

Reduce RF Interference with Gamma Suppressor Boot

by [Cameron Lanier](#) | Mar 26, 2021 | [Cable Protection](#), [Gamma News](#), [RF Weatherproofing](#)

“What if we made a boot that could reduce RF interference?” That was the question our engineering team set out to answer. We’ve been making boots that provide IP68 level weather protection for coaxial cable connections for years, but what if we took it a step further? What if we made a boot that provides weather protection *and* reduces RF (Radio Frequency) interference?



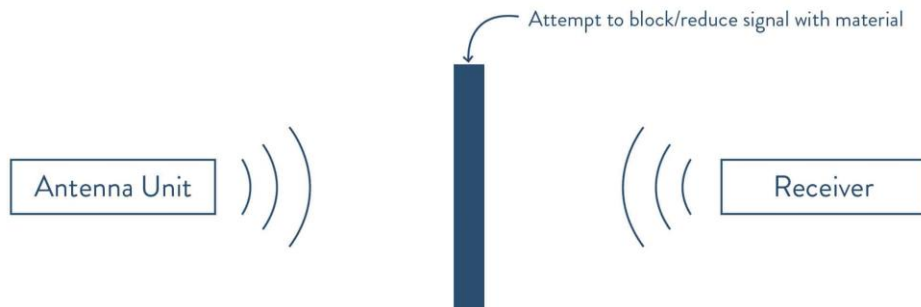
Proof-of-Concept

Immediately ideas began to flow on how we might accomplish this. The overall boot design was already in place as our engineering team has created boots for coaxial connectors ranging from NEX10 to 7/16 DIN before. The more pressing question became “what would the boot be made from?” All our weatherproof boots up to this point have been designed from silicone because of silicone’s incredible weather protection properties and resistance to environmental exposure. Pure silicone rubber does not however block RF signal that could easily find its way into nearby antennas from loose leaking connectors.

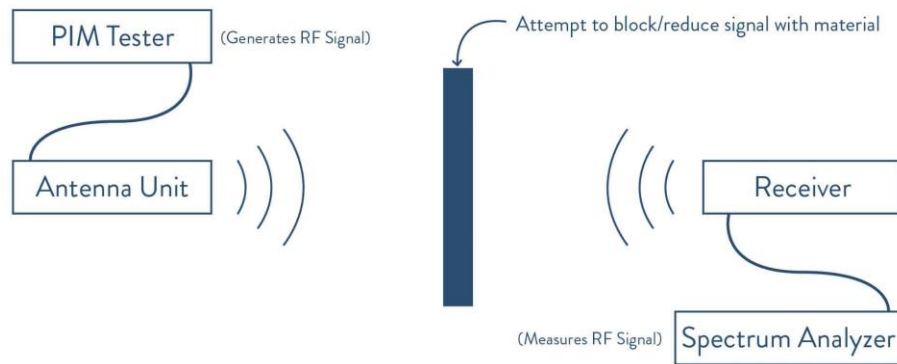
So the next question became, what material *would* block or reduce outside RF interference, and could a rubber style boot be manufactured from such a material? Those were the two key criteria that would have to be met for this to work and, needless to say, this brought about quite a bit of testing. Our team started by testing samples of different silicone rubber composite materials to see which ones would effectively attenuate, (or reduce), undesired RF egress, while still providing the level of weather protection our customers have come to expect from our boots.



To find the right material we had to put it through rigorous testing, which, (to vastly oversimplify the process), can be stated in a few steps. First, we would transmit an RF signal. Next, we would receive and measure the intensity of that RF signal. Lastly, we would place different materials in between where the signal was generated and where it was measured to see if the material made any noticeable difference to the RF signal, (i.e., block and/or reduce signal levels). The basic premise of this test is illustrated below.



