters without frequency-watt capability, the battery inverter will have reduced ability to regulate the battery charge. When surplus power from AC-coupled PV charges the batteries and the battery parameters (voltage, current or SOC) reach limits, the battery inverter frequency is ramped up and the PV inverter will cease producing power and disconnect. When the battery parameter which caused frequency shift drops below the limit due to loss of PV charge 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 `Absorbtion 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.

Installing

Each PV inverter requires its own AC breaker in the panel to which it is connected. Although there is room to add breakers for the PV inverters directly into the XW Pro Power Distribution Panel, it is easier to install the breakers in the AC sub panel. These breakers must be installed according to the *XW Pro Installation Guide (document number 990-91228 or 990-91403)*. The sub-panel may also contain load breakers.

To install an AC-coupled system:

1. Install one or more XW Pro inverters according to its Installation Guide.

2. Install one or more PV inverters according to their Installation Guides, and connected to the panel that is backed up by the XW Pro battery inverters.

Recommended Settings

NOTICE
RISK OF DAMAGE TO THE BATTERY OR BATTERY INVERTER
Always follow the recommended settings described below. The battery and the XW Pro may be subject to DC over-voltage and/or over-current events in backup power or off-grid operation. The below settings aim to achieve maximum system stability.
Failure to follow these instructions can result in equipment damage.

The XW Pro AC coupling controls may temporarily disconnect the PV inverters, as needed, based on battery state of charge, voltage, and the amount of power coming from the PV system.

Table 1 Battery inverter settings

| Setting	Value	Notes
`AC Coupling`	Enabled	Enables frequency-shifting mechanism in the battery inverter.
`AC PV Charge SOC`	90%	Recommended. Threshold for SOC-based frequency shifting. Increased PV curtailment at high SOC helps regulate the battery voltage and charge within the target range.
`SOC Control`	Enabled	Recommended. This requires external BMS or Conext Battery Monitor.
`Grid Code`	The battery inverter grid code must be set according to local utility interconnect requirements.	Ensure that grid code settings match the PV inverter. For advanced off-grid configuration refer to *"Off-Grid Operation" on the next page*. For advanced grid code configuration or troubleshooting see *"Troubleshooting" on page 1*.

Table 2 PV inverter settings

Setting	Value	Notes
`Grid Code`	The battery inverter grid code must be set according to local utility interconnect requirements.	Ensure that grid code settings match the PV inverter. For advanced off-grid configuration refer to *"Off-Grid Operation" below*. For advanced grid code configuration or troubleshooting see *"Troubleshooting" on page 1*.

Off-Grid Operation

For off-grid operation (with or without a generator), as a first option, both the battery and PV inverters are recommended to be set to the same grid code. For example for 60Hz, the recommended grid code is Rule 21 and for 50Hz - Australia AS4777. The battery's inverter frequency-shifting settings are auto-configured to match the grid code and, consequently, the PV inverter's P(f) settings.

As a second option, when it is not possible to set the battery and PV inverter to the same grid code, it is recommended to disable `Freq-Watt P(f) Droop` and `Freq-Watt P (f) PreDist` on the battery inverter (*Figure 6*) in `Grid Codes` settings. The smart AC-coupled PV inverter's P(f) curve should be set to start active power reduction at nominal frequency 50/60 Hz and finish it (fully reduce to zero) at 54/64 Hz. This is what the battery inverter frequency shift is configured to in case when grid code P(f) is not activated on it.

Figure 6 Disabling grid code frequency shifting in Conext Gateway GUI
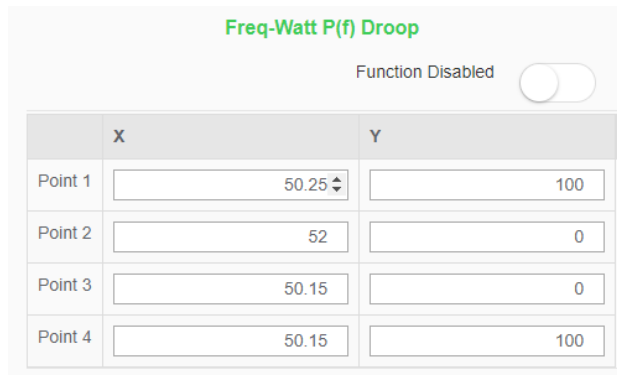
Legacy PV inverters without frequency-watt function must be set so that they trip instantly once frequency is approaching 54/64 Hz.