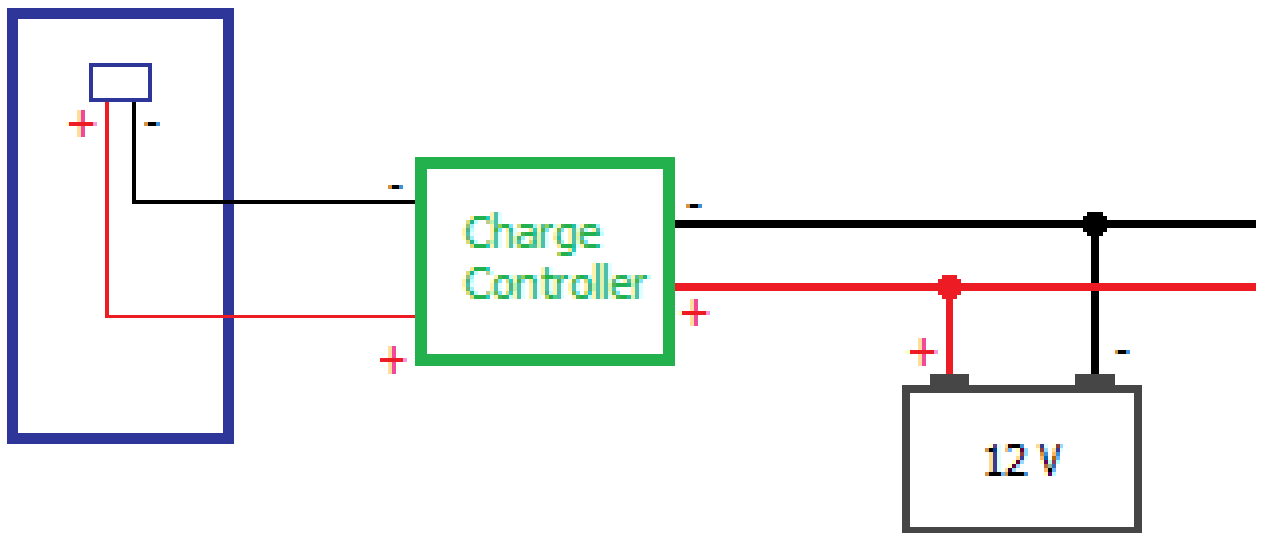# 100W Basic Kit (GS-100-Basic)
Configuration Manual

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Basic Wiring Diagram

Overview
This kit is designed for 12v Battery charging.
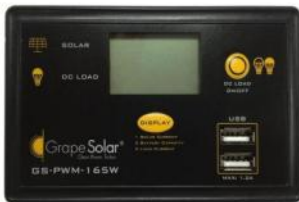
Table of Contents

Kit Components:

1pc GS-Star-100W Grape Solar 100W Solar Panel

1set 7.5' Solar Panel to Charge Controller Cable Con-
nection

1set 5' Charge Controller to Battery Cable Connection

1pc GS-PWM-165W 10Amp Charge Controller

1set Grape Solar Zippity Feet for Solar Panel Mounting

Step By Step Setup

Step 1: Cover the panel with a tarp, blanket, etc. to keep sunlight off the surface during setup.
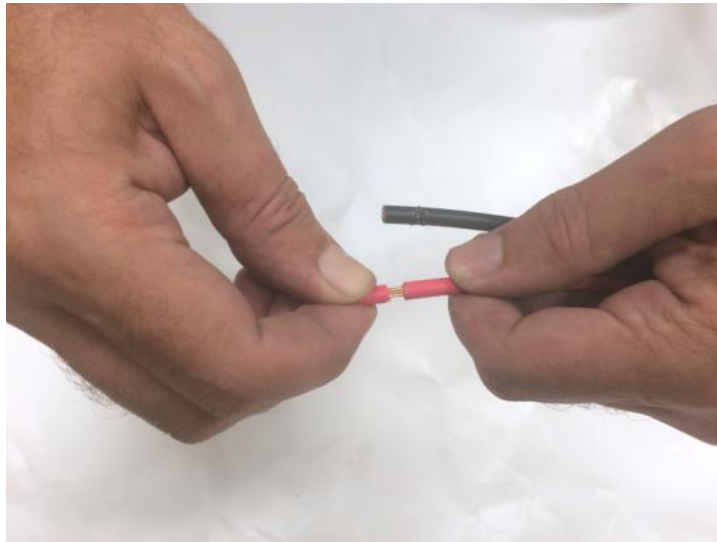

