Welcome to AntennaSelect™ Volume 38 – June 2018

Welcome to Volume 38 of our newsletter, AntennaSelect™. Every two months 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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Standing-Wave vs. Traveling-Wave Slot Antennas

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In the previous installment of this 3-part series on Standing-Wave vs. Traveling-Wave television broadcast pylon antennas, we discussed some of the basic properties of coaxial transmission lines. We presented an illustration of a section of transmission line showing the relative strength or magnitude of the electric fields present within the line as they are evaluated along its length. Also, the illustration contains the relative position of the array of radiating slots that are cut axially along the transmission line's length that for the actual antenna array. For convenience, we have included that diagram on the next page.

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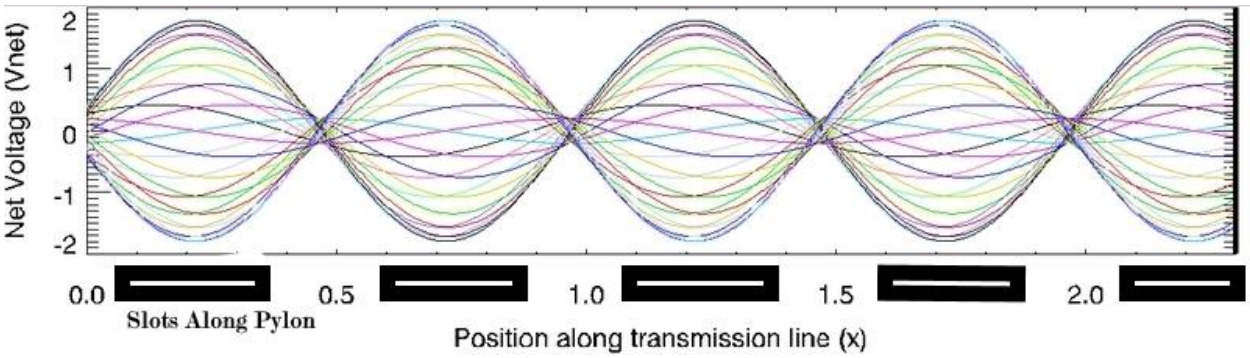

Again, please notice that each radiating slot in this sample array of a 5-slot pylon standing-wave antenna is positioned along the line at the electric field maxima. Standing-waves are formed from the superposition of two traveling waves; one wave traveling away from the input end of the antenna, and the other wave traveling back toward the input end of the antenna. In most standing-wave pylon antennas, a precision short circuit is placed at the end of the transmission line that is furthest away from the input end of the antenna. This short circuit will reflect nearly all of the RF power contained in the wave traveling away from the input end of the antenna, and send it back in the opposite direction, toward the input end of the antenna. This will set up a perfect set of standing-waves in the coaxial pylon standing-wave antenna, as shown above.

The E-Field maxima shown above will occur at every half-wavelength, along the transmission line. If the slots are configured correctly, an equal portion of the RF power within the transmission line will be extracted at each slot, and then radiated away. Since each slot in the antenna array radiates approximately the same level of RF power, each slot then contributes equally to the total radiated field profile of the antenna.

So now, what is a traveling-wave antenna, and how does it operate as opposed to the standing-wave antenna, discussed above?

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In a traveling-wave antenna there is no short circuit at the far-end of the antenna, that intentionally sets up a system of standing-waves along the antenna, as is the case with the standing-wave antenna. If there is no structure within the antenna, (such as the short circuit that reflects all of the RF power that encounters the short circuit), then there is no reflected power and hence, no standing waves in the coaxial pylon antenna. In the traveling-wave pylon antenna, the slots that are placed along the length of the antenna are designed to do two things:

A. Extract a portion of the RF power from the traveling-wave that is propagating inside of the antenna, and The Figure below indicates the pattern of standing-waves, (both voltage and current), along an RF transmission line with relatively high VSWR due to reflected RF power.

B. NOT generate any reflections at the slot in the antenna, and therefore, not cause any standing-waves inside of the antenna.

Here, the traveling waves that are set up in the antenna pylon from the RF input do not encounter anything in their path that will cause any RF energy in the traveling wave that is originating at the input of the antenna to be reflected back in the opposite direction, thereby causing any standing-waves. Along the antenna, each slot is designed to extract the same percentage of RF power that is contained on the system of traveling waves in the pylon. When this happens, the percentage of total RF power from the input of the antenna is reduced as this system of traveling waves propagates past each slot in the array. Is this design where each slot in the antenna is coupled equally to the system of traveling waves in the antenna, the first slot in the array, (the slot that is positioned closest to the input of the antenna), is then driven the hardest.

