Welcome to AntennaSelect™

Volume 4 – November 2013

Welcome to Volume 4 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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- **How the FML series FM antenna works.**
- **Tips on mounting your FM antenna on structures**

Where is the RFR at my site?

We have been getting a lot of questions about RFR in the last month – a good number of them from new LPFM applicants. The RFR graphs in the last issue of AntennaSelect raised some questions about RFR and the plots generated – lets take a closer look For this article we will look at the RFR footprint of a 100 Watt LPFM station.. We will start off with a two bay antenna for our LPFM station, and see what the power density is with the antenna mounted 30 meters (98.4 feet) above the ground. We will then change the height to 25 feet and run a few scenarios.

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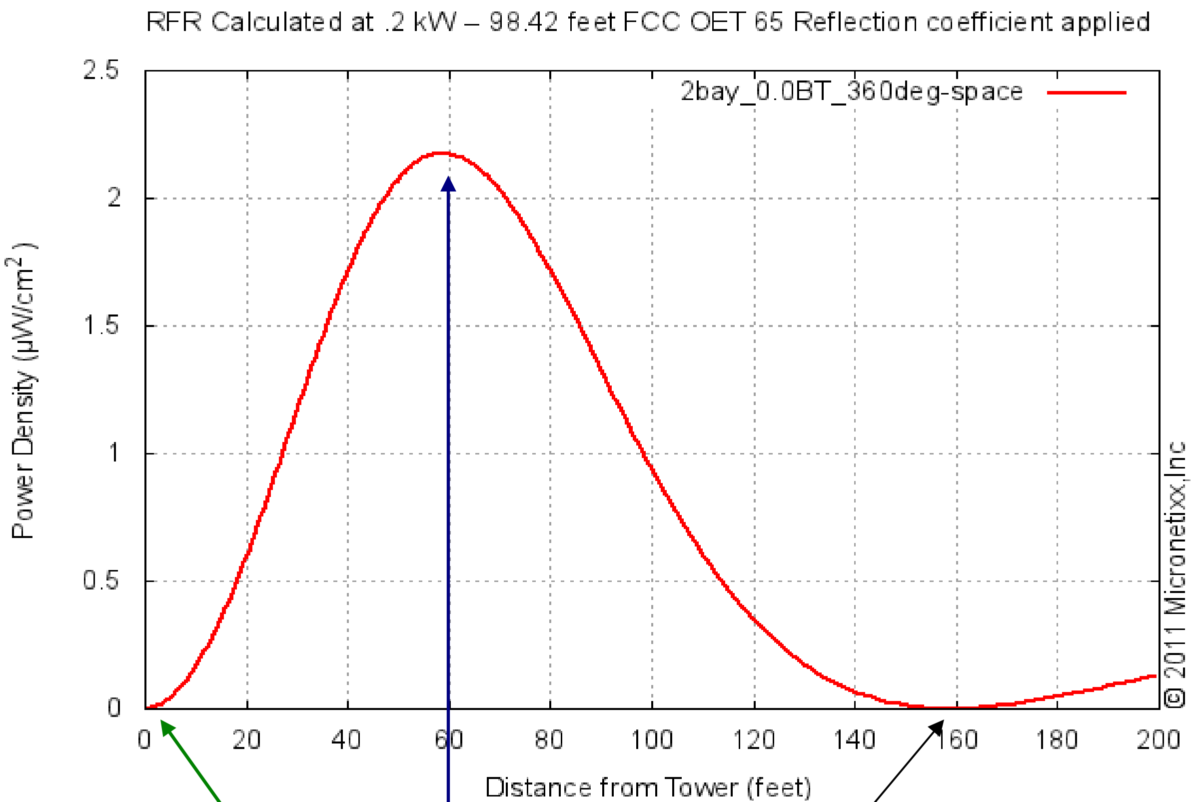
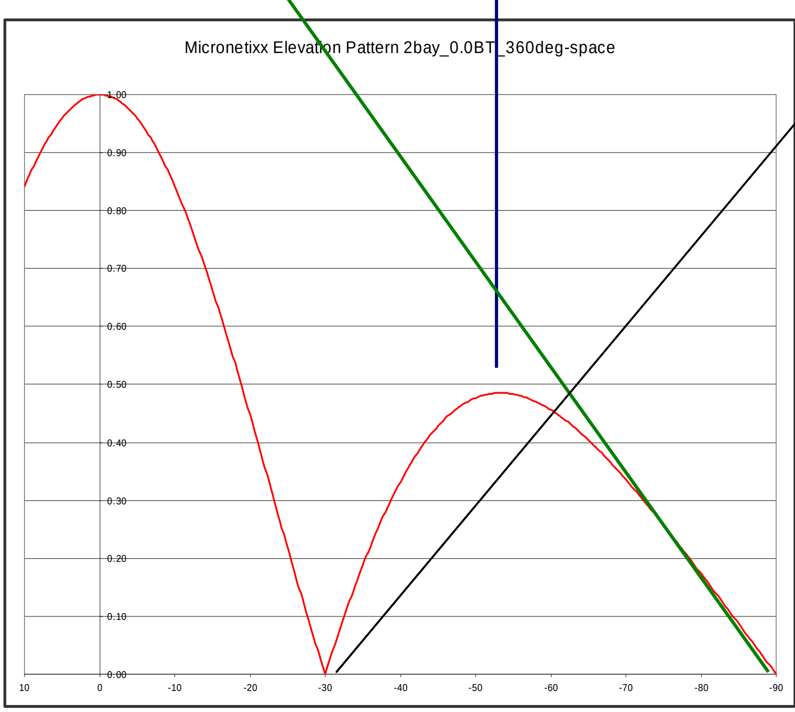
The first graph is a two bay 1 Lambda spaced C/P antenna, producing an ERP of 100 Watts at a height of 30 meters (98.42 feet) over flat ground. Since we are running C/P, we run the power calculation at 200 Watts.





