

Introduction

Solar energy is obtained through the use of Solar cells. The **Solar cells** convert sunlight into electrical energy, based on the principle of photovoltaic effect. When a number of solar cells are connected in series to get a specific voltage the unit so formed is called as **Solar Module**.

A **Solar panel** consists of a number of solar modules, which are connected in series and parallel configuration to provide specific voltage and current to charge a battery bank.

Solar Charge controller is the interface between Solar Panel Array and battery bank. It protects the battery from overcharging and moderate charging at finishing end of charge of battery bank.

Main Components of Solar Photo Voltaic System

The solar power system consists of the following components:

- Solar array
- Battery bank
- Solar Charge Controller
- Field Junction Box (FJB)
- Module Mounting Structure
- Earthing kit
- Cables

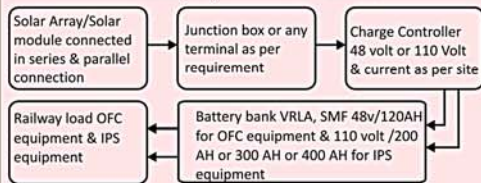


Fig. 1: Block diagram of Solar Photo Voltaic System

Installation Guidelines

The installation of Solar Power System involves the following major steps:

- Civil Foundation Job
- Assembly and fixing of support structure.
- Mounting of Solar Modules on the Support Structure.
- Installation of Battery Bank.
- Interconnection of SPV panel in series & parallel configuration, Charge Control Unit and FJB
- Connection of Battery Bank and Load
- Earthing of Lightning Protection Unit.

For getting maximum output from the solar modules:

- Modules should be oriented south facing to receive maximum sunlight.
- Any obstruction (such as tree or building) should be avoided in East, West or South of the place of installation. The following is the criteria:
 - East or West: The distance between solar panel and obstruction should be more than double the height of obstruction.
 - South: The distance should be more than half the height of obstruction.
- The support for the Solar panel need to be a robust one and should not be accessible to general public. It should be so installed that rainwater, bird dropping, leaves etc. do not accumulate and the top surface can be cleaned easily

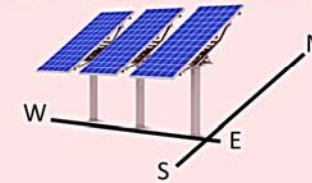


Fig. 2: Orientation of Solar Panel

- Locate the PV site latitude.
- Install solar panel at an angle given by $\theta = (\text{LATITUDE of the site} + 10)$ degree from horizontal. (Ref. Fig. 2)
- Maintain space between adjacent rows to avoid shadow of one module over other.
- The minimum panel spacing W is given by the formula $W = H \times U$, where H is the vertical height of the panel from the base as shown in fig.3 below and U can be determined from the table A corresponding to the latitude of PV site.

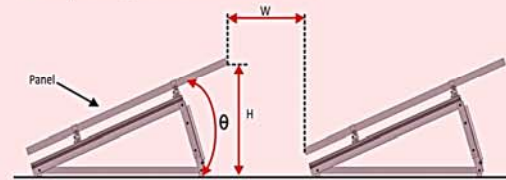


Fig. 3: Measurement of minimum panel spacing

Latitude	U
0	0.614
10	0.885
20	1.259
28	1.699
30	1.842
32	2.001
34	2.195
36	2.404
38	2.667
39	2.818
40	2.972
41	3.166
42	3.359
44	3.844
46	4.499
50	6.547
55	14.520

Maintenance

For maintenance of Solar panels require the associated equipments such as batteries and charge controllers are to be maintained. Once in a fortnight the surface of the panels should be wiped clean with wet rag to remove dust, fallen leaves, bird dropping etc. Only water is used and no other cleaning agent. General periodical maintenance of battery should be carried out in usual manner and as per maintenance manual.

Precautions and Preventive Steps

For efficient working of SPV system please ensure that:

- The SPV Panel is installed facing SOUTH and with the correct 'Angle of tilt'.

