Green Roving in a Red Rover

VHF roving with no carbon footprint.

Wayne Overbeck, N6NB

Though I've roved for a long time, I have to admit that I haven't been very "green" about it for most of that time. Even before roving was recognized as a category in ARRL VHF contests, I was operating portable on mountaintops with cars and trucks that consumed gasoline as if there were an endless supply and spewed out exhaust gases as if air pollution didn't matter.

For years I drove large Ford and Chevy vans and trucks coast-to-coast on amateur radio VHF expeditions, giving little thought to fuel consumption. The most efficient of those vehicles delivered about 14 miles per gallon — even less when towing a tower trailer.

A New Way to Rove

By 2020, electric cars became practical for roving. Tesla's all-electric cars have good reviews for their performance and style. The high-end models have an EPA-rated cruising range of around 400 miles, earning well over 100 MPGe (miles per gallon gasoline equivalent). These cars have no carbon footprint.

My 2020 Chevy Bolt has been outfitted with the same microwave toolbox station used on a gasoline-powered car with a V8 engine. The station covers all bands from 6 meters to 10 GHz.

This console controls the 10-band toolbox setup on the roof, providing instant band-switching. There's also a transceiver for straight-through operation on 6 meters, 2 meters, and 432 MHz, and acts as the IF for all bands above 902 MHz.

Almost every other manufacturer is rushing to challenge Tesla in the all-electric marketplace, encouraged by state and federal rebate programs and incentives to get people to switch to Earth-friendly cars. There are also ways to recharge these cars using clean electrical power sources.

More than one million all-electric cars have been sold worldwide, and that number is growing rapidly. The big obstacle for most potential electric-car buyers has always been limited range and the difficulty of recharging the main battery away from home. But many manufacturers now offer modestly priced electric cars with a cruising range of well over 200 miles, and there are charging stations along all the major highways. For more information, read *Energy Choices for the Radio Amateur: Your Power Sources in the 21st Century* by Bob Bruninga, WB4APR, available for purchase at **www.arrl.org/shop/Energy-Choices-for-the-Radio-Amateur**.

I decided to purchase a 2020 Chevy Bolt EV Premier with built-in side rails on the roof designed for mounting a platform. I doubt General Motors' target market was hams wanting to mount a 10-band microwave station on the rooftop for roving in VHF contests, but that's what sold me, so I set out to turn it into a rover. It was my project during the start of COVID-19.

Charging and Discharging

The Chevy Bolt is a subcompact crossover vehicle. Its EPA-rated range is 259 miles, but I quickly discovered that by driving conservatively I could make this little car go considerably further than that on one charge. I also found I could bypass all the charging stations (some free, some not) and park in a friend's driveway to recharge more than 225 miles from home as easily as I could recharge at home.

I immediately bought a level 2 EV charger that runs on 220 V and will recharge an electric vehicle (EV) overnight. Note that a qualified electrician may have to adjust the typical household 30 A clothes dryer 220 V circuit (NEMA 10-30). Most level 2 EV chargers are designed to draw 32 A and use a 50 A power plug (NEMA 14-50). The level 1 EV charger that comes with most electric cars will recharge the vehicle on 110 V, but that can take up to 48 hours. If you're on the road and want to recharge in a hurry, there are plenty of level 3 EV chargers in public places. How quickly one of those will recharge your EV depends on the car's built-in, high-voltage charging system. The Chevy Bolt owner's manual says it's possible to recharge to 80% of capacity in less than 1 hour, but I've found that it takes longer (up to 3 hours).

The Chevy Bolt main battery pack is a lithium polymer-based system and isn't lightweight. The one in a 2020 Chevy Bolt is a 66 kW hour, 344 V beast that occupies almost the entire subfloor of the vehicle and weighs about 1,000 pounds. The result is a subcompact SUV that weighs almost 4,000 pounds before amateur radio equipment and antennas are mounted. With that being said, it handles well, has surprising acceleration, and has a relatively high top speed. The center of gravity is

Inside the car is a 10-band station with a Vivaldi antenna that covers 900 MHz through 12 GHz. It includes small power amplifiers for all bands 2.3 GHz and up and has performed well on long paths with only the wideband antenna aimed out a car window on the microwave bands. The radio equipment is powered by two 100 Ah lithium iron phosphate batteries on the floor.

so low that I had no concerns about mounting a platform, an antenna rotator, and a stack of VHF+ antennas on the roof.

