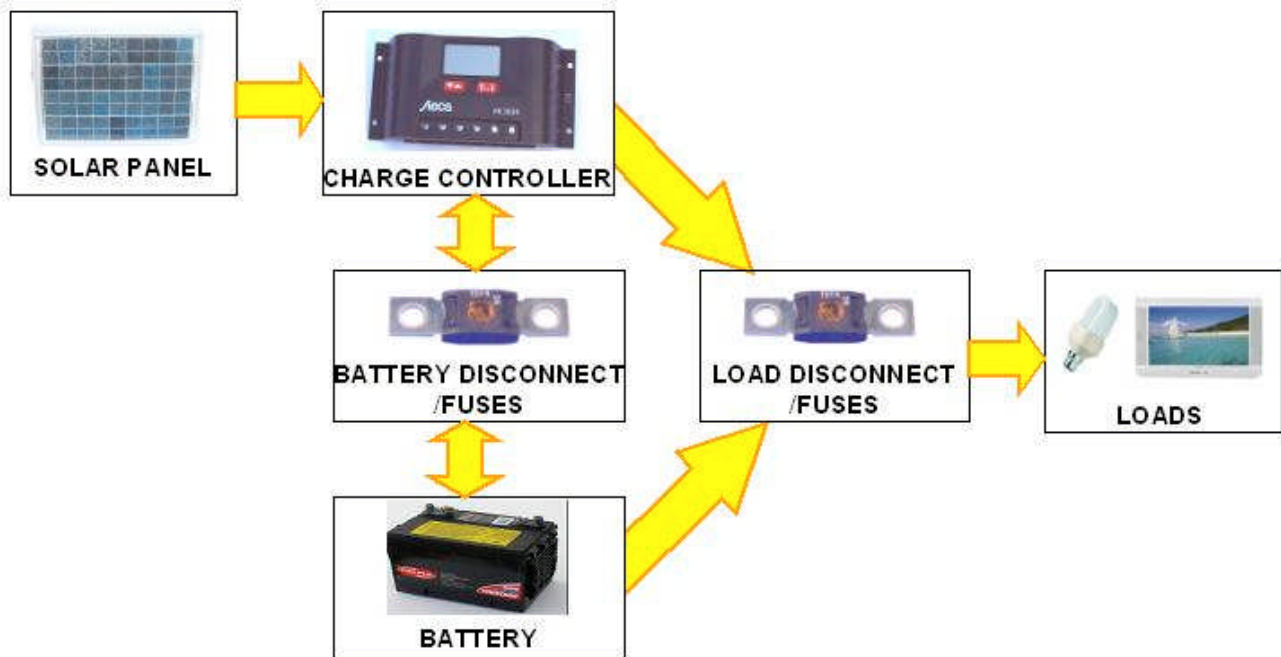


BASIC SOLAR SYSTEM GUIDE

The purpose of this guide is to provide you with a basic understanding of the things that you need to take into consideration in the design and supply of a solar system. When we discuss your system requirements with you, all of the things in this document are important to enable us to come up with a system that is tailor made for you.

A basic solar system comprises the following items;

- Solar panels
- Mounting of Solar panels
- Charge controller
- Circuit Protection, fuses etc
- Cable
- Battery



SOLAR PANELS

Determining the size of the solar panel you need is all about calculating the amount of energy you need to produce to balance with your ACTUAL energy consumption. We can calculate your energy consumption by looking at each item of electrical equipment that you want to run off the system, then, by multiplying the wattage (or current consumption) for each item by the amount of time you estimate you will use each item in a day, we can calculate the optimum panel size for your system.

For instance, if you use 6, 15 Watt (W) low energy bulbs for 3 hours per day the energy consumption is;

$$6 \times 15 \text{ Watts} \times 3 \text{ hours} = 270 \text{ Watt hours (Wh)}$$

If a pump uses 3 amps (A) powered by a 12 Volt (V) battery, and runs for 4 hours per day, the calculation is;

$$3 \text{ Amps} \times 4 \text{ hours} = 12 \text{ Ampere hours (Ah)}$$

$$12 \text{ Ah} \times 12\text{V} = 144 \text{ Wh}$$

On average, in the UK in summer, a solar panel will produce 4 x its rated maximum output in Wh per day. Therefore a 40W panel will produce;

$$4 \times 40\text{W} = 160\text{Wh}$$

In winter in the UK expect 1 x its rated maximum therefore the 40W panel will produce on average 40Wh per day.

The usage pattern of the loads also needs to be taken into account. For instance, if the system is only used at weekends, the solar panels have a week to produce the energy that you will use at the weekend and so a smaller panel can be used. OR, if the system is for summer use only, the size of solar panel required will be smaller.

