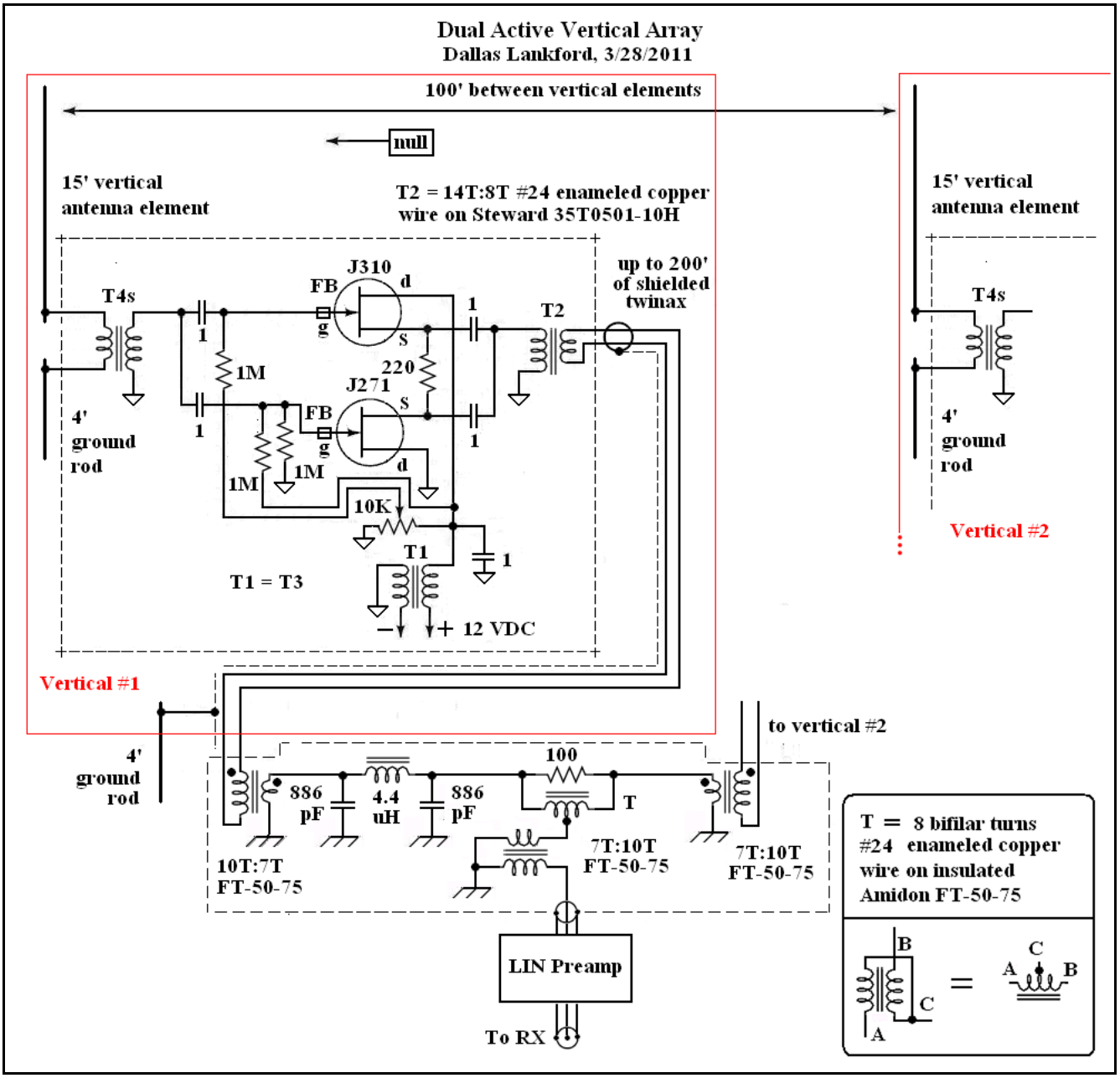
Dual Active Vertical Arrays

Dallas Lankford, 3/28/2011, rev. 3/30/2011

I had two PPL's which I had been using to test various dual delta flag and dual delta loop arrays using two 15' fiberglass masts, so it was natural to take down the delta elements and replace them with 15' vertical elements. I was also curious if the nulls of dual active vertical arrays would be any better than the poor nulls of the dual and quad passive vertical arrays which I tested about two years ago.



The actual test setup used two 13.6 dB gain LIN preamps at the phaser ends of the 200' lengths of shielded twinax, each PPL connected to the phaser by a short length of coax.

Testing began about 2 pm on ground waves with the array null aperture maximum depth pointed North (or South, by swapping the two phaser inputs). Ground wave nulls were generally poor compared to the nulls

obtained from the dual flag and dual loop arrays which I have been testing for about the past 3 months or so.

Several hours later, about 9 pm CDT, sky wave nulls of the dual active vertical array were studied. Two nulls, one for WHO 1040 kHz, Des Moines, the other for KMOX 1120 kHz, St. Louis, were fair to good, but all others were extremely poor, virtually non-existent. However, the strong Latin Americans (Mexicans?) on 720 kHz and 780 kHz seemed to be missing, with Chicago booming in on both frequencies, so it is uncertain if the nulls on those two frequencies were all that poor. On the other hand, 650 kHz Nashville was also booming in, with the usual Latin American grave yard totally absent. An hour and a half later the 720 and 780 Chicago nulls had improved from non-existent to fair. 650 kHz Nashville and 840 kHz Louisville nulls were still non-existent, and 890 kHz Chicago null was poor. High band MW nulls like 1510 kHz Nashville were generally poor throughout the evening. The dual active vertical nulls were perhaps slightly better overall than the dual passive vertical nulls had been about 2 years ago, but not enough for me to give it a thumbs up. Apparently the standard way of phasing arrays does not apply to vertical arrays which invariably have one negative resistance vertical element. The only information I have found for phasing such vertical arrays is "Negative Resistance Antenna Elements," Grant Bingeman, KM5KG, here. The two methods discussed there are narror bandwidth because both require resonating at least one of the vertical elements.

