Building a Hamshack in Your RV

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Original RV

- Bought as insurance company salvage (hailstorm dents) for $4000. 11 years old.
- Goal: learn about RVs with one that we could afford to trash.
- 7 years use, roof leaks, folding mechanism issues, shell crumpled near door.

Issues

- This RV was kept in a storage area more than 15 minutes drive from my home.
- Inconveninent to work on.
- Cost (then) over $1000/year for storage.

Resolution

- Get a solid rather than folding RV, as we got older it was getting harder to open or close.
- Get one that would fit in my driveway, so working on it would be easier.
- Driveway has fit issues, so new RV would have to be smaller.

The Driveway From Hell

- Loop driveway shared by 4 homes. The other entrance is *harder.*
- Has dip, turn, climb all close together.
- Tried to pull in new 17 foot external-length trailer, but it would have bottomed out.

The Solution

- These are called “Skid Wheels”. Two 6 inch casters coupled to frame.
- Touched ground for only 6 inches! Tires continued to support most of weight.

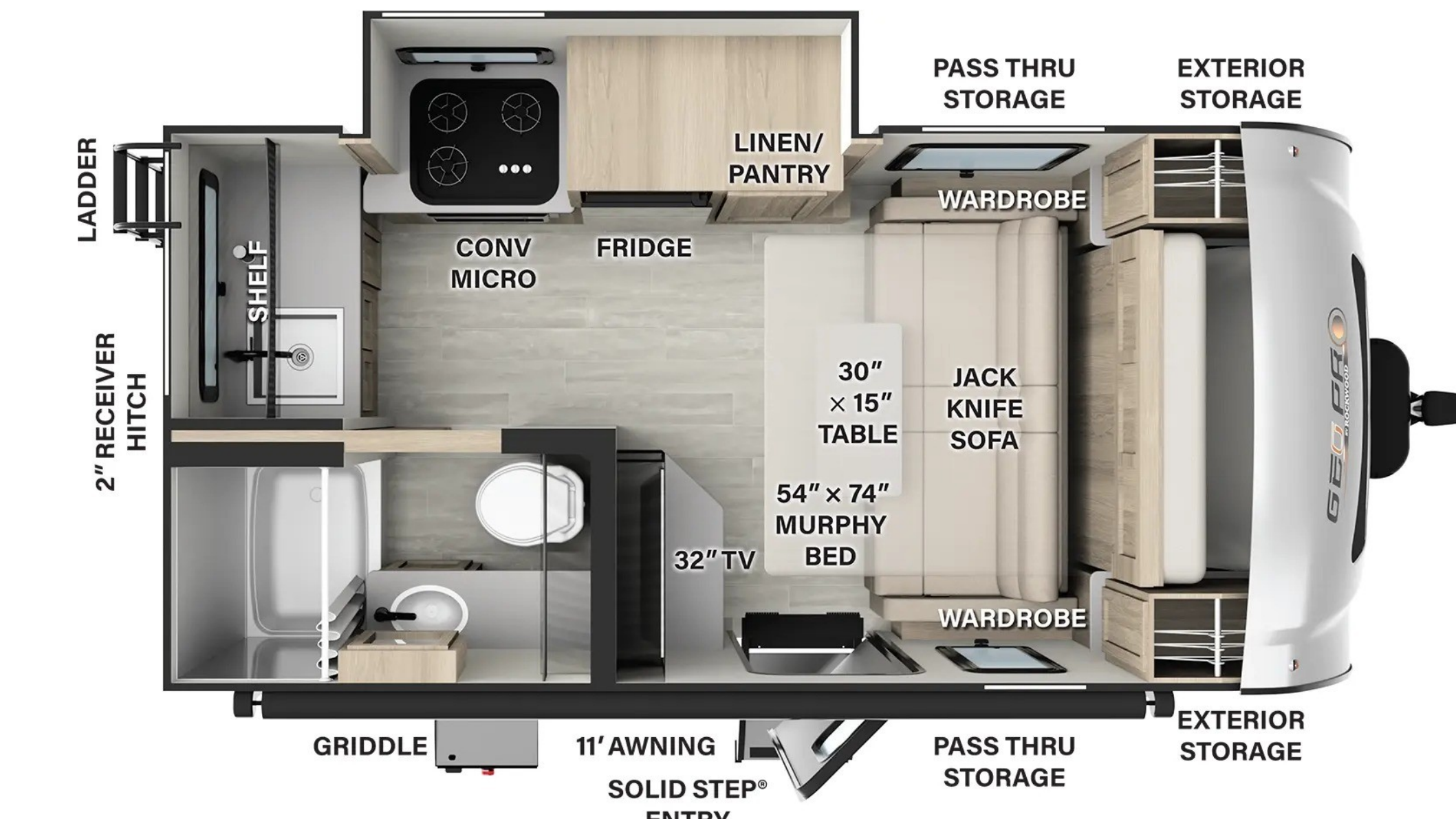
Smaller RVs are Improving

- Murphy beds fold into wall, improve usable daytime space.
- Slides make it bigger on the inside, but come with mechanical issues.
- I found the first 15-foot (inside) RV that had everything Valerie and I needed, except ham radio.

- Forest River Rockwood Geo Pro 15fbs
- Notice the 31 foot kite poles at each end.

