IMPORTANCE OF ANTENNA ISOLATION

Written by Ian Chen, Antenna Design Engineer
Sinclair Technologies, a Division of Norsat International

Abstract

This white paper introduces the concept of antenna isolation and its importance in ensuring robust wireless communication for various scenarios.

White paper

In modern wireless communication, multiple antennas are often used to improve data throughput and connection reliability. The antennas need to be correctly isolated to minimize mutual interference during operation to achieve this goal.

Antenna to antenna isolation is primarily affected by the physical separation of the antenna elements. Since the energy of a transmitting antenna decays with increasing distance, neighbouring antennas spaced the furthest away will absorb less energy than its closer counterparts. Spacing can be done horizontally or vertically, with each method having its unique relationship on distance vs. isolation. Some examples include the relative horizontal placement of antennas on a locomotive rooftop or vertically separating dipole antennas on a base station tower. Note that horizontal spacing is realized when the main beams of two or more omni-directional and/or directional antennas are in the same horizontal plane. Moreover, the vertical spacing is realized when the main beams of two or more omni-directional and/or directional antennas exist on separate horizontal planes parallel to each other.

When separating antennas horizontally from each other, a general rule of thumb can be followed: for every doubling in the distance between antennas, the isolation will increase by approximately 6 dB. This is derived from the Friis transmission equation given as:

$$Isolation\ Horizontal\ [dB] = 22 + 20 * \log\left(\frac{d}{\lambda}\right) - (G_t + G_r)$$

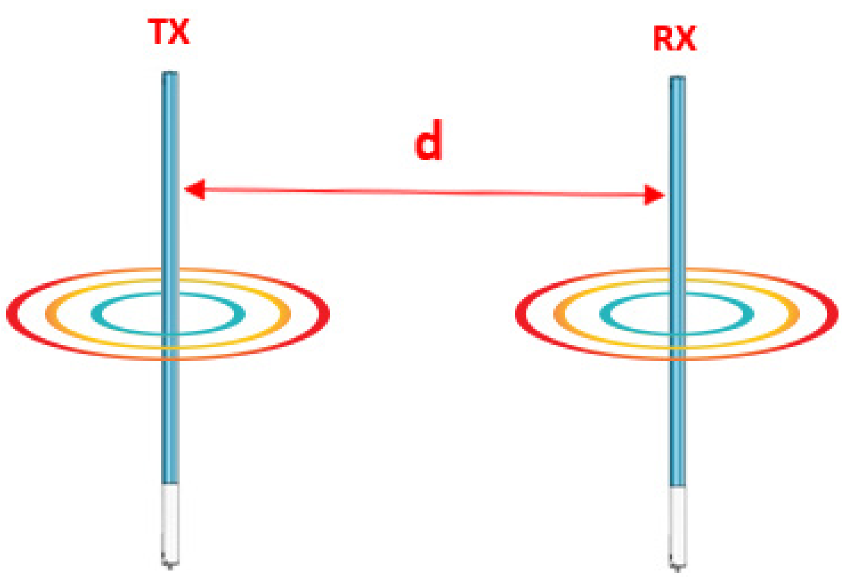

Figure 1. Two omnidirectional antennas spaced horizontally by distance d.
(Note: Colored rings depict energy propagation and may not represent the actual pattern)

d is the horizontal distance measured center to center between the antennas in [m], λ is the wavelength of operation in [m], G_t is the gain of the transmit antenna and G_r is the gain of the receiving antenna. This equation tells us that antenna isolation directly correlates with distance and a decrease in antenna gain. Furthermore, it is worth noting that VHF antennas need to be spaced out more than UHF antennas to achieve similar isolation values. The following chart depicts these findings. Note that the obtained values may vary somewhat, due to tower coupling or other reflective surfaces near the antennas.