Two bay full wave spaced elevation pattern

At exactly 90 degrees down there is no radiation. The energy from the secondary lobe peaks at 60 feet from the tower. The main beam forms about 350 feet away. The null is 160 feet away.

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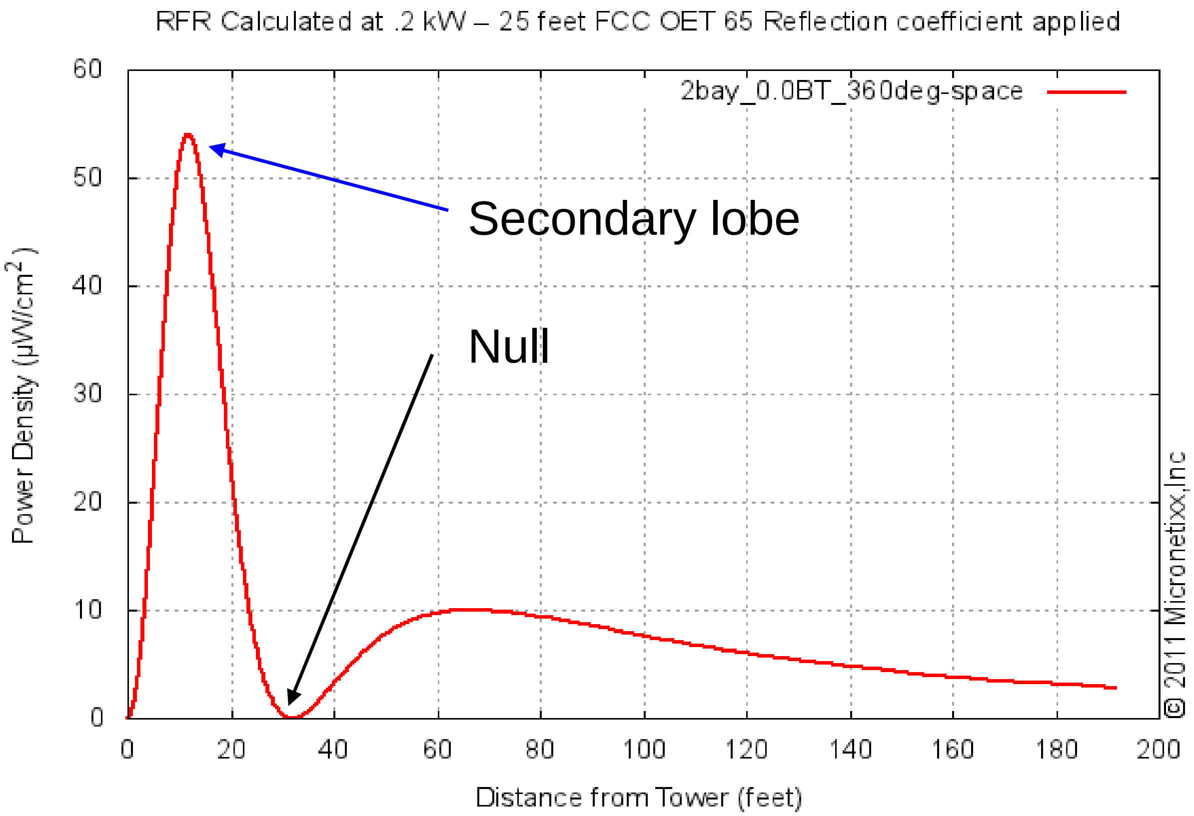
The antenna modeled on the previous page only contributes about 1% of maximum public exposure on the ground. What happen when we mount the antenna on a roof and the antenna is only 25 feet above the roof ? We will use the same two bay antenna to model.