No Pick-Up Truck Needed

- But most sedans and some smaller SUVs would be insufficient.
- Need weight-distributing hitch (*not* used in this photo). ProPride is best, but pricey! No sway ever.


PASS THRU STORAGE
EXTERIOR STORAGE
LADDER
LINEN/ PANTRY
WARDROBE
CONV MICRO
FRIDGE
SHELF
2" RECEIVER HITCH
30" × 15" TABLE
JACK KNIFE SOFA
54" × 74" MURPHY BED
32" TV
WARDROBE
GRIDDLE
11' AWNING
SOLID STEP® ENTRY
PASS THRU STORAGE
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Space, the Final Frontier!

- So, it doesn’t look like there’s much space for ham radio in there?
- Actually, there turned out to be a lot of hidden unused space.

Soon-to-Be Operating Position

How’s The Bed Work?


MURPHY BED OPERATION
EXIT
THE
Flagstaff
DIFFERENCE


EXIT
THE
Flagstaff
DIFFERENCE

Off-Grid

- 200W of solar panels and PWM controller from factory. Enough to keep the all-electric refrigerator running if your parking space isn’t shadowed.
- 31 gallons fresh water, 27 gallons gray, 27 gallons black.
- I can stay off-grid for 2 weeks with no problem. Showered every day, hauled fresh and gray water, black water tank was sufficient, laundry and food were limits.

Sandrig – Specialized Cart for Sand

- Once you have sited and leveled the trailer, and brought out the slide, and set up antennas, it's inconvenient to move it every time you want to change water.
- **5 gallons of water weigh 41.7 lbs**, and carrying that gets old fast.
- Works well on dirt or sand, while my *hand-truck was unusable.*
- **16-inch baloon tires** are what makes it easy on any terrain.
- Expensive. Made for surf fishermen. Comes with rod holders. They can hold antenna poles, so you can use this for portable operations.
- Made by "Yak Attack"
- Went on top of SUV first time, next time will go on hitch mounted cargo shelf in back of trailer.

Issues of Modern RVs

- The RV is essentially a styrofoam cooler for people. The body is a sandwich of thin fiberglass, styrofoam, and 1/8 inch Luan plywood on an aluminum frame, all of this is on top of a steel chassis. It's a good radome, RF-transparent. You can mount a Starlink antenna in the top of the kitchen cabinet, and it works fine.
- The plywood is 3 layers within that 1/8 inch. Luan is a rain-forest wood from Borneo that is light and strong, not long-term sustainable.

Issues of Modern RVs (2)

- Interior cabinetry and walls are made of that 1/8 inch Luan plywood. Forget about renting out that kind of RV, it would not survive.
- Factory electrical equipment has its issues, water plumbing is PEX, gas plumbing is thick rubber-like tubing.

Battery

- I added this Renogy 300A Core Mini lithium battery. Battery and shunt (also Renogy) fit in battery box made for 2 lead-acid. 2 of this lithium won’t fit and there is not space on the A-frame at the front of the trailer for a larger battery box.

Batteries

- Got the battery (and everything else) just before tariffs, it’s $150 more now. Lead-Acid batteries are no longer desirable from a cost/energy perspective.
- Don’t buy one without freeze cut-off, charging lithium batteries below freezing destroys them. Internal battery heater is better.

Batteries (2)

- Discount batteries from no-name brands can contain “re-sleeved” cells. These are reject cells that have been re-wrapped in plastic, and marked as factory pass.
- Set both chargers (AC and solar) to maintain battery at 80% charge, for best lifetime. Set to 100% for trips. Try not to knowingly discharge below 20%.

External Solar Panels

- 400 watt “solar suitcase”.
- 200W on roof was sufficient to keep the ‘fridge and other things running.
- Might need the additional power of this suitcase for 200W TX-480HX HF rig.

Using External Solar

- Factory “Solar on the Side” connector was too feeble to support the weight of 10 AWG wire.
- Factory “Solar on the Side” relies on panels having their own external charge controller.
- Installing 50 amp Anderson connector and second Renogy 40A MPPT solar controller.

Where Do The Radios Go?

- Obviously I’m still doing construction.
- RAM *Tough Track* mounted under TV for radio *heads,* provides a 30 inch *re-positionable* base for RAM mounting hardware.
- Radio bodies go in cabinet under desk.
- Notice the 30-inch-long white steel strip, microphones have magnets on back.

RAM *Tough Track*

- End-Loading Composite track comes in up to 38 inches long. Lots of screw holes in track provide support.

Tough Track

Tough Track Ball

- Ball grips the track.
- *B-size,* 1-inch ball used on all mounting parts. A-size 1.5 inch is used for larger marine electronics like depth-finders.
- RAM mounts are much higher quality than Lido (sorry, Lido!), truck-stop brands.