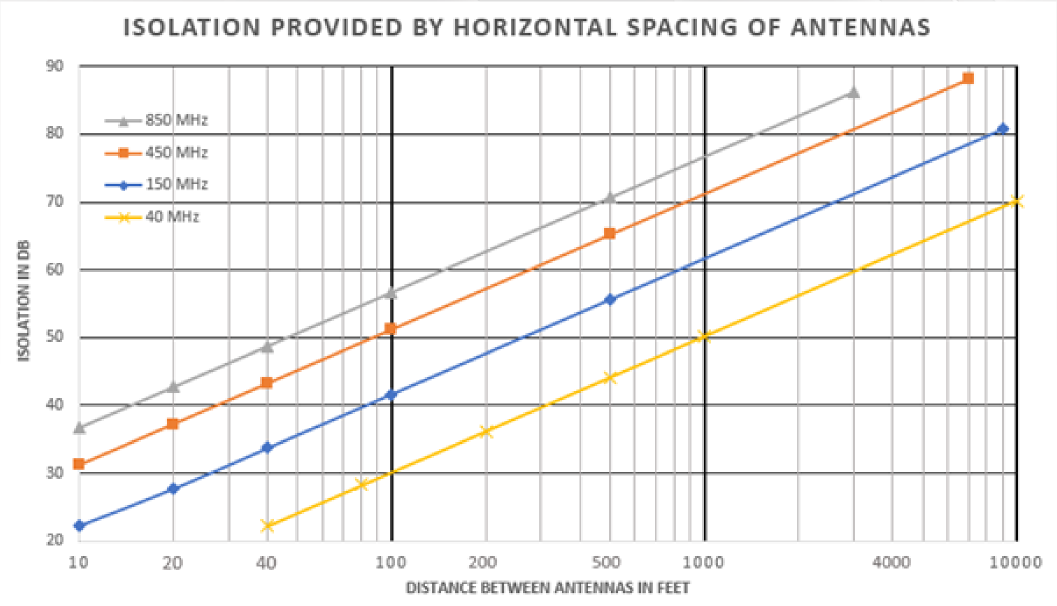

Figure 2. Isolation vs. Horizontal Antenna Spacing.

Vertically separating antennas generally requires less distance compared to horizontal separation to achieve the same isolation. However, physical real estate may be limited (e.g. low-profile vehicle rooftops). Therefore, this separation method typically applies to antenna towers, vertical poles, and walls.

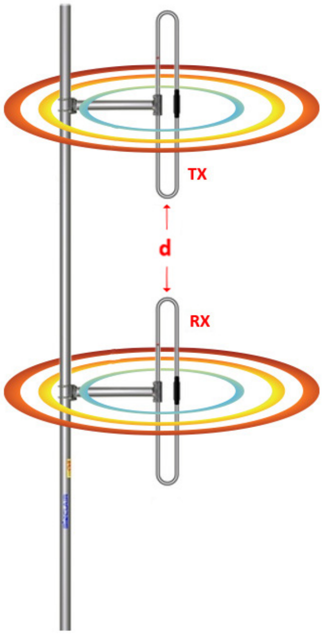

Figure 3. Two dipole antennas spaced vertically by distance d.
(Note: Colored rings depict energy propagation and may not represent the actual pattern)

Note that the previous rule of thumb for horizontal separation cannot be applied to vertical separation, as the following equation and chart dictating the relationship between isolation and vertical separation shows a slight non-linear curve. Here, d is the distance measured between the tip and bottom of adjacent antennas. Note that the obtained values may vary somewhat, due to tower coupling or other reflective surfaces near the antennas.

