Kill Your Interference

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This subject has been so well covered over the years that I can't adequately bibliograph past articles. Yet, I still hear a dozen times a week from hams, both old and new, that they can't operate various bands (or at various times, or whatever) because they cause interference to televisions, radios, telephones, intercoms, compute modems, fax machines...you name it.

Hey, folks, this is 1996. We're all part of the information superhighway, like it or not. Electronic trinkets abound, and thousands more will follow. Who doesn't have a PC? Who doesn't have a fax machine? Who doesn't have a stereo system? And surely, who doesn't have a telephone?

In many parts of the country, cable TV servers and telephone companies are cooperating to replace copper wiring with fiber-optic cables to create interactive television and telephone services with fantastic bandwidth. These services will be more difficult to interfere with, because you can't create electromagnetic interference to an optical transmission system. But it might be many years before our homes are suitably cabled, and we'll still be using conductor-type appliances for the foreseeable future.

The solutions are amazingly simple. But many hams don't seem to want to know, or do, anything, to help themselves. If you're not a total dimwit, follow some simple advice: Interference problems can be resolved, and it's up to you to resolve them.

TVI

This is a relatively easy one. Television sets are intended to be receivers, they're just not particularly selective ones. If you and your neighbors are on "cable," and you're having TVI problems in your own home or those of your neighbors, the first order of business is to reduce the number of peripheral wires connected in the cable signal line. If you (or your neighbors) have appliances other than an approved cable TV converter box or a TV set connected, disconnect everything else (VCRs, preamps, switches, etc.) and see if the TVI persists.

The coaxial line from the cable service to the television set should be as direct as possible. Don't connect VCRs in this path! If you need to use a VCR, as most of us do, connect its input/output ports using audio cables to the television's audio input/video input and audio output/video output jacks. All the modern sets have such provisions. I see many licensed hams who have VCRs and other accessories connected to their cable lines, when it is completely unnecessary. Why convert audio and video signals to Channel 3 and feed them into the TV's tuner when you'll get far better results just plugging them directly into the audio and video amplifiers in the set, without using any RF? It doesn't make sense.

If you're on cable, do *not* use a preamp. They're a total waste of time for cable television services. The signal level from the cable should be sufficient to provide a good, strong signal to four, five, or six televisions without the need for any kind of preamplification. If you think you get "better reception" with a preamp in your cable line, either you're kidding yourself, or there's something seriously wrong with the signal level provided by your cable company. Ask them to come out and perform a measurement on your cable signal level. They all have small, hand-held devices which let them know immediately if your signal level is sufficient. If it isn't, then it is their responsibility to fix the problem, not yours.

Another warning if you're on cable: If your cable was installed more than a few years ago, it is very likely the service has deteriorated due to lack of adequate maintenance. The coaxial cables used need to be replaced every few years. They don't last forever. The connectors are not waterproof, and often fill up with water, creating a reduction in signal strength and the possibility of mixing signals with your transmitter, which in turn creates interference. Connectors should be clean and dry. You can check them yourself, if you can reach them. If you disconnect the cable from the "feed" (either above or underground), and water drips from the connector, this is a real problem that needs to be addressed. Water in an RF connector almost always indicates that water will also be present in the coaxial cable attached to it. This, too, adds attenuation and reduces signal levels. Normally, maintenance of the cable right up to the entry point of your home is your cable company's responsibility. The cable inside your home is normally your responsibility.

If you or your neighbors are not on cable, you may not have sufficient signal levels to override interference. Unless you can literally see the television transmitter's antenna from your TV antenna site, the signal will not be all that strong. Replace old, oxidized antennas with new ones, and make sure they are properly aimed. Avoid using 300-ohm "twin lead" for TV antennas! Use a 300-ohm-to-75-ohm balun instead, installed directly across the antenna terminals, and feed the antenna with high-quality, double-shielded RG59- or RG6-type CATV coaxial cable. (RG6 "quad," which has *four* shields and is "100% shielded" is an excellent choice. It's what the cable TV companies use, and it's not expensive.) If you don't have the proper crimping tool for type "F" TV connector installation, borrow or buy one. The best ones are not expensive, and are a good investment, since it seems these connectors are here to stay. If your TVI problems are from HF

(1.8-30 MHz) transmissions, try using a high-pass filter in the coaxial line to your television set, with the filter installed right at the rear panel connector of the TV, or better still, *inside* the TV between the rear panel and the tuner. Try grounding the case of this filter. If that doesn't help or makes the interference worse, remove the ground.