The energy from the secondary lobe moves toward the tower, and is about 25 times stronger than what it was at 98 feet (30 meters). At the new lower height above the roof, the antenna produces about 30% of maximum public RF exposure. Other co-located sources could push the RF density over 100%.

Let's try a little experiment and close space the two antenna bays to 0.875 (7/8th) Lambda, or 315 degrees of spacing. The elevation gain does drop by about 5%. Our transmitter would need about 10 more Watts of power to compensate.

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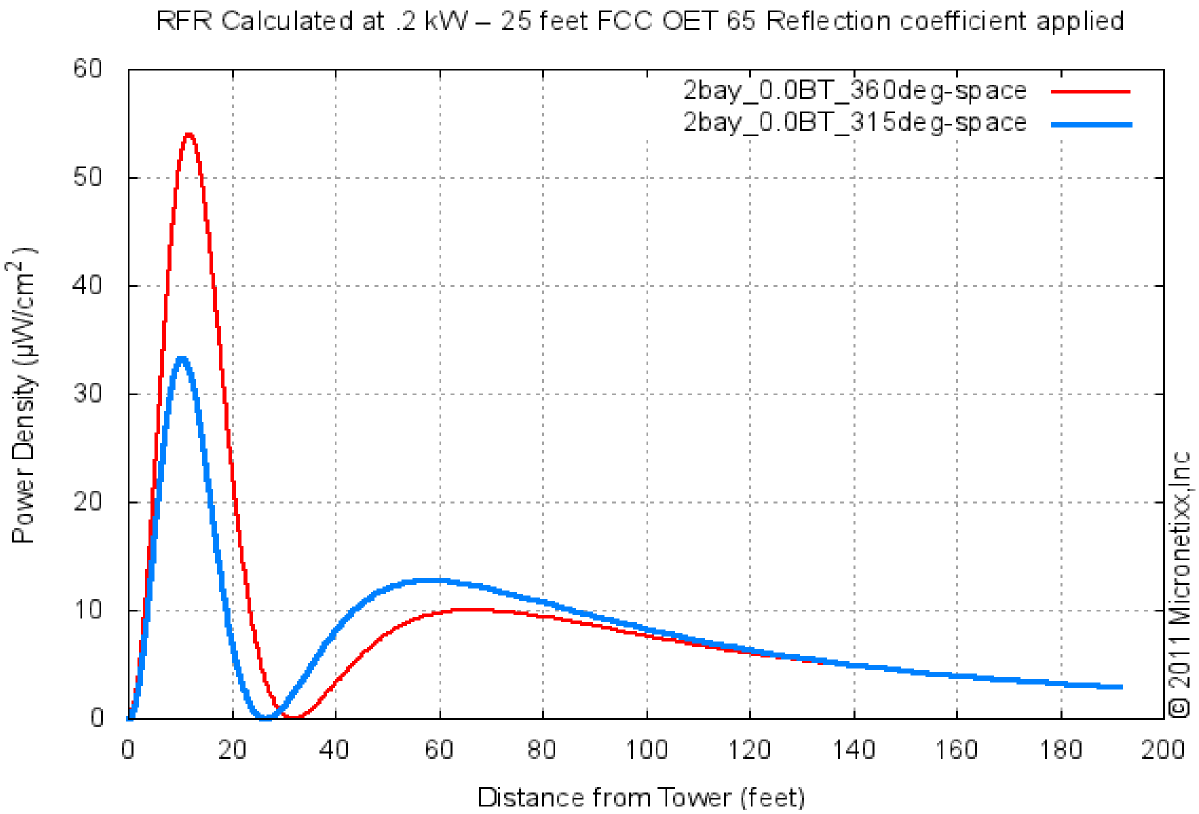
The graph below is a comparison of the full wave spaced antenna (red trace), versus the 0.875 Lambda spaced antenna (blue trace) RFR or power density.