RAM Composite Short Arm

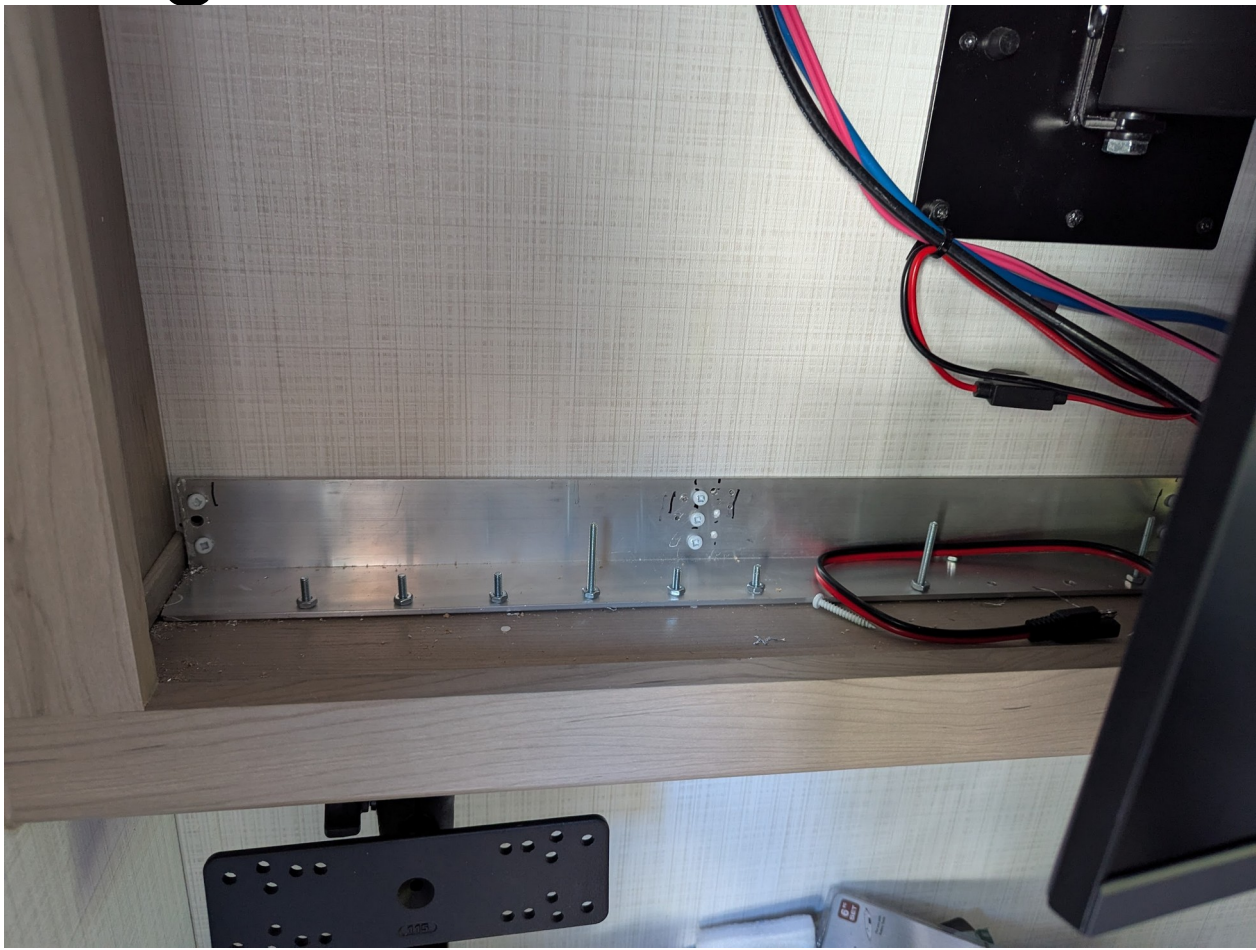
- This size works best with my track installation, I don’t need the radios to come forward far from the track. This is shorter than arm included in most RAM packages.
- You can get metal or composite parts from RAM. “Composite” may be fiber-filled ABS or delrin, seems tough enough. Composite is more than adequate for radio heads.
- 2.42 inch overall length.
- 1.75 inch socket-to-socket length.

RAM Back Plate

- There are a lot of *third-party* parts compatible with RAM available online. They are generally of OK quality, possibly less expensive. Be sure to check the ball size.

Supporting the Track

- The TV frame is made of 1/8 inch Luan, so the track is supported by this bracket into the studs. This was painted and I got shorter screws.



Drilling Holes

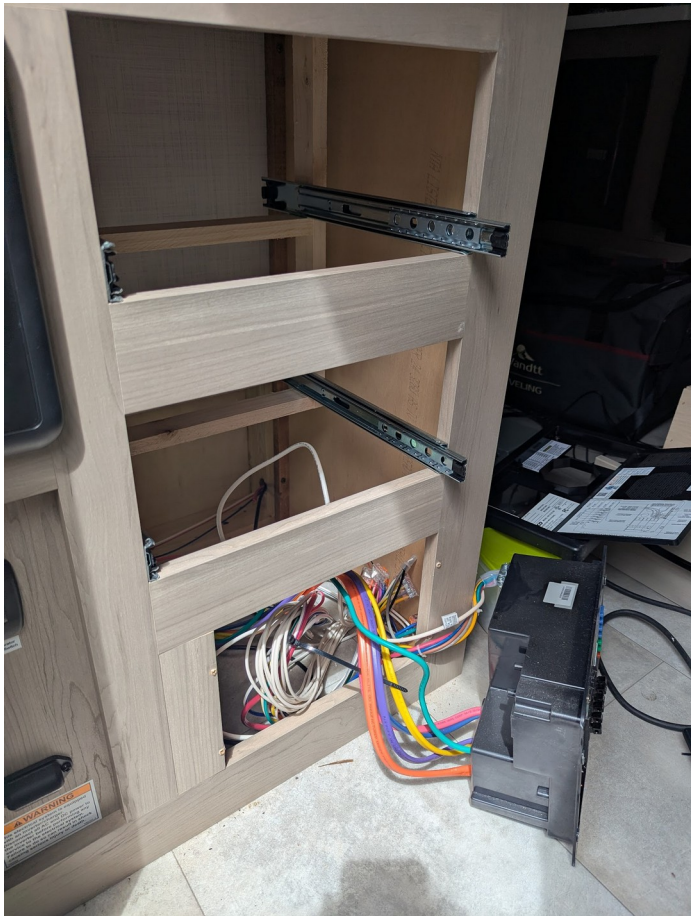
- Diamond Core Drills ($10 Amazon) grind neat holes through 1/8 inch Luan. Don’t push, it separates plywood layers.
- Notice 2 layers of 1/8 inch Luan in the hole, just space between them.
- When you *can* reach the other side, *drill from both sides.* The pilot drill hole keeps it aligned.

