Performance Degradation of an LPDA at the Upper End of the Band
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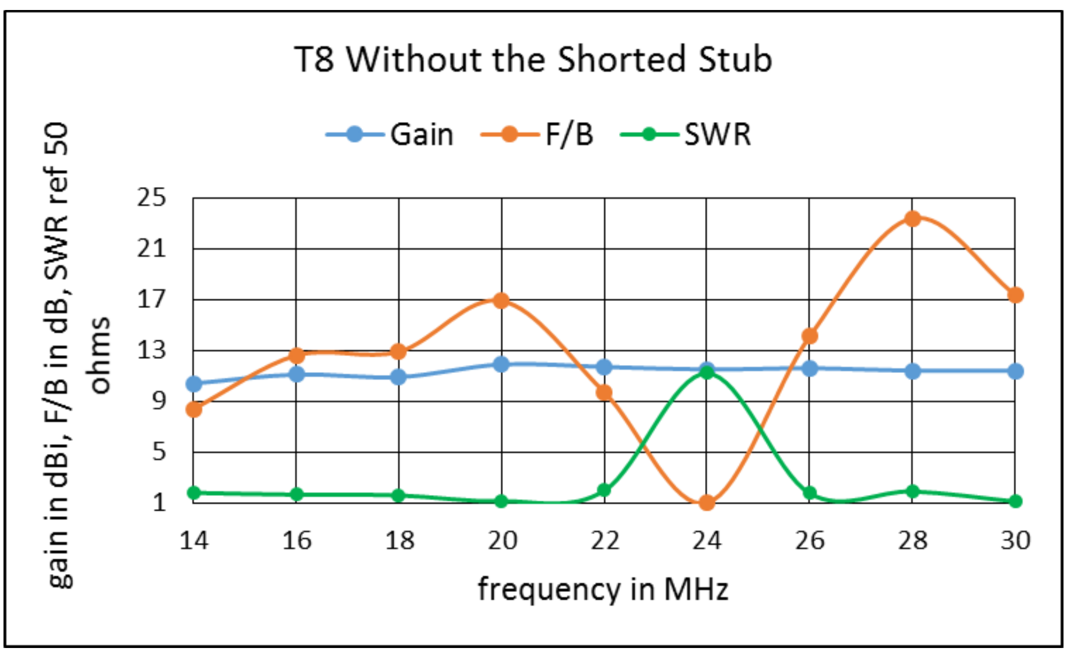
In the summer of 1995 I replaced my old trapped-tribander with a Tennadyne model T6 log periodic dipole array (LPDA). It covers 13 MHz through 30 MHz, has 6 elements, and is on a 12-foot boom. With a heavy taper schedule on the elements, its wind load is small enough to allow it to be mounted on my self-supporting aluminum tower.

The T6 has served me well since 1995. At 60 feet with 1 kW from a single 3CX800 tube amp, I've worked all current DXCC entities, and enjoy being able to QSY between 20m, 17m, 15m, 12m and 10m with the simple flick of a band switch on the radio (and on the amp, of course).

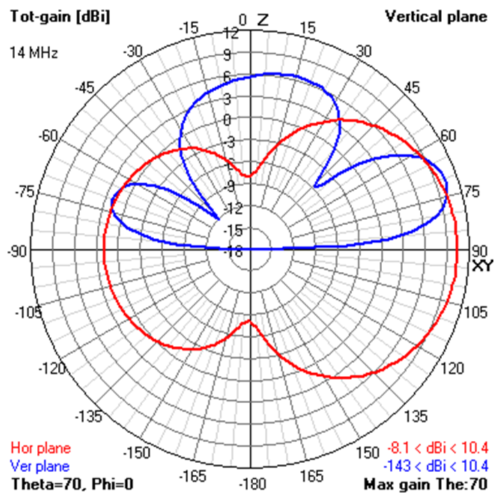
One of the fun tasks I did when I bought the T6 was to model it. The NEC model showed expected results. But there was no gain and no F/B around 27 MHz. This wasn't an artifact of the model, so I added a 3-foot long shorted stub at the low frequency end (the long elements) of the T6 boom (note 1). That resolved the gain and F/B anomalies around 27 MHz, and also improved the SWR at the low end of the band. For more details of this effort, check out my article titled *Log Periodic Dipole Array Improvements* in the ARRL Antenna Compendium Volume 6.

Recently one of the locals here in Fort Wayne (Jim Wolf KR9U) put up a Tennadyne T8 LPDA on a 48-foot HBX tower. It had a 1.5-foot long shorted stub on it, and I wondered if it was there to resolve a pattern anomaly at the high end of the band like my T6. So I modeled the T8 at 50 feet using 4nec2 (from Arie Voors). I looked at gain, F/B and SWR every 2 MHz from 14 MHz to 30 MHz. The plot of those three parameters without the shorted stub follows.