The 0.875 Lambda spaced antenna produces about 2.1 dB less radiation from the secondary lobe.

So what happens if the site you want to be at has strict RF emissions rules ? These rules may be in place to limit RF blanketing interference to other users, or just general policy of the building owners.

Let's look at going to a half wave spaced antenna. We will need 4 antenna bays and an additional 5 feet of vertical space. The elevation gain is 1.30 with the 4 bay antenna, so we can drop the transmitter power back a bit.

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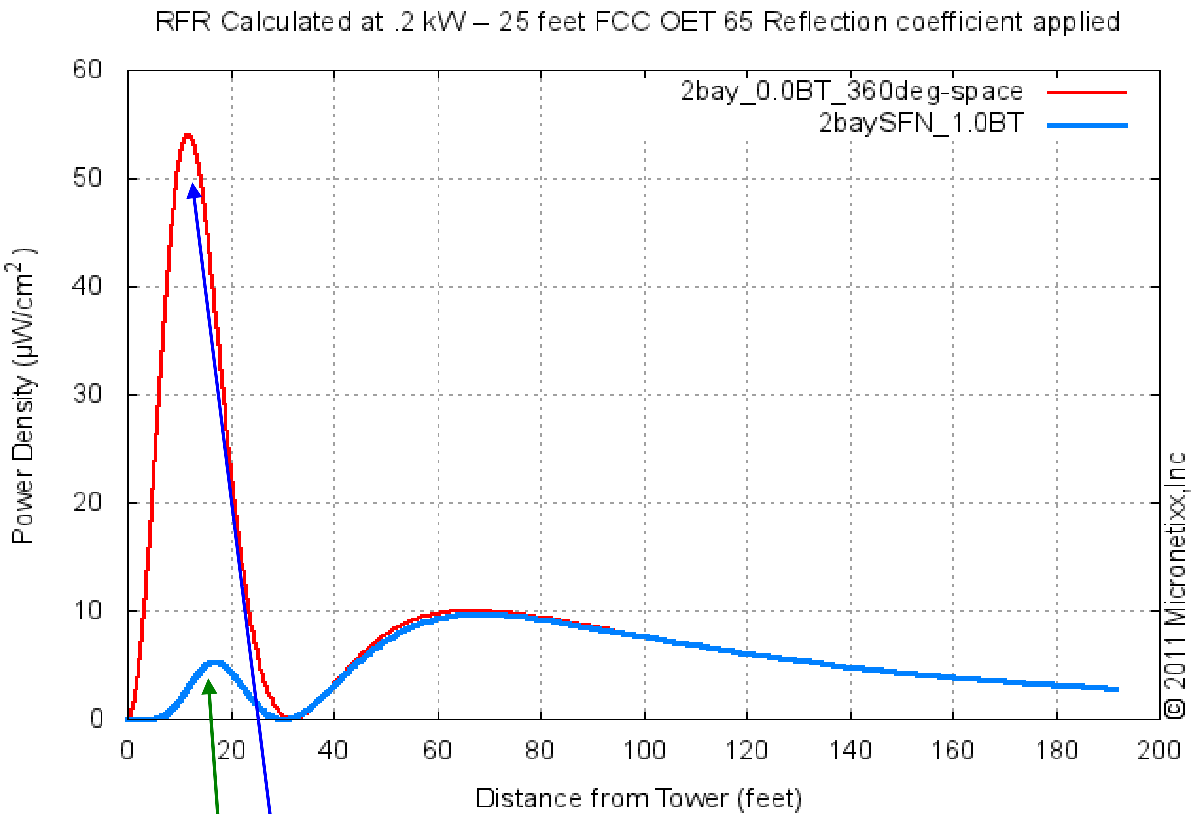