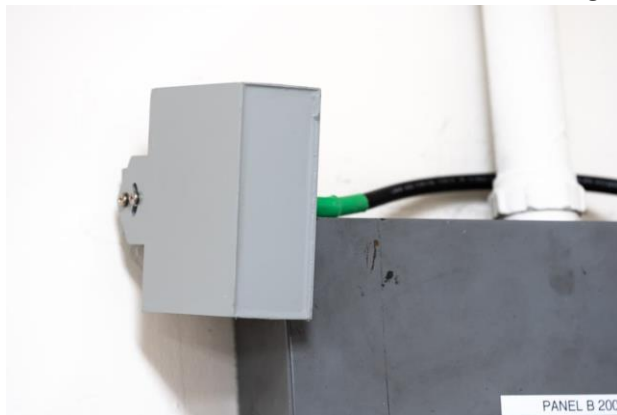
This process sounds basic but there are so many different ways to do it that we had to be sure we were using methods that would produce trustworthy test results. One way we found success in testing material was by generating the RF signals with a PIM tester which sent two RF signals (via cable) to a small antenna unit. The antenna unit would transmit the RF signals to be picked up by a field probe (receiver), with the results being shown on a spectrum analyzer, (illustrated below).



Below you can see some of the real-world equipment we utilized during the material testing phase of this process.



PIM Testing Equipment



Small Antenna Unit (Transmitter)

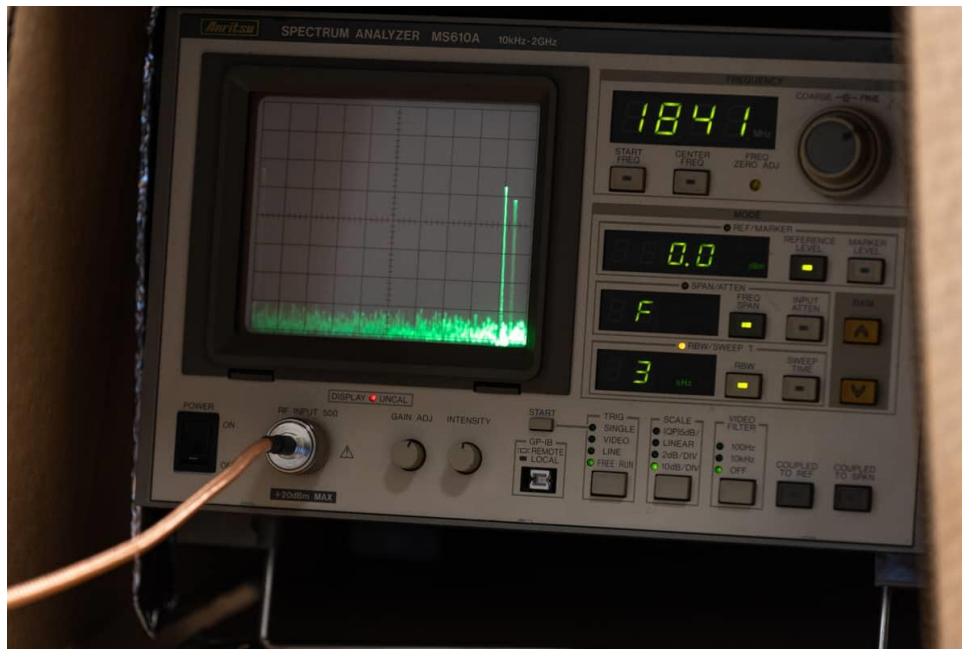


Magnetic Near-Field Probe (Receiver)



Spectrum Analyzer

We tested a number of different materials with this type of testing with some variations. As can be seen in the spectrum analyzer below we were able to pick up the two test frequencies, (1805 and 1880 MHz), quite clearly with this testing method.