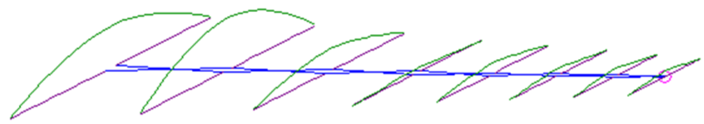


The gain is flat across the entire range at around 11 dBi. But the F/B and SWR have a problem around 24 MHz. Let's look at the azimuth and elevation patterns at 14 MHz, 28 MHz and 24 MHz to see what's happening to give the anomalous performance around 24 MHz.

Here’s the azimuth pattern (red), the elevation pattern (blue) and currents (green) in the elements at 14 MHz.

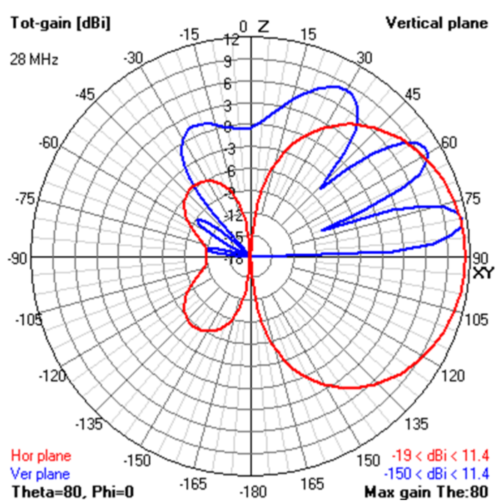


14 MHz without stub

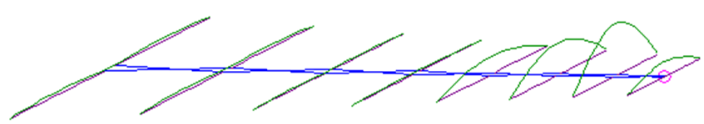


The azimuth and elevation patterns are decent, and for all intents and purposes the three longest elements are active at 14 MHz.

Here’s the azimuth pattern, the elevation pattern and currents in the elements at 28 MHz.

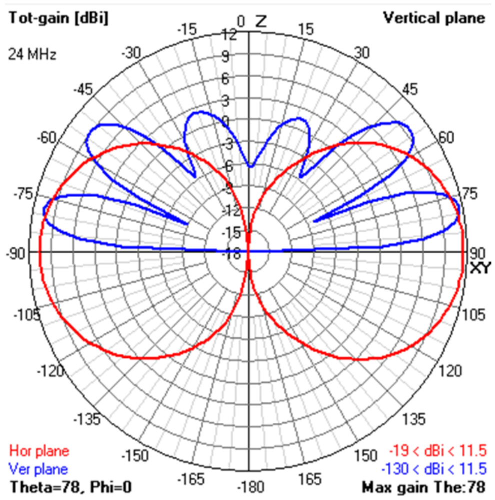


28 MHz without stub

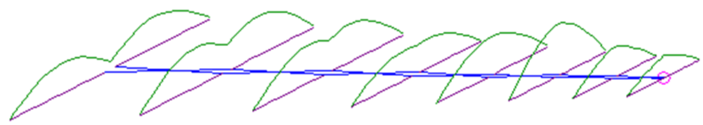


The azimuth and elevation patterns are much more “Yagi-like” at 28 MHz, and for all intents and purposes the four shortest elements are active at 28 MHz.

Finally, here's the azimuth pattern, the elevation pattern and currents in the elements at 24 MHz. What we expect to see at 24 MHz is the active region shift a bit to the left on the boom compared to 28 MHz.

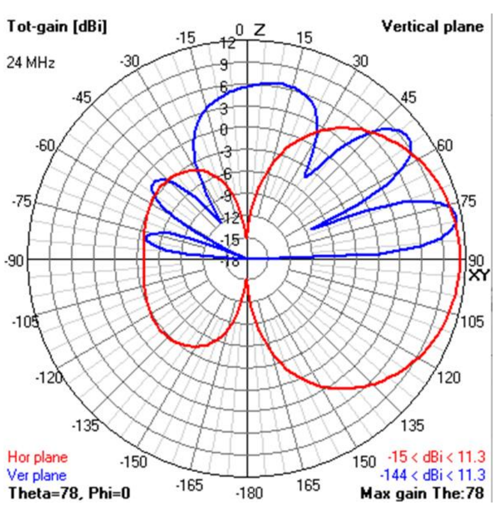


24 MHz without stub

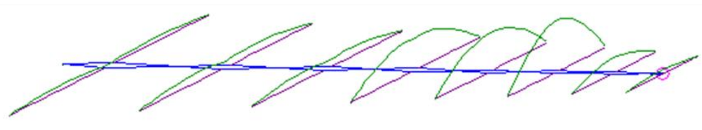


This doesn't look good – there's essentially no F/B, and as a reminder the SWR shoots up as seen in the plot on the first page. The problem is that <u>all</u> the elements are active around 24 MHz. What's happening is the longest elements are operating as two half-waves around 24 MHz (you can see it in the shape of the currents).