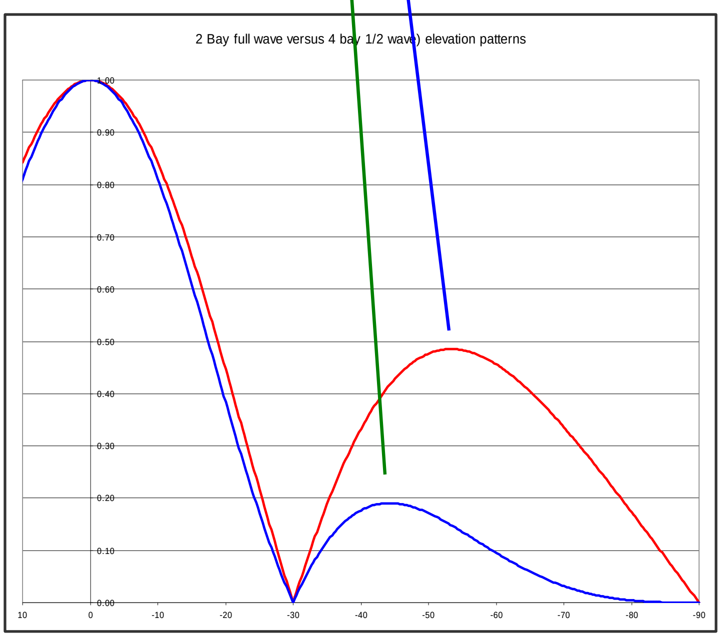

--Full Wave ---Half Wave

Going to a 4 bay half wave spaced antenna reduces radiation from the secondary lobe by a factor of about 9 times as compared to a 2 bay full wave spaced antenna. With the antenna mount up 25 feet, the RFR level is less than 5% of maximum public exposure.

If you have questions about the antenna design for your LPFM station, or RFR questions in general, please contact us. Our engineers have decades of experience in designing solutions to maximize your coverage area.

How the FML series FM antenna works

The Micronetixx Communications FML Circularly-Polarized FM Broadcast Antenna is designed to launch a true circularly-polarized system of electromagnetic fields from the transmitting site to the listeners in the field. The advantages of circular-polarization are many. Major among them is a compensation for what is known as **Faraday Rotation**. Electromagnetic Fields, of which radio waves are a subset, have both en electric and a magnetic field component. Both are known as vector fields, (meaning that they have both a magnitude, or strength, and, that they point in a specific direction.)

By convention, if the electric field component of a radio wave is oriented to that it points up and down, (perpendicular to the ground), that radio wave is said to be **vertically-polarized**. Conversely, if the radio wave has its electric field component oriented so that it is pointing from side to side, (parallel to the ground), in that case, the radio wave is said to be **horizontally-polarized**. In both of these cases, since the electric field oscillates back and forth, and has a specific linear orientation, the radio wave, (and by convention, as well as the antenna that transmits it), is said to be **linearly-polarized**.

Most antennas are linearly-polarized, meaning that they are designed to receive or transmit radio waves with their electric fields oriented in a specific orientation. That situation is fine as long as both the transmitting and receiving antennas are oriented so that their polarizations remain aligned.

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However, there are many cases where the orientation, (polarization), of the electric field in a propagating electromagnetic radio wave, can be altered by external, (mostly magnetic), fields that are present in regions through which the radio wave is propagating, while on its way to your receiver. In this case, the wave has undergone **Faraday** rotation; the polarization of the propagating wave has been rotated from its original orientation by the presence of external fields. (These can be from large iron deposits in geological formations, or from other sources in the environment.

If the radio wave encounters the receiver's antenna in an orientation that is not aligned with the polarization of the radio wave, the strength of the received radio signal can be severely reduced. This can cause fading of an analog radio signal, or drop-out periods if the signal is digitally modulated.

A good solution to this problem is to transmit a radio wave whose electric field orientation actually rotates smoothly from, say, an initial horizontal orientation, at relative time equal to zero, to a vertical orientation at a time one-quarter of a period later. Then it rotates smoothly back to a horizontal orientation at a time equal to one half of a period later, (now pointing in the opposite horizontal direction, compared to its initial horizontal orientation), then smoothly to vertical again three-quarters of a period later, (opposite in direction from the vertical orientation at one-quarter period). Finally the polarization rotates back to its original horizontal orientation from which it began, one full period earlier. (A Period is the length of time necessary for the electric or magnetic field in a radio wave to move through one complete cycle). Here, the radio wave is said to be **circularly-polarized**, or simply, **C.P**.

