

Inverter

- An inverter is an electrical device that converts direct current (DC) to alternating current (AC).
- Inverters have an input side and an output side.
- The input voltage, output voltage and frequency depend on the design of the inverter.
- Inverter does not produce any power. The power is produced by the DC source (battery).



Classification of Inverters

Input Voltage

- This is also referred to as system voltage on the DC side of the inverter
- The system voltage is usually graduated in steps of 12V (e.g. 12V, 24V, 48V, 96Vetc.)
- A 12VDC input voltage, for smaller consumers while 24, 36 and 48VDC, which are common standards for home energy systems. Inverters are either rated in kVA or kW.
- On the input side, the inverter is connected to the DC power source (e.g. battery or solar array)
- The output side supplied AC power (220V to 240V)

Inverter Rating	System Voltage
0.8kVA	12V
1.5kVA	24V
2kVA	24V
3kVA	24V - 48V
3.5kVA	48V
5kVA	48V – 96V
6kVA	48V – 96V
7.5kVA	48V – 120V

Classification of Inverters

Output Waveform

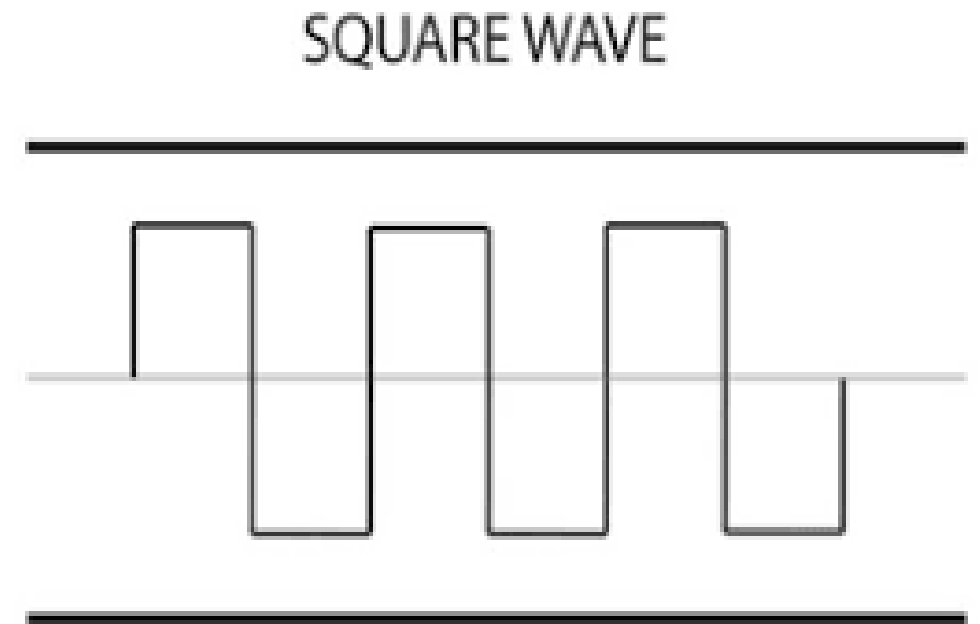
There are three different types of waveform found in most inverters:

- Square Wave Inverter
- Pure Sine Wave Inverter
- Modified Sine Wave Inverter

Output Waveform

Square Wave Inverter

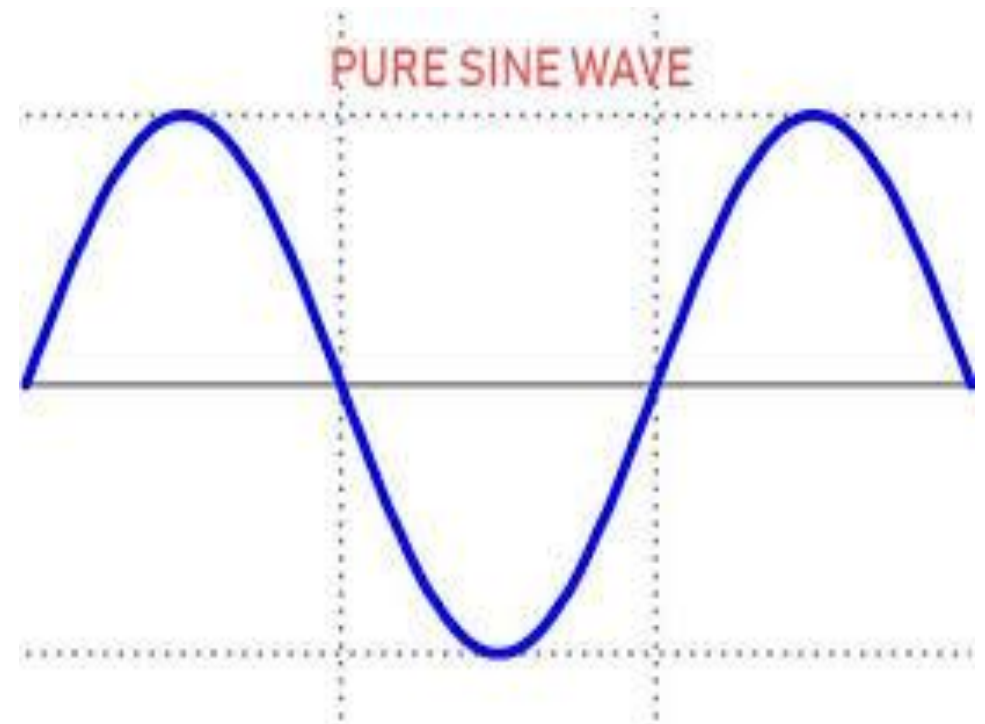
- Simplest and most basic
- It is useful for applications such as lighting and heating
- It is the cheapest form of inverter
- Square wave output can produce "humming" when connected to audio equipment.
- Unsuitable for sensitive electronics



Output Waveform

Pure Sine Wave Inverter

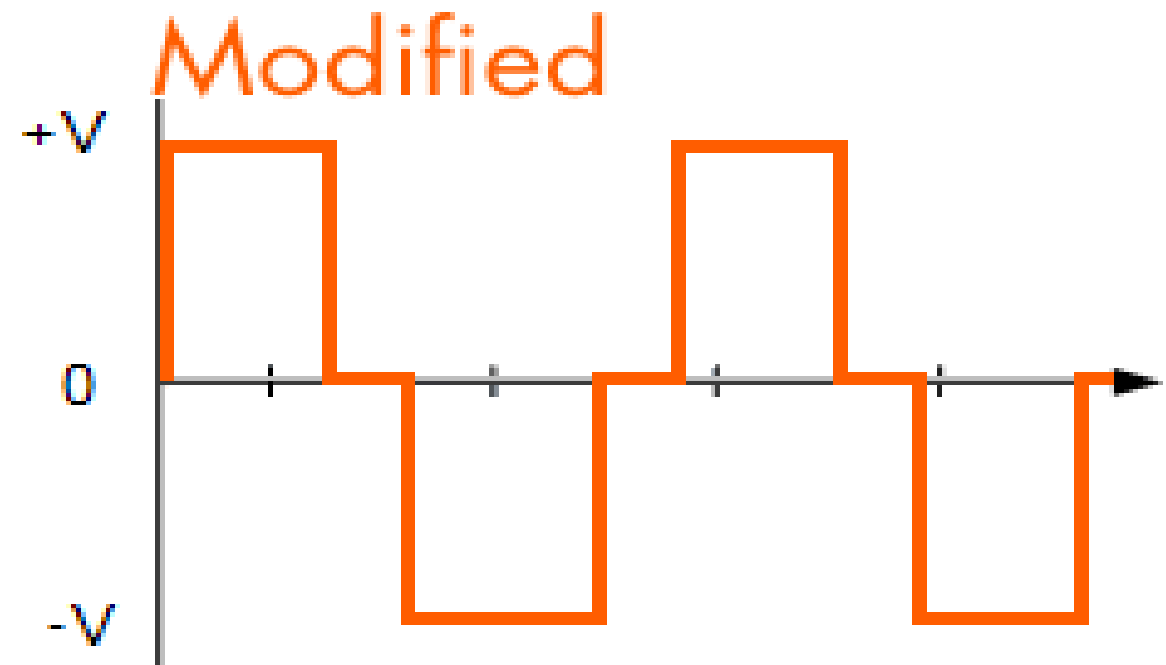
- Produces a multiple step sinusoidal AC waveform. Gives an output similar to the output waveform of the electrical grid
- This must be used if there are sensitive equipment to be powered.
- Most expensive type of inverter



