Solar PV System Installation and Maintenance

NTQF Level III

Learning Guide -16

Unit of Competence	**Install off-grid solar PV system**
Module Title	**Installing off-grid solar PV system**
LG Code	**EIS PIM3 M10 120 LO4 LG-16**
TTLM Code	**EIS PIM3 TTLM 0120 v1**

LO 4:- Carry out site preparation -16

Instruction Sheet	Learning Guide:-16

This learning guide is developed to provide you the necessary information, knowledge, skills and attitude regarding the following content coverage and topics:

- Performing pre installation procedure
- Performing procedures for installation of PV components
- Following schedule of work
- Checking Circuits/Machines/plant as being isolated
- Installing systems components to comply with technical standards & ob specification
- Terminating /splicing conductors /wires
- Accomplishing installation of off grid institutional & community solar PV system
- Following safety procedures & regulations

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:-

- Performing pre installation procedure
- Performing procedures for installation of PV components
- Following schedule of work
- Checking Circuits/Machines/plant as being isolated
- Installing systems components to comply with technical standards & ob specification
- Terminating /splicing conductors /wires
- Accomplishing installation of off grid institutional & community solar PV system
- Following safety procedures & regulations

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below:
3. Read the information written in the information Sheet 1 (page: 93), Sheet 2 (page: 96), Sheet 3 (page: 110), Sheet 4 (page: 122), Sheet 5 (page: 124), Sheet 6 (page: 127), Sheet 7 (page: 131), Sheet 8 (page: 133)
4. Accomplish the Self-Check 1 (page: 95), Self-Check 2 (page: 109), Self-Check 3 (page: 121), Self-Check 4 (page: 123), Self-Check 5 (page: 126), Self-Check 6 (page: 130), Self-Check 7 (page: 132), Self-Check 8 (page: 135)

LO4. Install Off grid PV power system Components

Information Sheet 1	Performing Pre- Installation Procedure

1 Performing pre-installation procedure

1.1 Introduction

The next step is to install the system. See Figure 57 for a high level overview of the process that will be followed in Module 10. LO4 (in Yellow) deals with the installation of the complete system.

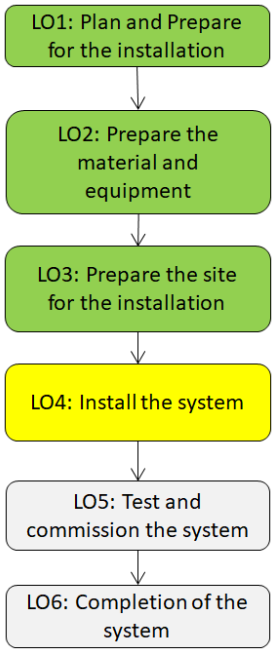


Figure 57: Installation Process

This Information Sheet deals with the pre-installation procedures. For the solar installation company, a protocol is needed to keep track of the work that needs to be carried out, i.e. planning the work schedule on site.

1.2 Planning Work Schedules

By now, detailed high-level planning has been done for the installation. Now that all equipment is on site, the site has been cleared and prepared for the installation, the areas for installation of the modules and equipment has been marked out, the work schedule should be planned by the foreman on site i.e.:

- Breaking down the tasks to be completed in logical order;
- Assigning the tasks to the relevant installer;
- Setting timeframes to complete the tasks;
- Assuring that the safety protocol is adhered to e.g. doing toolbox talks;

This should be done considering:

- The site conditions for instance, it may be a rainy day and therefore all tasks will be allocated to work indoors instead of installing the modules or certain equipment have not arrived yet and the work needs to be scheduled around that.
- The skills of the workforce e.g. allocating tasks to the person(s) that are best suited to do a proper job.
- The complexity of the task e.g. more than one person may need to be assigned to certain tasks.
- If there are trainees on site, allocating them to a suitably skilled person so that knowledge and skills can be transferred effectively.
- The available tools e.g. a certain tool is used on one task and is not available for another task.

Self-Check - 1	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	**Explain the planning of work schedules on site (4)**

Satisfactory	3 points
Unsatisfactory	Below 3 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 2	Performing procedures for installation of PV components

2 Performing procedures for installation of PV components

2.1 Introduction

It is important to follow the manufacturer's procedures for the installation of PV components. These procedures can be found in the installation manuals of the various pieces of equipment.

2.2 Mounting System

The installation manuals of the mounting system used will specify:

2.2.1 How to fix the roof anchors (hooks) to the roof

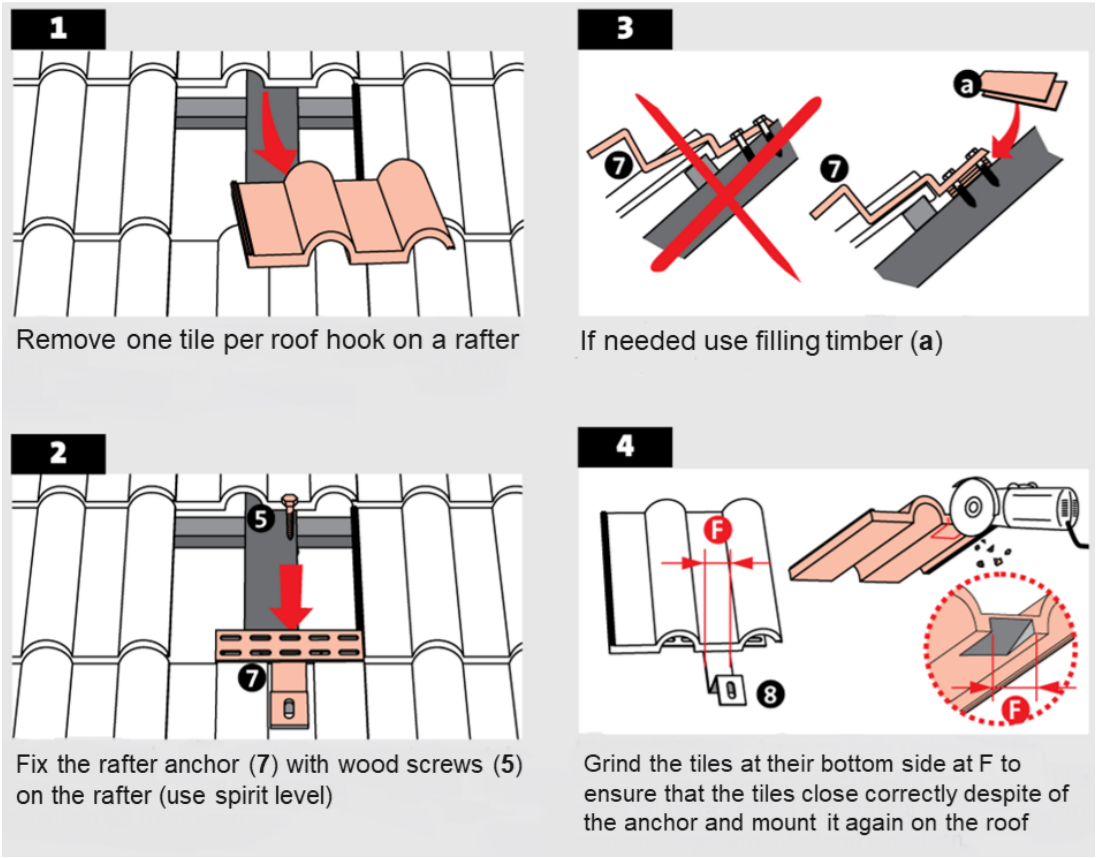


Figure 58: Fitting roof hooks for a tiled roof (source: Green SSS)

2.2.2 How to install hanger bolts

Hanger bolts are usually screwed into the purlins. For a video of the installation, look at https://www.youtube.com/watch?v=3wIdAxwYfgE