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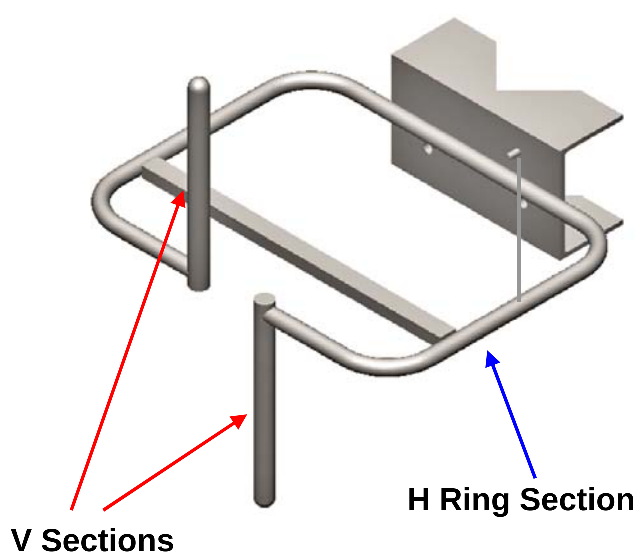
The best, and most practical way to develop and transmit a C.P. radio wave is to design an antenna which is actually two antennas in one. One section of the antenna would be, horizontally-polarized, and the second section vertically-polarized. If the antenna is designed so that its horizontal and vertical radiating sections are physically spaced, or electrically-phased such that they are exactly one quarter wavelength apart, a circularly-polarized radio wave results.

The Micronetixx FML Antenna is designed so that it will emulate that exact scenario. The FML antenna contains a ring-like horizontal section, specifically located at a region on the antenna where the impedance is lowest, (meaning that more of the electromagnetic energy from the transmitter is expressed in conduction currents in the horizontally-oriented ring section of the antenna), from the "Right-Hand Rule for Magnetic Fields", a magnetic field results from these conduction currents in that horizontal section of the antenna, that is oriented up-and-down, perpendicular to the ground.

The second half of the Micronetixx FML antenna is a vertical section, connected to the terminating ends of the horizontally-oriented antenna section that is oriented vertically, as shown in the picture to the right



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Since each of the two halves of the horizontal ring section of the antenna shown above is an approximate electrical one-eight wavelength long, at any given instant in time, the two ends of the horizontal ring section are approximately 90 degrees out of phase, relative to one another. Each of the two ends of the horizontal ring structure is then connected to a vertically-oriented conducting section, completing the antenna. These two vertically-oriented sections are positioned at the high-impedance portion of the antenna, (meaning that a large percentage of the energy from the transmitter is now expressed in the electric field).

Since the horizontal section of the **Micronetixx FML** Antenna radiator produces a vertically-oriented magnetic field, and then, exactly 90 degrees, (one quarter-period), later, the vertical section of the antenna produces a vertically oriented electric field. Since these two fields are coincident and their relative phases remain at approximately 90 degrees, we have successfully launched a nearly perfect circularly-polarized radio wave.

Tips on mounting your FM antenna on structures

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With LPFM (Low Power FM) becoming a long awaited reality, we are getting numerous applications questions on how to best mount the FM antennas. Because LPFM will be limited in range, the transmitter sites will be close into the population they serve. That translates to many more antennas being mounted on top of buildings rather than towers.