- There is no shadow on any part of the SPV Panel at any time of the day, to get maximum power.
- SPV Modules are protected against any act of vandalism and accidental strike or hit by heavy objects, like stone, hammer etc. If the SPV Panel is installed on ground, it must be fenced properly to protect it from cattle and to prevent from any damage/theft. Fencing should be made in such a way that no shadow should fall on SPV Panel at any time of the day.
 - Switch OFF MCB of Charge Controller before any connection.

- SPV Modules are connected in parallel and output voltage of one SPV panel is less than 25 Volts in open circuit conditions & under normal sunshine condition (for 12 V battery).
- All connections are properly made tight and neat using the crimped Red (for +ve) and Black (for -ve) wires supplied by the manufacturer in order to avoid reverse connection.
- The rating of the fuse in the charge controller is not changed.
- Make sure that the Solar PV module gets direct sunlight throughout the day where you install it.
- FIRST the Battery Bank, then SPV Panel and then Load is connected to SPV Charge Control Unit and for disconnection reverse sequence is adopted.

Charge Controller will be damaged if SPV Array is connected first and then the Battery bank

- Battery terminals are never shorted even momentarily as shorting will result in HEAVY SPARK AND FIRE. (To avoid the same connect the cable at Charge Controller end 'First' and then Battery end.)
- Never connect the Load directly to the SPV Panel as SPV Panel may give higher/lower voltage than required by the Load Equipment and hence the equipment may be DAMAGED permanently.
- Blocking diode is provided at the array output for protection against reverse polarity.

- The Green indicator on Charge controller is only an indication for charging. It will glow even at small amount of charging. So to ensure efficient charging, the availability of direct sunlight over the Solar PV module for the maximum hours of the day should be ensured.
- It is NOT HEAT BUT LIGHT that produces energy. So let direct sunlight to fall on the module surface without shades.

Switch ON MCB of the Charge Controller when all the connections are thoroughly checked and fuses are replaced in the junction boxes.

Troubleshooting

When the SPV Power Source is not able to drive the connected equipment:

- Check the voltage of the battery bank.
 - Typical per cell voltages at ambient temperature 24° - 25° C
 - Boost charging upto : 2.34 V
 - Float stage voltage maintains : 2.29 V
 - Boost stage reactivates at : 2.14 V
 - Battery low at : 1.74 V
- Check the fuses and diodes in field junction box.
- If the voltage is correct, then either inverter is tripped or switch/load MCB is tripped or load fuse is blown off. If none of the above is observed then check the specific gravity of the electrolyte in the secondary cells of the battery. There may be two cases:
 - If the specific gravity is above 1.2 (Hydrometer reading 1200) value or as specified, the battery is in order and the problem would be either with the Charge Controller or Load. Disconnect the load (S & T Equipment) from Charge Controller and connect it directly to Battery Bank. If the equipment operates, the defect may be with the Charge Controller.

- Disconnect the Charge Controller and check as per troubleshooting instructions given in the manual supplied with it or inform the manufacturer/supplier.

- If the specific gravity of the electrolyte is below the specified level and BATT/LOW (Red)) LED is glowing, the problem may be with any of the following:

Load: This may be drawing more current from the battery than required. In such case, check the load equipment and replace any defective components

SPV Panel: The SPV Panel may not be producing required power. In that case:

- Check for any loose connection/breakage of wire in SPV module interconnections.
- If there is no such loose connection, clean the SPV Modules with soft cloth.

Failure of blocking diode: Blocking diode fails in short circuit and open circuit mode. If it is failed in short circuit mode, voltage across its terminal will be zero in place of 0.7 V while charging current flows through it. When it fails in open circuit mode, the current will not flow through the diode. The diode may be checked as per standard method of checking of diode by removing from the circuit.

Whenever there is bright sunshine, the Open circuit voltage of each module should be around 21 volts and short circuit current should be as per table given in manufacturer's manual.

Disclaimer

It is clarified that information given in this pamphlet does not supersede any existing provision laid down in "Signal Engineering Manual", Railway Board publications and RDSO publications. This document is not statutory and instructions given in it are for the purpose of guidance only. If at any point contradiction is observed, then SEM, Railway Board and RDSO guidelines or Zonal Rly. instructions shall be followed

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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

Installation & Maintenance of Solar Panel



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