Output Waveform

Modified Sine Wave Inverter

- This is the mid-point between square wave and pure sine wave inverter
- It is much cheaper than pure sine wave inverter
- Most households and small offices run on this type without a problem
- Less efficient than pure sine wave inverters



Inverters: Modified vs. Pure Sine Wave

Modified Sine Wave

- For simplest systems
- Typically inexpensive
- Fine for older TVs, incandescent lights, motors with brushes.
- Generally not good with: electronics, audio, induction motors, rechargeable batteries and digital clocks

Pure Sine Wave

- Preferred for off-grid homes or larger systems
- Generally more expensive than modified
- Necessary for electronics, fluorescent lights, inductive load to operate at their best

Output

Frequency

- The AC output of an inverter is usually the same as that of a standard power line frequency (50Hz or 60Hz)

Voltage

- The output voltage of an inverter is often regulated to be the same as the grid line voltage (240VAC) at distribution level

Power

- Overall output power of inverters are expressed in their power ratings(W or VA)

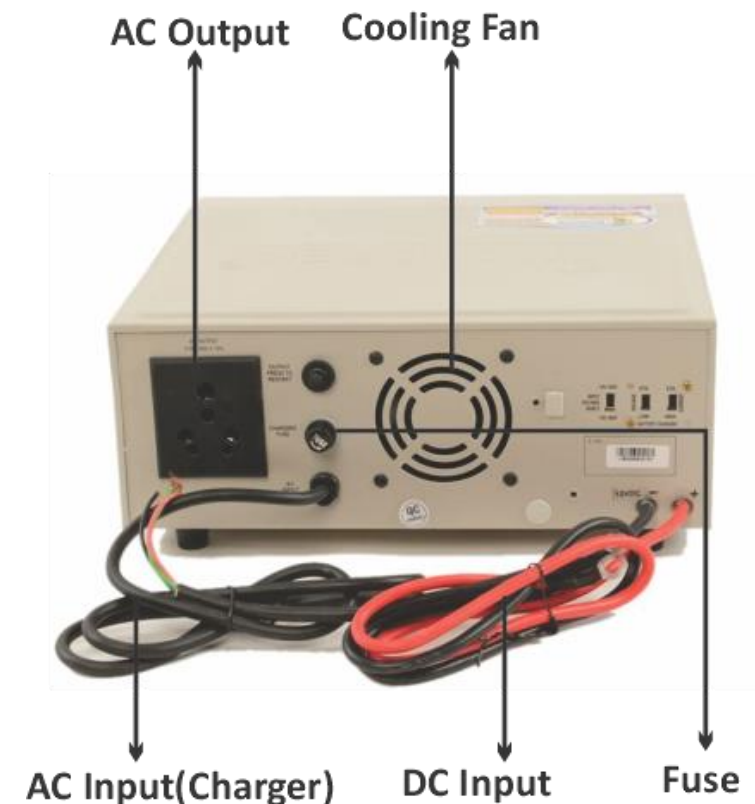
Stand-alone Inverters

- **Stand-alone inverter** or **off-grid inverter** is designed for remote stand-alone application or **off-grid power system** with battery backup where the inverter draws its DC power from batteries charged by PV array and converts to AC power.
- **Stand-alone inverters** provide variety of size and output waveform depending on your applications. For the best output, the **pure sine inverter** is required.
- It suits for **solar home system, rural electrification, village electrification** in remote area where the utility grid is not available