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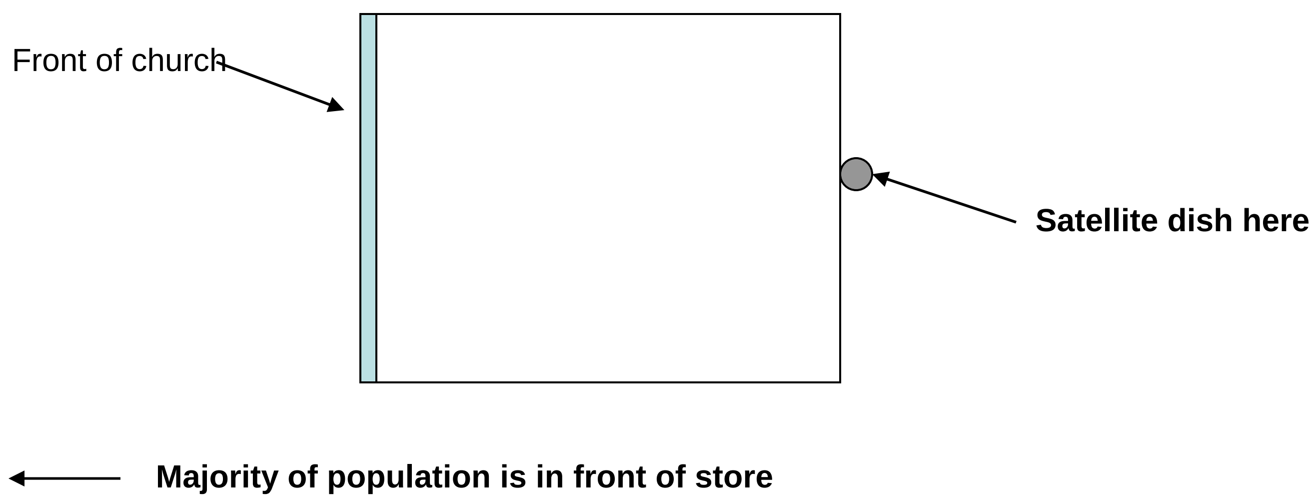
Let’s take a look at a few cases. The first case is a church that is building their radio station and is in a building that formerly housed a supermarket. They on top of a hill that looks down on the majority of the population they hope to serve. The roof is about 200 feet (61 meters) wide, by 250 feet (76 meters) deep, and is about 20 feet (6.1 meters) above street level. Going up 40 feet (12.2 meters) above the street level will put them at their maximum average height above terrain of 30 meters (98.4 feet).



On the back wall of building there is a satellite dish (no longer used) that is pole mounted. The mounts according to the church’s contractor could with some additional support take the loads from 30 feet (9.14 meters) of pipe above the roof, plus the two bay FML antenna they are planning to use. Will this work well ?

With the center of radiation being 20 feet (6.1 meters) above the roof, the bottom bay will only be 15 feet (4.6 meters) above the roof. At 20 feet (6. meters) that is less than 2 Lambda or wavelengths from the roof. The roof may be constructed with steel, which is excellent to cause reflections.

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If you were able to climb up the support pole to where the center of radiation was, you would not be able to see most of the parking lot in front of the church. The front edge of the roof would only be at a depression angle of -4.5 degrees from the front of the antenna. With 25 Lambda of reflective roof surface between the antenna and listeners, there is bound to be signal impairment. Remember there is only 100 Watts to work with on LPFM's.

What could we do to make the signal better to the listeners ? Two quick options come to mind. One is to locate the antenna at the same height as close to the front of the church's roof as possible. If that is not possible, mount the antenna 50 feet (15 meters) or so above the roof top at the back of the building. You would need to reduce your ERP slightly, but your signal would suffer much less Fresnel disruption from the roof. Your consulting engineer can run the numbers for you. The farther and clearer your antenna can see will help improve coverage.

One other tip. Your new support mast may well become the building lightning rod. Bond that support mast to the frame of the building (if steel construction) and if possible add ground rods.

Water Towers In many towns the water tower is the highest structure around, and many are in the range of 100 to 150 feet 30 to 45 meters) tall. Quite a few water towers already spout other antennas, ranging from public safety to TV translators. We got a call from a client in Florida who uses one of our UHF slot antennas mounted on water tower . Now they are planning for an FM station, how far away from the slot antenna does the FM antenna need to be?

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The slot antenna in question is mounted on the walkway railing that goes around the tank. The slot antenna is a very high front to back cardioid – so the tank has little influence on the directional azimuth pattern. The FM antenna however is omni-directional and operates at a frequency that is about 6 times lower than the slot antenna.

The water tank will greatly disrupt the azimuth pattern of the antenna and possibly cause to detune. There are two solutions. One is to mount the antenna so the bottom bay is more than 2 Lambda above the top of the tank. Be sure to bond the support pole to the water tower – your support pole becomes the new lightning rod.

The second solution is to mount the antenna below the tank. Again about 2 Lambda from the tank bottom to the top bay of the FM antenna will work. Outrigging the antenna off one of the legs a few feet will generally help reduce azimuth pattern interference.

When running into a mounting problem, we enjoy working with our customers on helping them get the best coverage. Our many decades of experience have solved some really odd problems. Take loads of photos of the site, and we will work up a solution for you.

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

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