

My Solar Installation Step by Step (2015 Born Free Freedom - Ford E450) October 2021

1. Find a good quality solar supplier who specializes in RV's. The closest one to us is AM Solar in Springfield, Oregon (AMSolar.com). They have a sterling reputation, and you can fill out a quotation request form online at AMSolar.com/quote. The form is very thorough, and includes specifics on your RV, intended uses, amount of travel, etc. I decided to use our existing Duracell Ultra SLI27MDR dual battery setup (less than 2 years old) and to stick with our Outback Mate2M converter/inverter. I submitted a quote to have them install, but they were really booked up so I also asked for a DIY (do it yourself) quote. With my wife Nancy's encouragement, I decided to do the installation myself. They suggested the Victron Complete Charger (50A) Kit for our needs and application. They also recommended that I get a Victron BMV-712 Battery Monitor Kit. AM Solar has many DIY videos, wiring diagrams, and help pages, that I spent a lot of time reviewing.

2. Measure, measure, measure! AM Solar suggested using four panels. I determined that I could indeed fit four 90W panels, but I had to use one that was a longer and narrower size. I ended up selecting three SunRunner ZS90S and one ZS90L panels. My panels are manufactured in Bend, Oregon. My tolerances for locating the panels on the roof were very tight, especially around the ladder and roof rack. Spoiler alert: We no longer have any space on the RV roof for storage.

3. Time the installation. We wanted to install before winter and I was installing mid-October, so I bit the bullet, ordered the equipment and drove to Springfield the next day to pick up the items and get started. All of the boxes fit into my Subaru Outback. Living in Oregon, we pay no sales tax and I saved any shipping costs. The total for my equipment was \$2,250.00. To have them install would have added over \$4,000 (rough estimate). I had the time and I am a handyman, so I decided to save the 4K.



Panel boxes in the back of my Subaru. The wiring box took the whole front passenger seat.

4. Set up the panels. Our RV is stored outdoors, and fortunately I had good weather with daytime temps in the 60's to 70's Fahrenheit. The first step is to attach the wiring. Details are on the AM Solar website. It is VERY important to double check that the positive and negative wiring is correct on all panels before you mount them. I made a lot of trips to the roof to determine cable lengths. This included deciding the best location for the combiner box, where the panel wires are combined into one heavier wire that goes to the batteries. AM Solar provided me with 60 feet (all in one piece). The DIY kits included 15 feet per panel. The next step was to attach the feet. Since some of my roof spaces are a tight fit, I had to strategically place the feet to fit around the AC unit, roof rack, and ladder. My panels have tracks on all four sides that allow for nearly infinite edge placement. There are also three height settings on each foot. The feet come with 3M VHB mounting tape. AM Solar says that they have never had a panel come loose with this tape *IF* mounted properly. Since my RV is unpainted fiberglass, that mainly entails cleaning each area on the roof thoroughly with 90% isopropyl alcohol, to mount only on flat areas, and to have temps in the 70's for several days while curing. There is an excellent video describing the procedures for cleaning and mounting. I had one location where I used both the tape and screws next to the AC ducting to ensure that I had a solid mount. I got the panels mounted on Day 1. After curing, using all of my strength I could not budge any of the feet!

A final note on the panels: I kept the packing cardboard taped on the panels with masking tape until my installation was complete. I read somewhere on another website about keeping the panels shielded from the sun to avoid getting shocked. I am not sure that this is true, but the cardboard also protects the panels from accidental breakage.

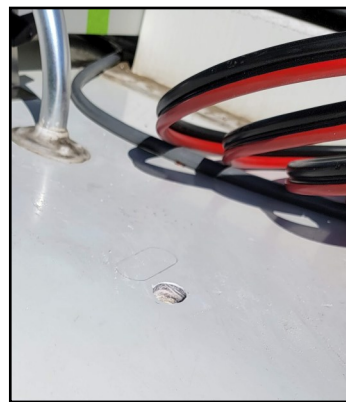
5. Determine placement of components inside the RV.

This includes the MPPT (Maximum Power Point Tracking) solar charge controller, High Current On/Off Mini Switch, and DC Breaker. These are all necessary for keeping the batteries from overcharging and to shut off items as needed. Since these should be located near the batteries, I decided to install them in the storage area beneath the driver's side bed adjacent to the kitchen cabinets. The battery monitor would go on the pantry wall next to the steps and outside door.

6. Run the wiring. This was the hardest part and took me two days. Our Born Free Freedom has pantry drawers between the refrigerator and the door where most of the RV wiring runs from floor to ceiling. I had to remove both drawers to access the wiring as well as to drill holes at the appropriate locations on the ceiling and floor. Measure, measure, measure both inside and outside to ensure that you are drilling in the right places. If you disconnect shore power and turn off the house power switch, you will be less likely to be shocked if you snag an electric wire somewhere. One tip I found said to reverse the drill when drilling in sensitive areas to make it less likely to snag wires, insulation or carpet; this worked well. Once I had the hole drilled in the roof, and the combiner box installed (using screws and Dicor self-leveling caulk), I fine-tuned the length of the panel cables and attached them to the roof using 3M VHB mounting pads and zip ties. All of these items are included in kits from AM Solar. Next, I



Panels covered with cardboard.



