

# UPGRADING THE ELECTRICAL IN YOUR AIRSTREAM

RICH HOWARTH - 3393



# HISTORY

- Purchased 2020 Airstream Bambi 19CB in May 2021
  - Came with factory solar (90W) and two AGM batteries (160 Ah)
  - The refrigerator was a NovaKool 3.1 AC/DC model (no propane)
  - It consumed 50-70 Ah per day which made dry-camping and boondocking difficult.
- Our first trip without a hookup drained the batteries to zero in a two days even though we were conserving power
- Very disappointing – dry camping was out of the question.



# EVERY INSTALLATION IS DIFFERENT

- What are your goals?
  - A weekend of boondocking?
  - A week between a campground with hookups?
  - Is occasional generator usage ok?
  - Continuous off the grid living with no generator?
- What size trailer do you have?
  - In larger trailers, anything is possible.
- Our goal was a week of boondocking in our 19' Bambi
- The size of our trailer was very limiting in what we could do.

# MY DREAM SOLAR/ELECTRICAL CONFIGURATION

- Ability to comfortably camp without a generator or shore power
- 500 Ah of Lithium Batteries inside of trailer
- 400 watts of solar on the roof
- MPPT solar controller
- 3000 watt inverter so we could use Microwave and other appliances while boondocking
- Ability to charge batteries from alternator when driving
- No reduction in closet or storage space

# FINDING SOMEONE TO DO THE INSTALLATION

- We talked to multiple vendors and the bids for my dream configuration were in the \$20K range.
- Cutting the battery capacity in half saved about \$3K
- Most quality shops could not do the installation for 3-6 months
- I decided that the only option was to do it myself.

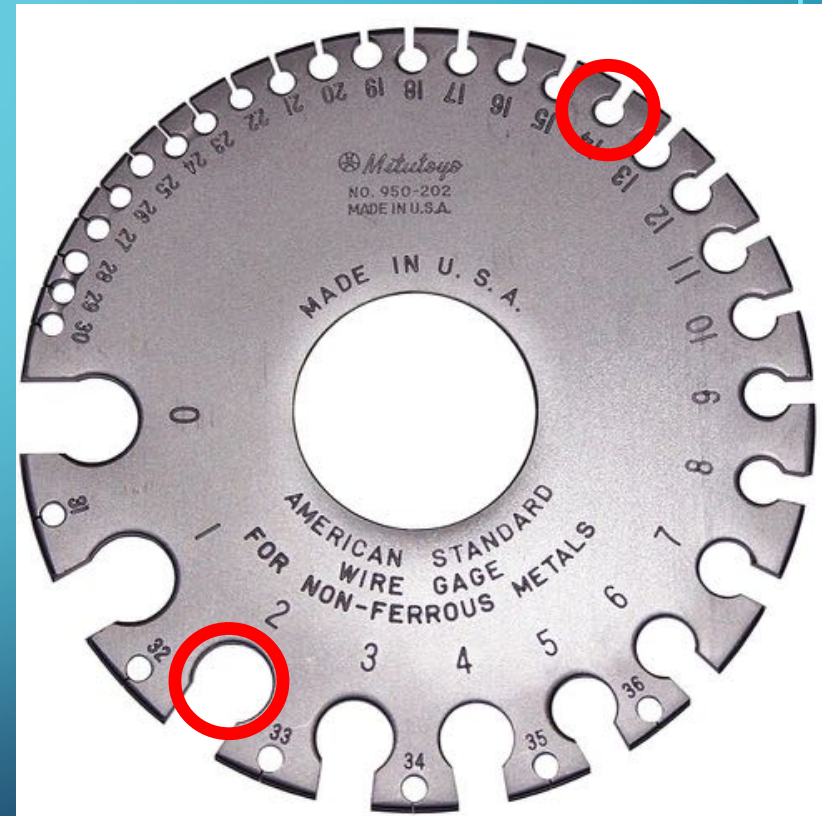


Camping Express  
(Dacono)

RV Solar Store  
(Granby)

# SOME BASIC ELECTRICAL CONCEPTS

- RVs have two primary circuits
  - AC 120 Volt
  - DC 12 Volt
- $\text{Watts} = \text{Amps} \times \text{Volts}$
- $\text{Amps} = \text{Watts} / \text{Volts}$
- Lets use a 1600 Watt Microwave example
  - At 120 Volts, the appliance would require **13.3 Amps** (14 AWG Wire)
  - At 12 Volts, the appliance would require **133 Amps** (2 AWG Wire)



