
## Welcome to AntennaSelect™ Volume 9 – April 2014

Welcome to Volume 9 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

**In this issue:**

- **LPFM: How many antenna bays are best ? – Part 2**
- **Optimizing VHF (Band III) Batwing style antennas**
- **FM Antenna Engineering: End Fed Antennas**

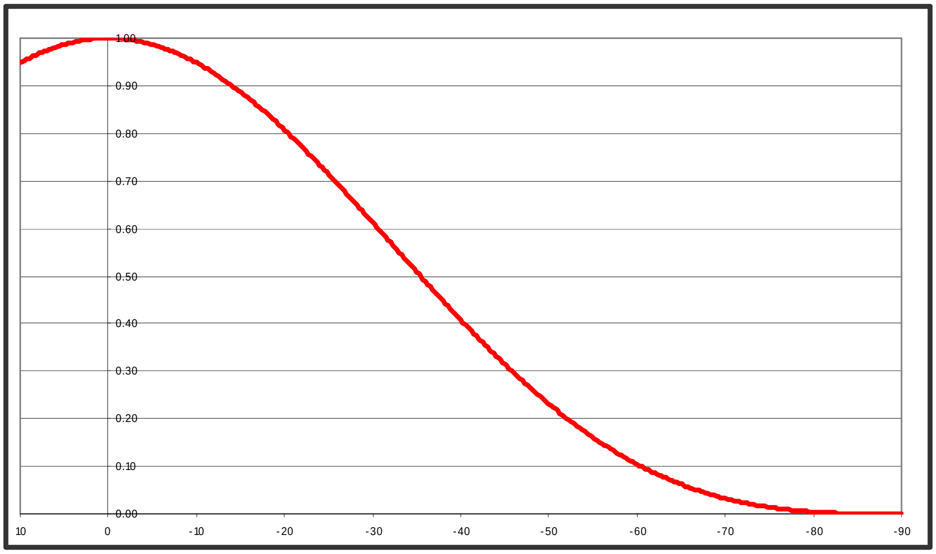
## LPFM: How many antenna bays are best ? - Part 2

MICRONETIXX COMMUNICATIONS

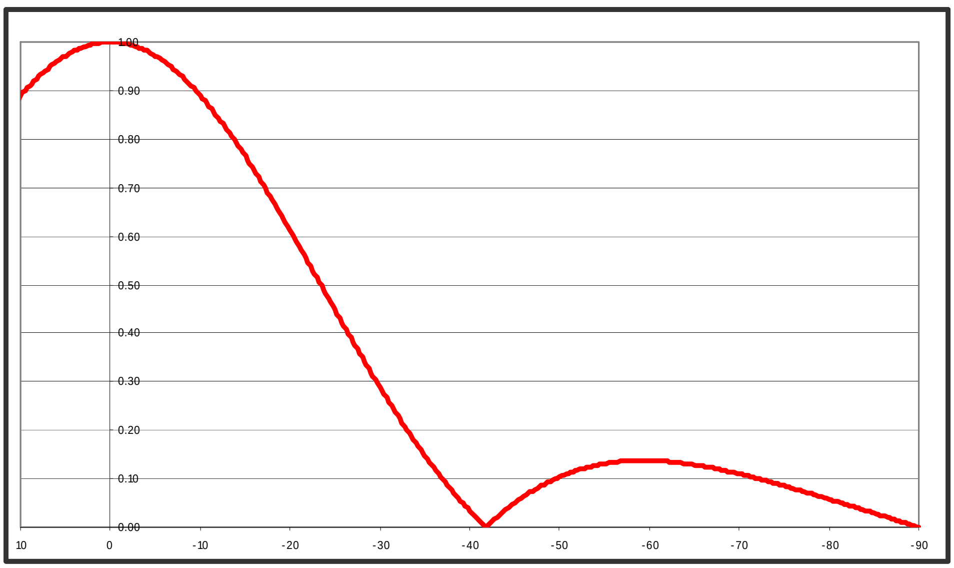
The article in last months issue of AntennaSelect™ about how many bays were best, brought up some questions. Some readers did not realize how much vertical real estate was needed for a multi-bay antenna. A few others wondered about other inter bay spacing options, like half wave or 0.875 wave would offer them.

