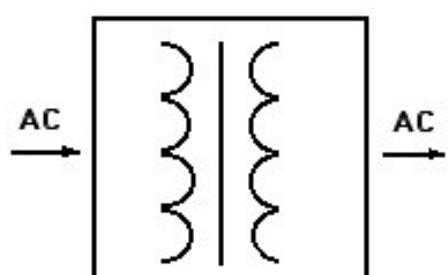


INVERTERS & INVERTER-CHARGERS FOR OFF-GRID SYSTEMS

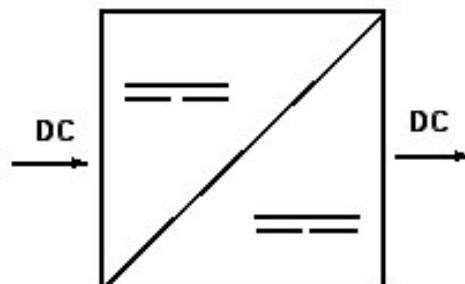
Inverters and inverter-chargers

- Types of voltage converters
- Inverter power ratings
- Other inverter characteristics
- Inverters-chargers
- Wiring
- Examples of inverters
- Examples of inverter-chargers

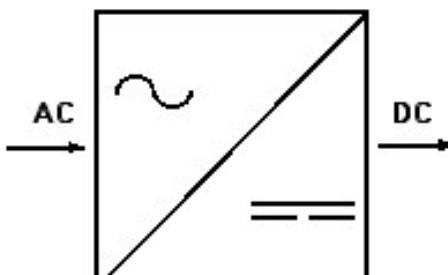
Main types of voltage converters



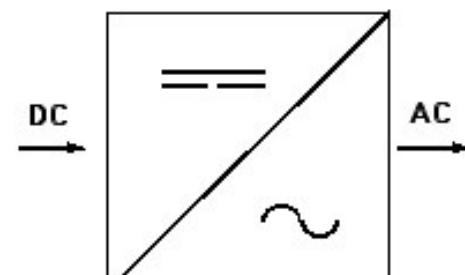
TRANSFORMER



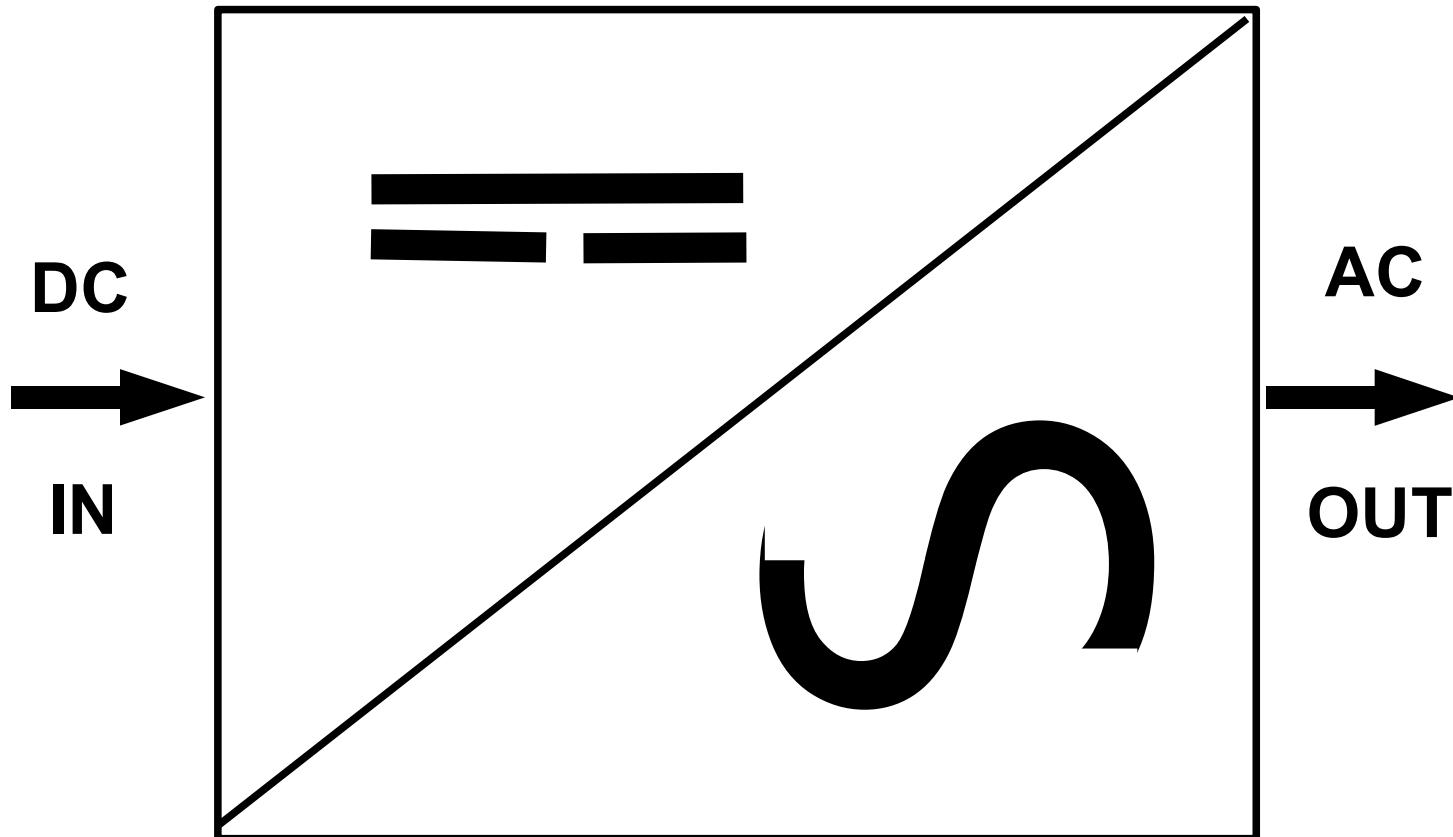
DC-DC VOLTAGE CONVERTER

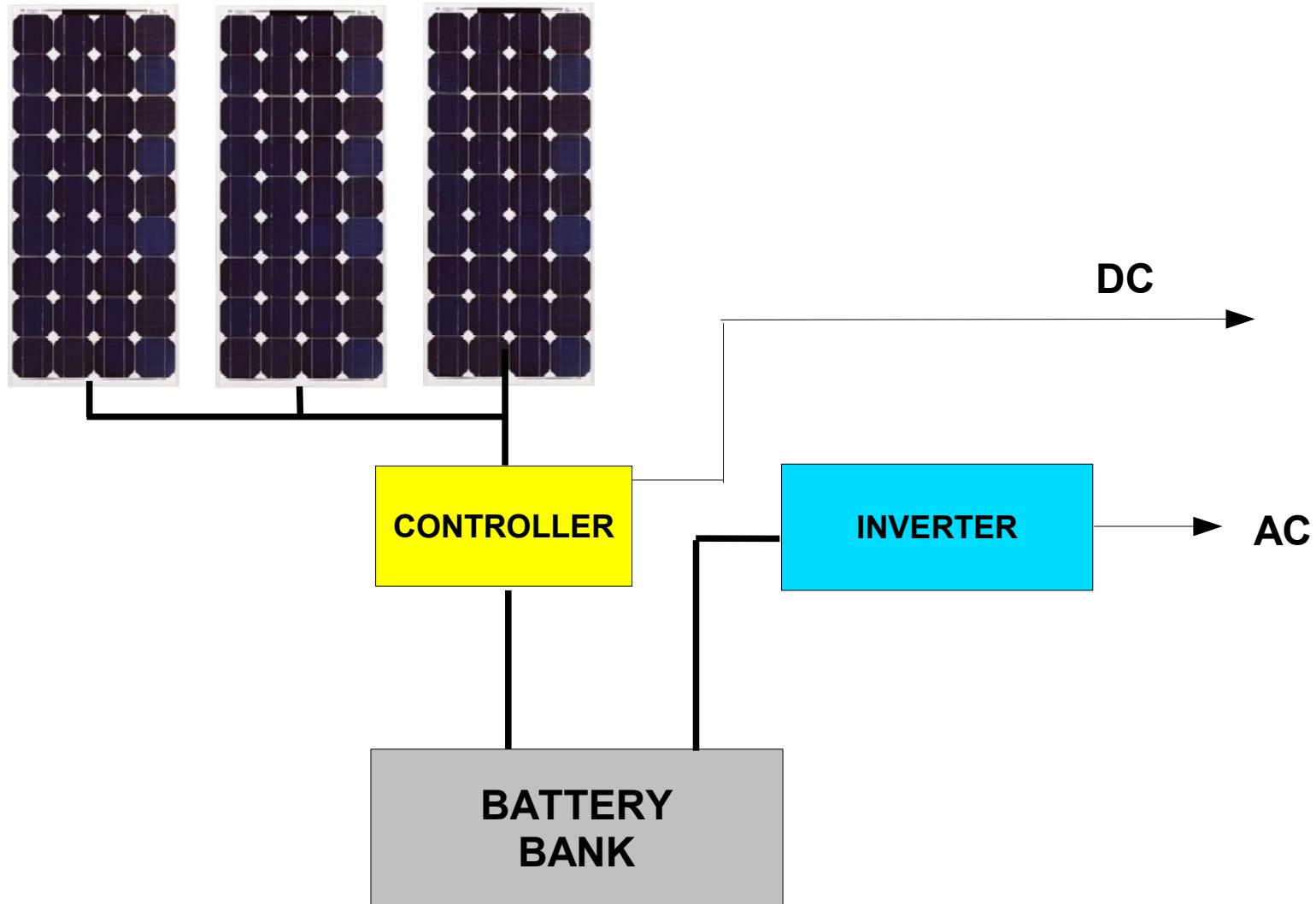


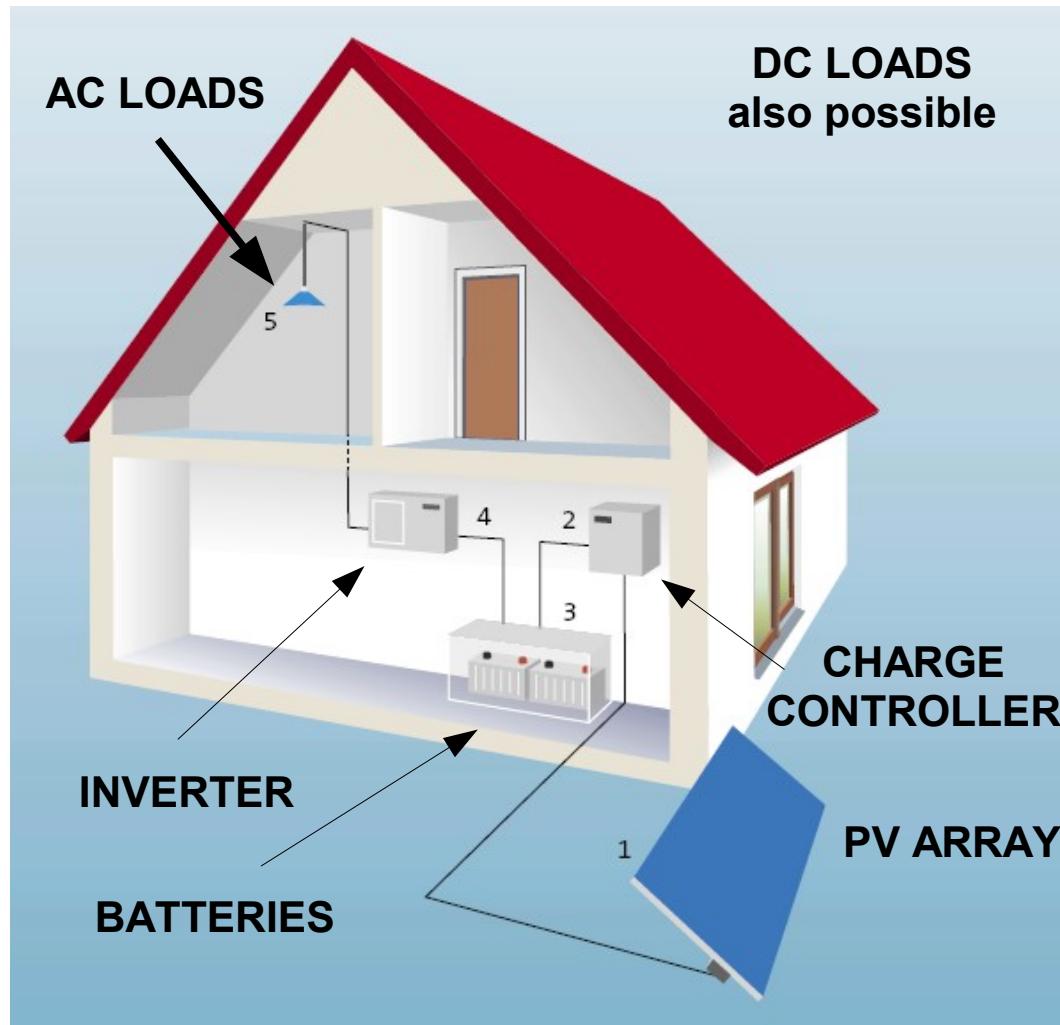
RECTIFIER



INVERTER







From
*Photovoltaics for
Professionals*

Main characteristics of inverters

- Size / power output
- Wave form
- Surge capability
- Overload protection
- Efficiency
- Stand-by power consumption
- Short circuit protection
- DC input
