



W1ZR

GETTING ON THE AIR

A Quick Look at Radio Frequency Interference

“RFI doesn’t have to be black magic, or keep you off the air.”

Radio frequency interference (RFI) has been a consideration for hams from the beginning. When I got my first license in the mid '50s, the big problem was interference to receivers in the then-new television broadcast service — TVI. During this period, hams and equipment manufacturers had to take a crash course on harmonics, shielding and filtering as well as public relations. It wasn't a one way street — hams also suffered with interference from TV sets, now called ITV. Battles raged for a time, but better engineering of amateur equipment and TV sets eventually resulted in compatibility in most areas — helped in large measure by the migration from over-the-air to cable TV, as well as the move from transmitters with harmonic-prone class C amplifiers to transmitters using linear class A, B or AB amplifiers.

That was Then, Now is Now

While the problems with TVI have certainly improved, the typical household is now filled with far more potentially RFI prone devices — both those that emit signals and those that amateur signals can interfere with. Some are in our own household, and some are on neighbors' property — and each has its own set of characteristics and suggested methods of avoidance.

This article can't provide the complete story — there have been many books on the topic — but we will try to give some background to help the beginning ham understand the issues and perhaps help deal with some.¹

Interference to Other Equipment

Sometimes operation of amateur transmitters results in interference to other equipment

¹A good resource for amateurs is the ARRL Lab Technical Information Service Web site at www.arrl.org/tis/info/rfigen.html. Also see *The ARRL RFI Book*, available from your ARRL dealer or the ARRL Bookstore, ARRL order no. 9892. Telephone 860-594-0355, or toll-free in the US 888-277-5289; www.arrl.org/shop/; pubsales@arrl.org.

in the household or neighborhood. There are a few ways to divide up the problem and one that I like is to make a distinction between equipment designed to receive radio signals and equipment that is not designed to do so.

Equipment Not Designed to Receive Radio Signals

If something that isn't radio equipment receives your transmissions, it clearly is not acting the way it should. The kind of effects we're talking about here range from someone listening to your transmission via the mythical filling in a tooth to noise on a telephone, flashing computer screens or lights coming on and off. As a rule, this is due to equipment deficiencies and no changes to your transmitter can be expected to solve the problem. Although reducing power and/or relocating

antennas can often eliminate the problem, they shouldn't have to.

In real life, however, if it is a family member trying to work or study at the computer, even though it might not officially be your problem, it quickly becomes your problem, nonetheless. Sometimes one must accept the responsibility, if only to preserve a happy home. The cure usually is to keep the RF energy from your station from getting into the device being interfered with.

RF energy can typically get from your radio to other devices in one or both of two ways. One way is direct radiation from your antenna to the ac power or interconnecting wiring going to the household equipment. This wiring includes telephone wires, speaker wires, TV antenna or cable connections, and often ac power wiring. Higher frequency signals can

