*Solutions for Advancing Communications*

**Application Note: 1101297**

# AIRPORT RADIO ANTENNAS

This application note discusses considerations in selecting, locating and installing mobile and base station antennas for airport radio communications (118-137 MHz).

## ***Vehicular Antennas***

For vehicular antennas, there is often little freedom in selecting the best mounting location. Ideally, the antenna should be (1) at the highest point on the vehicle (2) as far from the engine as possible, to reduce noise pickup (3) as far removed as possible from any other antennas on the vehicle and (4) on a surface that is flat and undisturbed for at least 30 inches in all directions. It is rarely possible to satisfy all these ideal conditions. For many vehicles, the only reasonably flat surface is the roof above the driver, which is closer to the engine than is desirable. Furthermore, the same roof often holds other equipment, especially rotating beacons and flashers which are electrically noisy and which disturb the radiation pattern of the antenna. Since many vehicles contain several communication radios, the best antenna location must sometimes be shared, introducing the risk of interference problems among the various radios.

Most antennas include an attached coaxial cable, typically 10-15 ft. long, and a connector to connect the antenna to the radio. There are three common mechanical methods of mounting antennas on a vehicle. These are (1) gutter clamp mount (2) magnetic base mount and (3) through-roof mount. Of these, (1) provides the simplest temporary mounting, although the least secure, but has the poorest radio performance. With no ground plane to one side, it is the most directional of the three—radiation and reception is reduced towards one side of the vehicle.

The magnetic base antenna also provides easy temporary mounting, usually with better performance—a more circular antenna pattern and a better ground plane. These antennas are easily transferred among vehicles. No hole is needed in the roof of the vehicle. The magnetic base antenna is easily moved if a rotating beacon is added. However, these antennas are easily stolen and after lengthy operation the wire in the cable may break due to repeated pressure from closing the door on it.

The through-roof antenna is the most popular mounting method, despite the fact that installation is more difficult and the antenna is not easily moved. A hole, typically 3/4 inch in diameter, must be drilled in the roof, and the fabric ceiling liner inside pulled back for access. The antenna mounts into the hole and the coaxial cable can run under the liner and down a door post to the rear of the dashboard (or wherever the radio is mounted).
Noise interference is a frequent problem in vehicular radio installations. The primary noise sources are the engine ignition system, alternators, engine control computers and electric motors, especially those having commutating brushes such as found in rotating beacons. If a vehicle contains other radio transceivers, interference among the radios often occurs.

Most noise enters the radio via the antenna, but some noise enters through the power and speaker wiring. Noise can also reach the receiver circuits by radiation passing through small openings in the radio's case. To help determine which of these routes carries noise into a radio receiver, disconnect the antenna (with the radio turned on), and observe if the interfering noise disappears or is greatly reduced.

Vehicular antennas are of the class called "vertically polarized quarter-wave ground plane". The physical length of the antenna's vertical rod must match the frequency of the signal. For many antenna models, the vertical rod may be trimmed shorter by cutting with a heavy duty wire cutter. Be careful—once cut, it cannot be lengthened.

This type of antenna is inherently "narrow band". This means it works best for a narrow range of frequencies. If the actual frequency is not within this range, the radio may not work as well. If your radio can operate on more than one frequency, and the frequencies are not close together, a compromise antenna length is necessary.

## Base Station Antennas

Base Station antennas should be mounted as high as practical. Except for very low power transmitters, the communications range is more affected by antenna height than by the power (watts) radiated. Adding 10 feet to the antenna height may significantly increase communications range.

Aviation communications antennas are vertically polarized and usually omni-directional (not directional), meaning they radiate and receive equally in all directions. The simplest antenna type is the 1/4 wavelength ground plane, which consists of a signal vertical rod and four (typically) horizontal or slightly drooping ground plane rods. A coaxial cable connects the antenna to the radio.

Broadly speaking, antennas may be divided into those types which exhibit "gain" and those which do not. Gain antennas don't amplify the signal. Instead they concentrate the radiated signal at low angles towards the horizon. While this means there is less signal power directed upwards, aircraft at higher angles to the horizon are much closer. Aircraft near the horizon are further away (or their altitude is very low). More distant aircraft need the extra radiation toward the horizon. This vertical directivity also makes these antennas receive signals more strongly from aircraft near the horizon.

While gain antennas are often effective for increasing range, they do also have disadvantages. One is that they sometimes produce "dead spots"—certain angles for which the radiated power is low. Another disadvantage: because they are more complex, they are more expensive. Gain antennas have even narrower bandwidths than one-quarter wavelength ground plane antennas. The vertical center rod is longer and because of this they are more difficult to ship and they tend to be somewhat more susceptible to damage in high winds.

Simple "no-gain" antennas are the most common and can be inexpensive and effective. Their cost depends on their ruggedness and their bandwidth. A wideband antenna—advisable if the antenna must accommodate several channels widely spaced in frequency—costs more than a simple narrowband antenna. Since the installation cost may exceed the antenna cost, a more rugged antenna can be justified if its accessibility is difficult.

The location of the base station antenna must be considered carefully. If the antenna can't be higher than surrounding buildings, then it should at least be as far from them as practical. Even more important is the proximity of antennas for other radio equipment. If at all possible, antennas should be spaced several hundred feet or more from each other, to avoid interference between different radio equipment.

Since coaxial cables cause transmitter power loss proportional to cable length, the cable between the radio and antenna should be kept as short as practical—preferably no longer than 150 feet. This may conflict with other factors influencing antenna location. It may be necessary to place the radio itself near the antenna and then use remote stations so operators can be located in convenient locations. A variety of remote stations using wires or telephone lines are available. The cables only carry audio and control signals, rather than radio frequencies, and can be used for distances from less than 100 feet to thousands of miles.