$$Isolation\ Vertical\ [dB] = 28 + 40 * \log\left(\frac{d}{\lambda}\right)$$

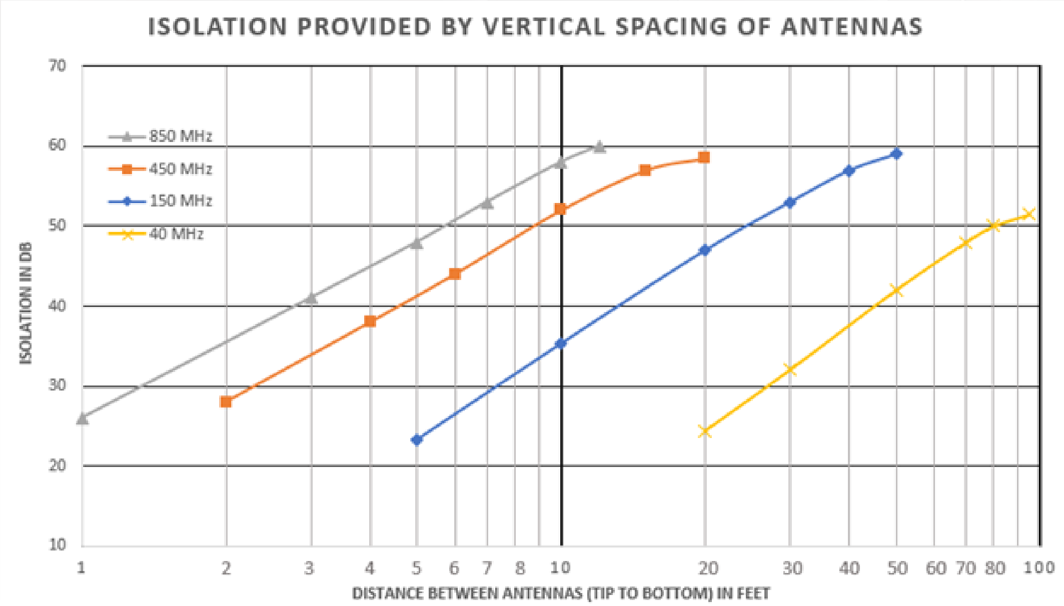

Figure 4. Isolation vs. Vertical Antenna Spacing.

Another method of improving isolation between antennas is to orient them such that one antenna is the polarized opposite of the other. For example, a wireless system using two Yagi antennas (one for transmit, one for receive) can increase its port to port isolation by rotating one of the antennas 90 degrees axially on the boom such that there is one antenna transmitting vertically polarized waves while the other receives horizontally polarized waves. This is shown in the following figure.

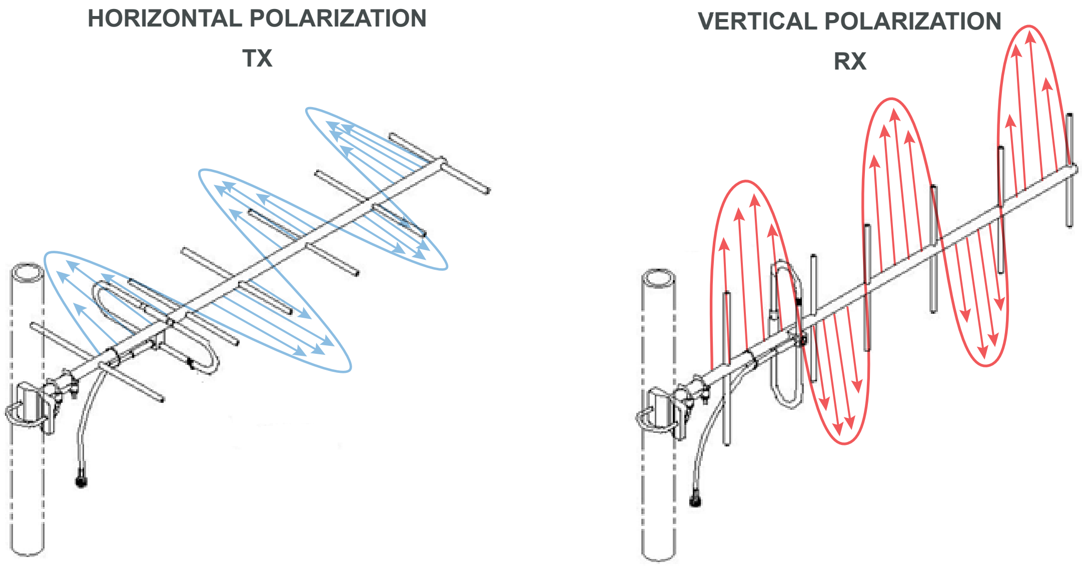

Figure 5. Oppositely polarized Yagi antennas.
(Note: Colored waves show the respective electric field polarization)

Sinclair's multi-element antennas are designed to achieve the optimal isolation for the given form factor. For example, the SM715 rugged 5 in 1 transit antenna comes in an ultra-low-profile size at a 6.3" diameter and 2.6" height, with two LTE and two WiFi antennas built in to achieve over 10 dB and 20 dB of isolation, respectively. On top of that, it also houses a GNSS antenna supporting the main constellations: GPS, Galileo, GLONASS, and Beidou.

- 5 in 1 Rugged transit antenna supporting LTE & WiFi MIMO, GNSS
- Excellent port to port isolation
- Ultra low-profile 2.6" design
- LSZH, UL94, and IP67 rated

Figure 6. SM715 5 in 1 transit antenna.

Sinclair continues to build on the reputation of its robust antenna and RF product lines to deliver new products, which are "Superior then, Superior now."