Welcome to AntennaSelect™ **Volume 7 – February 2014**

Welcome to Volume 7 of our newsletter, AntennaSelect. Each month we will be giving you an "under the radome" look at antenna and RF technology. If there are subjects you would like to see covered, please let us know what you would like to see by emailing us at: info@micronetixx.com

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LPFM: Why Circular Polarization (C/P) is better

MICRONETIXX COMMUNICATIONS

We are getting a number of questions about Circular Polarization (C/P). Is it really much better ? Are there tradeoffs or pitfalls in going C/P ? What kind of increased range will I get over using just a simple whip or vertical dipole antenna ?

We will answer the question on increased range of the station using C/P first. The answer is C/P will not increase the theoretical 60 dBu contours of the station. What it will do is greatly enhance the chance that there will be a useable signal within that contour.

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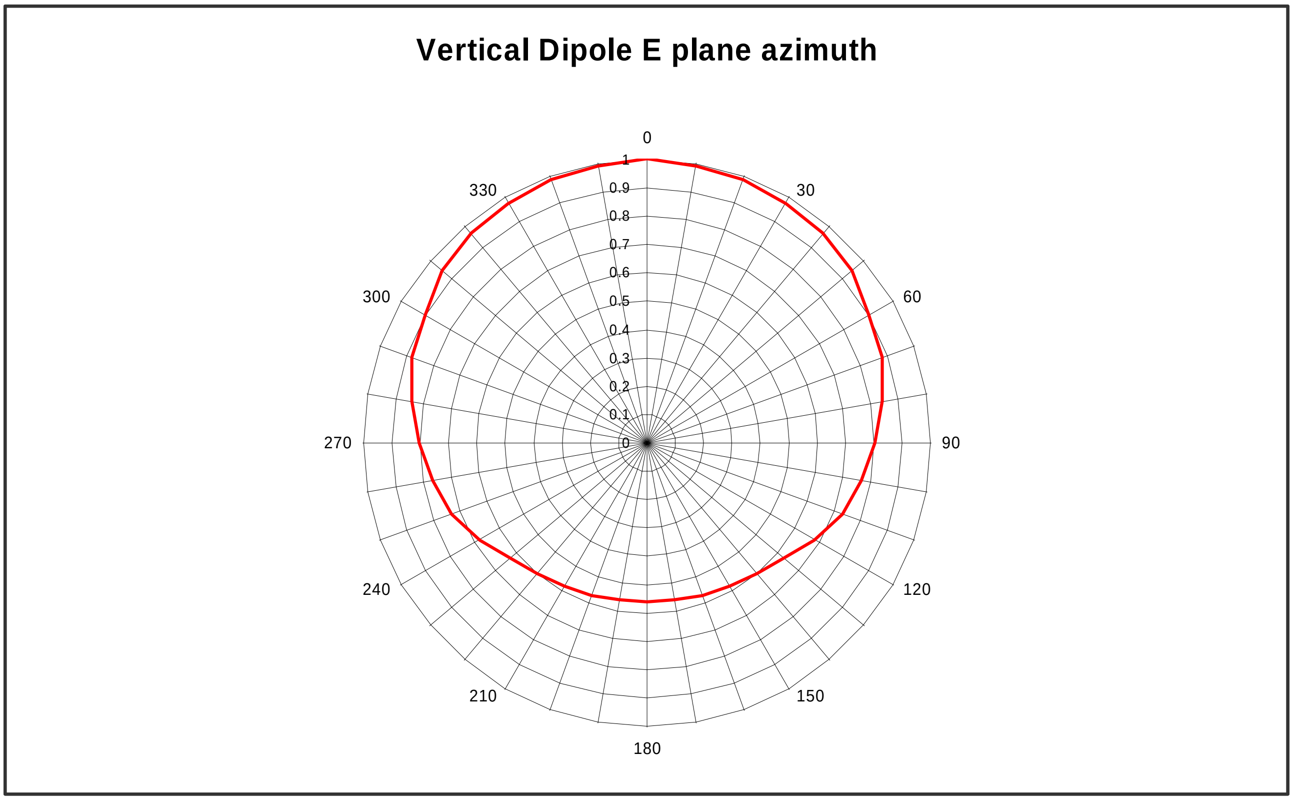
We took a call from a gentleman who was looking at using a vertically polarized folded dipole mounted on a small pole that extended 15 feet above an elevator penthouse. To get the 100 Watt ERP requires a transmitter output of 120 Watts due to the feedline loss.