A word about high-pass TVI filters: These come in several "flavors," and performance is unrelated to cost in my experience. The most effective ones are really the 300-ohm "twin lead" filters, where each side of the balanced line is filtered. Unfortunately, the most effective TV transmission line is coaxial cable, not twin lead. Herein lies a dilemma, but it's an easily solved one. For stubborn cases of TVI, I've often found that using a coaxial feedline to the back of the set, followed by a 75-ohm (coax)-to-300-ohm (twin lead) balun, followed by a 300-ohm high-pass filter, followed by another 300-ohm (twin lead)-to-75-ohm (coax) balun, into the TV set's tuner, is what works best. Sure, it seems crazy to transform from coax to twin lead and then from twin lead back to coax again just to install a 300-ohm filter, but there is a method to this madness.

The problem with most 75-ohm coaxial cable high-pass filters is that while they do a splendid job rejecting interference conducted within the cable, they do absolutely zero for "common-mode" interference, which is carried on the outer conductor of the coaxial cable. Such interference conducts right past a 75-ohm coaxial filter, and enters the television set on the outer conductor (shield) of the cable alone, and can create nightmarish problems. By breaking up the cable's shield using isolation transformers and a balanced filter, such common-mode interference is thwarted by the "broken circuit" created. (P.S.—Good 75-ohm-to-300-ohm baluns, and 300-ohm high-pass filters, have almost no insertion loss, so don't worry about losing a lot of signal strength with this system. If you use good coaxial cable and a good 300-ohm filter, it won't happen.)

If the interference problems are from VHF-UHF transmissions, the best high-pass filter in the world won't help. You'll need to use a "stub," which is tuned to reject the specific frequency of the interfering signal. Such a "stub" will need to be one quarter-wavelength long, measured *in coax*, at the interfering frequency, and connected in parallel with the coaxial feedline to your TV set's tuner, as close to the tuner as possible. One quarter-wavelength *in coax* will be shorter than a real quarter-wavelength because the length needs to be corrected by the *velocity factor* of the coax used. For solid-polyethylene coaxial cable types, the velocity factor is usually 0.66; for "foam" dielectric coaxial cable types, the velocity factor is higher, typically 0.78 to 0.80 or so. Such a "stub" is easily connected to the backside of a television receiver using a "T" (or "tee") adapter having a single type F male fitting and two type F female receptacles. Such items can be picked up for a couple of dollars at Radio Shack or similar retail stores. By the way, in case you didn't know, a quarter-wave "stub" rejection filter has *no connection* to the "open end" of the coax. Don't short-circuit the open end, and don't terminate it with anything, or it will be completely ineffective. The quarter-wave "stub" works on the principle that the impedance of a transmission line is inversely proportional to its termination impedance every quarter-wave. If you leave a quarter-wave stub open-circuited at one end, the reflected impedance will be a short circuit at the opposite end, on the frequency where the stub represents a quarter-wavelength in coaxial cable. Thus, a quarter-wave "open-circuited" stub will look like a short circuit on its resonant frequency, and will shunt interference to ground. It works.

If you try hard enough, TVI is possible to eliminate. I've never seen a situation yet where I couldn't do it. It may take several hours, it may take a few dollars, but it can always be done.

Telephone Interference

This is a broad category that applies to all appliances connected to a telephone line: telephone instruments, computer modems, fax machines, etc.

