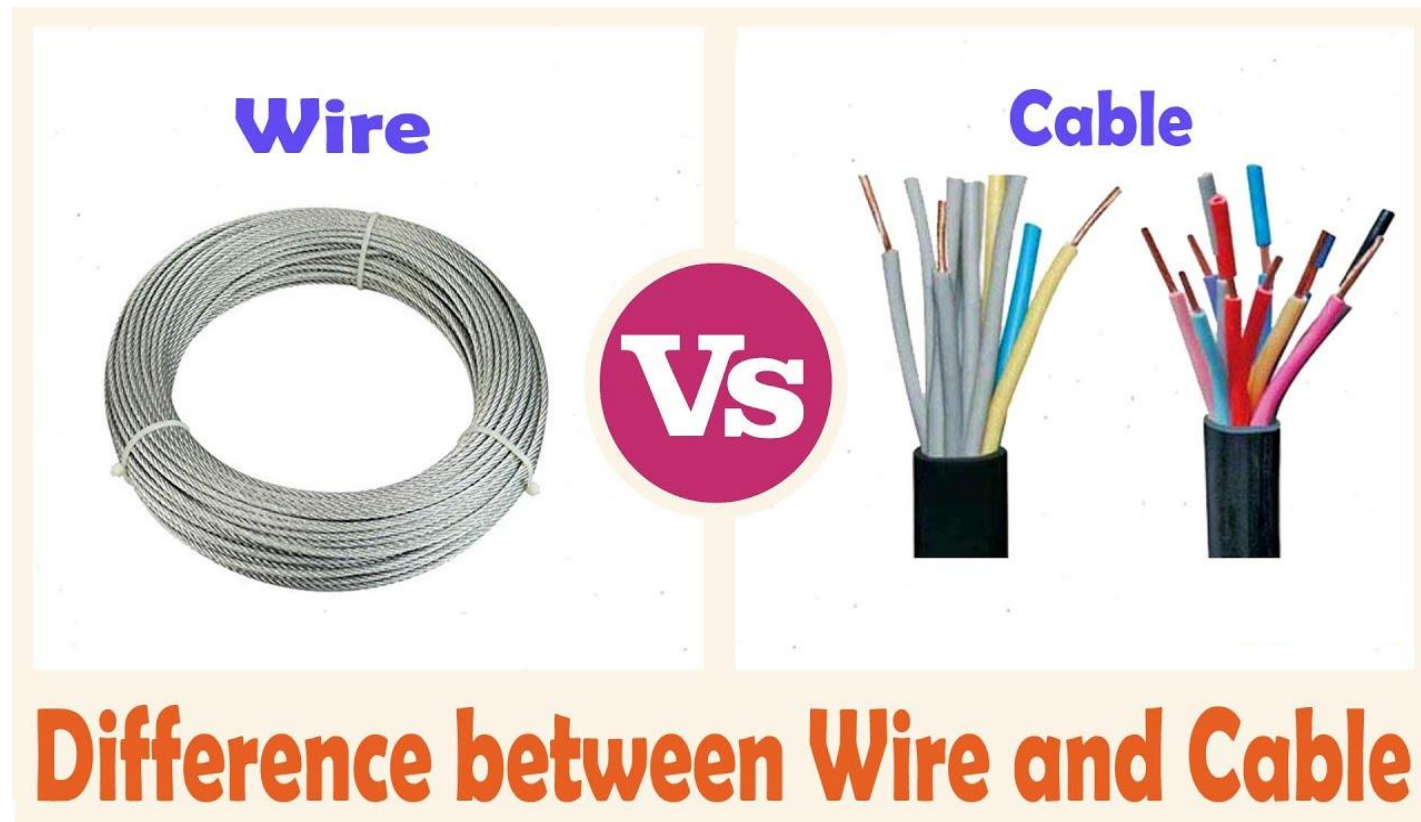


Solar Cable

- A solar cable is the interconnection cable used in photovoltaic power generation.
- Solar cables interconnect solar panels and other electrical components of a photovoltaic system. Solar cables are designed to be UV resistant and weather resistant.
- The two common conductor materials used in solar installations are copper and aluminum. Copper has greater conductivity than aluminum, thus it carries more current than aluminum of the same size.
- The cable could be solid or stranded. Stranded wires have slightly better conductivity.