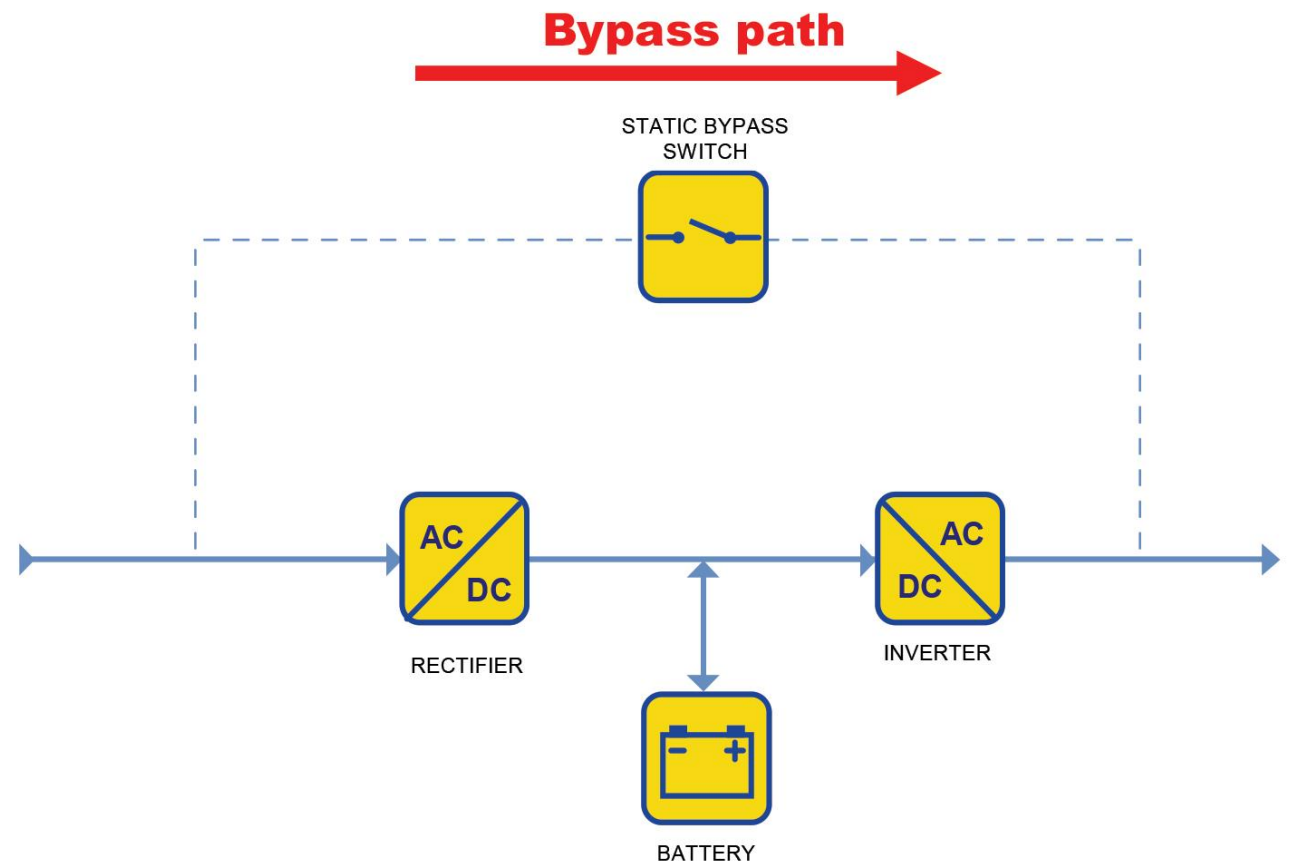
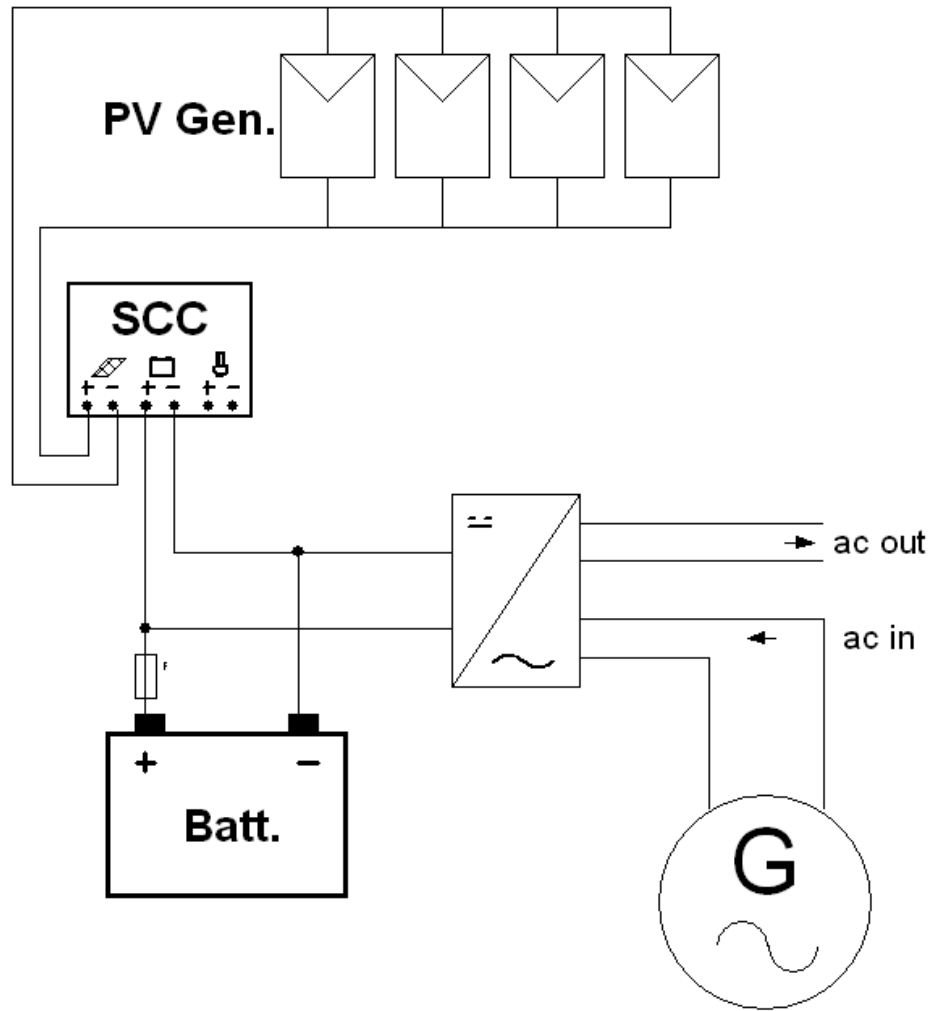