When it comes to powering a ham radio station in the car, some hams have used the 12 V auxiliary battery that's there to power accessories. It's recharged from the high-voltage battery, at the price of reduced range. Some amateurs have viewed the main battery as a gigantic portable Hoover Dam for running ham gear during Field Day. You can arrange to monitor the auxiliary battery's voltage as it declines and restart the car to recharge the auxiliary battery every time it gets too low (read "Electric Vehicle Power for ARRL Field Day" by Janelle Brisbine, NØMTI, in the June 2019 issue of *QST* for more information). If you're not far from home or another EV charging point, that will work fine. For a rover on a long trip, however, that's not a good idea. Additionally, don't hook anything up to the auxiliary battery or the high-voltage battery. If anything should go wrong with the car's electrical system, your ham gear will give the dealer an excuse to disallow the warranty.

My solution to power radios, transverters, amplifiers, and a 110 V inverter for an antenna rotator was a pair of 100 Ah, 12 V lithium iron phosphate batteries. They weigh less than half of what you might expect if you've ever lifted a lead-acid automotive battery of the same physical size, and with their built-in battery management system, they're easy and safe to recharge on any 14 V power source. Two of them fit easily on the passenger side floor and can be wired in parallel to run a VHF+ radio station for an entire weekend. They stay over 12 V until they're almost completely discharged and if you run them down, a few hours with an ac powered 12 V supply will recharge them.

Platform Design

The Chevy Bolt's built-in side rails each have four threaded rivets (thread size M6-1.0). I made four brackets of 2-inch aluminum angle stock that are ⅛-inch thick and 175 millimeters long. I mounted stainless U-bolts on the brackets to secure two 1½-inch aluminum 0.058-inch wall tubes that serve as crossbars. Those support the rotator bracket. An antenna rotator is very desirable for aiming highly directional microwave antennas, but it could be omitted by someone intending to use only short VHF antennas and aim them by turning the car.

I wanted to have a platform similar to those on many other vehicles used for VHF+ roving. Over the years, I've built quite a few 10-band rover stations. Seven of them are toolbox stations and all of them can be mounted interchangeably on the rotators on various cars' rooftop platforms. Carrie Tai, W6TAI, used a toolbox station for many years atop an Infiniti FX50 with a 390 hp V8 engine and shocking gasoline consumption numbers. It seemed only fitting to mount that station atop an electric car that uses no gasoline at all.

The Chevy Bolt is also well suited for newer 10-band rover stations where all microwave antennas are mounted atop an equipment console on the passenger seat inside the car with the antennas aimed out the passenger window (visit **http://n6nb.com/small_10_band_rovers_with_up_to_seven_transverters.pdf** for more information). Only antennas for bands 6, 2, 222, and 432 go on the roof in that kind of installation. That approach is greener due to less wind load (and less wind noise) on the roof. Some might even skip the rooftop antennas altogether.

Some cars generate enough RF noise that operating mobile in motion can be difficult. To test the Chevy Bolt for that problem, I mounted a motorized multiband mobile antenna on a bracket attached to the roof rail. Noise seemed minimal on 20 and 40 meters, except during the regenerative braking process. Usually outside noise from various sources exceeds noise generated by the car, but when braking was used to help recharge the main battery, several S-units of extra noise appeared (enough to mask weak signals). That problem might be even more severe if a mobile antenna were mounted lower on the car body instead of at roof level.

With or without rooftop antennas, an electric car can do just about everything a gasoline-fueled rover can do, but with zero pollution and dramatically better energy efficiency. With careful route planning, the one remaining drawback of an electric car (delays during recharging) can be overcome as charging stations at travel stops and hotels become more plentiful.

Wayne Overbeck, N6NB, was first licensed in 1957, and has been roving and mountain topping in ARRL VHF contests ever since. He has won at least an ARRL Division-Leader Certificate in a VHF contest in seven different decades (since the 1960s), with one or more national first-place finishes in more than 40 VHF contests, and was the 1980 Radio Amateur of the Year at Dayton Hamvention®. Wayne is a retired attorney and professor of communications at California State University, Fullerton. He holds a PhD from the University of California, Los Angeles, and a JD from Loyola Law School. Wayne is the author of 20 editions of the college textbook, *Major Principles of Media Law*. He can be reached at **woverbeck@fullerton.edu**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Congratulations