Differentiating solar wires and solar cables

- Although people use the terms solar wire and solar cable interchangeably, they are different. Solar wire refers to a single conductor, while solar cable is a composite of several conductors or wires held together by a jacket

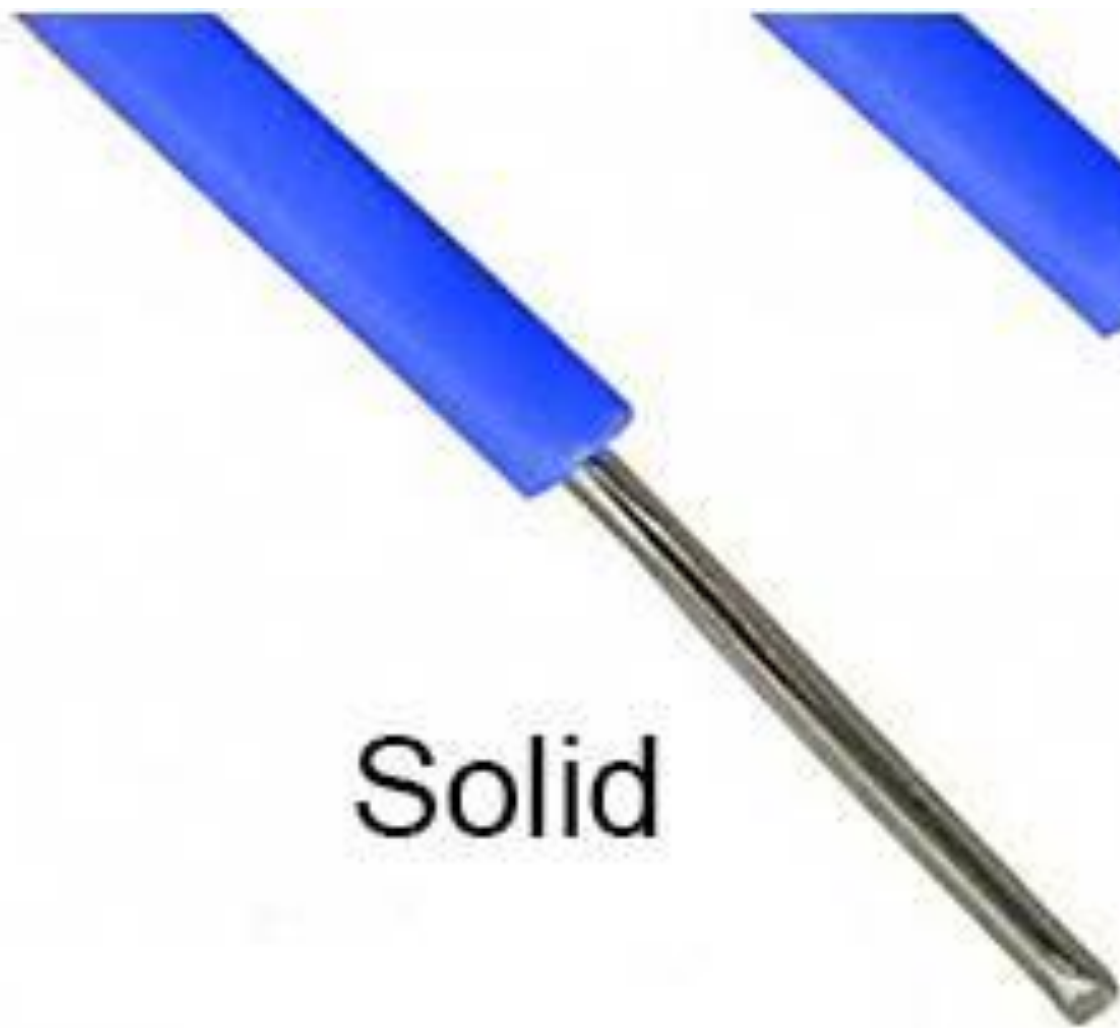


Solar Wire

- Solar wires, used to connect the components of a photovoltaic system, come in various types. Typically, it connects four components: the solar panel, the inverter, the charge controller and the batteries.
- Choosing an appropriate type of wire in a PV system is crucial to its operation and efficiency.
- Using a wrong solar wire might not deliver the appropriate voltage and fail to power up the electrical units or result in the battery bank's failure to charge fully.
- The standard cross section size are 1.5mm^2 , 2.5mm^2 , 4mm^2 , 6mm^2 , 10mm^2 , 16mm^2 , 25mm^2 , 35mm^2 , 50mm^2

Stranded or Single Wire

- There are two types of solar panel wires either single or stranded wire. As the name suggests, single or solid wire contains single metal wire core while stranded wire consists of multiple stranded conductors.
- A protective sheath insulates the single wire, but there are also bare wires. Solid wire type is recommended for static application, particularly for domestic electrical wiring.
- Stranded solar wire is more flexible and has the ability to sustain frequent movement. The recommendation is to use standard wire if you install your solar system . Since there are several conductors in a single run, stranded wire offers better conductivity.
- Compared to solid wire, stranded wire has larger diameter and is more costly.



Solid



Stranded

Wire material

- Solar wires can also be classified based on the conductor material used. For domestic and commercial installations, the use of aluminum and copper solar wires is common.
- Copper wire has superior conductivity compared to aluminum. The same copper solar wire size carries more current than aluminum. Copper offers flexibility and better heat resistance.

Wire rating and thickness

- PV wires have ratings based on their maximum amperage capacity. Basically, solar panels with higher amperage (current) require thicker solar wire with higher rating. Be sure to check the amperage rating of your system and use wire that can handle the load.
- Choosing solar wire with lower rating can cause voltage drop. Over time, it can lead to overheating and even increase the risk of fire.