How well would this installation work ? Would going C/P help ? Here are three answers to the question. First let's take a look at the azimuth pattern of the folded dipole antenna. These antennas are often marketed as being omni-directional, but are they ?

The folded dipole when mounted to a support pole begins to act like a two element Yagi. Below is the azimuth pattern of the dipole.



The vertical dipole antenna has a 4.7 dB front to back ratio. With an ERP of 100 Watts, the ERP at the 180 degree azimuth point would only be 33.6 Watts. So maybe the dipole is not the optimal solution.

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The second part of the answer deals with the signal loss from cross polarization of the receive and transmit antenna. In the case of the vertical dipole we are only transmitting in one electrical plane – in this case the vertical plane.

If the listener's antenna happens to be horizontally polarized, in the case of an outdoor TV/FM antenna, or an in-glass vehicle antenna, a signal loss of up to 20 dB may occur due to that antenna being horizontally polarized. A 20 dB cross polarization loss is like only having an ERP of 1 Watt. So a listener who is on the fringe area of a LPFM, may well not get a good signal even with putting up a good FM antenna. In the case of the station using the vertical dipole, a simple whip antenna at the receive site would have worked better.

C/P on the other hand launches a right hand spiraling signal that has nearly identical signal levels at every angle. With a C/P signal there is little or no cross polarization loss for many types of receive antennas. Going C/P could deliver up to 20 dB more signal to the listener who installed a good FM antenna hoping to receive the new LPFM station.

The third part of the answer discusses Faraday Rotation and Fresnel zones. To those new to radio imagine being able to go up where your transmitting antenna is mounted. Take out a pair of binoculars and look off in the distance where your listeners are located. Do you get a clear view of where they are ? Or are buildings or even a small hill or two blocking their view ? If you have a clear view of where your listeners are, the signal path or Fresnel zone has no impairments. If you are transmitting a vertically polarized signal (from the folded dipole), your listeners will be getting a high percentage of the signal vertically polarized at their location.

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If your transmitting antenna does not have a clear signal path to your listeners, the signal will suffer from Fresnel zone impairments. When a signal has a Fresnel zone impairment, the signal can change polarization due to Faraday Rotation. Faraday rotation occurs when the signal strikes the side of a building, the side of a steep hill, or simply the earth's magnetic field surface. Faraday rotation is not constant. A vertically polarized signal might be received in a given location as horizontally polarized, or it might come in at a 45 degree angle.

The Faraday rotation of the received signal can change every few inches, or remain constant for more than 100 feet, then change back. As the signal path is more impaired, more signal rotation can be expected. Since the C/P signal was launched with energy in all planes, a Faraday rotation of that signal greatly ensures that a signal will be received at the proper polarization to the receive antenna. With C/P there will be much fewer dead spots, where reception is difficult. In car and pedestrian reception will greatly improve with C/P operation.

A quality C/P FM transmitting antenna, such as the **FML**, or **FMP** series of antennas has an excellent V to H ratio of under 1.5 dB, with a nearly omni-directional pattern. C/P can help to deliver up to 20 dB more signal to a given listener's location as compared to a single linear polarized signal. With only 100 Watts to work with, get all the coverage you can.

The only down side to C/P is the need for additional transmitter power. Instead of the 120 Watts needed for a single polarization antenna, 240 Watts are now needed. There are some excellent 300 Watt transmitters with audio processing and full remote capabilities on the market that have great specs and a very affordable price tag. Go for C/P !

Radiofrequency Radiation (RFR) – a closer look

Radiofrequency Radiation is actually a sub-set of the overall Electromagnetic Radiation, (EMR), Spectrum. The entire EMR Spectrum includes not only the radiofrequency portion, (addressed in this Newsletter), but also encompasses light, x-rays and gamma rays, to mention a few. The fundamental difference between these types of EMR is the ***frequency range*** that characterizes each sub-set within the Spectrum.

