
## Welcome to AntennaSelect

**Volume 1 – August 2013**

This is the first issue of our new periodic newsletter, AntennaSelect. AntennaSelect will feature informative articles about antennas and antenna technology, plus general RF subjects. What we have found is many of our customers only see the antenna they have bought for a short time before it is installed. But what is under that shiny new radome ? AntennaSelect will be answering some of those questions over time. If you thirst for a particular bit of RF technical information, please let us know what you would like to see by emailing us at: info@micronetixx.com

**In this issue:**



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## How a slot antenna works

The slot antenna is a TEM-Mode coaxial structure. Coupling structures inside the pylon will distort and couple to the fields in this coaxial antenna, causing a voltage to be applied directly across each of the slots in the antenna. This voltage alternates from plus to minus and back again at the channel frequency of operation.

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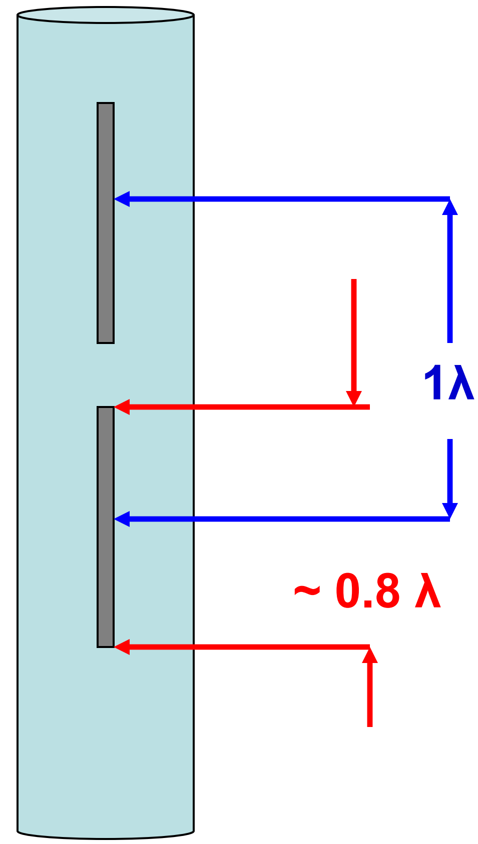
The length of the slots are adjusted so that the oscillating electric fields that develop across the gap that the slot creates will launch a radiating system of fields, propagating away from the antenna.

If the coaxial pylon antenna is oriented vertically, with the slots cut in the outer conductor oriented vertically as well, the electric fields across these slots will be oriented horizontally. The slot length is about 0.8λ long and the slot to slot spacing is 1λ. The example to the right would be a two bay antenna.




## Increased null fill antennas – The Vari-Phase design

Small bay count slot antennas offer limited null fill options due to the few relationships between bays that can be changed. Vari-Phase antennas have extra elements that allow precise control of first null fill and second null fill. On the average a Vari-Phase design will deliver a 10 dB stronger first null, as compared to a similar gain standard slot antenna.

Depending on element count the second null is 6 to 10 dB stronger as well. A secondary benefit is roughly a 6 dB reduction of RFR at high depression angles compared to standard antennas. The antennas are available in both VHF (Band III) and UHF (Bands IV,V) up to a 16 element count.