- DC low/high voltage disconnect
- Search mode
- Reverse polarity protection
- Over temperature protection
- Radio interference
- Indicators

Inverter size/power rating

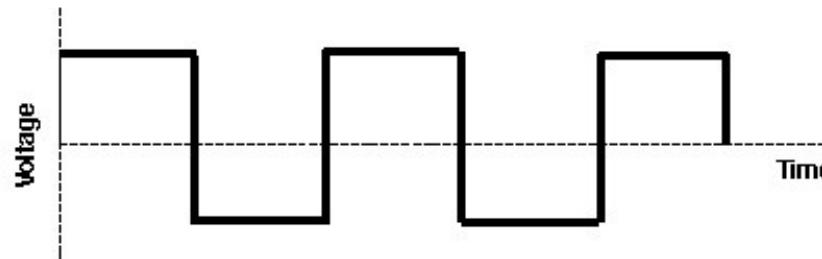
- Inverters are rated in their AC output in either Watts (W) or Volt-amps (VA).
- When the rated power output of an inverter is sized at say 500 W, this means that it is designed to power 500 W of appliances during normal operation.
- When designing a system, it is recommended that intended load be 75% of the rated power of an inverter. This is mainly to allow for addition of further loads later.
- Sometimes VA is used rather than W. This is to take into account the fact that some loads might have a “power factor” of less than one. As a rule of thumb, to change VA into W multiply by 0.9. Thus an 800 VA inverter can be considered to be equivalent to a 720 W inverter.

