AC Coupling with Xtender

General description

AC Coupling is a term used to describe systems that combine standard grid tie inverters (usually feeding all energy produced to grid) and battery based inverters (usually for off-grid or backup applications).

AC coupling can be used in different ways depending on the application and the purpose that you are looking for.

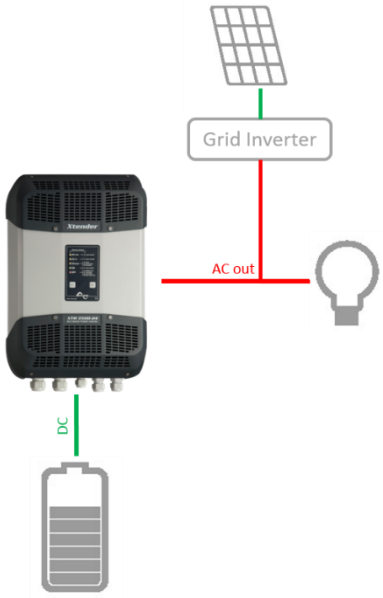
Features & advantages

- Direct use of renewable energy without cycling energy in the battery(-ies) to avoid their premature aging if used during the day.
- Ideal for long distances between production and storage.
- Compatible with all grid inverter brands (if no control of impedance).

Minimal configuration

- **Range of battery inverters**
  - *XTM 3500-24 or bigger (12V not allowed)*
- **Xtender**
  - *Software vers. : 1.5.xx and higher*
- **RCC-02/-03**
  - *Software vers. : 1.5.xx and higher*
  - *RCC User level : EXPERT*

Application schematic



(Figure 1) AC Coupling with Xtender and all brands of grid inverters

Detailed description

Description

AC Coupling is a term used to describe systems that combine standard grid tie inverters (usually feeding all energy produced to grid) and battery based inverters (usually for off-grid or backup applications).

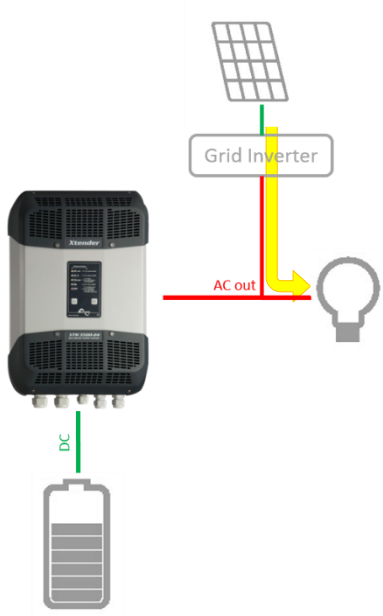
AC coupling can be used in different ways depending on the application and the purpose that you are looking for. This document describes off-grid applications using both inverters alone or with a generator.

AC coupling can also be used in systems connected to the public grid for self-consumption, for example, but that will be described in another document.

How it works

The AC Coupling system allows the grid inverter to remain working even when there is no grid. The Xtender is a voltage source when it works as inverter, converting power from DC to AC. Therefore, it supplies the voltage and frequency for the grid inverter to continue working, thinking it is still connected to a grid.

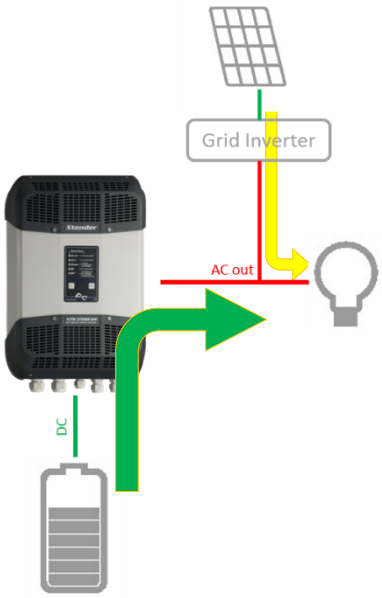
When the solar generator produces energy, the grid inverter pushes that current to the AC bus created by the battery inverter. If there are loads connected on the AC bus that can consume all the production, the energy consumed by the load has the best conversion efficiency. That energy directly consumed will leave the Xtender without the need to supply current from the battery.



