Installation and Integration of Whole-house Inverter System

2023 Grand Design Imagine XLS 22MLE Travel Trailer

Supplemental Instruction for

Grand Design Owner's Forum

GDRV's Technical Forum

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I wanted to be able to install and inverter in my '23 Grand Design Imagine XLS 22MLE trailer and tie it in to the main electrical system in the trailer, thus creating a "whole house" off-grid electrical solution. And that is subject of this multi-part article. ***Please note that this is NOT a beginner project, and if you're uncomfortable working with electricity or electrical components, please don't attempt!*** Secondly, this is how I completed this project. Your local electrical codes or other sensibilities may guide you to do things differently. ***You are responsible for your own installation***! *Do it right*. Electricity is not something you should underestimate. And integrating an inverter into your trailer's electrical system is serious business. Treat it as such.

This is a four-part article. Please read through the entire procedure a couple of times so that you have a clear understanding of what to do and when to do it. In the Preamble Ramble, I will discuss the basic design and my choice for components. In Part One, I will cover in the mounting and connection of the inverter into the trailer and the 12V battery system. Part Two will cover the installation and connection of the 120V system to include the transfer switch configuration and installation. And finally, Part Three covers inverter control panel and battery monitor installation, system final testing, and installing inverter/cable protection panels.

So, without further delay, buckle up and let's jump in…

Preamble Ramble: *System Design and Component Selection*

As previously mentioned, I wanted a whole house inverter solution with the full understanding that I would NOT be able to run the A/C or electric heater for any significant amount of time. Mostly, I simply wanted to have 120VAC available at the duplex outlets in the trailer when camping off-grid. The idea being to be able to watch a little TV, charge electronic devices, brew a quick cup of coffee, or run the microwave for brief periods. This meant that the inverter needed to be fairly large (2000 watts minimum) and the battery bank feeding the system needed to have a relatively large capacity (200Ah minimum). The other factor that played into this is that our trailer has a 12V refrigerator and a factory installed 165W solar panel and charger. It is important is to remember that running an inverter with a moderate load can drain a battery bank quickly, possibly leading to insufficient power to run the refrigerator and requiring many hours of bright sunlight to recharge the battery bank. So, to monitor the status of the batteries and to add warnings for battery discharge, I wanted to add a battery monitor.

I also decided that I wanted to have the inverter connect automatically to the 120VAC system when the inverter was activated and when not connected to shore power. For this purpose I needed an automatic transfer switch in the system. All of this had to feed into the current power center unit that came with the trailer (WFCO WF-8735-GE-AD). I felt that the supplied unit was sufficient to supply my needs and correctly charge the battery bank; I just had to figure out how to tie all of the components together.

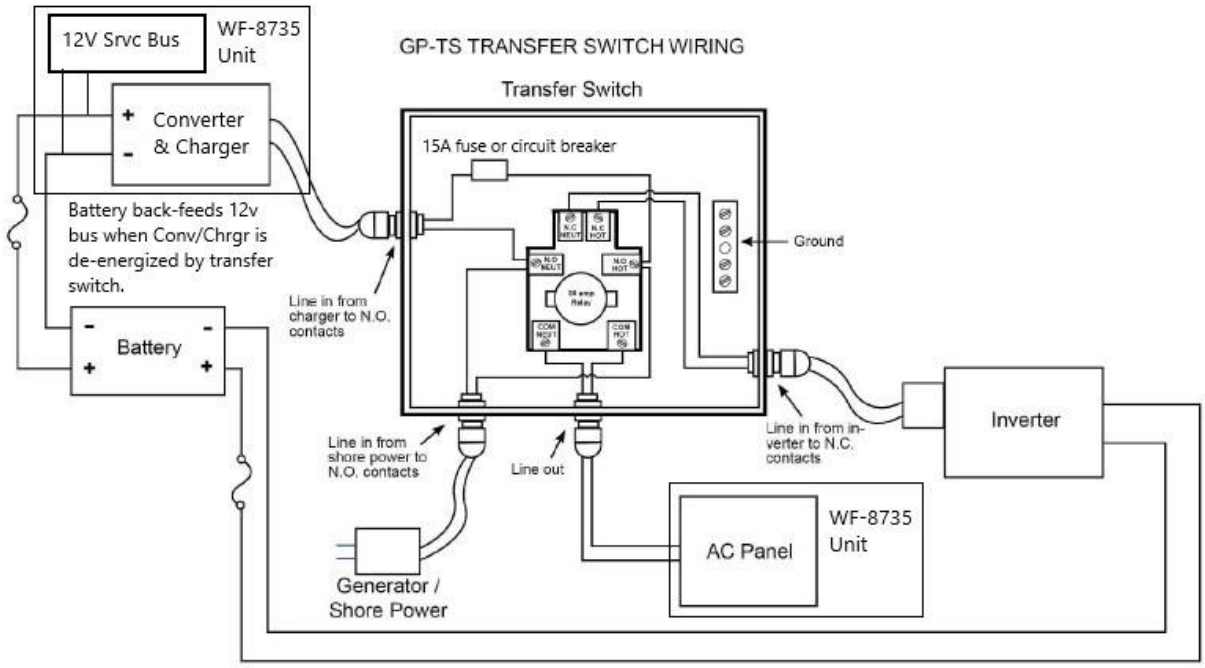
Quick discussion on the power center unit

The WFCO WF-8735 power center unit – like most RV power centers - has two distinct functions: 120V power distribution via six circuit breakers, and a 12V converter unit that converts the 120V input into 12V output to energize the 12V service bus as well as the battery bank charging circuit. The converter is actually a separate component - housed within the same unit housing - that is wired into the power distribution panel. Many may already know and understand this, but it's an important piece of information to comprehend when contemplating how to integrate an inverter into the electrical system.

Diagrammatically, these individual components (AC Panel/Converter) are represented as separate entities in the system design diagram, but they are contained within the same power center housing.

System Design

After reviewing many of the very helpful posts here as well as Jim Hinkle's excellent November 2019 paper on inverter installation, I settled on a very basic design that essentially inserted the inverter input into the shore power circuit when the trailer was not connected to shore power via an automatic transfer switch (Go Power TS-30). In this design, when connected to shore power, the WF-8735 receives 120VAC as before via an energized transfer switch. All functions of the WF-8735 remain unchanged. However, once shore power is removed, the transfer switch would switch to inverter input to then feed the VAC panel on the WF-8735. *However, as a result of the switch, the 12V charger function of the WF-8735 is disconnected and thus disabled*. This ensures that there is no battery charge back-feed loop. Note that the 12V service bus continues to be back-fed through the 12v battery bank charging conduits, just as it is whenever shore power is disconnected. The key here is that the charger is disabled when the inverter power is applied to the system.



Component Selection

Everyone has their own needs, opinions, and bank account, and because of this, opinions vary wildly on what components should be used and which ones shouldn't. Also, some components get a bad rap simply because they come with the trailer. In my case, I realize that I will not be using this trailer on lengthy trips across the world or living in it for extended periods off of the grid. With that in mind, I don't feel like I need a top of the line solution and can use components that may or may not have excellent longevity. And I also have a limited budget, so I needed to figure out how to strike a compromise.

First and foremost, if you have the funds, the Victron line of components is top-notch and especially well suited for RV (and marine) applications. However, I opted to go with lesser cost components that still had good reputations and manufacturer support.

Power center unit – As I mentioned before, I kept the *WFCO WF-8735-GE-AD* unit that came with the trailer. It appears that the WFCO folks have really been working on refining their components – especially the battery charging system, which is traditionally the biggest complaint on stock units. So, I decided to keep this unit as part of the system.

Inverter – This is, of course, the heart of the system and thus the main component. Since I would be operating electronic components, a pure sine wave inverter is a must. I also wanted something in the 2000-2500 watt range that could be hard-wired into the system (as opposed to wiring a plug to plug into the 120VAC outlets), had good reviews and good customer support… not to mention a reasonable price point. After doing much more research than I needed to, I purchased the *Voltworks Pure Sine Wave 2500W inverter*. It has the VAC terminal block that I wanted and also comes with a remote power switch/monitor panel which I will mount in the trailer; all at around $375 to my door.

Inverter Module – The inverter module consists of the inverter plus other components mounted on a board. Those components are: a battery shut-off switch used to isolate the battery bank from ALL trailer loads; a 250A resettable circuit breaker that protects the inverter and also acts as a master switch to remove the inverter from the 12V bus; and the battery monitor's shunt. These components, when mounted on the board, comprise the *inverter module*.

Automatic Transfer Switch (ATS) – I chose to go with an *automatic* switch rather than a *manual* transfer switch (as Jim Hinkle advocates in his installation) simply because I like the "automatic" function. Yes; it becomes a power drain while energized on shore power and is a less-robust failure point than a manual switch, but I've had good experiences with automatic transfer switches in the past. Plus, that's just one less step to perform when switching to inverter power. So that's where I plant my flag. As for selecting an automatic transfer switch, there's not a lot to choose from out there, but the *Go Power TS-30* was perfect for my design's needs and the Go Power people were very helpful when I had questions. There is one modification that I decided to make which was to bypass the 30-sec power switch-over delay that is defaulted to "On" from the factory. But I'll explain more during the installation section.