Inverter wave forms

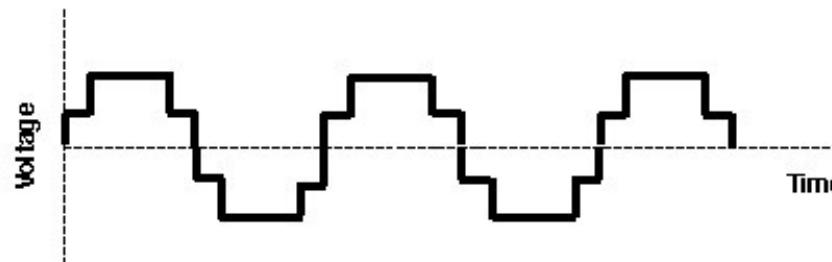
- Mains electricity has a sinusoidal waveform, a sine wave.
- Different models of inverters produce different wave forms:
 - true sine waves
 - modified sine waves
 - and square waves
- True sine wave inverters will run all equipment that can be run with mains power.

Inverter wave forms

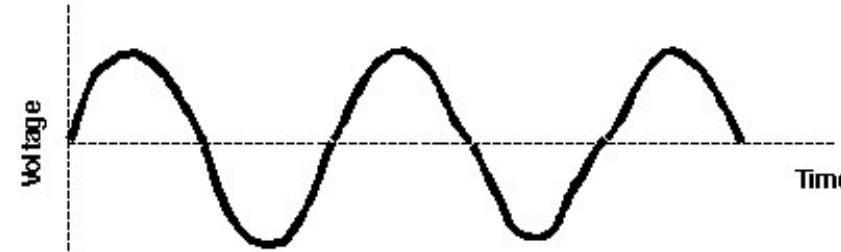
- Square wave



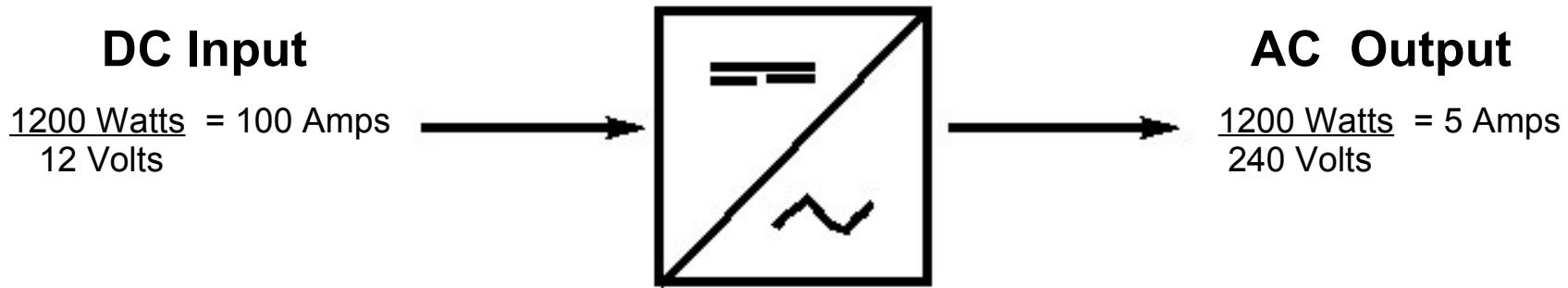
- Modified square wave



- Sine wave



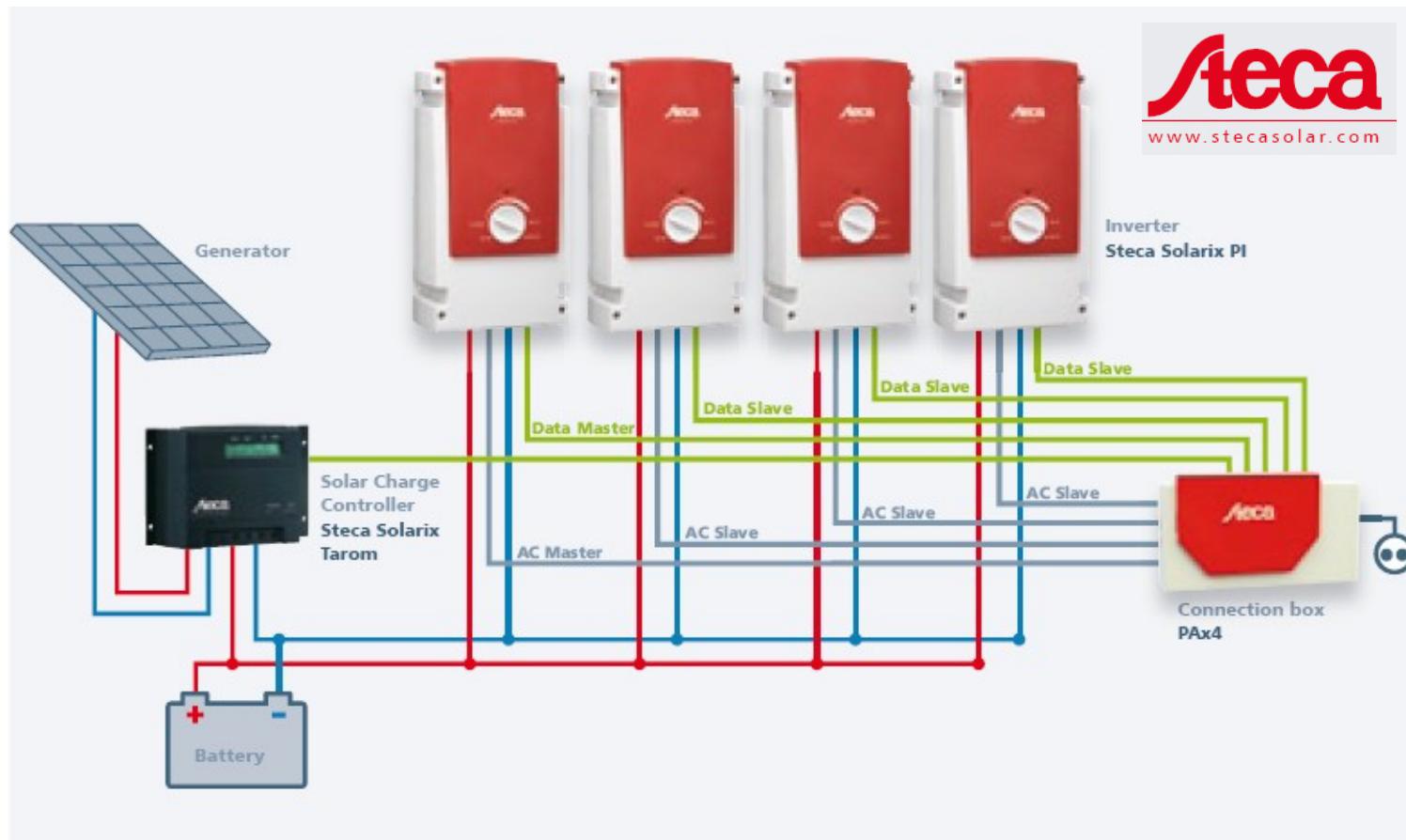
Power input and output of an inverter



- The above inverter is rated at 400 W continuous and 1200 W short-term
- Note how high the current can be on the DC side (inefficiencies not considered)
- The high DC input currents required by inverters is the main reason they are connected directly to batteries and not through solar or wind charge controllers

Inverter DC low & high voltage disconnect

- Most inverters will automatically switch off if the battery voltage gets too low
- This cut-off voltage is usually too low (typically 10 V or 10.5 V in a 12V system for example) to protect the batteries
- This cut off is to protect the inverter from undervoltage, not to protect the batteries from overdischarge
- Some inverters will have a circuit which protects them from damage if the input DC voltage is too high by immediately disconnection the inverter from the batteries

