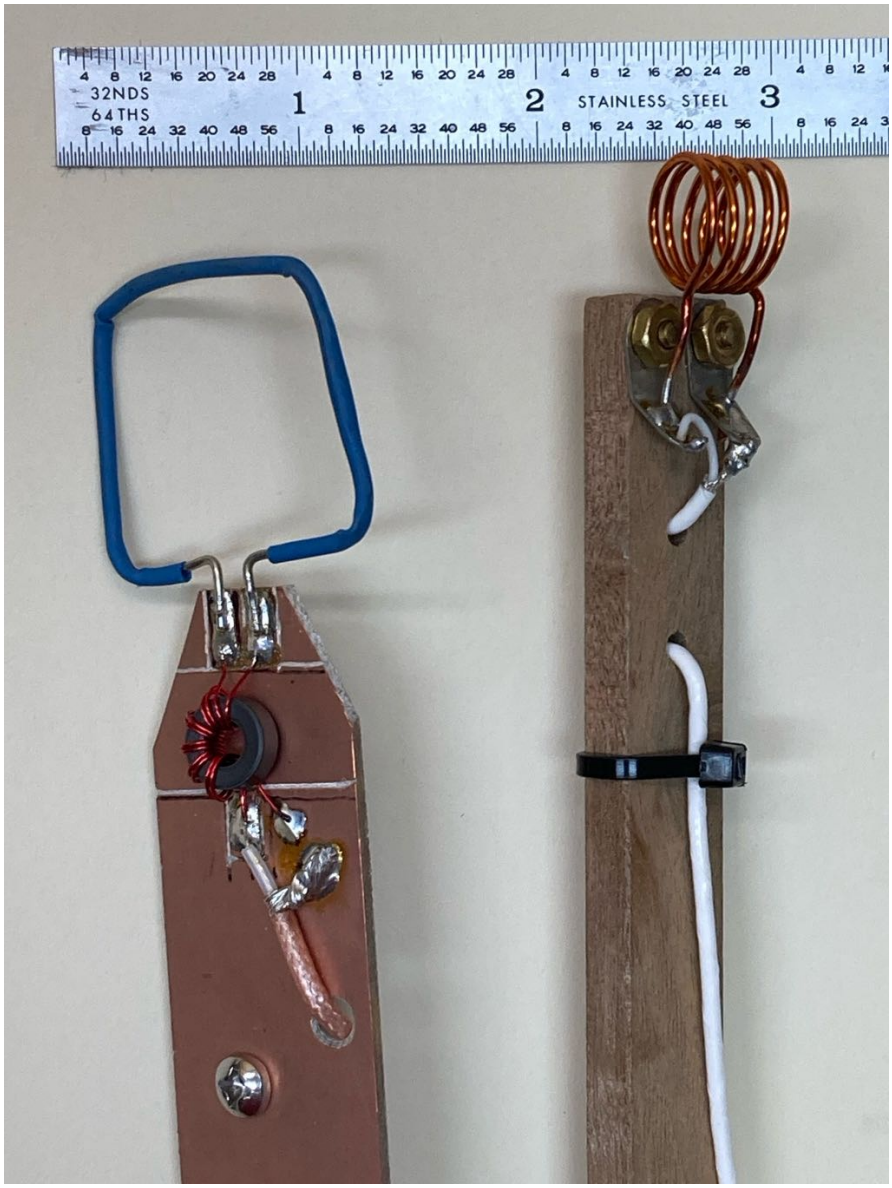
Detecting Common-Mode Current

Gary NA6O July, 2024

Since most of our ham radio RFI problems are due to common-mode current carried on various conductors, it's valuable to have some ways of localizing and measuring that current. There are two tools that I regularly use for this: Magnetic field sniffer probes and clamp-on current probes. These can be used with a spectrum analyzer or any sort of radio receiver.

Sniffer Probes

Common-mode current creates a local magnetic field around the conductor and placing a loop of wire within that field will induce a current into it. Expensive commercial probes are available but you can easily make one. Two of my favorites are shown below.



The left one is for VHF and UHF. It consists of a loop about 1 inch square connected to RG316 coax via a small wideband common-mode choke. The choke is 6 turns bifilar on an FT50-43 toroid.

The right one is for HF and is simply a small coil of wire affixed to a wooden stick and connected to small coax. In a pinch, you can just wind a few turns around your little finger and solder that to the end of a some RG58.

To use a sniffer probe, hold it nearly in contact with the conductor you are testing. Rotate the probe to maximize the signal. It's not unusual to find "hot spots" along the length of a conductor due to wavelength effects. In tight cable bundles, it's often possible to separate them a bit and then locate a particular offender if it's common-mode current is high enough. Your usual objective is find the device that's producing that current, and then address it by either replacing or modifying the device, or by adding a common-mode choke to the radiating conductor(s).

Current Probes

The best way to *measure* common-mode current is with a wideband current probe. This is typically a clamp-on device that uses either a transformer or a Hall-Effect sensor that directly couples to the magnetic field surrounding the conductor. The most important specifications are frequency response and sensitivity. (Avoid the more basic ones that are really only for 60 Hz.) Commercial ones are often quite expensive. My old favorite is a Tektronix P6303 with its associated AM503 amplifier which covers DC-15 MHz and has a large aperture. Smaller probes are typically more sensitive and have wider bandwidth but won't fit around things like RG8 coax. Clamp-on transformer types like the ones from Fischer Custom Communications are really expensive and only suited to metrology labs. But once again, you can make your own.

I used a clamp-on mix 43 ferrite core (Fair-Rite 0443164151) with 5 turns of #26 magnet wire. The coil is terminated into a 47 ohm resistor mounted on an SMA jack. A small copper foil shield is glued over inside the coil to reduce capacitance a bit. Core halves are glued to a Bessey XCRG2 2-inch clamp (from Home Depot) with silicone glue. After gluing, I cut off the hinge and locking tabs from the core and alignment was perfect.

Measured specifications for this probe are:

- Z_T (scale factor): 4.47 V/A into 50 ohm load
- Bandwidth (-3 dB): 140 kHz – 100 MHz

Clamp the probe tightly around the conductor you are inspecting. The core has to completely close with its surfaces in full contact. It should be connected to a 50-Ohm termination if you want to make accurate measurements but for general sniffing that's not important. Also note that this probe is very useful for antenna projects!

Test Equipment

Either of these probing devices are usable with spectrum analyzers or radios. My favorite portable analyzer is a TinySA set up with a waterfall display. On the test bench, I use my mighty Siglent SSA3021+ (I'm through with boat anchors!). As for radios, I have a simple Tecsun 660 but for difficult searches I borrow an Icom IC-705. It's very portable and has a nice waterfall display in addition to being able to hear the noise.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