Battery Monitor – As I mentioned before, I wanted to add a battery monitor that I could mount inside the trailer to stay appraised of the batter bank's charge status. As a note, the 22MLE comes with a battery monitor located in the forward pass-through compartment. However, it is designed to monitor the status of the battery bank as related to the solar charger/controller and the monitor shunt sample point is not optimal for the inverter system. Not to mention that it is in the pass-through, and thus not easily monitored during normal use. So, after doing more research, I settled on the *Renogy 500A Battery Monitor with 500A shunt*. I liked the various features of this monitor as well as having enough cable to run and mount the monitor inside the trailer.

120V Supply Cable – I make special mention of this detail because rather than opening up the coroplast under-panel of the trailer and having to reseal everything, I chose to run the power cable externally under the trailer frame (similar to how the propane line is run). However, to offer proper protection for the cable wires, I chose armored MC cable which is also certified for wet environments.

The following is a complete listing of the parts and pieces I used for my installation:

1. Inverter: *Voltworks Pure Sine Wave 2500W inverter*
2. Automatic Transfer Switch: *Go Power TS-30 30 amp transfer switch*
3. Battery Monitor: *Renogy 500A Battery Monitor with 500A shunt*.
4. Inverter Circuit Breaker: *250 Amp Surface Mount Circuit breaker with push button disconnect and manual reset.*
5. *Battery Cut-off Switch* – used to *completely* isolate battery bank from trailer.
6. *15A push button circuit breaker* – used to protect converter circuit within transfer switch.
7. (10 ft) *1/0 Battery cable; red and black conductors – Get good, solid copper cables*.
8. (25 ft) *Armored 10/2 MC cable* – (I used 10/3 MC because it was readily available.)
9. (5ft) 10/2 Non-metallic (NM) cable (Also known under the trade name of "Romex")
10. (5ft) 14/2 Non-metallic (NM)cable
11. (5ft) 8 gauge RED wire – used to connect trailer 12v bus to battery bank circuit.
12. (25ft) 4P4C "Telephone" cable and (2) RJ9 connectors – This will be needed to build a longer remote power switch cable. You will also need a crimper to connect the RJ9 connector ends.
13. (15ft) ½" split loom – used to sheath and protect data wires from monitor and inverter
14. (1) 2.54mm jumper cap for disabling transfer switch delay timer
15. 2x4ft sheet of ½" plywood – to mount inverter in trailer
16. 2x4ft sheet of ¼" plywood – to build shield to protect inverter/wiring
17. (4ft) 1x2 board ripped down center to create two 1x1's. (Actual dimension – ¾ x ¾)
18. (10 pcs) 1/0 AWG x 3/8" crimp on cable lugs with heat shrink – used to make cables for battery and inverter connections. You will also need crimper (or a friend with a crimper).
19. (4ft) Adhesive-backed cable protector sleeve ("Wiremold" or similar)
20. (30) ½ inch cable mounting clamps
21. Wire nuts (or Lever nuts - (2) 3-port and (4) 2-port lever nuts)
22. 3/8" (for ½" knock-out) NM clamp connector
23. 3/8" (for ½" knock-out) MC squeeze connector
24. (1) Circuit board 2.54mm jumper cap. (I used one from an old, unused computer circuit board)
25. Various other cable lugs to connect other wires to terminal lugs. (You'll need at least ten (10) 1/0 – 3/8" lugs for the 1/0 battery cable components as well as a couple of 8 gauge 3/8" lugs.)
26. Various screws, bolts, and blind nuts for mounting the inverter, the backing panel, etc.

Although there will be some minor omissions that we'll run upon along the way, this is a pretty comprehensive list.

What about tools?

1. Multimeter (If you have to ask why, you really shouldn't be tackling this project.)
2. Electrical work tools (cutters, strippers, etc.)
3. 120V circuit tester
4. Drill and/or Impact driver with assorted bits; especially a ¾" bit.
5. Zip saw (or equivalent)
6. Battery lug crimper tool.
7. Armored cable cutting tool

The total cost for this project was just south of $1500, and it took me a total of about 40 man hours from start to end. But remember – it's not a race! Take your time and do it right!

Just so you know what the completed project looks like, here are some photos:

Inverter module in place with protective panels

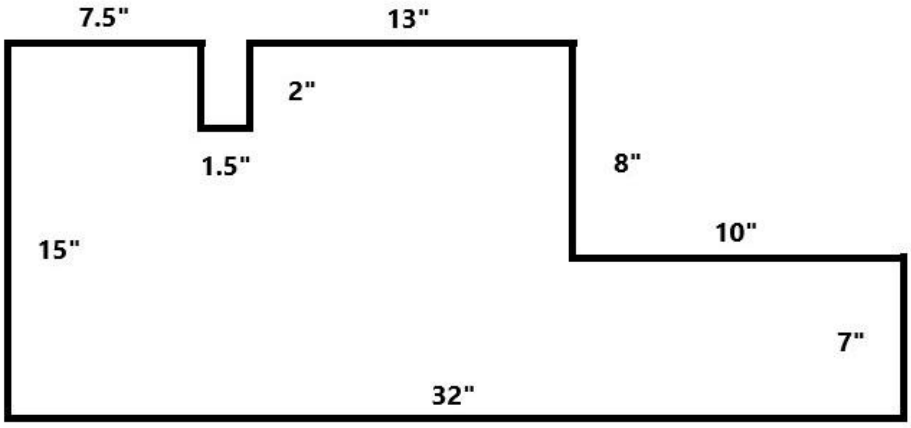
ATS mounting location under aft dinette bench

Inverter control panel and battery monitor in cabinet

So now that we know the design, have our parts ready to go, and have an idea of how the finished product should look, let's start!

Part One: ***Inverter and 12V Battery System Installation***

The first part of the inverter installation process is the fabrication of the inverter mounting board. This board is cut from ½" plywood, holes measured and drilled, blind nuts added for mounting screws, and then painted. Note that the inverter has rubber pads at its four mounting locations. I used slightly over-sized bolts and had to hollow out these rubber pads a bit so the bolts would fit through. I do NOT recommend mounting the inverter directly to the wood mount. I want to absorb as much shock and vibration as possible, and though the wood mount helps a lot in this area, the rubber feet/pads add an extra layer of protection.



Inverter Mounting Board Dimensions

After fabricating and painting the mounting board, I mounted the inverter, battery shut-off switch, 250A resettable circuit breaker, and battery monitor shunt to the board. I then fabricated the connecting 1/0 cables for these components using sections of the 1/0 cable and 1/0-3/8" copper lugs. If you're very careful, you can make the connecting cables on the board and the cables to the battery bank from two sections (red/black – each 10 foot length) of 1/0 cable. But you'll need every inch of that 10 feet, so be careful with your cuts. Once completed, *this is your inverter module*.

Inverter module complete and ready to mount

Now our focus turns to the trailer where we prep the pass-through area by drilling 4 (four) ¾" holes in the front passenger-side corner. These ¾" holes will be used to pass (in order) the ½" plastic wire loom that will contain the data a signal cables for the inverter control switch and the battery monitor, the negative and positive 1/0 battery cables, and the 120V MC cable. These holes are drilled about three (3) inches from the front wall, about an inch apart, with the right-most hole about 1" from the passenger-side wall. Most importantly, the holes are drilled at roughly a 45 degree angle *aft*. This configuration should clear the aluminum cross member in the pass-through floor and the metal bracket on the underside. (As a note, I found it easiest to drill from the top for about ¼ of the way, and then drill from

below the rest of the way, connecting the upper and lower hole.) As a final step, I connected the two inside ¾" holes with a ½" hole (which will be used to pass two 8 gauge wires for the trailer's 12V bus).

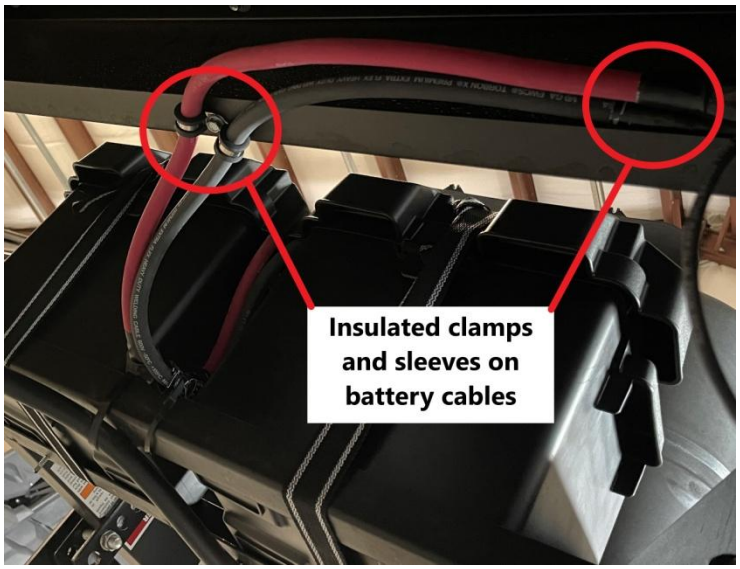
Drill ¾" holes about 3" from front panel. Try to not hit the aluminum cross member.

