Technical Note:
How to remote/solar power the Dust Monitor

Many customers choose to power their Dust Monitors using solar photovoltaic (PV) panels and batteries or just batteries alone.

This technical note provides a guidance for the construction of an off-grid power source for the Dust Monitor. On page 2 you can see a worked example for a typical Dust Monitor.

This guidance applies to both the Dust Sentry and Dust Profiler

Two off-grid configurations are considered:

1. A solar panel array with battery bank
2. A battery bank with external battery charger.

Key PV system elements include:

- Solar panels - convert sunlight into electric energy
- Deep cycle batteries - store power produced by solar panels and provide power to instruments
- Charge controllers - protect batteries from overcharging and optimize the battery charging function
- Wires and cables - connect the electrical components

Supporting structures include:

- Panel mounting - supporting framework for the solar panels
- Battery enclosure - protects batteries and charging circuitry from environmental elements

Optional system components include:

- Combiner box - combines the output of each individual solar panel into one circuit
- Disconnects - circuit breakers that protect the various system components; one disconnect is placed between the solar panels and the batteries and another is placed between the batteries and the instruments.

Designing a PV system

The off-grid PV system must keep up with regular power demands and infrequent peak periods. Keys to the design of such a system are: (1) computing power demands of the instruments, (2) evaluating how many batteries are needed to ensure operation at night and on overcast days, and (3) determining the number of solar panels that are required to satisfy power demands.

Power requirements

The first thing to know before designing a PV system is the power requirement of your system. You need to consider the following points:

- The 110/240VAC power supply will be bypassed in an off-grid application as the PV system will connect directly to the 12VDC inputon the Dust Monitor.
- A Dust Monitor with a modem and one third party sensor (e.g. wind speed and direction) consumes 24W (8.5W of this is used by the heated inlet).
- A regulated 12VDC input (± 2.5%) with <150mV (pk-pk) ripple is required for the Dust Monitor since the sampling pump is connected directly to the 12VDC supply and any fluctuation in supply voltage will cause a change in the sample pump speed and could affect the measurement.
- Due to the regulated 12VDC input requirement, a DC/DC converter should be installed between the solar system battery and the Dust Monitor input.
- Efficiency of the DC/DC converter may only be 85%, meaning the power requirement will be 28.2W in to get 24W out.

Compute amp-hours per day

To compute amp-hours per day, multiply the total system wattage by 24 hours and divide number with 12V. It is also necessary to apply a loss factor for the batteries (20% is a conservative guide).

Determine the size of the battery bank

Batteries are needed to provide power to the system during the night and through periods with overcast skies. The size of the bank will vary with latitude and according to your climate. For this reason alone engaging a local expert is strongly advisable. You also need to consider that the batteries should never be fully discharged, as they can be damaged.

Determine the number of solar panels

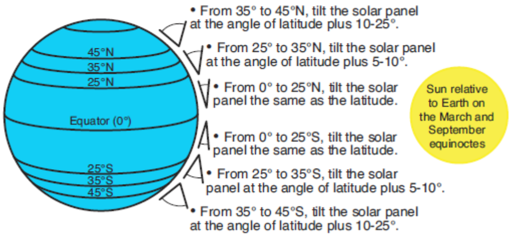
Solar panels must be sized according to the amp-hours per day for your system, and the efficiency of the panel. The number of sun hours per day determines the number of panels, and is location dependant. To find out the solar insolation (given in kWh/m2/day) for your location you can use reference websites such as: http://www.apricus.com/html/solar_collector_insolation.htm#.Ughu1pJgdqU.

System output and charge controller

A charge controller regulates the power transfer from the PV array to the batteries, which prevents overcharging. In addition, it prevents the batteries from discharging into the solar array. Some charge controllers also monitor the temperature of the batteries to prevent overheating. Charge controllers may offer remote power monitoring and can show the overall operating efficiency of the system.

Solar panel orientation

Solar panels should generally face toward the solar south in the northern hemisphere and toward solar north in the southern hemisphere. The angle of inclination of the panels should be similar to the latitude of the study site near equatorial regions, but increase at latitudes that are closer to the poles (see below diagram).



You also may wish to adjust the tilt closer to horizontal in summer and closer to vertical in winter. Please note that build-up of material (e.g. dust or bird droppings), or shading (e.g. from trees or buildings) will have a negative impact on the power output of the panels.

Worked example of a PV system designed to handle 1 day operation without solar charging.

Step 1:
DM system load is 24W including modem and Gill Windsonic sensor.

