Welcome to AntennaSelect™ Volume 10 – May 2014

Welcome to Volume 10 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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Optimizing VHF (Band III) Batwing antennas - Part 2

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Last month we looked at changing the inter bay spacing of Batwing VHF antennas and what the elevation patterns looked like. In addition to changing inter bay spacing, the batwing element may also be scaled to the channel or channels of operation. Lets use a 10 bay antenna example again and look at operation at channel 10 and 12. We will look at both the elevation patterns and how they are affected, plus the mechanical load savings by scaling the antenna.

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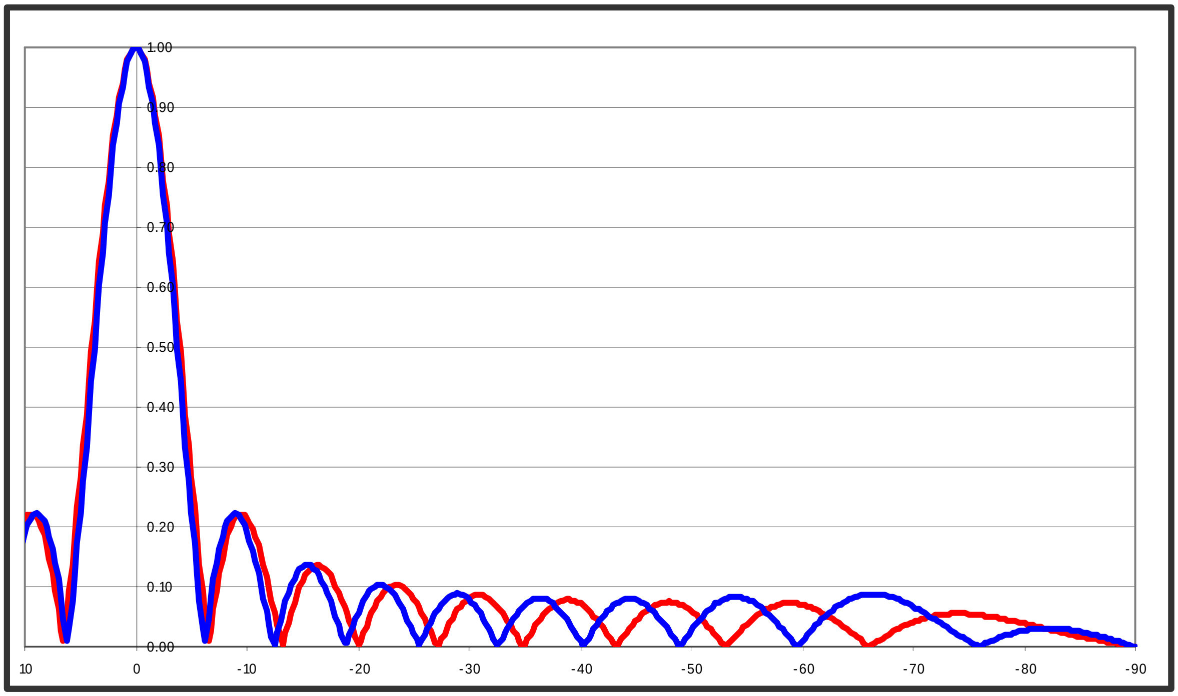
Since we are only concerned about the antenna's operation on channels 10 and 12, we can scale the size of the batwing elements to resonate just below channel 10. That will save a little weight and wind load area. Now for the elevation pattern. Last month we looked at spacing the elements or bays at 315 degrees or 7/8th of a wavelength. The graph below shows the channel 10 elevation in red that is spaced 315 degrees. At channel 12 that spacing increases to 334 degrees (blue plot).



The gain at channel 10 is 10.56 (10.24 dB), and at channel 12 is 11.09 (10.45 dB). The secondary lobes at depression angles of more than 30 degrees down are all below 10% of peak field. Remember last month the standard batwing at channel 10 produced a grazing lobe of 42.9% at -64 degrees ? The scaled and custom spaced array has only produces about 8% at that angle. If RFR is a problem, the scaled antenna produces about 14.5 dB less radiation at that angle. The gain is higher, 10.56 (10.24 dB) for the 315 degree spaced model, versus 9.90 (9.95 dB) for the standard antenna. And our scaled antenna is 10-1/3 feet shorter !