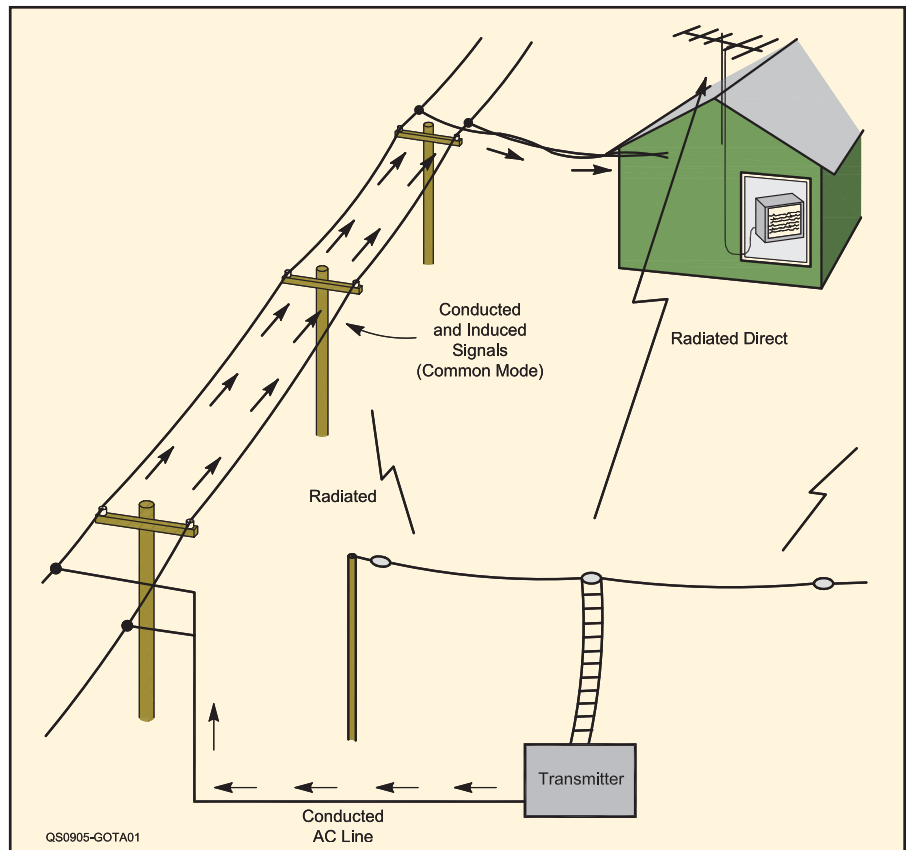
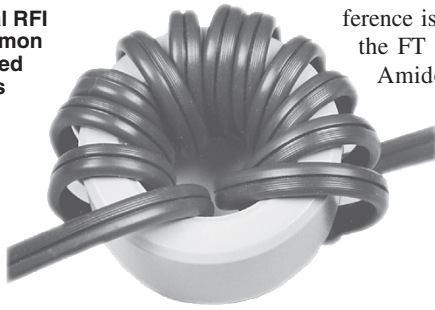


Figure 1 — Illustration of conducted and radiated RFI from an amateur transmitter.

Figure 2 — Typical RFI suppressing common mode choke formed by wrapping turns of a signal or power pair through a ferrite toroid.



sometimes get picked up by the short wires or other conductors inside some equipment. The other way is through conduction. Your transmitter not only puts its RF energy into your antenna, but also can put some into household ac or ground wires from which it gets conducted into the ac wiring going to the interfered equipment. Figure 1 gives an idea of the ways coupling occurs.

The good news is that in either case, the problem can be reduced — and often eliminated — in the same way. Filtering of the connections going into the unit displaying the symptoms will often go a long way toward elimination of the problem.

There's Filters and Then There's Filters

In most cases, the signal picked up on power or parallel signal lines in close proximity will be picked up on all lines together. This results in pickup of a *common mode* signal, compared to the *differential mode* signal, between the wires, that we're most used to. Depending on the termination within the equipment, sometimes this signal is converted into a differential mode signal, for example if one side is grounded, as is often the case with speaker wires. Still, by keeping the common mode signal out we resolve much of the problem. The filter should thus focus on having a high impedance to common mode currents at the frequency you are transmitting on. For best results, the filter should be located as close to the affected equipment as possible, since any coupling into the wires between the filter and equipment will not be reduced by the filter.

Commercial units are available that perform both common and differential mode filtering. We have tested a few good ones in the ARRL Lab, but don't assume the "filters" in the usual consumer grade power strips will be helpful.^{2,3}

It is also possible to fabricate your own common mode choke using available ferrite products. The usual "clamp on" ferrite beads allow insertion without disconnecting anything. These are often helpful at VHF, but quite a few are required to do much good at HF. A better solution for HF and VHF inter-

ference is to use a ferrite core such as the FT 240-43 type (available from Amidon, www.amidoncorp.com/categories/7/). This donut shaped structure will provide an inside diameter of 1.4 inches, which should allow the connectors to fit through as you wind. While 12 turns is perhaps optimum for HF, get as many as you can without removing the connectors and see if you have solved the problem. Figure 2 shows a typical toroidal choke.