- Solar wire thickness is often relative to its amp. The thicker the wire; the higher the amp capacity. Identify the appliance with the highest amperage and choose a wire capable of handling this current..

Solar Cable

- Solar cable is a composite of several insulated wires enveloped by an outer jacket. Professionals use them to interconnect solar panels and other components of a photovoltaic system. They handle high UV radiation, high temperatures, and are weather resistant.
- A cable varies in diameter depending on the number of conductors it contains. Classification of Solar cables is based on the number of wires and their C.S.A.
- In general, there are three types of cables used in a PV system: DC solar cables, Solar DC main cables, and solar AC connection cables.

DC Solar Cable

- DC solar cables can either be module or string cables. Typically, these are single core copper cables with insulation and sheathes. Used within the PV solar panels, they come with suitable connectors.
- DC solar cables are pre-built into the panels, so you won't be able to change them. In some cases, you will need string DC solar cable to connect it with other panels.

Main DC Cable

- Main DC cables are larger power collector cables that connect the positive and negative cables from solar PV junction box to the charge controller.
- To avoid short circuit and grounding problem, lay cables carrying opposite polarities apart from each other.

Selecting DC cables

When selecting cables avoid these mistakes:

- Don't use cables with coarse strands.
- Don't use non-flexible cables.
- Don't use AC cables.



Standard and Colour Codes for Cables

Country/region	Three phase				Single Phase		DC		Protective Earth
	Phase A	Phase B	Phase C	Neutral	Active	Neutral	Positive	Negative	
European Union	Brown	Black	Grey	Light blue	Black or brown	Light blue	-(1)	-(1)	Green/yellow with blue markings at ends
United States	Black or Brown	Red, orange or violet	Blue or yellow	White or grey	Black(120V), Red(208V),blue(240V)	White or grey	-	-	Green or green/yellow
Australia/New Zealand	Red (2)	White(2)	Dark blue(2)	black	Red	black	Red	Black	Green/yellow
China	Yellow	Green	Red	Light blue	-	Light blue	-	-	Green/ yellow
Japan	Brown	Black	Purple	White or natural grey	Black or grey	Light blue	-(1)	-(1)	Green or green/yellow
Russia	Brown	Black	Purple	Blue	Brown	Blue	Brown	Grey	Green/yellow
South Africa	Red	White or yellow	blue	black	red	black	-	-	Green/yellow

- Notes:
- (1) No recommendation given
 - (2) There are preferred colours, active conductors can be any colour except for green/yellow, green., yellow, black or light blue.