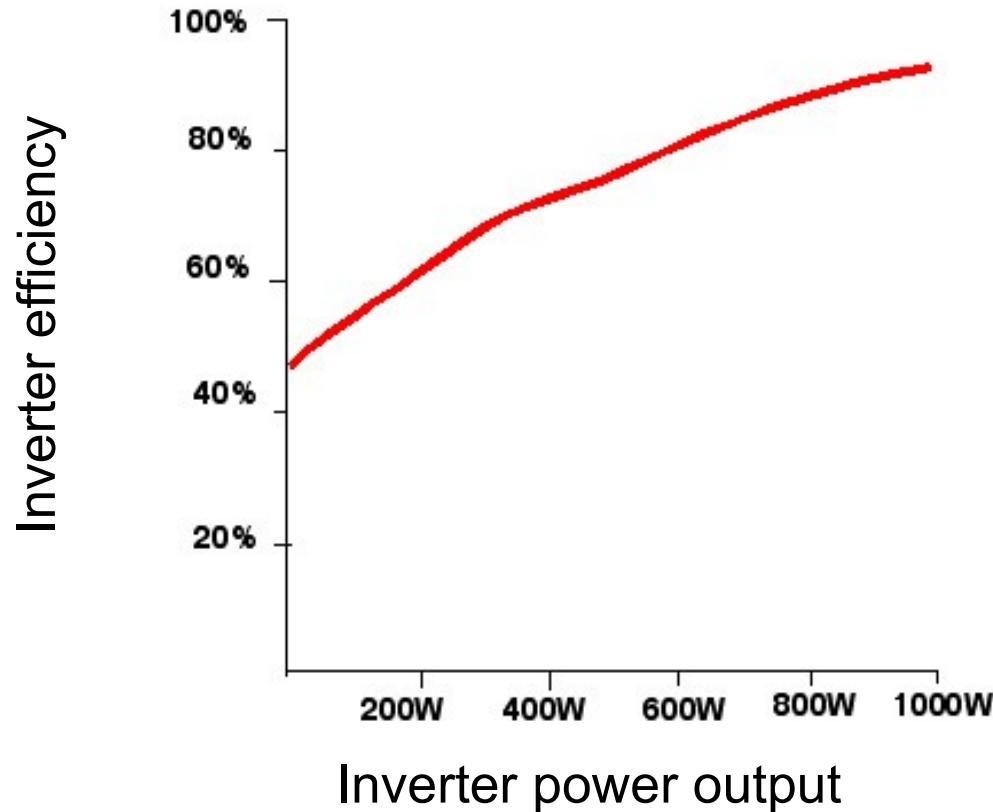


If the switch-off threshold of 30 % SOC is reached, the Solarix PI receives a signal from the solar charge controller and subsequently switches itself off in order to protect the battery from deep discharge. It turns itself back on again once the SOC has reached the 50 % mark.

Inverter efficiency

- The efficiency is defined as the ratio of power output to power input
- Inverters are never 100% efficient. 90% is good
- Inverter efficiency will vary with the load. For example a 400 W inverter may be 90% if it is powering a 360 W appliance and only 50% efficient if it is powering a 100 W appliance
- Each model of inverter will have an efficiency curve

Efficiency curve of a 1000 W inverter*



* Notional inverter

Inverter high-temperature protection

- During operation inverters get hot
- Some models will derate themselves as temperature rises
- Some have one or even cooling two fans
- Will shut down completely if the temperature gets too high

Inverter surge capability

- Ability of an inverter to withstand surge currents i.e. short periods of power consumption above its rated value
 - *Instantaneous surge capacity* gives is the ability to handle starting currents/power demands of appliances such as motors or energy efficient fluorescent light bulbs. Can be up to 5 times the normal rating, thus a 400 W inverter might be able to handle a surge of 2000 W for a second
 - *Short term power rating* is similar except that it can be for a period of minutes and will not normally be more than twice the continuous power rating of the inverter

Inverter overload protection

- An inverter should have a circuit breaker which switches the device off if it is overloaded by an AC appliance/s
- This will provide adequate protection most of the time, but care needs to be taken as a very large load may draw a current which is too much for the overload protection to handle and damage the inverter.
- Low cost inverters are more susceptible to be damaged in this way

Inverter stand-by power consumption

- Inverters will consume power when they are switched on and in stand-by mode
- In a good quality inverter this can be between 5 – 15 W
- For an inverter with even a low no-load power consumption of 5 W, if it is left in stand-by mode all day, this amounts to $5 \text{ W} \times 24 \text{ hours} = 120 \text{ Wh}$
- Over a few days this can become quite considerable. Inverters should be switched off if not in use (especially small ones)

Inverter DC input

- Inverter DC input voltages range
 - from 12 VDC, 24 VDC to 48 VDC
- Low voltage on the input side means high current
 - Input cables need to be sized accordingly (see manuals)
- Power can also be lost in the cables / cable voltage drop
 - Longer cables need to have greater cross-sectional area
- **Essential to put correct DC-rated fuse in the positive input cable as near as possible to the battery positive terminal**

Inverter indicators

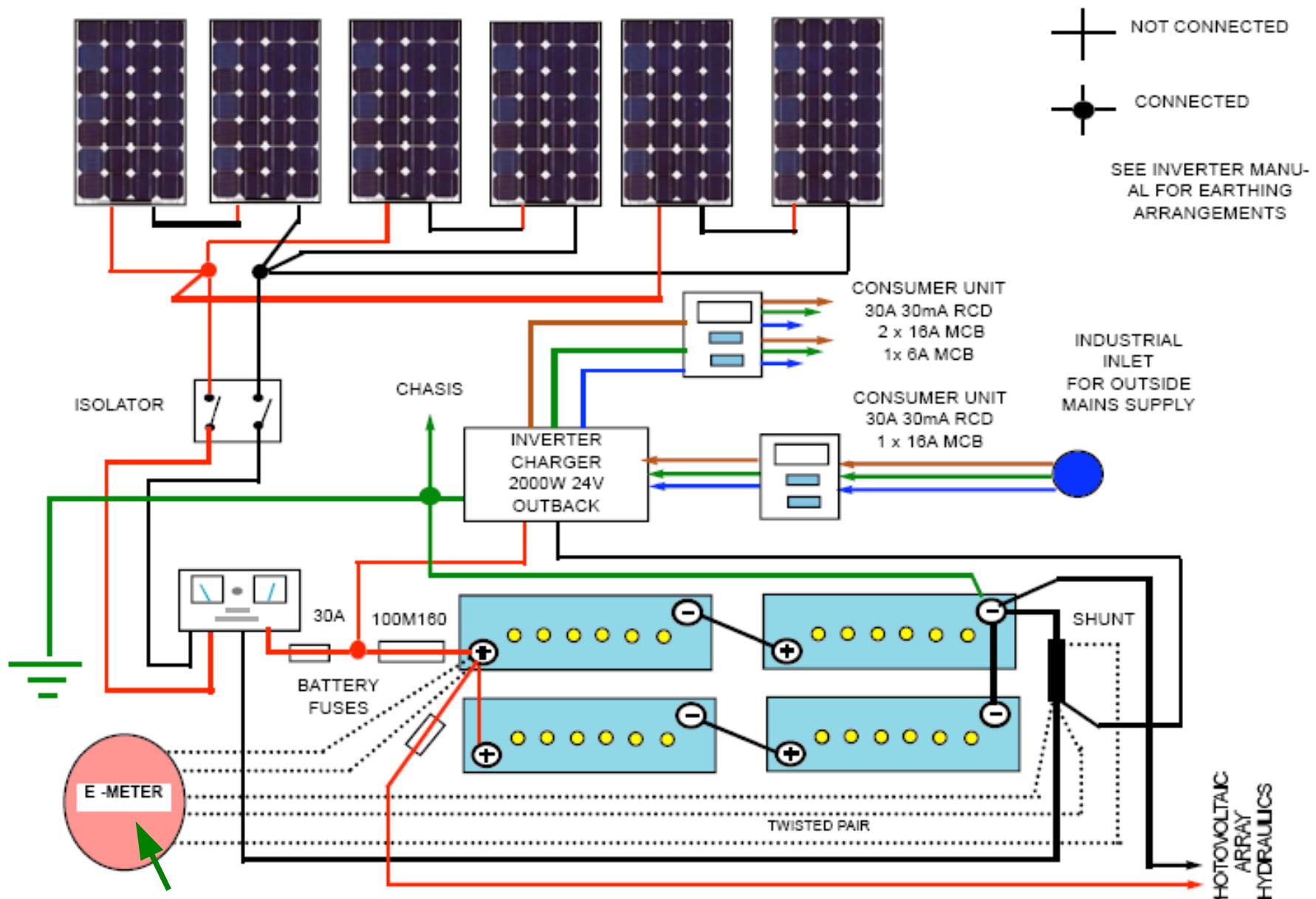
- An inverter should at least indicate when it is on/off and battery condition.
- Ideally, it should also give some indication of the state of charge of the battery.
- Remote monitors enable able system users to manage systems