(Figure 2) Same production as consumption

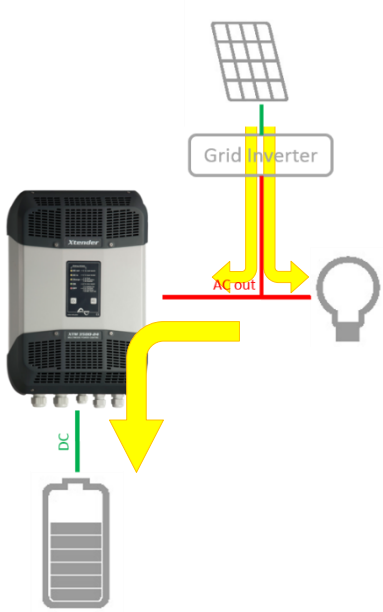
When the solar generator produces less energy than the consumer needs, it is the Xtender which supplies the energy difference from the battery. In this situation, the Xtender's power must be sufficient to supply the load requirement, even if the solar generator suddenly stops to produce (e.g. when clouds appear). Another problematic situation is if the battery is fully discharged. At this moment, the Xtender will switch off by low voltage and this will cause the load to stop, but also the grid inverter to stop. Since the grid inverter needs a grid to work, even if there is sun, the grid inverter will be stopped as well.

Therefore it is recommended to keep part of the PV production through a DC solar charge controller (i.e. VarioTrack/VarioString) in order for them to charge the battery, restart automatically the Xtender and subsequently the complete system.



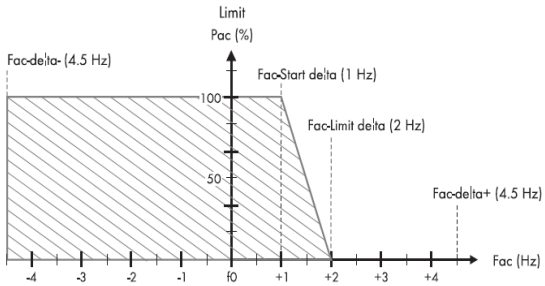
(Figure 3) Less production than consumption

When the solar generator produces more energy than the consumer needs, the excess energy produced will go to the Xtender and therefore to the battery. While the current required to maintain the battery charging cycle is not reached, the Xtender will not change the output voltage and frequency. However, in order to protect the battery from being over charged, there is the need to control the production or, in other words, to force a reduction on the production side.



(Figure 4) More production than consumption

This can be achieved by the Xtender changing its output frequency. The grid inverter works within a limited range of voltage and frequency. If the Xtender changes those values, the grid inverter will reduce its production or stop depending on its internal settings. Today a large number of manufacturers have included "frequency shift" behaviour on their grid inverters.



(Figure 5) Frequency shift behaviour from SMA

This allows the grid inverters to reduce their power output depending on the grid frequency. This functionality is perfectly adapted for off-grid situations where the production has to be controlled and limited in order to fit with the energy needs in the system. The Xtender can therefore control the produced energy by increasing the frequency when the battery is getting fully charged.

It can do this in two ways:

- Linear frequency shift: parameter {1549}
- Step-wise frequency change: parameter {1536}

You can see their complete description in the RCC manual in chapters 14.9.6 and 14.9.7.

Another solution to avoid overcharging the battery is to disconnect the grid inverter with an external control system. In that case, the Xtender has to allow the current to flow from AC-Out to the battery, but it will not be responsible for the security of the system. This can be achieved by adjusting the parameter {1438} Solsafe presence to Yes.

To summarize you have 3 possibilities to control the production in off-grid:

- {1549} linear frequency shift
- {1536} step-wise frequency shift
- {1438} external control

However, they must not be used at the same time. Only one of the above options can be activated in a given system.

Limits

Power limits

As per the system construction, there are some limits regarding power of grid inverter, battery inverter and battery capacity. The power connected by AC Coupling must be less than the Xtender nominal power. This is due to the fact that if there is full production and no consumption, all energy will pass through the Xtender. It has to be able to absorb that power and convert it to DC power. Continuing with that logic, the battery capacity must be big enough in order to absorb the corresponding DC current. The Xtender can change the frequency in order to reduce the production, but only if the battery voltage is near its charging step target (absorption, floating, etc.). But when the voltage is lower than this target, all the available power will go to the battery without limitation. As an example, if you have 5kW production and a 48V battery bank, the maximum charging current will be 5000/48= ~100A. Knowing that a lead battery should be charged with a current of 10 to 20% of its capacity, the minimum battery capacity would be around 500-1000Ah @48V.
Summary:

- AC Coupled power must be less than Xtender nominal power
- Battery capacity must be well dimensioned given the max allowable charge current of the battery bank

Xtender type limits

This AC Coupling functionality is available with Xtenders that are designed for 24 or 48V batteries and whose power is above 3kVA. It cannot be used with 12V systems or smaller units.
It is possible to have parallel and/or 3-phase systems with AC Coupling.