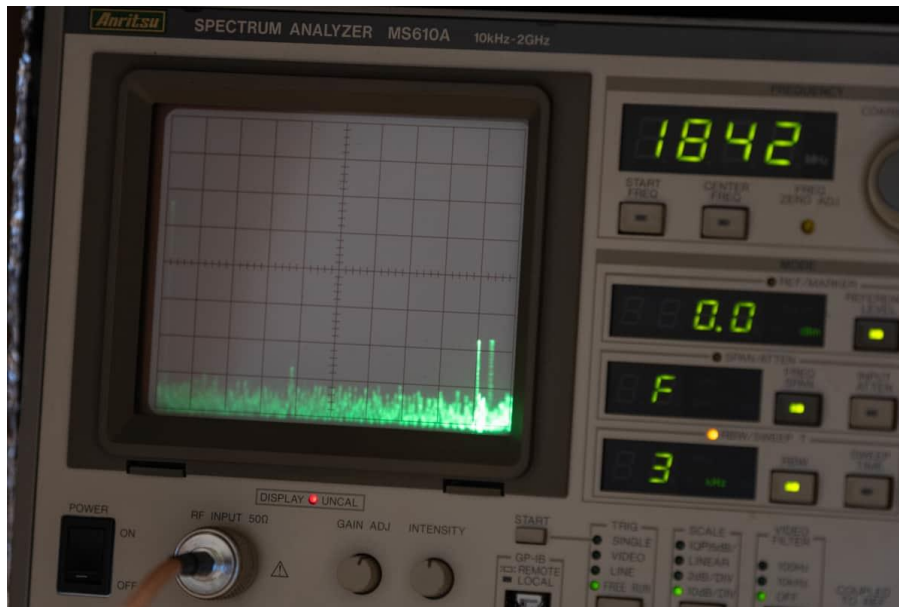
Spectrum analyzer read out of RF signal with no boot material

The next step was to test out different materials and see if those materials would impact the strength of those transmitted frequencies. Typically, we would take the material and place it over the antenna unit and check the spectrum analyzer for a difference in the strength of the signal.



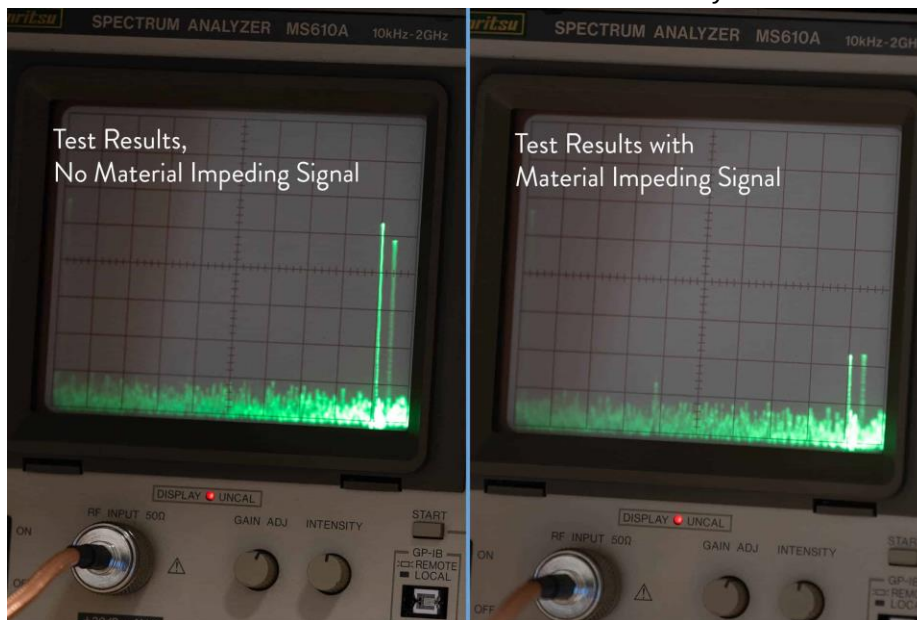
Antenna covered with material

We tested several materials, some of which had zero impact on the strength of the RF signal with others having negligible results. However, after going through several different iterations of materials we found a silicone rubber composite material that significantly attenuated the RF signals, as can be seen in the image below.



Spectrum Analyzer Read-Out of RF Signal with Boot Material in use

When compared to the earlier photo you can see that this composite material resulted in a reduction (or attenuation) of about 15-20 dB, a massive reduction. This led us to believe we had found the composite material that could be molded into a boot and realistically reduce RF interference. Here are the before and after results side by side.



We should note that these are proof-of-concept results and that a drop this significant, while fantastic, is not what would be expected in real-world results. In these tests we were looking for an effective material, but there is almost no real-world scenario where we would take that material and wrap it around the front of an antenna, (as we did in these early tests). Once we found a material

that worked, wrapping it around the front of the antenna unit *should* have drastic results, but not the same results as would be produced by a boot made of the same material over a connector.

