ARRL Antenna Book – 22nd Edition

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ARRL Antenna Book — 23rd Edition

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Using LPDA TV antennas for the VHF ham bands.

By John Stanley, K4ERO

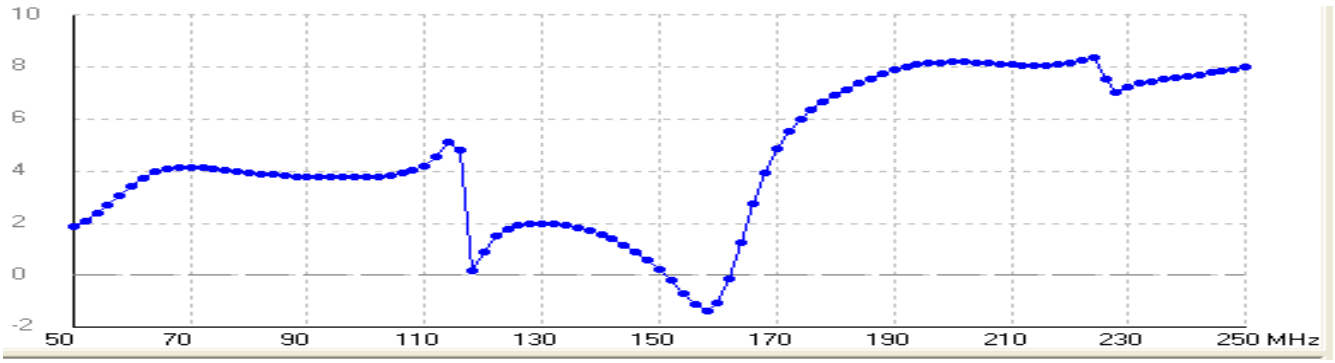
Probably the most commonly seen type of TV antenna is the log periodic, with corner reflector and parasitic directors for UHF. An example of this type of antenna is shown here. This one has V shaped elements for the lower bands, operating as a Log Periodic Dipole Array. The lower TV bands, VHF Ch. 2 - 6 (54 - 88 MHz) are received with the four largest elements, while Channels 7-13 (175 - 216 MHz) use the same elements operating in the third harmonic mode. The corner reflector works with a dipole at its focal point to receive the lower UHF channels while the higher UHF channels get gain from the multiple parasitic directors off the front of the antenna.

Variations of this general type may use straight elements instead of the V type, may use many more elements in the LPDA section, and may use more parasitic elements to enhance certain bands, but the operation is generally about the same. We can measure the various elements of a TV antenna and model it on NEC. Doing so will usually show that some thought went into the design and that it does quite a credible job for the frequencies it is intended to cover.

With the transition to digital TV, many of the VHF channels are no longer used as most of the digital signals have moved to UHF. Even though they retain their original channel numbers, with an additional digit added to allow for multiple programs from a single station, the actual transmission is often on a different frequency than the old channel numbers would indicate. For example, Channel 2 in Atlanta, long a bane of six meter operators there, is now actually on UHF Channel 39, even though it still operates as Channel 2 and your TV set will bring it up as Channel 2-1 or 2-2. In some areas, all of the local channels are now on UHF, making it possible to trade your all band antenna for one that does a great job on the UHF channels only, while being much smaller than the all band job.