XANTREX LINK 10 and 20

Product Features

- ▶ Digital Numeric Display - LED display shows numeric read out of volts, amps, amp-hours and time remaining
- ▶ Easy to read multi-color LED bar graph
- ▶ Splash proof panels allow for outdoor mounting and hands free operation
- ▶ Displays key historical battery information such as charge efficiency, deepest discharge, and average discharge
- ▶ Compatible with 12 and 24 volt DC systems
- ▶ Works with any battery type
- ▶ Includes DC shunt
- ▶ One year warranty
- ▶ CE and E-mark





Reverse polarity protection

- Inverters do NOT usually have reverse DC polarity protection
- If the DC cables from the batteries are not connected up correctly, (i.e. if the negative of the battery is connected to the positive terminal of the inverter and the positive of the battery is connected to the negative of the inverter), the inverter will be badly damaged
- Guarantees do not cover this eventuality

Inverter radio interference

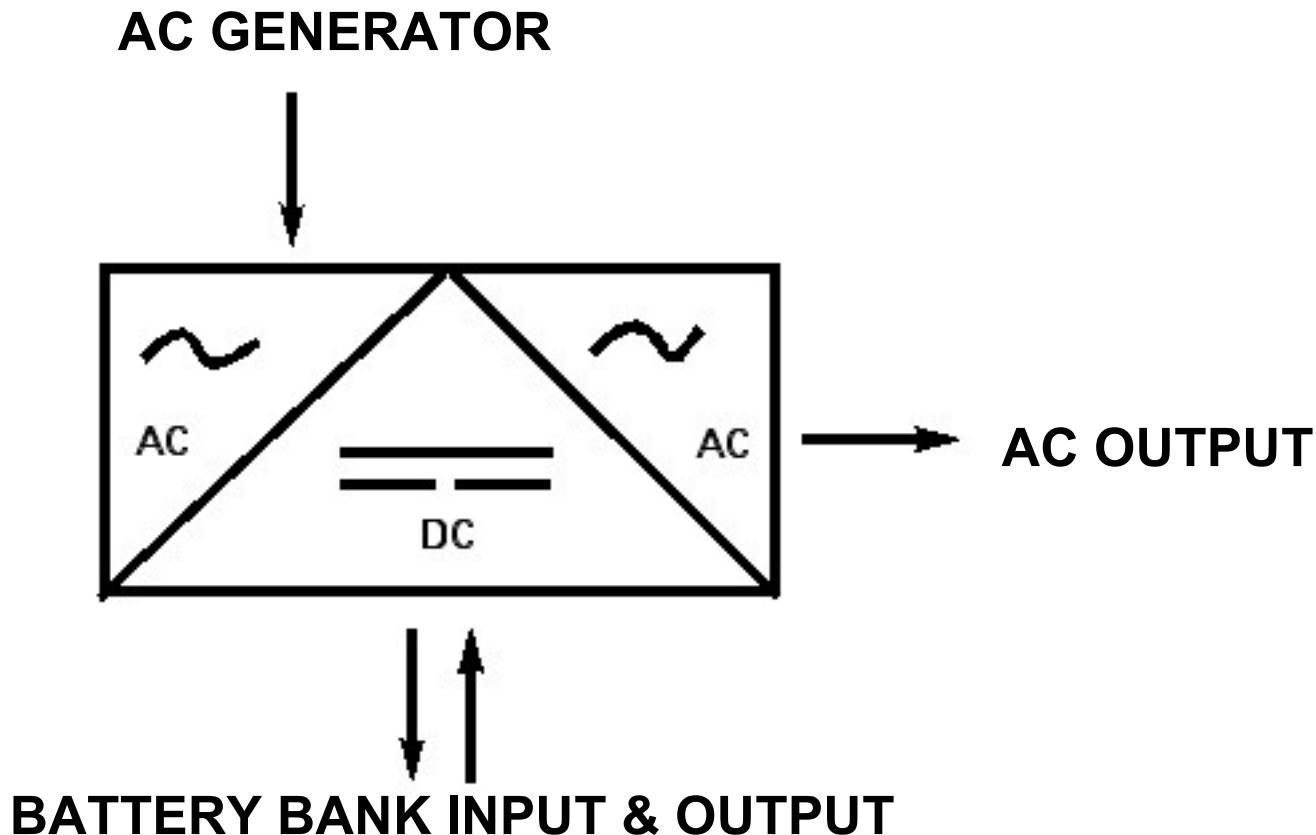
- Inverters create electro-magnetic fields which *can* interfere with the function of other electronic equipment
- Types of equipment which can be effected are audio equipment (humming), radio and communication equipment, TV and computer monitor screens, induction motors (humming), electromagnetic relays, electronic switches etc.
- Manuals of quality inverters will give instruction on how to avoid such effects by wiring in steel conduit and earthing
- *Ask manufacturer or supplier if in doubt*