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As the system of traveling waves propagates past that first slot, and it extracts its requisite portion of RF power the remaining power is reduced by the amount of RF power that is extracted by that first slot. As the system of traveling waves continues propagating down the antenna, it encounters the next slot in the array. It then extracts the same percentage of RF power in the system of traveling waves. However, the amount of RF power there has been reduced by the amount extracted in the previous slot. The remaining RF power in the traveling wave that has now passed by two slots, has now been reduced by twice the amount present at the input, (since it has passed by two slots). This is the case as the traveling wave propagates down the antenna, toward the end of the antenna, furthers away from the input end.

Finally, at the end of the antenna, there is a special array of slots that is designed to extract all of the remaining RF power in that system of traveling waves, and radiate it. In this antenna, it should be obvious now that each slot is not radiating the same amount or percentage of RF input power. In this case, the slots are termed as exponentially-illuminated or powered. (Therefore, this antenna is not a uniformly-illuminated antenna array.)

In this antenna, since each slot is not illuminated at the same level along the array, the elevation pattern of the antenna is relatively free of the successive nulls and peaks in the elevation pattern of the antenna. A typical elevation pattern of an exponentially-illuminated traveling-wave antenna is shown on the next page.

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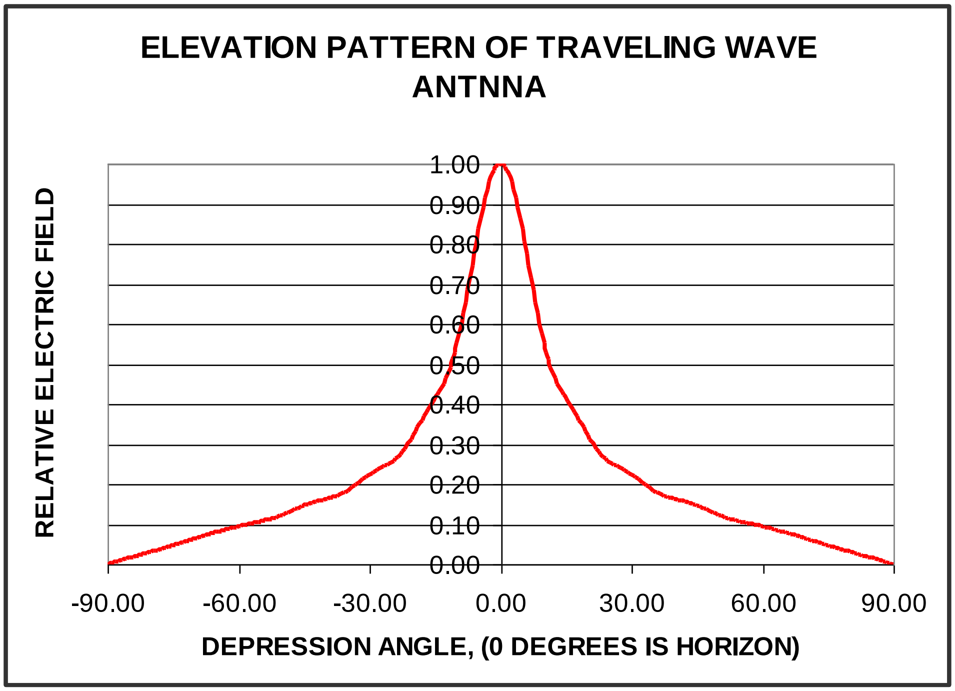

Figure 2

The above is a depiction of the effects of exponential illumination, for a traveling-wave antenna. Below is a depiction of a uniformly-illuminated standing-wave antenna.