Cable connections

- There are several ways to connect cables to batteries and other solar components.
Connections are made in a variety of ways:
 - **Bolts, nuts and screws**
 - **Screw connectors**
 - **Push connectors**
 - **MC connectors**
 - **Battery clamps**

Bolts, Nut and Screws

- The wire lugs are metal-based components that are required to make a solid connection between the connections to the batteries
- A special crimping tool is needed to attach a cable lug onto a cable.
- When connecting the cable eye to the bolt, place a washer and spring ring and then the nut.
- Ensure that the lug is flat against the surface below. Do not insert anything between the lug and the mounting surface, like washers or fuses. This will reduce the current carrying capacity of the connection.
- Use insulated tools when tightening the nut. An accidental battery short circuit can be very dangerous, and the currents can melt your uninsulated spanner, or the spark can cause a battery explosion.

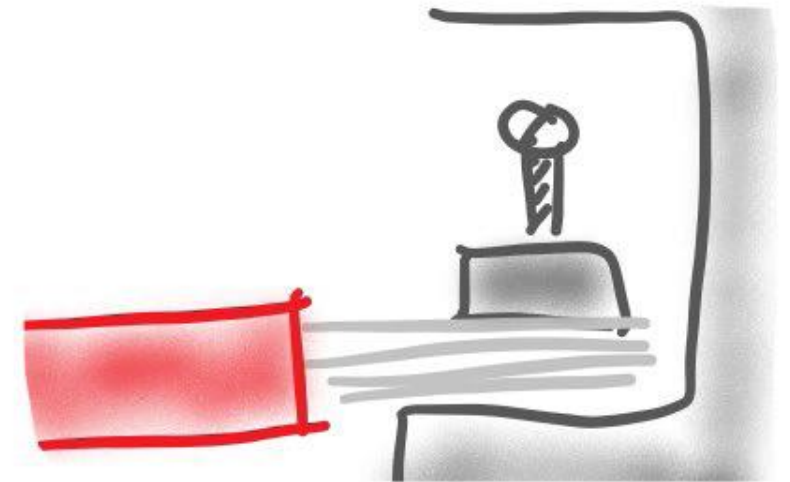
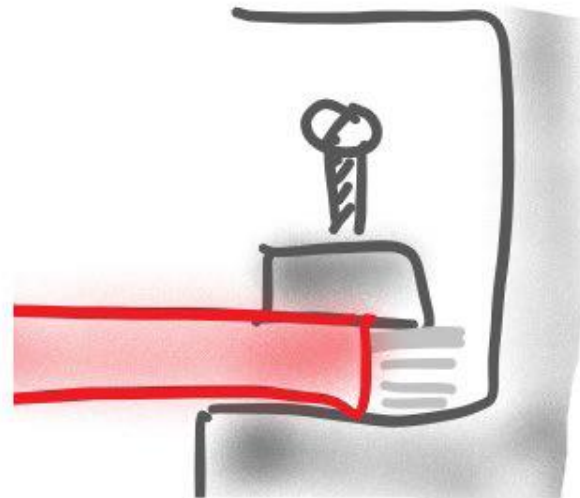
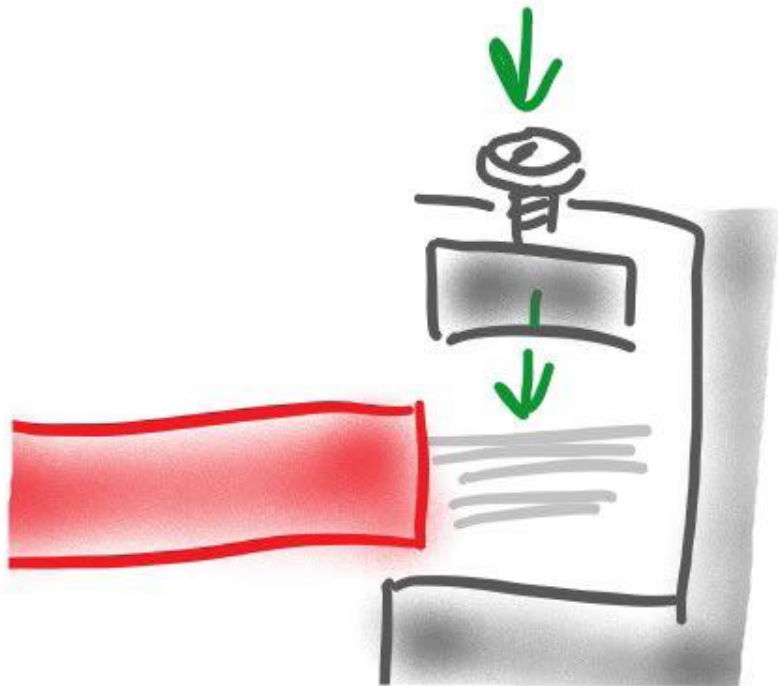
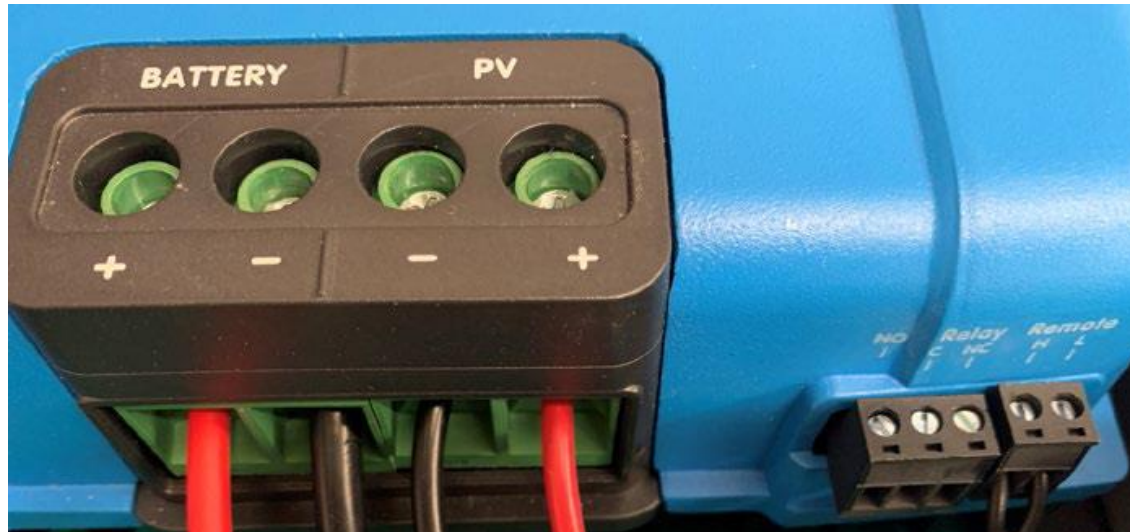
Cable lugs and nuts