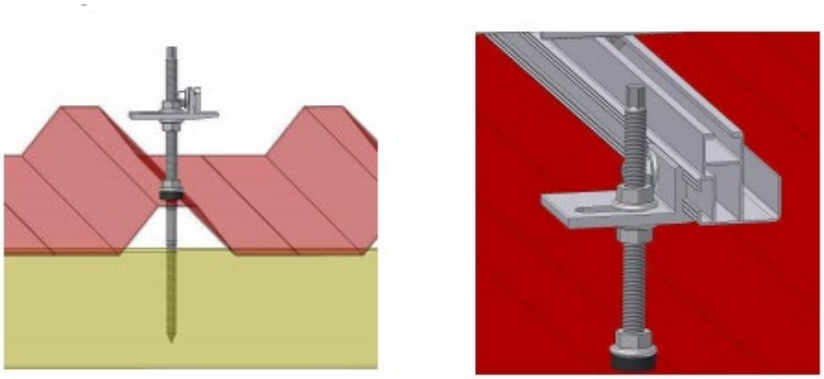


Figure 59: IBC Hanger bolts

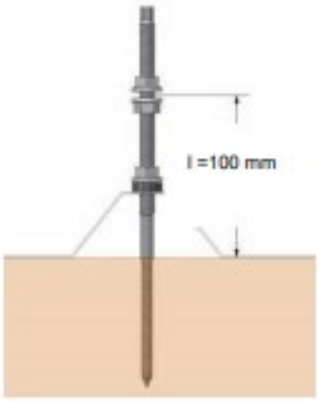


Figure 60: Hanger bolt maximum height (IBC Solar)

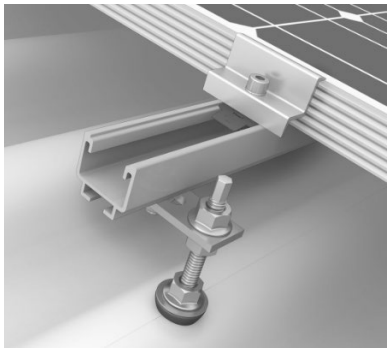


Figure 61: Hanger bolt (K2 systems)

2.2.3 Seamed Roof Clips

Seamed roof clips are non-penetrating and screws onto the seam of a seamed roof.

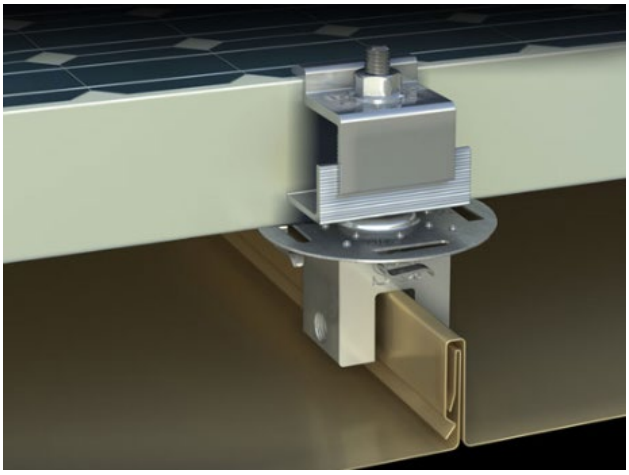


Figure 62: Seamed roof clip (renusol)

Figure 63: Rails mounted onto seamed roof clips (https://rooftech.de/)

2.2.4 Short Clamps

There are a number of ‘short clamp’ systems available where only short pieces of rail are mounted onto the roof and the modules clamped to the short rails.

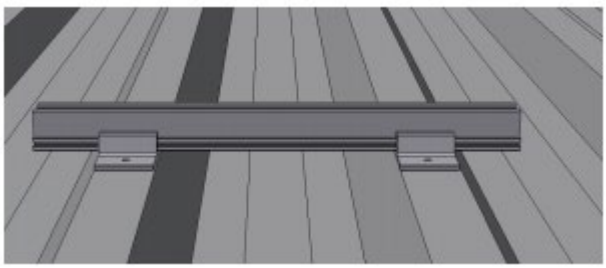


Figure 64: Short Rail (IBC Solar)

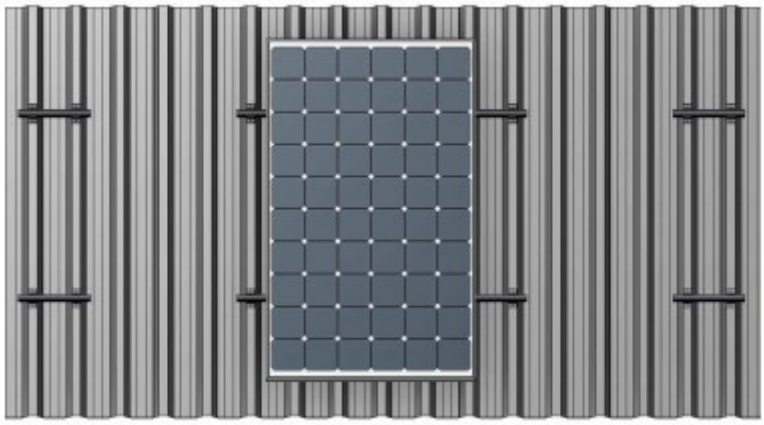


Figure 65: Module on short rails (IBC Solar)

2.2.5 Ground Mounted

There are many ground mounted systems available. Some rest on concrete footings, some are screwed into the ground and some are hammered into the ground with special machinery.

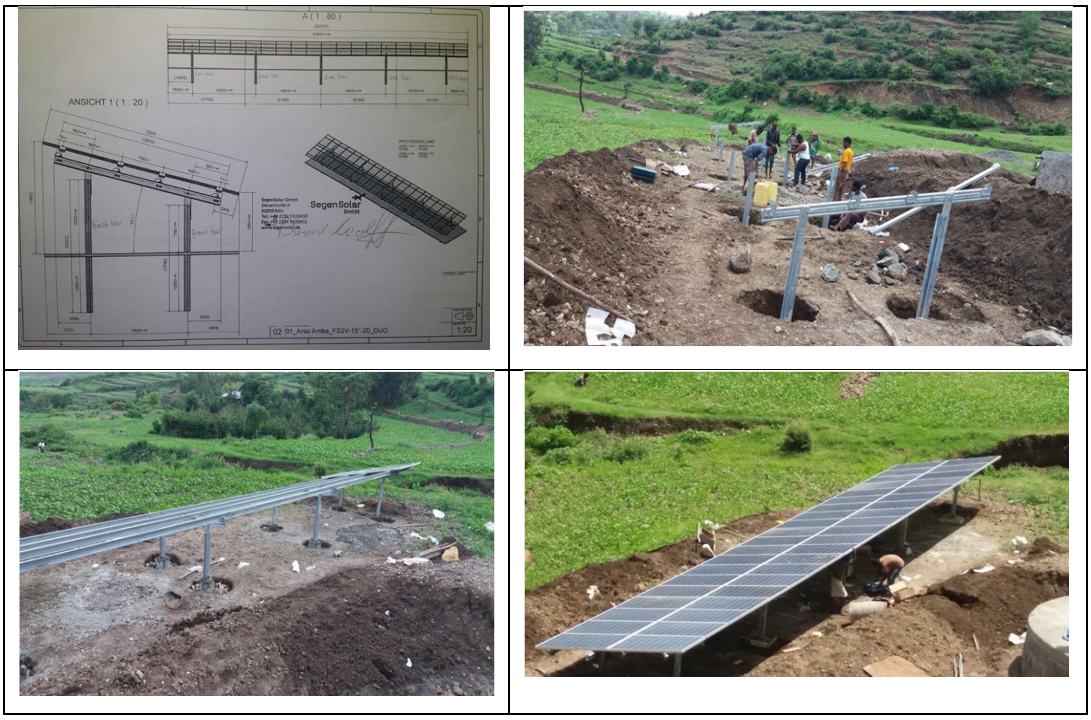


Figure 66: Ground Mount, from design to final installation (SEF/water pump installation)

Figure 67: Phaesun support structure (ground or roof mounted)

Figure 68: Schletter pile driven system

Figure 69: Screw mounting system (https://www.terrasmart.com/)

2.2.6 Pole Mounted

Figure 70: Pole Mounted System (https://cuttingedgepower.com/)

2.3 Mounting Rails

Mounting rails comes in various lengths, profiles and materials. The rail installation manual should specify:

- The maximum span between roof anchors. Some manufacturers offer sizing software to determine the number of anchors and the spans (e.g. K2 systems, IBC Solar)
- The maximum continuous rail length. Due to thermal expansion, there is a maximum length of rail before an expansion gap should be used.