# STEP 1 – UNDERSTANDING CURRENT WIRING

- There were no detailed wiring diagrams on the Airstream so I had to reverse-engineer and identify all the key wires
  - AC in from shore power outlet
  - AC distribution panel & breakers
  - DC distribution panel & fuses
  - Charge controller
  - 7 pin wiring
  - Solar wiring
  - Lots of other random wires (e.g. electric hitch wiring, breakaway box)







# HOW MUCH SOLAR IS ENOUGH

- When mounting panels on the roof they will not be optimally aligned, and you will typically get far less than rated capacity.
- I average about 100-150 Ah per day from three 90W panels during the spring-summer-fall season.
- I typically use less than 125 Ah per day. This includes the refrigerator, lights, fans, some microwave usage, laptop charging, television and some furnace usage.
- Assuming it is sunny (and I don't run the AC), I'm able to boondock continuously without draining my batteries.
- Less-sunny locations (e.g. Alaska) will be more challenging and will require larger battery capacity or another form of charging .



## ADDITIONAL SOLAR PANELS



# SOLAR CHARGE CONTROLLER

- Many Airstreams with Solar came with a PWM Solar Charge Controller
  - PWM technology is older and less-efficient than MPPT
- Today most installations should utilize a MPPT charge controller
  - They can utilize higher voltage panels without losing power
  - You will typically see a 20-30% improvement in battery charging



# CHARGE CONTROLLER & DISTRIBUTION PANEL

- Airstream charge controller (WFCO-8955) and distribution panel were integrated.
- The WFCO charge controller was not designed to charge Lithium batteries and needed to be replaced.
- You can buy a drop-in replacement charger controller from Progressive Dynamics that supports Lithium charging



# COMBINED INVERTER / CHARGE CONTROLLER

- Since the Airstream charge controller didn't support Lithium and had to be replaced, I decided to go with a combined inverter/charge controller.
- In order to power the AC and other appliances from battery, we required 3000 Watts.
- The Victron MultiPlus 12/3000/120 unit met all our requirements and fit into our limited space.



# LITHIUM VS. AGM (LEAD ACID)

- 2 Lithium Batteries – 200 Ah
  - 200 Ah of Lithium - \$800-\$1,600
  - Total Usable capacity – 200 Ah
  - Price per usable Ah - \$4 - \$8
  - Weight – 58 Pounds
  - Useful Life – 2-3X better than AGM
- 2 AGM Batteries – 200 Ah
  - 200 Ah of AGM - \$300-\$700
  - Total Usable Capacity – 100 Ah
  - Price per usable Ah - \$2 - \$7
  - Weight 138 Lbs





# CHOOSING A LITHIUM BATTERY

- I wanted to mount batteries inside of trailer
- Battleborn makes a 270Ah LiFePO4 battery called the GC3.
- The GC3 has an integrated BMS, comes in a different form factor than standard batteries and can be mounted horizontally or vertically.
- A single GC3 can sustain 300 Amps and charge at 135 Amps
- Two GC3 batteries (540 Ah total) could be fit under the dinette benches.
- Fewer batteries requires less 4/0 cabling.





# MONITOR / DISPLAY OPTIONS

Victron CCGX  
Or GX Touch



Victron Connect  
Phone App



Victron Multi Control  
and  
BMV 712 Smart Bluetooth

# BMV 712 AND MULTI CONTROL & PHONE APP



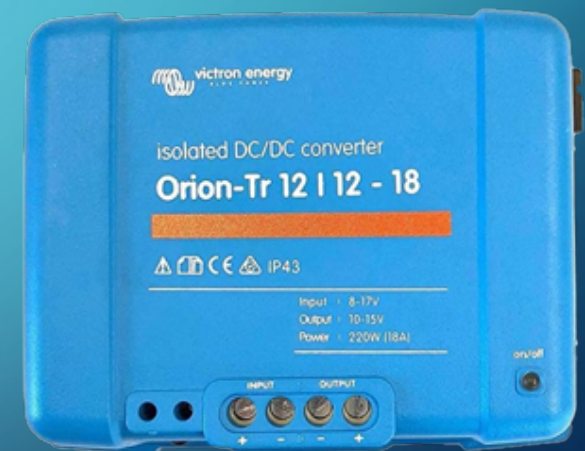
# CHARGING FROM TRUCK

- The standard 7 pin connector has a 12V power line that can be used to charge the battery.
- Normally these use a small wire size and deliver limited current – depending on the truck.
- They will usually provide enough battery charging while driving to at least cover the power needs of a small DC refrigerator
- Our 2022 Ford F-150 (Ecoboost 3.5) provides up to 30 amps



