AC Coupling of Inverters for Grid Tied PV Systems

Application Note

AC Coupling with Conext™ XW Inverter/Chargers, Xantrex™ GT Inverters, and Conext TX Inverters

976-0240-01-01 Rev B

⚠ DANGER

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

This Application Note is in addition to, and incorporates by reference, the relevant product manuals for each product in the Schneider Electric Conext XW series of inverter/chargers, Xantrex GT series of single-phase inverters, and Conext TX series of single-phase inverters. Before reviewing this Application Note 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.

This Application Note outlines how Conext XW inverter/chargers, Xantrex GT single-phase inverters, and Conext TX single-phase inverters (Conext XW, Xantrex GT, and Conext TX inverters) can be interconnected or 'AC coupled' to form an AC grid while in stand-alone mode.

This Application Note contains the following sections:

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Scope

This Application Note provides safety guidelines as well as planning and setup information. It provides procedures for forming an AC grid. For information on particular brands of photovoltaic (PV) panels, consult your PV manufacturer.

Audience

This Application Note is intended for qualified installers. To design and install a system that will operate correctly, qualified installers must have training and experience in solar power systems to safely and correctly follow these instructions and the applicable electrical and building codes. Qualified installers must have an awareness of the hazards involved in performing electrical installation work and how to reduce those hazards.

⚠ DANGER

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

- Conext XW inverter/chargers and Xantrex GT/Conext TX inverters contain no user-serviceable parts. Attempting to service the inverters yourself may result in a risk of electrical shock or fire and may void your warranty. Internal capacitors remain charged after all power is disconnected.
- Only qualified personnel should perform the instructions contained in this Application Note.
- To reduce the risk of electrical shock, qualified installers must disconnect both AC and DC power from Conext XW inverter/chargers and Xantrex GT/Conext TX inverters before attempting any maintenance or cleaning or working on any circuits connected to them.
- Putting the inverter in Standby mode does not reduce the risk of electric shock.

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

Introduction

An AC-centric, or AC-coupled system, is one where all the energy sources and loads are connected directly to the AC bus. The benefits of an AC-centric system over a DC-centric (DC-coupled) system are:

- Low voltage high current DC connections are kept to a minimum by using AC power coupling. Thus, installation is easier and less expensive, due to the reduced number of large DC wired connections.

- Improved array-to-grid efficiency due to the removal of a conversion step. In an AC-centric system, the array is connected to the grid through a grid-tie inverter: DC (array) -->Inverter -->AC (grid). In a DC-coupled system, the array is connected to the battery bank through a charge controller, which is then connected to the grid through an inverter/charger: DC (array) --> Charge Controller --> DC (battery) -->Inverter --> AC (grid).
- Improved array-to-load efficiency if demand occurs at the same time as solar production.

The weaknesses of an AC-coupled system over a DC-coupled system are:

- Lower array-to-load efficiency if demand does not occur at the same time as solar production necessitating that energy is stored in the battery for later use. When using energy which was first stored in the battery the conversion steps are: array --> charge controller --> energy stored in battery --> energy taken out of battery --> inverter --> AC loads.
- Grid-tie string inverters are generally more expensive than solar charge controllers.