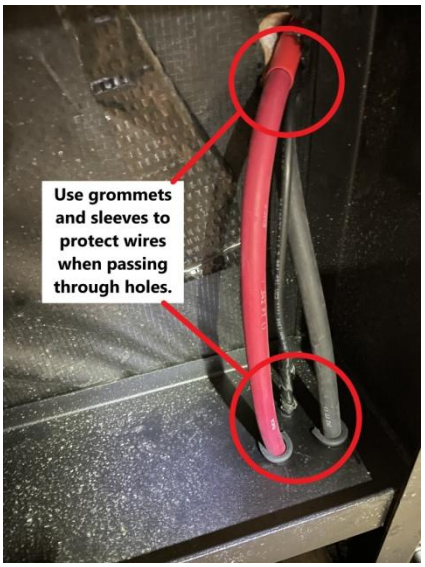
To mount the inverter module, I drove 5 self-tapping screws through the upper edge of the module board into the front aluminum cross member. However, I wanted some additional support on the bottom of the board. To do this, I mounted a 32" piece of ½" x ½" aluminum channel on which to rest the bottom edge of the board. I then secured the bottom edge of the board into the channel with 5 more screws. (*Pro tip* – It's MUCH easier to determine the location of this lower support strip by using the empty mounting board before adding the components.)

Inverter module mounted in place. Note support under lower edge.

Once the inverter module was mounted, I ran the two 1/0 battery cables through the inner two ¾" holes in the pass-through floor, through ¾" holes in the trailer frame, and over to the battery bank.) You will

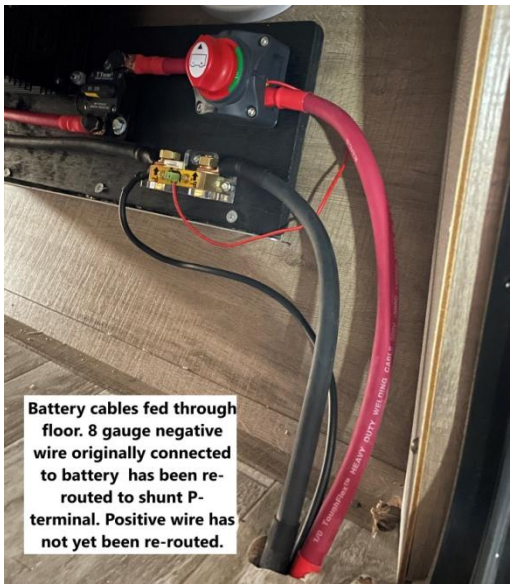
need to drill holes through the frame to pass the cables. Be sure to add grommets to these holes so that the cables will not chaff and short! Take your time with this! I added extra protection against chafing wherever the cables passed through or around metal and secured them with insulated ½" clamps. **DO NOT** connect the cables to the battery bank at this time!

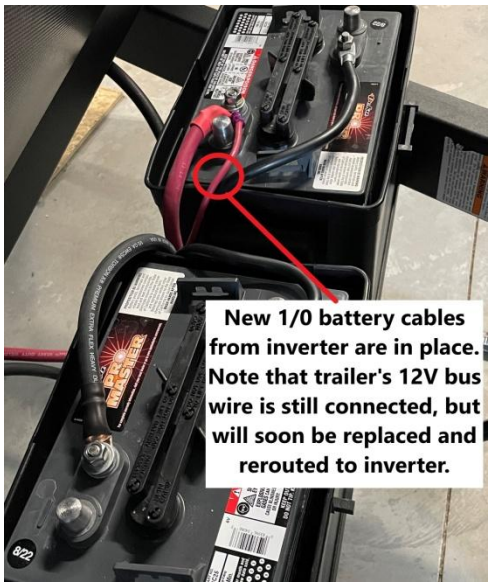




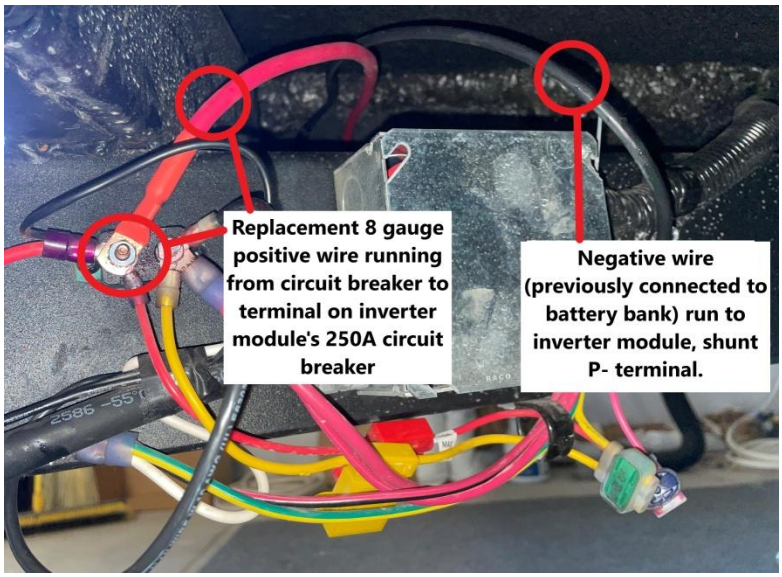
Grommets and sleeves should be used when cables pass through holes or over metal edges

The next two steps involve taking the trailer's existing 12V bus wires that are connected to the battery bank and connecting them instead to the inverter module. This will enable the shut-off switch to act as a battery bank isolation switch for the trailer (and inverter). First, remove the negative(-) wire from the battery and run it through the smaller hole between the inner most ¾" holes in the floor of the pass-through, and connect to the shunt's P- terminal. (The stock 8 gauge negative (-) wire is long enough, though you will have to cut and crimp on a new 8 gauge 3/8" lug once it has been run to the shunt.)

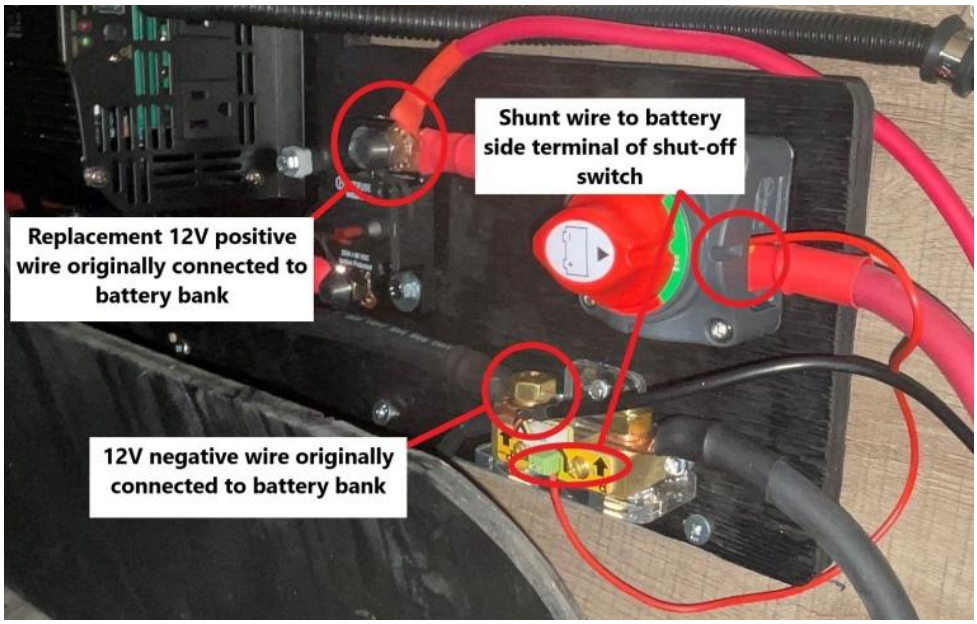




Next, you'll need to replace the trailer's positive(+) wire to the battery bank with a new wire. (The stock wire is not long enough.) To do this, run a 5 foot length of red 8-gauge wire from the trailer's 12V bus (left side of resettable circuit breaker mounted on the trailer frame/tongue) and connect it to the top terminal of the inverter module's resettable 250 A circuit breaker.



Next, run the supplied shunt wire from the B+ terminal in the center of the shunt to the positive terminal on the battery side of the shut-off switch. The system is now ready for its initial tests.



Before testing, ensure all of the wires – *especially the 1/0 cables coming from the battery bank* - are installed securely and correctly and the cable run has been triple checked. You do NOT want a short in these cables! Once all wires/cables are checked and correct, plug in the inverter control panel's modular wire into the inverter front panel, and connect the battery monitor's 5-pin data connector to

the shunt and the monitor. Turn the shut-off switch to the "off" position, *then, carefully connect the battery cables to the battery bank*. Once the cables are connected to the bank, the inverter control panel and battery monitor are connected, turn "on" the shut-off switch. Now, using the inverter control panel, turn on the inverter. The system should come to life with the proper led lights showing and the proper voltages showing on the inverter's display screen (on the inverter outer case). Once everything is running properly and within specifications, your inverter module is mounted and complete. Take this opportunity to configure the battery monitor according to the instructions and your particular battery bank's specifications. Once this is complete, turn off the inverter and turn the shut-off switch to "off". Now we move to the next part - installing the 120V supply system.