Glands

- Glands fill the hole and allow wires to pass through. Available on Amazon.

Installing Equipment in The Cabinet

- The cabinet under the desk turned out to be mostly empty space, except where the drawers went. More than enough for 4 rigs. There was about 2 inches of space behind the drawers for thinner equipment.



Power Pro

- *Power Pro,* the factory voice-command + bluetooth switch bank controls lights, slide and awning, pump, water heater (gas and electric), reads fluid levels, and indicates faults like the water heater not lighting. And makes electrical noise.
- This panel is shallow and there is lots of space in the cabinet behind it.

Switches

- I installed this switch-and-breaker bank from *Blue Sea Systems* under Power Pro. One switch will turn Power Pro off, to stop interference. May add bypass for lights. Blue Seas is pricey, but the best.
- Custom labels cost $5/each. The panel comes with boat-specific labels like “VHF”.

In the Cabinet

- The back and left side of the cabinet were reinforced with ½ inch oak plywood. In the back, it’s screwed into studs. On the left, there are no studs and it’s glued to the sandwich wall. It holds weight and takes screws for mounting. A second panel went below this one, and two on the left.
- A wiring tunnel runs from here to the roof, bathroom, and behind the TV.

Re-Doing the Solar Controller

- The original solar controller, was PWM. MPPT is more efficient, so I replaced it. There is also a power monitor for the two solar controllers and the battery shunt. All from Renogy.
- Notice the noise suppression with dual-stage filters made for AC, used on DC.

Why Not Victron?

- For this installation, I went with *Renogy* equipment.
- Victron is a very high quality, pricey vendor of equipment mainly for marine applications. It’s made for salt-water, and is thus fully potted.
- It’s meant not to fail in the middle of the ocean, but if it does, it’s unrepairable due to potting. And yes, I do surface-mount soldering.
- The price-differential was not worth it for the features I needed in an RV, rather than a boat.

The Trouble With Toroids

- This was my first try for noise-filtering the MPPT solar controller. It has 3 different ferrite mixes for protecting 100 Khz to 2 GHz. *Do you see the problem?*

Toroids Saturate!

- If Palomar Engineers, the *quality* source for toroids used by hams; ever talks about them saturating, I didn’t notice.
- Magnetics expert *Manfred Mornhinweg XQ2FOD* told me the Mix 31 toroid wound with 2 meters of wire would saturate at *1.5 amps,* the others not far behind it! No noise suppression once that happens.
- Toroids are about the worst shape for saturation, they don’t break the magnetic flux, as a bar would.

Toroids Saturate! (2)

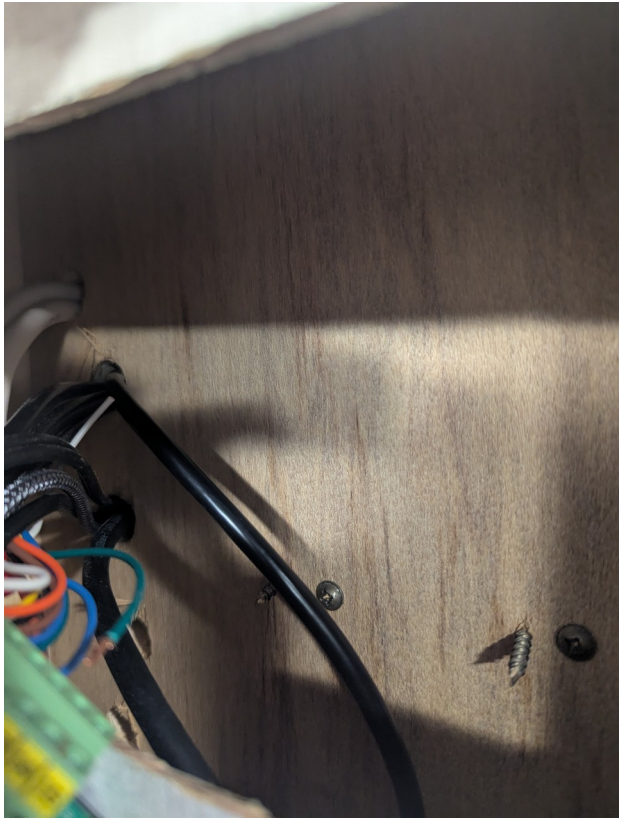
- One solution is to run both conductors through the toroid, so that they cancel each other’s magnetic fields, and you can still suppress common mode.
- Manfred suggested that I just use pre-manufactured AC filters. There’s no reason they would not work on DC. They have toroids internally, but run both conductors through them.

