Components of an Off-Grid Photovoltaic System for Solar Team 7

Gallup Solar 12 Volt Hogan Basic System



Your Solar Panels





Your solar panel label

windynation

www.windynation.com

100 Watt Monocrystalline Photovoltaic Solar Panel			
Part #:	SOL-100M-01		
Maximum Power (Pmax): Open Circuit Voltage (Voc): Short Circuit Current (Isc): Max Power Voltage (Vmp): Max Power Current (Imp): Max System Voltage:	100 Watts 21.45 Volts 6.09 Amps 18.15 Volts 5.51 Amps 1000 VDC (600 VDC UL)		
Dimensions: Weight: Max Series Fuse Rating: Nom Operating Cell Temp:	39.2" x 21.3" x 1.0" [995mm x 540mm x 25mm] 13.3lbs [6.0kg] 8 Amps 48°C [+/-2]		
	RoHS		

Your solar panel label explained

Solar panel output is measured by the manufacturer under Standard Test Conditions (STC)1,000 watts of irradiance/sunlight per square meter.

Pmax - Max Power - Vmp x Imp = 100 Watts
Voc - Open Circuit Voltage = 21.45 Volts
Isc - Short Circuit Current = 6.09 Amps
Vmp - Max Power Voltage = 18.15 Volts
Imp - Max Power Current = 5.51 Amps

Watts Law: **Vmp** x **Imp** = **Pmax** 18.15V x 5.15A = 93.47W

I-V Curve drawn from the label

This curve shows the relationship between I (Amps) and V(Volts) produced by your panel. The rectangle under the curve is the amount of power produced under ideal conditions.



I-V Curves measured under real world conditions show how irradiance/sunlight affects output



The more sunlight falling on a panel, watts per sq. meter, the more amperage...*bigger space under the curve*

I-V Curve Temperature



Wiring of solar cells inside the panel affects performance

Solar cells are wired in series. One shaded cell can shut down a whole string. It could create a hot spot that damages the panel.

This is resolved by adding *bypass diodes* across cell strings.

When one cell is shaded, current will pass through the diode and no current will go through that string. But one third of the panel's wattage may be lost.



You can choose to put your two 100 Watt panels together in parallel for more amps or in series for more voltage.

For our 12 Volt system we will wire in parallel to double amps.



Watts Law 200 watts ÷18.15 volts =11.02 amps

Wiring your solar panels with MC4 combiners





Wiring in parallel



Solar Panel Mounts (up to you)

Roof Mount

15







Now what is inside? Controller Battery **DC Charging Outlets** Inverter **Circuit Breakers Refrigerator**

30 Amp Controller

DC Charging Outlet

1500 Watt Inverter 4 Circuit Breakers

> 110 Amp Hour Battery

DC Refrigerator

18

Your Solar Charge Controller



Your Solar Controller

The purpose of a solar charge controller is to keep your deep cycle batteries properly fed and safe for the long term.

The basic functions of a controller are quite simple.

A charge controller blocks reverse current, prevents battery excessive discharges, and protects battery from DC overload.

Wiring up your solar controller



Red Wires are Positive + Black Wires are Negative -

MODES Bat V (Main) Bat T PV A LVD -LVR - OVD - Loads

MODE windynation P30L

LOAD

ON/OFF (Main)

+ # -

SOLAR BATTERY LOAD

Solar **Battery** DC Panels Load

22

Main interface



Your solar controller's liquid crystal display (LCD)



The Main Interface displays the current state of the Load,

PV charging, Load discharging, battery capacity, and overall system working condition.

LCD symbols

LCD Symbol	Description		
	Stop power supply to LOADs		
	Supply power to LOADs, No current drawn from Load		
	Supply power to LOADs, Load is drawing current		
Ŷ	Load Icon		
*	Solar Panel Icon		
	Battery Icon		
C	Load Light Control Icon		
\bigcirc	Load Timing Control Icon		
₹ Ĵ	Stop Charge to Battery		
	Full Charging to Battery		
	Float Charging to Battery		
\sim	Normal Working Condition		
\sim	Error/Abnormal Working Condition		
	Battery Capacity		
25			





PWM vs MPPT Controllers

Your PWM (Pulse-Width Modulation) controller is in essence a switch that connects a solar array to the battery. The result is that the voltage of the array will be pulled down to near that of the battery.



An MPPT controller is more sophisticated (and more expensive): it will adjust its input voltage to harvest the maximum power from the solar array and then transform this power to supply the varying voltage requirement of the battery plus load.

If you do decide to add panels with higher wattage you may have to upgrade to an MPPT controller.