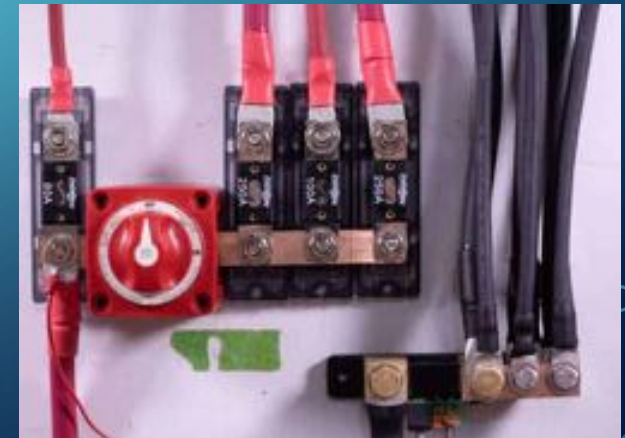
# CHARGING FROM YOUR TOW VEHICLE

- There are multiple options depending on your tow vehicle and the amount of current you want to flow
  - Use standard 7 pin 12V source directly
  - Use standard 7 pin 12V source with a DC-DC charger
  - Run a separate high-amperage cable from battery/alternator to a DC-DC charger.
- The DC-DC charger has several functions:
  - Limiting the number of amps pulled from the tow vehicle
  - Providing the correct voltage for multi-step charging of lithium batteries
  - Isolating the tow-vehicle and camper batteries from each other



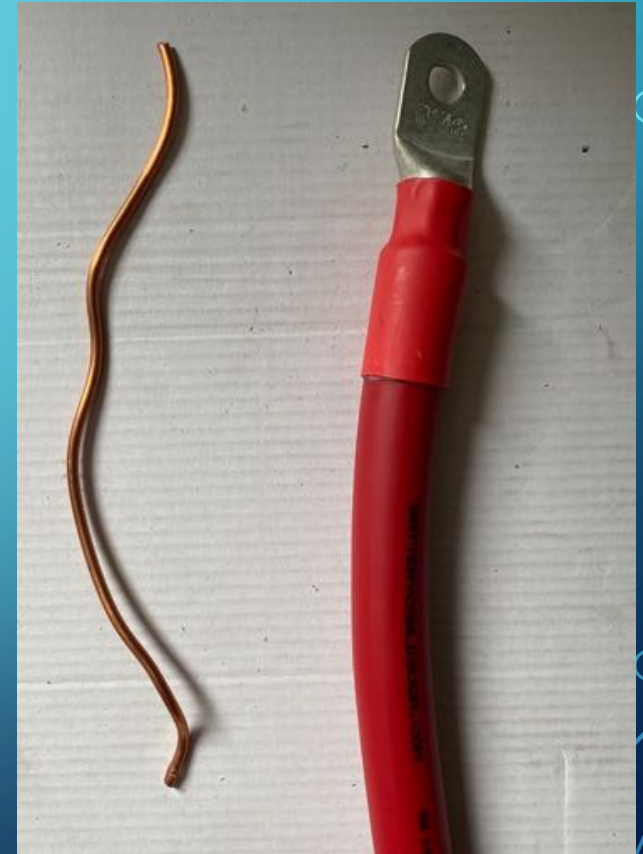
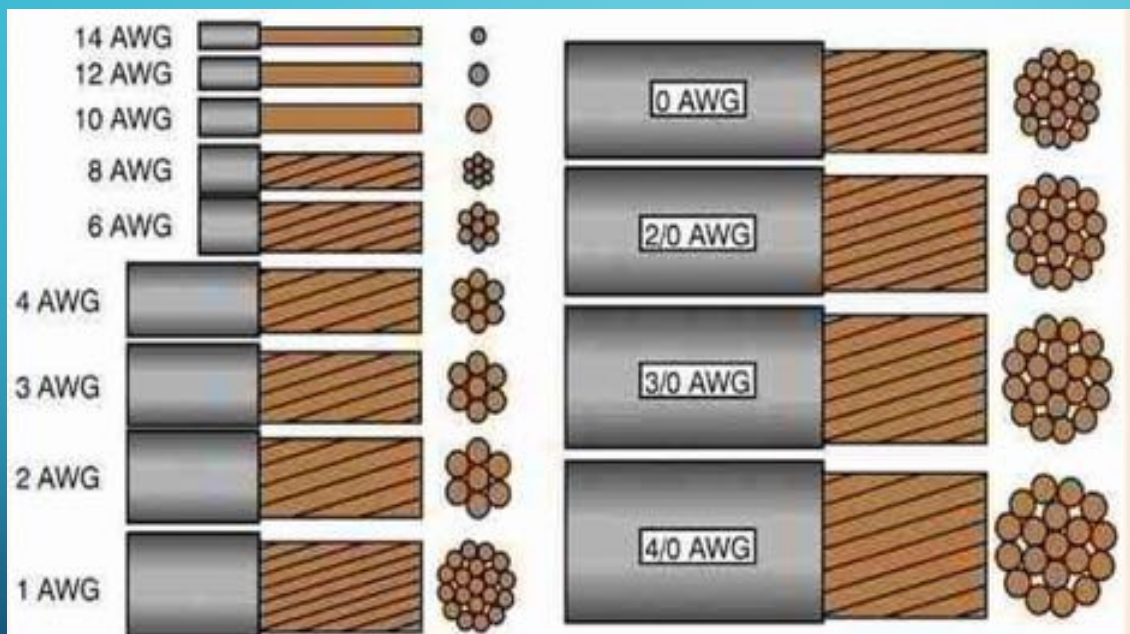
# BUSBAR – VICTRON LYNX DISTRIBUTOR