Truth be told, what is shown above is only a fraction of the amount of testing that took place to choose the right material. Furthermore, the more testing we did the more refined our testing process became, (which can be seen in the actual boot testing below). These proof-of-concept tests were simply to make it easy for us to identify the right material that we would attempt to make a boot out of and, (of course), to see if our concept could work.

From Theory to Practice

It was time to take the material and put it into boot form. Luckily, we are well versed on manufacturing weatherproof boots and we were able to produce them with ease. We were very pleased that the boots did in fact have the elasticity we were looking for, and that the install/uninstall experience is essentially identical to our normal weatherproofing boots. In fact, if you were going by the feel of the boot alone you might find it difficult to tell the difference between our normal weatherproof boots compared to the Suppressor Boot. So we had now met one of the 2 needed criteria.



Gamma Suppressor Boot

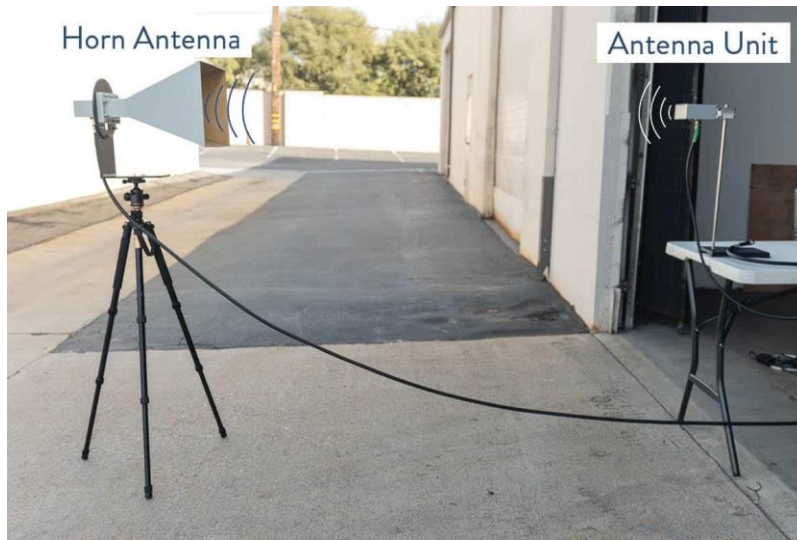


Antenna Unit

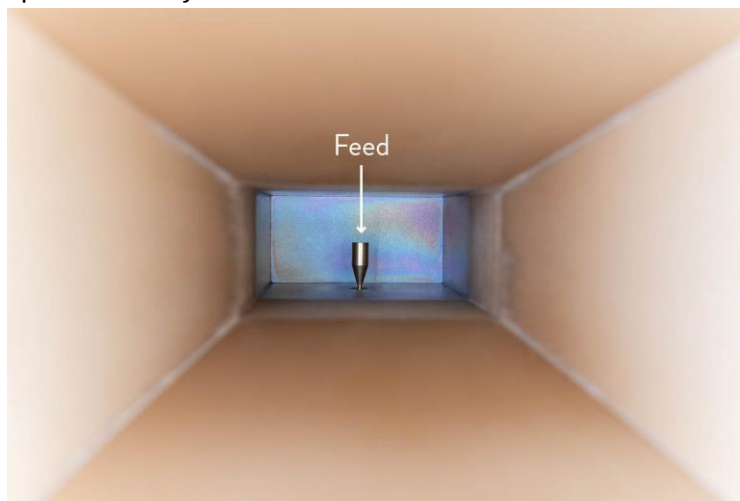
Once the boots were made, we knew we had to test them again and that the testing process would look a bit different. We improved upon the testing process for the actual boot while utilizing the basic idea used in the proof of concept tests.

First, like the proof-of-concept test, we generated RF signal from our PIM tester and sent the signals, (via cable), to the antenna unit. This time we took all the testing outdoors to help eliminate any wall reflections.

Next, we aimed the antenna at a horn antenna designed to receive the RF frequencies being transmitted much like water going into a funnel.



RF Signal Radiated by a Waveguide Antenna and Collected by a Horn Antenna
 Inside the horn antenna cavity is a dipole feed element measuring the intensity of the RF frequencies being transmitted to it. The signal intensities are then measured by our trusty spectrum analyzer.