Telephone interference is rare at VHF-UHF levels, but can be very troublesome at HF. One reason is that VHF-UHF signals are quite well shunted to common by the capacitance of the lines and instruments connected to them, but at HF this isn't the case. Another reason is that wavelengths are so much longer at HF that the near field interfering signals might be as far as a few hundred feet away on HF, while the near field is very short on VHF-UHF. Radiated signals are reduced in intensity by an inverse square law based on the wavelength being used. While 100 feet is very "close" on 80 meters, it is very "far away" on 2 meters.

Many telephone interference problems can be eliminated by terminating unused jacks. Since telephone lines are often "daisy-chained" (connected from jack to jack to jack within the house), any unused jack wiring becomes an antenna which can be an efficient receptor of signals. If you have telephone jacks in your home (or a neighbor's home) which are unterminated (no telephone instrument connected), these can cause problems. The easiest solution is to terminate them, whether a telephone instrument is used there or not, with correct passive terminations. Such terminations provide a 500-ohm terminating impedance (*not* a resistance alone!) across the line, simulating a real telephone-type instrument, and they are available for a couple of dollars from your local phone company or at Radio Shack.

If you've tried this and still have interference problems, try another trick: Go to the point of entry of the telephone line to the house and find the connection box located there. This is often a four-terminal "block" with brass machine screws, flat washers and nuts, where the telephone line from the utility connects to the house telephone wiring. Frequently, you will find unused wires just "floating" (not connected to anything) there. Any and all wires floating at this point (wires just twisted together and not connected to anything) can be grounded, since they're not being used, anyway. Strip the insulation off the unused wires, twist the exposed copper conductors together, and tie them to the nearest ground post, which is likely to be close by, since the telephone utilities usually provide an earth ground inside of or nearby this junction box. By grounding unused conductors in telephone wiring, you can short out some RF current which might be causing interference directly to ground. Also, since telephone wiring is often "twisted" along its route, grounding unused conductors tends to "shield" the entire bundle of wires, which can also help reduce RF interference.

If you try both of the measures outlined above and still have interference

problems, try using single-instrument telephone filters. These are sold by many manufacturers as "aftermarket" fixes, and usually have modular telephone plugs and jacks included. If telephone filters are used, they often work best when installed right at the telephone instrument (or computer modem, or FAX modem, or whatever), as close as possible to the equipment. Don't bother installing a telephone filter at the wall receptacle when a cord will be used between the wall socket and the instrument. It will be much more effective when used right at the telephone (or whatever). Sometimes a filter might be necessary in the handset cord as well. I've even seen situations where one filter did very little to reduce interference, but two or three filters in series at the same point worked perfectly. These filters usually retail for about $10 each and, if they work, are well worth the investment.

If you try all the tricks above and still have telephone interference, take a look at how your antenna transmission line is routed. Is it close to, or in parallel with, your (or your neighbor's) household telephone wiring? If so, move it! Is your HF antenna close to the telephone wiring from a street utility pole to your home? If so, move it! You are free to reroute telephone wiring as required to cure interference problems. You don't need the telephone company's permission. Just be sure that if you do reroute telephone wiring outdoors, use the telephone company's original cable, which is designed to withstand the abuses of mechanical stress and weather. Inside your home, these factors are unimportant and you can pretty much do whatever you want, since you own this wiring, anyway.

If in the process of investigating telephone interference you happen to find frayed, worn, or broken cables outdoors (between the telephone company's street wiring and your home), call the phone company and ask them to replace it. Beware of telephone lines. As benign as they look, they do carry a "ring" voltage capable of inducing quite a shock, and they need to be well insulated. Don't handle exposed conductors with bare hands. (This hazard only exists during a "ring," but you never know when that might occur.)

You might also try different telephone instruments. The complicated ones with electronic memory for telephone number storage and redial are sometimes more prone to interference than the old-fashioned "no frills" phones, purely because they contain additional electronic circuitry. The old Western Electric-built telephone instruments (remember the 1960s and 1970s?) which had a simple one-transistor tone oscillator, carbon microphone element and mechanical bell ringer were pretty "bulletproof" compared to most of the cheapie imports we use today. You can still find these simple but effective telephones, both new and used.