Stereo and Power Monitor

- The original TV had a FM receiver, but I replaced it with a 4K monitor.
- The lower left device monitors both solar controllers and the battery shunt.
- The stereo will get a frame, for neatness.
- Wood pieces are glued inside the Luan plywood to give screws something to bite.

Complications

- I had to drill holes in a stud to get the wiring around a corner to the back of the TV.

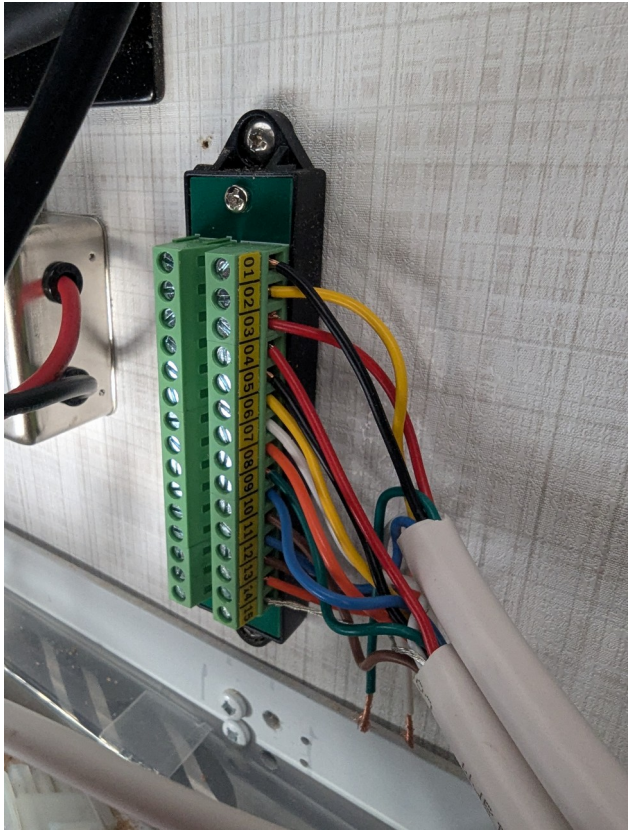


Wiring Behind TV

- The stereo and power monitor wiring come out behind the TV, so that I can access them. Not tied up yet.
- There is an inch or two of space behind the TV, and I have put a *lot* of stuff in it. The TV mount pulls out, for access.
- I may have to put a plate behind the bottom of the TV to hide some wiring.

Car Stereo Wiring Junction

- Behind TV.
- Wiring for 4 speakers, 2 power lines + ground, some ancillary functions like antenna raise.

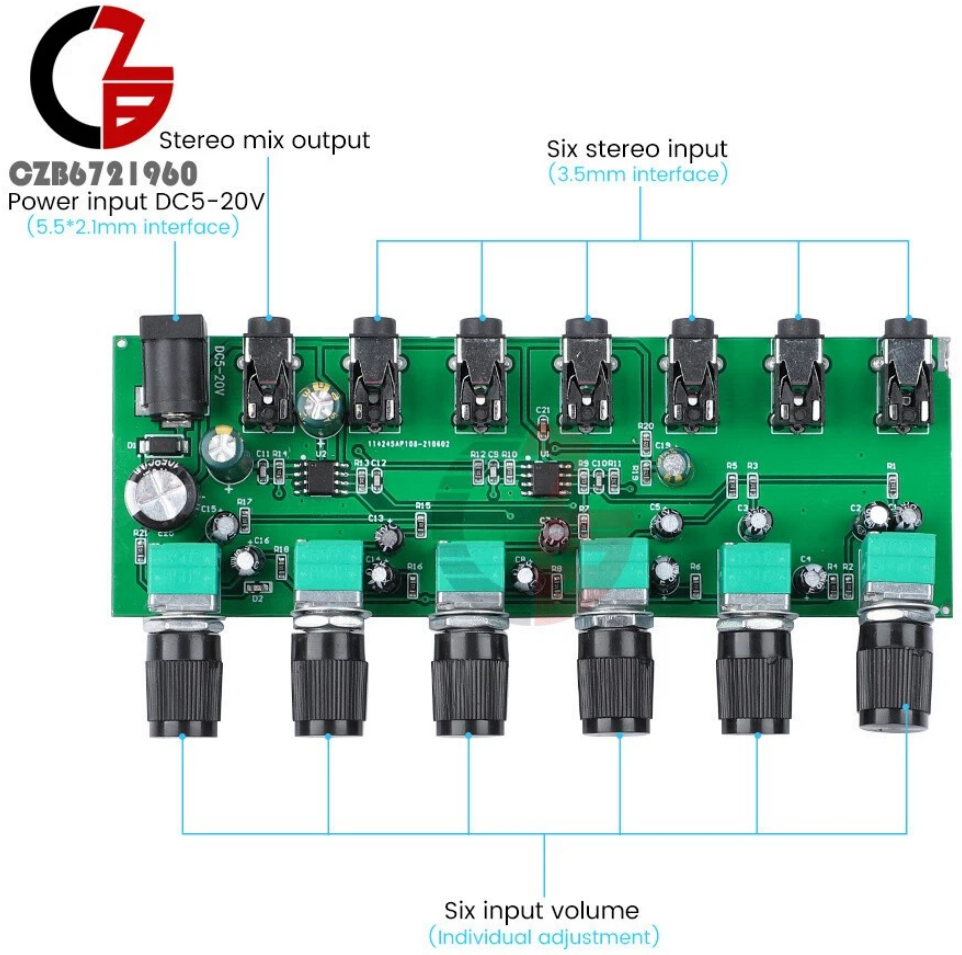


Car Stereos Have *Lots* of Wires

- More than 16 wires for speakers, power, etc.
- HDMI output.
- USB cable for external storage.
- External microphone connector.
- Antennas for AM/FM, GPS.