Feed inside of Horn Antenna Cavity

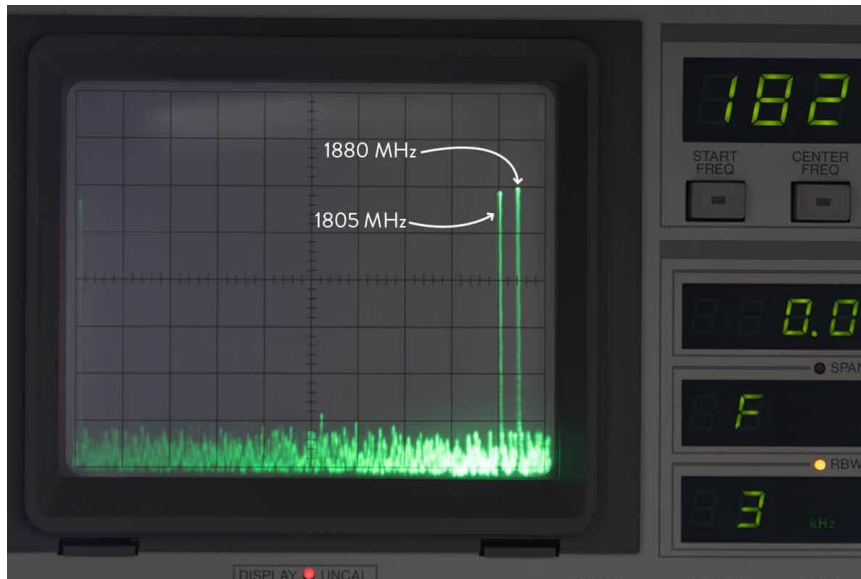


PIM Testing Equipment next to Spectrum Analyzer

Like before, the spectrum analyzer would tell us how much of the transmitted signals were being picked up and how much was attenuated by the suppressor boot. Note, in the photo above that we covered the spectrum in two different boxes, one of which is covered in foil, to shield it from any outside interference. We did this despite the fact that it should only be showing frequencies coming via the cable from the horn antenna, but we wanted to make sure we were eliminating any potential interference.

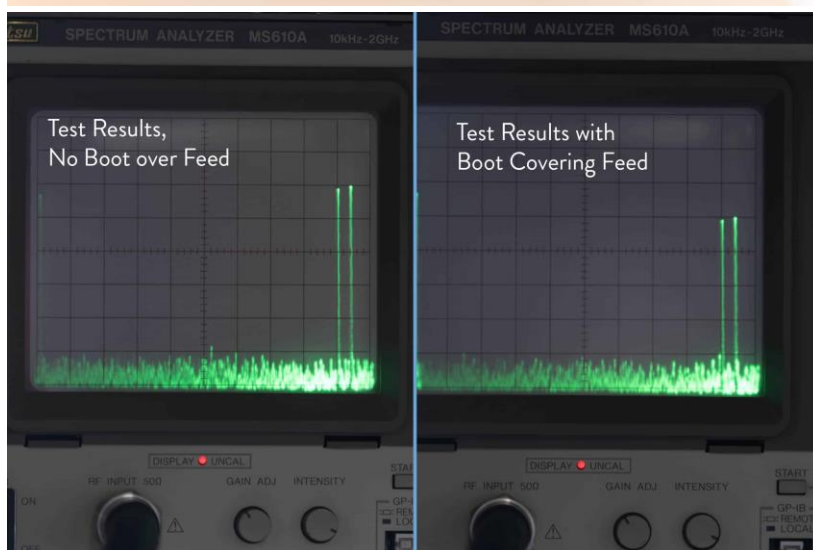
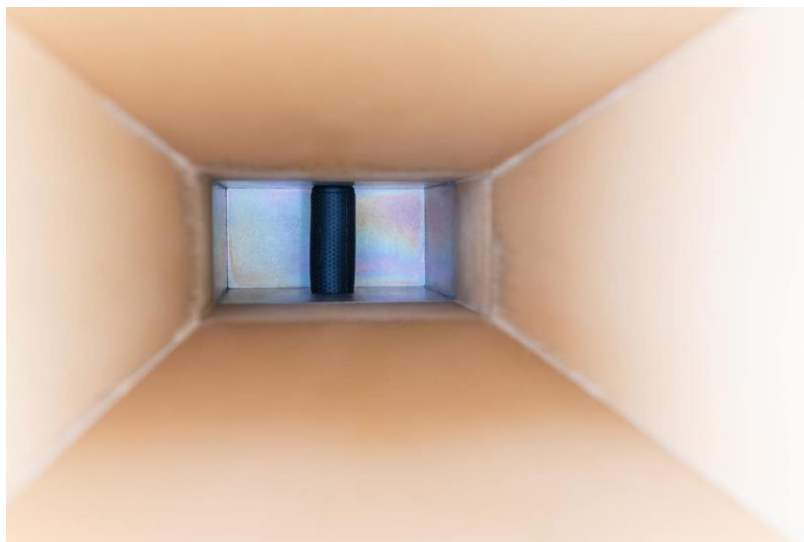
Testing the Boot