2.4 Module fastening

Modules can be fastened to the rails with special clamps. There are also mounting holes on PV modules for bolting modules onto the roof.

Figure 71End Clamp (Renusol)

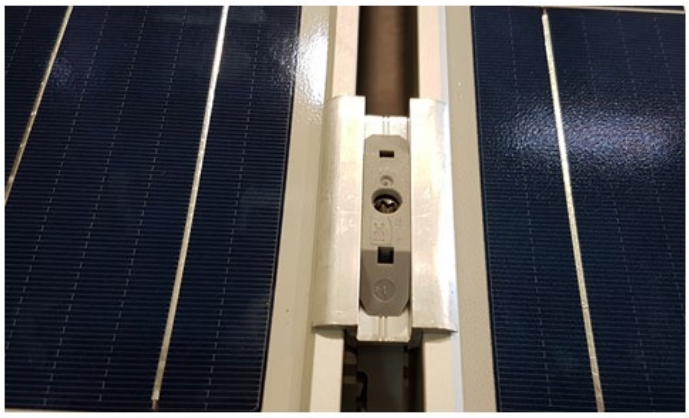


Figure 72: Mid-clamp (IBC Solar)

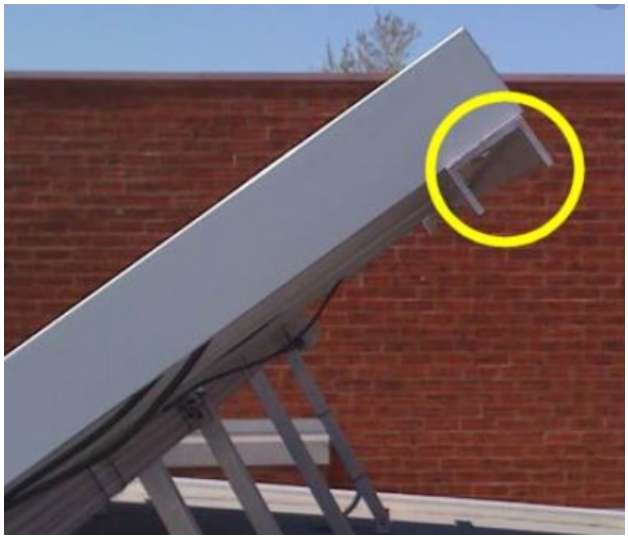


Figure 73: Solar Panel bolted to frame

2.5 Modules

As discussed in LO3 Information Sheet 3, the modules should be clamped only in the clamping zones approved by the suppliers. This information can be found in the module installation manual. Some manufacturers specify different zones for different wind and snow loading.

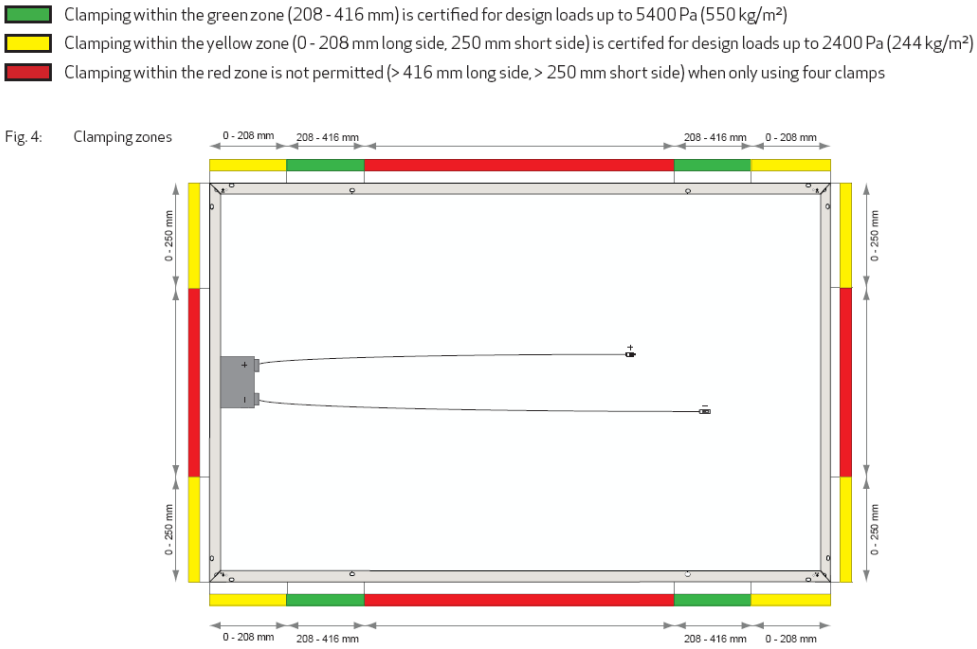


Figure 74: allowable Module fastening position [REC]

Additionally, the installation manual specifies:

- The orientation of the modules e.g. only mount modules upright with the junction box facing upwards or transverse
    - Minimum inclination e.g. 5°
    - Module backside must note come in contact with structural elements

- No drill (if needed only drill on the allowed area, Green marked on the picture
- Clamp Symmetrically at 4 points
- Minimum distance between the modules at least 10mm, 20mm recommended
- Grounding of modules as per country regulation, Green/Yellow cable;
- Safe handling;
- Cleaning.

2.6 Charge Controller and Inverter

The installation manuals for the charge controller and inverter specify:

- Mounting holes;
- Ventilation areas to keep clean around the unit;
- Connection terminals type and size;
- Fuse size;
- Cable Size;
- Connection and startup sequence e.g. batteries before PV modules etc.
- Special settings
- Safety procedures;
- Troubleshooting procedures.

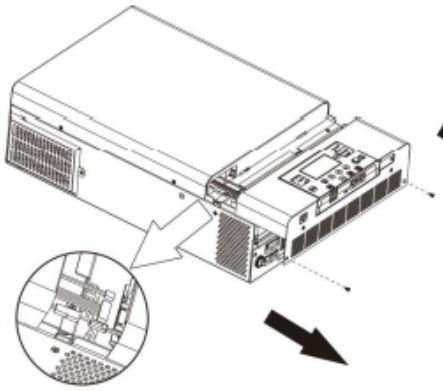


Fig. 4: Removal of bottom cover

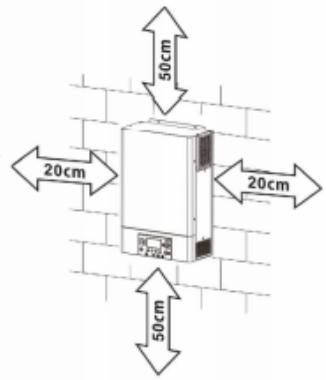


Fig. 5.1: Minimum distance to other objects

WARNING: Only mount this unit on concrete or another solid non-combustible surface capable of securely holding the weight of the unit.

- Install this inverter at eye level to ensure legibility of the display
- Ensure the ambient temperature is between -10 ~ 50 °C, 14 ~ 122 °F at all times. In order to fulfill UL requirements, inverters must be operated at an ambient temperature of -10 ~ 40 °C, 14 ~ 104 °F.
- Avoid excessively dusty environments
- The unit is designed for vertical installation on a solid wall
- Ensure a minimum distance to other objects and surfaces as shown in **Fig. 5.1** to guarantee sufficient heat dissipation and to have enough space for removing wires.
- Install in a room where noise is not an issue as the unit has fans for cooling

Install the unit by using three M4 or M5 screws (**Fig. 5.2**) appropriate for the weight of the unit and wall material, use wall plugs. The bottom screw hole is only accessible after removal of the bottom cover (**Fig. 4**). This bottom cover must remain removed for the rest of this "**Installation**" chapter until instructed otherwise.

