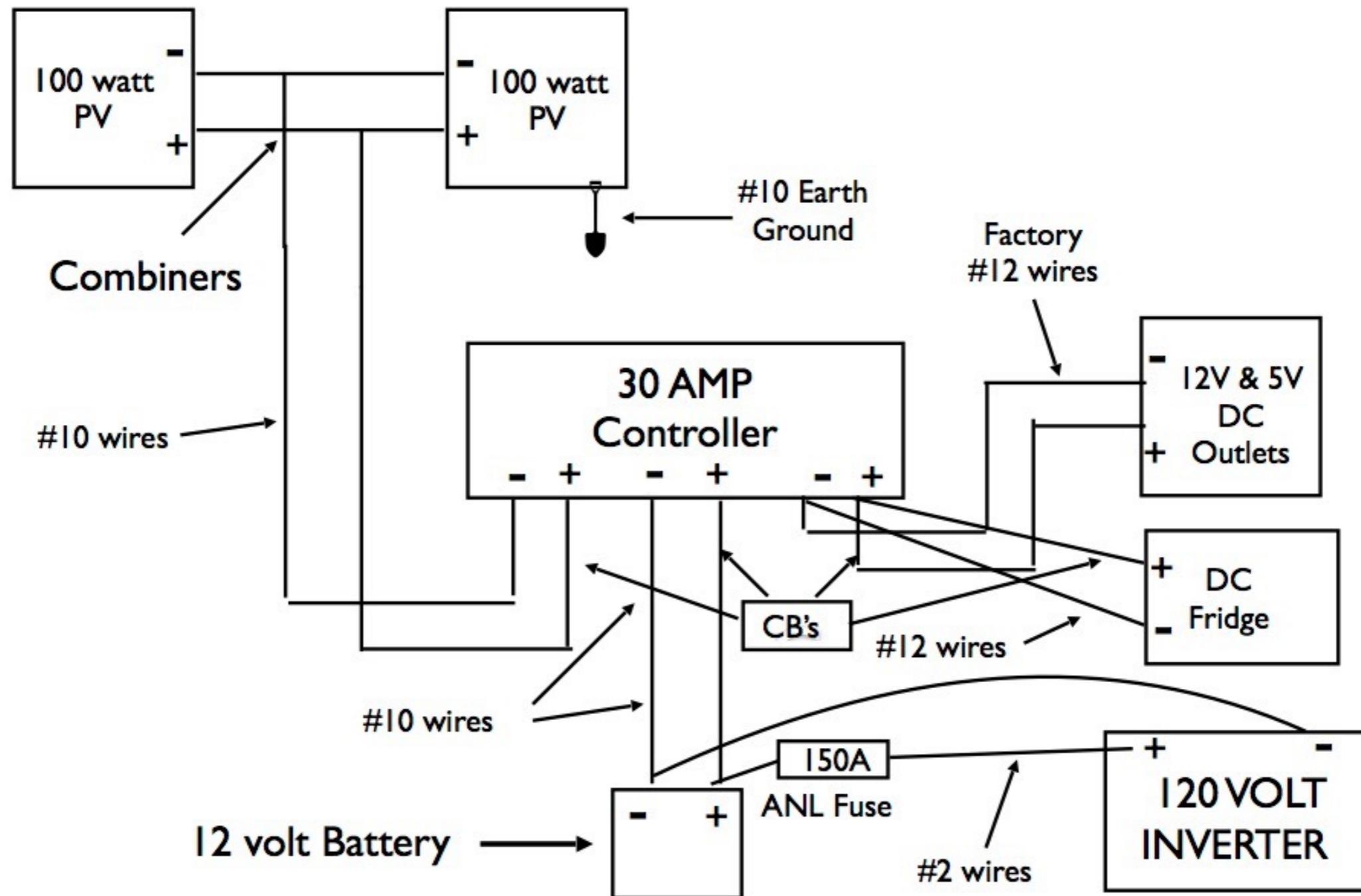


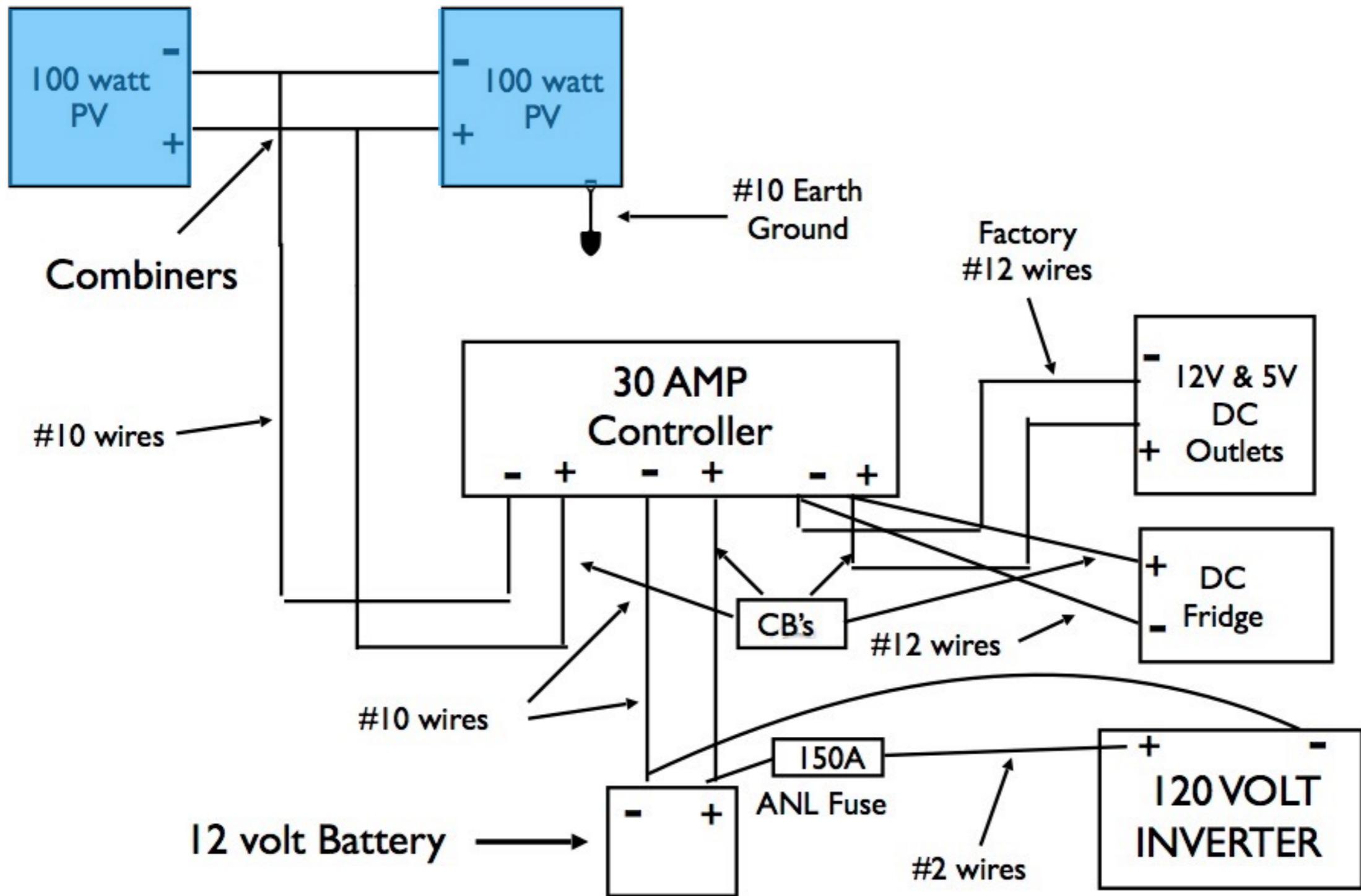
Components of an Off-Grid Photovoltaic System

for Solar Team 6

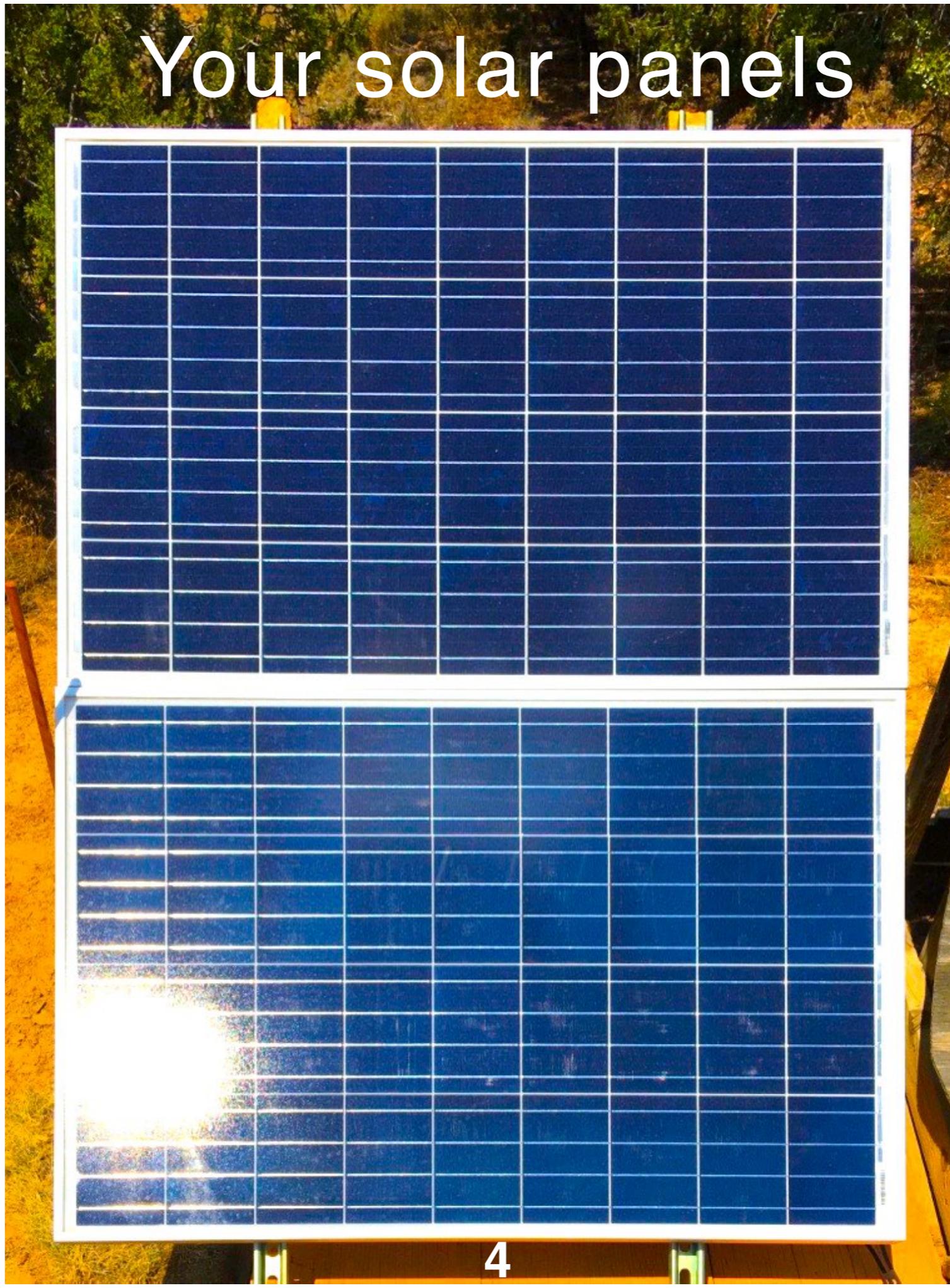
Gallup Solar 12 Volt Hogan Basic System



Your Solar Panels



Your solar panels



Your solar panels

This label on the back of your panels has all the information needed to draw an I-V curve.

windynation
clean | power to the people

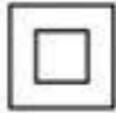
www.windynation.com

100W Polycrystalline Photovoltaic Solar Panel

Part #: SOL-100P-01

Maximum Power (Pmax): 100 Watts
Open Circuit Voltage (Voc): 21.60 Volts
Short Circuit Current (Isc): 6.32 Amps
Max Power Voltage (Vpm): 17.40 Volts
Max Power Current (Imp): 5.75 Amps
Max System Voltage: 1000 VDC (600 VDC UL) *

Dimensions: 40.0" x 26.4" x 1.2"
[1015mm x 670mm x 30mm]
Weight: 18.7 lbs [8.5kg]
Max Series Fuse Rating: 8 Amps
Nom Operating Cell Temp: 48 C [+/-2]

* 1000 volts direct current is the biggest system within which these panels can be used

The I-V curve of solar panels

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

P_{max} - max power - $V_{mp} \times I_{mp}$ - knee of the curve - point at which the largest rectangle can be contained

V_{oc} - open circuit voltage - horizontal axis

I_{sc} - short circuit current - vertical axis

V_{mp} - max power voltage

I_{mp} - max power current

I-V curve drawn from the label

Maximum Power (Pmax): 100 Watts
Open Circuit Voltage (Voc): 21.60 Volts
Short Circuit Current (Isc): 6.32 Amps
Max Power Voltage (Vpm): 17.40 Volts
Max Power Current (Imp): 5.75 Amps
Max System Voltage: 1000 VDC (600 VDC UL)