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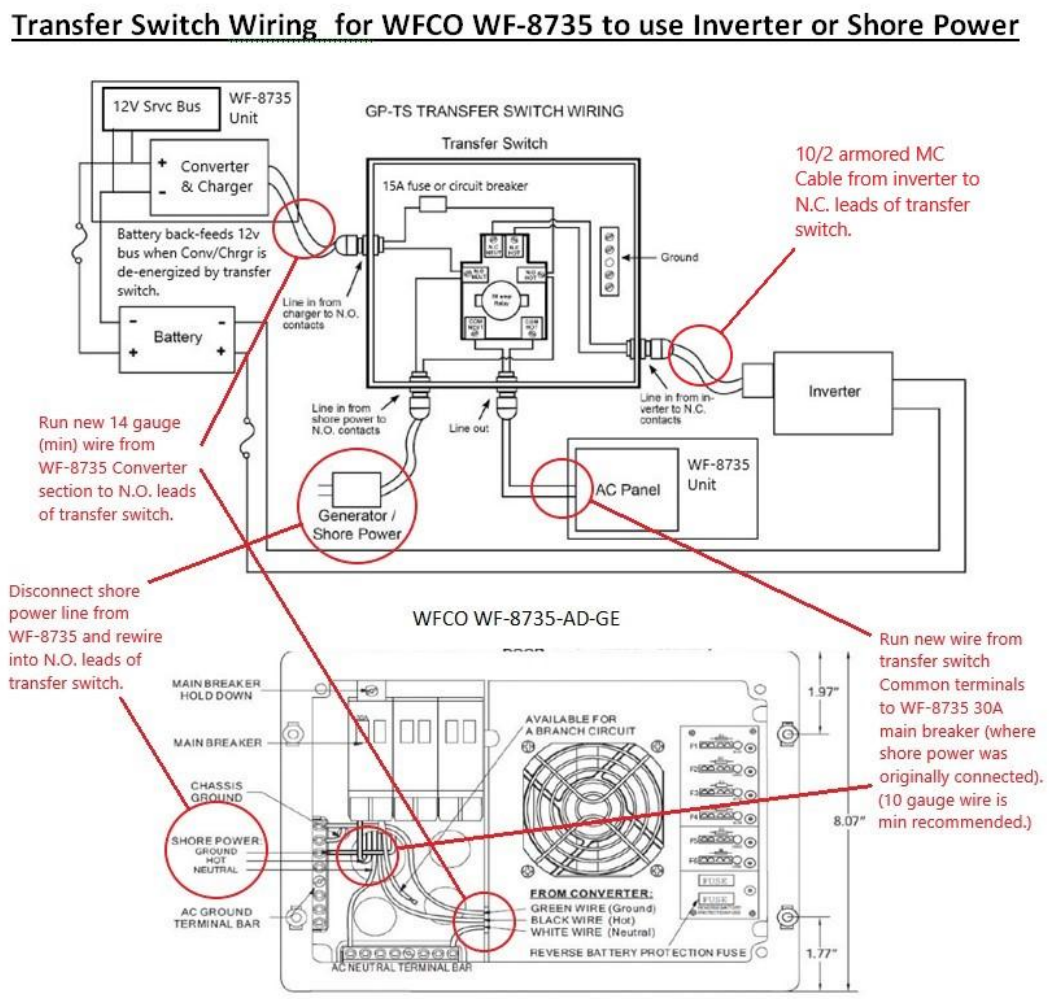
Part Two: *120V System Install*

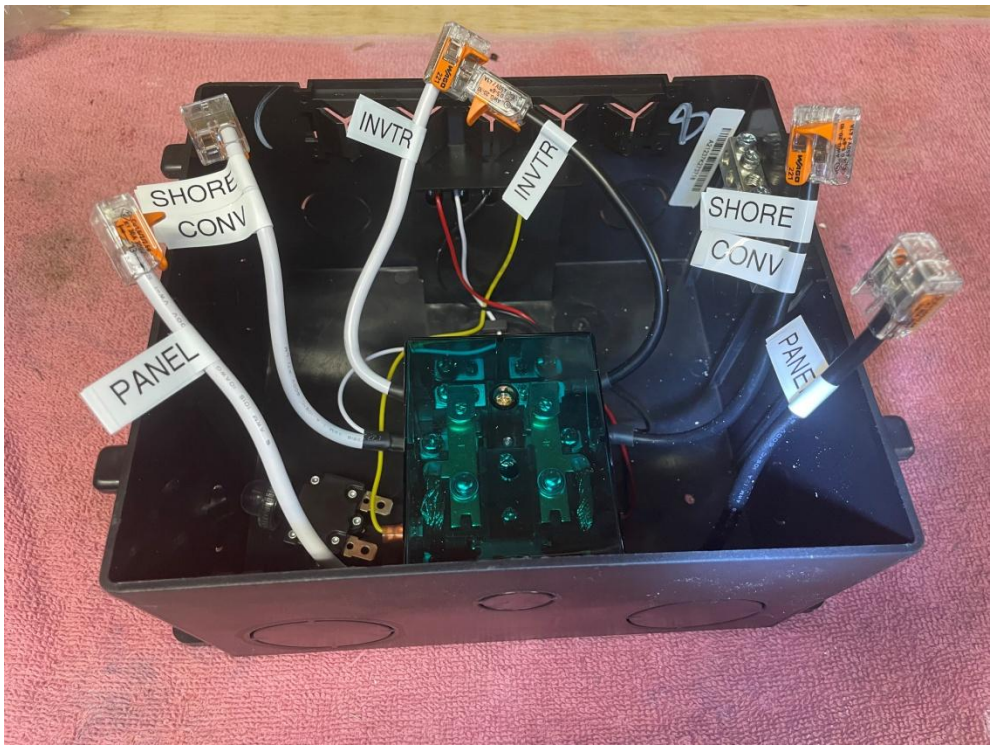
The first step for the 120V system is to prep the various components before installation; specifically, the Automatic Transfer Switch (ATS). The diagram below gives a schematic of how the ATS will be configured:



In practice, the preparation of the ATS is done by opening the case of the ATS and labeling the wires. With the case positioned such that the circuit board compartment and wire pass-through ports on top, the relay wires are labeled as follows: (clockwise, starting in the lower left corner of the relay) –

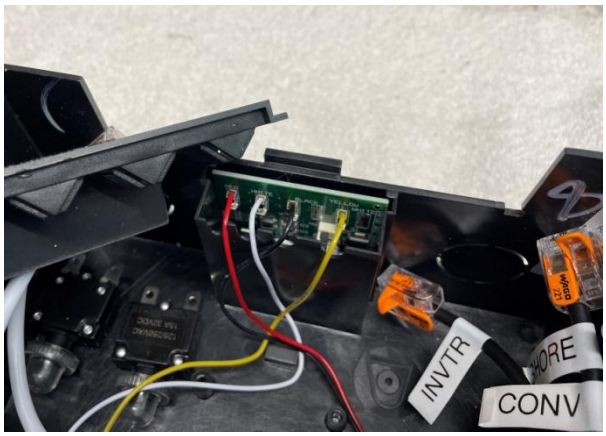
- "PANEL" white wire – 120V Power Panel Neutral
- "SHORE/CONV" white wire - Shore Power/Converter Neutral
- "INVTR" white wire - Inverter Neutral
- "INVTR" black wire - Inverter Load ("hot")
- "SHORE/CONV" black wire - Shore Power/Converter Load ("hot")
- "PANEL" black wire – 120V Power Panel Load ("hot")

I also add the wire connector lever nuts to these wires at this time as well. (I chose to use the lever nut-style connector for a more solid connection given the vibrations of a moving vehicle. In this case, I connected the two 3-port lever nuts to the "SHORE/CONV" wires (white and black) and the four 2-port lever nuts to the other four wires. (PANEL and INVTR wires, white and black.)

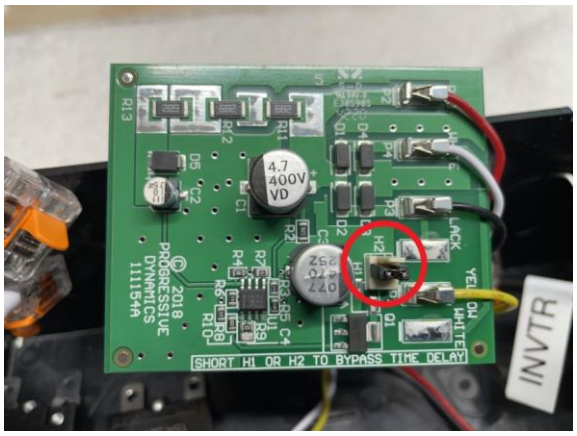


Note how ATS' relay wires are labeled. This is a critical step.