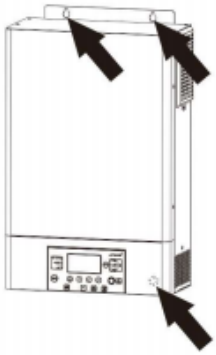


Fig. 5.2: Mounting holes

Figure 75: Phocos Anygrid mounting instructions

• WIRING SYSTEM FOR ES SERIES HYBRID INVERTER

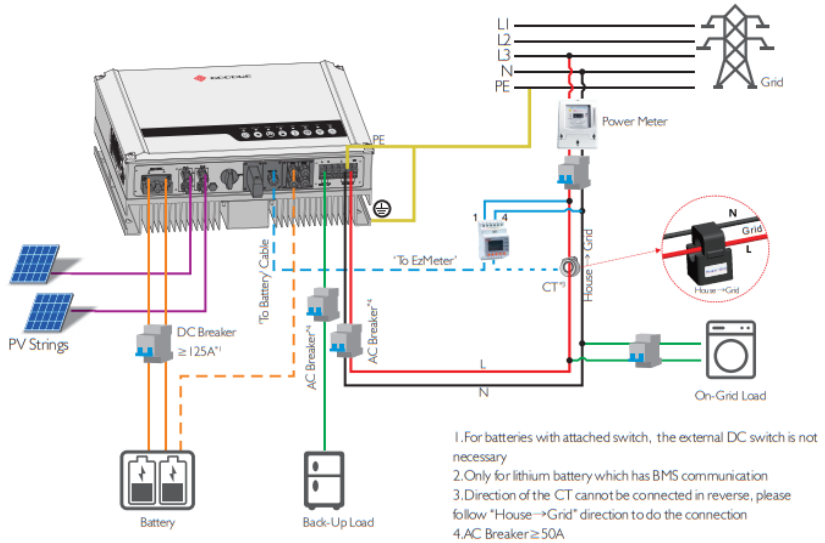


Figure 76: Goodwe hybrid inverter connections

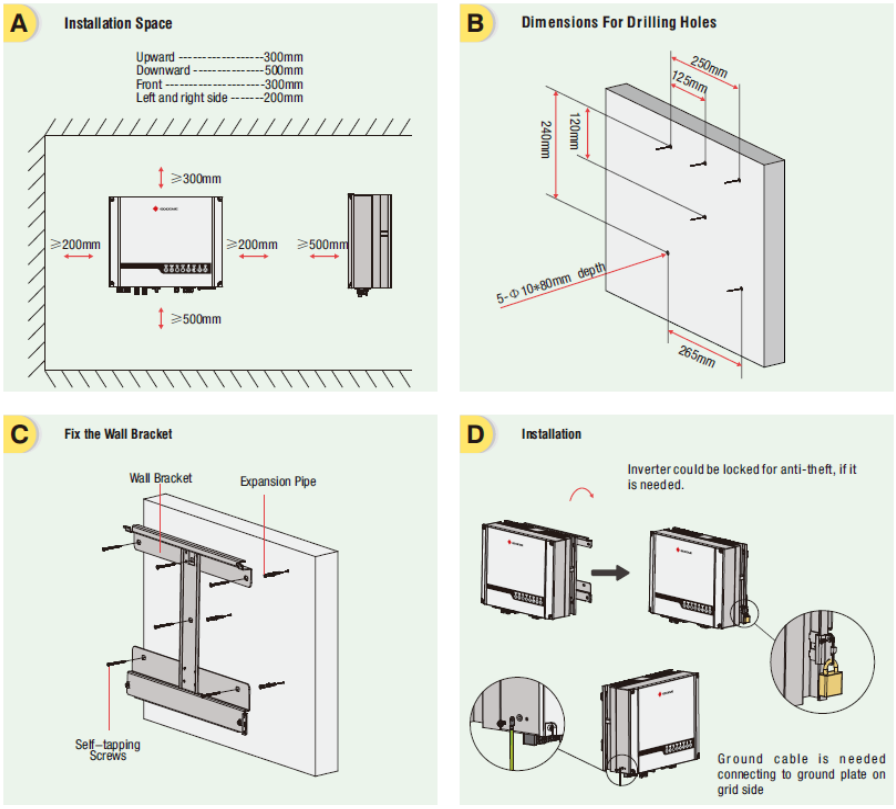


Figure 77: Goodwe mounting instructions

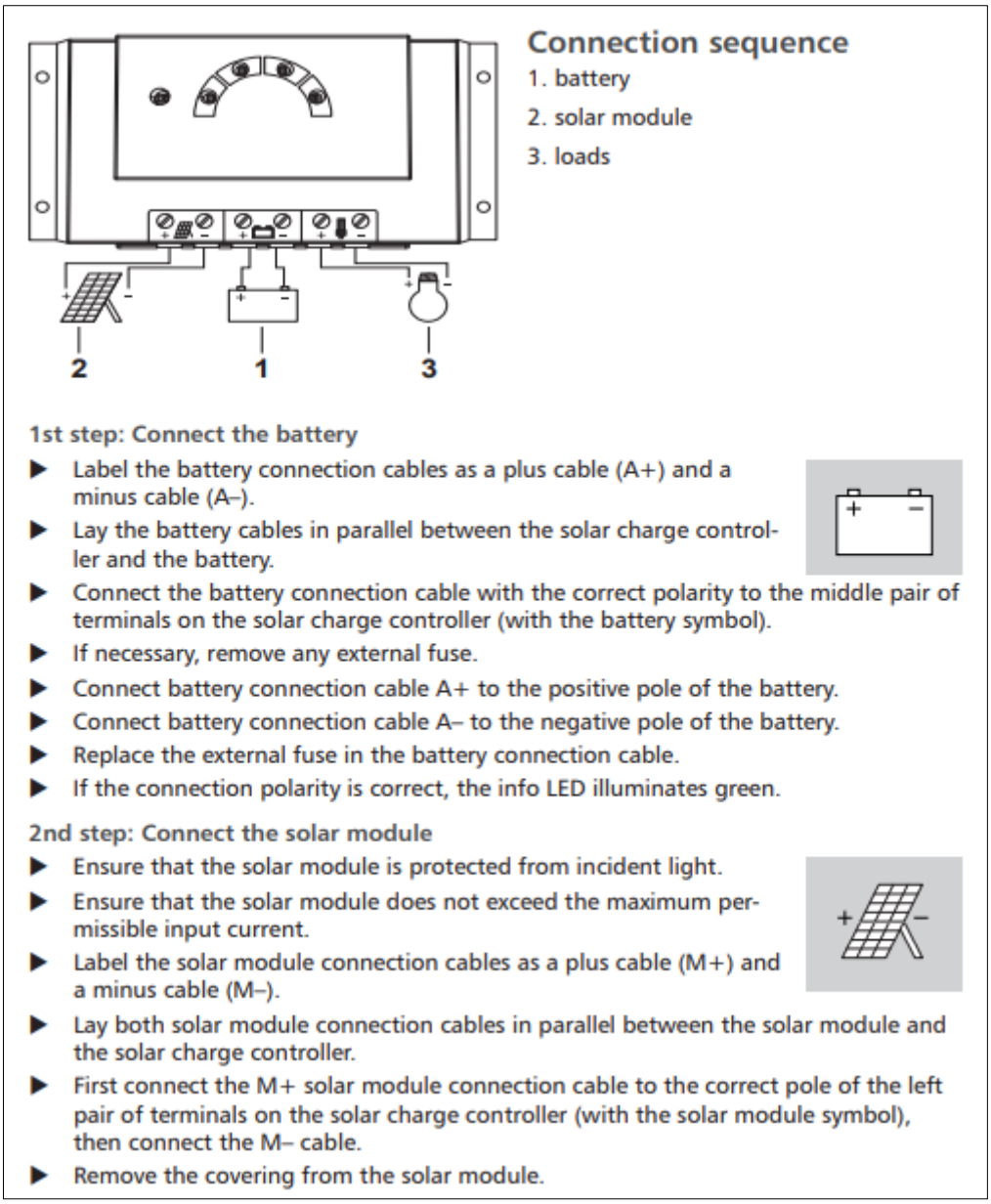


Figure 78: Steca Solarix Connection

2.7 Batteries

The battery datasheet and installation manuals specify:

- Mounting position e.g. upright or flat;
- Handling instructions;
- Cleaning and maintenance;
- Connections and terminal sizes;
- Communications ports (for Lithium batteries);
- Charging instructions;
- Filling instructions;

Figure 79: Battery Rack for Hoppecke batteries

Figure 80: Battery Connections (Pylontech)

Self-Check - 2	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	**What are the two main Solar Module mounting types? (2)**
2	**Write some of the considerations for battery installation. (4)**

Satisfactory	5 points
Unsatisfactory	Below 4 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 3	Following Schedule of work

3 Following Schedule of work

3.1 Introduction

Once all the procedures are understood (see previous section), the installation can commence.