Inverter earthing

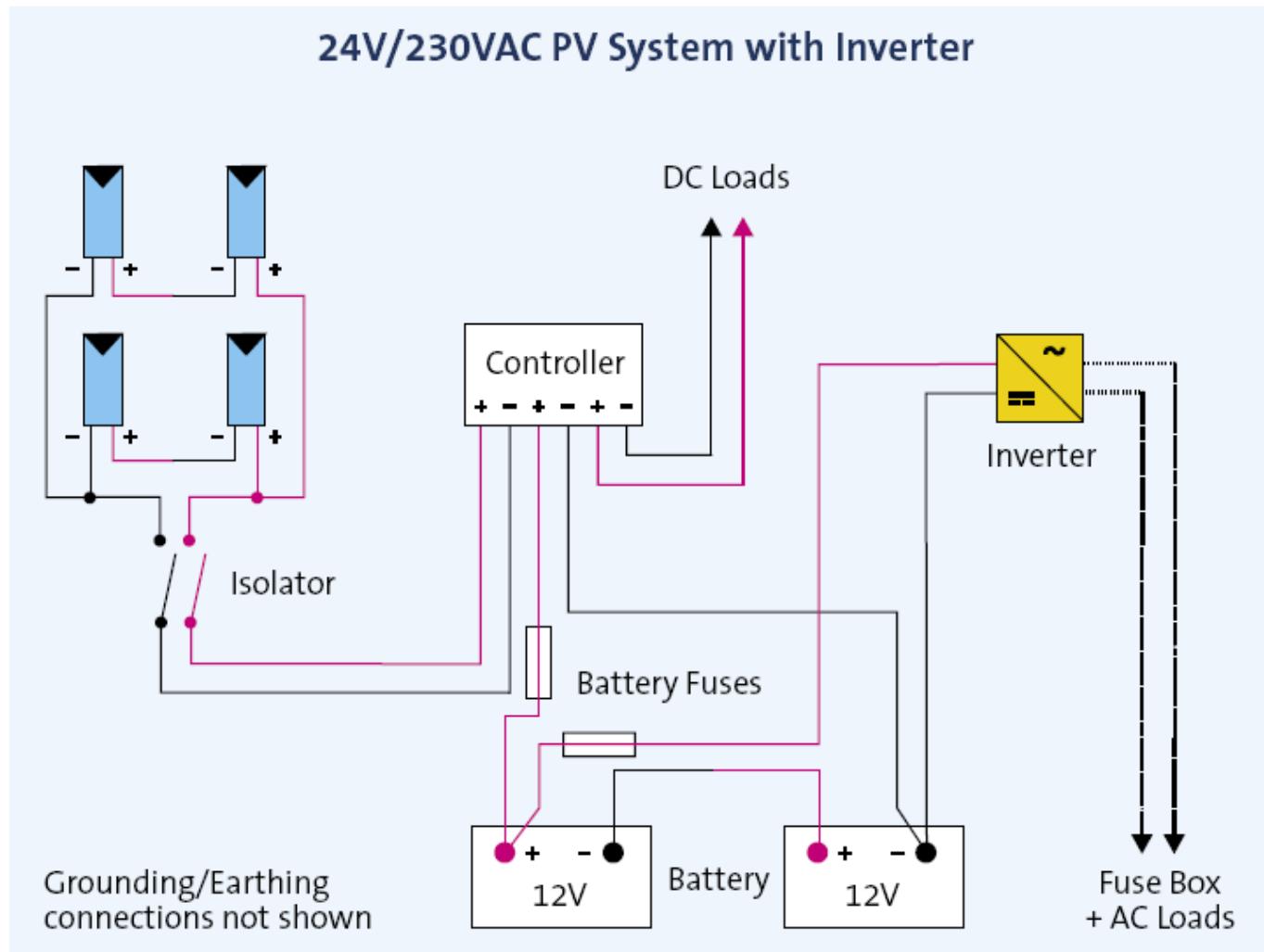
Inverter manuals
are the best guide

If in doubt, ask

The inverter-charger

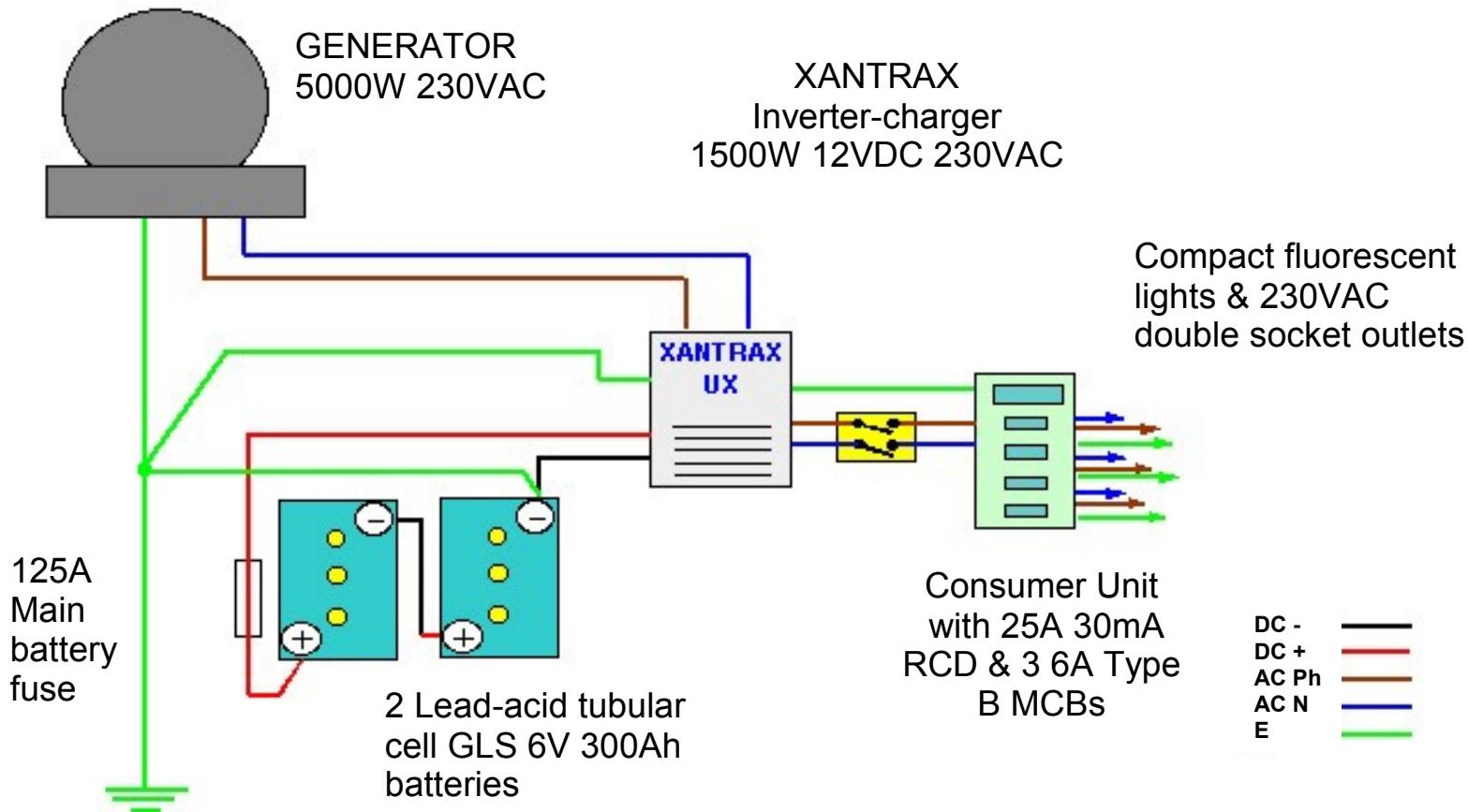


24V/230VAC PV System with Inverter



From
*Photovoltaics for
Professionals*

Wiring of inverter-charger



Portable inverters

- Modified sine wave output usually
- Power output range of 150 W, 300 W & 500 W
- Voltage input of 12 V
- Low cost
- Can be inefficient
- Some are very low quality



STECA AJ SERIES inverters

- Pure sine wave output
- Power output range of 200W, 400W, 800W & 2000W
- Voltage input range of 12V, 24V & 48V
- Also available as inverter-chargers
- Some models have solar charge controller



Steca AJ

275-12, 350-24, 400-48,
500-12, 600-24, 700-48,
1000-12, 1300-24,
2100-12, 2400-24

STECA COMPACT SERIES inverters

- Pure sine wave output
- Power output range of 1300W, 2300W & 3500W
- Voltage input range of 12V, 24V & 48V
- Built in battery charger makes it an inverter-charger
- Remote on/off switches available



OutBack Power Systems, Inc.

MODULAR RUGGEDIZED SINEWAVE INVERTER/CHARGERS

NOW ITS YOUR CHOICE!

Although OutBack has become known for offering the first and only sealed sinewave inverter/charger, we still found some real reasons to consider offering a vented version of the popular FX series as well...

