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ASK THE EXPERTS

Antenna Terminology Question

Editor:

Our company makes 802.11 WLAN products, and I have recently been given responsibility for selecting the antennas. We try to treat the antennas like any other component, and have generally selected them with the usual engineer's criteria—confidence in the supplier, mainly determined by their technical support, measured performance of the samples, and of course, price.

I would like to know more about what I'm buying. What are the key specs I need to understand? Where is there likely to be over-specification (hype) by the manufacturer? And, do these specs mean anything once we install it in the product?

FYI, our products include hubs, PC Cards, and USB-connected terminals for both laptops and desktop machines.

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Some Antenna Basics

It is impossible to cover this subject on one page, but there are some key issues that can be introduced for you to explore in further reading.

The most common antenna performance parameters are gain, directivity and feedpoint impedance (or VSWR). These do not completely define the antenna's behavior, but they must be understood before moving on to more complex behavior.

Gain—Gain is the field strength radiated by an antenna, in dB relative to either a theoretical isotropic source or a resonant half-wavelength dipole. An isotropic source radiates from a point, spreading energy equally in all directions, as if illuminating the inside surface of a sphere from the center. A dipole is a real antenna, not a theoretical source, so it makes better intuitive sense to many people. A dipole has a peak gain of 2.14 dBi (dB relative to isotropic), and of course, 0 dBd (dB relative to a dipole).

Directivity—This is the shape of the radiation pattern from an antenna. For example, a dipole in free space (another theoretical construct) has a pattern that is roughly doughnut-shaped with the "holes" aligned with the radiating element. Directivity is defined as dB relative to the peak radiation. This peak in radiation will also be the peak gain if the antenna is 100% efficient. If the antenna is less than perfect, the peak gain will be reduced accordingly.

VSWR or Feedpoint Impedance—The feedpoint impedance of an antenna is essential information if we are to match it to a typical feedline. Because they incorporate the requisite matching networks, commercial antennas are almost always specified by VSWR into 50 ohms (75 ohms for some applications). Efficient radiation requires both an efficient radiating structure *and* an efficient matching network.

Confusion and "Specsmanship"

There are several areas where non-expert users and customers can misunderstand specifications. One is confusing VSWR bandwidth with radiating bandwidth. Some antennas are truly broadband in both VSWR and radiation pattern (such as log periodic antennas). Other types almost always have some degree of variation in the directivity, gain and efficiency versus frequency.

VSWR should not be confused with efficiency, either. It is too easy to measure an antenna, observe a low VSWR and assume that the antenna is working well. But, a low VSWR only means that the feedline is matched—a resistor will provide a low VSWR and not radiate at all.

It is also easy to confuse gain and directivity. Both are important, but they are not the same thing. Directivity tells us what kind of discrimination the antenna will exhibit in various directions. Highly directional antennas excel at reducing interference in unnecessary directions, while other applications benefit from nearly omnidirectional radiation.

A published directional pattern can be misleading if it does not also include the gain. All reduced-size antennas achieve their compactness with some expense in efficiency, which can vary widely from one design to another. Advertising literature may only show a pattern shape, but somewhere in the data sheet you will find the additional information on gain. This is needed when calculating the link budget for your system.

There are other characteristics of antennas that should be learned. Efficiency, which has been mentioned here, is not a simple concept. Variations in impedance and radiation patterns over frequency must be understood. And there is near-infinite variety in antenna physical construction.

Finally, to answer your last question, interactions with surrounding materials in the product, or its nearby environment, can be complex and often subtle. Experience with a large number of situations is the best way to gain an understanding of these effects.