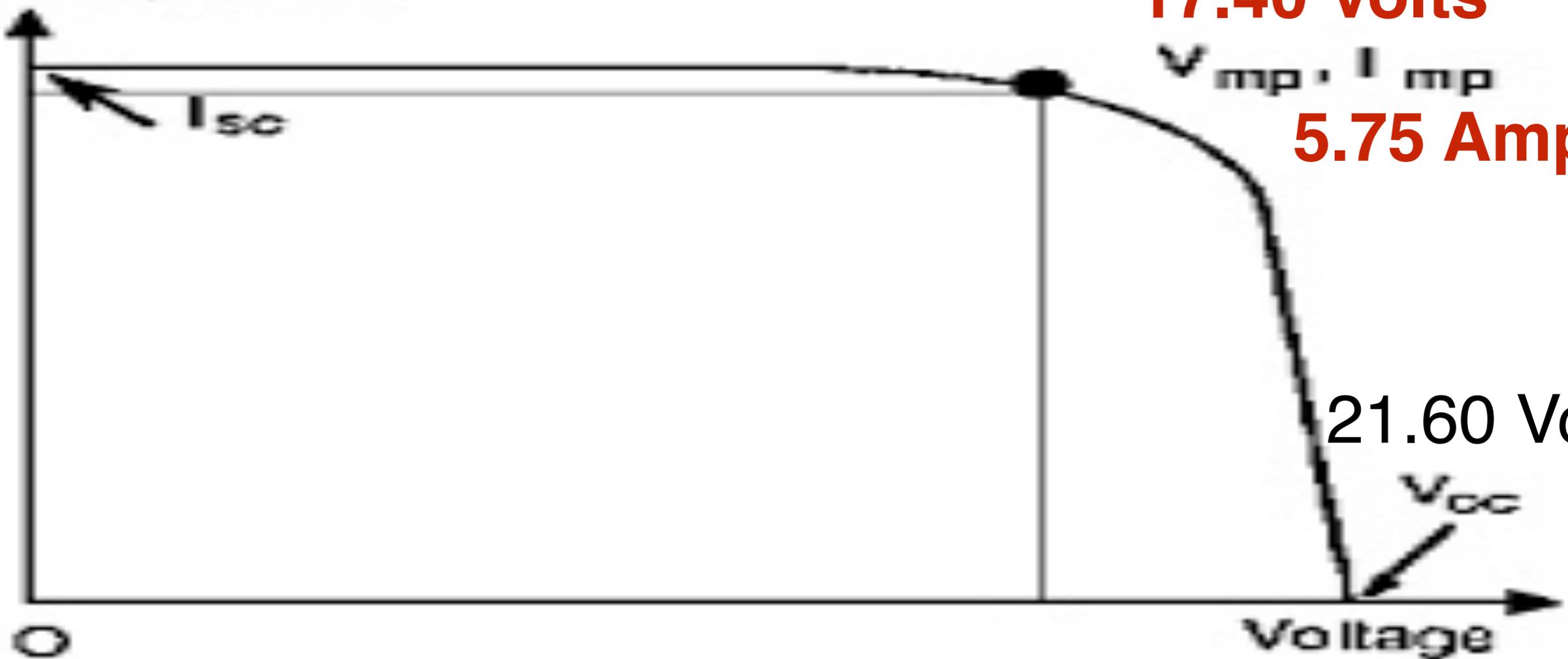
6.32 Amps

Current, Power

17.40 Volts

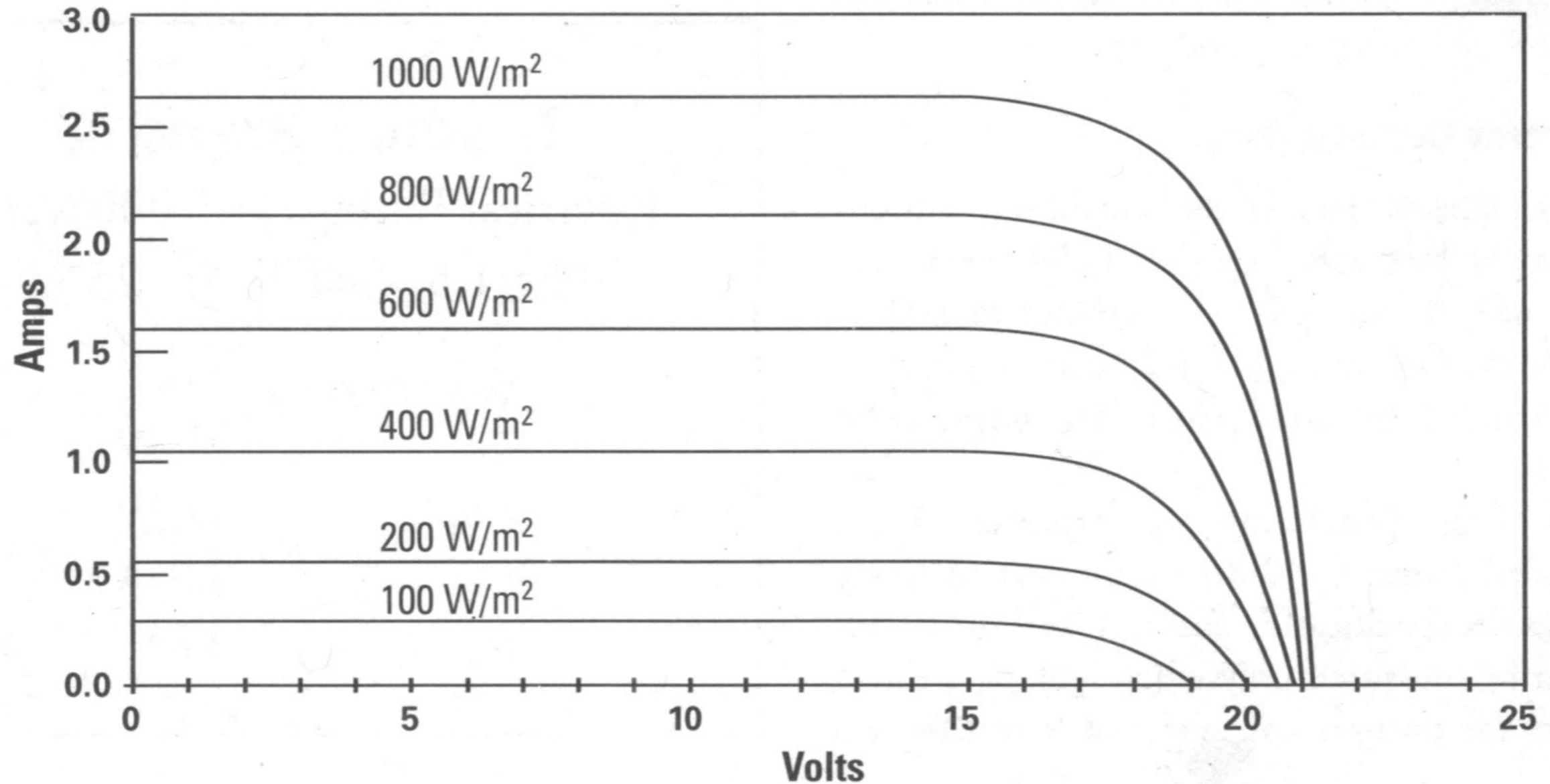
5.75 Amps

21.60 Volts



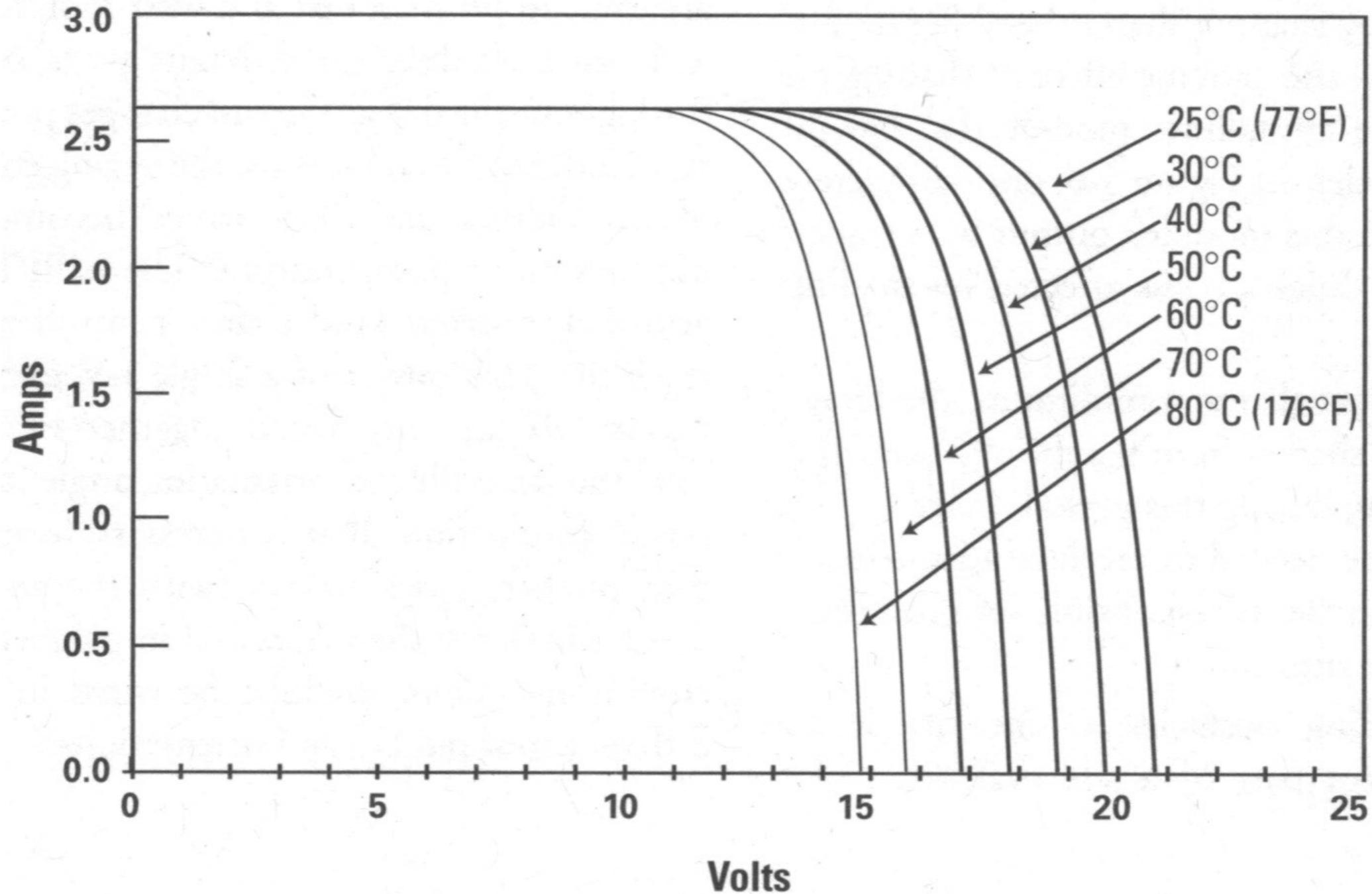
17.40 Volts x 5.75 Amps = 100.05 Watts, Watts Law.

I-V Curve Irradiance



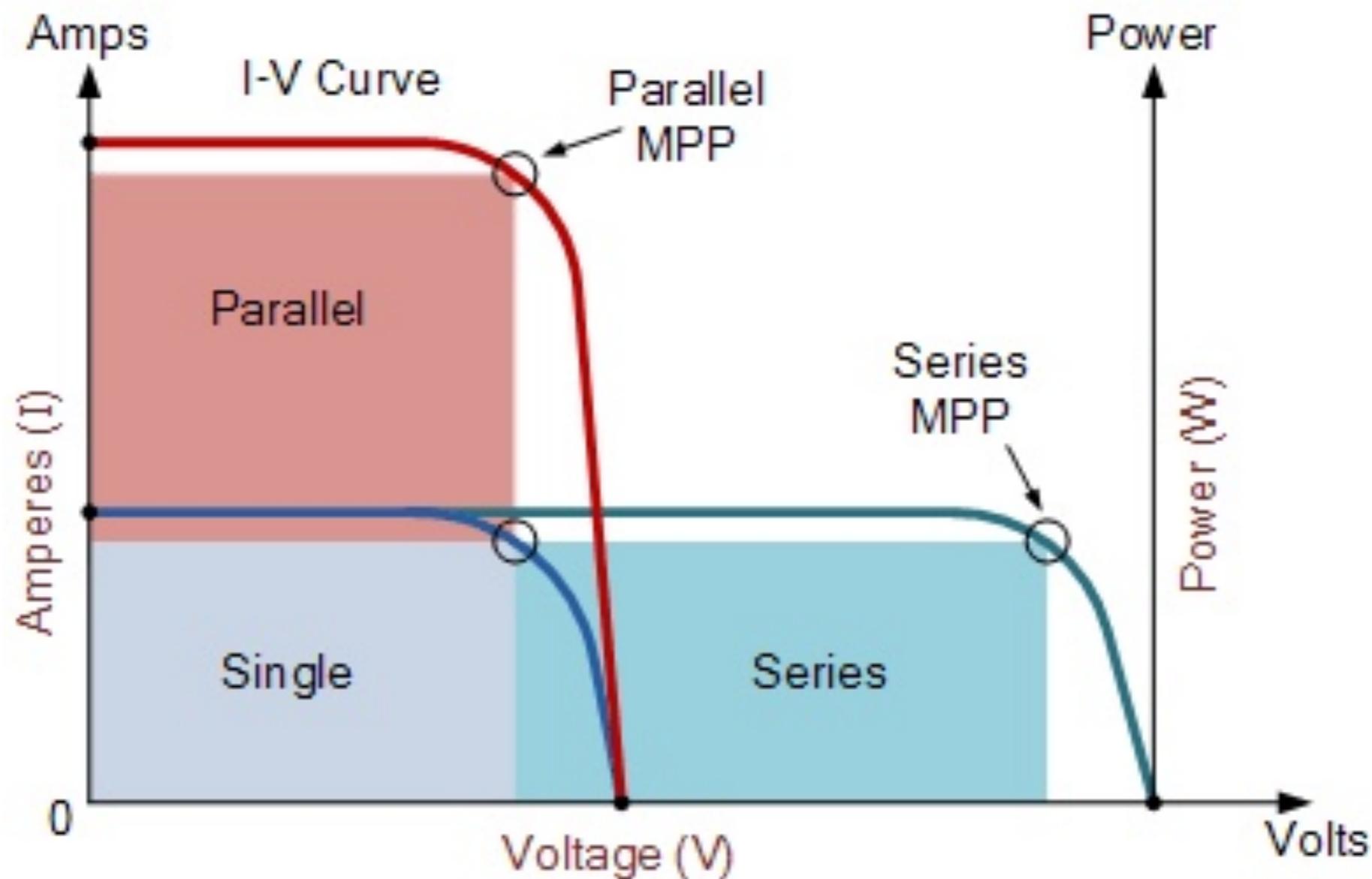
The more sunlight falling on a panel, watts per sq. meter, the more amperage