3.2 Installing the Photovoltaic array

3.2.1 Installing the Anchors and Rails

The roof anchors and rails should be installed according to the installation manuals of the mounting system – see Information Sheet 2. In short:

- Measure and mark out the roof;
- Identify the mounting positions for the anchors (Roof hooks, hanger bolts or roof clips);
- Install the anchors
    - Install the end anchors first;
    - Use a building line between end markers to line up the row of anchors;
    - Install the rest of the anchors.
- Make sure that all holes are sealed, tiles grinded etc. to prevent water ingress into the roof.
- Install and level the rails;
    - Install the bottom and top rail first – make sure that the rails follow the roof ridge line (using a spirit level will only work if the roof is level). Use aq building line to get the rail flat.
    - Use a building line to line up the rails in the middle – the goal is a flat mounting surface.

Figure 81: Lining up roof hooks

Figure 82: Mount the rails

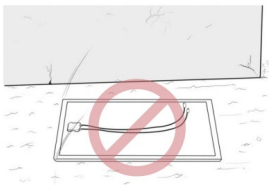
3.2.2 Handling PV modules

Solar photovoltaic modules are manufactured to withstand difficult weather conditions.

Their aluminium frames and tempered glass covering further provide strength. However, they could be damaged if they are not handled properly during transportation and installation.

It is important to note the following when handling and transporting solar PV modules:

Until installation, always transport the modules in their original packaging to prevent damage.	
Inappropriate handling may break the module ✓ Hard objects can strike the back of the module and cause permanent damage ✓ When one cell is broken, the whole solar PV module is unusable or permanently compromised and its use is limited to a low value and lower power application. ✓ Protect the PV modules against scratches and similar damage. ✓ Do not rest PV modules unprotected on its edges, as this can damage its frame.	

Never move or lift the PV modules using the cables or at the junction box	
Don’t lay solar PV module face down on any surface	
Don’t stand on PV modules	
Don’t cut or modify parts or rails of the solar PV module. I you must drill holes in the frame, drill from the base or from the side and avoid damaging the solar cells	

3.3 Mounting and connecting the modules

Mount the modules starting at one end. Connect the cables as the modules are mounted and fasten the cables to the rail so that there are no cables hanging loose on the roof.

Figure 83: Tying up the cables

Make sure you have thought your wiring plan before starting and if necessary refer to a schematic. Safety should be taken into consideration at this stage; large arrays can produce currents sufficient to shock and/or hurt you.

Be careful to follow the proper wiring techniques. Solar panels often come with a length of wire with a so-called MC4 (multi-contact 4 mm²) connector. These connectors are weatherproof and easy to plug together. There is a male and a female connector (for positive and negative connections), which makes it very easy to connect.

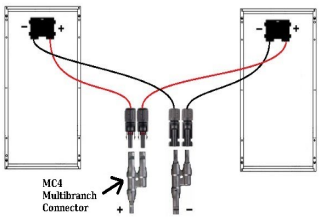
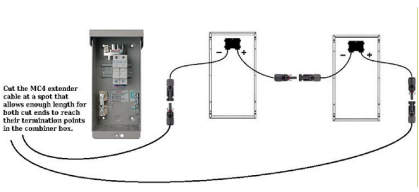
 MC4Male and Female connector	 MC4 extension cable	 MC4 Multi-branch connector
 MC4 Extender Combiner	 MC4 disconnect tool	

Figure 84: MC4 connector, Extension, disconnect tool

However, the pre-mounted MC4 connectors can only be used to connect solar panels in series. When a parallel connection is required, you will need to cut off the

MC4 connector (male or female) and use a common cable connector (screw connector). Or branch connector. Alternatively, the modules can be paralleled in a combiner box.

When connecting solar PV modules, always observe the following rules:

- Be aware that a solar array generates close to its full voltage even with minimal sunlight
- Choose a main feeder cable from the array to the charge controller to keep the voltage drop below 3%
- Avoid unnecessary cable lengths
- Use screw connectors for all connections. Splicing is very unreliable, since tight connections are difficult to assure and twisting weakens the wires. Splicing also complicates the disconnection of wires, which can be necessary for maintenance and troubleshooting.
- Connect solar module cables to the charge controller feeder cable inside a junction box or DC combiner box.
- Observe the colour code,
- Junction boxes must be protected from rain, preferably inside the roof.
- Secure the cable and protect it from mechanical stress and impact from objects such as debris, hail, etc.

Example of series and parallel solar arrays:

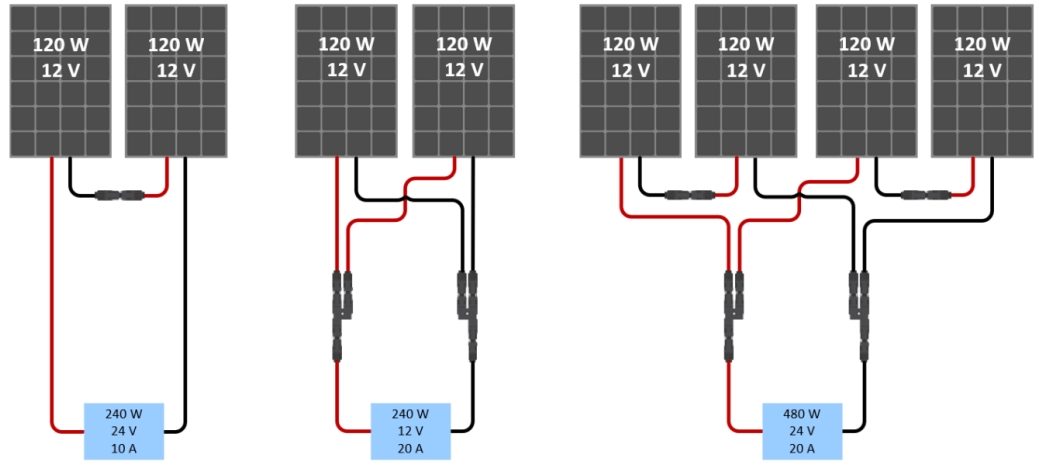


Figure 85: Example of serial and parallel solar arrays

3.4 Installing the Battery Bank

Small Home Systems have only one or two batteries while larger systems can have rooms full of batteries. Batteries vent gasses, therefore they should be installed in well ventilated spaces. This is particularly true for large battery banks.

Batteries are the most volatile component in a photovoltaic system. Work done on batteries always poses a risk and maximum care must be taken to avoid all forms of injury.

Figure 86: Battery Bank

Figure 87: SHS with one battery

Figure 88: Battery connection links

3.4.1 Parallel battery bank wiring

The correct way of connecting multiple batteries in parallel is to ensure that the total path of the current in and out of each battery is equal.

There are 4 ways to do this:

- Connect diagonally.
- Use a positive and negative post. The cable lengths from post to each battery need to be equal.
- Connect halfway. Make sure all cables have the same thickness.
- Use bus bars.