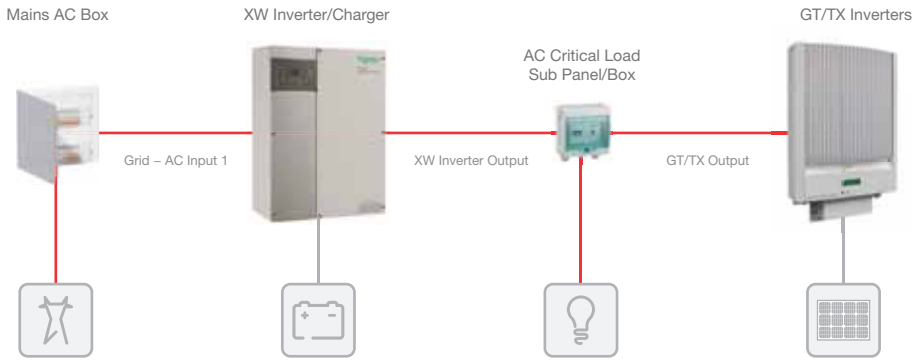

Figure 1 AC coupled diagram

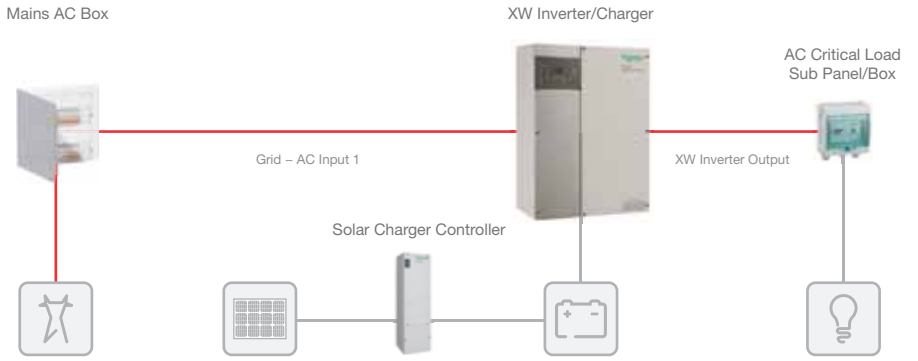

Figure 2 DC coupled diagram

Operation While Grid Connected

On each of its two bi-directional AC input ports, the Conext XW is equipped with a relay that closes only when the AC source is qualified (within the user-adjustable range). Closing the relay connects the AC source directly to the AC output terminals of the Conext XW. In this pass-through mode, the Conext XW stays in charge mode and charges the battery bank. If the grid voltage and frequency are within limits, then-after a five minute delay-the Xantrex GT/Conext TX PV string inverter will harvest the solar energy from the array. This energy will be consumed by the AC loads and used by the Conext XW to charge the battery, following the normal three-stage charging process. Any excess energy will be exported to the grid (either through the Conext XW or through a separate transfer switch and Feed-in meter connection, depending on the applicable regulations within the jurisdiction where the system is installed).

The Conext XW continuously monitors the AC input voltage and frequency. If the voltage or frequency move beyond the acceptable ranges-for example, during a power surge or outage-the Conext XW opens its relay, disconnecting both the Conext XW inverter/charger and the Xantrex GT/Conext TX inverter from the grid and forcing them to stop exporting energy to the utility grid. As soon as the relay opens, the Conext XW transfers from charge mode to invert mode to provide backup power to the critical loads. The Xantrex GT/Conext TX may detect the temporary loss of AC during this transfer and stop harvesting until it detects a stable AC voltage for a minimum of five minutes.

NOTE: Before enabling the "SELL" feature on the Conext XW or on the Xantrex GT/Conext TX, consult with the electric utility company or electrical inspector for the jurisdiction to obtain a written authorization.

During utility outages or instability, the system meets all anti-islanding requirements and becomes a stand-alone system by detaching from the grid.