One of the features of the ATS is that it has a default 30-second delay in switching between modes. I did not want this delay and luckily this feature can be disabled. (You do NOT have to disable the delay if you don't want to.) You disable this function by first carefully removing the circuit board from the ATC's circuit board compartment, and then add the 2.54mm circuit board jumper across terminal H2. Once this is done, reinstall the circuit board back into the circuit board compartment.



Removing ATS circuit board from compartment



Place 2.54mm jumper on terminal labeled "H2"

Finally, I installed the 15A/120VAC push-button circuit breaker into the left side of the ATS case. This will be wired in series in the new converter supply circuit. Once this was completed, I selected a location underneath the aft dinette bench (where the water pump is located) and mounted the ATS to the floor. The ATS is now prepared for wire/cable installation.

Location of the new 15A/120V push button circuit breaker

The next step is to drill a ¾" hole in the same space under the dinette to bring in the 120V MC armored cable. This hole is drilled exactly 12 inches from the inside face of the exterior wall, and 3 inches from the cabinet wall. Now we will run the 10/2 MC cable from the inverter module to the ATS through the hole we just drilled.

Starting at the front of the trailer, the MC cable is run through the right-most ¾" hole in the floor of the pass-through, up to the 120V terminals on the inverter. The MC cable is cutback to expose roughly 10 inches of wire. (If you are using 10/3 MC cable, terminate the extra conductor – the red wire in my case.) Insert a protective collar into the end of the MC casing and wrap the end with a couple of wraps of electrician's tape just to finish it off and cover any burrs. Then, secure the metal MC cable to the aluminum cross member with an uninsulated metal clamp immediately after the wrap of electrician's tape. This clamp grounds the MC cable's metal casing and also serves as a grounding point for the inverter's grounding lug. Cut to proper length and strip the three (3) 10/2 wire conductors in

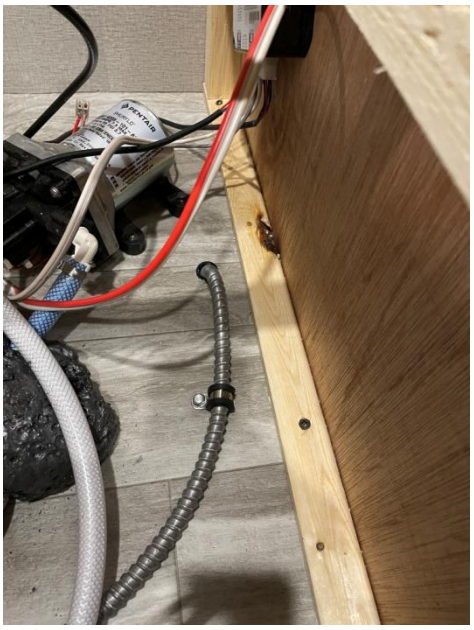
preparation for connection to the inverter's 120V terminals. However, do **NOT** connect the wires to the inverter at this time!

Run the remaining length of MC cable underneath the frame using clamps secured by the self-tapping screws securing the trailer's under panel. I ran the MC cable through the axel shackle brackets, but you can run them outside of the brackets if you wish. However, the MC cable will come around behind the last bracket and then go through the ¾" hole drilled previously. As a note, every time the MC cable passes over a sharp metal area and when coming through the wheel well area, I wrapped it with a piece of ½" ID heater hose just to offer a bit of protection from chaffing or road debris kicked up by the tires. Also, when penetrating the metal floor pan I also pass it through a 3/4" plastic bushing.

MC cable mounted with clamps

Using ½" ID heater hose to sheath MC cable around metal

More heater hose as protective sheath



MC cable through floor. Note plastic bushing

Now that the MC cable has been pulled into the space under the dinette, I run the cable over to the ATS box, securing it with clamps along the way, and terminating it into the ATS box using an MC cable squeeze connector, making sure to have at least 12 inches of wire exposed for connecting into the ATS wiring.

The wires from the 10/2 MC cable are then connected as follows:

Black wire (Inverter 120V Load) – ATS Black Wire (Labeled "INVTR")
White wire (Inverter 120V Neutral) – ATS White Wire (Labeled "INVTR")
Green wire (Inverter Ground) – ATS Ground Block

The 120V supply cable from the inverter is now installed, but continue to leave the 120V terminals on the inverter disconnected for now.

Connecting the power panel and 12V converter unit to the ATS
This is where everything comes together, and it can get a little complex to explain. So bear with me and look at the pictures.

At this point you have to remove the power center and run additional NM cable into the unit. To do this, first DISCONNECT the trailer from the 120V source (shore, generator, inverter, etc.). We do NOT want the panel to be energized when we're working on it! Next, remove the power center's flip-down cover, the four captive screws that hold the front cover on, and then the four screws that hold the power center unit in place. Remove the cabinet drawer immediately above the unit (to give yourself some working room), and then gently pull the unit away from its in-cabinet mounting area, being careful NOT to strain any wiring.

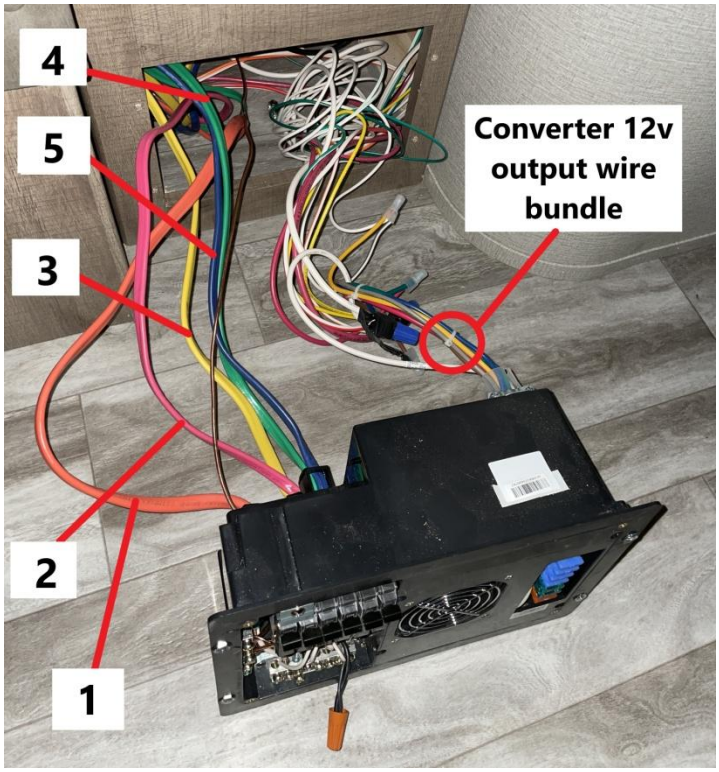


Photo Legend-

NM Cable feeding into WFCO Power Center:

1: **Orange** NM cable – *Main (Shore/Gen) Power Input*

2: **Red** NM cable – *Water Heater*

3: **Yellow** NM cable – *AC Unit*

4: **Green** NM cable – *Microwave*

5: **Blue** NM cable – *GFCI's and converter*

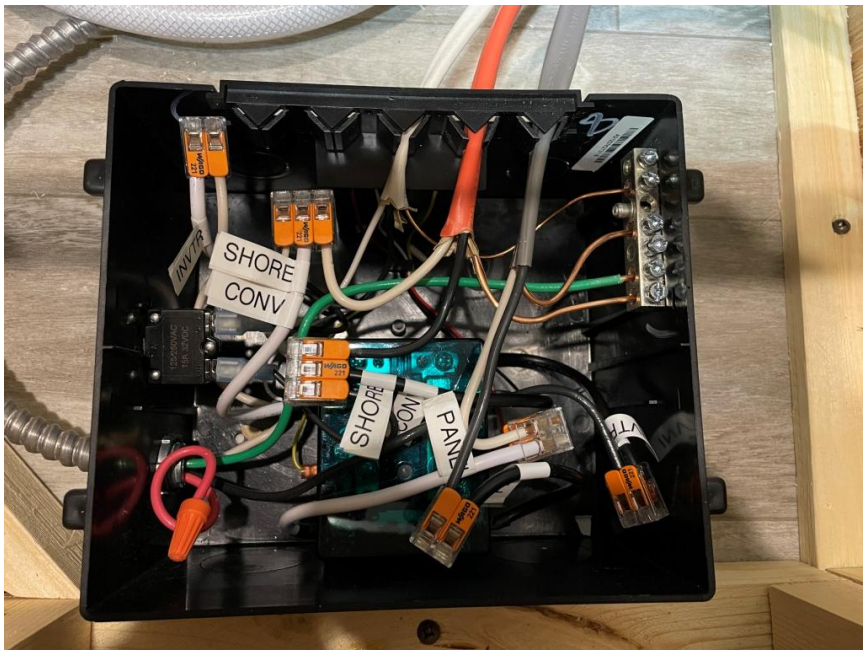
Note: NM colors may change depending upon the factory's supply availability.

Prepare the area to receive the wiring running to and from the ATS by drilling a 1 inch hole in the cabinet wall between the power center mounting area and the under-dinette space where the ATS is located. The hole should be about 12 inches back and 4 inches above the floor level.