Screw connectors

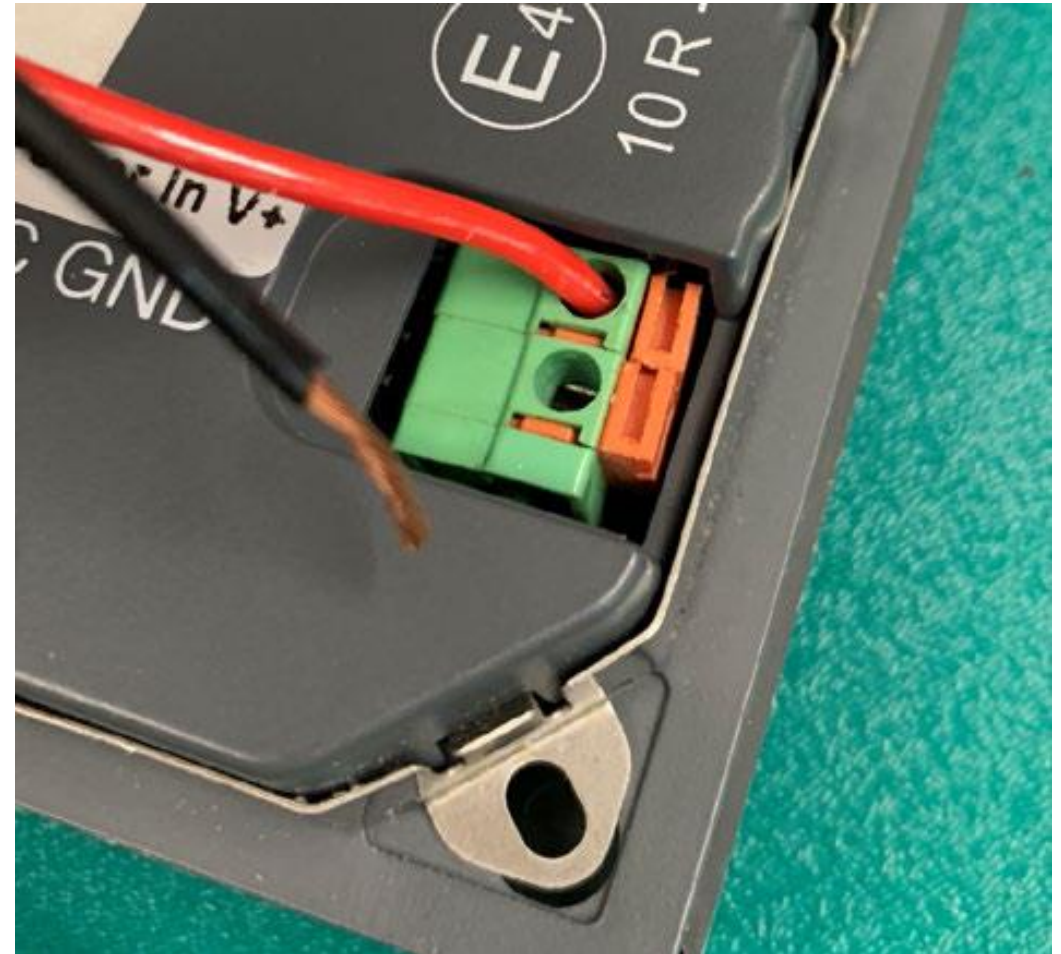
- Screw connectors come in a variety of shapes and sizes, suitable for thick or thin wires
- Strip a sufficient length of cable insulation before inserting the bare end into the connector cavity. Avoid cable insulation entering the connector. This can lead to too much resistance and the connector will heat up and potentially melt.
- Avoid un-insulated cable (bare cable) to be visible outside the connector. This is dangerous it can cause electrocution or a short circuit
- The screws inside electrical connectors are usually made out of tinned brass. Over tightening might break the screw.

Screw connectors



Push connectors

- Strip away a sufficient length of cable insulation.
- Push down the orange part with a flat screwdriver.
- Insert the stripped wire.
- Avoid cable insulation entering the connector. This can lead to too much resistance and the connector will heat up and potentially melt.
- Avoid uninsulated cable (bare cable) to be visible outside the connector. This is dangerous it can cause electrocution or a short circuit.
- Release the orange part.
- The cable is now locked in place. Give the cable a small tug to check if the cable is securely fastened.



MC connectors

- These connectors are exclusively used to connect solar panels to MPPTs. The most common is the MC4, but MC , MC2 and MC3 also exists, but are not used anymore. The letters 'MC' stand for MultiContact, this is the name of one of the original manufacturers which caught on. The digits 1 to 4 stand for the contact pin cross-section in mm².Some specifics:
- They are waterproof (IP67) and can be used outdoors.
 - Male or female connectors.
 - Rated for 20 A, 600 V (newer versions 1500 V).
 - A special crimping tool is needed.
 - Can be bought as pre-assembled cables.
 - MC4 Y-pieces (or Y cables) used to connect solar panels in parallel.