Introducing the VFX series sinewave inverter/chargers



original sealed **FX SERIES**

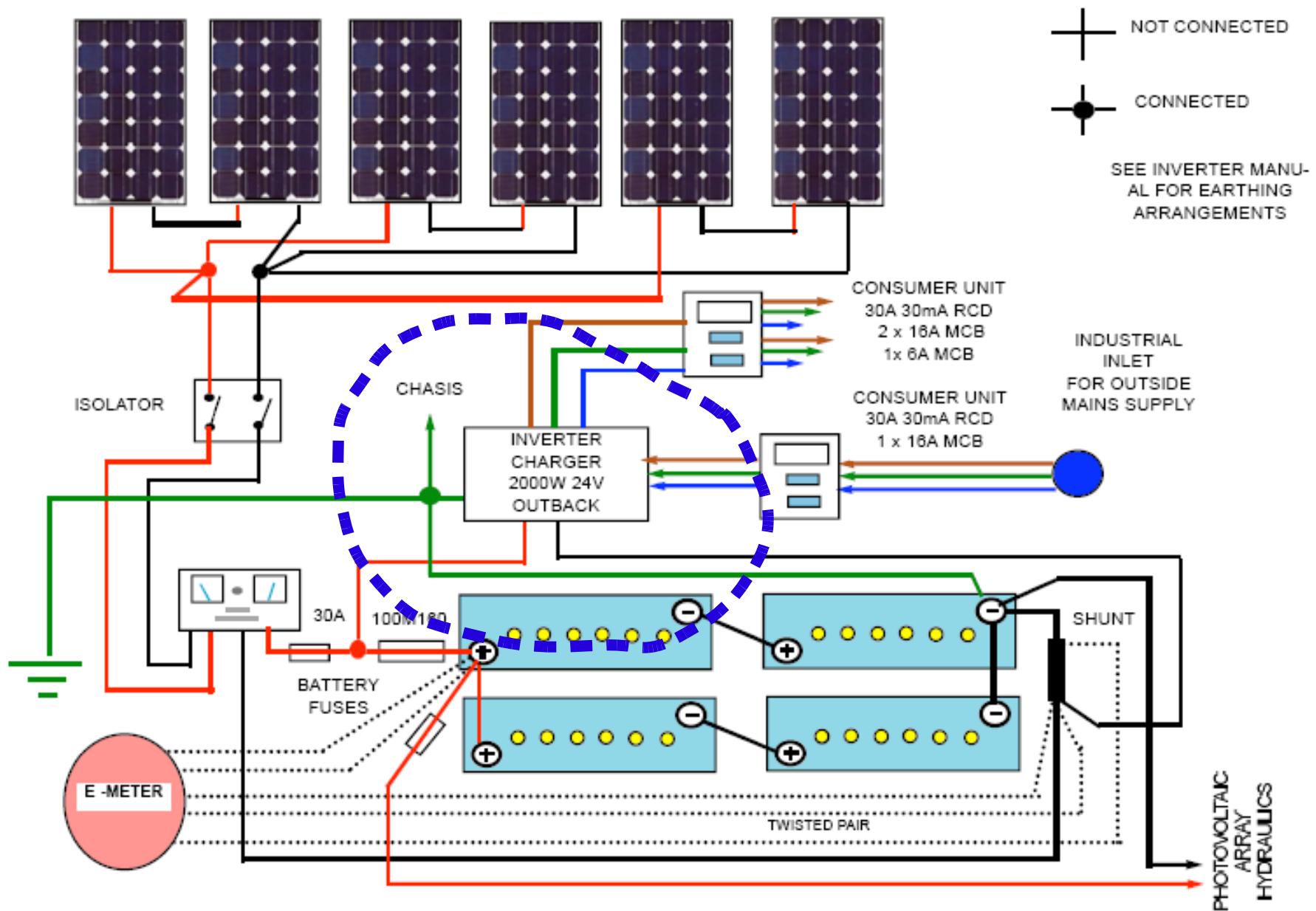
FX2012T	2.0 kWAC	12 VDC	\$1995 USD
FX2024	2.0 kWAC	24 VDC	\$1795 USD
FX2548	2.5 kWAC	48 VDC	\$2245 USD