Summary:

- 12V Xtender models cannot be used
- Xtenders with less than 3kVA nominal power cannot be used

AC Coupling with uncontrolled AC sources

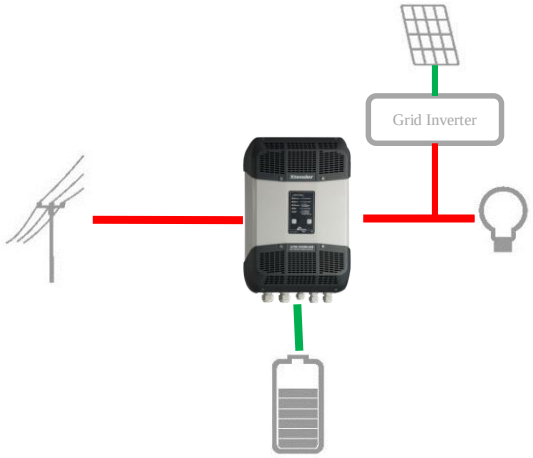
Of course, AC Coupling can be used in systems where there is an AC source such as the grid or generator. However, in this case the Xtender will have a different behaviour when the AC source is running. The above description is correct when the AC source is off or disconnected, but as soon as the AC source is present, the Xtender will not be able to change the frequency and therefore to control the power output of the grid inverter.

Grid on AC-In

When the grid is connected, the Xtender will synchronize with it and transfer its voltage and frequency to the loads. Therefore, the Xtender cannot control the direction the energy flows. When there is excess energy, this excess current will go to the Xtender node, where the current can go to the battery (if it needs charging) or to the grid (if the battery does not need it or if there is too much excess).

It is not possible to force the Xtender to charge the battery and avoid the current to go straight to the grid. Therefore, the system has to be allowed to feed back to the grid that excess energy. If not, you should disconnect the grid inverter when the grid is connected to the system.

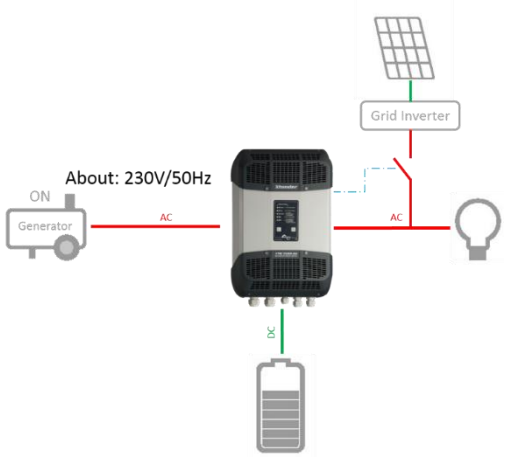
In any case, if you want to use a grid inverter having the mains on AC-In, the grid must be able to absorb all current produced by the grid-tie inverter. Therefore, the maximum AC-Input current limit that you adjust on the Xtender must be equal or greater than the current the grid inverter can deliver.



(Figure 6) AC Coupling with grid

Diesel/Gas generator

As per the grid situation, the generator is fixing the voltage and frequency. But in this case, if there is excess energy produced by the grid inverter while the generator is running, that excess current might damage the generator. In order to avoid that situation, you should disconnect the grid inverter when the generator is running. This can be done thanks to the AUX contact (check current and voltage limits of that relay in the Xtender manual). This relay can be adjusted in order to close or open depending on the transfer relay status. With that command it will be possible to pilot a bigger contactor that will connect or disconnect the grid inverter to the AC bus.



(Figure 7) AC Coupling with generator

The energy that will be lost while the grid inverter is not connected will not be so much. The reason is that normally the generator will only be used if the battery is discharged. If that happens it means the solar generation is not enough to supply the loads. Therefore even if the solar generator is disconnected, the energy that will be lost is not significant.

Settings to be controlled and modified if necessary

Ref	Parameter	Value
1536	Inverter frequency increase when battery full	No
1549	Inverter frequency increase according to battery voltage	Yes
1438	Solsafe presence Energy source at AC-Out side	No

All other parameters not directly concerning this application are still to be set under the responsibility of the installer.

Notes

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