Inverter Charger

- Inverter charger typically have a built in transfer switch that sense when you are plugged into an AC source or generator
- When AC is recognized by the inverter charger, the unit will act as a pass through, power your devices from the AC source and also charge the batteries if desired.
- When the inverter charger detects a loss in AC power, the unit will switch over to DC mode and power your devices off the batteries that the power inverter has been charging.



Inverter Charger



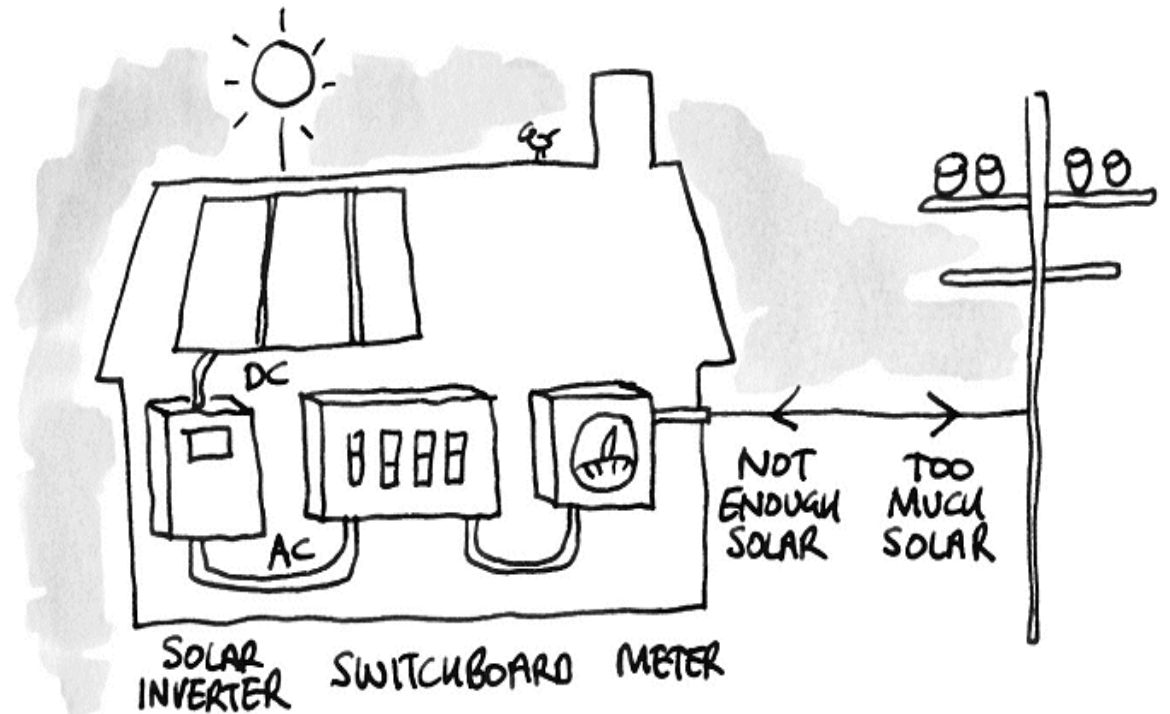
Hybrid inverter

- These inverters are similar to stand-alone inverters but with the added functionality of interacting with the utility grid.
- This has an integrated charge controllers, so can work with a solar panel connected directly to it to charge the battery.
- It also has an inverter charger which helps charge the batteries from utility supply. So it can actually use dual means of charging the battery- the PV source and the inverter charger to charge the battery from the utility or generator.
- If one source is not available, the other source can charge the battery.