In last months article we modeled a station with the antenna at 98 feet or 30 meters above. Lets look at several more antenna options.

**Continued on next page**

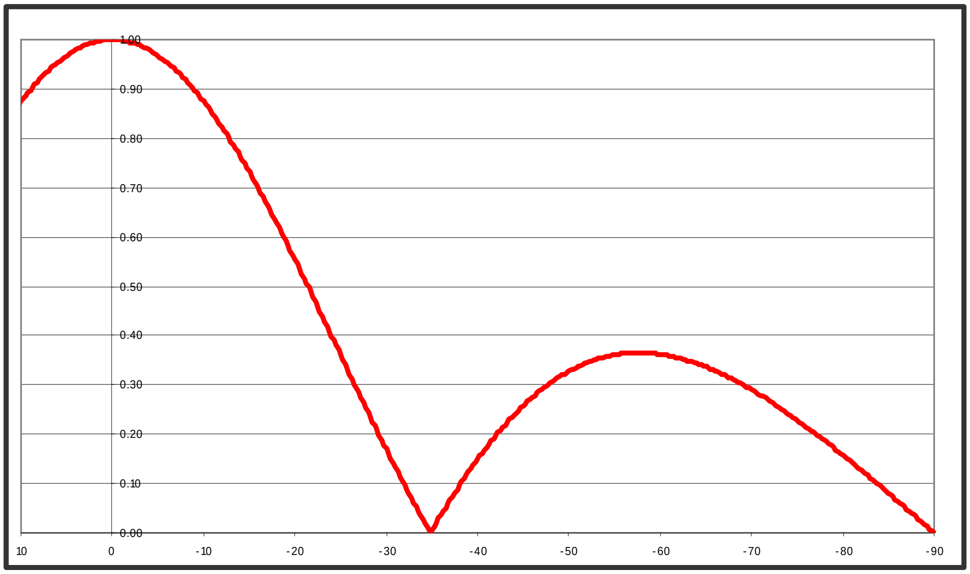



Here is the elevation pattern of two **FML** series antenna bays spaced a half wave apart. This pattern has an elevation gain of 0.68 or -1.67 dB. The radiation from a half wave spaced antenna goes to near zero in the -80 to -90 degree depression angles. If the antenna is mounted near a roof top or occupied area, this design greatly lowers NIR levels.




Here is the elevation pattern of a three bay **FML** series half wave spaced antenna. It has an elevation gain of 1.00 (0.00 dB). When mounted 98 feet above the ground the first null will fall 43 feet from the tower at a depression angle of -43 degrees.

**Continued on next page**




Here is the elevation pattern of a 2 bay **FML** series antenna, with a bay spacing of 0.875 Lambda or 315 degrees.. This antenna has an elevation gain of 0.92 (-0.36 dB). When mounted 98 feet above the ground the first null is located at a depression angle of -35.00 degrees, which is 140 feet from the tower.

**Which of the three patterns would work best for an LPFM ?**

As with the patterns we looked at last month, all would work equally well for an LPFM station. The null found on the two and three bay patterns are not a problem since they are so close to the tower. There would be enough signal level at those locations to receive a great signal. If NIR at the site is a problem, a half wave spaced pattern will work much better.

**So coverage being equal, what are the tradeoffs between the three elevation patterns we have looked at ?**

There are two tradeoffs to look at when comparing the three elevation patterns. One is the amount of room or space you have to mount the antenna, and the second is the amount of transmitter power needed to make your 100 Watt ERP.

**Continued on next page**

Here is a comparison of the amount of space needed to mount a single bay antenna, a two bay model and a three bay model. We will assume that the station is on 98.1 MHz and needs a 120 foot long piece of transmission line. We will model LDF4-50A flex line, which has a loss of -0.784 dB (83.5% efficient). The ERP is 100 Watts, and we are running circular polarization.