Equipment Designed to Receive Radio Signals

Equipment designed for radio reception can suffer from the same types of interference problems as equipment that isn't designed for that task, so the above filters or chokes should be tried first.

If the interference is still there, we have to investigate the possibility that your transmitted radio signal is getting into the problem radio receiver. If the radio were tuned to your frequency, as a shortwave set could be, we would certainly expect to hear your signal! If the listeners don't want to hear you, they could just tune to another frequency and be done with it. Unfortunately, it is not that simple!

We again have two possible situations to consider — and it is also possible that both are happening:

Your transmitter is putting out on its assigned frequency. It is possible for your transmitter to be doing exactly what it's supposed to be doing — but by putting out such a strong signal, it is overloading the front end of the problem receiver. This is often the case if the transmit frequency is close to the receiver frequency — often a problem with a transmitter on 6 meters (50 to 54 MHz) and a TV receiver tuned to Channel 2 (56 to 60 MHz), particularly if the TV is using an outside antenna. The input filter of the TV is not sharp enough to keep your signal from clobbering the receiver.

There are only a few things you can do in this situation — besides changing bands or TV channels. You can reduce your transmitter power, but of course this can also reduce your transmit range — not good if you are collecting grid squares or trying for meteor scatter communication. You may be able to move your transmit antenna farther from the receive antenna, or at least aim both so they are in each other's nulls. You can also purchase specialty filters with very sharp skirts that will attenuate your signal at the problem receiver. Note that for this case a filter at your transmitter won't help.

Your transmitter is putting out one or more spurious signals off its assigned frequency. This is a different kettle of fish. While all transmitters put out a bit of energy

on undesired frequencies, a properly designed transmitter usually emits spurious signals too weak to cause problems. On the other hand, it is possible that your transmitter is putting out significant energy on or near the frequency that the receiver is intended to receive. An example of this kind of problem would be if your transmitter were operating on 10 meters and it put out a strong second harmonic. A signal at 28.3 MHz, for example, has a second harmonic at 56.6 MHz — smack within the band that the TV receiver is designed to receive while tuned to TV Channel 2. In this case, there is nothing that you can do at the receiver that won't also reduce the reception on Channel 2. You can, however, add a *low-pass* filter at the HF transmitter that cuts off all energy above 30 MHz, and you may find yourself back on speaking terms with your neighbors and family.

Interference to Your Equipment

Electronic and electromechanical devices can cause problems with your equipment, too. Most consumer type (unlicensed) appliances and equipment capable of causing RFI are typically classified as incidental, unintentional or intentional radiators under Part 15 of the FCC rules.⁴ The FCC specifies absolute emissions limits for intentional and unintentional emitters. The limits are high enough, however, that interference can still occur even if the signals are within the FCC's absolute emissions level standards. This typically occurs if the device is in relatively close proximity to a radio receiver. In the case of incidental emitters, there are no specified absolute emissions limits. Regardless of the emitter type, however, no Part 15 device is allowed to cause harmful interference to a licensed radio service as defined in the FCC rules including the Amateur Radio Service. As with interference to other services, you can be dead right but just as dead if you try to explain to your spouse that the toaster oven is not compliant and it must be kept off while you're operating.

In many cases the interference can be filtered in similar ways to those discussed earlier for conducted radiation. First try filters as close as possible to the offending device. Then try additional common mode filtering on the cables going to your radio.

Wrapping It Up

While this investigative sequence sounds straightforward, plan to put in some effort. Keep in mind that in some cases you will be dealing with more than one of these effects at the same time. Thus if one "cure" doesn't seem to help, don't immediately remove it — it may be eliminating a part of the problem even though you can't tell yet. Keep at it and know that most such problems can be solved successfully.

⁴www.fcc.gov/oet/info/rules/ — search for "Part 15." 

²S. Ford, WB8IMY, "Short Takes — ICE Model 475-3 AC Line Filter," *QST*, Mar 2005, p 48.

³M. Tracy, KC1SX, "Product Review — MFJ-1164 AC Line Filter," *QST*, Jan 2007, pp 68-69.