- Ensure to read the manual properly. Most times when inbuilt charge controller is faulty, the inverter cannot supply AC output until the problem is fixed.



Grid-Tie Inverter

- Convert DC to AC. Suitable for injecting power into the grid
- Used between local power generators(hydro-electric, solar panels, wind turbine etc.) and the grid
- They inject electrical power efficiently and safely into the grid, grid-tie inverters must accurately match the voltage and phase of the grid sine wave AC waveform
- The inverter will only work when the grid is present, excess power produced can be sold to the utility grid for cash



PV Inverter

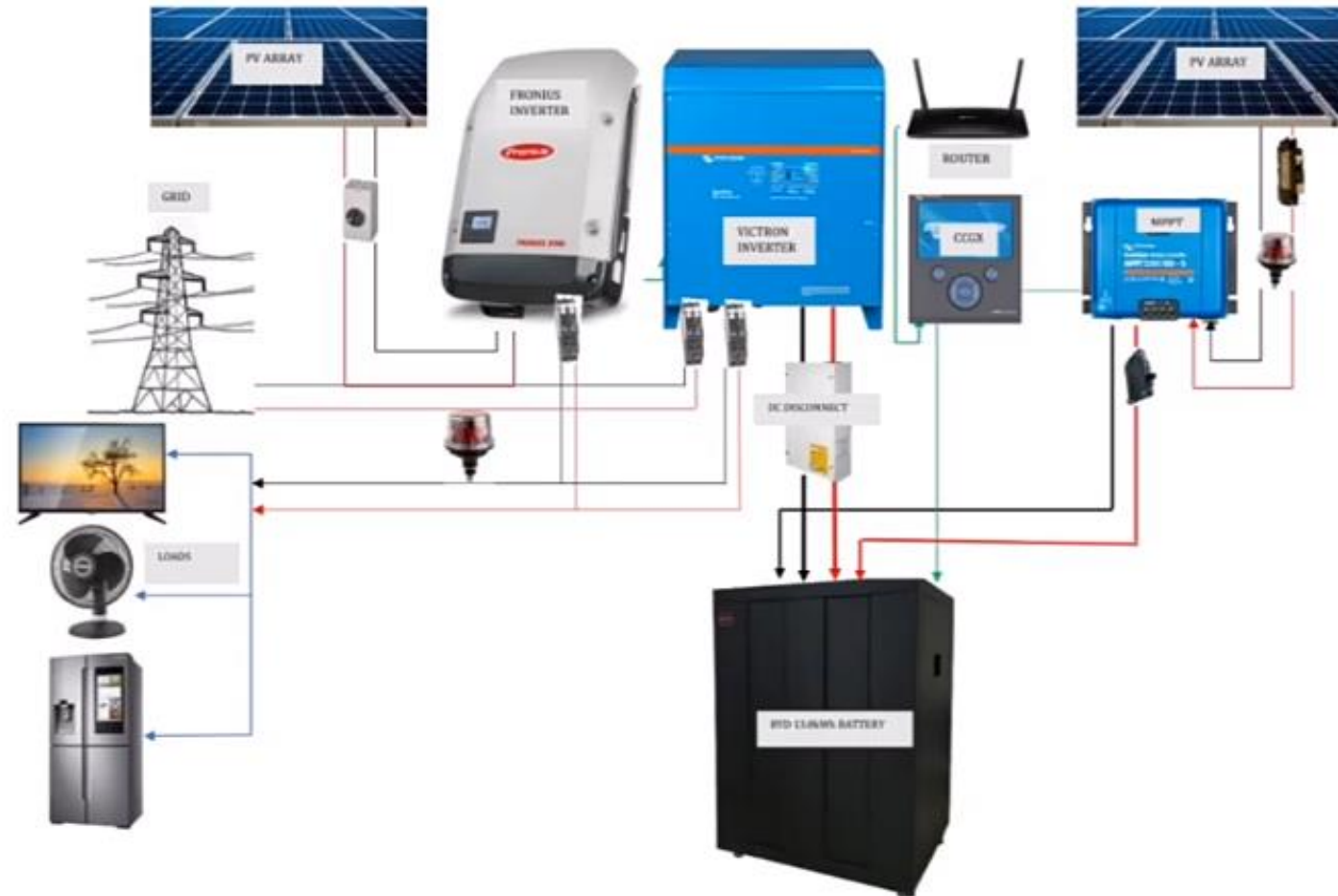
- A solar PV inverter, is a type of electrical converter which converts the variable direct current(DC) output of a photovoltaic(PV) solar panel into a utility frequency alternating current(AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network.
- Solar power inverters have special functions adopted for use of PV arrays, including maximum power point tracking and anti-islanding protection.