In order to know how much RF signal was or was not being affected by the boot we first had to measure how much the transmitted frequencies were being picked up by this testing setup. The first image below shows the results with no boot over the feed (unattenuated).



Like the proof-of-concept testing we can clearly see two frequencies being transmitted: 1805 and 1880 MHz.

Next, we placed the Suppressor Boot over the feed inside the horn antenna, (click photo to enlarge). As soon as we placed the boot over the feed there was an immediate signal drop shown on the spectrum analyzer. You can see the before & after photos below.



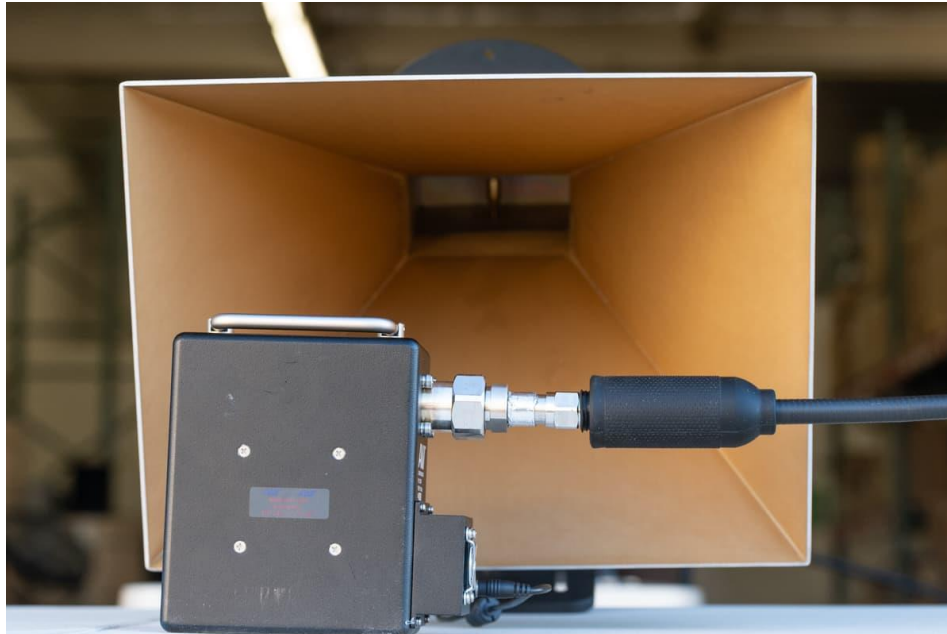
With the suppressor boot over the feed we saw an immediate drop of at least 10 dB. Don't let the spectrum analyzer fool you, a 10 dB drop is huge. Decibels (dB) are not charted on a linear scale, instead the spectrum analyzer is giving us a logarithmic reading. In other words, a drop of 10 dB is not simply a loss of 10 units but amounts to a 90% reduction in signal intensity. If the Suppressor Boot were to reduce the signal by 3 dB that would mean it effectively reduced the original signal's power by half. **A 10 dB reduction means the Suppressor Boot has effectively reduced the RF signal to 1/10 of the original signal.** It doesn't quite look that way in the test result but that's the nature of a logarithmic scale: the logarithmic scale is designed to make numbers that are greatly spaced apart easier to read on a graph.