I-V Curve Temperature



The colder, the more voltage

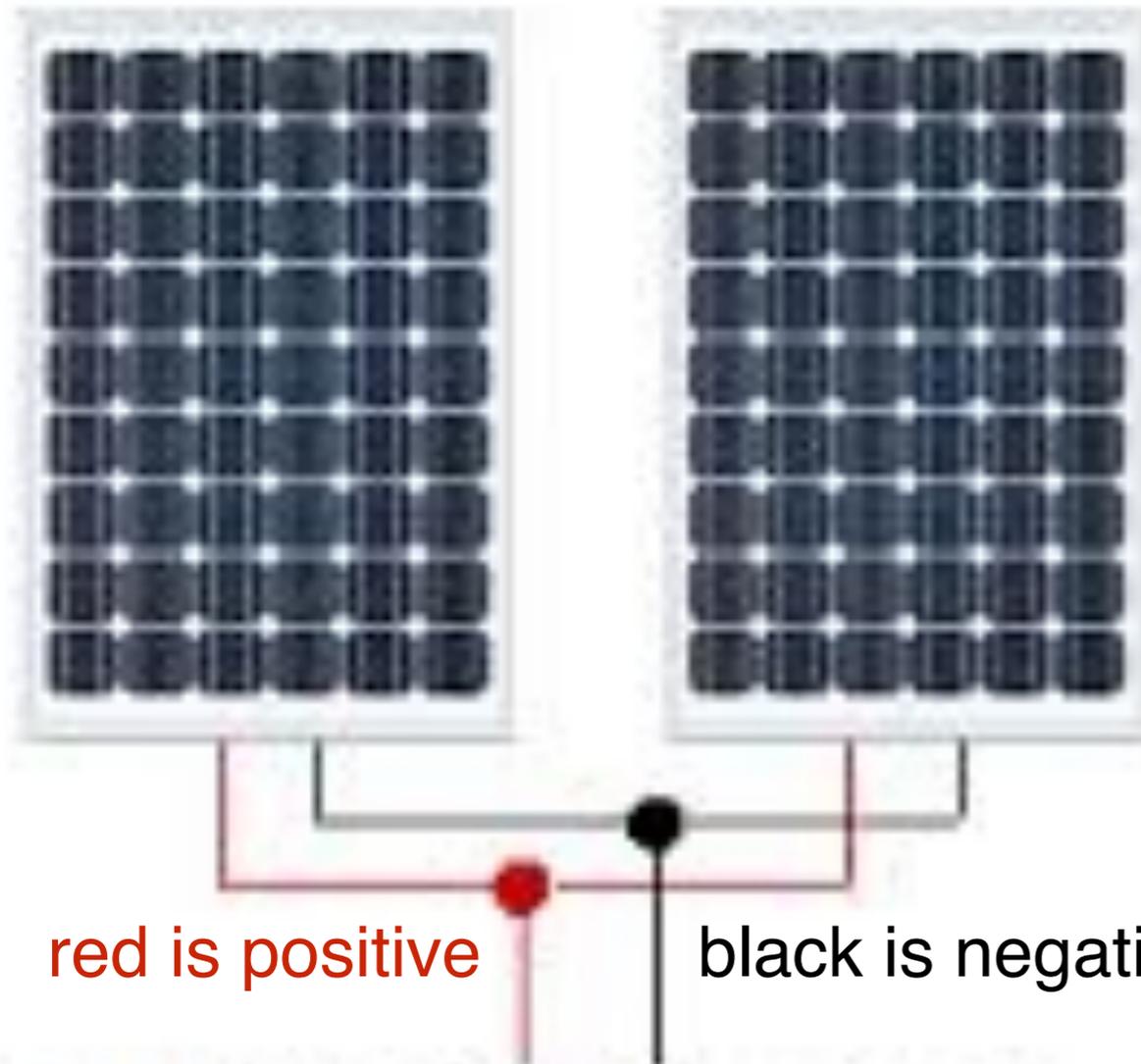
You can choose whether to put your two 100 Watt panels together in parallel for more amps or in series for more voltage....



For our 12 volt system
wire in parallel to double amps

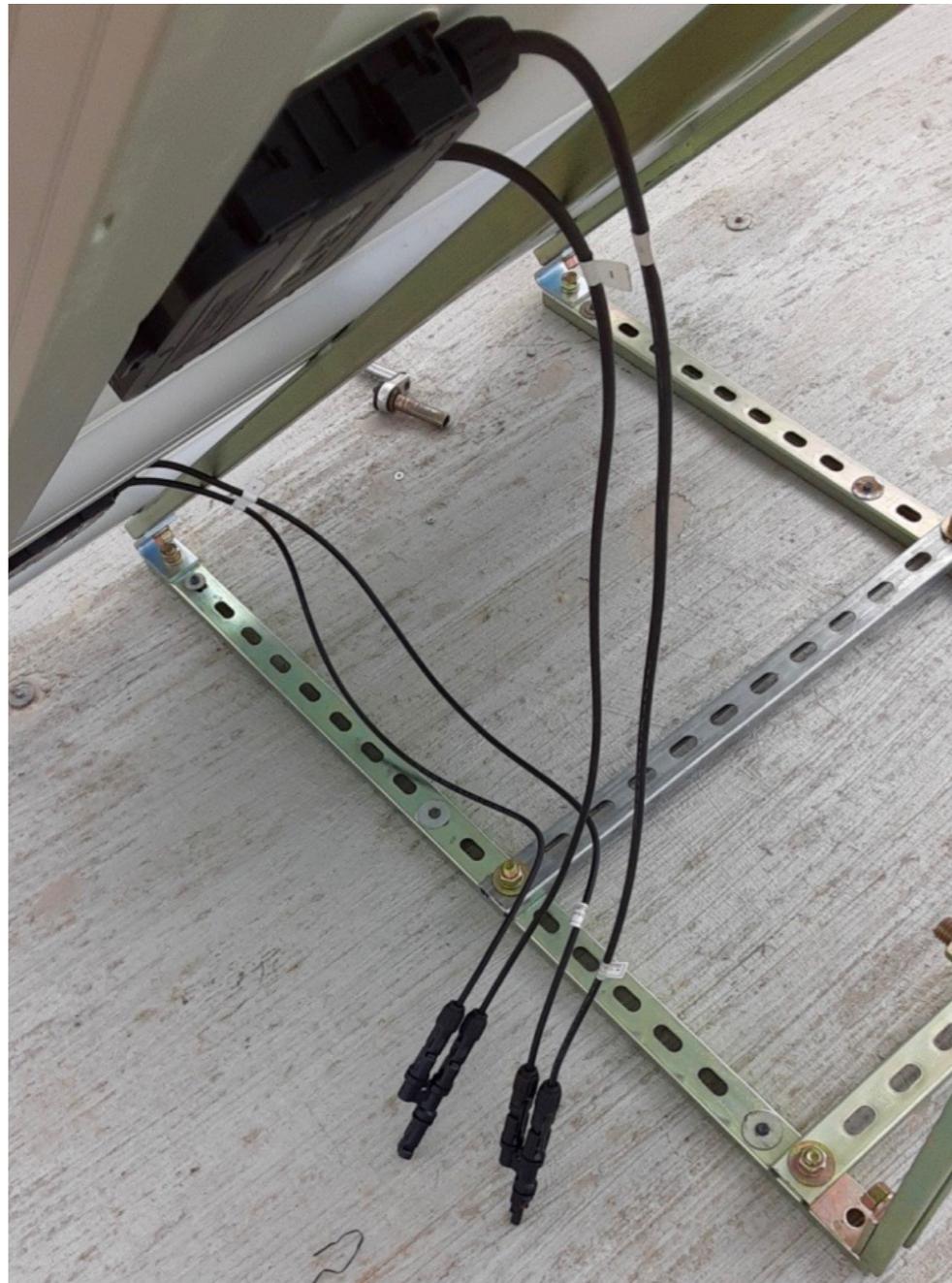
Output

200 watts \div 17 volts = 12 amps



Maximum Power (Pmax): 100 Watts
Open Circuit Voltage (Voc): 21.60 Volts
Short Circuit Current (Isc): 6.32 Amps
Max Power Voltage (Vpm): 17.40 Volts
Max Power Current (Imp): 5.75 Amps
Max System Voltage: 1000 VDC (600 VDC UL)

Wiring your solar panels with MC4 combiners



Wiring in parallel

Two positives
going to
one MC4.

Two
negatives
going to
the other.



Solar Panel Mounts (up to you)