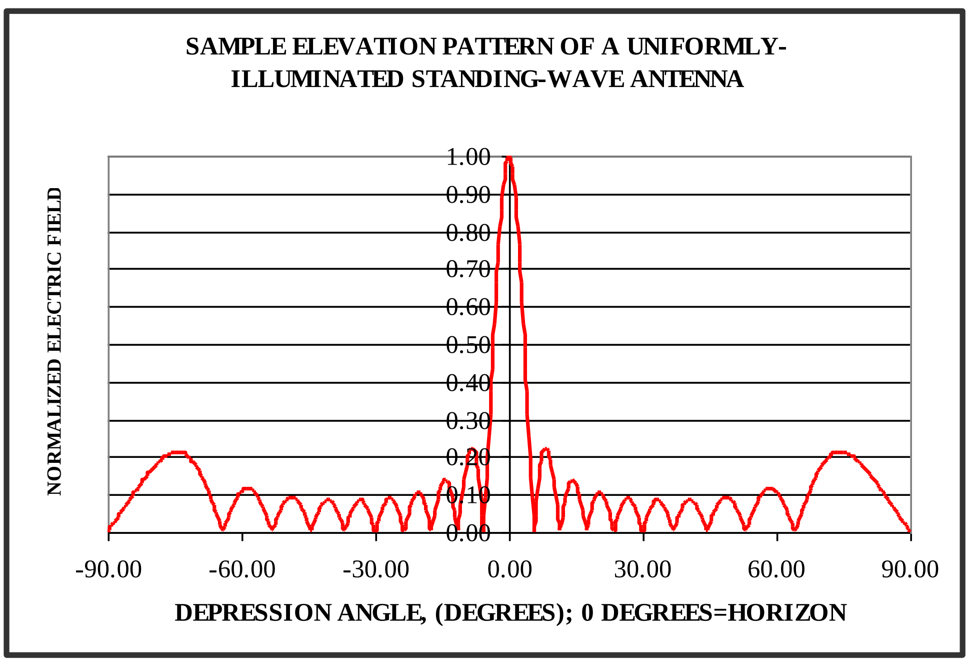

Figure 3

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Both antennas are designed to drive a maximum relative signal at the horizon. However, there are some differences in the two antennas, some are fairly significant. A summary of some of these differences are presented and discussed below.

In a traveling-wave antenna the inner conductor of the coaxial antenna is not held at DC ground. This allows for greater possible damage from lightning strikes. In order to remedy that situation, usually, a quarter-wave shorted section of coaxial transmission line is installed at the input of the antenna. Depending on the specifics of the system, that quarter-wave shorting stub may cause unwanted group delay difference characteristics, which are undesirable for digital transmission. On the other hand, in a standing-wave pylon antenna, however, the inner conductor is firmly held to DC ground by the short-circuit that is intentionally placed at the end of the pylon antenna in order to set up the required standing-wave pattern internally. Also, because of the exponential nature of the elevation pattern of the traveling-wave antenna, the gain for this type of antenna is somewhat lower for the same amount of vertical real estate on the tower or supporting structure. Further, since a traveling-wave antenna has exponentially-illuminated slots, the slots nearest the feed-point are usually driven with a higher RF power flux, and therefore, could present an elevated failure propensity.

When examining these two types of antennas, for modern digital television broadcasting, a robust standing-wave antenna generally exhibits a higher aperture efficiency, (best utilization of tower space), far-superior protection against possible damage from lightning and excellent group delay difference characteristics.

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And now you know why our UHF slot antennas are all standing wave pylons. We hope that you enjoyed this series, and that it has "shed some light" on a very interesting subject! As we very much enjoy this unique and extremely valuable technology, please do not hesitate to let us know if there are any other subjects like this that you would like to see in future additions of Antenna Select.

Antenna Delivery Times

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Since our move into a larger facility almost a year ago, we have been adding manufacturing staff. We also have invested in new machinery to allow more work processes to be performed under our roof. We still have outside sub-contactors that can help fill in when the shop floor is very busy.

Most of the repack work will be UHF slotted antennas. Our modular approach to building these antennas, allow us to stock various piece parts that can be used on different antenna lines. For VHF or UHF side mount slotted antennas the delivery remains at 8 weeks. We can expedite antennas, to cover such conditions as an early phase move, the need for a standby antenna, or a displacement from T-Mobile

For a top mounted antenna, there are more working parts that go into the design. First every top mounted antenna pylon or antenna goes through a structural analysis with a professional structural engineer. As we get into future repack phases, these resources may experience a backlog. Next once the members of the pylon are certified, short delays in obtaining steel might add one to two weeks to the delivery time.

So depending on the size and design of the antenna, arrival of the bare pylon will range from 30 to 60 days to our factory. While this has been happening, we will have been busy building couplers, inner conductors, and other components to build the antenna. From there delivery is under 30 days from our dock.

What helps speed along the process? The more information that we have where the new antenna will be living is always a good thing. For top mount antennas, bury section dimensions, and top plate bolt hole patterns information. This information allows the design certification of the pylon to be faster.

If we are building a side mounted antenna, knowing where it is going to be mounted helps ensure the best performance. Leg dimensions and tower face width information greatly help us plan the mounts.

If we are supplying the transmission line, knowing the type and size of tower members help greatly. Photos do tell a thousand words. Our engineering department loves photos. Often we can see what others miss.

Several weeks before shipping we send out install drawings. Send a copy to your antenna installer and tell them to contact us if there are any questions. It's much better to solve a problem before the crew arrives on site.

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

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