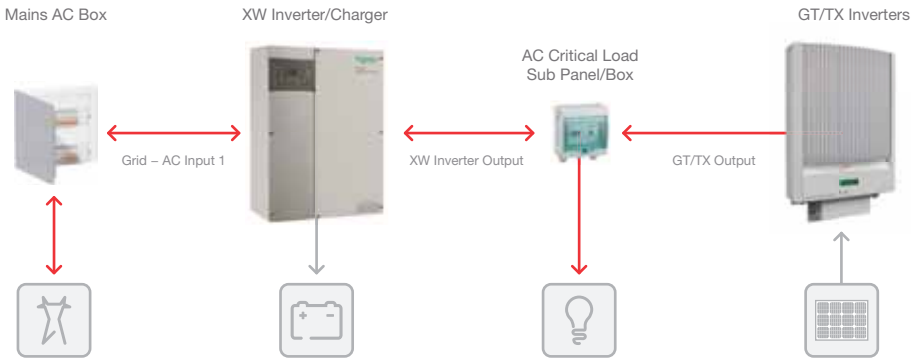

Figure 3 Power flow while grid-connected

Operation While Not Grid-connected

When the utility grid is not present and the Conext XW is inverting, it acts as an AC voltage source, forming a local stand-alone AC grid by providing tightly controlled voltage and frequency. The Xantrex GT/Conext TX and AC loads are 'coupled' to this AC voltage through the installed sub-panel. The Xantrex GT/Conext TX will qualify and connect to the AC voltage provided by the Conext XW just like it would the utility grid.

When the Conext XW is in invert mode, AC electrical current is free to flow in either direction. This means if the Xantrex GT/Conext TX is providing more power on the AC bus than the loads can consume, current will flow back in through the Conext XW invert output connection and charge the battery bank.

Unlike its normal three-stage behavior when charging from utility grid, the Conext XW does not tightly regulate charging in a three-stage process when power is back fed through AC inverter output connection to the battery. In this mode charging is a single-stage process, and the absorption charge and float stage are not supported. Charging is terminated when the battery voltage reaches the bulk voltage settings, which prevents overcharging of the batteries. Repeated charging of lead acid batteries in this way is not ideal and could shorten their useful lifetime.

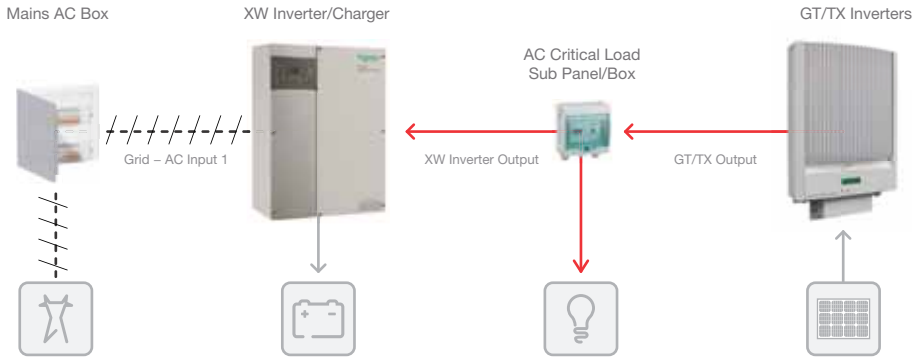

Figure 4 Power flow while not grid-connected

Limitations

The Conext XW is only recommended for use with grid-tie AC-coupled systems.

The rated power of Xantrex GT/Conext TX inverter should not exceed the rated power of the Conext XW inverter/charger, and it must match the phase configuration. If the Xantrex GT/Conext TX does exceed the rated power of the Conext XW the Conext XW may repeatedly shut down due to overload or phase configuration issue and each shut down will require a manual restart of both the Xantrex GT/Conext TX and Conext XW.

The Conext XW is not recommended for, nor can we provide advice for, AC-coupling in completely off-grid installations, due to its reduced ability to charge batteries (see “Operation While Not Grid-connected” on page 5). Additionally, battery suppliers may not fully warranty their batteries which have repeatedly been charged in this manner.

The power metering on the Conext XW may not work properly when the inverter/charger is acting as the grid forming voltage source and power is flowing back into the batteries.

Conext XW AC Coupling Firmware

NOTICE

HAZARD OF BATTERY OVERCHARGING AND DAMAGE

Use the Conext XW only with firmware which has the AC coupling feature implemented. Use the firmware version (or higher) listed in Table 1 for your model.

Failure to follow these instructions may cause equipment damage.

AC coupling with earlier firmware versions is not supported. For firmware upgrade instructions, see the Conext XW Config User's Guide (document part number: 975-0365-01-01) available on the Schneider Electric website.