PANEL MOUNTING

We recommend that wherever possible, a solar panel is installed permanently because it will be generating all of the time and will be out of the way so as to avoid any damage.

Site Latitude in Degrees	Fixed Tilt Angle
0° to 15°	15°
15° to 25°	Same as latitude
25° to 30°	Latitude + 5°
30° to 35°	Latitude + 10°
35° to 40°	Latitude + 15°
40° +	Latitude + 20°

Wherever possible the panel should face south (north in the Southern Hemisphere) and be tilted from the horizontal. If the panel is in a fixed position the optimum tilt angle for all year round performance is based on where in the world it is mounted, as given in the table.

For the UK the latitude is between 50° for the very South of England to 58° for the Northern tip of Scotland therefore the tilt angle should be between 70° and 78°.

Mounting surfaces vary e.g. slate, tiles, caravan roof, flat building roof and we can supply mounts for all types of structures. Some of our more basic products are available for purchase from the website, for any other products please contact us for details.

Choosing the site for the panel is extremely important primarily because you must avoid any shadow on the face of the panel to maximise the charging while the sun crosses the sky. Even a small amount of shade can reduce the solar panel output to virtually zero.

CHARGE CONTROLLER

The rating of the charge controller;

- *must be greater than the combined short circuit currents (I_{sc}) of the solar panels and,*
- *if power is to be taken through the controller to power an item, must be greater than the maximum current that can be taken by the item.*

You will find the short circuit current (I_{sc}) from any panel specification document you may have or from the rating plate that is fixed to the back of the solar panel.

Using the previous example for the 6 bulbs the combined maximum load current would be;

$$6 \times 15W / 12V = 7.5A$$

Therefore if the bulbs were connected to the load terminals of the controller it would need a rating of at least 7.5A.

If the load is being taken through the controller it is worth ensuring that the controller has a Low Voltage Disconnect (LVD) function which switches off the load connection if the battery becomes over discharged, so further protecting the battery.

Controllers include circuitry to compensate for changes in the temperature of the batteries because the amount of charge a battery requires changes with temperature. The controller should therefore be installed in the same space as the batteries. Some of our controllers (PR range and Tarom) have remote temperature sensors which enable them to sense the battery temperature but be mounted remotely from the battery enabling the display to be seen easily.

BATTERIES

Batteries are sized to provide sufficient energy to run the system without any battery charging taking place for a number of days, how many days depends on the criticality of the loads.

The information supplied to calculate the solar panel size is also used to calculate the battery capacity. Using our 6 low energy bulb example, for each day of standby capacity required the battery capacity would have to be;

$$270Wh/day / 12V = 22.5 Ah$$

Bear in mind that charge controllers with an LVD function will switch off the load when the battery charge has reduced to 30% in order to protect the battery. Anything lower than this can reduce the capability of the battery to hold a charge. Quite simply, this means that only 70% of the battery capacity is usable.

Therefore per day the battery capacity would have to be;

$$22.5Ah / 70\% = 32.14 Ah$$

Therefore if it is critical that the lights work every day, even in winter we would probably use a standby capacity of 7 days, giving a total battery capacity of;

$$32Ah \times 7 \text{ days} = 225Ah$$

BATTERY CIRCUIT PROTECTION

It is necessary to provide circuit protection in the positive cable as near to the battery positive terminal as possible. The protection ensures that if there is a fault in the system that short circuits the battery that the battery is isolated quickly. Without this protection a short circuit could cause a fire.

Protection can be achieved using fuses and circuit breakers which must be rated for the dc voltage being used. Components only rated for ac are unsuitable.

CABLE

mm²	AWG
1.0	18
1.5	16
2.5	14
4	12
6	10
10	8
16	6
25	4
35	2

Cable sizes are expressed by the cross sectional area of the conductors, usually in mm², although you may see some cables given in AWG sizes. The table shows equivalent sizes.

The size of cable required is dependent on the length of the cable used, the power it is to transmit, and the system voltage. Using the correct size cable will keep the voltage drop, along the length of the cable, to a minimum which will minimise the solar energy loss. Using the incorrect size cable can result in the battery never being fully charged.

LOADS

Loads can be connected;

- *directly to the battery, or*
- *through the charge controller load connections*

Because of the high currents required, inverters should only be connected directly to the battery, for example, a 1000W / 12V inverter will take in the region of 100A from the battery when running at full capacity.

All load connections need to be protected by fuses or circuit breakers in the same way as the battery to controller connection.

LOSSES

In the example calculations we have not taken into account any losses that are part of the system. These include;

- *inefficiency of the batteries to accept charge*
- *inefficiency of the wiring*
- *inefficiency of the solar panel*

We take all of these into consideration when performing our system calculations.