Step 2:
We use a **Victron Orion 12/12-100W** DC/DC converter which is 85% efficient, i.e. 24W / 85% **= 28.2W**

Step 3:
The DM will run 24 hrs a day. 28.2 W x 24 h = **677.7 Wh**.

Step 4:
We are running off 12V. 677.7 Wh / 12 V = **56.5 Ah** per day.

Step 5: The system will have to run for max. 1 day without the sun. 56.5 Ah x 1 day = **56.5 Ah.**

Step 6:
We will use lead acid batteries. Lead acid charge should not go below 50%. 56.5 Ah / 50% = **113 Ah** battery capacity needed. e.g. PDC-121200 battery from Power Sonic http://www.batterydirect.co.nz/uploads/specsheets/PDC-121200.pdf.

Step 7:
To allow battery recharge from 50% back to 100% in 2.5 hours of full sunshine: 56.5 Ah / 2.5h **= 22.6 A** of battery charging current is needed. This is 22.6 A x 12V = **271 W** of power.

Step 8:
DC/DC converter also consumes power while battery is charging: 271 W + 28.2 W = **~300 W**.

Step 9:
The charging system is not 100% efficient; a good rule of thumb is to allow for 20% charging losses i.e. 300 W / 80% = **375 W**.

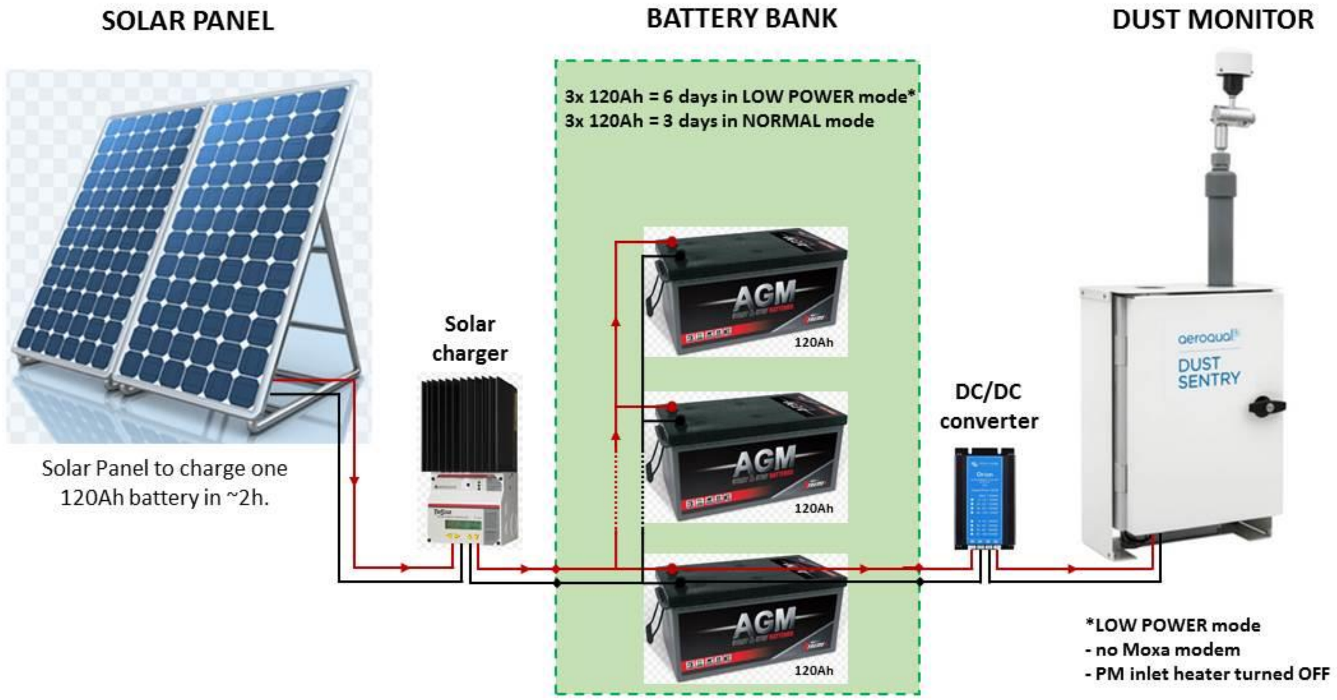
Step 10:
For contingency it would be wise to add another 20% i.e. 375 Watts + 20% = **450 W.**

Step 11:
We use **250 W Grape Solar panel** http://www.grapesolar.com/250w-mono-gs-s-250-fab5.html. This means we need 450 W / 250 W = **2 solar panels**.