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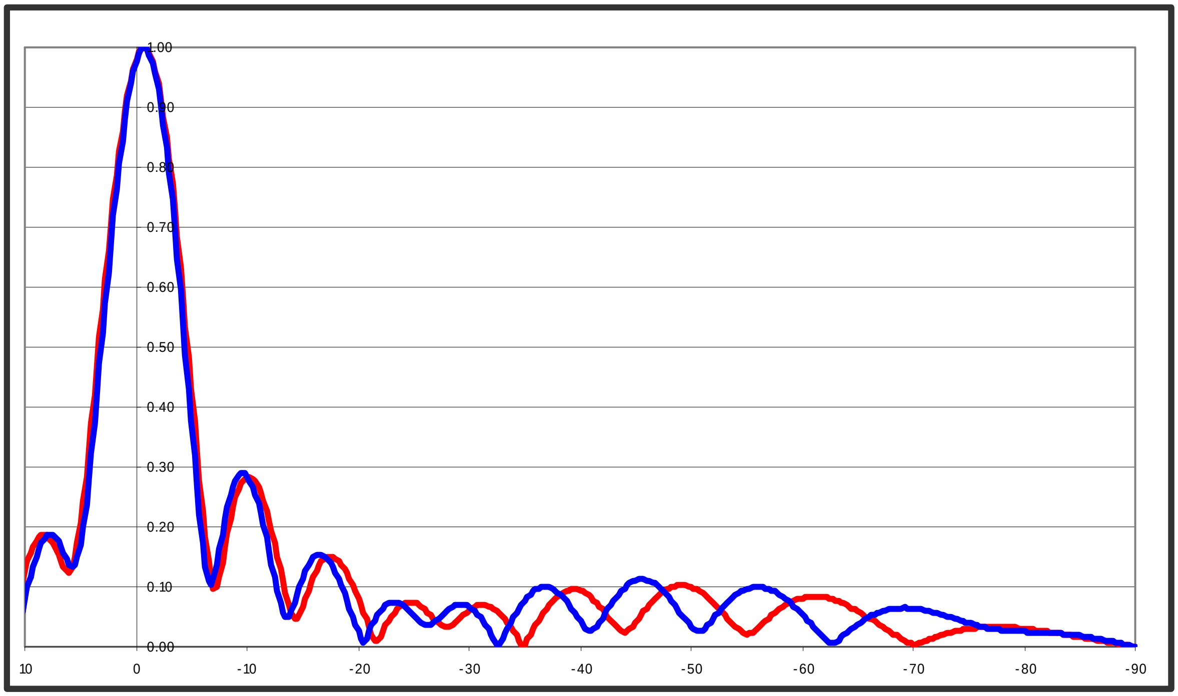
So far we have only looked at elevation patterns with no beam tilt or null fill. What happens at each channel as we add beam tilt? We will add beam tilt by electrically short spacing the last two top elements by 41 degrees at channel 10. This will give us a first null fill of 10% and a beam tilt of -0.75 degrees. At channel 12, the effective short spacing is 43.5 degrees.



The elevation pattern with the added null fill and beam tilt are shown above. The channel 10 plot is shown in RED, while the channel 12 is shown in BLUE. The elevation gains have fallen slightly from 10.56 to 10.08 (10.03 dB) at channel 10. At channel 12 the gain fell from 11.08 to 10.50 (10.21 dB). Both patterns have 10% first null fill and provide a a minimum of 10% of field down to -13 degrees.

By scaling and custom spacing the batwing we end up with an antenna with better gain than an off the shelf design. The scaled antenna is over 10 feet shorter and about 1000 lbs. lighter. The RFR performance is greatly improved. At Micronetixx we love to customize our designs to get the best results. In this case less (antenna that is) is a whole lot more. Can we build one for you ?

Slot Antennas versus temperature

We got a call from a customer fairly new to being involved with RF at his station. He noticed the V.S.W.R. would be slightly higher when it was very cold out before sunrise. By early afternoon the V.S.W.R. would fall slightly. The pattern kept completing itself. In the Spring and Summer the V.S.W.R. changes were even less. Was there something wrong with the antenna ?

The answer is no. The antenna was a 32 bay center fed slot antenna on a very low UHF channel. The total length of the antenna was 71 feet and is built with 6061-T6 tube stock. The antenna is being fed with a 350 foot run of 3” Air Flex cable. So what is going on ?

Slot antennas are built with the majority of the slots 360 electrical degrees or 1 Wavelength apart. A few of them at the top of the array are short space to form some beam tilt and null fill. They are built from Aluminum. The antenna is center fed and has short circuits at both ends of the antenna.