Table 1 Firmware versions and part numbers

Model	Firmware Version	Firmware Part Number[a]
XW6048 120/240 60	1.05	150-0175-01-05
XW4548 120/240 60	1.04	150-0176-01-04
XW4024 120/240 60	1.07	150-0177-01-07
XW6048 230 50	1.07	150-0218-01-07
XW4548 230 50	1.07	150-0219-01-07
XW4024 230 50	1.07	150-0220-01-07

a.The last two fields are the same as the firmware revision, Make sure your firmware’s part number matches or is higher than what is listed in the table (based on the last two fields).

The firmware with the AC coupling feature is a power control program that varies the Conext XW output line frequency causing the grid-tie inverters to cease producing power, thereby protecting the battery from being overcharged and also preventing the over supply of power to the local stand-alone grid.

While the Conext XW and Xantrex GT/Conext TX are AC coupled, the Conext XW changes the frequency only when the battery voltage reaches the Bulk Voltage setting. Note: The Bulk Voltage setting is user-adjustable in Custom battery set up menu.

The internal maximum frequency adjustment range when the Bulk Voltage setting is exceeded is:

- North American models: fLINE=[60-55]Hz
- European models: fLINE=[50-45]Hz

Figure 5 shows the effect of the frequency generation function when the Conext XW changes the grid frequency with a rate of change of 0.4Hz/s.

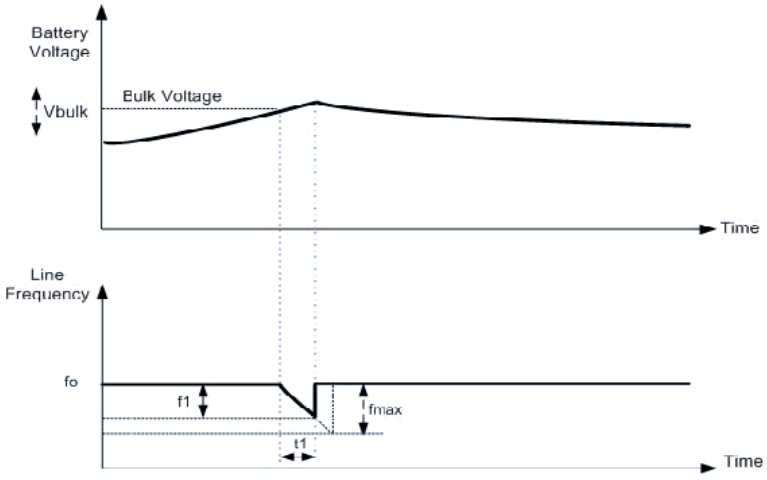

Figure 5 Results in stand-alone mode[a]

a.The Conext XW decreases the grid frequency at a rate of 0.4 Hz/s when the DC exceeds the *Vbulk* setpoint limit. The change in frequency will quickly take the Xantrex GT/Conext TX off-line ceasing AC current generation. This will cause battery charging to stop.
b) *fo* is the nominal line frequency at 60 Hz or 50 Hz.
c) If *fo* is 60 Hz: *fmax* = 5 Hz.
d) If *fo* is 50 Hz: *fmax* = 5 Hz.
e) *Vbulk* setpoint = [50...64]V.

Installation in Single-Phase System

Each Xantrex GT/Conext TX requires its own AC breaker in the critical load sub-panel that is connected to the AC load (output) of the Conext XW. Although there is room to add breakers for the Xantrex GT/Conext TX inverters directly into the Conext XW Power Distribution Panel (XW PDP), it is easier to install the Xantrex GT/Conext TX breakers in the AC sub-panel. These breakers must be installed according to the installation guide for the Conext XW inverters. This sub-panel may also contain load breakers. (See Figure 1 for reference).

Install one or more Conext XW inverters according to the procedures outlined in the Conext XW Power System Installation Guide (document part number 975-0239-01-01).

Key Settings for Conext XW Installation

Search Disabled

Grid Sell Enabled

Grid Support Enabled

For all other settings, see the Conext XW Power System Installation Guide (document part number: 975-0239-01-01) and the Conext XW Series Hybrid Inverter/Charger Operation Guide (document part number: 975-0240-01-01).