- The Lynx Distributor simplifies the wiring of electrical components.
- It provides a positive and negative busbar and has 4 protected fuse connections.
- It uses MEGA fuses which can be purchased with different current ratings.
- The alternative is to install a positive and negative busbar and multiple AML fuse blocks.





# WIRE GAUGES



# GAUGES REQUIRED TO SUPPORT DC AMPERAGE

Distance (3% Voltage Drop)	0-6 Feet	6-10 Feet	10-15 Feet
10A	AWG 16	AWG 14	AWG 12
20A	AWG 14	AWG 12	AWG 10
30A	AWG 10	AWG 10	AWG 8
40A	AWG 8	AWG 8	AWG 6
50A	AWG 6	AWG 6	AWG 6
60A	AWG 6	AWG 6	AWG 4
80A	AWG 4	AWG 4	AWG 4
100A	AWG 4	AWG 4	AWG 2
150A	AWG 1	AWG 1	AWG 1
200A	AWG 2/0	AWG 2/0	AWG 2/0
250A	AWG 4/0	AWG 4/0	



# WIRING CONSIDERATIONS

- Ran new AWG 8 Romex from shore power to Victron MP3000
- Ran new AWG 4 cable from Victron MP3000 to DC distribution panel
- Ran new AWG 8 Romex from Victron MP3000 to main AC breaker in panel
  - This powers all AC plugs and devices as if it is plugged into shore power
  - If you use a smaller inverter, you may want to separate out some circuits (e.g. AC)
- Used AWG 4/0 for battery to Victron MP3000 and to chassis ground
- Used 400 Amp fuse from battery positive to Lynx Distributor
- Used high-amperage switch to allow battery to be disconnected
- Used medium switch to allow solar to be disconnected

# WIRING CONSIDERATIONS

- With a 3000 Watt inverter, 4/0 wire is required for connecting the inverter to the batteries, connecting the batteries and grounding the system.
- 4/0 cable is about \$10.00 per foot plus another \$10 for two installed connectors.
- Because of this, and to reduce voltage drop, the batteries and inverter should be near each other.
- The 120V AC cable from the shore power unit (8/10 gauge) is cheap and can be run a longer distance.
- The DC output of the inverter is limited to 55A and only requires AWG 4 cable which is also cheap.



