Handy Checklist

Tips and tricks to enhance wireless quality

By Gary Stanfill

Many of the problems encountered with entertainment wireless systems are avoidable, with the majority happening because of a small number of misunderstandings, oversights and mistakes.

Here's a checklist for finding, fixing and preventing wireless problems.

✔ **Frequency Planning.** The first step is to determine the TV channels in any area where a wireless system(s) will be used. Several leading wireless manufacturers provide this information on-line, and it's also available from the Federal Communications Commission (FCC) web site.

Both analog and digital channels must be considered. If there is a conflict, the wireless frequencies will have to be changed. This may be relatively simple for synthesized systems, but the solution is more difficult for fixed-frequency wireless.

Wireless systems should never be used on occupied TV channels. Not only is interference almost certain, it's illegal. And as DTV (digital television) transmitters fill up previously vacant bandwidth, it will become increasingly difficult to find usable wireless frequencies, making frequency planning more important than ever.

Oh no! Two systems ganging up on a third one, creating intermod – even though all three systems are on different, "clear" frequencies.

✔ **Intermodulation.** It surprises some users to learn that wireless systems can experience severe interference even when operating on "vacant" frequencies. This interference is created by "intermodulation distortion" – basically two strong signals on other frequencies combining in the receiver to create an interfering signal.

"Intermod" is typically caused by other wireless systems, or by wireless in conjunction with local TV signals. Even single systems can be affected, but the probability of problems grows roughly proportionally to the square of the number of systems in simultaneous use, plus the number of active TV channels present.

When intermod occurs, one or more wireless frequencies have to change. Synthesized equipment can

be very helpful, as can systems that search for "vacant" frequencies. However, any frequency can potentially interact with any other, so changing one frequency can solve one problem and create another (or several others).

When changing frequencies or searching, it's absolutely critical that all RF (radio frequency) systems of any type at the location be turned on and operating. As one good wireless frequency is found, that system must be left on, and the next system tested, until all are operational. Otherwise, the situation can quickly become a frustrating snarl of changes and more changes.

✓ **Shielding or Covering Antennas.** In order to properly launch radio waves, a sizeable volume of free space is required around a wireless antenna. Metal objects in particular will weaken or distort signal and reduce range. (This is true of both transmitters and receivers.)

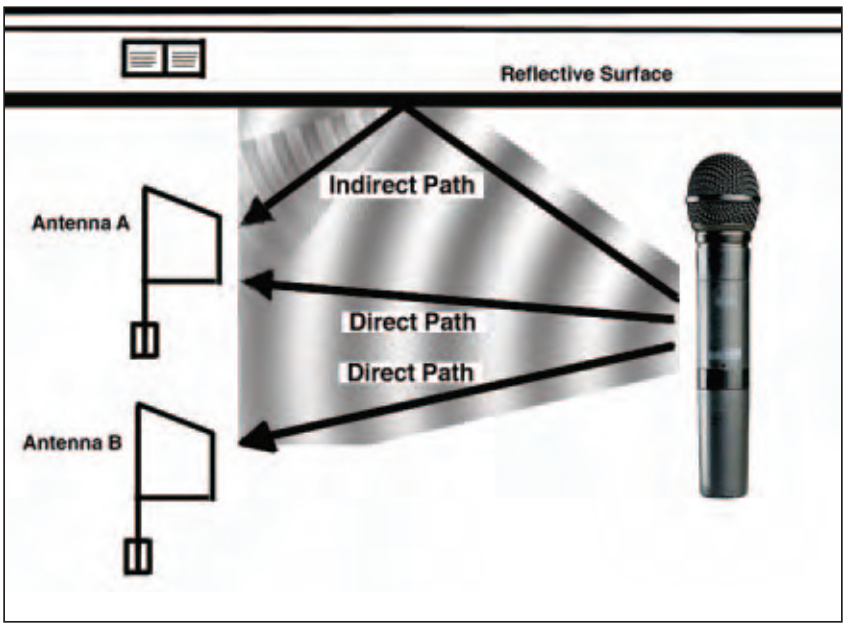
For bodypack transmitters, the antenna must be kept away from the microphone cable and away from the bodypack case. Securing antennas to the transmitter case and tying antennas to mic cables can be absolute death to range.