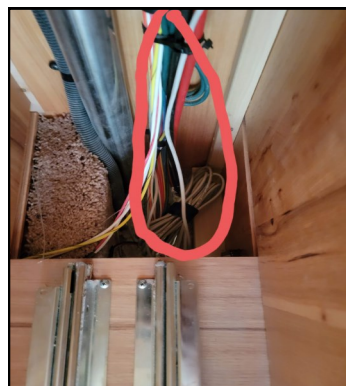
Careful measuring enabled me to drill from the inside this close to my outside mark.



Combiner box mounted on roof and waterproof!



Pantry area with drawers removed



Pantry bottom. New wires circled. Hole is in floor at



Wiring running through rear passenger side wheel well.



Typical shot of new wiring following and zip-tied to existing wiring.



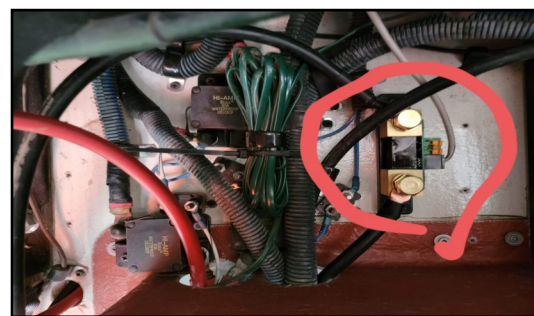
Circle shows the hole in the floor underneath the pantry.

drilled through the floor in the back of the pantry cavity. I routed the heavy battery cable from the combiner box through the roof, through the floor, then on a circuitous path through the right rear wheel well, over the front of the leaf springs, and across the RV over the exhaust shield. The exhaust shield is a large piece of sheet metal over the top of the exhaust. Look for the existing chassis wiring and cross there. You will want to purchase and use Polyethylene Split Loom Tubing on the outside of the wire for protection from the elements and heat. A 3/4 inch loom tubing works best and I found some at a local auto parts store. I used a lot—over 30 feet! I used zip ties all along the route of the wire to hold it in place. Under the RV, next to the battery compartment and under the storage area where I would mount the MPPT, switch and breaker, I discovered a U-shaped sheet metal shield covering various electrical components. I was able to remove this (6 Phillips screws), relocate a few cable clamps securing other wires and drill safely into the storage compartment. I also mounted the shunt that is a part of the battery monitor kit underneath the RV in the area protected by the metal shield. Wiring to the batteries is connected last, but the wires run from the shunt to the negative terminal on one battery and from the DC breaker to the positive terminal on the other battery. I have two batteries connected in parallel; yours may be different. I discover that the AM Solar website contains an archive of many variations on wiring and I found my battery set-up pictured there. The diagram, supplied by AM Solar with my kit, showed a battery bank connected in serial fashion instead of parallel. Leave the metal shield off until the very last or you may end up taking it off and on multiple times like I did. It will leave you with a face full of dirt and crap each time. I was a slow learner on that part. Haha!

7. Mount the inside components. As explained earlier, I mounted nearly all of the inside components under the driver's side bed. This was even more cramped than the pantry area and working with heavy battery cables to get the lengths and placement correct, as well as screwing the boxes to the wall, was a real challenge! This work took me the better part of a day and seemed to require a lot of creative vocabulary! At this point, I remembered that I had yet to run the wiring from the battery monitor shunt to the battery monitor display. I basically used the same route for this wire (similar to a phone wire) under the RV as I had previously. I did not use wire loom on this except in the wheel well area; I did so because Born Free had used similar wires in the original assembly that were also not covered. I used my drill running backwards to make the hole in the



Metal shield under the RV right next to battery compartment



Electrical wiring behind the metal shield. Shunt is circled.



Inside electrical components mounted on wall underneath the driver's side bed.



Battery monitor mounted on wall between pantry and door.

wall for the battery monitor display. This made a nice clean hole without splintering the wood.

8. Make sure that all of the switches on the RV related to supplying power are turned off, then connect wires to the battery terminals. I included the house power switch, the chassis to house switch, as well as the High Current On/Off Mini Switch, and DC Breaker. Also, be sure to unplug from shore power if you haven't before now. Connect to the positive battery terminal first and then the negative. On my setup, I connected to a positive terminal on one battery and the negative terminal on the other battery. I also had a wire to connect to the positive side from my battery monitor shunt.

9. Turn on all power switches cited in step 8, but hold off on shore power. At this point, the light saying "bulk" should be lit up on your MPPT (Maximum Power Point Tracking) device. If so, proceed to the next steps. If not, go back over your previous steps or call AM Solar for support. The Victron charger and battery monitor are Bluetooth enabled so that you can monitor solar input on a smartphone app. Cool!

10. Finish up. Caulk every hole that you have made. AM Solar provides lots of Dicor self-leveling caulk to be used on the roof. I also used that on the top of the holes I made in the floor. This will run and form to shape of any hole, but can also run out the bottom of vertical holes, so plug the bottom of larger holes with plumber's tape. On the bottom side of the roof and floor holes, use the non-leveling Dicor or another caulk rated for outdoors. Use this also for holes in walls. Reinstall the electrical shield plate underneath the RV as well as pantry door and any other items you removed in the process of your project. Double check the tightness of all of the panel hardware on the roof before taking a test drive.

11. Pat yourself on the back or have a friend do so if you are flexibility-challenged due to all of your sore muscles and joints.

This is my first solar installation. I thought that, by writing this up, I could possibly help someone else. I invite your questions on my specific installation. And, if you decide to pursue your interest, I encourage you to contact AM Solar.

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