

Exploring Common Mode Chokes

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I suppose there exists urban legends in every area of human endeavor, and amateur radio is no exception. I've heard one bit of folk lore a few times over the years, and I've always been curious about how I could see if it was true or not. That bit of wisdom: "to prevent common mode currents on an antenna feedline from entering the shack, just run the coax through a length of iron pipe." Some amateurs swear by it. But is it true?

To resolve the mystery I explored a few methods, most notably techniques detailed by the late Walt Maxwell, W2DU, in his seminal work, *Reflections III: Transmission Lines and Antennas* in Section 2.18, "Verifying Output-Current Balance in Current Baluns." Incidentally, that's a book that everyone should read, even twice. Nevertheless, I wasn't seeking to ensure that the antenna currents were balanced. I wanted hard numbers on the suppression of common mode current when the transmission lines were out of balance.

Then good fortune intervened. I attended Four Days in May and, particularly, vendor night where I came across Halibut Electronics and their Common Mode Current Choke Test Rig (CMCC) (Figure 1). This is a wonderful little device (in kit form) that is used together with a VNA, in my case a NanoVNA, to produce a graph of actual attenuation and impedance across a selected frequency range. That happened to be exactly what I was looking for.

It wasn't enough to simply measure the attenuation of an iron pipe. I wanted to compare its effectiveness against more conventional current chokes. That's when the surprises began.

First, I connected my NanoVNA to a laptop running NanoVNA Saver version 0.2.2-1. This Windows 11 application provides an easy-to-use and easier to see control interface for the

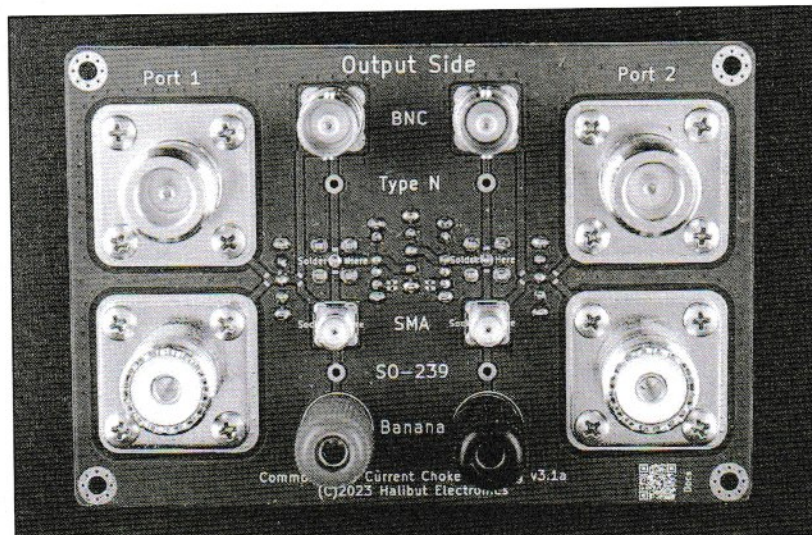


Figure 1—The output side of an assembled Halibut Common Mode Current Test Rig. This model accommodates type N, BNC, SO-239, and SMA connectors. It also has banana plugs to connect cables lacking connectors. The reverse side of the board has SMA connectors to interface with two ports of a VNA along with switches to calibrate the VNA using on-board components.

NanoVNA. Both ports of the NanoVNA connect to the CMCC Test Rig. I then performed a two-port calibration using the short, open, and load circuitry of the CMCC with a sweep range set from 1 MHz to 30 MHz. Then, as a baseline, I swept a commercial RG58 common mode choke, and graphed the S_{21} values in NanoVNA Saver. I use this choke quite successfully with Georgia QSO party QRP portable activations. According to the choke specifications, this device uses five mix 31 ferrite cores. The results of this sweep are in Figure 2.