Step 2: Connect the MC4 connector ends of each of the 7.5' black cables to the MC4 connectors on the solar panel.
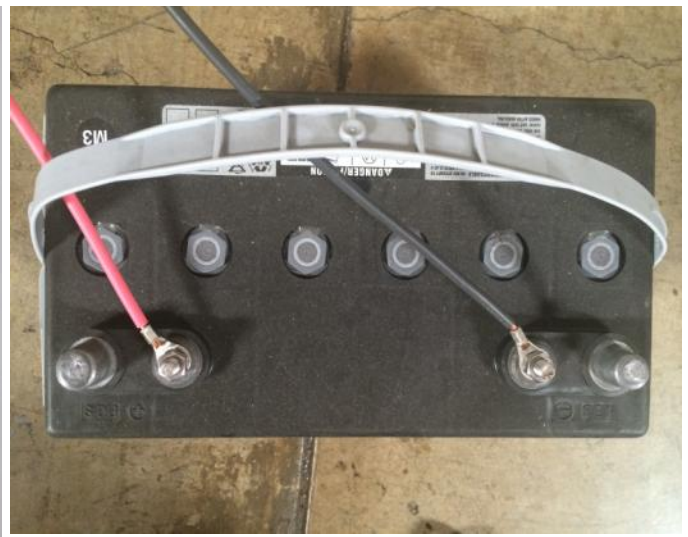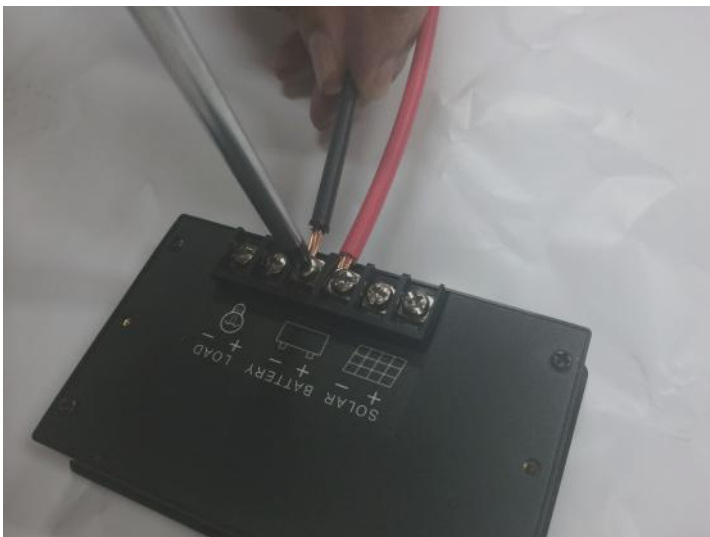
Step By Step Setup

Step 3: Remove ends off of the 5-foot red/black cable set

Step 4: Connect the Grape Solar charge controller to your deep cycle battery bank with the 5-foot red/black cable set, using the red cable for positive and the black for negative.

Step By Step Setup

Step 5: Connect the stripped bare wire ends of your 7.5 foot cables to the inputs of the charge controller, making sure that the positive cable connects to the positive input and vice versa.

Step 6: Remove the covering from the panel

Step 7: When the panel is in full sunlight, check the charge controller to make sure there is charging current when in Mode 1 (see manual). The "solar" and "battery" lights should be lit during normal operation.

NOTE: The optional zippity mounting feet included in this kit may be used to mount the solar panel after Step 2.

Basic Kit Facts

This 100 watt panel kit will produce an average of 25 amp-hours per day when used in a 12 volt system. This equates to approx. 300 watt-hours of usable power per day. The production amount will vary seasonally, depending on your location and the panel placement. For more detailed production estimates, see http://pvwatts.nrel.gov/pvwatts.php .

When your battery is fully charged, you will see very low output from the controller. This is normal, and prevents the battery from being overcharged.

If the battery is discharged below 10.6 volts DC, the controller will no longer function. This is because it is powered by the battery, not the panel. In this case, it is necessary to use an AC-powered trickle charger to bring the battery up to the proper voltage.

System Sizing: Step 1 - Determine Consumption

To determine the total system size you must first calculate your consumption in Watt hours (Wh) per day.

Lighting
If you have four 15W LED lights (actual wattage not equivalent wattage) that you plan on running for 8 hours per day, you would take the wattage of each bulb, multiply it by the number of bulbs and multiply that by the number of hours of run time per day.