Installation with a Generator

To prevent the generator from being back fed power from the Xantrex GT/Conext TX inverter an 'either-or' interlocked switch can be installed between the generator output and the AC2 (gen) input.

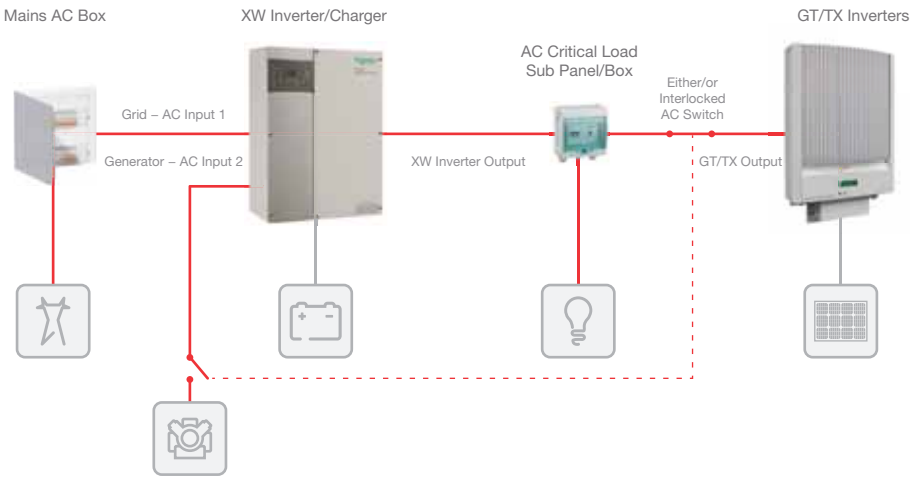

Figure 6 Installation of AC-coupled system with a generator

Installation in a Renewable Feed-In-Tariff (FIT) System

If a Xantrex GT/Conext TX system is connected to the grid according to a FIT program, then it can be converted to an AC backup system by using a Conext XW and an AC transfer switch. The output from the Xantrex GT/Conext TX is connected to the common point on the AC transfer switch. The normally closed contacts are wired to the sub panel of the Conext XW. The normally open contacts are wired to the utility grid supply.

- Use an AC transfer switch with an AC coil type energized from utility grid line-to-neutral voltage.

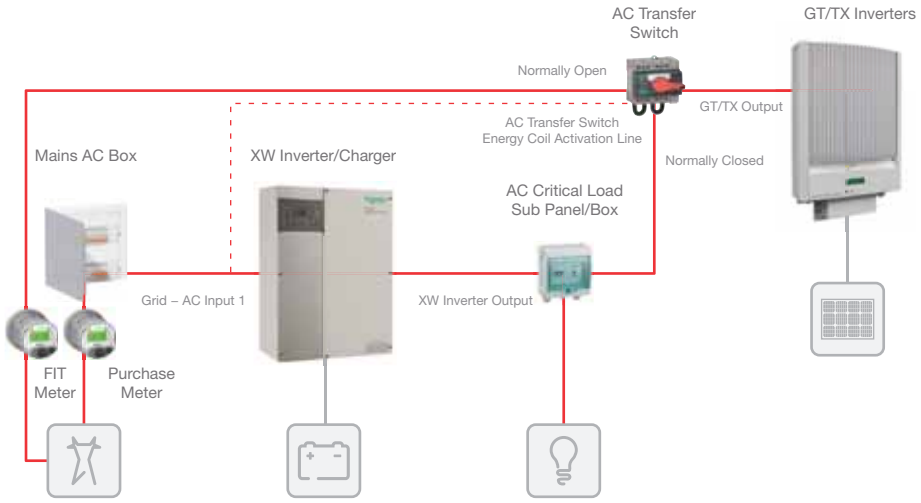

Figure 7 Installation in a renewable feed-in tariff system

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