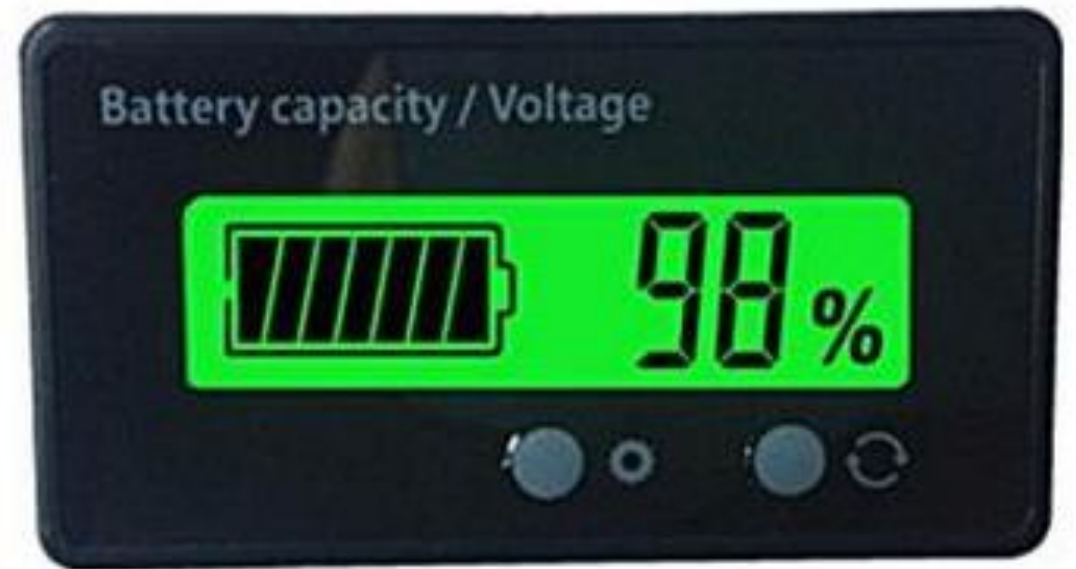
Battery clamps

- These are only meant for temporary connections.
- They often do not have a high enough current rating.
- Should never be permanently used in an electrical system.
- Limit or avoid their use.



Display

- In order to have a visual of the charging stage of your battery or the solar power output that is generated, you will need to have a display instrument.
- This device will constantly show the values of the variables related to voltage, current, and power that you can locate in any other place that has easy access.