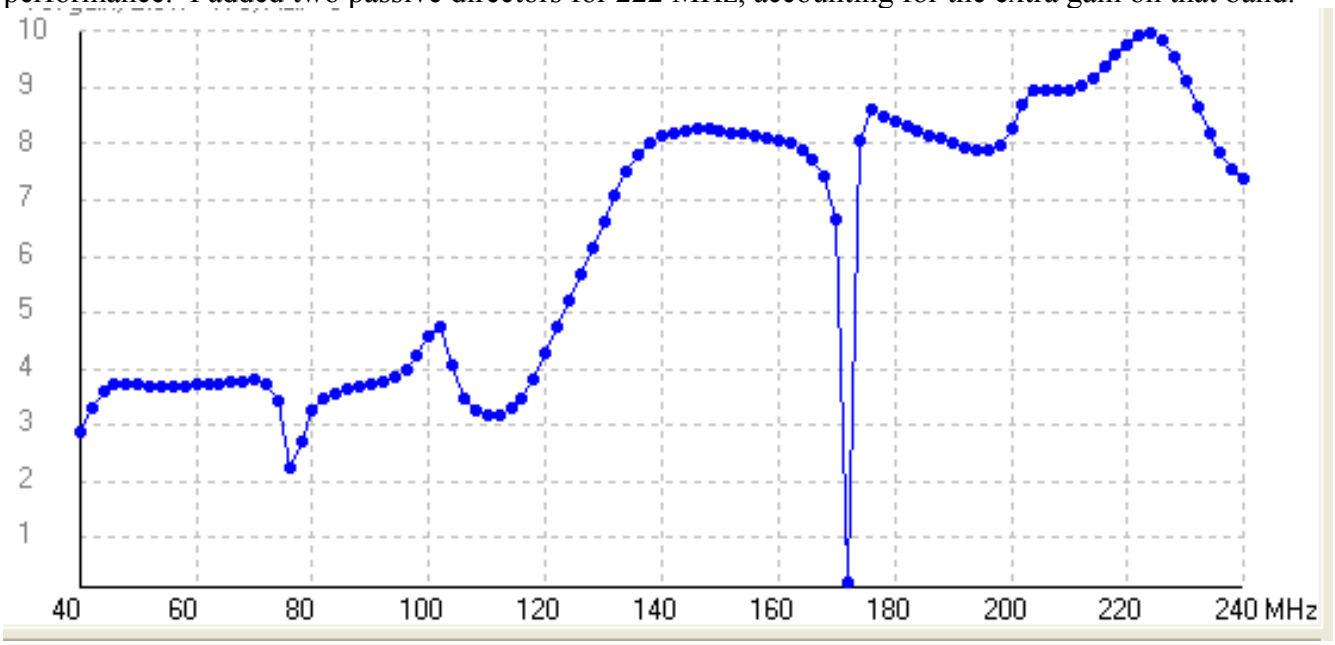
As the "go to geeks" for all of the widows in our community, my wife and I have replaced quite a few older antennas with newer more suitable ones. Since I never throw anything away, we had quite a stash of various all band TV antennas around, and the obvious thought was to see how they might work on the ham bands. TV antennas are generally not as robustly made as the better ham antennas, but even at that, they usually survive wind and weather fairly well. Furthermore, to allow easier shipping and installation by less than "ham qualified" homeowners, they fold up into very compact packages while allowing easy snap in place deployment. This feature, along with the multi band coverage, might be very useful to hams in a field day or VHF contest as a roamer. TV antennas are also rather stealthy for those who would rather the neighbors not know they are operating an amateur station.

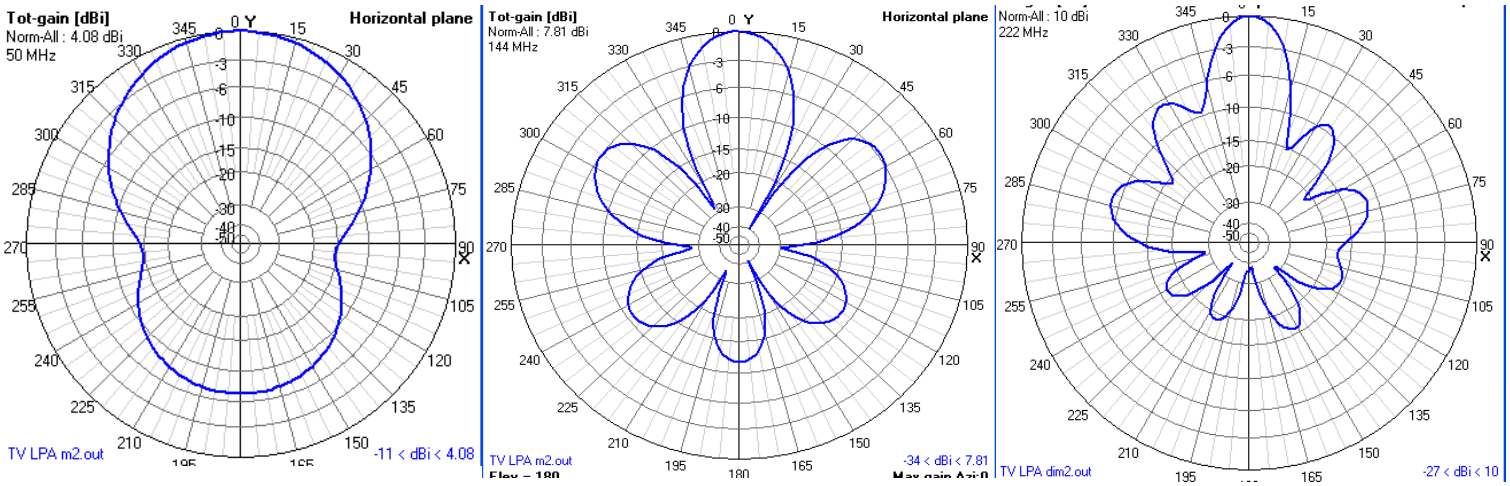
Modeling an antenna like the one shown above, NEC showed the following gain curve:



Obviously, the antenna is designed for the low VHF band just above 50 MHz, and also operates well on the high VHF band which is above 144 MHz. This high band operates on the third harmonic mode and, therefore, has significantly more gain than the low band VHF channels. It seemed to offer the possibility of lengthening the elements so as to cover 50 MHz as well as providing third harmonic operation on 144 and 222 MHz.

Since the location of the elements is difficult to change, involving changes to the crossing transmission line as well, the NEC trials involved only lengthening the elements, not moving them. This, of course, makes some change in the value of σ, but since this is not critical in LPDA operation it was thought to be worth an try and indeed, the resulting NEC model looked very encouraging. After some adjustments on the NEC model, I was able to move the frequencies of operation down so as to get the following performance. I added two passive directors for 222 MHz, accounting for the extra gain on that band.

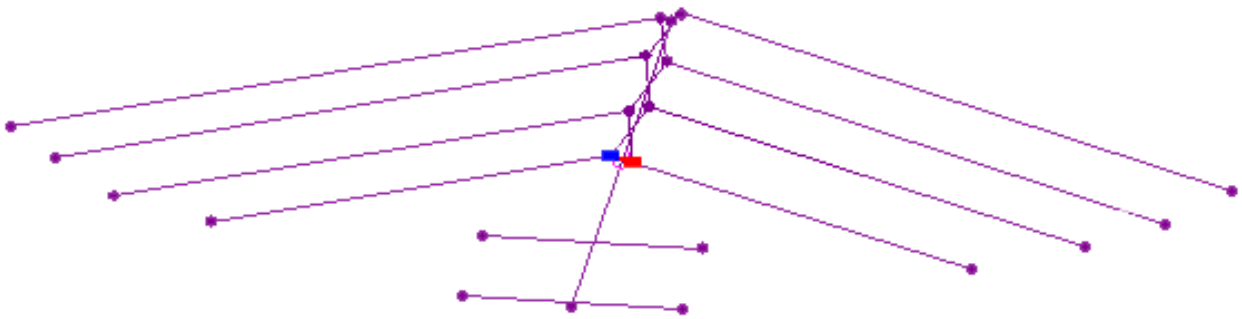




The predicted pattern was very clean on 50 MHz but had lobes on the two higher bands due to the third harmonic operation. The calculated match to a 300 line was about 1.5 to one or better for all three bands of interest. The front to back ratio was only 7 dB on 6 meters, but I felt that was not a serious problem. and the mechanical complications of adding a passive reflector for that band was not justified.

The actual modification involved removing the UHF portions and lengthening the LPDA elements to the values predicted by NEC. This took only a couple of hours. Since I had extra elements from another similar antenna, nothing had to be bought but a few stainless steel bolts to replace some of the corroded rivets.

I had elected to stay with the original feed system, since changing it would represent quite a bit of complicated construction, and thus, ended up with a 300 ohm feed point impedance. This could go into a 300 to 50 ohm balun transformer at the antenna, but I elected to use twin lead and a tuner at the transmitter. Although not as commonly found as HF tuners, VHF tuners can be easily built. Using twin lead could be attractive for a roamer or other portable operator as there is no other line as light weight and compact that has comparable low loss. I chose to remove the UHF portion of the antenna and used that part of the boom to mount a couple of elements from the corner reflector that serve as directors on 222 MHz, adding about 2 dB additional gain on that band.

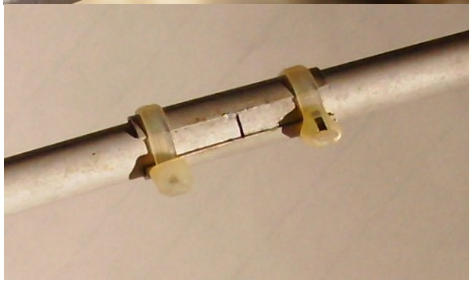


The dimensions of the modified antenna are as follows:

Element lengths, 69, 63.5, 55, 43 inches (each half element); parasitic elements 22.5 inches total
Element spacing 10, 22, 34 inches from rear end of boom (same as original TV antenna)
Location of parasitic elements 1 inch and 16 inches from front end of boom.
Total boom length 71 inches (same as original TV antenna)

Of course, your recycled TV antenna may not be exactly the same depending on what you start with. In general, adding length to LPDA elements should have a similar result, but you need to prove that with a NEC analysis before proceeding with the modifications. If you wanted to keep the appearance of the antenna nearly like the original for stealth purposes, you could replace the unwanted elements with non conductive materials, such as wood or plastic and paint them white or silver. But even without that extra effort the modified antenna still looks very much like a TV antenna.