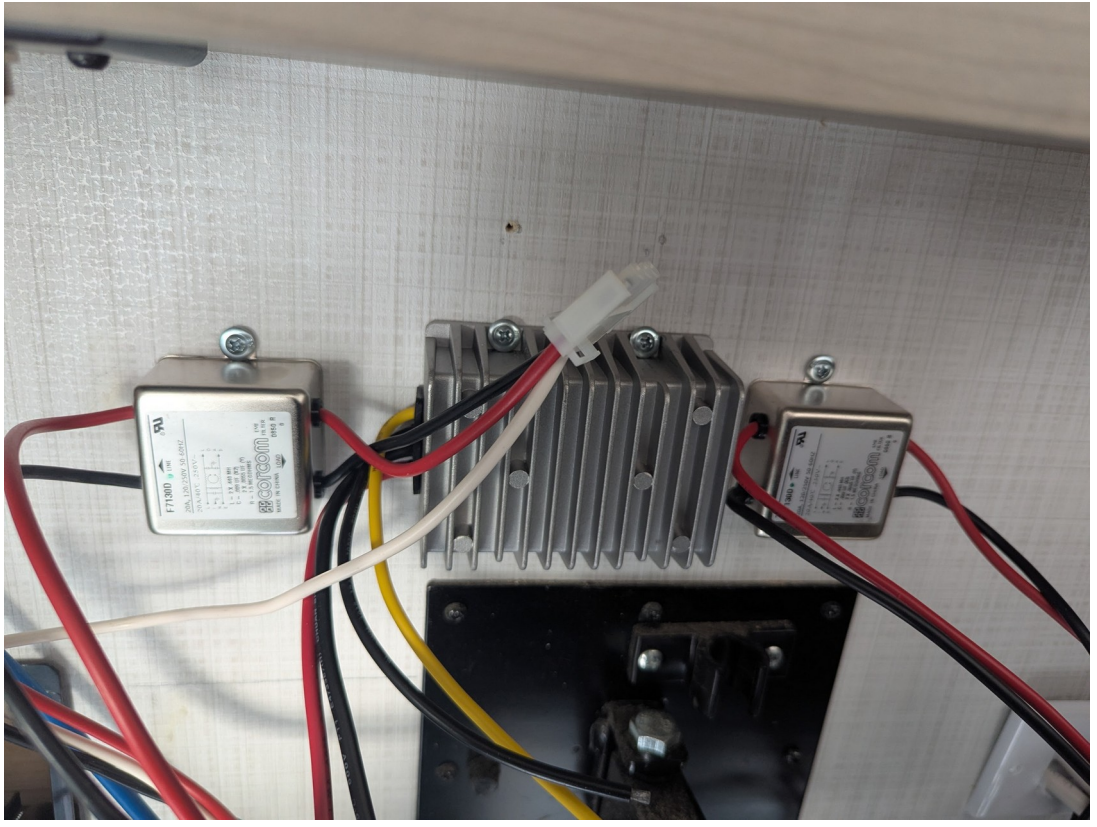
Car Stereo and Rig Output

- There are enough rigs, TV, and computer, that it makes sense to mix their audio output and put them out through the car stereo. Also you can pan to the “rear” output and activate the outdoor speakers.
- Mixer PCB, $11 on eBay. Will be mounted in panel.
- Can build resistor pads for rig outputs.
- This does *not* include transmit-mute, that would be yet more work.
- This will be a project for when everything else is done.



TV Power Supply

- The 4K monitor runs on 24 volts. This is installed behind the TV, not yet wired, and will power it.
- There is an external ATSC tuner (1080p), I will get ATSC 3 (4K) when it’s less expensive. The TV is mainly for other things than broadcast.



Mounting the Radios

- The radio bodies aren’t mounted yet.
- M4x8mm thumb screws work for most radios and will allow them to be mounted in the confined space of the cabinet, where getting a screwdriver to the side of a radio is not possible.