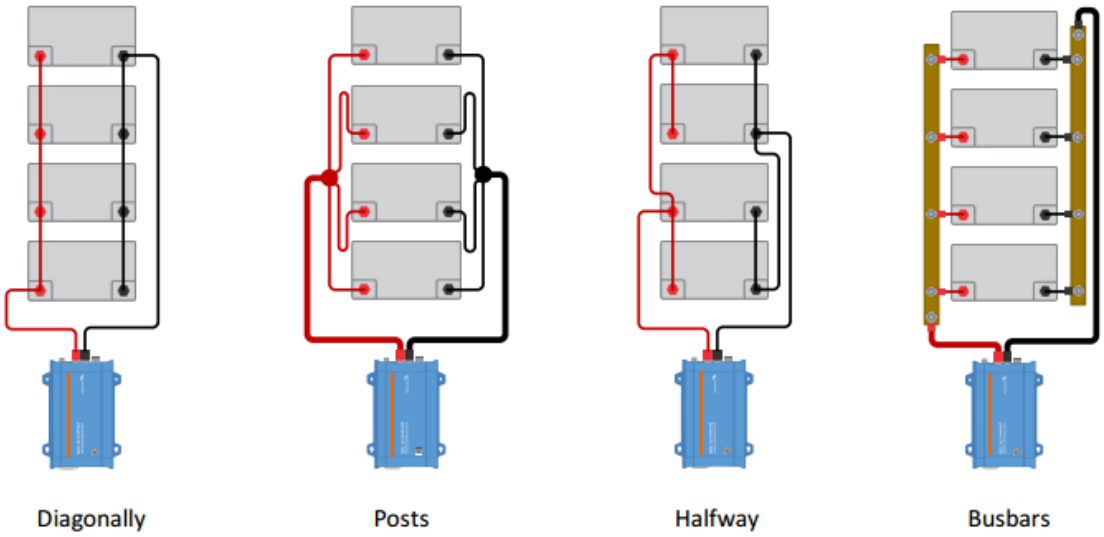


Figure 89: Parallel Battery bank wiring, Source/Victron

Table 8: Recommended Battery Cables

cable diam	cable section	L(+) + L(-) tot 5 meters	L(+) + L(-) tot 10 meters	L(+) + L(-) tot 15 meters	L(+) + L(-) tot 20 meters
mm	mm²	I max A	I max A	I max A	I max A
0.98	**0.75**	2.3	1.1	0.8	0.6
1.38	**1.5**	4.5	2.3	1.5	1.1
1.78	**2.5**	7.5	3.8	2.5	1.9
2.26	**4**	12	6	4	3
2.76	**6**	18	9	6	5
3.57	**10**	30	15	10	8
4.51	**16**	48	24	16	12
5.64	**25**	75	38	25	19
6.68	**35**	105	53	35	26
7.98	**50**	150	75	50	38
9.44	**70**	210	105	70	53
11.00	**95**	285	143	95	71
12.36	**120**	360	180	120	90

Recommended battery cables, maximum current with a tension losses of 0,259 Volt

The losses over the contacts are not included!!

The total length of positive and Negative battery cable has to be counted

3.4.2 Precausions when working with Batteries

- Care should always be taken to prevent arcing at or near battery terminals. Always open the main DC disconnect switch between the batteries and the inverter prior to servicing or working on the battery bank.
- Battery banks can store voltages with very high current potential. These higher potentials can create electrical arc hazards. Metal tools and personal jewellery can create arcing on batteries that lead to severe burns or battery explosions. Remove personal jewellery and only use appropriate tools when working on batteries.
- Always wear eye protection when working on liquid lead-acid batteries.
- Currents on the battery cables can be very high in normal operation. Choose the correct cable size and the right connectors to connect batteries.
- A short circuit on the battery terminals can result in an enormous release of energy with strong sparks. Batteries must be protected from mechanical impact (falling objects, etc.). The installation must also allow some airflow, as batteries generate warmth during use.

3.5 Installing Inverter and Charge controller

Most inverters do have a fan for cooling. Nevertheless, because Inverters and charge controllers can get very hot during operation, you should always provide enough space for a cooling airstream when choosing the installation site. Never cover ventilation slots.

The inverter can draw high currents from the battery during operation. For example, a 24 V/2,000 VA inverter might draw 2,000 VA/24 V = 83 A under full load. The

connector wires from the inverter to the battery must be strong enough to handle the maximum current.

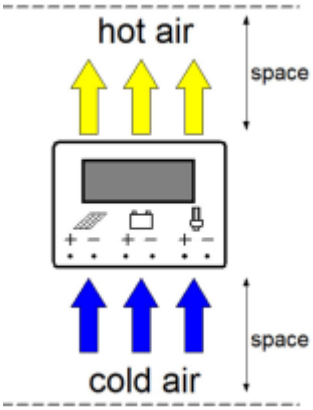


Figure 90: Cooling in a charge controller

Many inverters are immediately destroyed when connected with the wrong polarity. If the label does not say ‘polarity protected’, you should assume it’s not. Always observe the following rules when installing an inverter:

- Read the manual
- Mind the specified ventilation space around the charge controller according to the manual
- Use the battery connection cables which are usually supplied with the inverter. Otherwise, use 16 mm^2cables.
- Check if the voltage rating matches the battery
- Mind the polarity
- Make sure all connections are tight.

Always observe the following rules when installing a charge controller:

- Read the manual
- Check if the voltage and current ratings match the solar array
- Mind the specified ventilation space around the charge controller according to the manual.
- Mind possible setup options for different battery types
    - First, connect the battery
    - Second, connect the solar array
    - Make sure all connections are tight

3.6 Safety devices

Install all safety devices e.g. switches and fuses and make sure that they are in the open circuit position or that the fuses are not inserted.

3.7 DC connections

It is vitally important to connect the components of a PV system correctly. The following needs to be considered:

- Connect from the safety devices to the modules, charge controller, battery and inverter **(the safety devices needs to be open circuit).**
- When connecting components on the DC side of the PV system, you must connect the negative (-) terminal before the positive (+) terminal.
- The Charge Controller needs to be connected to the battery first before connection to the PV system. Many charge controllers auto-adjust their voltage to the voltage of the first connected source. This should be considered when commissioning.

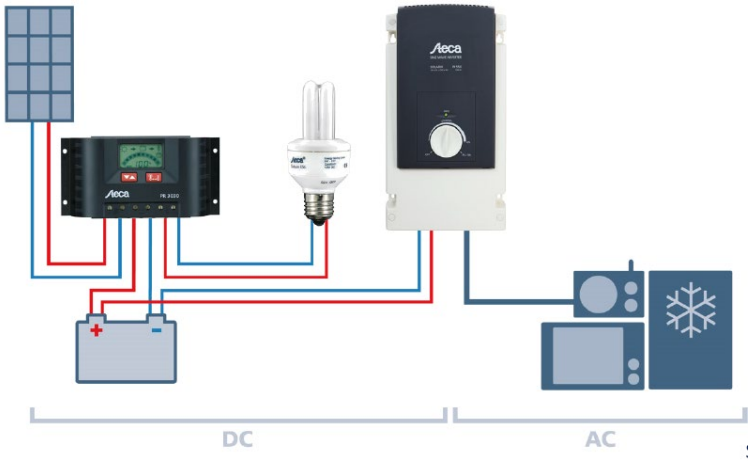


Figure 91: off- grid solar system with inverter

Self-Check - 3	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	**Explain the steps to install the Anchors and Rails (6)**

Satisfactory	5 points
Unsatisfactory	Below 4 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 4	Checking circuit/machines/plants as being isolated

4 Checking circuit/machines/plants as being isolated

Lock-out/Tag-out (LOTO) is a specific set of practices and procedures to safeguard workers from unexpected energising or start-up of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

An effective lock-out/tag-out practice requires, a designated employee turn off and disconnect any machinery or equipment from its energy source(s) before doing any required activity on the asset. This authorized employee(s) should either lock or tag the energy-isolating device(s), preventing the unwanted release of hazardous energy. Additionally, the employee(s) should take additional measures to ensure the energy has been isolated effectively.

Lockout devices are designed to keep energy-isolating devices in a safe or "off" position, preventing machines or equipment from becoming energized. These devices can't be removed without a key or other verified unlocking mechanism or through extraordinary force by using bolt cutters or a similar tool. **Tagout devices** are warning tags attached to energy-isolating devices to warn employees not to turn on or re-energize the machine. Tagout devices are easier to remove and provide less protection. It's best practice to use the two together.	

Self-Check - 4	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	When do we apply Lock out/tag out?