**Two Bay ½ wave spaced FML antennas**

**Minimum Vertical space needed: 95 inches**
**Optimal Vertical space needed: 135 inches**
**Transmitter power needed: 176 Watts**

**Three Bay ½ wave spaced FML antennas**

**Minimum Vertical space needed: 150 inches**
**Optimal Vertical space needed: 185 inches**
**Transmitter power needed: 120 Watts**

**Two Bay 7/8th wave spaced FML antennas**

**Minimum Vertical space needed: 210 inches**
**Optimal Vertical space needed: 315 inches**
**Transmitter power needed: 130.5 Watts**

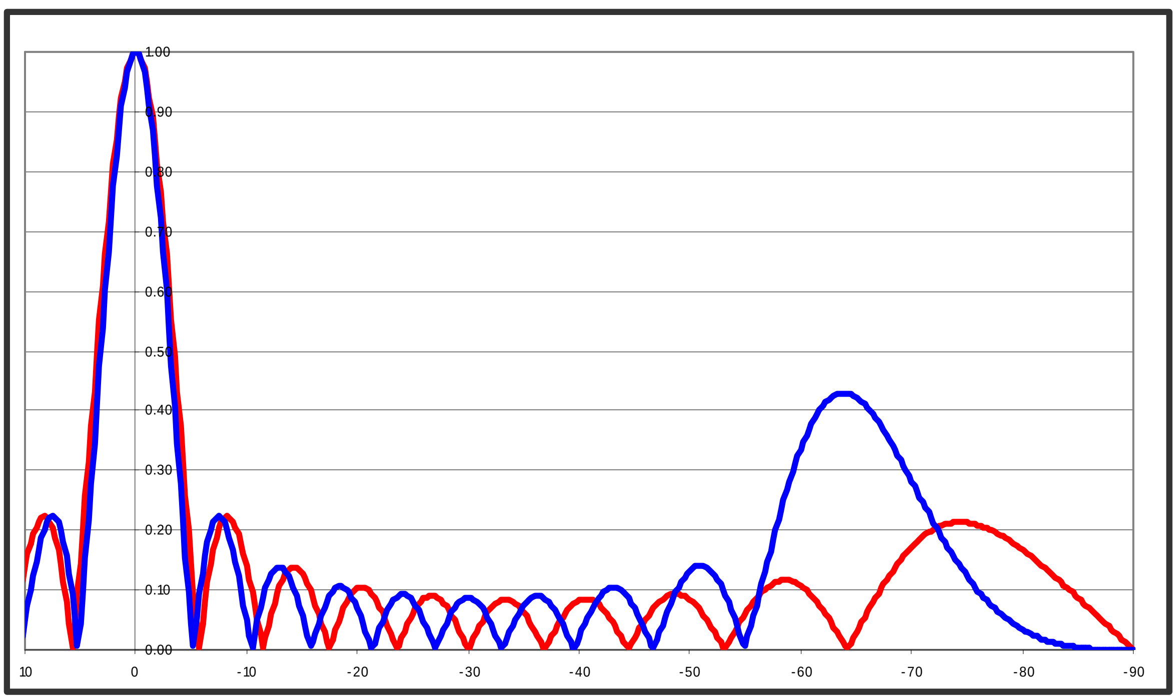
As with the patterns we looked at last month, any of the three patterns above will work well. If there is an NIR problem at the site, the half wave spaced patterns will lower NIR by 6 to 14 dB as compare to full wave spaced bays. If there are LPFM antenna questions, please call us at (207) 786-2000 or email us at: info@micronetixx.com. We will be glad to share our many decades of antenna engineering knowledge with you to make your new LPFM station shine.

# Optimizing VHF (Band III) Batwing antennas

The batwing or turnstile antenna design is more than 60 years old. This time tested design is not only very reliable, but very broadband too. A number of broadcasters are looking at the possibility of moving to high band VHF in the future, if spectrum allotments change.

Could the batwing antenna technology be improved on to produce a better elevation pattern or even take up less room on the tower ?

Lets look at a 10 bay Batwing antenna designed to cover channel 7 through 13 (174 to 216 MHz). The antenna is designed for the batwing element to be designed to be resonate at about 170 MHz and the spacing between elements is 1 Wavelength at 174 MHz.
Here is the elevation pattern plot of the antenna at channel 7 (177 MHz), channel 10 (195 MHz).