If worse comes to worst and you can't fix a telephone interference problem, try calling the phone company. Although their line filters are rarely effective, they do occasionally help, and they might find some unique problem in your local wiring or instruments. (But don't count on it: Since the divestiture of AT&T several years ago, I've found the local operating companies critically lacking in technical talent.)

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If worse comes to really worst (like civil actions, threats with deadly weapons, etc.—don't underestimate the actions of a neighbor who can't use his telephone!), experiment with band and power changes. If you clobber your neighbor's phone when using 100W on 20 meters, try 10, 12, 15, 17, 30, 40, 80 meters instead. Or you might try reducing power to the minimum required to make contacts (which is a procedure we're all supposed to follow according to FCC Part 97, anyway). Although I'm an advocate of "Why use low power when a kilowatt will do the job?" thinking myself, experimenting with operating frequency and power level might reveal some useful data. You might find that the interference is frequency-specific, for which the obvious conclusion might be that the telephone wiring in question is resonant on some band you choose to operate. This is good to know, because telephone wiring can be altered in length without any notable change in performance, and simply adding or subtracting some length to your neighbor's telephone instrument wiring might shift the resonance out of the band you're trying to use.

Alternatives

Filters on your transmitters will be of absolutely zero help with telephone interference; however, a good low-pass filter on your HF transmitter *might* help reduce TVI ("might" is the key word here—don't count on it). If you're using modern-day equipment, with a high-quality coaxial transmission line connected to resonant antennas that are well matched, a low-pass filter may not help at all, but that doesn't mean you shouldn't try one. If you do try a low-pass filter on your HF transmitter, get one that is well-shielded and rated for considerably greater power output than you ever intend to use. Transmitting filters used on VHF-UHF transmitters almost never help reduce interference to appliances not intended to receive amateur radio signals.

If you're using an "end-fed wire" HF antenna, this is often asking for trouble. Although end-fed wires work just fine on any frequency where the wire length is not a half-wavelength, it usually means strong RF fields inside your own home, which can coincide with angry family members. There are some compelling reasons to use end-fed wire antennas (like no transmission line loss, regardless of VSWR), but if you have TVI/RFI/telephone interference, they are best avoided.

Experiment with grounding. Sometimes a good, low-impedance ground on your transmitter, or the interfered-with appliance, or both, can help. However, I've seen as many cases where a good ground makes no difference at all, and some cases where the grounding actually made interference worse. "Grounding" is not a magic cure. If you decide to try grounding, there are a few points to ponder:

1. The primary reason for a station ground is not to reduce interference. It is a safety precaution that can help save your life should other grounding systems (such as through your three-wire AC line cord) fail. Grounding station equipment can also help prevent lightning damage in the event of a direct or secondary strike, but is by no means a "fail-safe" precaution. At least one ham I know lost his home to a direct lightning

strike, even though his station was as well grounded as any I've seen.

2. There are differences between types of "grounds." A *DC* ground is any ground path that eventually leads to earth, no matter how long or resistive it may be. An *RF* ground is one offering low *impedance* (not necessarily resistance) to earth on a specific frequency or range of frequencies. It is almost impossible to achieve an RF ground at VHF-UHF since the path to earth would have to be just a few inches long at most. At HF, a true RF ground is achievable, but not easily. One example of a reasonably effective RF ground is the one that I use: a pair of 8'-long copper-clad steel ground rods driven into the earth directly below my operating bench (which is in the garage), connected to the station equipment using 2"-wide tinned copper braid capable of conducting more than 1,000 amperes of current. Such braid costs about $5 per foot retail, and isn't easily found. Also, not many folks can install ground rods directly below, and less than five feet from their station equipment. I did it by using costly masonry drill bits (1"-diameter) to drill through about one foot of solid concrete in my garage floor, then using a 16-pound sledge hammer to pound the ground rods in. This task took several hours to accomplish, since drilling through 12" of concrete isn't easy, and the ground was fairly hard. It also used up two masonry bits costing more than $30 each. And the work would have been impossible to do if the station had already been installed. (I did it prior to building the operating bench or installing any equipment.) Was it worth the expense and effort? Probably not. Do I really have an effective RF ground? Maybe. I wouldn't bet the farm on it.