Getting the Coax To The Roof

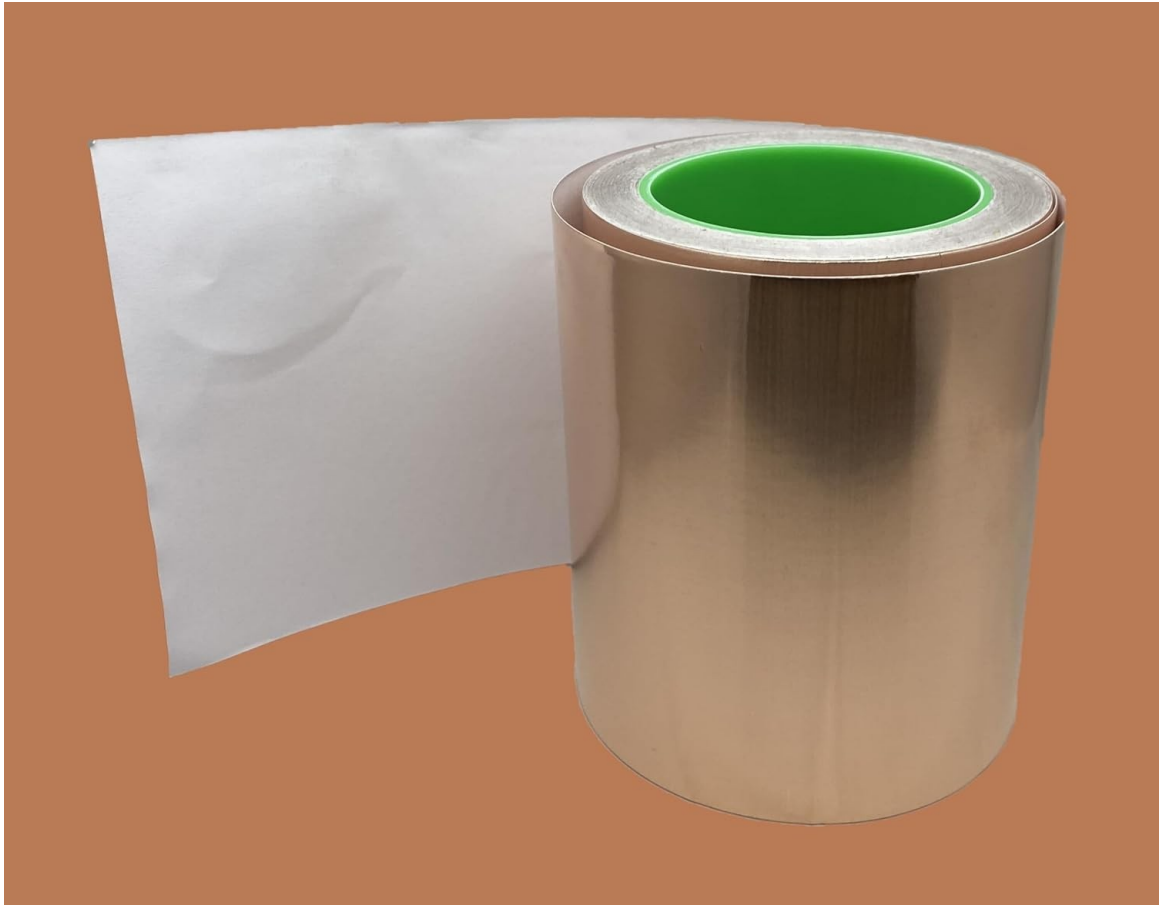
- Solar wire gland housings can be made to work for PL-259 instead of the wire gland. *Anina* barrel on Amazon is the right diameter.

The Antennas

- The HF antenna is the biggest problem due to its size and the potential need for a large counterpoise.
- Mobile VHF/UHF antennas meant to be mounted on an automobile *will not work,* or at least work poorly, without the addition of a counterpoise!

Counterpoise Tape

- This is thick copper tape 8 inches wide, which can be applied to an RV roof to make a VHF/UHF counterpoise, and a poor HF one because it’s too small.
- Sold by “Fuel the Army” on Amazon.
- Aluminum tape can also be used.



HF Antenna

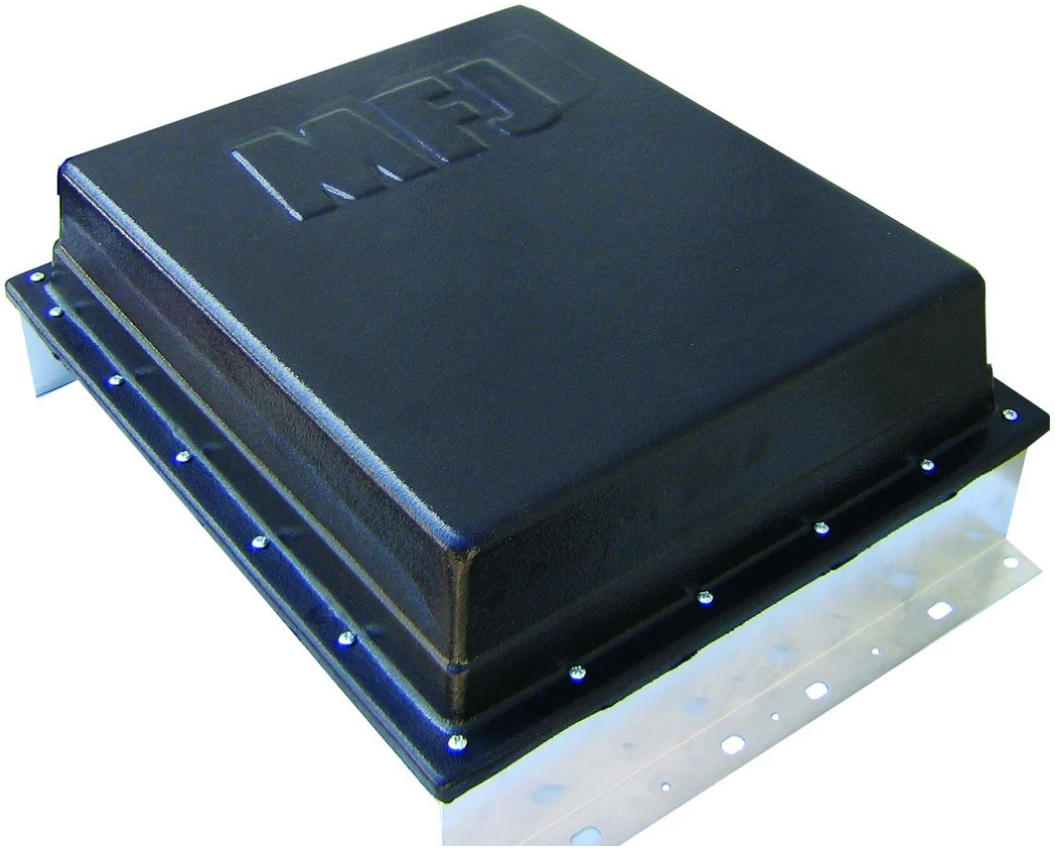
- I put the two 31 foot kite poles on the trailer to support a rectangular loop. You can get up to 80 feet of wire between them. A loop doesn’t need a counterpoise. A loop could be up to 90% efficient on 20 meters, and get down to 10% efficient on 160. Modeling its pattern on each band is yet to be done, so I expect to tweak the length, etc. If this fails I can always do a vertical.
- Pole bending issues to be determined.