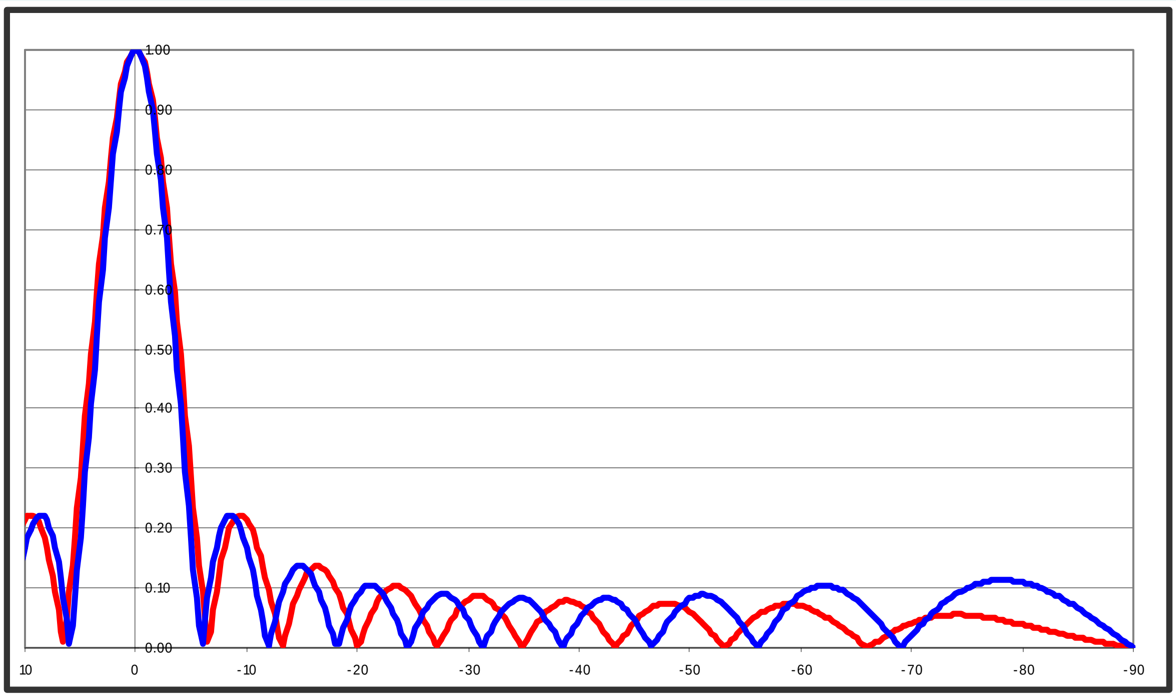



**Channel 7 – RED Plot  Channel 10 – BLUE Plot**

**Continued on next page**

The raw elevation gain of the antenna at channel 7 is 11.30 (10.53 dB, and at channel 10 is 9.90 (9.95 dB). When the batwing antenna elements are spaced more than 360 degrees apart, the efficiency of the array decreases. As element spacing is increased above 360 degrees, a set of grazing lobes begins to increase in size and move up in depression angle. The energy in those grazing lobes reduce to gain in the main beam. At channel 10 the spacing between elements has been increased to 395 degrees.

So lets try an experiment. We will use the 10 bay antenna design and look at the performance of the antenna at channel 7 and 10 again. This time we will reduce the spacing of the elements to 315 degrees (or 7/8th wavelength) at channel 7. Here is the elevation plot of the antenna on two channels.




**Channel 7 – RED Plot  Channel 10 – BLUE Plot**

At channel 7 the raw elevation gain is 10.56 (10.24 dB), at channel 10 the gain is 11.36 (10.55 dB). The spacing of the elements at channel 10 is 347 degrees, just short of a wavelength. In this case the antenna gain increases as a wavelength spacing is approached.