There are two things going on that will affect V.S.W.R. From the antenna side, the physical length of the antenna is changing with temperature. Using 70 degrees F as a base, the antenna will be 0.392 inches shorter at 30 degrees F, and 0.584 degrees shorter at 10 degrees F. Drop down to -20 degrees F and the antenna is 0.875 inches shorter The diameter of the pylon will also get smaller as it gets colder and being a coaxial structure there would be a very small change in impedance. The antenna array has an electrical length of 11,160 degrees. At 485 MHz a wavelength is 24.33 inches long. So if the antenna has become 0.584 inches shorter, the short circuits

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at each end of the antenna are closer together. In electrical terms the short circuits are now 8.65 degrees closer. Drop the temperature down to -20 degrees F and they are now 13 degrees closer. This is a very small change. Since the antenna is normally tuned to have a V.S.W.R. of under 1.05:1, a large change in temperature will affect it ever so slightly. At -20 F the V.S.W.R might have shifted to 1.06:1 or 1.07:1. Still excellent numbers.

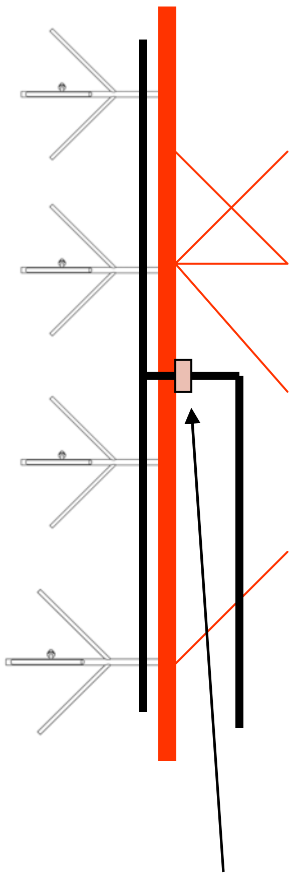
The second thing to look at is the transmission line itself. The diameter of the transmission line changes with temperature. The inner conductor diameter will not change as much due to the heat it is dissipating. So the impedance of the line is changing ever so slightly. In the case of this station 1700 Watts are lost in the transmission line or 4.85 Watts per foot.

Now lets do the math and see what we are looking at. When the antenna was installed and the transmission line connected the system swept out at a V.S.W.R. of 1.08:1. The antenna was installed in the Summer. The transmitter TPO is set at 6700 Watts. The returned power read just under 9 Watts indicating a V.S.W.R. of just under a 1.08:1 In the coldest nights that the V.S.W.R. was monitored the return power crept up to 18 Watts. That works out to a system V.S.W.R. of 1.11:1 – still a very good installed spec using air flex line. Less cold nights saw the returned power only move to about 13 Watts – a 1.10:1 V.S.W.R. .

This is an extreme case due to the very long length of the antenna and the extreme range in temperature at the site. A 2:1 ratio (18 versus 9 Watts) in returned power might look like a big deal – but with a 6700 Watt TPO both numbers are in the noise. In this case both very small changes in the antenna and transmission line worked in unison to cause the small difference in reflected power.

FM Antenna Engineering: Center fed antennas

We looked at end fed antennas last month. A center-fed antenna actually consists of two end-fed antennas, whose inputs are connected to the two outputs of a power dividing tee. (The complete antenna is implemented in two halves, consisting of the two end-fed antennas.) The input to the antenna is actually the input of the tee, where the signal from the transmitter is divided into two equal components, both in-phase, and fed to the two halves of this antenna, fed at the center. There are several advantages of feeding the antenna in this manner, including:



Depiction of a 4 bay center fed FM antenna

1.The antenna will have a broader impedance bandwidth, due to the fact that the phase shift of the feedline reflection coefficient over the channel at the input end of a center-fed antenna is only half that of the phase shift of an equal-aperture end-fed antenna.

2.The power is divided in half at the in-feed section of the antenna by the tee, reducing the power in each section of the antenna to half the levels seen for a given power input, as opposed to that seen in a single end-fed antenna configuration.

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3.There will be a reduced RF ice-loading affect on the antenna's elevation beam, since the bottom half of the antenna is fed from the top, and the top half of the antenna is fed from the bottom. These unwanted loading effects will tend to add out, diminishing these effects, compared to those exhibited in an end-fed antenna of the same gain.

As with the end-fed antennas, the antenna elements are connected in parallel, and their equivalent impedance needs to be equal to the characteristic impedance of the transmission line. The antenna elements are also arranged such that their relative phases are nearly identical. Depending on the needs of each station, the relative phases of the radiating elements along the array may be adjusted such that the main elevation beam of the antenna array is tilted, usually downward. Adjustments in the relative phases may also be made in order to fill in certain areas near the antenna where there are field nulls present.

An additional advantage to the center fed antenna is that the inner conductor is DC grounded at each end of the array. This short circuit also causes a total reflection of the RF signals along the antenna feed line, allowing the same impedance to appear along the feedline periodically, intervals of one half-wavelength. This allows the antenna radiating elements to be fed along the line at the same impedance. We will talk about corporate fed FM antenna in the next issue.

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

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