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Mobile radio installation notes

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The installation of a mobile radio into a vehicle is an important job. In busy commercial radio shops, though, this work is usually assigned to someone who is considered to have less technical ability than the bench or field technicians. This job's importance should not be minimized. In this column we will look at one of the most important issues that the installer must consider.

With the proliferation of all the on-board electronics in today's vehicles, especially microprocessor-based electronics, the proper installation of the mobile radio has become more important than ever. Interference issues are bi-directional-that is, the radio can interfere with on-board electronic systems or the on-board electronic systems can interfere with the radio. Either type of interference is undesirable, but when the radio interferes with the vehicle electronics, the results can be anything from comical to disastrous. (Actually, seldom will the vehicle owner find it to be comical.)

Interference to vehicle's electronics system most often is caused by the mobile radio in the transmit mode. However, interference can result when the radio is in the standby or receive mode. Any signal that is radiated or conducted away from the radio is a possible cause of interference to any on-board electronics. This type of problem should be eliminated in the radio design stage through proper internal shielding and decoupling of input/output (i/o) wiring. The one thing that can't be shielded is the antenna, because its job is to radiate the signal from the transmitter and capture the signal for the receiver.

Obviously, the choice of antenna placement or location on the vehicle is critical. Antenna location must be considered from both the standpoint of interference to vehicle electronics and from vehicle electronics. Several factors have to be considered in choosing the proper location for the antenna. These factors include the customer's preference, the best operating location from the receive/transmit perspective, and the best location to minimize any possible electromagnetic compatibility (EMC) problem. It may not be possible to totally eliminate all EMC problems within a given vehicle. However, no vehicle should be allowed to leave the installation bay if potentially hazardous or disastrous EMC problems are known or suspected.

The use of a magnetic-mount antenna can be helpful in checking out various antenna-mounting locations for possible EMC problems. Proper routing of the antenna's coaxial cable is also crucial. Avoid running the cable near other vehicle wiring-especially wiring that connects to the vehicle's electronic control modules. Coaxial cable is not 100% shielded, so there will be some RF leakage from the cable. Because antennas generally are manufactured with the coaxial cable

attached, look for antennas with cables that have a higher percentage of shielding-the closer to 100%, the better.

Most mobile radio manufacturers provide information on how to check out any possible interference with the antilock braking system. Follow these instructions carefully and fully to ensure that no EMC problems exist. Check for other EMC problems during a test drive. Check for proper receiver operation and for any interference to the vehicle operation while transmitting. Check all operating frequencies.

Figure 1 on page 22 shows a test setup that can be used to quickly determine if the vehicle is causing any interference to the radio receiver. You don't have to connect a sinad meter to the receiver's audio output at first. The antenna connected to the signal generator is a magnetic-mount antenna that is placed near the vehicle's antenna for signal coupling. If the test antenna is placed near the vehicle's antenna, little coupling loss will occur, and the coupling won't be adversely affected by movement of people or objects around the vehicle. It's the next best thing to closed-circuit coupling-without all the hassle.

With the test setup shown in Figure 1, set the signal generator to the receiver's frequency and modulate the signal generator with a 1kHz tone. With the vehicle's ignition switch turned off and the radio turned on, set the signal generator to produce a usable signal in the radio's loudspeaker with a significant amount of white noise apparent in the background. It should sound slightly better than a 12dB sinad signal. Next, turn on the ignition switch without starting the vehicle. Listen for any additional noise in the speaker. If none is heard, then start the vehicle and listen for any additional noise. If still none is heard, you're in great shape. If there is only a slight increase in noise you're probably still in good shape.

If you notice a significant or drastic increase in noise you should connect the sinad meter to get a more scientific measurement of just how much the noise is degrading the receiver's effective sensitivity. To determine the amount of degradation the noise is causing, do the following:

1. Turn off the vehicle ignition. 2. Set the signal generator level to produce 12dB sinad at the receiver's audio output. Record the signal generator level in dBm. 3. Start the vehicle. 4. Increase the signal generator level to again produce 12dB sinad at the receiver's audio output. Record the signal generator level in dBm.

The difference between the signal generator levels in steps 2 and 4 is the amount of degradation the noise is causing to the receiver.

Is the noise being caused by common-mode coupling, or is it picked up by the antenna? The test setup shown in Figure 2 on page 22 can determine this. Here, a directional coupler is used to couple the signal generator to the receiver input. To determine if the antenna is the primary source of noise pickup, perform the following steps:

1. Turn off the vehicle's ignition switch. 2. Set the signal generator to produce 12dB sinad at the receiver output. 3. Start the vehicle, and observe the sinad reading. It should be degraded with

noise from the vehicle. 4. Remove the antenna rod from the antenna mount and observe the sinad reading.

If the sinad reading returned to about 12dB, then the antenna is the source of noise pickup, and common-mode coupling is not a significant contributor to the problem. If the sinad reading remains greater than 12dB, then common-mode coupling may be the problem. If you discover that common-mode coupling is the problem, installing ferrite chokes on the coax, near the receiver input, should significantly reduce the noise.

If common-mode coupling is not the problem, the next order of business is to trace the noise back to the source. This procedure can be tricky because the noise can have more than a single source. It can also ride on wiring and appear at many points in the vehicle, causing confusing readings on the test equipment. A spectrum analyzer can be used with a homemade probe or pickup coil to perform the trace. A coil, such as the one shown in Figure 3 on page 24, can be used.

An alternative is to use the receiver itself as a monitoring tool and the sinad meter as an indicating device. (See Figure 4 above.) Here, the signal generator is coupled to the receiver input through a directional coupler and set to produce a greater-than-12dB sinad reading at the receiver output (perhaps 18dB-20dB sinad). Then, the probe or pickup coil is connected to the input of the directional coupler through a length of coax cable that will allow you to move the pickup coil around to various locations to locate the noise source. A step attenuator should be used between the pickup coil and the directional coupler to "home in" on the noise source.

It is important that the coax itself does not become an antenna. Technically speaking, the only noise pickup should be through the probe or pickup coil. Well-shielded coax should be used to connect the pickup coil or probe to the directional coupler. It might be wise to use a ferrite choke on the coax near the input to the directional coupler to minimize common-mode coupling through the coax.

Once the noise source is pinpointed, the vehicle's manufacturer should be contacted for assistance. Often, a subcontractor is responsible for the manufacture of specific parts of the system, and direct contact with that vendor may be necessary. My experience is that it takes three things to get many of these noise problems rectified: persistence, persistence and persistence. These steps can be time-consuming, frustrating and not too profitable, if you're a commercial shop.

As far as the radio interfering with the proper operation of vehicle electronics, the onus is on us. If a customer is injured in an accident resulting from a malfunction of the vehicle electronics caused by interference from a mobile radio transmitter, who is likely to be held responsible? You guessed it.