If you have a second-story (or higher) ham shack, the likelihood of getting a real RF ground to your station is minimal. You're too far away from earth. However, this does not mean you cannot achieve a *tuned*, or frequency-specific, RF ground for a particular frequency of operation. One reasonably effective "counterpoise" (artificial ground, which works for RF but is neither a DC ground nor a hazard-preventing ground) is to use a quarter-wavelength "radial" of wire connected to the ground post of your equipment, with the free end connected to nothing at all! Trust me, it works. The MFJ product which effects an artificial ground and is tunable might also work in some cases.

Cable TV converter boxes also vary in workmanship and engineering quite a bit. Some are in plastic cases which are completely unshielded. Some are in metal enclosures which appear to be an effective shield, but really aren't. Most have only two-wire AC line cords which provide no grounding at all. In some cases I've seen, simply shielding the converter box using household aluminum foil has helped reduce TVI. These "boxes" are really cheaply made and designed to a price, rather than performance, specification. They should cost hundreds of dollars to perform their intended tasks, but in reality they sell for very little and barely work. Most have the insignia of an American company on them, but they're actually built offshore, in Taiwan or somewhere with even lower labor costs. There's nothing wrong with offshore manufacturing, except that these factories often cut corners on what were already cheap designs. If it has an AC power cord on it, the equipment is undoubtedly "UL Listed," which means absolutely nothing with regard to performance.

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Check your antenna system, too. If it's an old installation, your connections could be oxidized or corroded, which can help generate higher levels of interference than a system built with shiny new components. Also check your coaxial cable. Brand-new, high-quality coax made by reputable manufacturers is usually pretty good; but lower-cost cables, surplus cables, or ones that have been in use for a few years or more may not be. Coaxial cables, especially when used outdoors, do deteriorate and require replacement.

While SWR is not a figure of merit for antenna performance, it can be an indicator of something being right or wrong. If you are using an antenna with a high SWR and "tuning" it in the shack to make it match better, there is still a mismatch between your feedline and your antenna, and there are still standing waves on your transmission line. Antenna mismatch will often cause transmission line radiation, which may tend to make interference problems worse. Adjust your antennas so they match your transmission line. This is not only more effective than using antenna tuners, transmatches, etc., it can also help reduce radiated interference.

You might also consider raising the elevation of your antenna, to get it farther away from the appliances you're interfering with. I had an interesting experience with TVI on 6 meters (50 MHz). This band is notorious for causing problems with TV Channel 2 reception, since 50 MHz is very close in frequency to TV Channel 2 to begin with. I was running 100W output power to a six-element beam up about 35 feet, and causing TVI to two or three neighbors. I tried several cures, none of which worked. In desperation, I finally tried raising my 6 meter antenna. I raised it to 45 feet, then to 55 feet, and finally to 60 feet, while testing for TVI. All these changes took some time, as I was adding tower sections!

Two weeks or so later, after adding the last tower section that raised the beam to 60 feet, I ran some TVI tests with the neighbors again. The interference had literally vanished! I raised my transmitter power. Eventually, I had 1200W output power on 6 meters (from a pair of 3-500Z's) and literally zero TVI. Previously, I had severe TVI with the same transmitting equipment (and much lower power) and the same beam antenna, but the beam was up only 35 feet. The difference was that when the beam was up 35 feet, it was only slightly above my neighbors' rooftops, and nearly in line with their TV antennas. By raising the antenna another 25 feet I was well above their homes and their antennas, thus considerably reducing the strength of my radiated signal to their TV antennas, even when operating at far greater output power.

Agency Approvals

They mean absolutely nothing. Really. Many consumer electronic and electrical appliances are "UL Listed," "UL recognized," "FCC Class B approved," and so forth. It doesn't mean a thing. U.L.