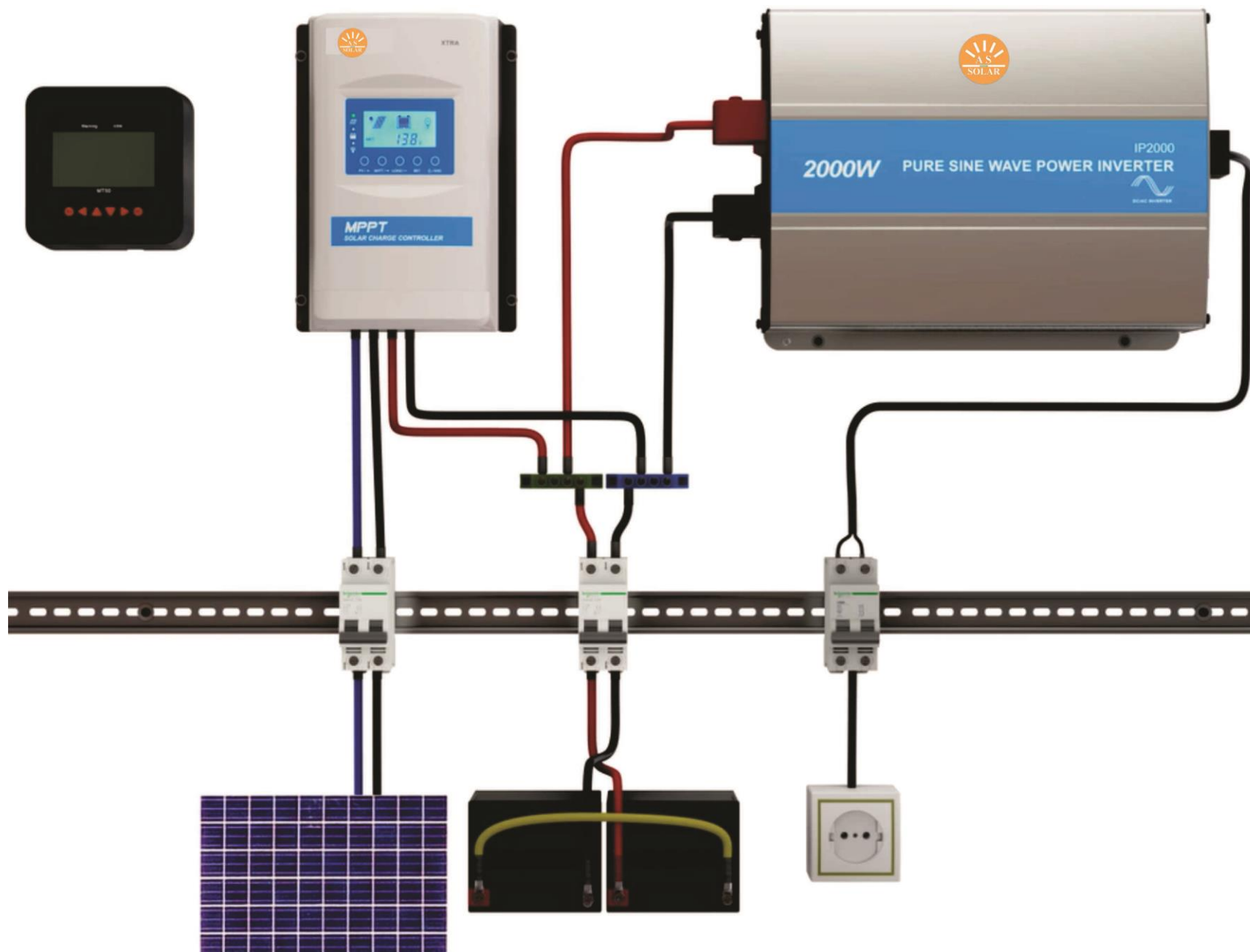


Bus bars

- Busbars are employed to connect various circuits to each other.
- To prevent confusion in wiring, busbars are suitable to reduce the amount of cables used in solar system's installation.
- Busbars terminals are electrically connected.
- Free busbars and rail mounted busbars are commonly used in solar PV systems.
- There are several uses for busbars:
Positive busbar, Neutral busbar, Ground busbar



Bus bars



AC Connection Cable

- The AC connection cable interconnects the solar power inverter to the protection equipment, load and the electricity grid.
- In a house installation, the incoming electricity is divided into groups, usually on a distribution board.
- The diameter of the electrical wiring for each AC circuit (group) needs to be matched to the size of the expected maximum current in that circuit. This is to protect the connected loads and the electrical wiring.
- Voltage-drop and heating of cables can also occur in AC circuits. Voltage drops can lead to damage of the connected appliance and can cause heating up of cables and in extreme cases can lead to house fires.
- It is also important to make good cable connections. Bad cable connections can also lead to voltage drop and heating. Use the guidelines as already described earlier.

Rules for wiring

- **Wiring rule 1:**
 - Never use longer wires than you really need. Wires should be kept as short as possible. Ideally, leave an extra metre (1 m) at each end of the cable when laying to allow for easy termination.
- **Wiring rule 2:**
 - Always use the right cable for the job.
- **Wiring Rule 3:**
 - Never use cables less than 2.5 mm² when wiring solar systems. Poor termination and insulation could lead to fires
- **Wiring rule 4:**
 - Ensure that cables are properly terminated and well insulated

Rules for wiring

- **Wiring rule 5:**
 - Never twist wires together. Always use connectors.
- **Wiring rule 6:**
 - Always use proper wire connectors. Do not use wire nuts. Instead use screw-type connectors.
- **Wiring rule 7:**
 - Ensure that all cables used follow the correct wire coding for AC and DC systems in Nigeria.