Now let's add the 1.5-foot shorted stub on the low frequency end of the T8 boom (you can see it in the model). Here's the azimuth pattern, the elevation pattern and currents in the elements at 24 MHz for the T8 with the stub.

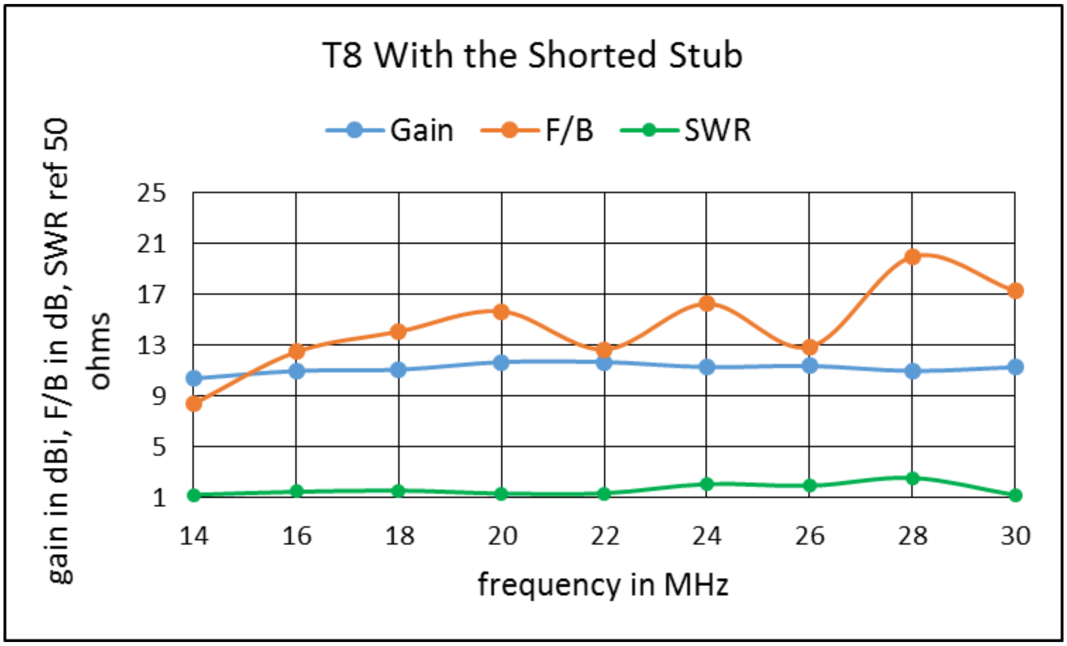


24 MHz with stub



Now things are back to what we expected – the active region shifted a bit to the left on the boom compared to 28 MHz, and the azimuth and elevation patterns look very nice. So the 1.5-foot shorted stub resolved the performance anomaly near the high end of the band.

A good question to ask is "what effect does the shorted stub have on the other frequencies?" It's easy to run the model with the shorted stub. Here's that plot.



The gain is very similar to the 'without stub' configuration. The F/B shows higher F/B as frequency is increased, and it shows a cyclic nature that is expected of a log periodic structure. The SWR is respectable across the 14 to 30 MHz range. The SWR does increase to 2.5 to 1 at 28 MHz (from 1.9 to 1 without the stub), but that should not be a problem (especially with a run of coax to the shack that adds some loss). As a side note, I varied the length of the shorted stub and found that a 1.5-foot stub is optimum for the T8 model.

In conclusion, wide band log periodic dipole arrays can show a performance anomaly near the high end of the band. With the use of a proper-length shorted stub on the low frequency end of the boom, this anomaly can be eliminated with minimal impact at the other frequencies.

Note 1. Adding a shorted stub on the low frequency end of the boom came from an obscure remark in one of the many technical papers about LPDAs. It said the shorted stub helped performance at the low end of the band due to the array being so abruptly truncated at low frequencies due to physical limitations. Nothing was mentioned about the anomalous performance at the high end of the band. The more well-known benefit of the shorted stub is putting the entire structure at DC ground.