Roof Mount





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

30 Amp
Controller

DC Charging
Outlet

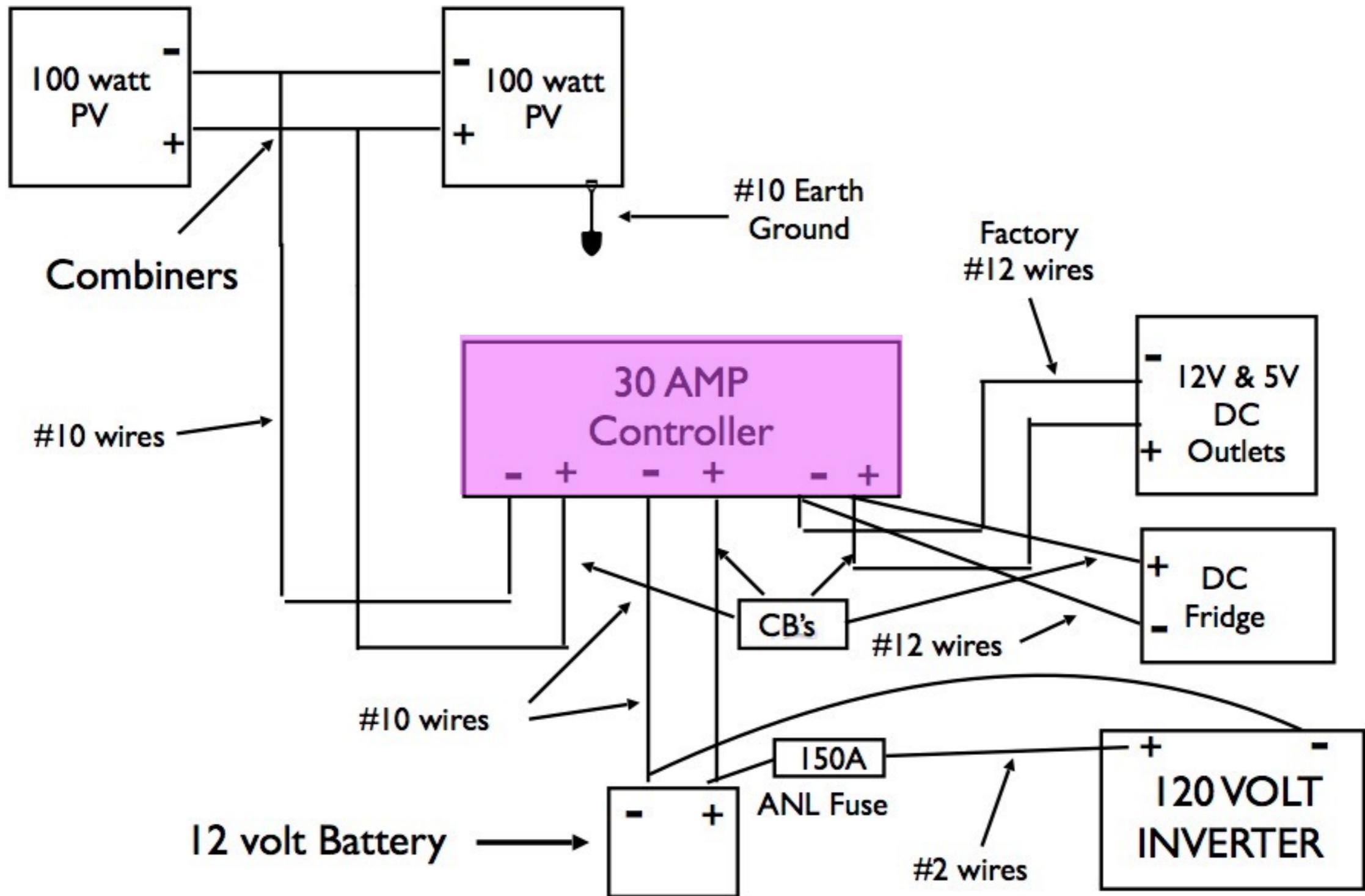
1500 Watt
Inverter

4 Circuit
Breakers

110 Amp Hour
Battery

DC →
Refrigerator

Your Solar Charge Controller



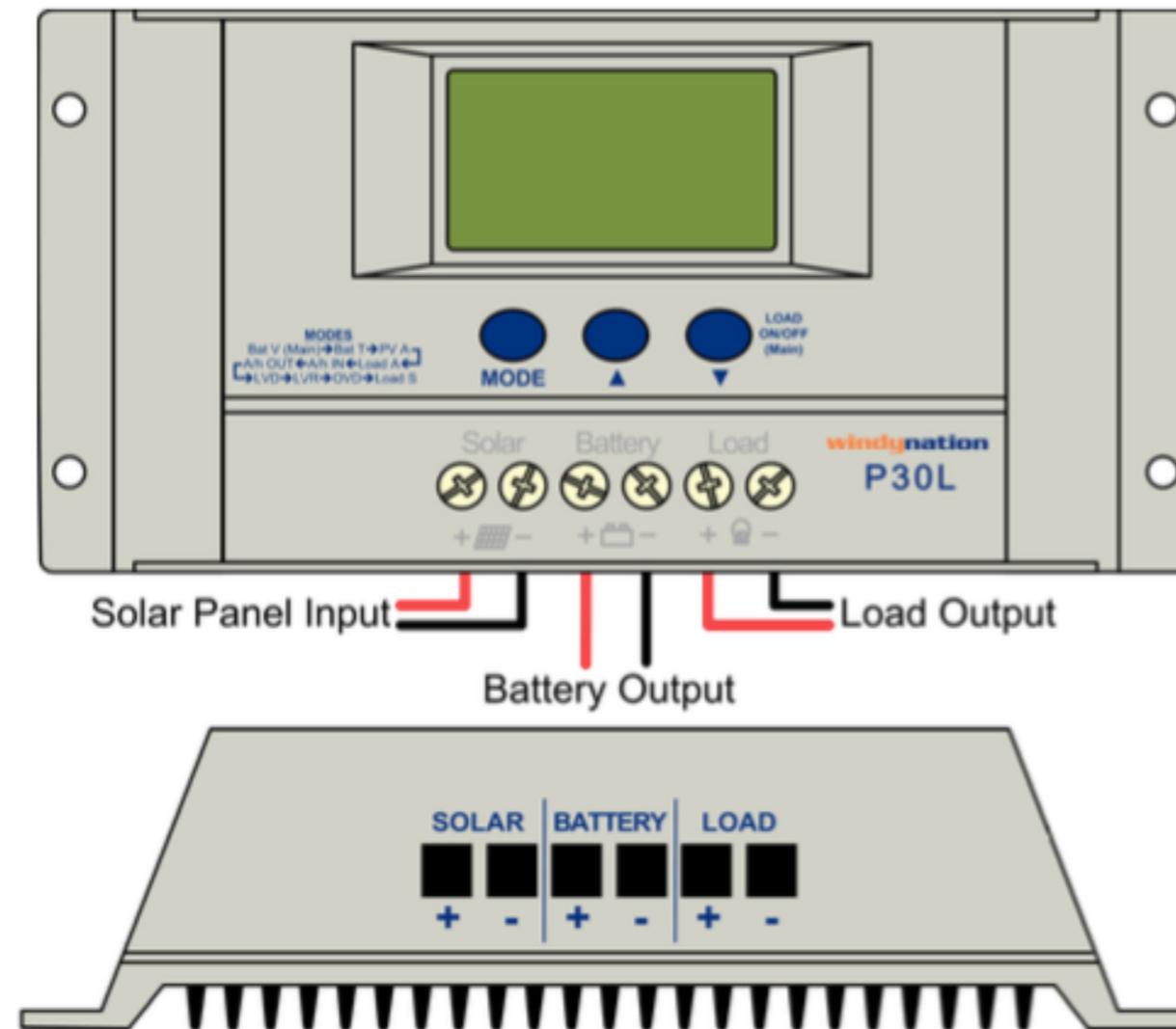
Your Solar Controller

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 overcharge, and protects battery from DC overload.

Wiring up your solar controller



With Circuit Breakers off...

1. Connect the Battery
2. Connect the Solar Panels
3. Connect the DC Load
4. Connect the Battery Temperature Sensor

an optional feature that will be explained when you wire up your systems



MODES
Bat V (Main) → Bat T → PV A
A/h OUT ← A/h IN ← Load A
LVD → LVR → OVD → Load S

LOAD
ON/OFF
(Main)

MODE

windy nation
P30L

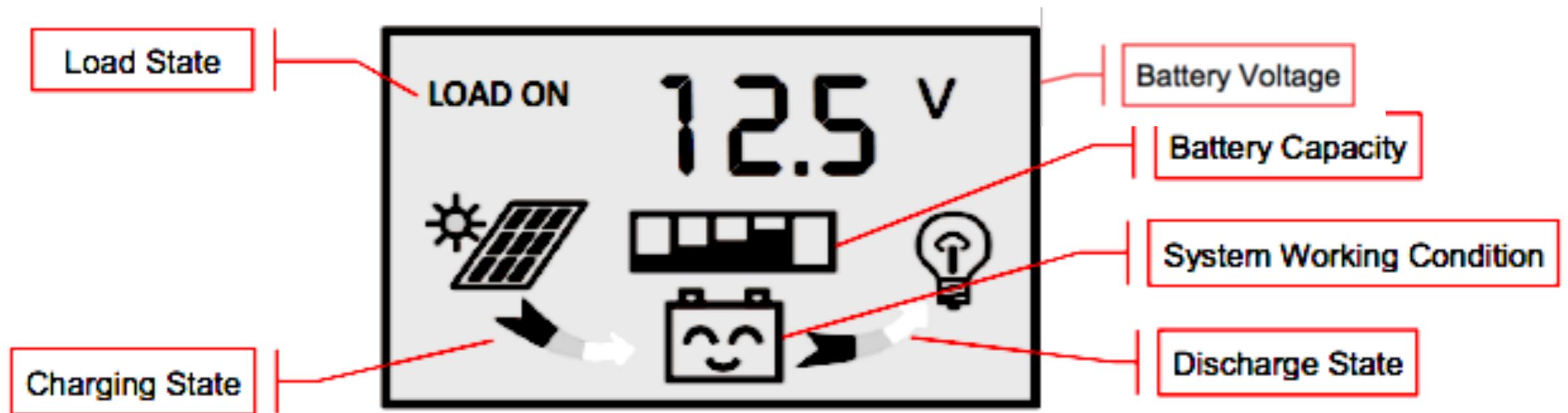
+ [battery icon] - + [battery icon] - + [load icon] -

SOLAR

BATTERY

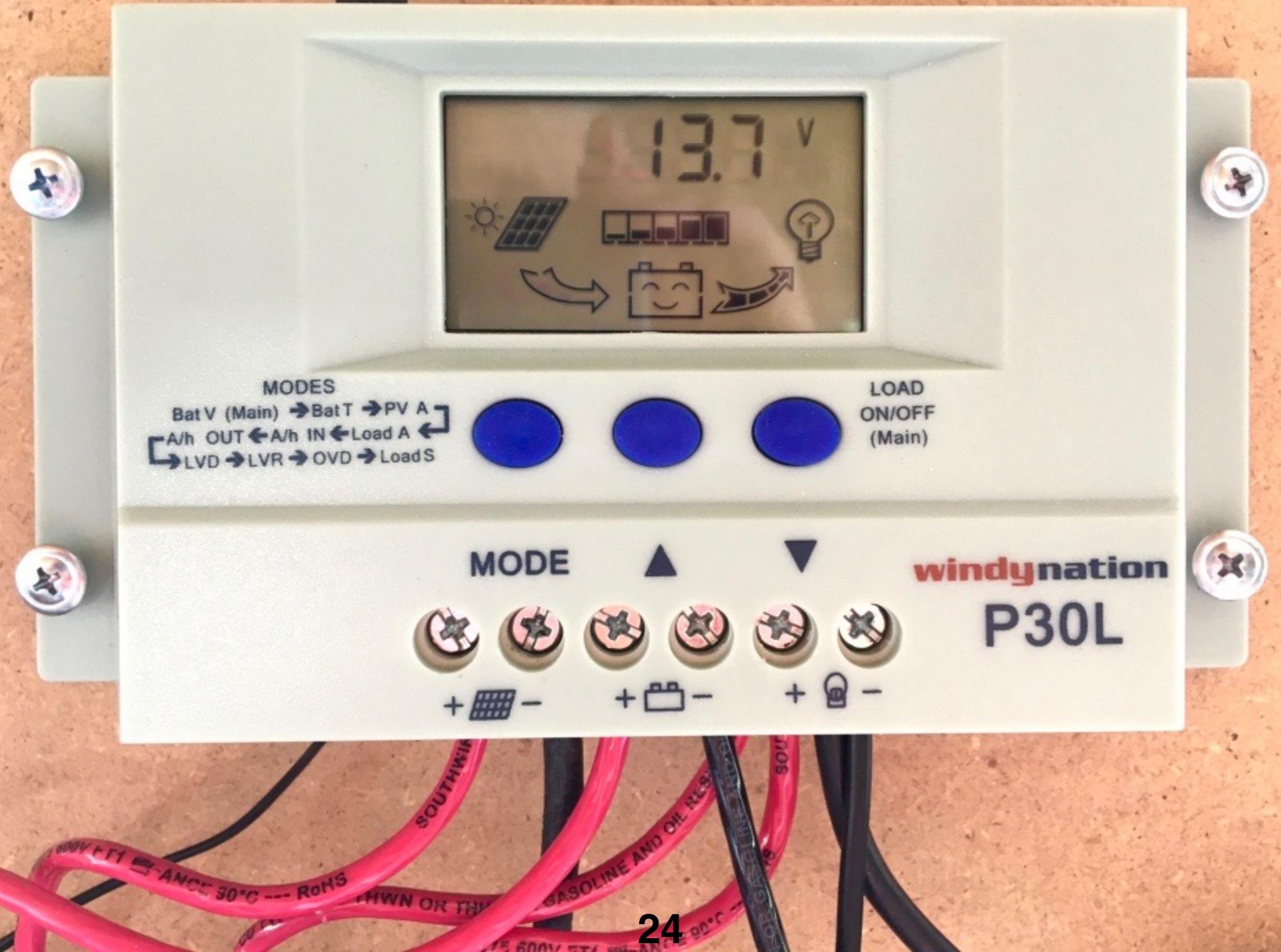
LOAD

Your solar controller's liquid crystal display (LCD)

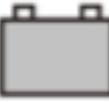


The Main Interface displays the current state of the Load, PV charging, Load discharging, battery capacity, and overall system working condition.

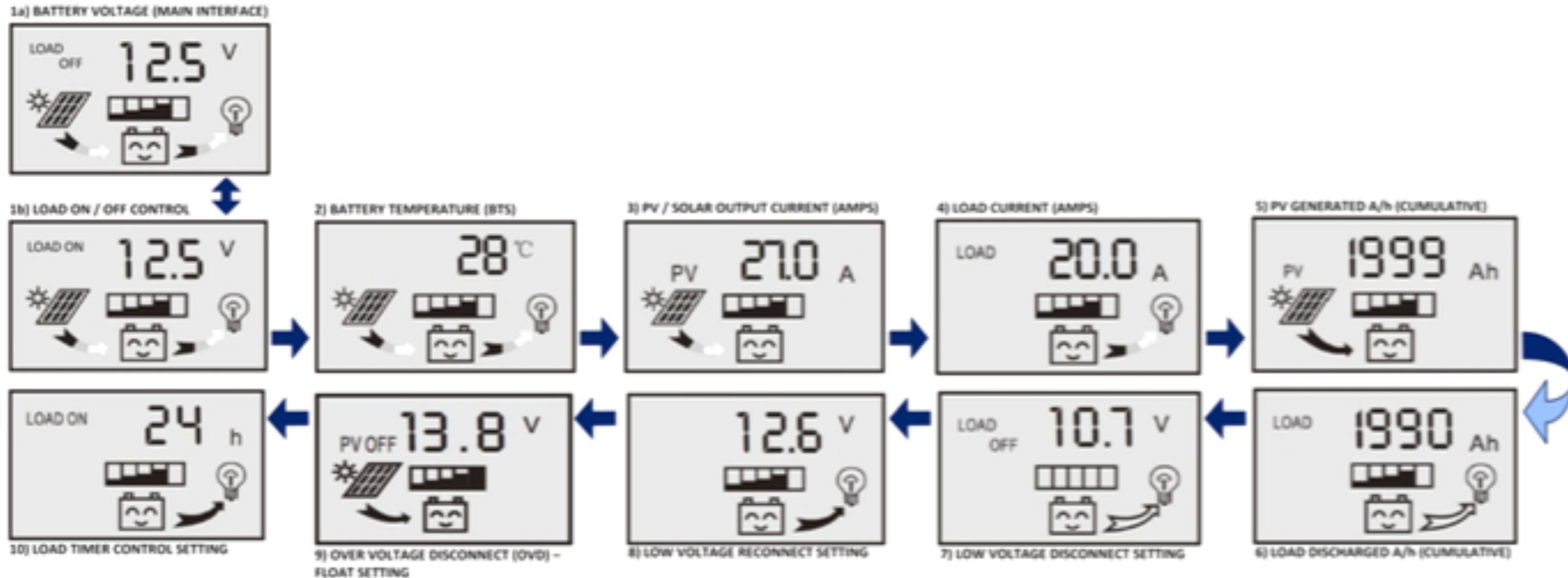
Main interface



LCD symbols

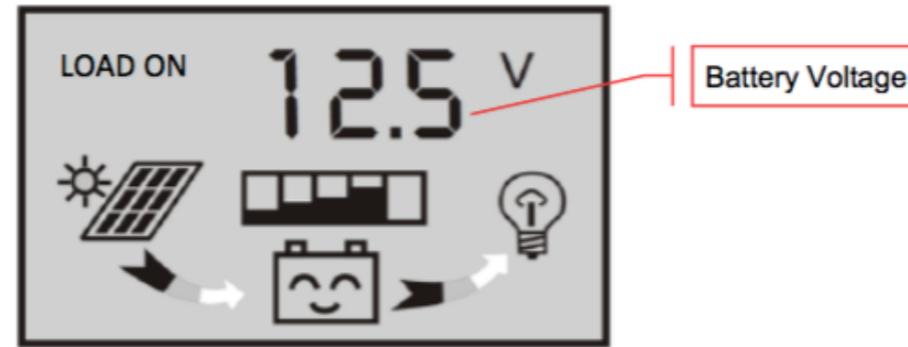
LCD Symbol	Description
	Stop power supply to LOADs
	Supply power to LOADs, No current drawn from Load
	Supply power to LOADs, Load is drawing current
	Load Icon
	Solar Panel Icon
	Battery Icon
	Load Light Control Icon
	Load Timing Control Icon
	Stop Charge to Battery
	Full Charging to Battery
	Float Charging to Battery
	Normal Working Condition
	Error/Abnormal Working Condition
	Battery Capacity