The graph clearly shows the commercial choke giving me about -17 dB attenuation beginning in the 40 meter band and then improving all the way to 10 meters when the S_{21} minimum gain

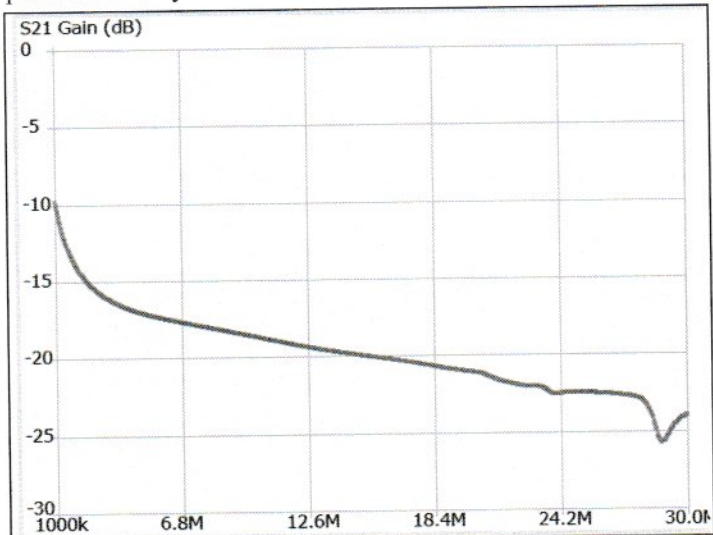


Figure 2—The NanoVNA Saver application plot of attenuation from 1 MHz to 30 MHz using a commercial common mode choke. The greatest attenuation is in the 10 meter band with a value of -25.826 dB at 28.5626 MHz.

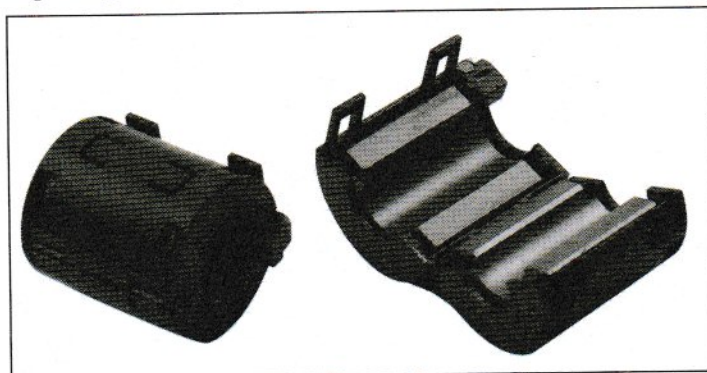


Figure 3—Ten of these mix 31 snap-on ferrite cores were used around the fifty feet of ABR 400-UF coax for the measurements. Snap-on cores, of course, are not continuous and their choke characteristics may differ sharply compared to the use of continuous cores. More experimentation is warranted.

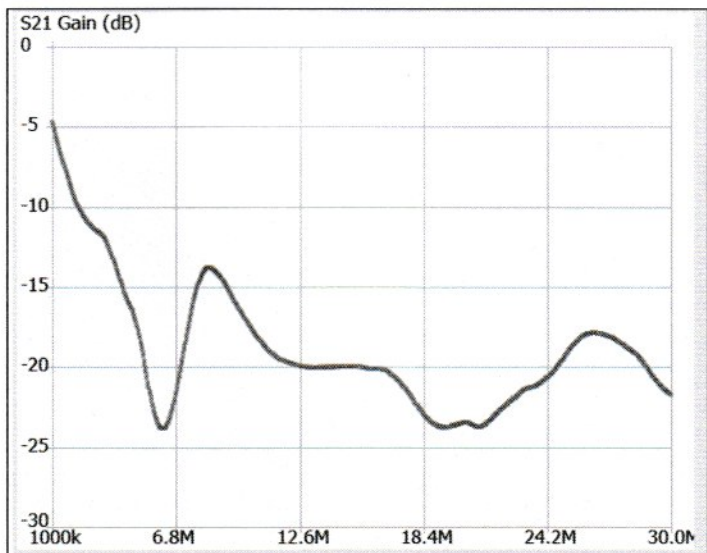


Figure 4—The attenuation curve of ten snap-on ferrite cores is neither flat nor linear. Nevertheless, the attenuation is likely adequate for the 40 meter through 10 meter HF bands.

hits -25.825 dB at 28.5626 MHz. This was the first surprise. I had naively expected attenuation to be rather flat across the spectrum.

Next, I performed the same sweep on fifty feet of ABR 400-UF coax with ten snap-on mix 31 cores (Figure 3). These results are in Figure 4 and are really surprising. I had expected the ten mix 31 ferrite cores to outperform the five cores of the commercial choke. Notably, the commercial choke uses continuous solid cores while the ten cores used on the long coax are snap-on. Also, the commercial choke cores are threaded on RG58 coax and the ABR 400-UF is RG8 coax. Obviously, the difference in attenuation warrants further investigation and comparison; but I'm now biased against snap-on cores. Nevertheless, for the bands of my interest, mainly 40 meters and 20 meters, the attenuation is satisfactory and, indeed, comparable to that provided by the commercial choke.