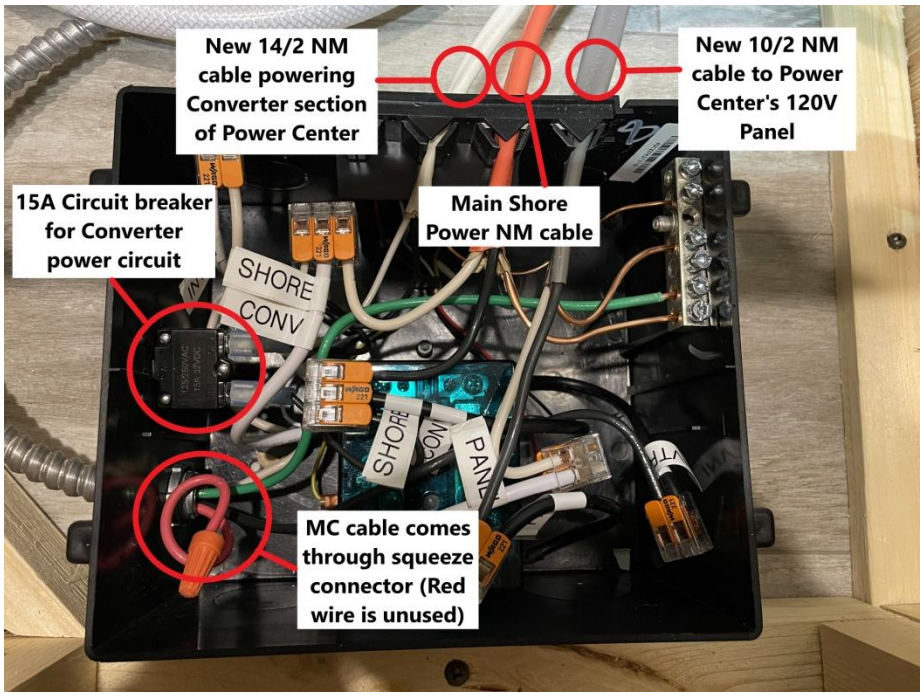
Looking at the back of the power center unit, you will see various colors of NM cable entering the unit. (See photo above.) You'll be removing the orange "main power" NM cable from the unit, so carefully disconnect the cable's wiring from the 30A main breaker and remove the NM cable by prying out the plastic strain relief fitting. You may discard this fitting; we won't be using it.) At this point, go ahead and mount the replacement 3/8" NM clamp connector in the vacant ½"knock-out hole. Now, run the orange NM cable through the 1" cabinet hole that you drilled earlier, over to the ATS and feed into the ATS enclosure, connecting the black wire to the SHORE/CONV black wire, the white wire to the SHORE/CONV white wire, and the ground wire to the ATS' ground bus bar.

Run a new 5 foot section of 10/2 NM cable from the ATS (after connecting to the PANEL black, PANEL white, and ATS ground bus bar) through the cabinet hole and into the vacant knock-out with the NM clamp connector. (Don't tighten the clamp down yet. We're going to run more cable into this port.) Cut the cable to length making sure to leave enough slack to mimic the route of the other NM cables feeding the power center. Cut, strip, and connect the 10/2 NM cable's wires to the 30A main circuit breaker (black wire), neutral bus bar (white wire), and ground bus bar.

Next, we will run the power cable for the Converter section of the power center. To do this, take the 5 foot section of 14/2 NM cable, feed it into the ATS case, strip the wires out and add a lug connector on the end of the black wire. This black wire with lug will connect to one terminal on the resettable circuit breaker mounted on the ATS case. You will also need to take a 6" scrap piece of 14 gauge black wire and make a jumper wire that connects (via another lug connector) to the other terminal of the circuit breaker and then connects to the SHORE/CONV black wire. Now connect the 14/2 NM cable's white wire to the SHORE/CONV white, and the cable's ground wire to the ground bus bar.



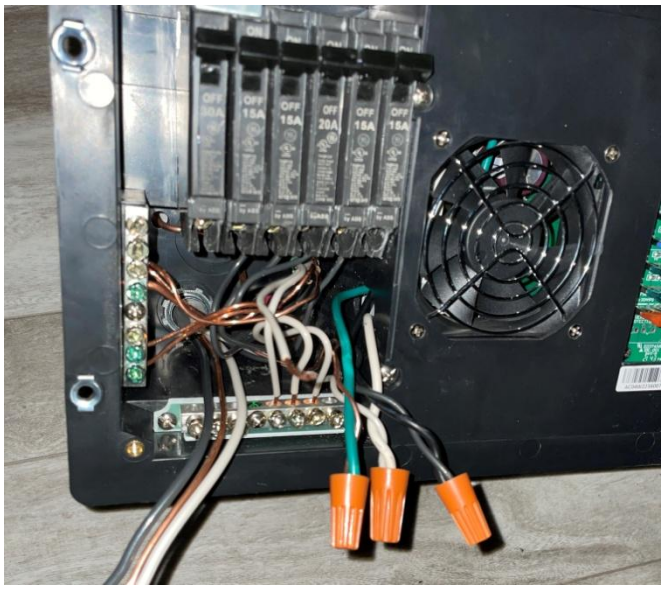
ATS with wiring completed



Run the connected 14/2 NM cable from the ATS to the power center through the clamp connector, sistered with the new 30A NM cable. (Again, leave enough slack to mimic the route of the other NM cables.)

New 10/2 main power NM and converter circuit 14/2 NM through squeeze connector.

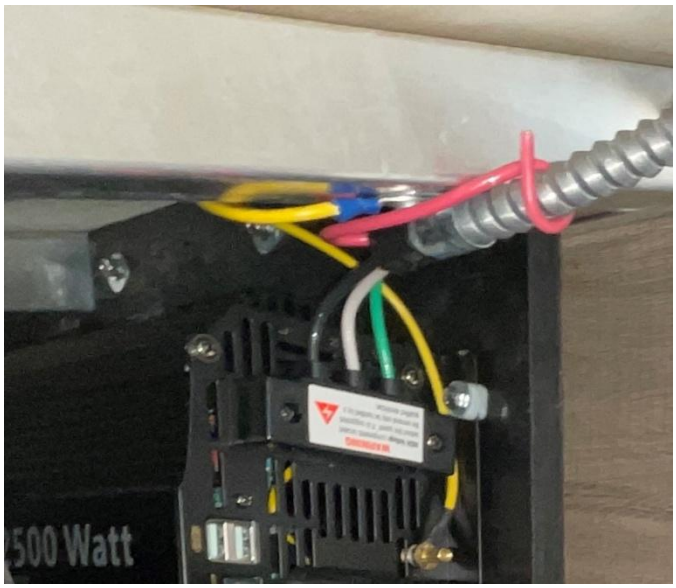
Identify the three 120V power wires feeding the converter from the 120V power panel and connect them to the 14/2 cable's wires that you just brought into the unit.



Converter section power wires connected to 14/2 NM cable

Once the 30A main wires are properly connected and the converter wires are properly connected to the 14/2 NM wires, go ahead and tighten the connector clamp. Take a moment and run the new NM cables through the securing clamp that the other NM cables pass through, and reinstall the power center unit being careful not to pinch any wires during reinstallation.

Now, return to the front pass-through compartment and connect the 10/2 MC cable's three wires to the inverter's 120V lugs, replacing the safety cover when complete.



120V wires connected to inverter. Note inverter ground lug is grounded to the frame. The red wire is the unused conductor from the MC cable.

The inverter is now connected to the 12V system and connected to the ATS, and the ATS is now connected to the power center and ready for testing.

Testing our work so far

At this point, be sure to go back over all of your work so far, making sure all wires are properly connected and all covers are properly in place. Once you are confident that everything is installed as it should be, re-connect the inverter's control pad and the battery monitor data wire to the shunt, turn on the battery shut-off switch, and *carefully* reconnect the trailer to shore power. Everything should come back to life without any circuit breakers tripping and the battery monitor should show a charging status. If you turn on the inverter, there should be no change (other than to see an additional 1-2 amp load on the battery monitor). The ATS has the inverter disconnected, so it is not connected to the system. However, if you unplug the trailer from shore power, you will see that the ATS transfers power seamlessly and immediately to the inverter. You will also note that there's no charging to the battery bank. Again, the ATS has disconnected the charging system so there is no feedback loop.

If ALL of your components are grounded properly – i.e. to the frame – the power source transfer operation should be seamless with no circuit breaker tripping; even when connected to a generator. (However, this can get dicey given that a generator may have a "floating" ground that can trip GFCI outlets.)

Once you have verified that all 120V outlets are operational and the 12V bus and battery bank charging is normal, turn off the inverter and disconnect the battery monitor data wire. Our next part covers permanently installing the inverter control panel and the battery monitor, and building protective panels for the inverter module and cables.