2 bulbs x **15** W/bulb x **8** hours/day **= 240** Wh/day

Pumps and Motors
If you plan to run a 1 horse power (hp) pump for 1/2 hour per day you would first convert the hp into Watts: 1hp = 745W, Then multiply that by number of hours of run time per day.

1 pump x **745** W/pump x **0.5** hours/day = **373** Wh/day

Misc. Electronics
If you want a system to power your laptop for 6 hours per day plus a microwave oven for 10 minutes per day you would first need to determine the wattage of each device. This information can usually be found on the device or approximated with the help of an internet search. Let's assume that the laptop consumes 65W and the microwave oven consumes 800W. Multiply each device's wattage by its run time and add the two numbers together.

1 laptop x **65** W/laptop x **6** hours/day = **390** Wh/day
1 oven x **800** W/oven x (**10/60**) hours/day = **134** Wh/day
390 Wh/day + **134** Wh/day = **523** Wh/day

Battery Charging
If your plan is to keep a battery bank charged, first add up the Amp hour (Ah) capacity of all the batteries in your system. The Ah capacity is usually shown on the side of the battery. For example, an RV with two 80Ah would have a 160Ah battery bank. For this calculation it doesn't matter if the batteries are con-nected in series or parallel. Most batteries can only discharge 50% of their Ah capacity so only 50% of the total Ah rating needs to be fed to them to bring them to full charge. In this case that would be 160 divided by two, equaling 80Ah. To convert Ah into Watt hours, multiply 80Ah by 12V.

2 batteries/day x **80** Ah/battery x **0.50** x **12** V = **960** Wh/day

Watts vs. Watt hours
Keep in mind that Watts is an instantaneous power measurement, not to be confused with Watt hours, which is the actual energy consumption. Watts must be multiplied by estimated run time to determine en-ergy consumption. A good analogy would be speed vs. distance. Watts are equivalent to speed, where as Watt hours would be the distance. In order to determine how many panels are needed you need to know the "distance."

System Sizing: Step 2 - Calculate Panel Count

On an average day, a single 100W panel will produce about 300 Watt hours (Wh) of charge. This figure will vary depending on temperature, brightness and time of sun exposure. In the Summer production will be higher than in the Winter. On bright sunny days the output will be higher than on cloudy days.

A single 100W panel will have an average daily production of:
300 Watt hours (Wh) = **0.30** kilo Watt hours (kWh) = **25** Amp hours (Ah)

After determining your consumption in step one, divide that number by the production of a single panel:

Lighting example:
Two15W LEDs for 8 hours per day

240 Wh / **300** Wh/panel = 0.8 panels = **1 panels**

Pumps and Motors example:
One 1hp pump for 1/2 hour per day

373 Wh / **300** Wh/panel = 1.24 panels = **2 panels**

Misc. Electronics example:
One 65W laptop for 6 hours and one 800W microwave for 10 minutes, per day

523 Wh / **300** Wh/panel = 1.74 panels = **2 panels**

Battery Charging example:
Two 80Ah batteries per day

960 Wh / **300** Wh/panel = 3.2 panels = **4 panels**

Area Specific Production:
More accurate panel production estimates can be made by using an online program that takes into account the local climate, latitude, tilt angle and bearing of the panel.

The simulator can be found here: http://rredc.nrel.gov/solar/calculators/PVWATTS/version1
1. Click on your State
2. Click on the city nearest to your location
3. Change the DC rating from 4.0 to 100 (to simulate a single 100W panel)*
4. Change the tilt angle to whatever your panel is tilted at (ideal is equal to your latitude)
5. Confirm that your azimuth is correct (180 degrees, facing South, is optimal)
6. Click "Calculate"
A new page will show a "Results" box. The middle column "AC energy" will show your panel output broken down per each month in Watt hours*. For example, the total Watt hour for an optimally tilted panel for one year of production in Eugene is 106,794Wh. The daily production would be 292Wh.

*Please note: PV Watts deals in kW & kWh. If you typed 0.1kW to represent a 100W panel the program would round your input up to 4.0kW. To adjust for this, mentally substitute W for kW. Input your data in Watts (W = 1/1000 of a kW) and know that your output is in Wh, not kWh as shown on the website.