Satisfactory	2 points
Unsatisfactory	Below 1 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 5	Installing system components to comply with technical standards & job specification

5 Installing system components to comply with technical standards & job specification

5.1 Introduction

All components should be installed according to the manufacturer's instructions and should comply with the relevant regulations and standards for the specific country. The company may also have certain installation standards that need to be adhered to.

5.2 Standards and Job specification

Some countries will have very specific regulations for the DC installation as well as the AC installation while others may only have regulations for the AC installation. These regulations set standards for many aspects of the installation e.g.:

- Colour codes for wires;
- Wires sizes and types;
- Rules for conduit and trucking;
- Rules for laying cable in trenches or wall cavities etc.
- Label requirements.

In general, the following of sets of rules apply:

- Prepare the installation diagrams, i.e. a single-line diagram or wiring diagram, which shows the interconnection between system components.
- Install conduits (pipes and trunkings) along the planned cable route.
- Install cables in conduits.
- Label all cables according to circuits.
- Install solar panel mounting systems.
- Install system components in the pre-determined locations.
- Mount PV modules on structures at an appropriate angle (15º) and orientation (facing south).
- Connect PV modules according to desired series/parallel connection.
- Connect batteries according to desired series/parallel connection.
- For an AC system, connect batteries to the inverter (input side). Ensure that the inverter output switch is in the OFF position.
- Ensure that the main distribution board (MDB) breaker is in the OFF position.
- For an AC system, connect the inverter output to the home distribution board. Take care to ensure that only relevant circuits are connected.
- Connect the battery bank to the charge controller.

- If the system consists of DC loads, connect the loads to the charge controller.
- Connect the solar photovoltaic array to the charge controller

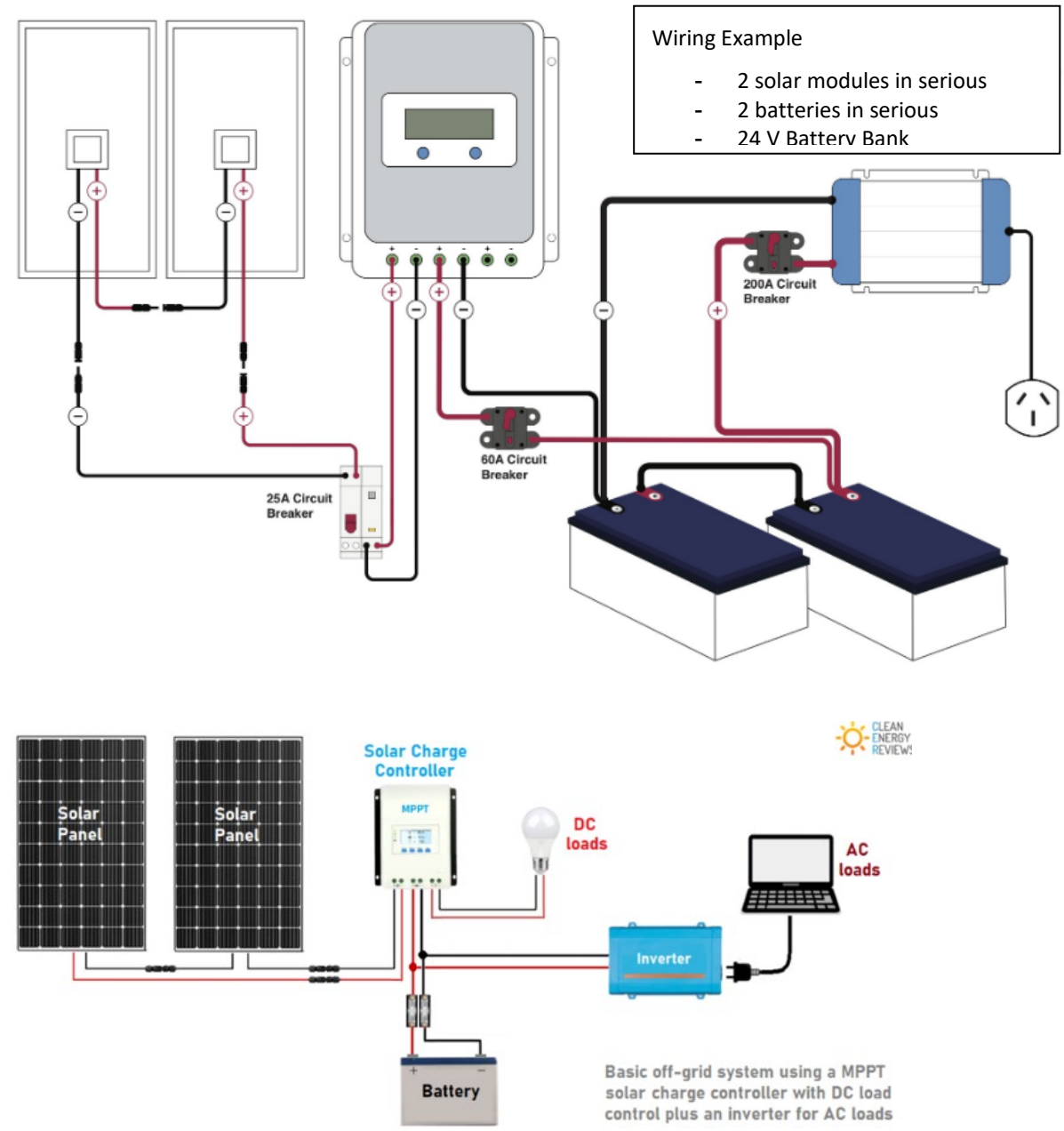


Figure 92: Wiring example

Self-Check - 5	Written Test

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	**Why is checking polarity important before we connect our solar modules?**

Satisfactory	2 points
Unsatisfactory	Below 2 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 6	Terminating /splicing conductors /wires

6 Terminating /splicing conductors /wires

6.1 Splicing and terminating cables

A SPLICE is a method to connect two or more wires together.

A TERMINATION is a connector or other treatment at the other end of wire. This can be at a piece of equipment, a terminal block or a patch panel.

6.2 Splicing

Conductor splices and connections are an essential part of any electrical circuit. When conductors join each other or connect to a load, splices or terminals must be used.

The basic requirement of any splice or connection is that it be both mechanically and electrically as sound as the conductor or device with which it is used. Quality workmanship and materials must be used to ensure lasting electrical contact, physical strength, and insulation. The most common methods of making splices and connections in electrical cables are explained below.

6.3 Types of Splices

- **Western Union Splice:-**The Western Union splice joins small, solid conductors. The steps in making a Western Union splice are:

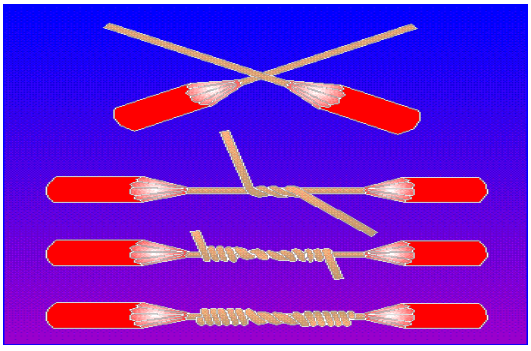


Figure 93: Western Union splice

- Prepare the wires for splicing. Enough insulation is removed to make the splice. The conductor is cleaned.
- Bring the wires to a crossed position and make a long twist or bend in each wire.
- Wrap one end of the wire and then the other end four or five times around the straight portion of each wire.

- Press the ends of the wires down as close as possible to the straight portion of the wire. This prevents the sharp ends from puncturing the tape covering that is wrapped over the splice.

- **Staggering Splices**

Joining small multi-conductor cables often presents a problem. Each conductor must be spliced and taped. If the splices are directly opposite each other, the overall size of the joint becomes large and bulky. A smoother and less bulky joint can be made by staggering the splices.