(Underwriters Laboratories) and C.S.A. (Canadian Standards Association), as well as many foreign agency approvals (T.U.V., V.D.E., etc., ad nauseam) don't mean anything in the real world. Many consumer devices such as personal computers and modems are "FCC Class B" accepted, which similarly means nothing at all. While PCs and peripherals are all "Class B approved," they radiate RF energy like mad, and can similarly receive RF energy that can render them useless in strong RF fields.

U.L. and other agency approvals have nothing to do with performance. U.L. employs almost no real engineers, and has literally zero experience in RF interference or other real-world situations. They "list" or "recognize" equipment based on safety criteria (meaning, the equipment probably won't catch fire when operated according to instructions), irrespective of any performance ratings or criteria. I've dealt with them quite a bit over the past 25 years or so and am extremely unimpressed with their knowledge of electronic circuits. To wit, I asked four different U.L. "engineers" how they determine if electronic equipment is safe for use. Without referring to manuals, not a single one could answer my question. After referring to manuals, none gave a satisfactory answer that even peripherally indicated they had any experience with electronic circuits. If these folks are the "experts," we're in serious trouble.

"This can open a Pandora's Box of problems that will haunt you forever."

When All Else Fails

Ask your neighbors to contact the FCC. Don't be afraid! The FCC isn't out to "get" you. If you're a licensed amateur radio operator and are using your equipment within its ratings and limits (and the limits of your license class), you're probably in good shape. The FCC recognizes that amateurs are licensed to transmit, and your neighbors are not licensed to receive. Reception of television and radio signals is a privilege, not a guarantee. Even telephone calls unencumbered by interference are not guaranteed by the FCC. Indeed, your local telephone utility company guarantees its users some degree of communications which should not be encumbered by radio interference, and if its users find telephone services to be worthless, they really don't have to pay their telephone bills until the problem is corrected.

Utilities are regulated by the Public Utilities Commission, which guarantees users some degree of service in return for fees paid. Communications services are further regulated by the Federal Communications Commission, which recognizes the weaknesses of many user appliances and are usually empathetic with amateur radio operators. It is a ham's responsibility to try his (or her) best to resolve interference problems prior to requesting FCC intervention. But when all else fails, you'll be surprised to find that the FCC is not an enemy, but rather an advocate. I've dealt with the FCC on interference problems more than once, and they've never asked me to stop transmitting yet.

Summary

Interference problems can all be resolved. It takes mutual cooperation on the part of the amateur and the complainant. If the complainant won't let you help him or her, you won't get very far in negotiating with them.

Don't try to "fix" your neighbor's television, radio, telephone, computer or whatever. This can open a Pandora's Box of problems that will haunt you forever. I once voluntarily installed a high-pass filter inside a neighbor's TV set (more than 20 years ago), which did help resolve an interference issue. Two years later, that neighbor tried to sue me for ruining her television, when her picture tube failed and required replacement. (Trust me, I never touched her picture tube.) It's better to recommend filters and so forth, and recommend they be professionally installed or installed by the user. It's even a nice gesture to offer to pay for such filters. I've done it, and I'd do it again, if it makes my neighbors happy.

For a short while I lived in a townhouse community where I had neighbors quite close by. I didn't get into their televisions, but I did cause quite a problem with their telephones. As a neighborly gesture, I offered to buy them all telephone filters. The filters worked great, but it cost me more than $200 to buy all the filters required. This sounds like a lot of money, but I don't regret the decision. It quelled a real problem and allowed me to operate the HF bands without having neighbors complain about it! (One case of telephone interference was so severe, no amount of filtering seemed to help. I offered that neighbor free use of my portable cellular telephone, which had no interference at all, when he needed to call someone and I was on the air. The bills amounted to maybe $10 or $15 a month, but the neighbor was satisfied, I was working DX, and the world was a nice place.)

If you still have problems, write or call me and I'll try to help you out. If you don't, then this article served its purpose. 73 and good DX!