106,794 Wh/yr / **365** days/yr = **292** Wh/day

System Sizing: Step 3 - Inverter Sizing

The solar panels put out DC power that is fed through a charge controller onto a battery bank. If you have an application that requires AC power you will need an inverter to take that power off of the battery and turn it into 120V AC.

+V   **DC - Direct Current**

+12

time

-V

+V   **AC - Alternating Current**

+120

time

-V   1/60th of a second

When selecting an inverter it is important to know the total Wattage of your load. In Step 1 we determined the Watt Hour consumption, but for inverter sizing we can go back to just using Watts, and ignore the time factor.

The GS-100+KIT has two options for inverters, a light 450W modified sine and a heavy 2000W pure sine. Because of the modular design of this kit, other inverters may be used as long as they are compatible with the voltage of the battery bank.

Lighting example:
Four 15W LEDs for 8 hours per day

4 Bulbs x **15** W/bulb = **60** W   **Use the small 450 W inverter**

Pumps and Motors example:
One 1hp pump for 1/2 hour per day

1 pump x **745** W/pump = **745** W   **Use the larger 2000 W inverter**

Misc. Electronics example:
One 65W laptop for 6 hours and one 800W microwave for 10 minutes, per day

1 laptop x **65** W/laptop = **65** W   **Use the 450 W inverter**
1 microwave x **800** W/microwave **= 800** W   **Use the 2000 W inverter**
Together = 65 W **+ 800** W = **865** W   **Use the 2000 W inverter**

Battery Charging example:
Two 80Ah batteries per day

No AC required - No inverter needed

Pure Sine vs. Modified Sine
The 450W inverter option uses what is called a modified sine wave. This means that the output of the in-verter looks more like a stair step pattern than the smooth wave shown in the diagram above. Modified Sine is fine for charging small devices but if you plan to use anything that has an AC motor you will need the 2000W inverter with pure sine output. Also, some stereos and musical equipment may emit an un-wanted "hum" when powered by a modified sine inverter.

System Sizing: Step 4 - Battery Bank Sizing

The GS-100+ Preconfigured Kits do not come with batteries, but will work with most deep cycle batteries. A deep cycle battery is designed to be charged and discharged regularly, unlike standard car batteries that are meant to hold a somewhat constant charge. Deep cycle batteries come in many forms including lead acid, sealed AGM and Lithium Ion. A typical deep cycle battery can discharge about 50% of it's Amp hour (Ah) capacity.

If you need a battery to store 1200Wh of charge you first need to convert the 1200Wh to Ah by dividing it by 12V (the voltage of a battery) to get 100Ah. Since the battery can only discharge 50% of it's capacity, you must divide the 100Ah by 50% to get 200Ah. A 200Ah battery bank will store 1200Wh of usable power.

$$\textbf{1200 Wh / 12 V = 100 Ah 100 Ah / 0.50 = 200 Ah battery bank}$$

Lighting example:
Four 15W LEDs for 8 hours per day, one day back-up

$$\textbf{480 Wh / 12 V = 40 Ah (40 Ah / 0.50) x 1 day = 80 Ah battery bank}$$

Pumps and Motors example:
One 1hp pump for 1/2 hour per day, three day back-up

$$\textbf{373 Wh / 12 V = 31 Ah}$$
$$\textbf{(31 Ah / 0.50) x 3 days = 187 Ah battery bank}$$

Misc. Electronics example:
One 65W laptop for 6 hours and one 800W microwave for 10 minutes, one week back-up

$$\textbf{523 Wh / 12 V = 44 Ah}$$
$$\textbf{(44 Ah / 0.50) x 7 days = 616 Ah battery bank}$$

Battery Connections:
Multiple batteries can be connected to each   other to increase the Amp Hour storage capacity of your system.   Since the charge con- troller and inverters in the GS-100+KIT are de-   signed for 12V systems it is important that multiple 12V batteries are   connected in parallel and if your system incorporates 6V batteries   they should be con- nected in series pairs.
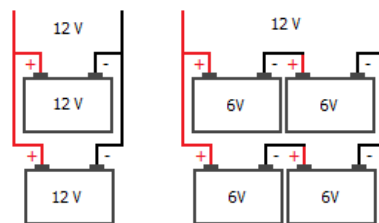
Battery Life:
Batteries have a limited life. A battery that is discharged 50% every day will not last as long as a battery that is only discharged 20% every day. Consider this when designing your system, adding "too many" bat-