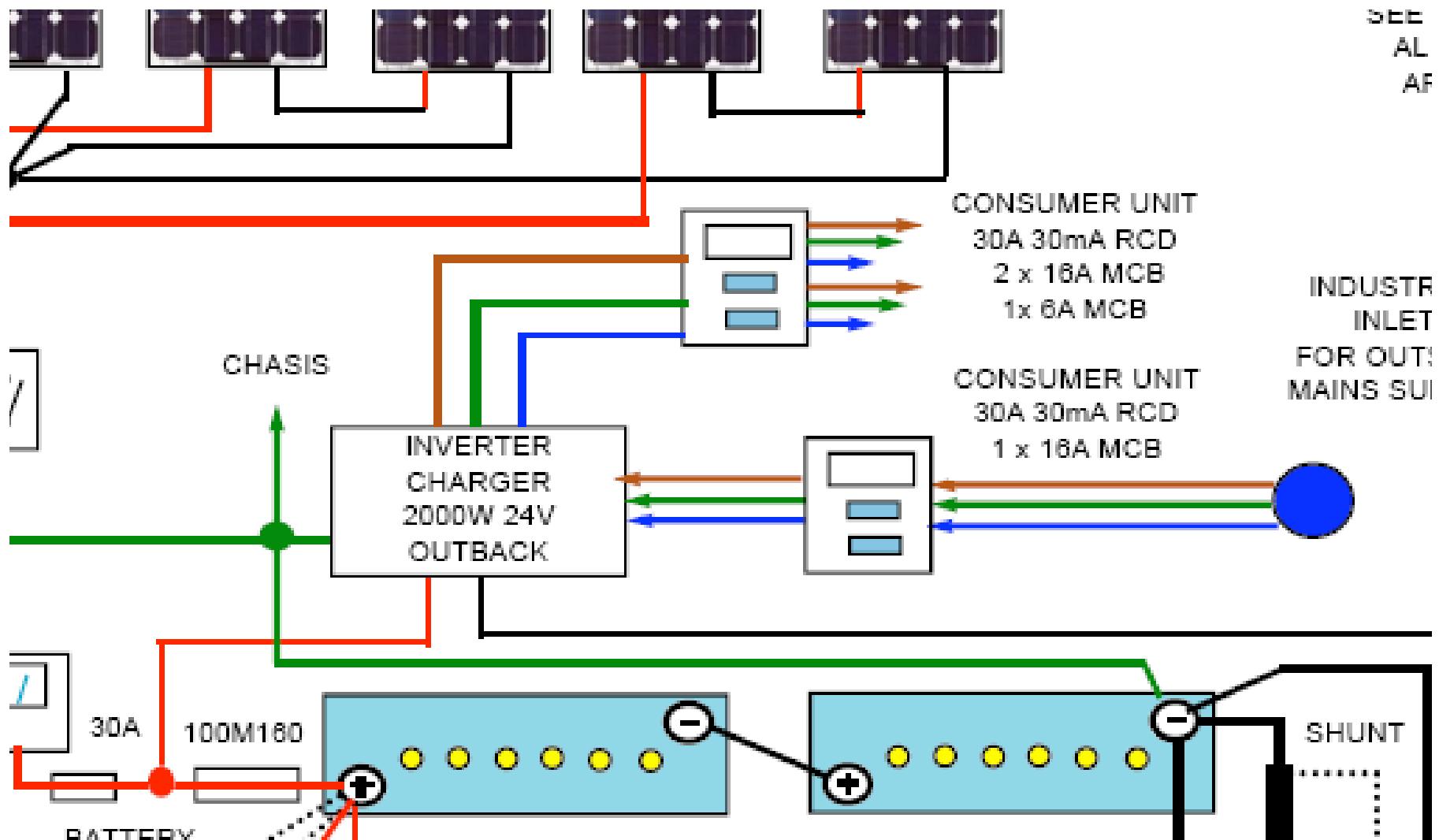


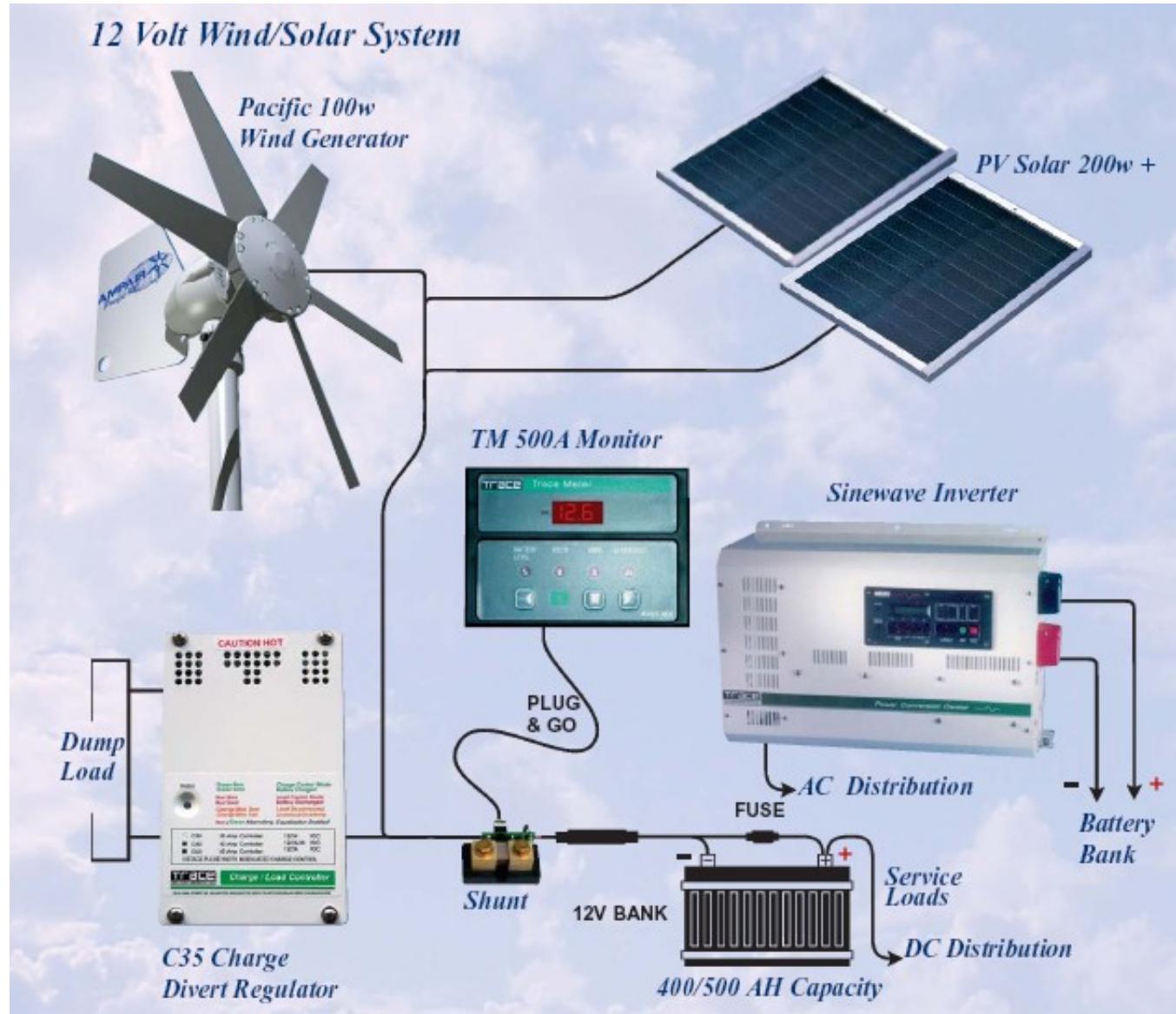
new vented **VFX SERIES**

VFX2812	2.8 kWAC	12 VDC	\$2345 USD
VFX3524	3.5 kWAC	24 VDC	\$2345 USD
VFX3648	3.6 kWAC	48 VDC	\$2345 USD

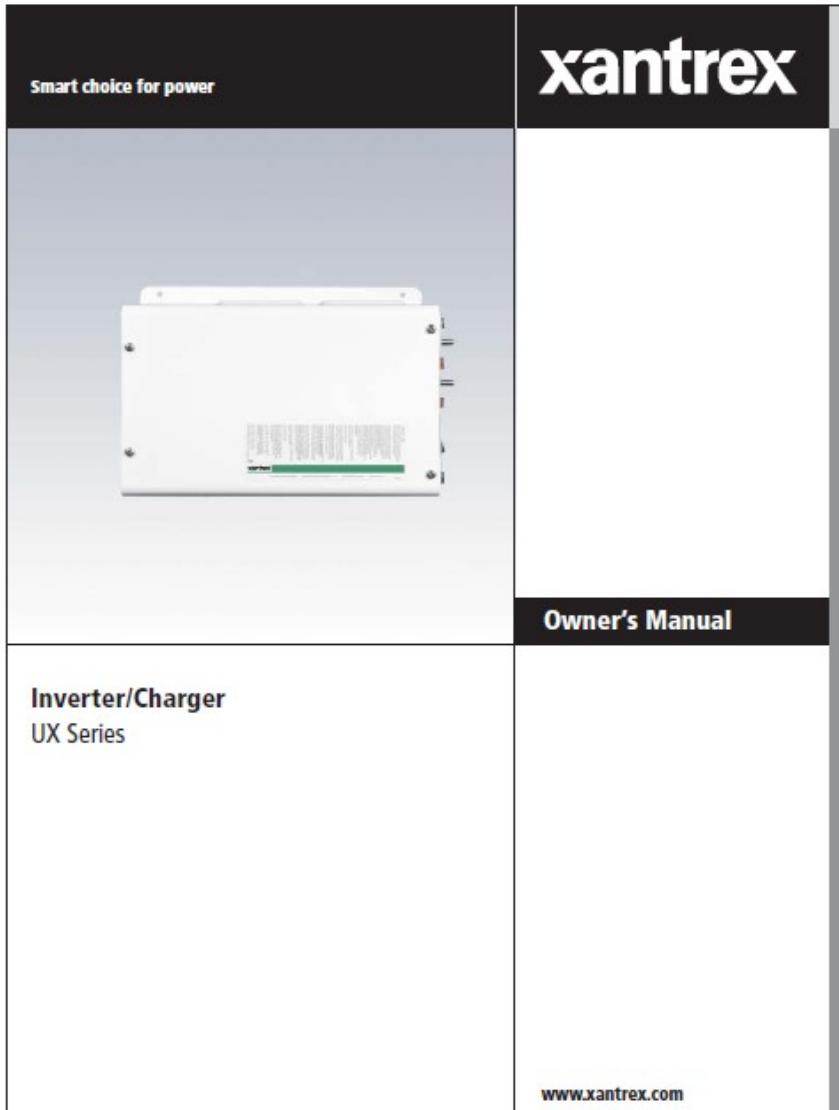








www.ampair.com



See XANTRX UX Series
inverter charger manual
for range of possible
configurations
Pages 19-29 (PDF)