Other Pole Options

- Carbon fiber: 49 feet would be $2500 for the pair from DX Engineering, conductivity makes them questionable for the loop antenna.
- Spiderbeam has fiberglass poles up to 85 feet! Enough for full-size 160 meter vertical. This would be a guyed installation on ground, not the RV.

Tuner

- An MFJ-998RT tuner will be mounted on the roof at the back corner of the loop. Connecting there gives vertical polarization.
- The feedline to the MFJ-998RT will get a 1:1 transformer to isolate it from the feedline shield, because this is *not* a balanced tuner, and the loop *is* balanced. Otherwise, the feedline would become part of the antenna.



Kite Pole Mount, Front

- Available on Amazon.
- There are multiple holes for the hitch pin, so you can push the mount inwards for driving, extend to full length for operation.

Kite Pole Mount, Rear

- The pole gets above the roof at 8 feet, leaving 23 feet above the roof. The front one is mounted a foot higher.

Other Issues

- LED lights may be noisy, USB PD chargers are getting filters on their power supply side, we can put chokes on cables, etc.
- Water heater and room heater have embedded CPUs and could possibly be noise sources.
- Lithium battery internal controller and bluetooth shunt may be noisy and need yet more filtration.

Getting the Right Price

- Take the time to learn *exactly what trailer you want* before you buy one, rather than having the dealer pick one for you. This protects you from price issues Trailer shows (*Goodguys,* Pleasanton Fairgrounds in January) are a good place to start.
- I was aware of the price of my trailer from *every dealer that stocked it in California,* and many in other states, before I bought it.
- If you aren't handy and don't want to *always* do your own repairs, buy an *Outdoors RV* or a *Nash* (same factory), or a ($$$$$) Newmar. They are *heavy* and not the cheapest, but made of good materials, and known for their reliability.

RVs Need Repairs Continuously

- Imagine a home that had to endure a 5.6 earthquake, *but for hours at a time.* That's an RV.
- Also, in the quest for lighter weight and lower cost, the materials are crap and the factory work *will* come with errors.

All RV Repair Facilities Are Overloaded At All Times

- Experiences with RVs being held for service for many months, and then not fixed correctly, are widespread.
- Camping World Vallejo had at least 150 units waiting around for service.
- A repair-only business close to me quoted an opening for service months in the future.
- If you aren’t going to do your own repairs, maybe an RV is not right for you.

RV Dealers Stink

- The first thing you get asked is when you have a trip coming up, so they know they can pressure you to buy by then.
- Most have *no fixed price,* so you must determine the best price before trying to buy.
- Many try to use use a service contract as a main profit generator.

RV Service Contracts Stink

- One easy test is to see if the terms of the service contract are easily available online. Almost none are.
- Most dealers will only present you with the terms of the service plan when you are signing a contract, so you can not evaluate them or show them to a lawyer. The terms are kept secret, no kidding, by the company behind them, and this is required of the RV dealer.

What RV Service Contracts Really Do

- They provide you with the *feeling* of protection.
- Not actual protection.
- They have arbitrary maximum amounts that they will pay for any particular repair. These are generally far less than the actual cost.
- Look at their BBB complaints, many pages long.

How RVs Age

- Ultraviolet and rain are the RVs worst enemy.
- UV causes the polymers of the fiberglass resin in the walls, and the rubber-like material of the roof, to de-polymerize, turning them brittle.
- Water *will* cause leaks.
- Cover your RV for longer life. Use a tarp on the roof, and one of the Tyvek-like covers for the rest.

Rodents, Ugh!

- Rodents *will* find their way into your RV.
- An RV left alone for months will be an RV destroyed by rodents.
- Screen refrigerator vents *on their inside* with ¼ inch hardware cloth, cut and bent to meet edges and edges glued with hot-melt glue gun, screen all other openings that can be chewed. You will need metal shears and gloves, easy to get cuts.
- Look at wire entrances and seal them.
- Spray foam sealant from the home store turns to dust in 5 years.

Contact the Speaker

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