Frequency:

In order to understand the concept of the frequency associated with Electromagnetic Radiation, it's very useful at first to briefly discuss the two individual fields of force that comprise EMR. Electromagnetic Radiation, as its name implies, consists of **Electric** and **Magnetic** fields. All of us are at least, somewhat familiar with both of these. An Electric Field is produced, and its effects are what we experience, when a balloon is rubbed on a woolen sweater and afterwards, attracts strands of hair or pieces of paper to it.

Another manifestation of the Electric Field is that it will cause the balloon to "stick" to a wall. The Electric Field around the balloon generates a force that attracts the hair strands or pieces of paper to it, or holds the balloon to the wall. A Magnetic Field is produced by magnetic materials in a magnet, or by an electric current passing through a conductor. A Magnetic Field's effects are observed when a magnet, or a wire connected to a battery, (so that the wire is carrying an electric current), is brought near a compass needle and the needle moves in response.

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Electric and Magnetic Fields can be very strong or very weak. The strength of the field is referred to as its magnitude. Also, each field points in a unique direction. Since they have **both** a magnitude, (strength), and point in a certain direction, they're characterized as **vector** force fields.

By convention, in the case of the Electric Field, its vector always points away from a positive charge and/or toward a negative charge. Similarly, by convention, a Magnetic Field vector points away from the "north" magnetic pole and toward the "south" magnetic pole. In both of these examples, the fields are stationary, i.e., they're not changing with time. Therefore, they're often referred to as "static" or stationary fields.

So how does all of this explain what electromagnetic radiation is? …THAT is where this entire discussion becomes very interesting!

The above discussions were of static or stationary electric and magnetic fields. Stationary fields are not electromagnetic radiation at all. BUT let's now consider what happens when we begin to move or change these fields with time. Let's take a look at a common bar magnet, like the ones used in science class in school. The magnet has a "north" and a "south" magnetic pole, usually marked "N" and "S" on each end. (Because there are two poles, north and south, it's an example of what's known in physics as a magnetic **dipole**…two poles.) Now let's imagine that we mount that magnet to an electric drill, motor shaft or something that will spin the bar magnet from its center, like an airplane propeller, and spins it at, say, 3,600 revolutions per minute, (RPM).

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When the magnet is spinning in the drill, it should be fairly easy to visualize that the magnetic field around it will be spinning too. Each full revolution will constitute one complete “cycle”, or revolution. If we check out the **Magnetic Field** at a fixed reference point in the space near the spinning magnet, it will be moving too, following the magnet’s rotation. This is an example of an alternating magnetic field. The field will alternate or rotate through one full cycle following the magnet, 3,600 times per minute. Since frequency is measured in cycles per second, and there are 60 seconds in a minute, the Magnetic Field at that fixed reference point in space rotates through one complete cycle, (3,600 divided by 60), or 60 times each second.

NOW comes the leap from the spinning magnet and its corresponding oscillating Magnetic Field to Electromagnetic Radiation! The laws of physics tell us that this **time-varying** magnetic field, (from the spinning bar magnet), will CAUSE a time-varying **ELECTRIC FIELD,** whose magnitude and direction oscillate as well, linked to the time-varying Magnetic Field causing it! (Please bear in mind that this only happens in response to a magnetic field that is **changing in time**…static magnetic fields do not give rise to static electric fields.) FINALLY…the laws of physics tell us another thing…they tell us that when an ELECTRIC FIELD is changing in time…It will then give rise to a time-varying MAGNETIC FIELD again, following the time-changes of the causal, time-varying Electric Field.

The time-varying Magnetic Field initially from the spinning magnet gives rise to a time-varying Electric Field which in tern causes yet another time-varying Magnetic Field and so fourth. These two interrelated time-varying Electric and Magnetic fields move off together, away from the rotating bar magnet through space at the speed of light.

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This resulting system of fields moving through space is called an ELECTROMAGNETIC FIELD and is RADIATING away from the source…in this example, the spinning magnet. We have **Electromagnetic Radiation**!

In this example, the two fields alternate back and fourth, making one complete cycle 60 times each second. Therefore, this electromagnetic field has a frequency of 60 cycles per second…or 60 Hertz.

