Wideband antennas – a crucial element in today's RF systems

COJOT

Wideband antennas are a crucial part of today's military Radio Frequency (RF) systems and are essential for engineers working in the field of Communication and Electronic Countermeasure (ECM) applications.

Selecting the right antenna for the right application and integrating it correctly into a RF system will be invaluable for system designers. Particularly with regard to ECM applications, where RF systems are used to prevent the detonation of Radio Controlled Improvised Explosive Devices (RCIED) it is vital to understand the technological characteristics of wideband antennas; What type of antenna to select for a certain system or application? Which aspects to consider when installing the antenna? How important is the position of the installed antenna and what effect does a ground plane have?

Selecting the proper antenna

The function of an antenna is to transmit and receive a radio signal from the air at a certain frequency or frequency range. The frequency range is one of the most important parameters that determine the selection of an antenna.

The radiation characteristics of an antenna are often presented using two typical projections of the radiation pattern; Elevation (vertical) and azimuthal (horizontal). In most applications both projections need to be taken into account. A transmission upwards (shown by the elevation pattern) is specifically required in SATCOM and ground-to-air applications whereas a good radiation performance towards the horizon or even slightly downwards is of essential importance in counter-IED applications. On the other hand, for a counter-IED antenna it is also important that the azimuthal pattern shows fully omnidirectional radiation to avoid blind spots.

In military mobile applications the intended transmission direction is often changing as the vehicle or person carrying the RF System is moving and continuously changing its position. That is why in mobile applications typically wideband antennas with an omnidirectional radiation pattern are used.

An omnidirectional wideband antenna is able to serve multiple systems enabling far fewer antennas to be used in a RF system. The most common types of omnidirectional wideband antennas are monopole and dipole antennas. The main difference between these types is that the monopole antenna requires, in addition to the radiator, a ground plane as an essential antenna element whereas the dipole antenna has this element already built-in, enabling it to work properly without the need of a ground plane.

As the monopole antenna typically can use an existing platform to which it is attached to as a ground plane (e.g. roof of a vehicle), the monopole antennas will usually be smaller in height and slimmer in design than dipole antennas. This becomes especially important with antennas for lower frequencies as their size can be of the order of several meters.

Antenna ground plane

The antenna ground plane has to be of electrically conductive material like steel or aluminium (electrical isolators like fiber glass are therefore not suitable). It should be noted that the ground plane needs to be large enough compared to the size of the antenna for the antenna to perform properly. In addition, ground planes with a symmetrical shape are usually of advantage as an unsymmetrical ground plane may affect the radiation pattern of the antenna at certain frequencies - making the antenna radiate more to certain directions while decreasing its radiation performance in some other directions.

Installation location

In order to achieve a good radiation performance (coverage), it is crucial that the antenna is properly installed and its location carefully selected. When installing an antenna or especially several antennas, for instance on top of a military vehicle, there are potentially many factors that can have a deteriorating influence on the radiation performance of the antenna:

- The close-by surroundings, (near field), of an antenna should be kept free of any objects, as the antenna may otherwise not work at all. The size of the near field is roughly a function of the frequency and the antenna size. For instance, a 2 meter antenna has a near field with an approximate radius of 0.8 m at 30 MHz.
- Objects blocking the radio wave propagation may attenuate the signal or cause unwanted reflections, refractions etc. which would cause the system to not operate properly. Therefore the wanted transmission directions as seen from the antenna should be kept clear of any obstacles.
- When using monopole antennas one should be aware that the exact installation location on the ground plane may have a very significant effect on how the antenna radiates in different directions. Dipoles are slightly less sensitive to the possible ground plane below them but may nevertheless be affected.

In conclusion

It will often be difficult to exactly determine how antennas are affecting each other and how the presence of certain objects will deteriorate the RF System's optimal coverage. In many cases it is therefore necessary to find a most feasible tradeoff between the number of installed antennas and the RF System's achieved radiation efficiency. In applications where life and property are at risk, it will be inevitable for system designers to revert to simulations backed up by real measurements for a proper analysis of the antenna's coverage in a particular installation environment. It is COJOT OY that has dedicated itself to the design and development of advanced wideband antenna technology and providing simulation services - helping system designers to select the right antenna and set-up for their specific RF Systems.

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