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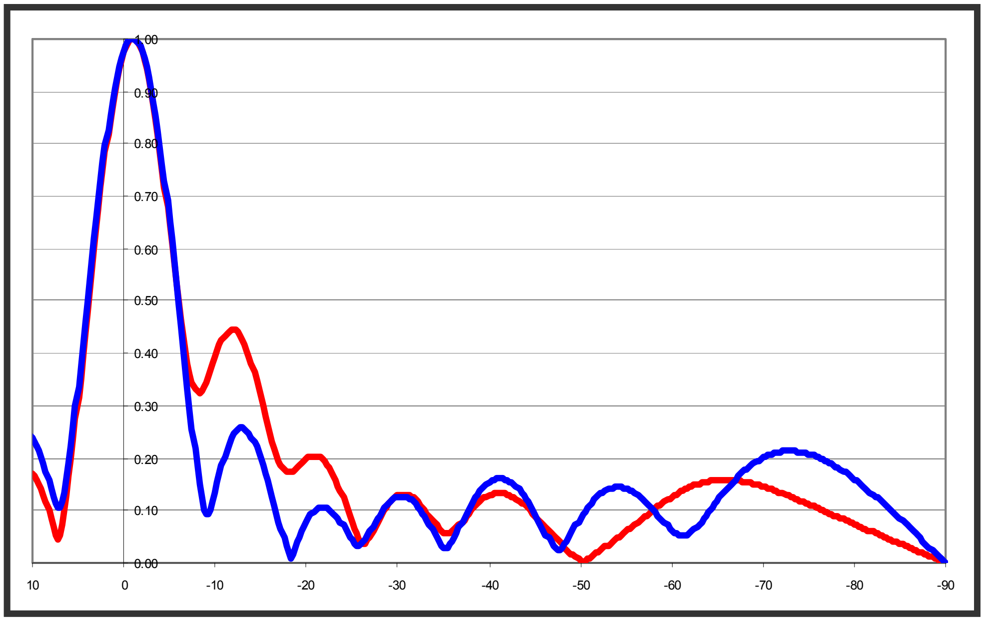
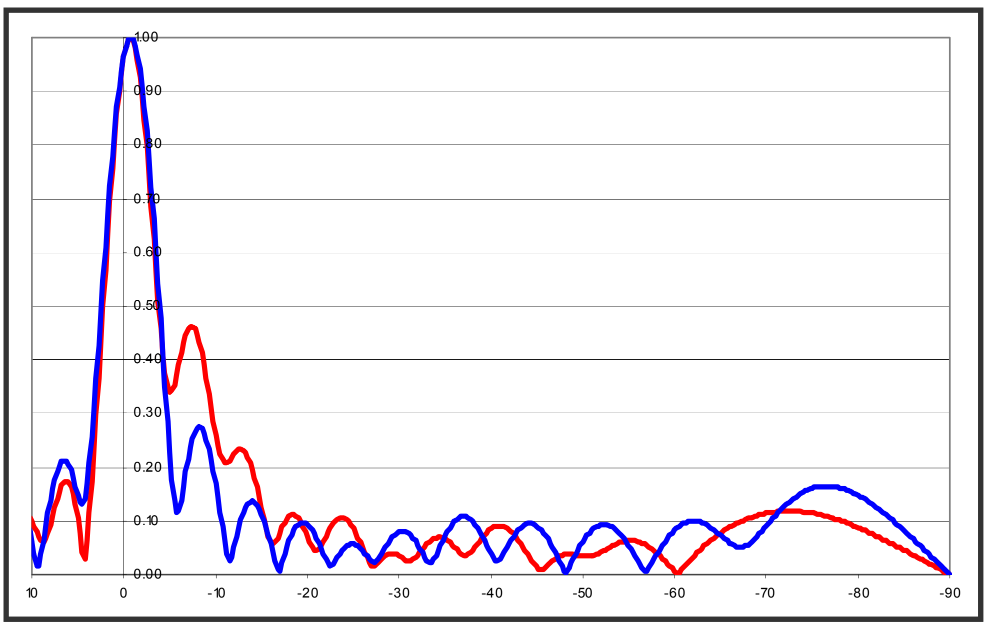



The plot above shows a elevation plot of a 10 element Vari-Phase antenna **(RED plot)** versus a 7 bay standard slot antenna **(BLUE plot).** Both have a beam tilt of 1.0 degree. The elevation gain of the Vari-Phase is 7.08 (8.50 dB), and has a 32.4% first null fill, plus a physical length of a 7.5 bay antenna.




The plot above is a 16 element Vari-Phase antenna **(RED plot)** versus an 11 bay standard antenna **(BLUE plot)**. The elevation gain of the Vari-Phase antenna above is 11.44 (10.58 dB) and has a 34% first null fill, plus the physical length of a 12 bay antenna.

Power Dividers are RF devices that do what their name implies; RF power from the input port is divided between two or more output ports, at specific power division ratios. There are two major types of broadcast antenna power dividers that we will look at in this article; isolated power dividers and non-isolated dividers, such as so-called "matched tees", matched 3-way, 4-way or "pancake" style power dividers with one input and multiple output ports. We will refer to these types as junction power dividers.

Many antennas require power dividers in order to feed RF signals from the transmitter to various sections or elements of the complete antenna system. Power dividers come in several different configurations, depending on the requirements of the application.

## Isolated Power Dividers:

Here, we'll consider typical two-way isolated Power Dividers. The Isolated Power Dividers that are normally used with Broadcast Antennas are usually tightly-coupled coaxial or stripline transmission line directional couplers. In these devices, the physical dimensions and geometries of the internal structures, relative to the wavelength of the frequency in use, are adjusted so that the electric and magnetic fields interact in specific ways in order to implement the isolated power division function. They are four-port devices, where there is one input, two outputs and a fourth port that is usually terminated with a dummy load.