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Part Three: *Control Panel and Monitor Installation and Inverter/cable protection*

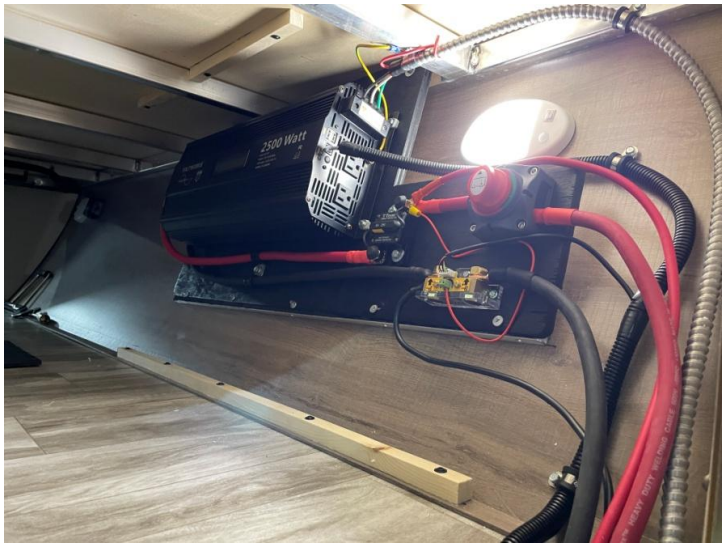
I wanted all of the trailer control panels to be in the same location, and Grand Design let a nice blank space in the upper section of the upper left cabinet where the other control panels are located. The issue then became how to run the monitor/panel cords to this location. The Renogy battery monitor's 6 meter (19 ½ ft) cord is sufficiently long to get to the upper cabinet, but the inverter control panel modular cord was too short to reach. Luckily, this cord is just a standard 4P4C telephone cord with RJ9 connectors on each end, so making a new 20 foot cord is pretty simple if you have a crimper and have practiced before. You may even be able to find one to purchase, but be sure that it has RJ9 connectors on the ends and that it's wired "straight" (i.e. black/red/green/yellow wires connected to the same pins both ends), and not a "crossover" type (which is what most commercially available phone cords are). In any event, be sure to test the function of your new cable BEFORE installing it.

Once you have two properly functioning cords (one for the inverter panel and the other for the battery monitor), insert them into the split loom and run the wire/split loom into the left-most ¾" hole drilled in the front corner of the pass-through area. (It should be the only hole available at this point.) I found that it was easiest to take a moment and run both cords through the entire 15 foot section of split loom

sheathing before installation, and wrapping electrical tape to close the slit loom about every 24 inches or so. This allows the cords/split loom to be handled as a single cord.

Both cords inserted into split loom and closed up

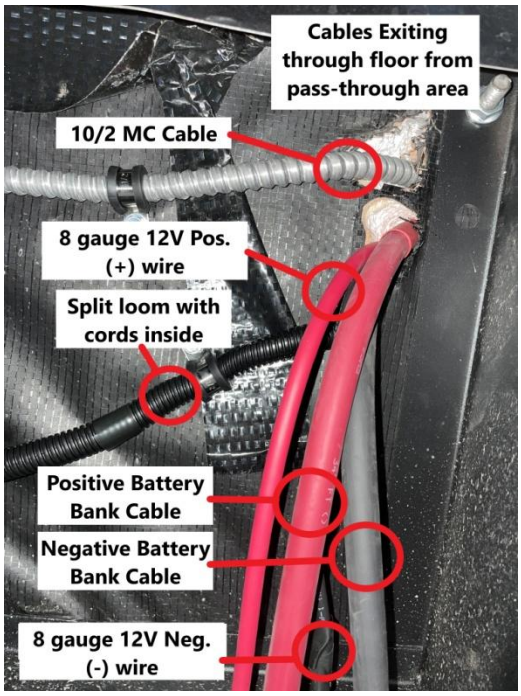
In the pass through area, insert the inverter control panel cord connector into the inverter and pull the battery monitor data wire out of the split loom and connect to the shunt. I then secured the split loom with two clamps on the interior of the pass through.



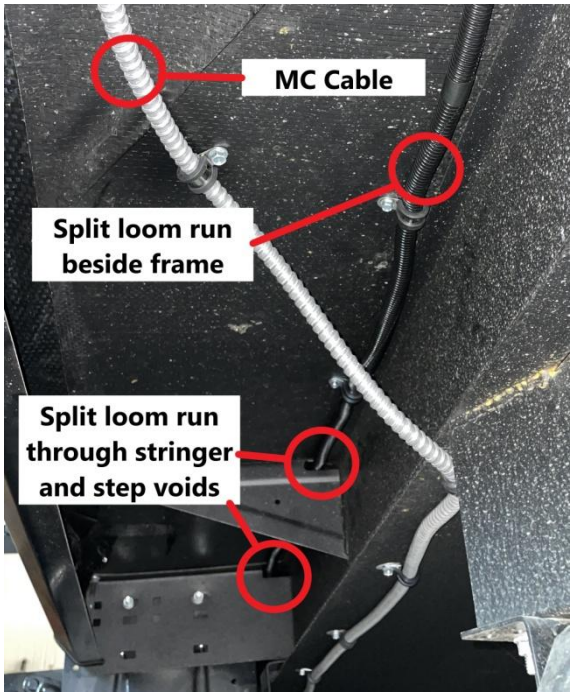
All cables, MC, and split loom connected to module

Split loom, cables, and MC through floor

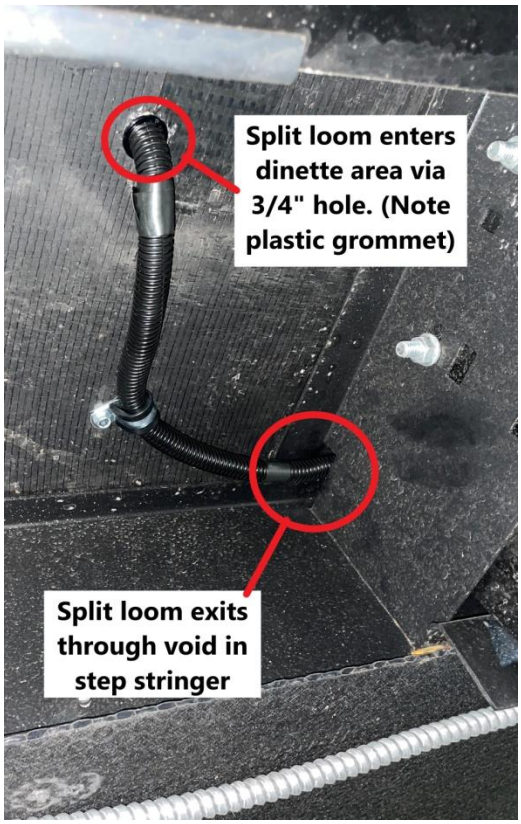
I then continued running the split loom underneath the trailer along the frame through the voids in the frame stringers, through the step well, and immediately to the other side of the step well where I had drilled another ¾" hole through the floor and into the forward dinette bench area. (Between the outer wall and the wall of the shoe garage.) I secured the split loom inside this area with another clamp and then drilled another hole through the dinette bench's horizontal stringer located directly below the corner of the upper cabinet. I then passed the split loom through this hole. I cut the split loom flush with the top of the stringer (being careful not to cut the data cords inside!) exposing the remaining ~5 feet of cords.



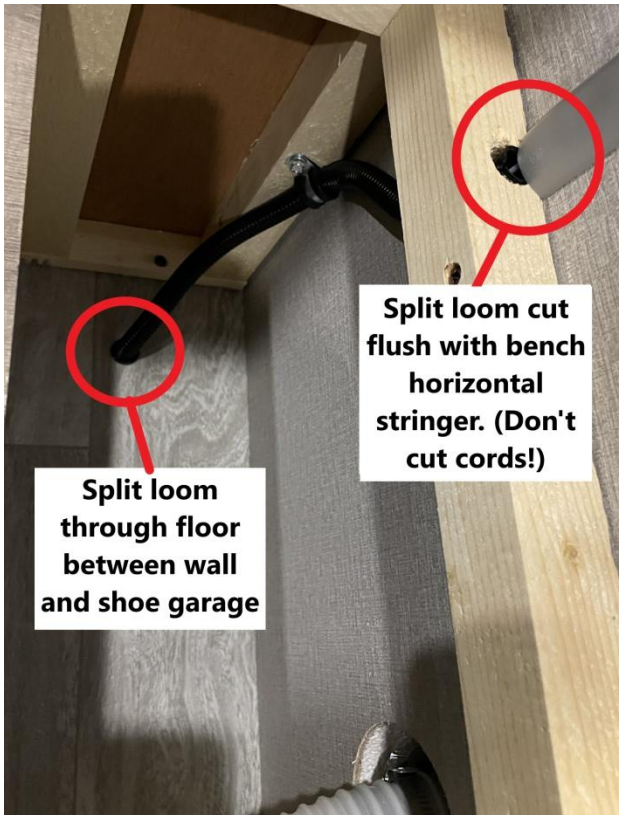
Cables layout as they exit through floor



Split loom and MC cable runs along/under frame



Split loom routed into floor of dinette



Routing of split loom to bench horizontal stringer

Preparing the upper cabinet control center

The first step in this process is to remove the lower electronic control panel. This is done by carefully prying off the bevel around the panel, and then removing the four mounting screws. Carefully pull the panel forward making sure to NOT strain or crimp the huge nest of wires behind this panel. Once you've cleared most of the wires through this hole, reach in to the back left corner of the cabinet and make sure there are no additional wires or other obstructions. Once cleared, drill an oblong ¼" hole through the bottom left corner of the cabinet, immediately above the hole in the bench stringer where the cords now protruded. This hole should be just big enough to pass the cords through. Once the cords have been run into the lower corner of the cabinet, cover the cords with the 4 foot of protective cable cover, i.e. wiremold. The cover should extend flush to the bench stringer such that the bench cover panel has to be modified slightly to fit around it. The cabinet and data cables are now ready to cut and mount the control panel and the battery monitor.