Testing for Real-World Scenarios

Next, we performed a test that was more like a real-world scenario. Instead of using a waveguide antenna to transmit the frequencies we instead created a "leaky connector" scenario by sending the signal from the PIM tester to a 50 Ohm dummy load, (commonly used when testing RF cables). We

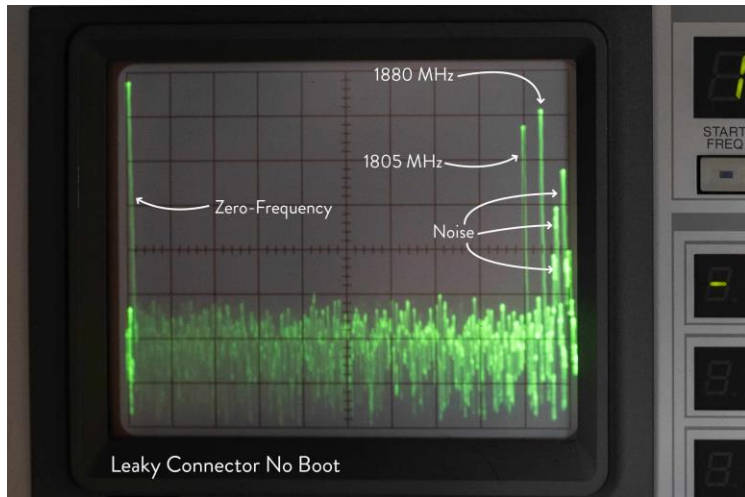
used a Type N connector and only hand tightened the connector to the load. We then placed this leaky connection in front of the horn antenna.

In essence, the leaky connection is replacing the antenna as the transmitter in this test. As can be seen in the photo below the cable did have the Suppressor Boot on it, (in preparation for the next step in the test), but the boot was not covering the connection.



For this test, the RF power of each frequency from the PIM generator was 43 dBm versus 33 dBm, (which is what we used in the previous test with the waveguide antenna). This increase in power was to compensate for the reduced radiating efficiency of the leaking connector compared to that of the waveguide antenna. In other words, the leaky connector doesn't radiate signal the way the waveguide antenna does and we wanted to make the signal clearly visible when seen on the spectrum analyzer. If you compare the photo to below to earlier tests above you can see the change in power on the spectrum analyzer. Each horizontal line on the spectrum analyzer represents a division of 10 dB, and the results in the leaky connector test do show up as 10 dB higher than previous tests due to this power change.

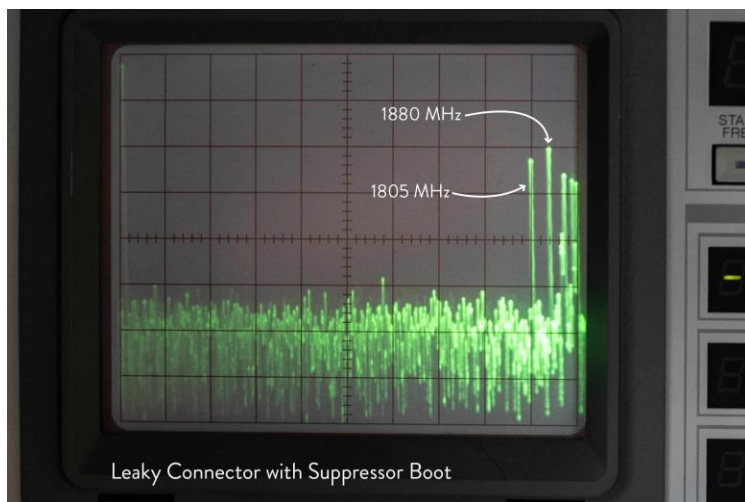
The reduced radiating efficiency also resulted in a larger signal-to-noise ratio. As opposed to previous tests with the waveguide antenna where we really only saw the 1805 and 1880 MHz frequencies, we are now seeing more noise showing up alongside the signal on the spectrum analyzer. Again, the results from a leaky connector were not going to be as clean and clear as results from the waveguide antenna. As a result of this larger signal-to-noise ratio, the spectrum analyzer was operated with a much larger gain setting to help separate the signal from the noise. The noise at zero-frequency and frequencies greater than 1880 MHz is comparable to the signal itself as seen in the pictures below. However, in each test, the gain was set to a fixed value before the Suppressor Boot was applied so the before-and-after signals are apples-to-apples comparisons. Long story short, we made some adjustments to make the results more clearly visible but those adjustments had no bearing in determining how effectively the boot would work.