Your solar controller's liquid crystal display (LCD)



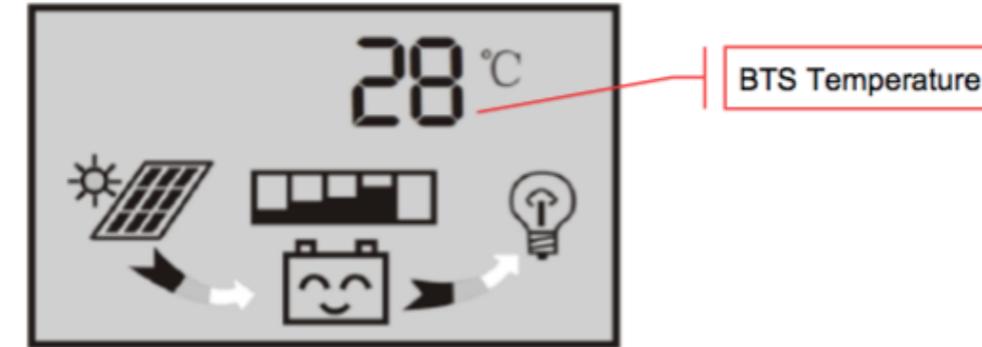
And there are 9 more interfaces.
Each contains different information.

Main screen



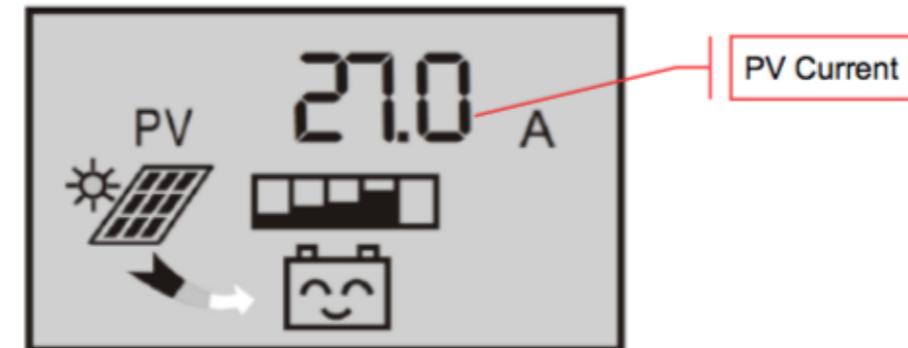
Battery Voltage

Battery temperature



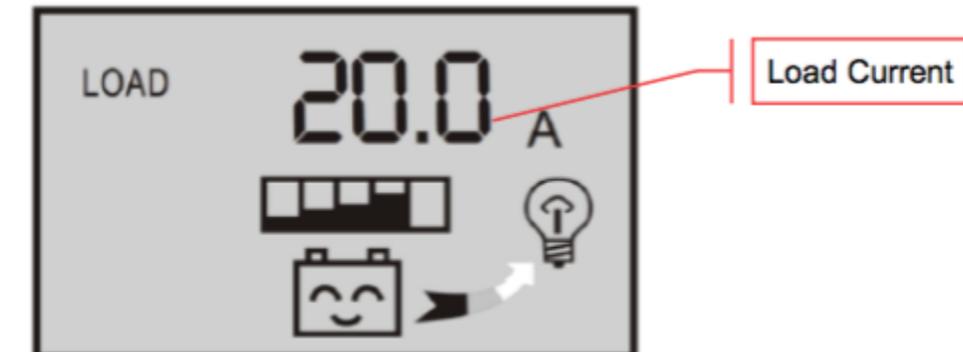
BTS Temperature

PV Amps



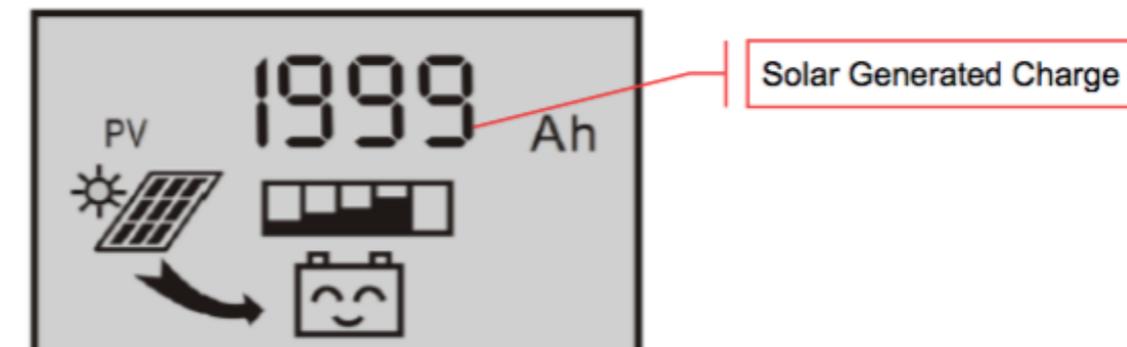
PV Current

Load Amps



Load Current

Total Amp/Hours produced can be reset



Solar Generated Charge

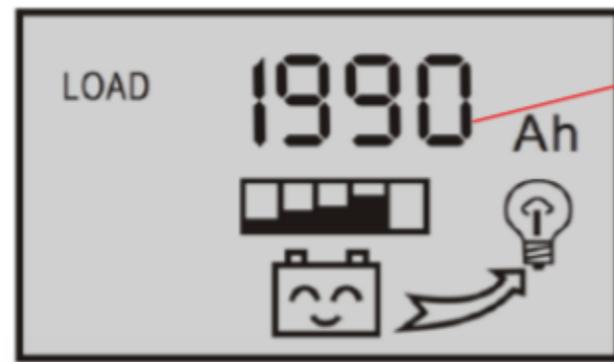
Total Amp/Hours
used
can be reset

Low Voltage
disconnect setting

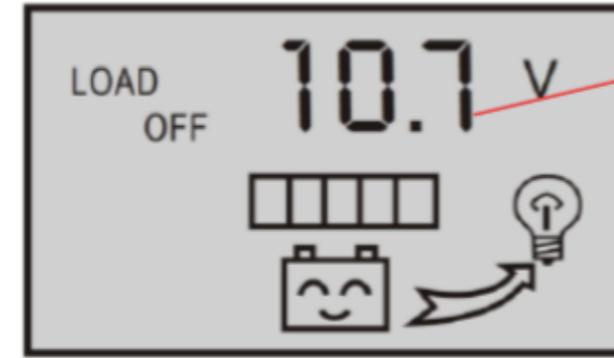
Reconnect when
Voltage gets back up

Over Voltage
disconnect

Load
timing setting



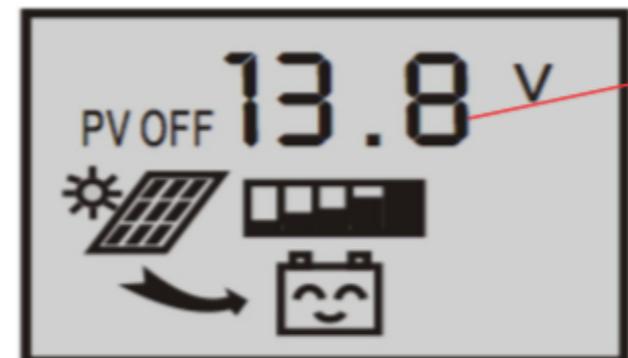
Load Consumed Charge



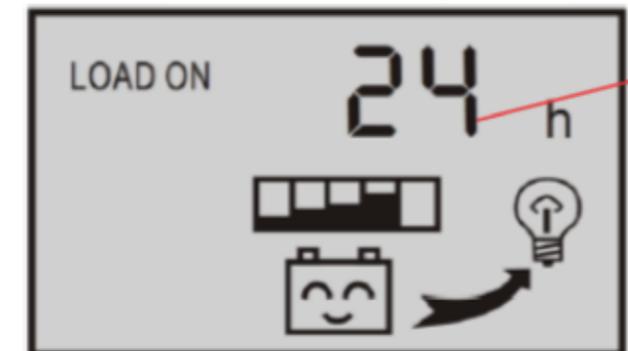
LVD Set Value



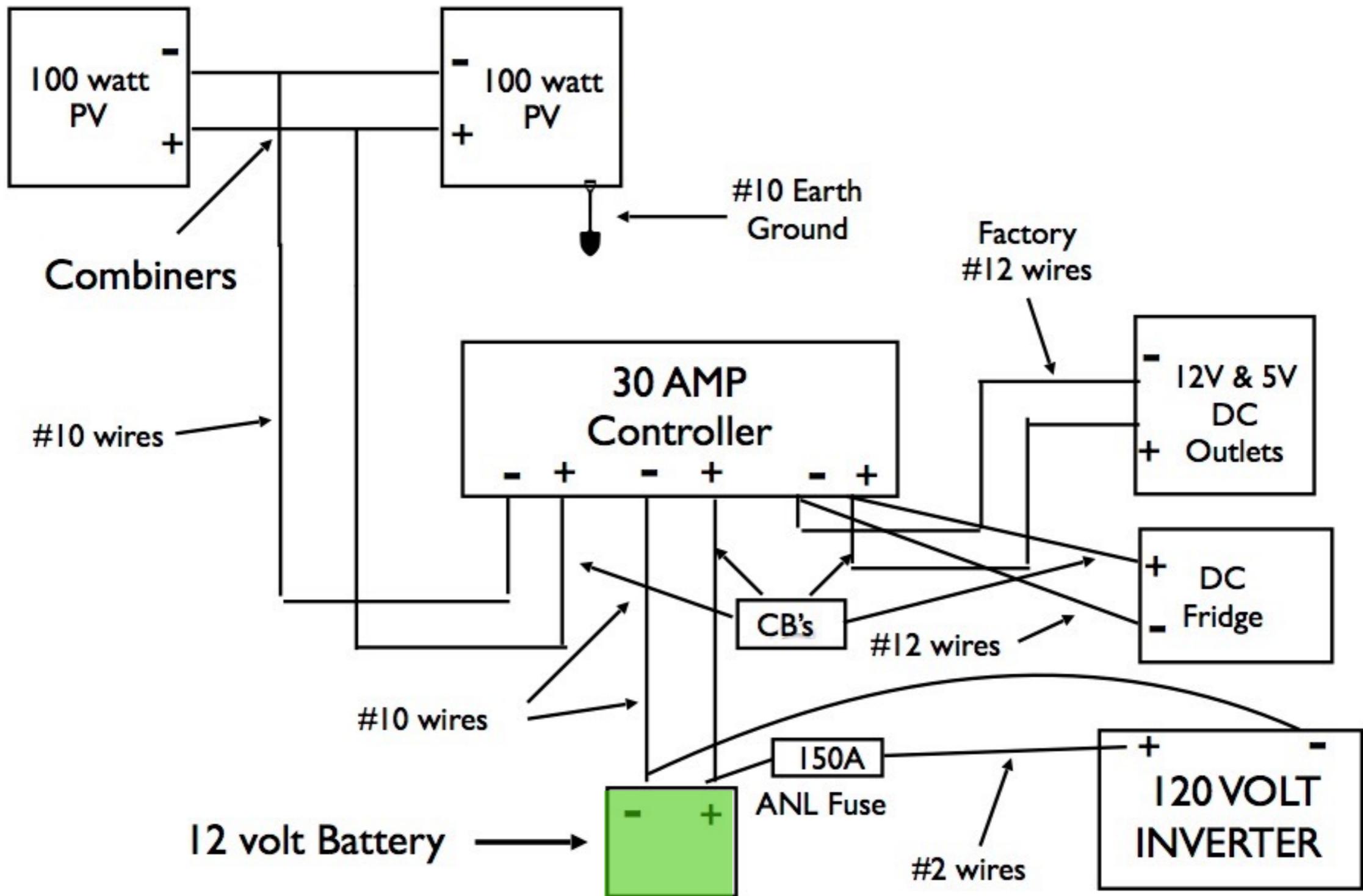
LVR Set Value



OVD Set Value



Load Mode Set Value



Your Battery



Your battery

12 Volt Battery

110 Amp/ Hour

Absorbent Glass Mat (AGM)*

*AGM has very low internal resistance, is capable to deliver high currents on demand and offers a relatively long service life, even when deep cycled.