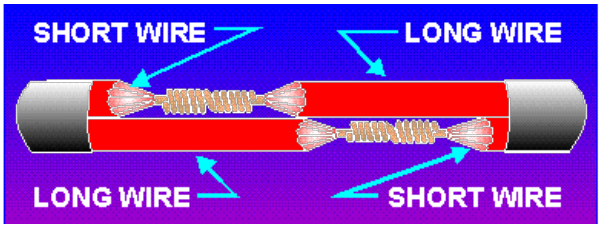


Figure 94: Staggering splices

- **Rattail/Pig tail Joint**

A splice that is used in a junction box and for connecting branch circuits is the rattail joint Wiring that is installed in buildings is usually placed inside long lengths of steel or aluminium pipe called a conduit.

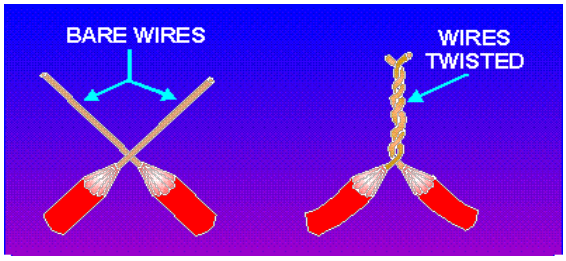


Figure 95: Rattail/pig tail joint

- **Fixture Joint**

The fixture joint is used to connect a small-diameter wire, such as in a lighting fixture, to a larger diameter wire used in a branch circuit. Like the rattail joint, the fixture joint will not stand much strain. The steps in making a fixture joint are:

- The first step is to remove the insulation and clean the wires to be joined.
- After the wires are prepared, the fixture wire is wrapped a few times around the branch wire. The end of the branch wire is then bent over the completed turns.
- The remainder of the bare fixture wire is then wrapped over the bent branch wire.

- Soldering and taping completes the job.

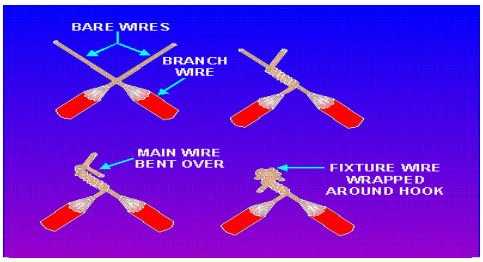


Figure 96: Fixture joint

- **T-type splicing**

T-splice is a splice that is used for connecting the end of one wire to the middle of another wire, thus forming a shape like that of the letter "T." This splice can be used with solid or stranded wires. The existing wire is called the main wire. The new wire that connects to the main wire is called the branch wire or tap wire

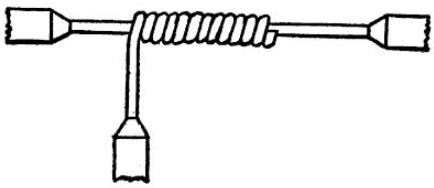


Figure 97: T-Type splicing

- **Knotted Tap Joint**

In Knotted Tap Joint the main wire, to which the branch wire is to be tapped, has about 1 inch of insulation removed. The branch wire is stripped of about 3 inches of insulation.

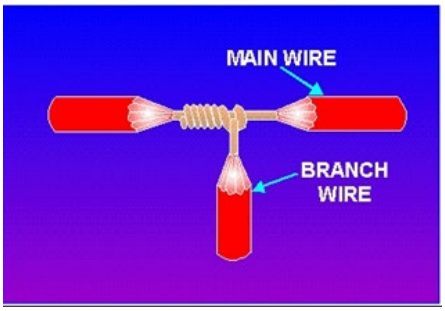


Figure 98: Knotted Tap Joint

Self-Check - 6	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	When are we using T-Type Splicing?

Satisfactory	2 points
Unsatisfactory	Below 2 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 7	Accomplishing installation of off grid institutional & community solar PV system

7 Accomplishing installation of off grid institutional & community solar PV system

7.1 Introduction

Once all installation work has been done, it should be thoroughly checked before testing and commissioning.

7.2 Final Connections

- Check all necessary wiring circuits for connection and polarity;
- Do comprehensive visual inspection, labelling and torque checks.
- Make sure that all switches is in the open position (and locked out) and fuses are not installed
- Make sure that all changes done while installing is indicated and noted on drawings so that final ass-build drawings can be prepared.
- Make sure that all tools are packed away and that the site is clean.
- Notify the supervisor that testing and commissioning can commence.


Table 9:Final look

Self-Check - 7	Written Test

The following are true or false items, write true if the statement is true and write false if the statement is false.

N°	Questions and answers
1	**Checking Polarity, Voltage and current then Connect solar module is not necessary at final connection.**

Satisfactory	1 points
Unsatisfactory	Below 1 points

Answer Sheet

Score = _____

Rating: _____

Name

Date

Information Sheet 8	Following Safety procedures & Regulations

8 Following Safety procedures & Regulations

8.1 Site safety

Sometimes it is necessary to troubleshoot a PV system that is not working correctly. Safety should be the main concern both in planning, before you go to the site and during the actual testing. Before travelling to the installation site:-

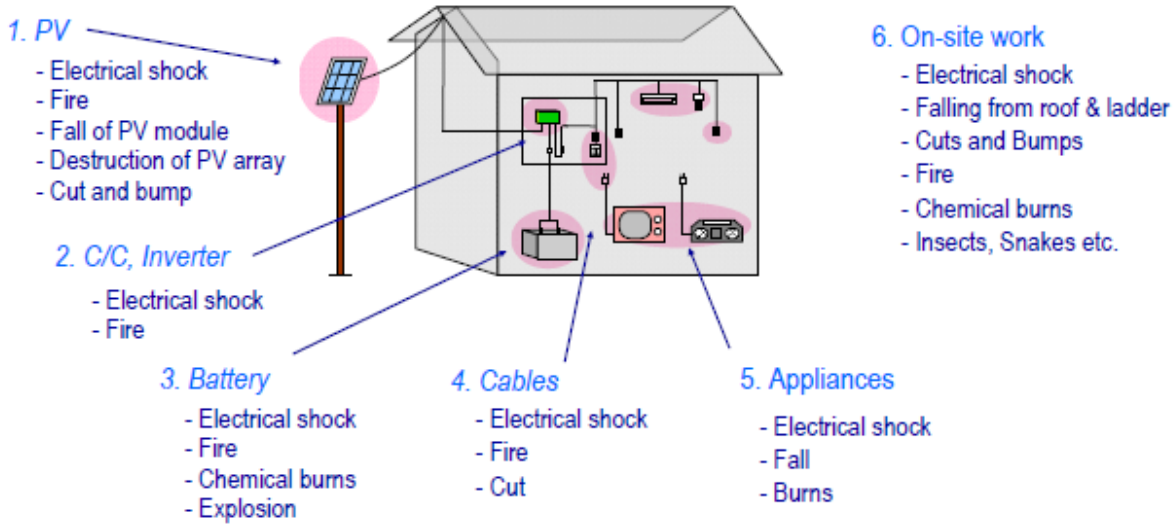
- Remove jewellery;
- Walk around the site and record any apparent hazards;
- Locate and inspect all disconnect switches, check any fuses, and determine if the switches are designed to interrupt both positive and negative conductors; and
- Disconnect the source circuits and measure the open- circuit voltage to verify the proper operation of the disconnect switch.

In addition

- Keep the work area clear of obstacles; particularly behind you and around the ladder base
- Never disconnect a wire before measuring voltages
- Keep your hands dry and /or wear gloves
- Use circuit lockout equipment and lockout procedures to prevent inadvertent reconnection. This includes safety tagging. Where this can't be guaranteed, Have a partner or team member stationed near the disconnect switches.
- Once the wire is disconnected, don't leave the end exposed –either tape it or use a cable connector for temporary covering.

8.2 First Aid

First aid can be life-saving if someone has experienced trauma, or been involved in an accident. It is highly recommended that people working in the electrical industry have first-aid training, and ensure that their training remains current



1.

Figure 99: Available risks at site

Self-Check - 8	Written Test

Answer all the questions listed below. Use the Answer sheet provided in the next page:

N°	Questions and answers
1	**Explain some of the safety consideration while working at the installation site.**

Satisfactory	4 points
Unsatisfactory	Below 2 points

Answer Sheet

Score = _____

Rating: _____

Name

Date