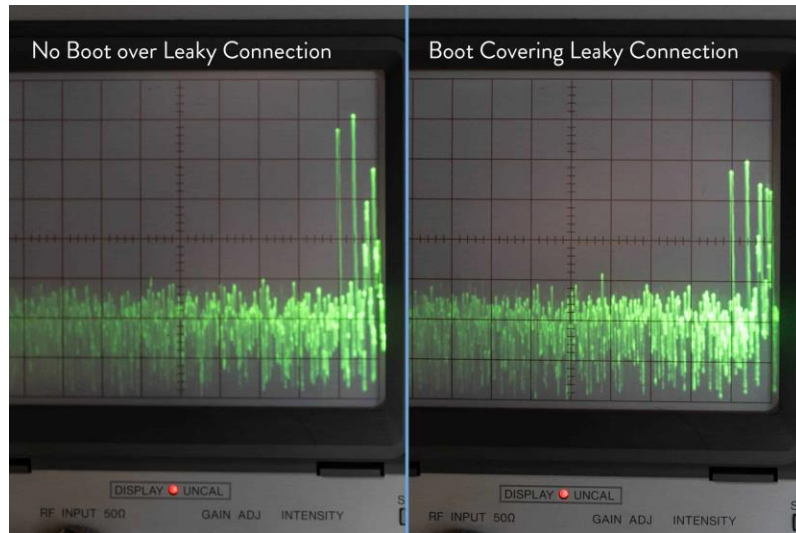
The only thing left to do now was to cover the leaky connection with the Suppressor Boot and see if there was a drop in intensity of any significance on the spectrum analyzer.



It was the moment of truth. Months of work came down to this test.



Just as we saw in the previous test, there is **at least 10 dB in attenuation/reduction. A massive reduction.** Again the 10 dB reduction indicates that **the frequency intensity has been reduced to 1/10 of its original intensity.** Here's the results without and with the boot side by side.



We've tested the Suppressor Boot time and time again and each time it produces the same results: at least 10 dB attenuation. We had achieved what we set out to do. We had successfully found the right material and manufactured it into a great RF interference attenuation/reduction solution.

What It All Means

A reduction of about 10 dB is impressive, but what does it really mean?

Anyone with familiarity of cell phone towers or fixed wireless in general is aware of the often dozens of cables being utilized at a single site, all of them carrying RF signal. With that much electromagnetic signal flowing any type of egress or leakage can quickly become a major problem as those signals can interfere with one another, resulting in poor service and/or cross talk. In some cases, interfering with the wrong frequencies can even result in being fined.

Over the past ten years, the problem of CATV, 4G LTE and now 5G signal interfering with each other is compounding. RF interference is a huge problem for Cable TV providers as they are strictly regulated by the FCC and run the risk of getting fined if their RF networks are leaking. In fact, it is well known that when they leak RF signal into the air AT&T, Verizon or T-mobile will come knocking on their door letting them know that they their CATV network is interfering in their network. If the cable TV provider is unresponsive, it can lead to significant fines. It all has to do with a hierarchy and who has the rights to the frequencies transmitted. The shared frequencies of 600 MHZ and 700 to 800 MHZ is especially problematic. The Gamma Suppressor Boot was designed largely with these problems in mind.

The testing above shows that if a single connection were to be leaking signal that the Gamma Suppressor Boot would greatly help contain that RF leakage. The boot is designed to simply reduce and/or block RF frequency from getting through and possibly finding its way into an antenna, which would introduce Passive Intermodulation, (PIM), to the system. Add to this that the Gamma Suppressor Boot also provides IP68 rated weather protection and the incredibly fast install/uninstall process, and you have an easy-to-use solution providing multiple layers of protection.

Available to Order Now



The Gamma Suppressor Boot is now available in 4 different variations:

NEX10 to 1/4 inch superflex Suppressor Boot

4.3-10 to 1/4 inch superflex Suppressor Boot

4.3-10 to 1/2 inch annular Suppressor Boot

7/16 DIN to 1/2 inch annular Suppressor Boot