I recommend purchasing  
cables from  
[batterycablesusa.com](http://batterycablesusa.com)

## LOCATION – WHERE TO PUT ALL THIS STUFF

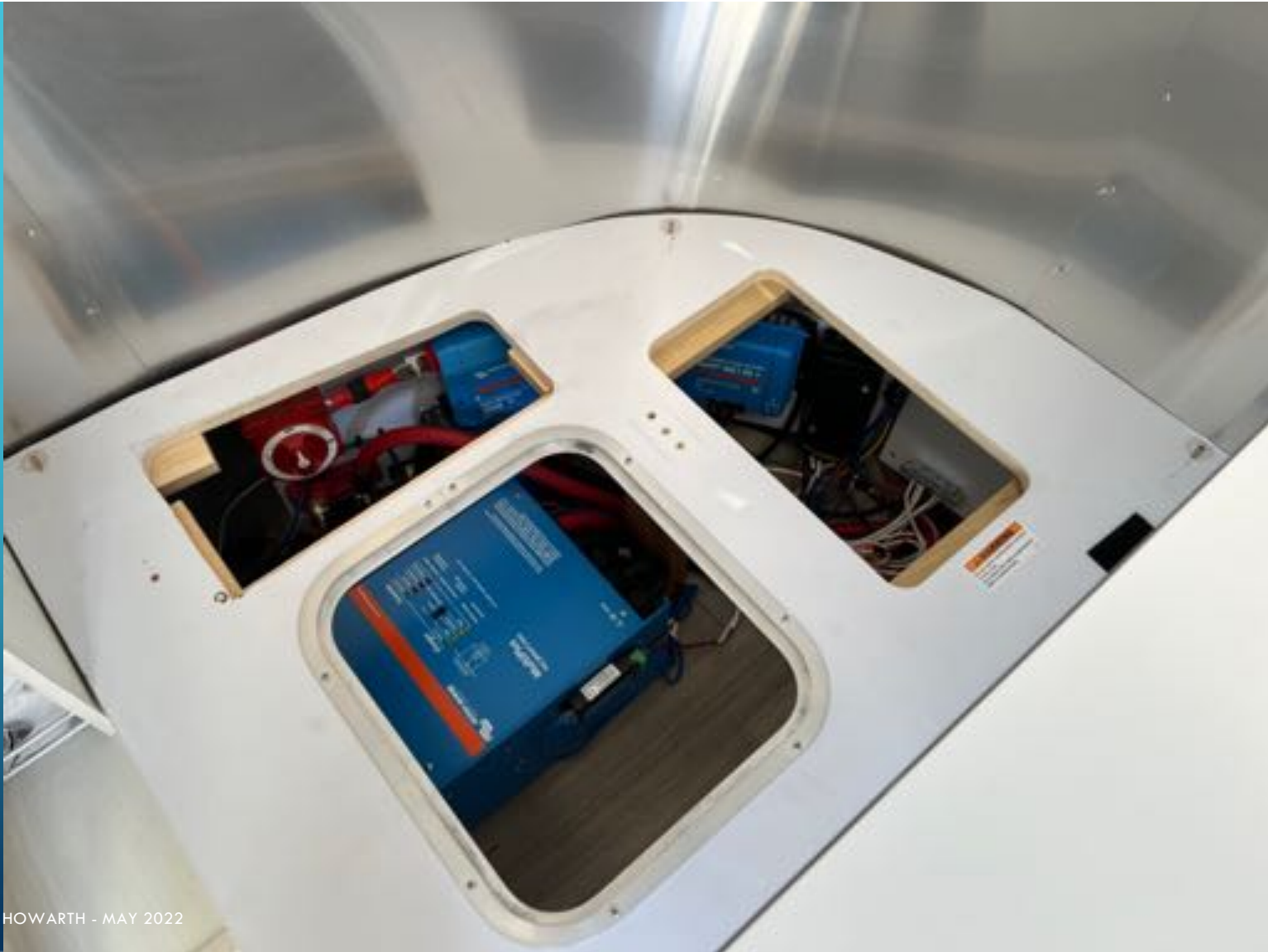
- The front of our RV had a small dinette area
- There was enough room under the left bench for the inverter, most other electrical and one battery.
- I was able to fit a 2<sup>nd</sup> battery under the right dinette. We didn't reduce any usable storage space.