Anti-Islanding

- Anti-Islanding is a type of electrical protection for embedded generators such as grid connected solar, wind or diesel. It ensure the generator disconnects electrical supply to the grid in event of blackout
- Anti-Islanding exist to protect personnel and equipment connected to the grid in occurrence of a fault or maintenance.
- An installation with an array of solar panels and inverters attached to convert the varying DC current provided by the panel into AC power that matches the grid supply. If the grid is disconnected, the voltage on the grid line would be expected to drop to zero, a clear indication of a service interruption

Application of PV inverters



Peak or surge power of inverters

- Surge is the maximum power that the inverter can supply usually for a short time.
- Air conditioners, freezers and pumps may startup surge of three to seven times the continuous rating
- Typical power is what the inverter has to supply on a steady basis. This is the continuous rating. This usually a factor in choosing an inverter.
- All inverters have continuous rating and surge rating. The surge rating is usually specified at so many watts for many seconds. This means that the inverter will handle overload of that many watts for a short period of time.
- The surge capacity will vary considerably between inverters, and different types of inverters, and even within the same brand.

Inverter High Temperature protection

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

Efficiency of inverters

- There is no ideal system, even human's efficiency is not 100% as humans falls ill and breakdown
- Inverters also cannot work 100%. Usually inverter efficiency is between 60 and 95%
- Always check manufacturers efficiency rating on the data sheet for each inverter to be used

Selecting the right inverter

- One sign to discover a poor quality inverter is when it does not have a datasheet with full information about its design
- If you are going for locally made inverter, you should ensure it meets **SON** standard for certification. Hence all technical information is made available.
- The datasheet and instruction manuals are vital materials to read through during design stage.
- Inverters needs to be chosen carefully, the type and characteristics matters a lot as to be able to meet up your design goal.

Inverter Brands

- Sukam
- Microtek
- Luminous
- SMA
- Fronius
- Prag
- Felicity
- Mercury
- Victron
- Genus
- Eastman
- Signal
- Huawei
- Schneider
- Thundervolt
- Growatt

Inverters in the Market

- 500VA/12V
- 850VA/12V
- 900VA/12
- 1kW/12V
- 1kVA/12V
- 1.5kVA/24V
- 2.5kVA/24V
- 2.5kVA/36V
- 3.5kVA/24V
- 3.5kVA/48V
- 4kVA/48V
- 5kVA/24V
- 5kVA/48V
- 5kVA/96V
- 6kVA/48V
- 6kVA/96V
- 7.5kVA/48V
- 7.5kVA/96V
- 7.5kVA/120V
- 10kVA/48V
- 10kVA/96V
- 10kVA/120V
- 10kVA/180V
- 10kVA/192V
- 15kVA/48V
- 15kVA/96V
- 20kVA/120V

Huawei iSitePower-M 6kVA 15kWh All-in-one system