**Continued on next page**

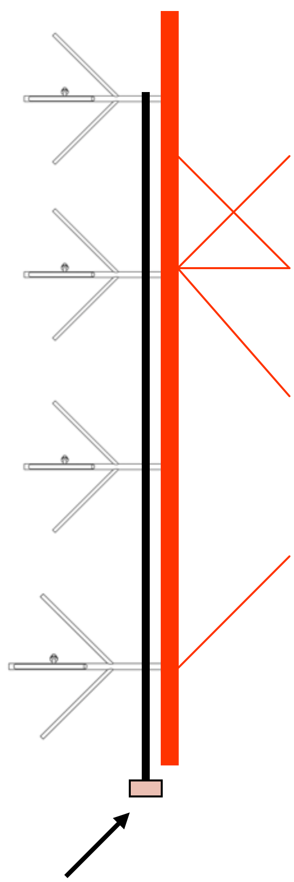
There are a few benefits to short spacing the antenna. First, the gains between channels are more identical. Second, with both channels being spaced below a wavelength, the grazing lobes at high depression angles is reduced. The first elevation plot showed a large grazing lobe at channel 10 when the antenna was spaced at 395 degrees, with a peak field of 42.9%. The antenna when spaced at 347 degrees (at channel 10) only produces a grazing lobe of 11.2%. If the station has an NIR problem due to being on a short tower or being building mounted, the short spaced antenna will reduce NIR at high depression angles by just over 11 dB.

And the last benefit is the reduction in overall size of the antenna. Since each bay at channel 7 has been spaced closer together by 45 degrees, the antenna is 405 degrees, or 1-1/8 wavelengths shorter. This works out to 5-1/2 feet (1.67 meters) shorter.

Pictured to the left is a high band VHF (Band III) **THB** series antenna in fabrication. Next month in the May edition of AntennaSelect™ we will look at some other improvements that can be done to the batwing style antenna. Be on the lookout for the "Batwing 101" antenna article coming out later this Spring.

At Micronetixx, we enjoy coming up with custom antenna solutions to maximize coverage of our customer's stations. We have a solution waiting for you.

# FM Antenna Engineering: End fed antennas




**Depiction of a 4 bay end fed FM antenna**

Most broadcast antenna systems consist of an array of radiating elements arranged along a straight transmission line. This type of antenna is designated a linear antenna array. These linear arrays are connected to the transmitter via a transmission line, (usually coaxial line), and are fed either from the center point along the array, (center-fed), or from one end, (end-fed).

In an end-fed array of radiating elements, the elements are usually spaced linearly along the antenna feedline at intervals of either one half or one full wavelength in free space. The end-fed antenna feedline is set so that the transmitter signal is applied to one end of the antenna line, and at the other end, there is an abrupt transmission line discontinuity causing a total wave reflection at this opposite end of the array. (This discontinuity is usually a short circuit that connects the inner conductor to ground for increased protection against damage to equipment from lightning.) In an end-fed array of the type shown (see drawing to the left), the circuit dual can be represented by a series of resistors connected in parallel.

**Continued on next page**

If the system's characteristic impedance is 50 ohms, (as is usually the case), each resonant radiating element along the array will need to be adjusted so that its terminal impedance is resistive, and this resistive impedance  set to a value such that the equivalent resistance of all of the elements connected in parallel is 50 ohms. For example, if the array consists of four elements, each element must present an impedance to the feedline of 200 ohms; (each of the four 200-ohm elements, connected in parallel along the end-fed feedline will result in an equivalent parallel resistance of 50 ohms.)  In this example, the spacing between the radiating elements ensures that the excitation from the transmitter arrives at each of the elements in the array in the same phase, relative to one another. That way, a predictable, uniform elevation pattern is developed from this antenna.

Finally, even though each radiating element in the end-fed array is fed in the same relative phase, the individual tuning of the elements may be slightly modified, such that the relative transmission phases of the elements are altered in order to generate the desired level of elevation pattern null-fill and/or elevation beam-tilt.

At the beginning of the article we brought up the subject of center fed antennas. Are there are advantages to a center fed antenna ? Find out in next months AntennaSelect$^{TM}$ newsletter.

**Be on the lookout for the next volume of AntennaSelect$^{TM}$ coming out in May**