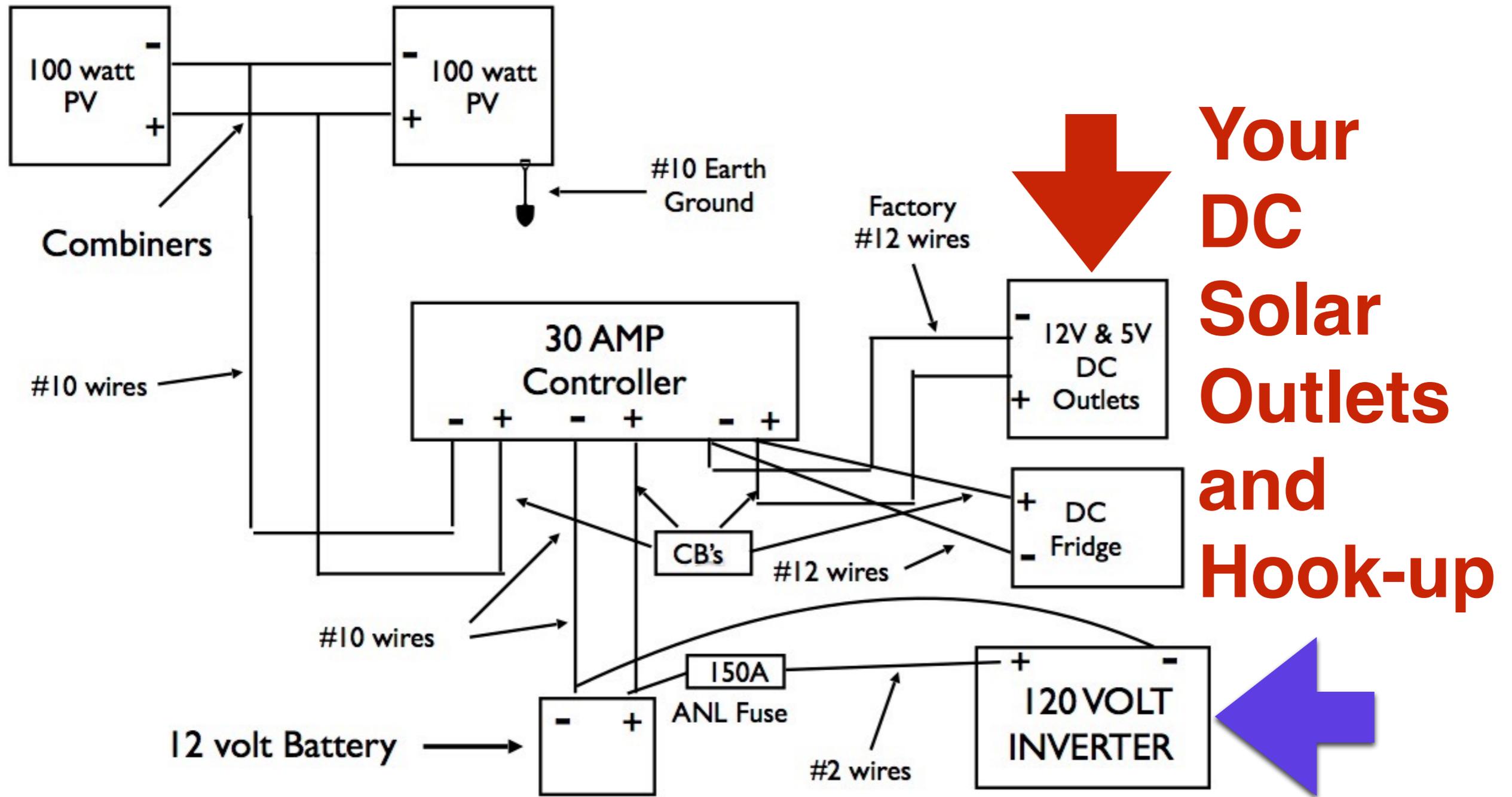
The sulfuric acid is absorbed by a very fine fiberglass mat, making the battery spill-proof.

AGM is maintenance free, provides good electrical reliability and is lighter than the flooded lead acid (FLA) type.

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%

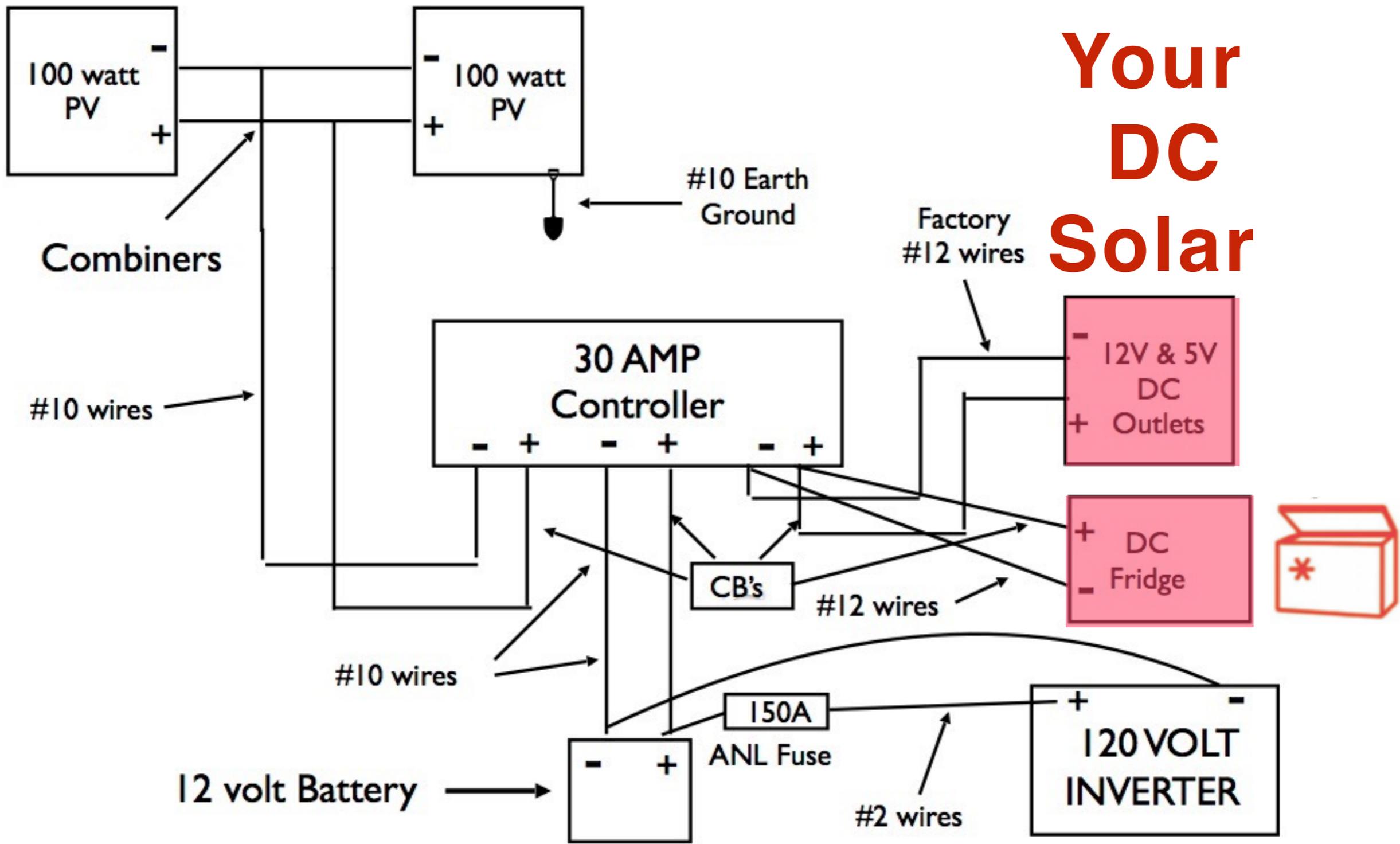
Voltage reading on your controller indicates how much charge your battery has.

Your AC and DC



Your AC Solar Inverter

Your DC Solar

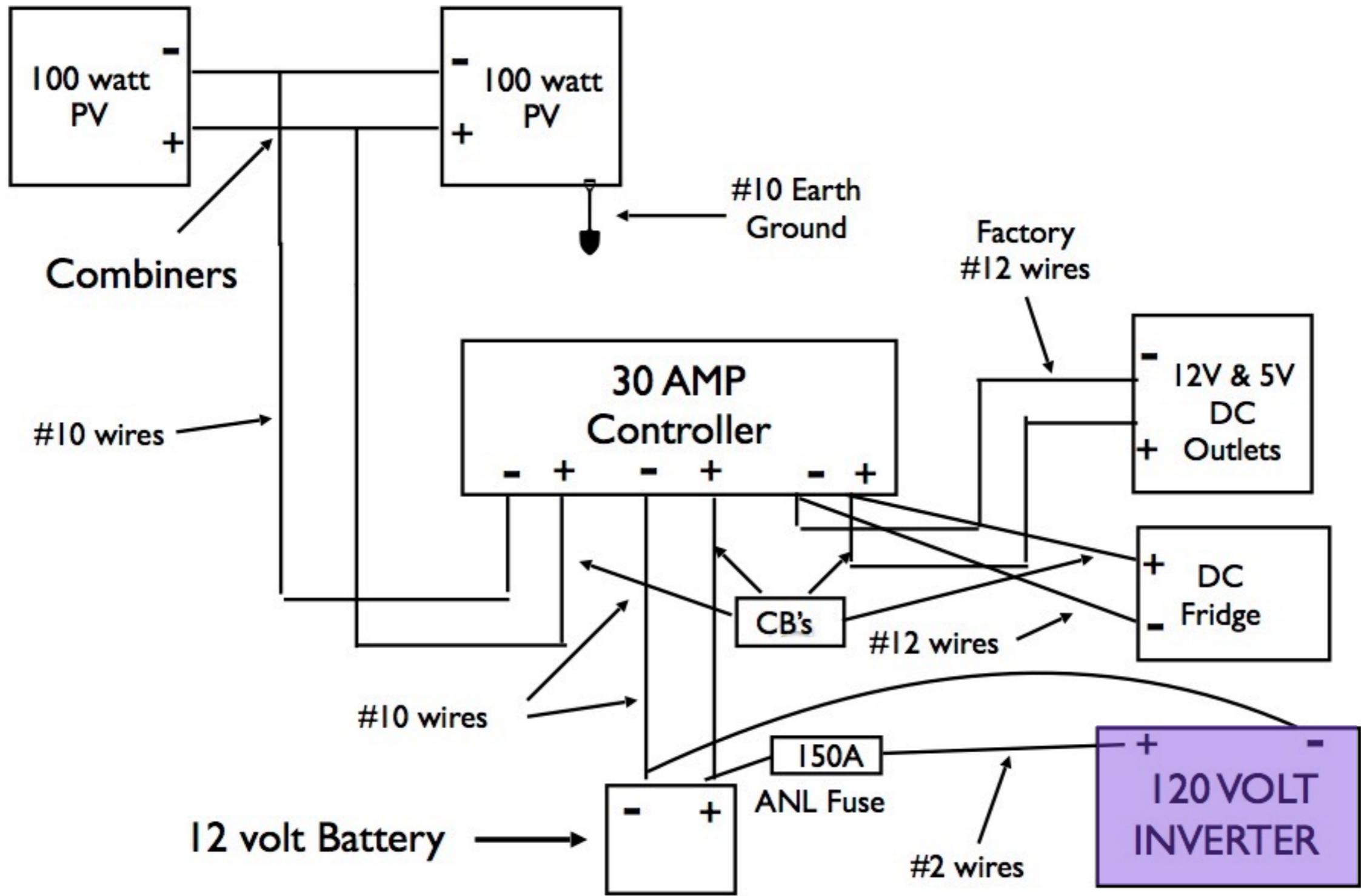


**DC
outlets**

12V

USB

Your AC Inverter



Your Solar Inverter



Your solar panels produce DC.
You need an inverter to make DC into AC.

An Inverter
converts **12V DC**
power from your
battery into into
120V AC power.

Volts go up x 10

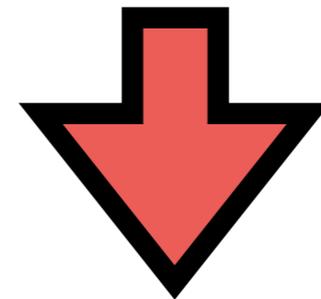
Amps go down x 10

Watts law.