Step 12:
Solar charge controller should be able to withstand 125% of a max. solar panel current. **500W /12V** = **41.7A**. 41.7 A * 125% = **52.1 A**. e.g. **Morningstar TriStar TS-MPPT-60** controller. [http://www.morningstarcorp.com/products/tristar-mppt/.](http://www.morningstarcorp.com/products/tristar-mppt/)

NOTE: To protect the batteries it is recommended that you limit the solar charge controller charging current based on the battery bank size. To charge the batteries in **2.5 h** the current limit should be set to: **300W /12V** = **25 A**.

Solar panel and battery bank configuration.



3x 120Ah = 6 days in LOW POWER mode*
3x 120Ah = 3 days in NORMAL mode

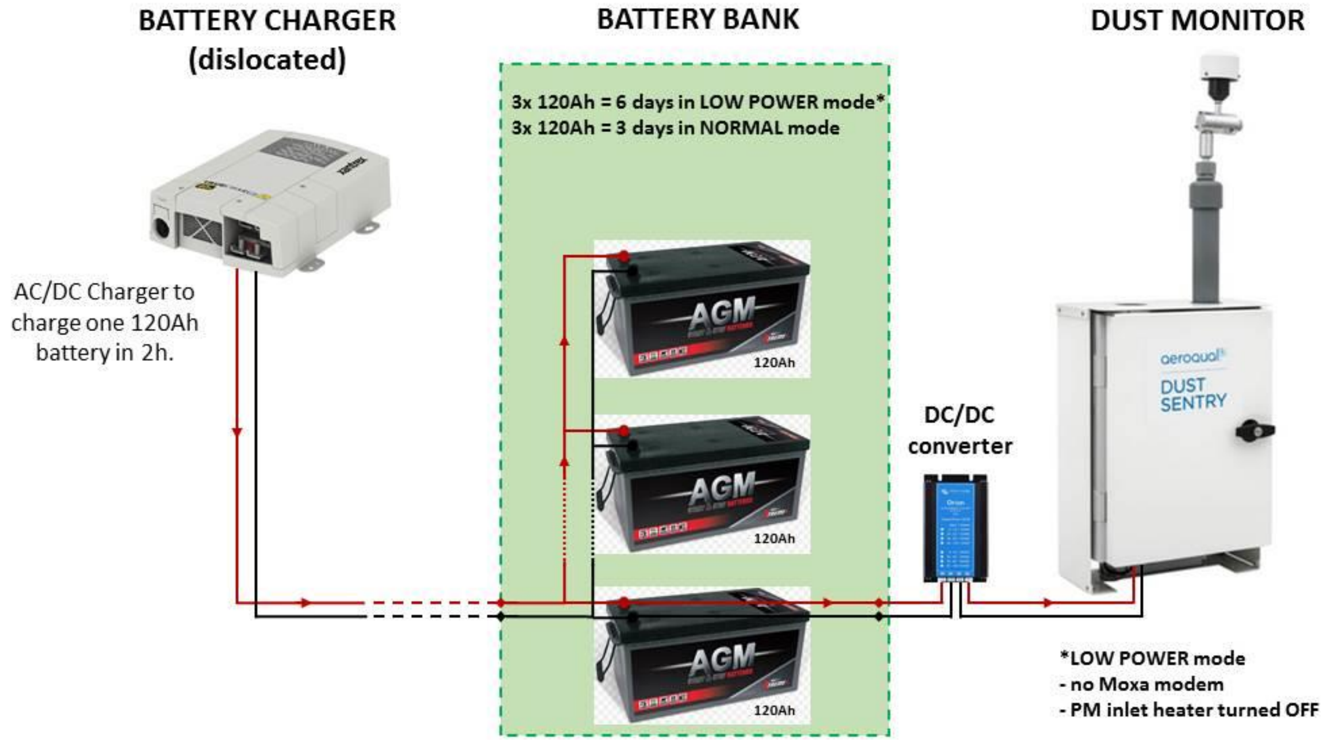
Solar Panel to charge one 120Ah battery in ~2h.

***LOW POWER mode**
- no Moxa modem
- PM inlet heater turned OFF

SYSTEM COMPONENTS

Solar Panel: 2x Grape Solar GS-S-250-FAB5
Solar Charger: Tristar TS-MPPT-60
Battery Bank: 3x PowerSonic PDC-121200
DC/DC Converter: Victron Orion 12/12-100W
Dust Monitor V1.3

Battery charger and battery bank configuration.



SYSTEM COMPONENTS

Battery Charger: Xantrex Truecharge2-60
Battery Bank: 3x PowerSonic PDC-121200
DC/DC Converter: Victron Orion 12/12-100W
Dust Monitor V1.3