Receiver antennas must extend away from the receiver case and away from other antennas, equipment racks, other equipment, cabling and metallic objects. Therefore, best to mount receivers at the top of the rack. And using rear-mounting antennas inside a metal rack will almost always result in very poor reception.

For multiple receiver installations, the common practice of positioning front-mounted antennas in a "V" configuration, with all antennas parallel, will also reduce range. With this arrangement, the various antennas will function together somewhat like a TV antenna that is pointed upwards. Even worse is when antennas from two different receivers touch.

✓ **Clear RF Path.** A clear path is also required between receiver and transmitter. This is sometimes called a clear line-of-sight, but remember that light will go through a small hole and radio waves won't. Similar to the free space needed around an antenna, radio waves require a sizeable space in which to travel. The amount of space depends upon frequency; the lower the frequency, the more space needed.

There should an imaginary tunnel of open air between the transmitter and the receiver antennas. For UHF, a diameter of 3 feet (1 meter) or so is



If possible, large, flat metal objects, such as steel ducts that are parallel to the signal path, should also be avoided. (Graphic concept courtesy of Shure.)

usually adequate, but for VHF it should be at least twice as large.

If possible, large, flat metal objects such as large ducts, rows of cabinets, truck bodies and similar items that are parallel to the path should also be avoided. Even though they might not be in the direct path, they will act similar to a mirror, reflecting RF energy away from the direct path. Even with diversity reception, range and performance can be compromised.

✔ **Long Antenna Cables.** At times it's necessary or desirable to locate antennas at a distance from the receiver. RF coaxial cables can be used to link remote antennas; however, keep in mind that coax typically presents considerable losses that can reduce operating range. The amount of loss depends upon the length, size (diameter), construction and quality of the cable, and upon a system's operating frequency.

High quality RG-58 cable will have a loss of about 8 dB per 100 feet (30 meters) at 200 MHz, and about 17 dB at 700 MHz. Since every 6 dB of loss cuts range by half, the working range with 100 feet of this cable will be only 40 percent of normal at 200 MHz, and a mere 14 percent of normal at 700 MHz.

For best results with long runs, a large premium foam-dielectric cable is needed. It has only 1.8 dB of loss per 100 feet at 200 MHz, and 3.6 dB at 700 MHz. Generally, it's preferable to run audio cables out to remote receivers and keep RF cables short – particularly true when cable runs are longer than 75 feet (23 meters).

✔ **Remote Whip Antennas.** Using whip antennas at the end of coax cable is usually not a good idea. That said, whips may be deployed remotely when the necessary ground plane is provided.

If the outside shell of the cable or antenna connector is electrically connected to a good-sized metal object such as a pipe, cabinet, microphone stand or the like, good performance is possible. (Remember, however, that the whip must extend away from the object being used for the ground plane.)

For best results a metal plate should be used. For UHF, a plate approximately 12 inches (30 centimeters) square will work well; for VHF, the size should be at least 30 inches (75 centimeters). A hole is drilled in the middle of the plate, and a "feedthru" RF connector installed. The whip is then connected to the top of the feedthru, and the cable connected to the bottom. The whip must always be at a right angle to the metal plate.

✔ **Antenna Splitters.** In remote situations, it's convenient to use antenna splitters. But a common (and serious) mistake is to use "T" connectors for splitting. Because of the resulting impedance mismatch, signals are rarely divided properly, and it's entirely possible for a particular receiver to get essentially no signal at all. Plus, much of the received RF energy may simply be reflected back toward the antenna.

Impedance matched passive splitters (RF power dividers) will provide an even split of the available RF energy and relatively little will be lost to reflection. However, signal level to all will be lower. If splitters are truly required, active (amplified) splitters, or multicouplers, can be used. Such units make up for the splitter losses by adding a RF amplifier. Keep in mind that the amplifier increases the chances of intermod and other interference.

To reduce intermod, most units are designed for specific frequency ranges and tailored to specific types of receivers made by the same manufacturer. Attempts to use them on other frequency ranges will almost always result in extremely poor performance.