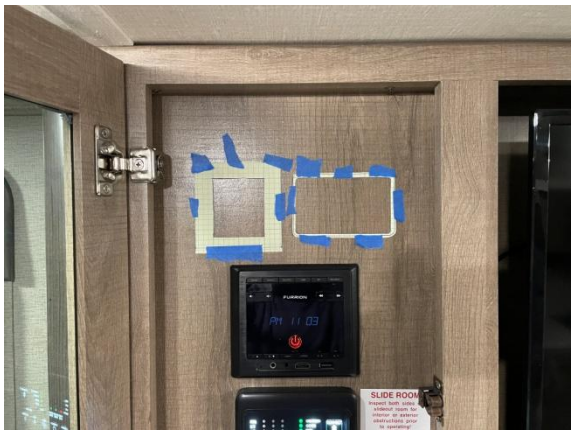
Wiring behind lower control panel

Oblong hole drilled under cabinet for cords

Wiremold is flush with top of stringer

Bench cover is cut to fit around wiremold

The method I used for this is to first cut two paper templates for the mounting locations, position them and hold them in place with painter's tape. Then, I used a permanent marker to draw the outline of the cuts I wished to make. At this point, take a moment to protect all of the wiring and the control panels from flying dust and debris; there's going to be a lot.



Stencils in place

Ready for cutting

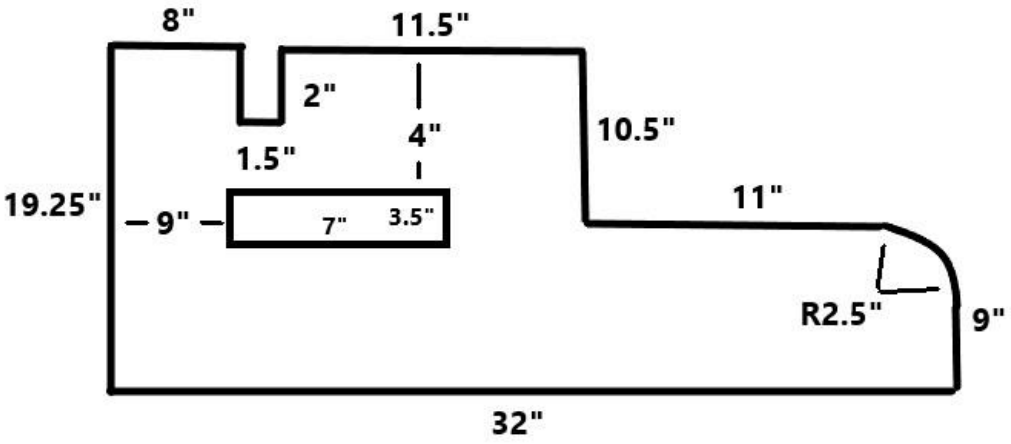
Using a zip saw (a sawzall with a small blade or a jig saw could be used, but they would be more cumbersome), I cut out the openings for the panel and monitor. (Note that GD used ½" thick particle board here so, it's a pretty substantial substrate to cut through.) Once the cuts are complete and the components are test fitted, connect the cables to their respective devices, mount them into place, and test them by turning the inverter off and on, and also verifying that the monitor is operating properly.

Panel and monitor in place and tested

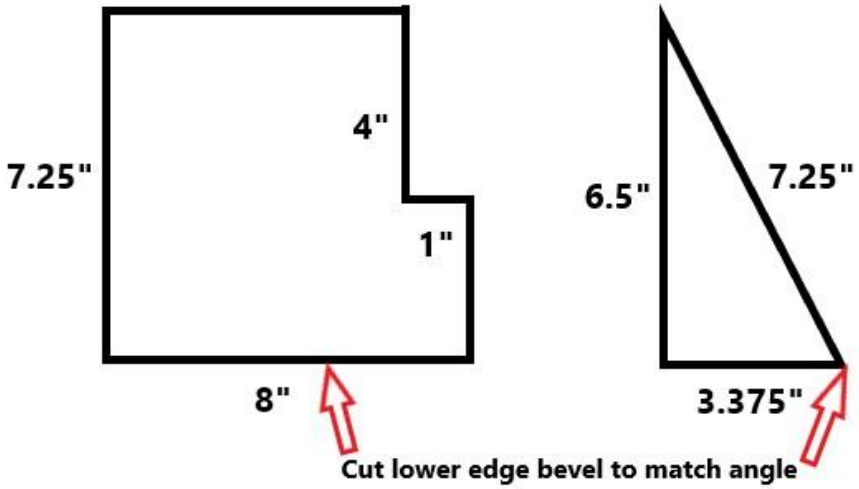
Once the test is complete, carefully reinstall the control panel and clean everything up. Your inverter installation is ALMOST complete! Now we have to build a protective barrier in the pass-through for the inverter and wiring.

Protecting the inverter and associated wiring -

Since the pass-through area is used to store a myriad of loose items, it is essential to protect the inverter module from items moving around inside the area. To do this, I designed and built a multi-part protective cover that protects the inverter and cables, but still allows visual access to the inverter's LCD panel and manual access to the shut-off switch and light fixture. To do this, I used a 2'x4' sheet of ¼" plywood and cut (and painted) the pieces as laid out in the diagrams.



Protective Board Dimensions (not to scale)



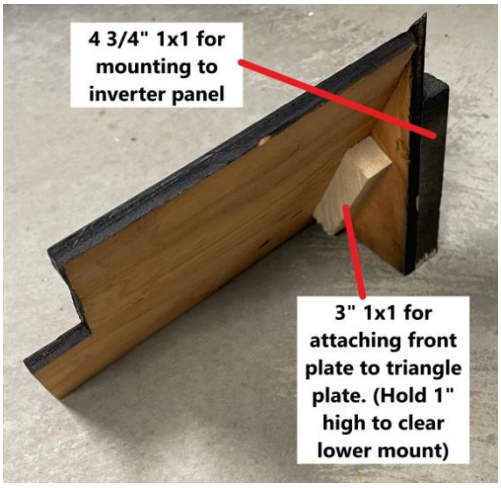
Cable Protective Panel Parts

To mount the inverter protective panel I took a 1x2 and ripped it into two 1x1's (actual dimension – ¾"x ¾"). I used a 32" piece for the bottom mount, and an 8" and 11" piece for the upper mounts. Then, after carefully checking the position for the mounts, I glued and screwed them into place. (Be careful that your securing screws are not too long, especially the upper mount.) I then installed the inverter protective panel and secured with more screws.

Inverter panel in place. Note 7 ¾" 1x1 mount in place for cable panel

The cable protective panel is a little trickier because it connects to the inverter panel and then slants at an angle over the cables. This protective panel consists of two pieces of plywood, cut according to the diagram, and connected together. (Note that the bottom edge of the cable protective panel is cut at an angle that matches the triangle bottom edge.) The mounts for this 2-piece panel are a 4 ¾" piece of 1x1 (used to join the triangle piece to the inverter protective panel), and a 7 ¾" 1x1 piece that is glued and screwed to the floor that the cable panel screws to. (Note that this piece of 1x1 is also cut at an angle to accommodate the slant of the cover.) Assemble the two cable panel parts separately, connecting the flat piece to the long edge of the triangle. (A 3" 1x1 is used to attach the front plate to the triangle plate.) Also attach the 4 ¾" 1x1 to the tall edge using small screws and glue.

Cable protective panel assembled



Note placement of 3" and 4 ¾" 1x1's

Then, custom fit the 7 ¾” 1x1 mounting block to the slanted panel. Once you’ve got it fitted properly, secure it into the floor mount and the inverter panel mount using screws.

Both protective panels are in place. Project is complete!

Once the protective panels are in place and everything else is cleaned up and buttoned up, Take a moment to test the system and verify that everything is working as desired. If everything is to your liking, your project is complete!

Not only do you have an integrated inverter that automatically gets switched into the system when shore power/generator is disconnected, but you now have a battery bank isolation switch that will completely remove the batteries from the system, as well as a new battery monitor located in a more convenient location. Again, you won’t be able to run your AC off of it for very long (unless you have a much larger battery bank than I do), but you will be able to run the microwave (briefly) as well as a small coffee maker and/or television. And all of your 120V outlets are energized by the inverter as well. Just be sure not to over-discharge your battery bank.

Good luck!

Melsman