Brass Tacks

An in-depth look at a radio-related topic

The RF choke

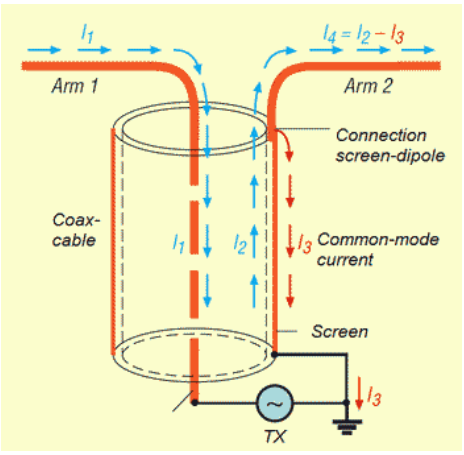
Every so often, you might have seen a photo of a rooftop antenna with a large coil of wire or what appears to be a length of leftover coax under it. Not to be confused with a drip loop, that strange coil is known as an ***RF choke***, and might be something you need, if you install an external antenna (one that's attached to your radio through coaxial cable), even if that antenna is inside your house. But what is it, and where could you get one, if you need one?

What it is

Most conventional (dipole-type) external antennas present two conductors, known as *antenna elements*, to the air, so that during each half of the AC cycle, one element carries the electrical signal to the air, then the signal is returned to the transmitter through the other element because the two elements are capacitively coupled with each other. But many antennas do not possess this other conductive path back to the transmitter, meaning they have to return the signal some other way. Unfortunately often, that return path is the *outer shield* of the coaxial cable.

When coax is used to transfer the RF energy to the antenna, much of the electrical signal is normally conducted through the outer-most layer of the center conductor and the inner-most layer of the conductive shield. This is known as *skin effect*, which becomes more pronounced at higher signal frequencies. The resulting current flowing in the center conductor is always equal and in opposite direction of that flowing through the shield, and is known as *differential-mode current*.

When the RF signal returns by the coax shield, it will often be carried on the outer-most layer of the conductive shield, meaning that the total coax signal is no longer balanced, but will now have two currents being returned to the transmitter, the extra outside signal known as ***common-mode current***. There are other ways that common-mode current can get into the transmitter, but very commonly through the coax outer shield.



Common-mode current presents two problems for most amateur stations: *it radiates* and *it generates RF noise* through external coupling. The radiating part isn't all bad; after all, antennas radiate exclusively by common-mode current. But when that radiation is undesirable, like that being presented to your computer speakers or a neighbor's television set, you might need to take extra steps to control that noisy interference. Furthermore, as mentioned, those problems become worse at higher frequencies.

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You can reduce the amount of common-mode current traveling on the outer shield of your coax by using an RF choke. The purpose of an RF choke is to create enough inductance to suppress or reduce the common-mode current flow in coax to a minimum for the given frequency. This works because an inductor opposes changes in AC current flow, which changes a lot at radio frequencies. There are a variety of different kinds of RF chokes that can be used, depending on frequency, power, and amount of common-mode current to be suppressed. Also, you can either purchase store-bought RF chokes, or you can make them yourself.

Do I need one?

Whether you need an RF choke (also known as a common-mode choke) will depend on two things: the presence of *common-mode noise* and the type of antenna is being used. Even if you and your neighbors never notice the noise from your station, your antenna type alone might be prone to (transmitting and receiving) common-mode noise, requiring you to install one anyway. Common-mode noise is often called ***RF feedback*** because it's most often heard as a buzzing in the speaker of your listeners when you transmit, leading them to believe it's an AC house current hum. It can also be experienced as a small high-frequency shock when you touch a metallic object or enclosure in your shack while transmitting, often called ***shack RF***.

Common-mode noise and shack RF are most prevalent, if not noticeable, as a result of single-pole antennas, such as end-fed antennas, random-wire antennas, coaxial antennas, and J-poles. And due to the unpredictable nature of common-mode current, an amateur can operate with any of these antennas for many years, and not realize that his antenna has needed an RF choke all this time. The safer and wiser thing to do is be sure to install an RF choke when using any of these antennas, whether you believe you need it or not. The added cost is a few feet of coax, or the price of a store-bought RF isolator, and will impact your antenna system performance very little.

Where you can get one

You can create your own RF choke quite easily, depending on the frequency and your coax type. To make one for 2 meters and 70 cm, tightly (unable to see daylight between the turns) coil six turns of RG-8X (or RG-58 or LMR-240) coax in an eight-inch diameter. (This will require 6 x 8 x 3.14 ÷ 12 = 12 feet of coax.) The coil does not need to look perfectly neat, and can have turns overlapping or crisscrossing each other, and will still work perfectly. Some use a coil of coax neatly wrapped around a form, such as a plastic soft drink bottle or PVC tube, nicknamed the *ugly balun*, which works just as effectively. This geometry (number of turns for a particular coax at the prescribed diameter) is *somewhat* optimized for 2 meters, but will actually be an effective RF attenuating inductor for a very wide range of frequencies.

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Then again, if the shack RF appears to be excessively strong, or your coax is thick, like with LMR-400 (or RG-213 or RG-8/U), you can still make one yourself, but with a toroidal core instead. If you're using RG-8X (mini RG-8) or RG-58, wrap eight to ten turns of the coax through an FT240-43 ferrite toroid. If you're using LMR-400, use an MFJ-915 RF isolator in-line instead.

The "Ugly Balun", installed under a vertical HF antenna

The RF choke should be installed as closely as possible to the feed point of the antenna, because every inch of coax between the antenna and the RF choke will potentially radiate. It doesn't matter how you install the RF choke or where you mount the coil, as long as it's not next to the antenna radiating element itself. If you make the coil out of five or eight turns of coax, or you make it using a ten-inch diameter, it'll be just as effective. These differences change the frequency range covered, but the bandwidth is already so large that these modifications will make little difference in performance.

Conclusion

So, does your antenna system need an RF choke? It might if people complain about a hum in your signal through an external antenna, or yours is an end-fed antenna or J-pole. But if you do, it's easy to either purchase one, or make one of your own by coiling the antenna-end of your coax with six turns 8 inches in diameter for VHF and UHF.

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