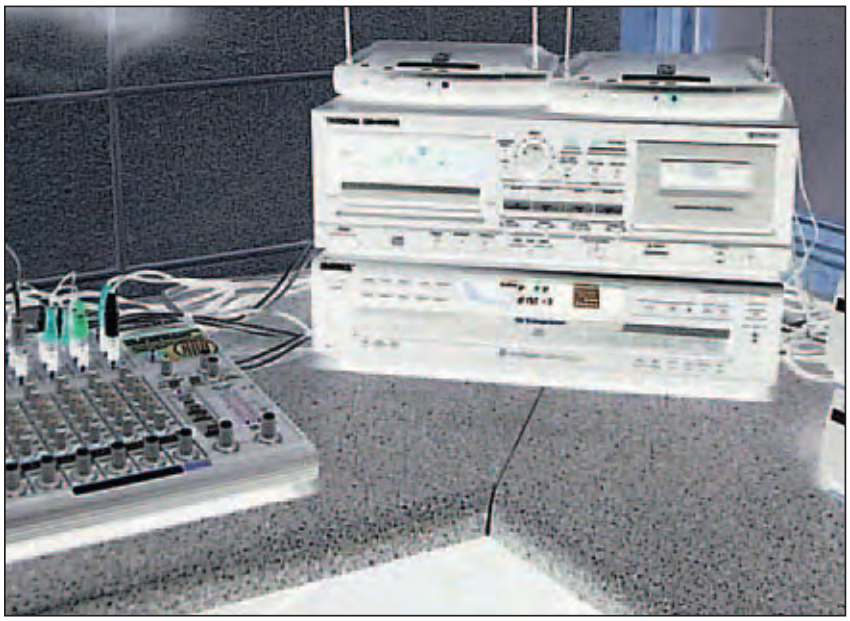
✔ **Digital Interference.** Modern digital equipment – processors, equalizers, controllers and other audio gear – operate at high clock frequencies and generate considerable RF noise (RFI). As a result, it's not all that unusual for such equipment to interfere with wireless systems. Symptoms include low-level spurious tones, buzzing sounds, hissing and a varying noise floor. Digital interference can also cause an unexplained loss of range and other problems.

Although the FCC requires such

equipment be tested to meet spurious emission standards, not all companies do this. In addition, loose covers, warped metalwork, loose grounds and other mechanical problems can greatly increase spurious RF emissions.

As a general precaution, wireless receivers should be separated as far as possible from digital gear. Often just moving the equipment a few rack spaces apart is enough to solve a problem. More severe cases may require separating the wireless power, signal and RF cables from those going to the digital equipment.

Using remote antennas for the wireless antennas may also be helpful. And try tightening up the covers on any offending digital gear and adding a ground strap to the cabinet or other local ground point.



If you hear some gnarly sounds in your wireless, be sure the receivers aren't positioned too close to digital gear.

✔ **Batteries.** Yes, you knew it was coming! Batteries probably present the number one, easiest to fix (and most overlooked!) problem. One very basic issue is that a used battery doesn't look any different than a new one, and it's all too easy to get them mixed up. Batteries also gradually lose their capacity even if not being used, and heat and humidity greatly accelerate the rate. Unless cost is a major issue, always better to toss questionable batteries.

Name-brand alkalines such as Duracell and Eveready are the best bet. Be sure to buy batteries that are date coded, and don't accept any with expiration dates less than three years away. Never use zinc carbon or toy batteries; most can't even properly power up a modern wireless transmitter. For several reasons, some wireless manufacturers don't recommend the use of rechargeable batteries. (At the same time, some manufacturers are offering rechargeables packaged with their systems.)

It's also wise to invest in the highest-quality system that can be afforded – you get what you pay for. Plus, higher quality gear is more likely to be able to cope with DTV, intermod and RFI.

Obviously, there are a lot more (and more complicated) problems that can impact wireless systems. But the next time a wireless problem is encountered, use this as a starting point and you'll likely find the problem and solution with minimal stress, strife or hair loss. ■

Gary Stanfill's Wireless Handbook, *providing a wealth of basic, real-world strategies for successful wireless operation, can be found on* ProSoundWeb *at http://www.prosoundweb.com/sr/com. Reach Gary at gjstanfill@earthlink.net.*