28



Your Battery

Solar Power is stored In your 110 Amp Hour Battery Watt Hours from the sun divided by 12 Volt System are stored as Amp Hours WH \div 12V= AH 110 Amp Hours is full up

Your Deep Cycle Battery



12 Volt Battery 110 Amp/ Hour Absorbent Glass Mat (AGM) Sulfuric acid is absorbed by a very fine fiberglass mat, making the battery spill-proof.

Deep cycle batteries have thicker lead plates compared to traditional lead-acid batteries, allowing the battery to provide longer sustained amounts of electricity but less power compared to traditional batteries. These batteries can withstand 80% or more DoD, Depth of Discharge, although the lifespan of the battery will benefit from keeping the DoD above 50%.

Voltage	State of Charge	
12.6+	100%	
12.5	90%	
12.42	80%	
12.32	70%	
12.20	60%	
12.06	50%	
11.9	40%	
11.75	30%	
11.58	20%	
11.31	10%	
10.5	0%	

Voltage reading on your controller indicates how much charge your battery has.

Your 1500 Watt Solar Inverter



Your system produces two kinds of electricity to power your appliances, Alternating Current AC & Direct Current, DC.

Solar panels produce **DC**. You need an Inverter to convert **DC** to **AC** which is what most appliances run on.

Your inverter draws some DC electricity to run itself.

Your AC and DC



35



DC outlets

USB

Your AC Inverter





An Inverter converts 12V DC power from your battery into into 120V AC power. Volts increase x 10 Amps decrease x 10 Watts law!

- Most appliances
 - use AC.

Your inverter input





The VertaMax has two DC terminals to connect to the battery.

When connected, positive must connect to positive (red to red), negative connect to negative (black to black)

Your inverter output



From the AC Output end of the inverter, switch the rocker power switch to the ON position. The green power indicator will light and the VertaMax will now deliver AC power to the outlet(s).

Plug the AC product(s) you wish to operate into the AC outlet(s) and switch them on, one at a time.

Your solar inverter is a pure sine wave inverter



Pure sine wave inverters use sophisticated technology to protect sensitive electronics such as televisions, laptops, digital microwaves, refrigerators, and inductive type loads.

Please read these safety warnings from the manual

The VertaMax produces the same potentially lethal AC power as normal household outlets. Treat it with the same precautions as a normal 115 VAC outlet.

Do not operate the VertaMax near flammable fumes or gases, such as in the cabin of a gasoline powerboat, or near propane tanks.

Never work or service the AC wiring without disconnecting the DC Input connections.

Do not connect or disconnect batteries while the Inverter is operating from the battery supply. Dangerous arcing may result.

Although the inverter has over-voltage protection, the input voltage should never exceed 15V.

Input voltages of 16VDC or more will permanently damage the inverter.

Due to high voltages inside the inverter, the inverter should never be opened when in use.

Your inverter beeps a warning & turns off to protect from excessive discharges, and also turns off when overheating.

The second second second

Circuit Breakers For Safety

43





A circuit breaker opens a circuit as soon as Current (I) climbs to unsafe levels.









Gallup Solar 12 Volt Hogan Circuit Breaker Wiring Detail



And finally! Your DC Solar Refrigerator.



47

Worth waiting for!



VOLTAGE	10-31 VDC	PRODUCT DIMENSIONS (WXDXH)	25.75 x 26.75 x 30.5 in
AVERAGE ENERGY USE - DCR50	114 Watt-hrs/day at 32°C 9.6 Amp-hrs/day at 12V, 32°C 280 Watt-hrs/day at 32°C 24.5 Amp-hrs/day at 12V, 32°C		67.3 x 58.4 x 77.5 cm
REFRIGERATOR		SHIPPING DIMENSIONS (WXDXH)	27.5 x 24.5 x 36.5 in 69.9 x 62.2 x 92.7 cm
AVERAGE ENERGY USE - DCF50 FREEZER		INTERNAL DIMENSIONS (WXDXH)	17.625 x 13 x 12.75 in 44.45 x 33 x 31.75 cm
GROSS CAPACITY	50 L 1.8 ft3	WEIGHT	75 lbs 34 kg

Terms for Discussion

Off-Grid Irradiance Solar Controller MC4s **Roof Mount** Inverter IV Curve Ground Mount **Circuit Breakers Reverse** Pmax VOC Current ISC Deep Cycle Liquid Crystal Display VMP IMP Load **Open Circuit** AGM Battery Short Circuit **FLA Battery** Standard Test Conditions Sine Wave