These two test cases provided a baseline. Now it was time to put the urban legend to the test and measure the fifty feet of ABR 400-UF threaded through a 3/4-inch × 72-inch Black Steel Pipe (the kind of pipe used with clamps for woodworking). See Figure 5. The iron pipe beats the ten snap-on cores on 40 meters (-24.481 dB) but is substantially worse everywhere else. So, to my mind, the urban legend is simply false. Or maybe those proponents of an iron pipe operate solely on 40 meters.

But wait just one minute! What if I combined the ten snap-on ferrite cores together with the iron pipe. See Figure 6. That produces a nice boost on 40 meters: nearly -25 dB attenuation and provides at least -20 dB attenuation on the higher HF bands.

Testing common mode chokes with the little Halibut Common Mode Current Choke Test Rig has been a revelation. First, I had expected attenuation to be relatively flat, or at least more linear. That's obviously not the case. Second, these exploratory tests are now simply begging for a comparison between snap-on and con-

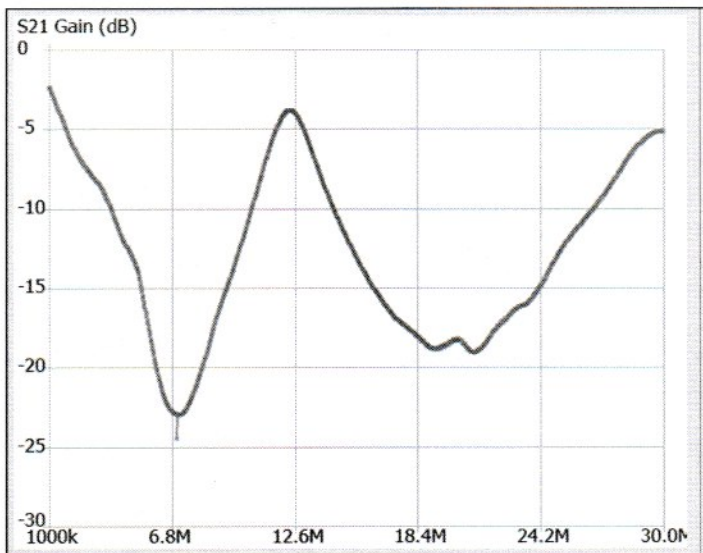


Figure 5—The attenuation scan of the 72-inch × 3/4-inch iron pipe shows acceptable attenuation only for the 40 meter band, thus disproving the urban legend that such a choke is adequate for HF operations. Nevertheless, the 40 meter attention is quite good; but attenuation for the other HF bands is inadequate.

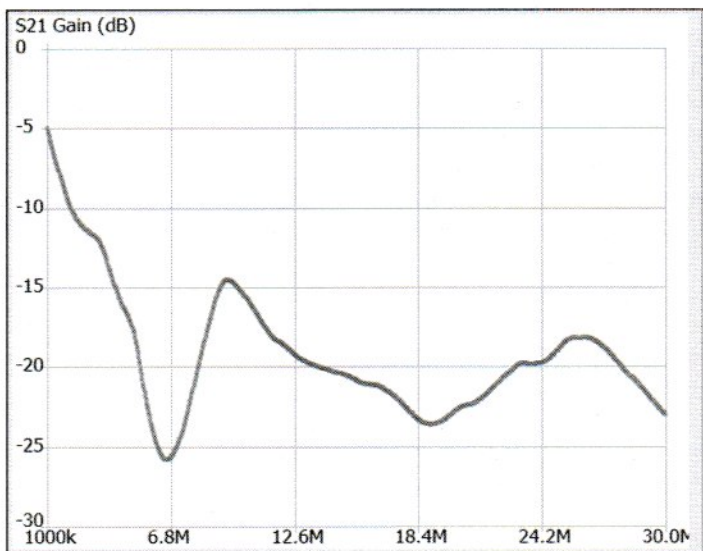


Figure 6—Combining the iron pipe with the ten snap-on ferrite cores gives the best results. Common Mode Current attenuation measures better than -20 dB for all HF bands 40 meters through 10 meters.

tinuous cores. Also, might it be effective to combine different ferrite core mixes in one choke, each optimized for maximum attenuation at the frequencies of interest? I foresee many hours of testing adventure.

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