Most appliances
use **AC**

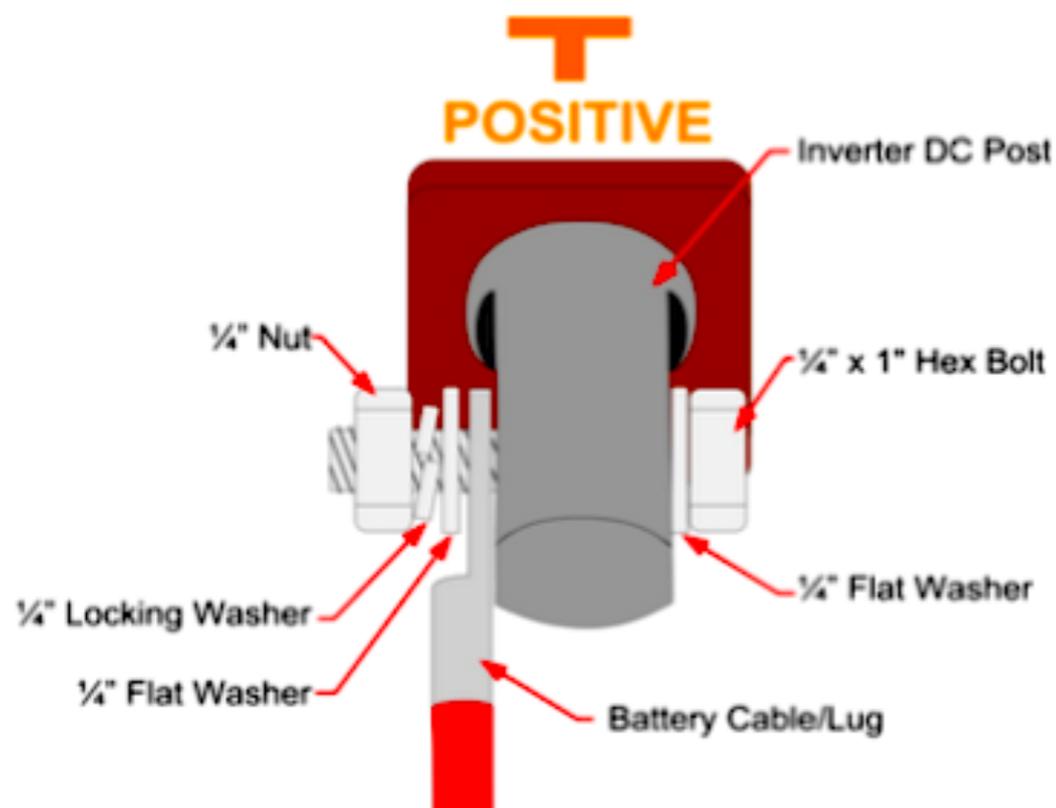


DC



AC

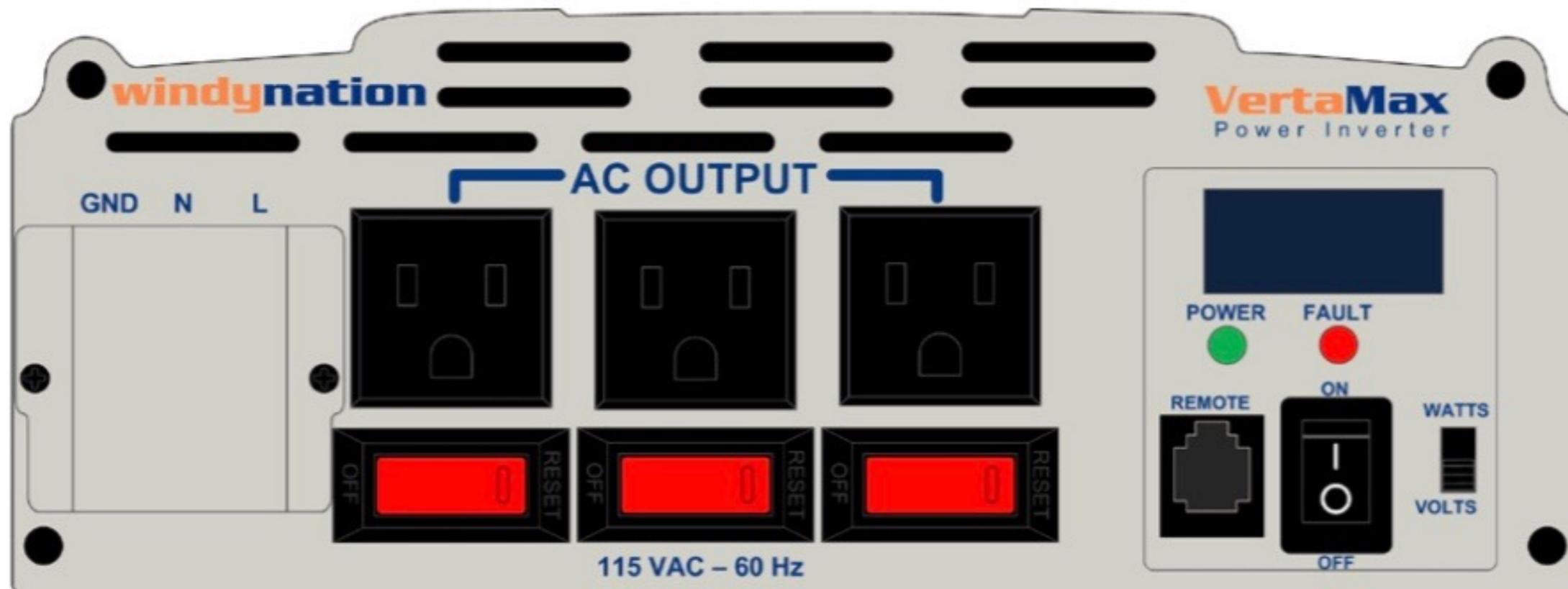
Your inverter input



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



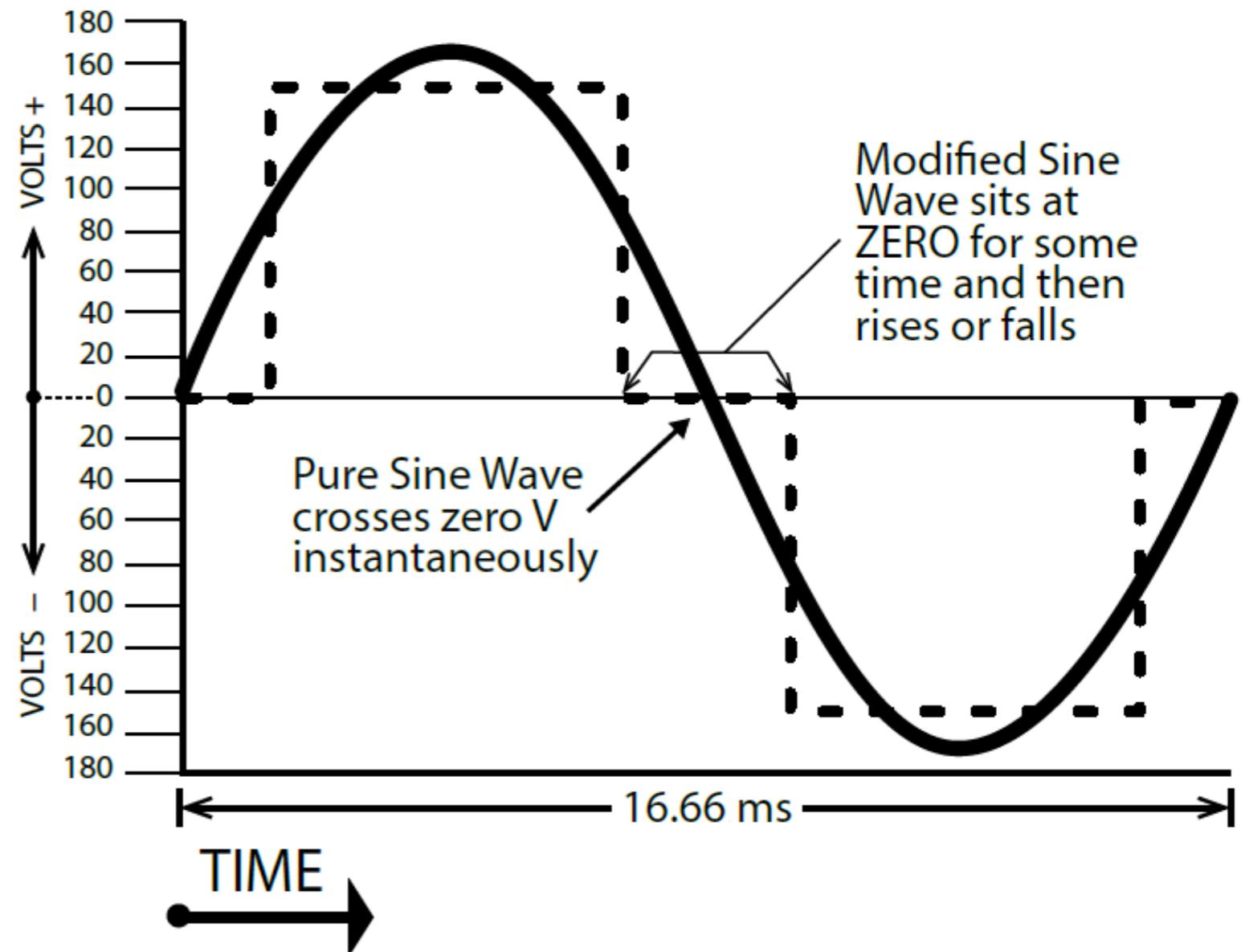
From the AC Output end of the inverter,
switch the rocker power switch to the ON position.

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.

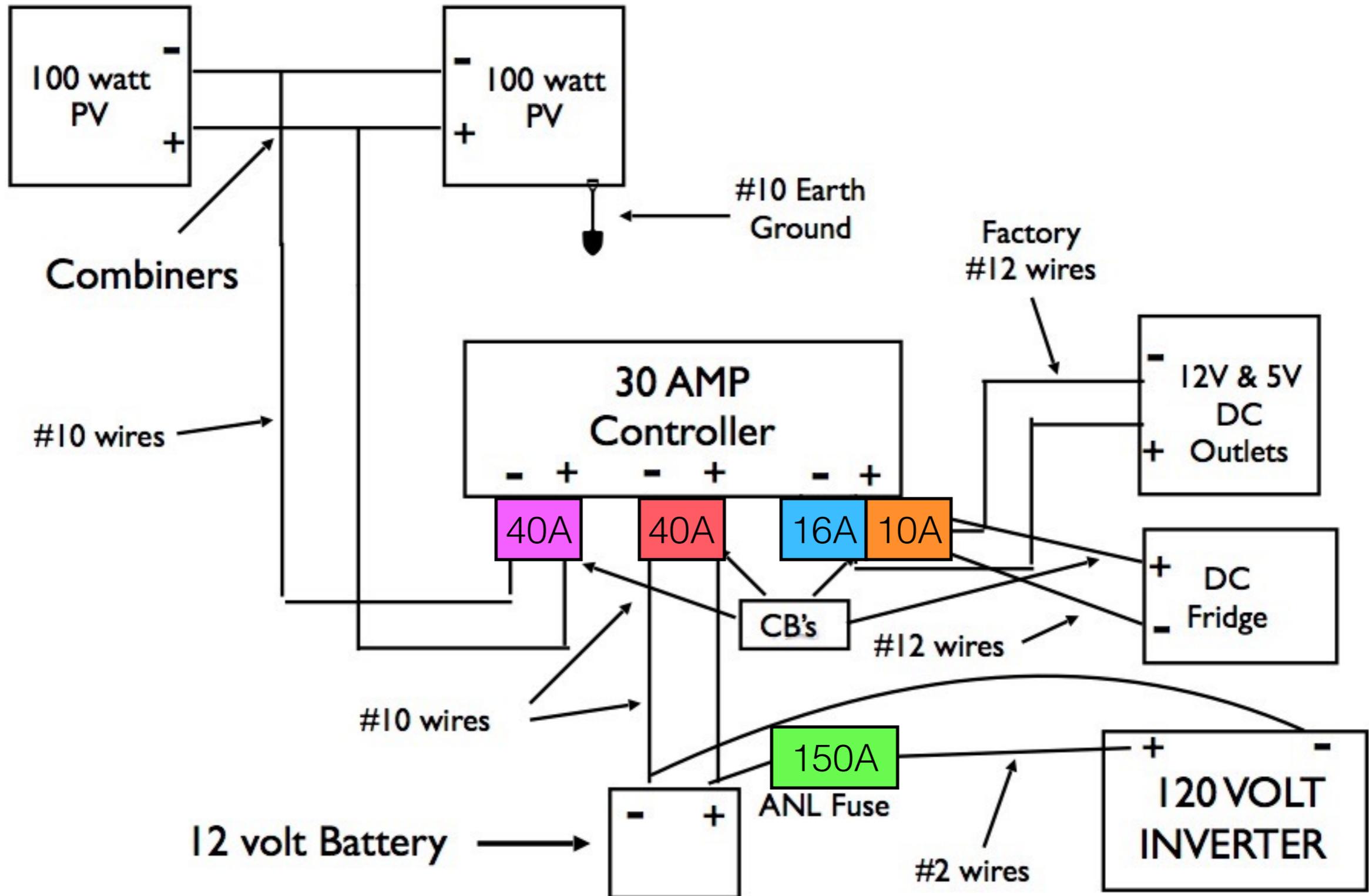
Input voltages of 16VDC or more will permanently damage the inverter.