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One popular power divider is one where the power division ratios are evenly split, (or a 50/50 power division ratio), between the two outputs of the network. In this case, each power divider output level is half the level of the input power level, or about 3.01 dB down relative to the input power level. (This 50/50 or 3 dB isolated power divider is often called a hybrid coupler, or simply a "hybrid"). Isolated Power Dividers with power division ratios other than 50/50 are also available.

These are sometimes called hybrids as well; such as a "4.77 dB hybrid". Actually that is not correct because a "hybrid" specifically has a power division ratio of 50/50, where its output power levels that are each half, or 3.01 dB below that of the power divider's input.

## Isolated Power Divider Advantages:

Consider a two-way isolated power divider, that supplies power to two separate sections of the same antenna. The isolated divider provides RF power to each of the two sections of the antenna in a manner such that the effects of the RF characteristics of each one of the antenna's two sections or elements connected to the two power divider outputs is isolated from one another. For example, with this configuration, if either one of the two sections of the antenna fed with the isolated power divider exhibits abnormally high reflected power, there is little effect on the power level supplied to the other antenna section. In this case, the high reflected power coming back from the bad antenna section is split between the power divider's input port and the dummy load that is connected to the fourth port of the isolated power divider.

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Another advantage of the 90 degree, (phase-quadrature), isolated power divider is that the 90° phase difference at the two output ports of the isolated divider remains relatively constant over a relatively wide bandwidth, (usually within a few relative degrees over more than 10% bandwidth). This is an essential characteristic where these power dividers are used to feed both horizontal and vertical radiating elements at the same plane relative to the direction of signal fire, (such as cross-dipoles), in order to develop circular polarization over wide bandwidths. This is required where these types of antennas are used in master antenna systems with several stations are using the same antenna simultaneously.

## Isolated Power Divider Disadvantages:

Disadvantages of isolated power dividers include:
-The physical size is usually larger than the simpler matched tee
-The isolated power divider requires a dummy load for high isolation

## Junction Power Dividers:

Here, we will consider coaxial Junction Power Dividers, which are very often utilized in broadcast antenna systems. Junction power dividers are simpler power division networks compared to the isolated dividers covered in the preceding section. They are usually implemented by simply connecting the inner and outer conductor sections together in parallel within a common outer conductor assembly.

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Since the characteristic impedance of the output ports of the junction power divider are the same as that of the input port of the divider, impedance-matching structures, such as stepped-impedance sections, (capacitive "slugs" or inductive undercut sections), are used in order to keep the impedance of the input and output ports matched to the characteristic impedance of the antenna system. Power division ratios can be set between the outputs as well. Input V.S.W.R. is kept low by adjusting the impedance of each of the output ports such that when they are all connected in parallel, (as they are in a coaxial junction power divider), the equivalent impedance is equal to the characteristic input impedance of the power divider network and the antenna system.

Power output division ratios are set by adjusting the relative port impedances of each of the outputs on the divider network. If the output port impedances are all equal, and are adjusted so that their equivalent parallel-connected impedance is equal to the input characteristic impedance, then the power divider will supply RF power to each of the output ports in equal proportion, and the input V.S.W.R. will be low. Unequal power division is achieved by adjusting the output port impedances of the parallel-connected power divider according to the Ohm's Law equation:

$$\mathbf{P_{OUTPUT\ PORT} = (V^2) \div (output\ port\ impedance)}$$

Where V is the RMS voltage on the inner conductor with respect to ground.

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However, in order to be sure that the input V.S.W.R. is kept low, the equivalent parallel impedance at the junction of all of the output ports, when terminated in their operating impedance, (as they are connected in parallel), equals the characteristic input impedance at the input port, at the operating frequency of the system.

## Junction Power Divider Advantages:

-They are usually much less expensive
-They require no fourth port dummy load
-They are usually much smaller and lighter
-They are available in multiple output ports, (from 2 to 10 or more)

## Junction Power Divider Disadvantages:

-No isolation between output ports; (high V.S.W.R. at one of the output ports can affect the power division ratios at other outputs)
-Can be used as a cross-dipole feed for circular polarization only with narrow-band antenna systems

**Be on the lookout for the next volume of AntennaSelect coming out in September**

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