

How to DETERMINE ANTENNA GAIN

Gain figures must have a common reference.

CONFUSION often arises when antenna gain is being discussed. This happens because gain is dependent on a reference—a given antenna will have varying amounts of gain, depending on what it is being compared to. Normally, the gain of an hf antenna is measured by comparing it to a horizontal, half-wave dipole. In vhf and uhf FM communications, the reference for antenna gain is a vertical half-wave dipole. However, many manufacturers advertise gain figures for their products referenced to an isotropic source (a theoretical antenna that radiates equally well in all directions). To add to the confusion, some manufacturers rate their antennas referenced to a quarter-wave ground plane.

The ground plane antenna comprises

It has 1.2 dB of gain over a half-wave dipole, 3.0 dB over a quarter-wave ground plane, or 3.3 dB gain referenced to an isotropic antenna.

Higher omnidirectional gain can be obtained by using collinear arrays or a group of stacked half-wave dipoles. For example, four stacked vertical dipoles will provide approximately 6 dB of gain and an omnidirectional polar pattern. The gain is referenced to isotropic.

When comparing two or more antennas, be sure that all gain figures share a common reference. This can be done by adding or subtracting corrective factors. For example, two antennas are being considered for a fixed station. One has 4.0 dB gain referenced to an isotropic source (sometimes denoted 4.0 dBi)

ANTENNA GAINS

Antenna Type	Gain Over Isotropic	Gain Over Ground Plane	Gain Over Dipole
Isotropic	0 dB	-0.3 dB	-2.1 dB
Ground plane	0.3 dB	0 dB	-1.8 dB
Dipole	2.1 dB	1.8 dB	0 dB
5 λ / 8 Vertical	3.3 dB	3.0 dB	1.2 dB
4 Stacked λ / 2 dipoles	6.0 dB	5.7 dB	3.9 dB
8 Stacked λ / 2 dipoles	9.0 dB	8.7 dB	6.9 dB
2-Element Yagi	7.1 dB	6.8 dB	5.0 dB
3-Element Yagi	10.1 dB	9.8 dB	8.0 dB
4-Element Yagi	12.1 dB	11.8 dB	10.0 dB
5-Element Yagi	14.1 dB	13.8 dB	12.0 dB
2-Element quad	9.1 dB	8.8 dB	7.0 dB
3-Element quad	12.1 dB	11.8 dB	10.0 dB
4-Element quad	14.1 dB	13.8 dB	12.0 dB

a quarter-wavelength vertical radiator positioned over a metallic ground plane—either solid sheet metal or an array of radial wires. This antenna has 0.3 dB gain over an isotropic radiator. A half-wave dipole has 2.1 dB of gain referenced to an isotropic source, or 1.8 dB over a quarter-wave ground plane antenna. The $\frac{5}{8}$ -wave vertical, which also requires a metallic ground plane, is commonly used in FM mobile installa-

and the other has 2.0 dB over a dipole (sometimes denoted 2.0 dBd). Which has more gain? Add 2.1 dB to the gain of the antenna referenced to the dipole and note the antenna has a gain of 4.1 dBi, slightly better than that of the isotropic-referenced antenna.

The accompanying table compares antenna gains for some common antennas referenced to isotropic, ground plane, and dipole antennas. \diamond