February 2021
QST Cover Plaque Award Winner

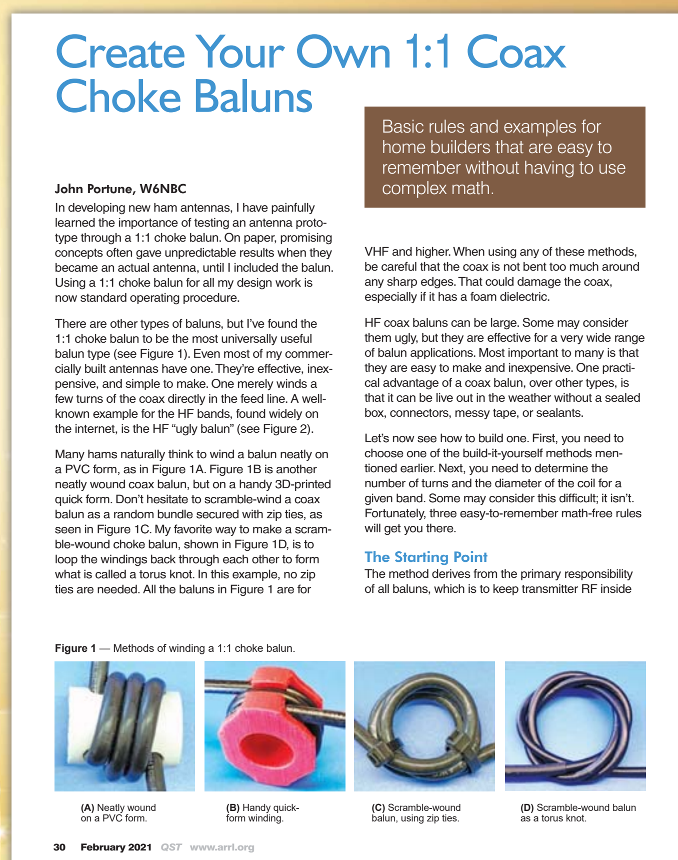
John Portune
W6NBC

In his article, "Create Your Own 1:1 Coax Choke Baluns," John provides design information to allow anyone to quickly make their own choke balun with a few turns of coax. With this handy information, there is really no reason for anyone to operate their coax-fed antenna without using a balun.

QST Cover Plaque Awards are given to the author or authors of the most popular article in each issue. *You* choose the winners by casting your vote online at

www.arrl.org/cover-plaque-poll

Log in now and choose your favorite article in this issue!



Create Your Own 1:1 Coax Choke Baluns

Basic rules and examples for home builders that are easy to remember without having to use complex math.

John Portune, W6NBC

In developing new ham antennas, I have painfully learned the importance of testing an antenna prototype through a 1:1 choke balun. On paper, promising concepts often gave unpredictable results when they became an actual antenna, until I included the balun. Using a 1:1 choke balun for all my design work is now standard operating procedure.

There are other types of baluns, but I've found the 1:1 choke balun to be the most universally useful balun type (see Figure 1). Even most of my commercially built antennas have one. They're effective, inexpensive, and simple to make. One merely winds a few turns of the coax directly in the feed line. A well-known example for the HF bands, found widely on the internet, is the HF "ugly balun" (see Figure 2).

Many hams naturally think to wind a balun neatly on a PVC form, as in Figure 1A. Figure 1B is another neatly wound coax balun, but on a handy 3D-printed quick form. Don't hesitate to scramble-wind a coax balun as a random bundle secured with zip ties, as seen in Figure 1C. My favorite way to make a scramble-wound choke balun, shown in Figure 1D, is to loop the windings back through each other to form what is called a torus knot. In this example, no zip ties are needed. All the baluns in Figure 1 are for VHF and higher. When using any of these methods, be careful that the coax is not bent too much around any sharp edges. That could damage the coax, especially if it has a foam dielectric.

HF coax baluns can be large. Some may consider them ugly, but they are effective for a very wide range of balun applications. Most important to many is that they are easy to make and inexpensive. One practical advantage of a coax balun, over other types, is that it can be live out in the weather without a sealed box, connectors, messy tape, or sealants.

Let's now see how to build one. First, you need to choose one of the build-it-yourself methods mentioned earlier. Next, you need to determine the number of turns and the diameter of the coil for a given band. Some may consider this difficult; it isn't. Fortunately, three easy-to-remember math-free rules will get you there.

The Starting Point

The method derives from the primary responsibility of all baluns, which is to keep transmitter RF inside

Figure 1 — Methods of winding a 1:1 choke balun.

(A) Neatly wound on a PVC form. **(B)** Handy quick-form winding. **(C)** Scramble-wound balun, using zip ties. **(D)** Scramble-wound balun as a torus knot.

30 **February 2021** *QST* www.arrl.org