Mounting Hardware & Additional Accessories

Mounting

This Kit comes with 4x Grape Solar Zippity Feet for easy installation on a variety of materials.
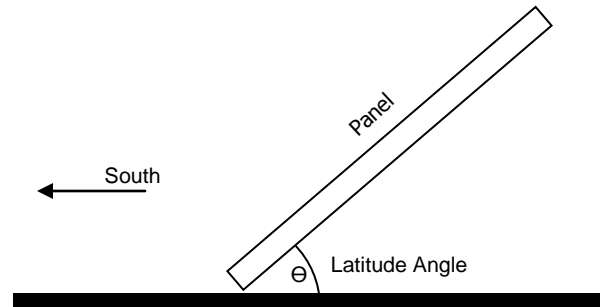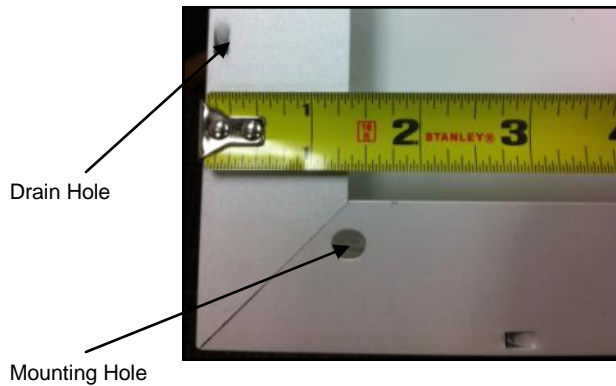
For optimum energy production solar panels should be pointed in the direction of the sun to maximize the surface area that can receive light. Since the sun is a moving target, this is best approximated by pointing the panel to the South (for those of us that live in the Northern hemisphere) at a tilt angle equal to your latitude.

If you plan to mount your panel to an RV, boat, or other vehicle Grape Solar Technical Support can recommend some quality products. Call Grape Solar Technical Support at **1-877-264-1014.**

Breakers and Fuses

The GS-100-Basic kit is designed to include only the basic components needed for operation. In low volt-
age photovoltaic systems the likelihood of a power surge damaging your equipment is nearly nonexistent,
therefore breakers and fuses are not included. However, we do recommend using correctly sized break-
ers and fuses for your system. Breakers or fuses can be added between the panels and the charge con-
troller (10A per every panel), between the charge controller and the battery bank (60A) and between the
battery and inverter (250A).

Grounding

Grape Solar off-grid panels have grounding holes on the panel frame. Please refer to the Safety and In-

stallation Manual . We recommend 12 gauge wire for grounding. Inverters and charge controllers should

be grounded according to the manufacturer's instructions.

Common Questions

How many batteries will I need to go with my panels?
Batteries have to do with how much power storage your system needs regardless of how much generation capacity you have. You can have 10kW of solar panels charging a 36Ah battery or you could have one 100W panel charging 1200Ah of batteries. The panel just affects how quickly the battery can be charged. If the battery bank is fully charged the charge controller will prevent over charging.

What inverters will work with my panels?
In an off-grid, battery backup system, the inverter is connected to a battery bank and the panels feed power onto the battery bank through a charge controller. Since the inverter isn't directly connected to the panels, you can use any size inverter you want as long as it is compatible with your battery bank and the devices you plan to power. You can have 10kW of solar panels in the same system as a 450W inverter or you could have one 100W panel in the same system as a 7kW inverter. The size of the inverter just limits the size of the devices that your system can power, which affects how quickly the battery bank is drained. Inverter size has nothing to do with panel count.

Are these 12V or 24V panels?
Panel voltage varies depending on temperature and brightness and load. The typical operating voltage of these panels is 18.5V. If the panel was exactly 12V there wouldn't be a large enough differential between the panels and the battery for current to flow from the panel to the battery. If you find panels advertised as "12V" they likely aren't actually 12V panels. If they were 12V panels you wouldn't want them for charging 12V batteries because they wouldn't work. The charge controller changes the output of the panel from the 18.5V to around 13.5V that would be fed onto the battery.

If the charge controller is lowering the voltage, am I losing power?
Power equals voltage multiplied by current (amps). When the charge controller lowers the voltage it increases the current, like a transformer.

My equipment is connected correctly but I'm barely getting any current, why?
Check the voltage of your battery bank. If it is over 13V the charge controller may be reducing the flow to prevent over charging the battery. This means your system is working perfectly. If the battery voltage is low, the battery may be damaged. If the problem persists, contact Grape Solar customer support.