Since the LPDA elements had to be lengthened, and this was the main work involved, I will spend some time addressing that issue. I had some extra element tubing from other antennas, so I simply joined it to the existing elements. If you don't have an extra antenna for parts, and not enough extra element material even after removing the corner reflector and other extraneous parts, you can probably find some 5/16 inch aluminum tubing or rod at the local hardware store. This fits nicely inside the TV elements. For best strength and weight distribution, it is best to attach these heavier parts to the boom, attaching the lighter weight original elements to them at the end.



Sometimes, the rivets that hold the elements to the boom are corroded. For reasons I don't understand, some antennas seem to use a mixture of aluminum and steel hardware. Either type can be drilled out, but don't plan to reuse them. Instead, get some long 8-32 or 10-32 stainless steel machine screws and bolts.

If you have enough original element material from this or another antenna, you can join it to the existing sections as shown here. Cut the end off of the existing element using a jeweler's saw. This has very fine teeth and will cut the thin walled element easily without damaging it. If you don't have a jeweler's saw you might take the tubing to someone who does to get it cut. Perhaps your local jeweler might have a jeweler's saw!

Push the nose of a long nosed plier into the open end, twisting as you do. Since the elements are usually rolled, rather than solid tubing, this will flare the end out like a bugle. A properly sized pen or pencil can also be forced into the tubing to flare it out, while keeping it round. For the extension elements to be added, use a tubing cutter to cut the extension piece to length. The cutting wheel on the tubing cutter tends to push the metal in, making the diameter a bit smaller. You should then be able to push the smaller end into the spread out end overlapping about 1 inch. It will be gripped quite tightly by the larger piece due to the natural spring of the metal. Then put a cable tie over the flared end to further clamp it on the extension. This will make quite a tight fit. If you wish, a drop of super glue (cyanoacrylate) will make it even more secure, but use only a drop so it doesn't spread all over and leave an insulating layer between the metal pieces.

If you are using the 5/16 tubing or rod, the TV elements will fit over it fairly snugly. Rather than cutting the extensions, simply slip as much as necessary over the 5/16 tubing or rod. Secure by either crimping the TV element a bit, or by using small screws (4-40 is suggested). Again a drop of super glue can be used. With either type of extensions, a bit of shrink tubing could also be used for extra robustness.

Another good option is to use a 1 inch piece as a splice between two pieces that have been cut with the tubing cutter. Spread the entire splice by pushing a pencil, pen or long nose pliers into it. Both element pieces should slide snugly into the splice. Put a cable tie on each end of the splice. This makes a very strong and straight joint. If you have trouble getting the element pieces into the splice, try tapering the end of the element a bit more using a file or sandpaper, rather than overspreading the splices, as that could prevent them from gripping the elements tightly. Using a countersink or tapered reamer on the splice may also help.

Feed the antenna just as it was fed before, except that you may need to remove feed leads that connected to the UHF parts. Depending on the antenna used, some slight modifications at the feed point may be needed. Just remember that the LPDA elements are fed from the center of the antenna, at the shortest element, and that the feed line crosses itself between each elements. Use TV standoffs to keep the 300 ohm line away from the mast as with any TV installation.

If you have kept the mounting of the elements as they were, the antenna should still be able to fold up as before. It will make a very compact and light weight package considering that 3 bands are covered, and it can be set up in a matter of seconds. When folding, but sure to pull up the flap that holds the elements in place to avoid bending them. When opening, these flaps insure that the element is put into the correct position. With the extended elements, the antenna will not be as robust as before as far as wind and, especially, as far as bird perching are concerned, but should be able to withstand most normal situations. Fortunately, LPDA arrays are quite forgiving with regard to slightly bent elements.

The TV LPDA folds to a small package for transport, and within 60 seconds can be unfolded and ready to mount. A single feed line is used for all three bands.

John (K4ERO) and Ruth (WB4LUA) have been hamming together for over 40 years, while working as technical missionaries in many overseas radio stations. John is a technical advisor for ARRL, and his writings have appeared in many ARRL publications.