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

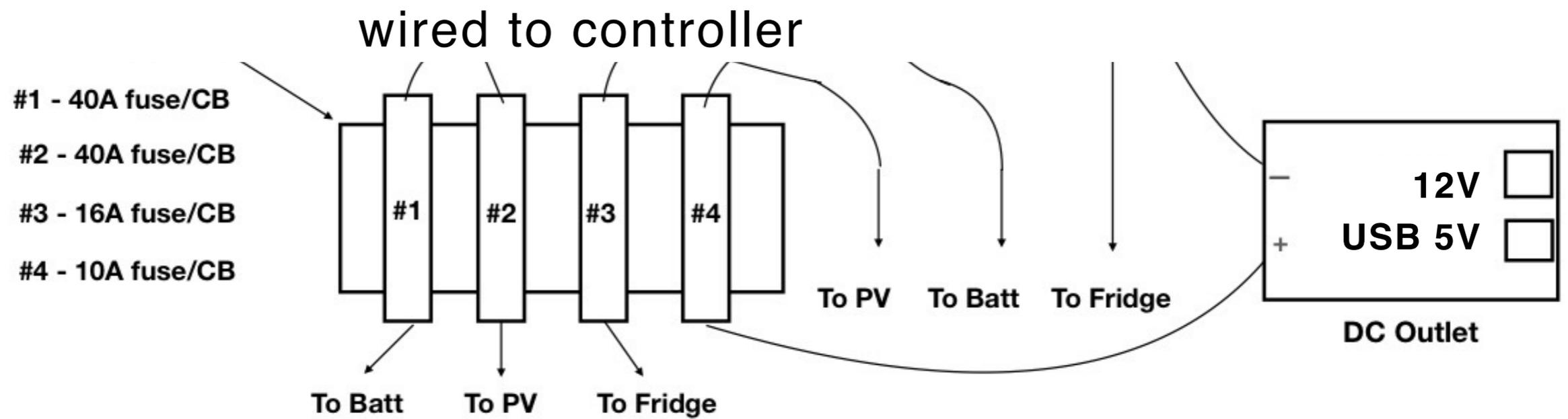
Circuit Breakers



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

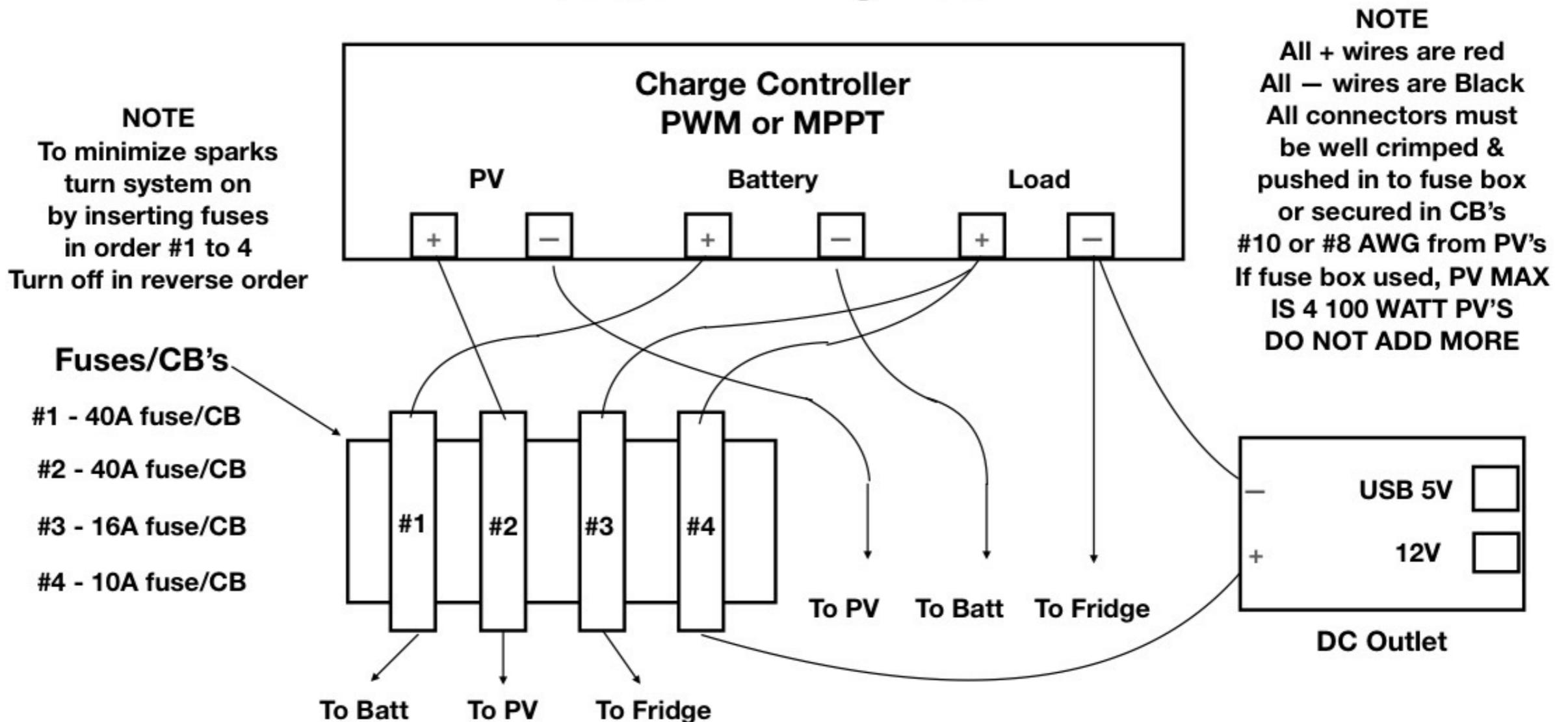


Circuit Breakers



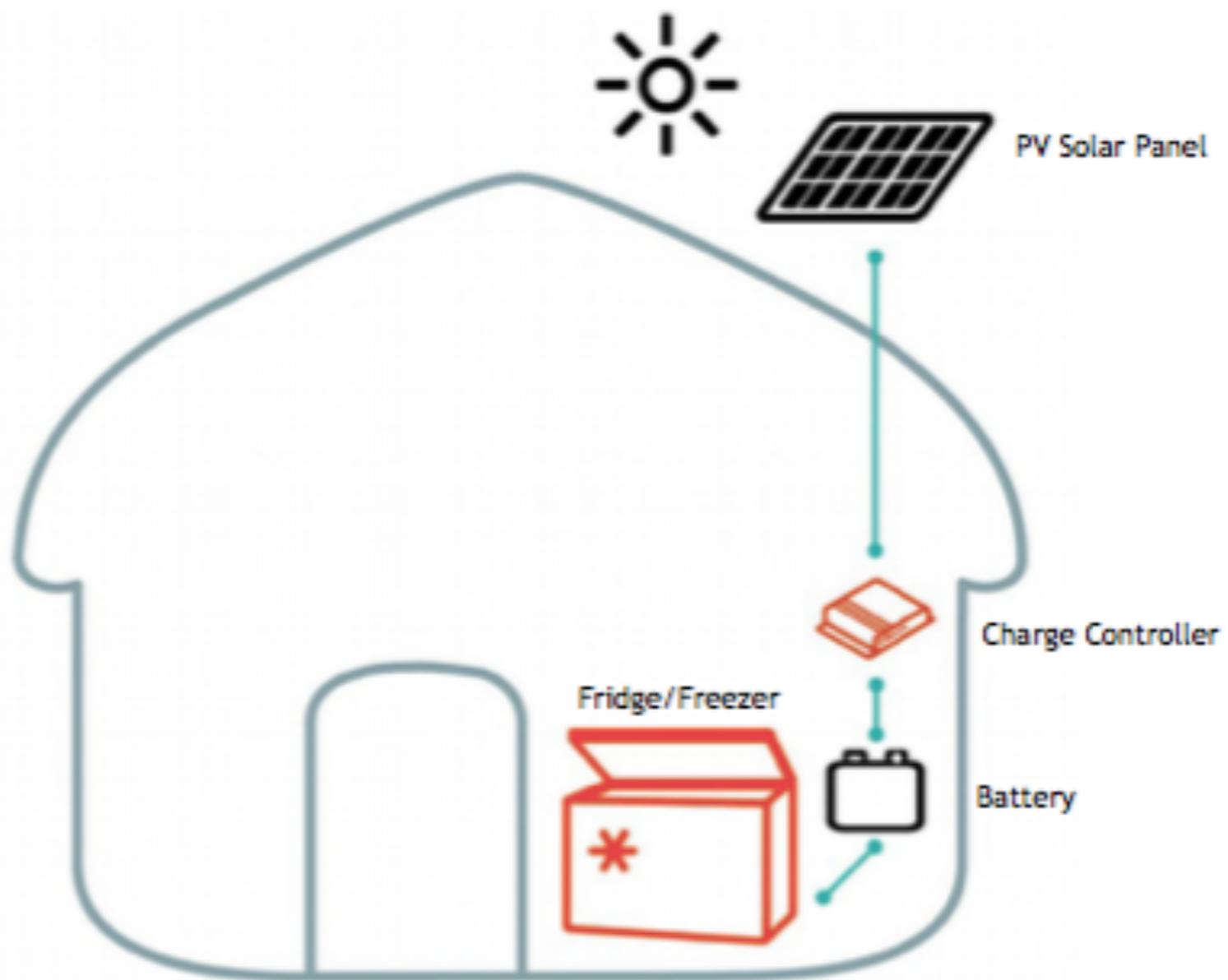


Gallup Solar 12 Volt Hogan Fuse/CB Wiring Detail



At last! Your DC Solar Refrigerator.





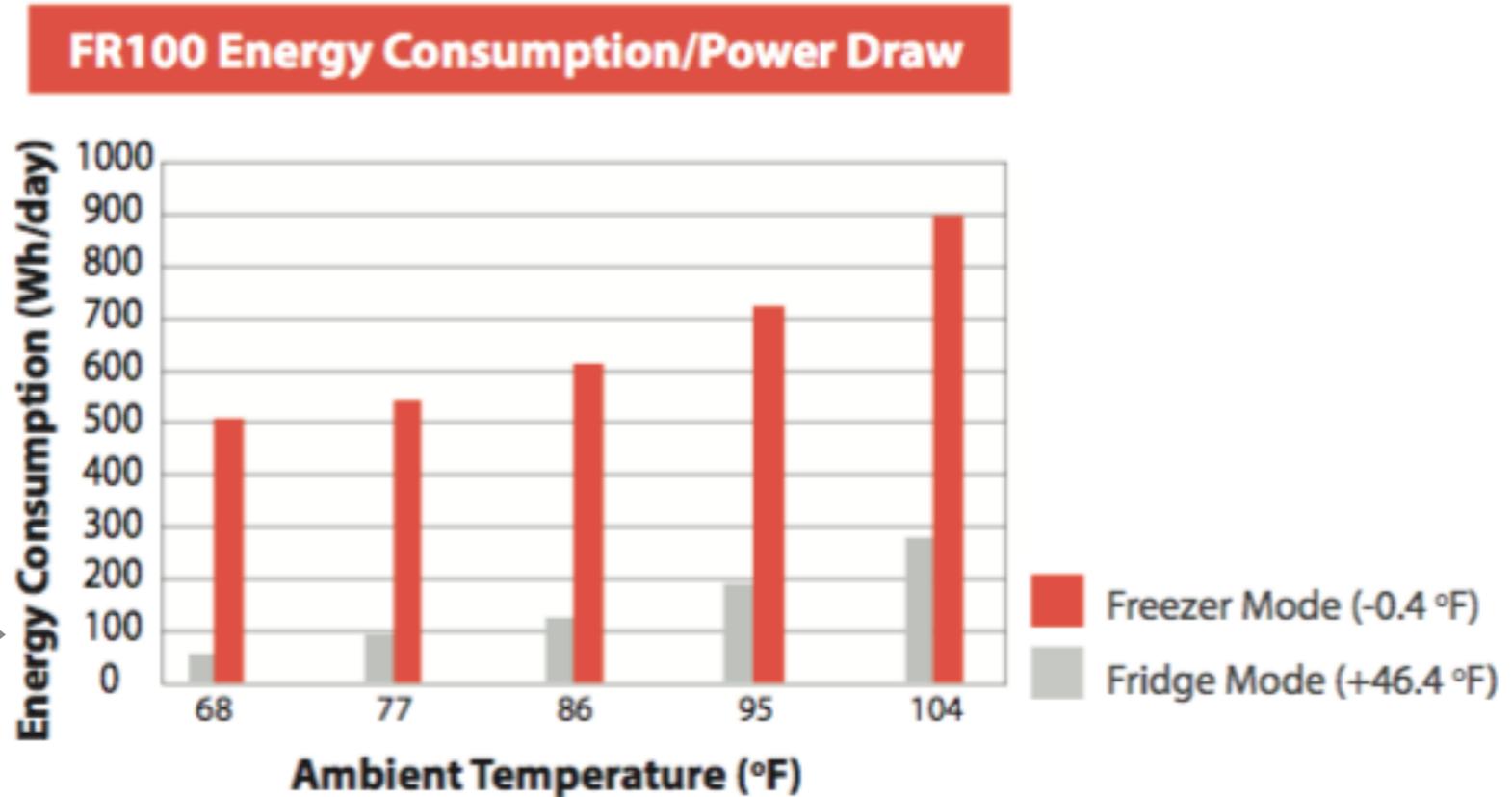
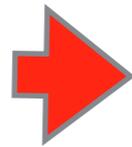
Technical Data

Type	FR100	
System Voltage	12 / 24 V auto recognition	
Temperature Range	-18* to +8 °C / -0.4* to +46.4 °F	
PV Panel Size	70 W	
Energy Consumption at +21 °C / +70 °F	in our area	108 Wh / day (fridge**), 553 Wh / day (deep-freezer**)
Energy Consumption at +32 °C / +90 °F	in hotter places	181 Wh / day (fridge**), 659 Wh / day (deep-freezer**)
Content (Net Capacity)	104 L	
Refrigerant	R600a	
Ambient Temperature	+10 to +43 °C / +50 to +104 °F	
Door Type	Top opening	
Cabinet Dimensions (WxHxD)	685 x 850 x 590 mm / 27 x 33.5 x 23.2 in	
Inner Dimensions (WxHxD)	505 x 640 x 375 mm / 19.9 x 25.2 x 14.8 in	
Battery Compartment Dimensions (WxHxD)	n/a	
Weight	29 kg / 64 lbs	
Warranty	2 years	

* Up to +38 °C / +100 °F ambient temperature.

** Measured at +8 °C / +46.4 °F (fridge) and -18 °C / -0.4 °F (deep-freezer) temperatures.

in our area
the *phocos*
refrigerator uses
about 108wh
per day
in fridge mode



2 Using your estimated power draw value, find the recommended solar array from the chart below (assuming a solar irradiation of >3 kWh/m²/day)*

Power Draw (Wh/Day)	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
Recommended Solar Array (Wp)	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450

3 Determine the recommended battery capacity for your system using the solar array value suggested above*

Solar Array (Wp)	50	75	100	125	150	175	200	225	250	275	300	325
Battery Capacity (Ah)	50	100	150	150	200	250	300	350	400	450	550	600

Your Refrigerator

Maximum Efficiency

- Direct DC operation eliminates wasted inverter energy
- Chest-style design and extra-thick insulation keeps the cold in and reduces compressor run time

Flexible

- Can be powered with a 12 or 24 V battery (auto detection)
- Wide temperature thermostat allows every unit to run as a refrigerator or freezer (temperature setting is defined by user)

Low-Maintenance

- Maintenance free, brushless DC compressor
- Low-frost system reduces formation of condensation and ice
- Sturdy integrated handle

Simple Design

- Direct DC operation from battery, no costly inverter required
- Lock on lid standard
- Environmentally-friendly refrigerant

Not at Gallup Solar



"Solar panel sold separately."

Terms for Discussion

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