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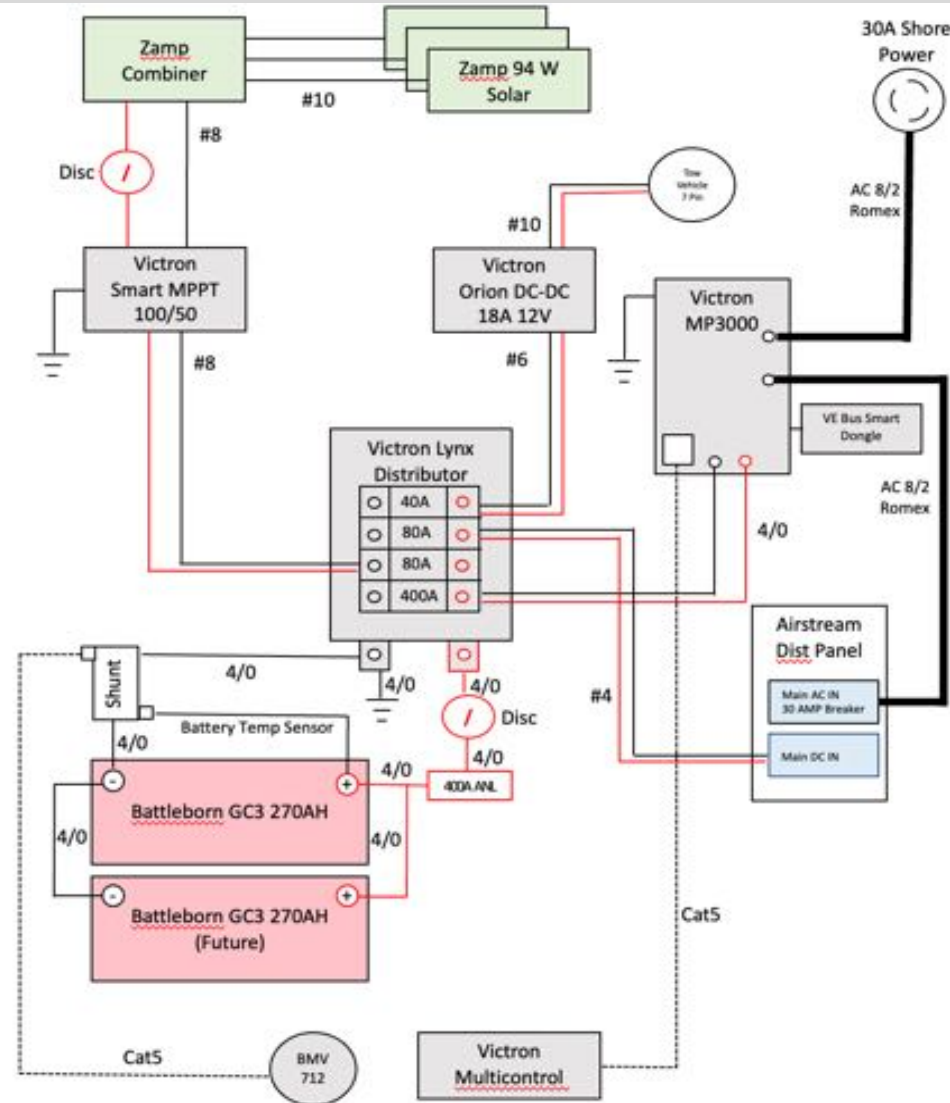


# TOTAL COSTS

- Battleborn GC3 270AH Battery - \$2,359
- Victron 712 Battery Monitor - \$206
- Victron Smartsolar MPPT 100/50 Controller - \$324
- Victron Multiplus 3000 - \$1,285
- Victron Smart Bus - \$80
- Victron Orion DC-DC 12-12 18A - \$120
- 190 W Solar Panels – \$600
- Lynx Distributor - \$200
- Digital Multi-control - \$130
- Cables , Fuses, Switches and tools – \$800

Total Cost: \$6K

# WIRING DIAGRAM



# HOW TO GET STARTED

- Determine your overall requirements
  - Battery capacity, solar capacity and inverter size
- Understand where you will install the batteries and electronics and determine how to run the wires
- Break the project into steps and test as you go. For example,
  - Install the solar and validate it works
  - Install the batteries and inverter and validate it works
- Watch as many youtube videos as you can stand – you will learn something from each one.

# RECOMMENDED RESOURCES & WEBSITES

- Youtube Channels:
  - <https://www.explorist.life>
- Vendors:
  - <https://www.victronenergy.com>
  - <https://battlebornbatteries.com>
  - <https://www.renogy.com>