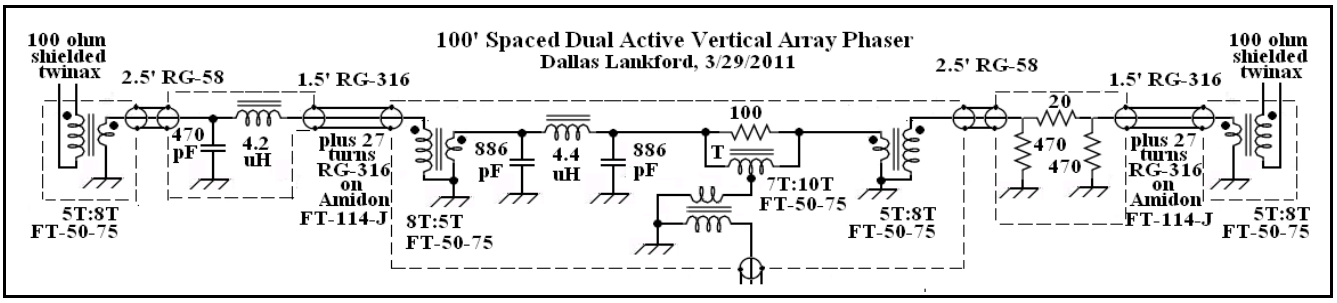
Interestingly, high band MW signal levels day and night for the dual active 5 meter high vertical array were not as great as for the best dual 40 square meter element area dual flag and dual loop PPL (active) arrays despite EZNEC simulations showing that 5 meter high dual active vertical arrays have much higher dBi than 40 square meter antenna element delta flag arrays. Low band MW signal levels were about equal. This means that signal levels produced by well designed 40 square meter area active dual flag and active dual loop arrays in the MW band were on the average about the same as or better than for a dual 5 meter active vertical array.

However, splatter reduction and RDF of active dual flag arrays and active dual loop arrays is much better than the active dual vertical array above. Splatter reduction can be compared by comparing optimized null apertures using EZNEC. RDF's were 11.1 (WF) , about 10 (loop array optimized for RDF), and about 8 (the best I could do for the verticals, though some claim to have done considerably better) respectively according to EZNEC.

In the past flag arrays tended to be insensitive. But this was because previous flag arrays were passive. Now that active flag arrays have been introduced in "High Z PPL's For Loop And Flag Arrays" in The Dallas Files and further developed in "Dual And Quad MW PPL Flag Arrays," they are clearly the first choice for relatively compact MW arrays.

Normally I would not publish an antenna array with non-competitive performance characteristics, but in this case I am making an exception.

But Wait, There's More !



This morning, 3/29, I spent more time playing with the dual vertical array. I seemed to remember that for previous vertical array flops, I had tried a variable phaser, and it produced excellent nulls. A 3 port (dual array) variable phaser varies both amplitudes and phases of two inputs. But my variable phasers do not have dials from which the amplitudes and phases can be read. So I proceeded by trial and error. A variable step attenuator showed that the required attenuation was on the order of 1 or 2 dB . So a 100 ohm pot in series with the appropriate signal path gave me the variable amplitude adjustment control that I needed. The variable delay was

obtained with a variable length RG-316 which switched in and out 1, 2, 4, and 8 foot lengths, and several fixed ≈ 6' lengths of RG-58. The total length of coax delay required for deepest null on 580 kHz Alexandria about 100 miles due South was about 37 feet. I replaced the 33 ohm resistor with a pi network of 3 resistors as shown in the schematic above. The pi network has 100 ohm input impedance and 50 ohm output impedance, so there is mismatch, but I got tired of fiddling with the attenuator after it maximized null depths. After all, this isn't a transmitter phaser, but rather a receiver phaser. The delay turned out not to be a standard delay either, but rather an L network. And its input and output impedances are also mismatched. Moreover, its delay does not agree with the coax delay on which it is based. Again, I don't care because it works: all of the usual daytime ground wave signals which I use for testing a new phaser were nulled as well as any of my best phasers, from one end of the MW band to the other. It remains to be seen how it performs with sky waves tonight.

The nighttime sky wave null with the improved fixed phaser was considerably better than with the "standard" fixed phaser, although not as good as I had hoped for. But then it dawned on me that the vertical pattern was not a dual flag pattern that I had become accustomed to; rather it was a dual flag pattern. The EZNEC patterns below show the difference. The 30 dB null aperture of the dual flag is about 0 to 55 degrees, while the dual loop is about 21 to 36 degrees. Clearly the dual flag array is quite inferior to the dual flag array wrt splatter reduction in the MW band. A dual ALA-100 array is equally inferior to the dual flag array wrt splatter reduction in the MEW band. I have no idea how quad active vertical arrays or quad ALA-100 arrays would perform wrt splatter reduction in the MW band. By using non-standard phasing, EZNEC predicts that a quad ALA-100 array would perform almost as well as a QDFA. But a quad active vertical array, because of negative resistance issues, would have to be adjusted by trial and error for best splatter reduction in the MW band, an unenviable task.