Note: For the science-minded readers of this Newsletter, the mathematical or quantitative characterization of this interrelationship between the time-varying electric and magnetic fields in electromagnetic radiation is governed by a set of physical laws described by mathematical equations, collectively known as Maxwell's Equations, named for James Clerk Maxwell, a Scottish theoretical physicist who lived in the mid 1800's and who elegantly described these phenomena.

Radio Waves and Microwaves

In the example above, an easy-to-visualize scenario of a rotating bar magnet was used in order to develop the concept and to describe electromagnetic radiation. The physically-spinning bar magnet in this example was used to develop electromagnetic radiation whose fields alternated at only 60 Hertz. Radio waves characterize electromagnetic radiation where the fields oscillate at frequencies that are much, much higher. Instead of oscillating at 60 Hertz, in order for electromagnetic radiation to be characterized as radio waves, their fields must oscillate at up to SEVERAL HUNDRED BILLION Hertz! Obviously, a source for electromagnetic radiation at these frequencies cannot possibly consist of anything "spinning" at that rate.

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Instead of a spinning bar magnet, in order to produce EMR in devices that use it like cell phones, electrons are made to move back and fourth inside of these devices at radio and microwave frequencies, (several billion hertz). Since moving electrons constitute electric currents, and an electric current causes a magnetic field, (as with the wire-and-battery and compass needle example), these rapidly-oscillating electrons will generate likewise, rapidly-oscillating magnetic fields in response. That gives rise to electromagnetic radiation at radio and microwave frequencies, used in all of our modern electronic devices.

New FMP series medium - high power C/P FM antenna

We are introducing a new FM circular polarized transmitting antenna to the market. The **FMP** series of antenna is a medium to high power omni-directional antenna. The bays consist of a pair of opposing Vee elements. This design offers exceptional bandwidth and an excellent H to V ratio at all azimuths.

The **FMP** bays are constructed from stainless steel, ensuring along a long life in any environment. For the fed system we offer two options, a tapped feed line or corporate feed using a power divider. For export applications, the corporate feed system greatly reduces the shipping size and cost of the antenna.

The **FMP** can be furnished in full wave, half wave, or 0.9 wavelength spaced versions. Null Fill and beam tilt can be customized as needed.

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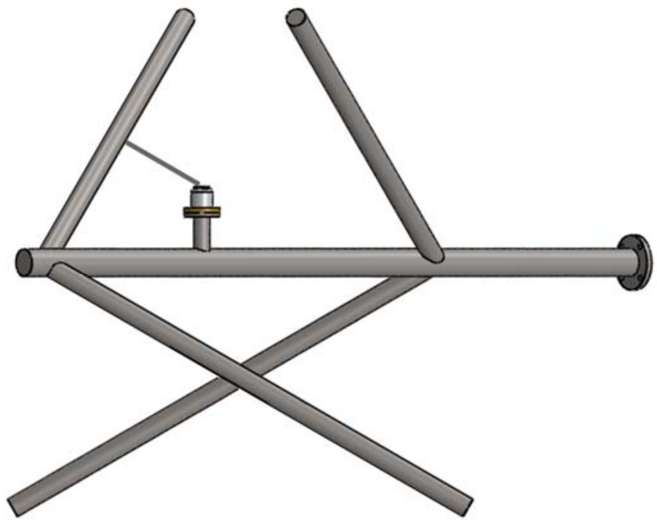

The **FMP** is available with a 1-5/8”, 3-1/8”, or 6-1/8” EIA input depending on the power level needed. On inter bay tapped models, the line sections are constructed from aluminum.

Corporate fed antennas come with phase matched flex cables and input power divider.

A 6 bay **FMP** full wave spaced will have a power gain of 3.0 (4.77 dB). The 0.9 wavelength spaced antenna has a gain of 2.8 (4.47 dB), while a 6 bay half wave spaced model has a gain of 1.65 (2.17 dB).

The mounting brackets are stainless steel and mount to a 2.375 (6 cm) to 3.5 (8.9 cm) inch nominal mounting pole or tower leg. Each bay is DC grounded for excellent lightning protection.

! If you are working on a TV project, the design concept of the **FMP** is also used on our high band VHF (Band III) series, the **THP**. The **THP** series are single channel 6 or 8 MHz bandwidth antennas, with up to a 25 kW input rating.

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

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