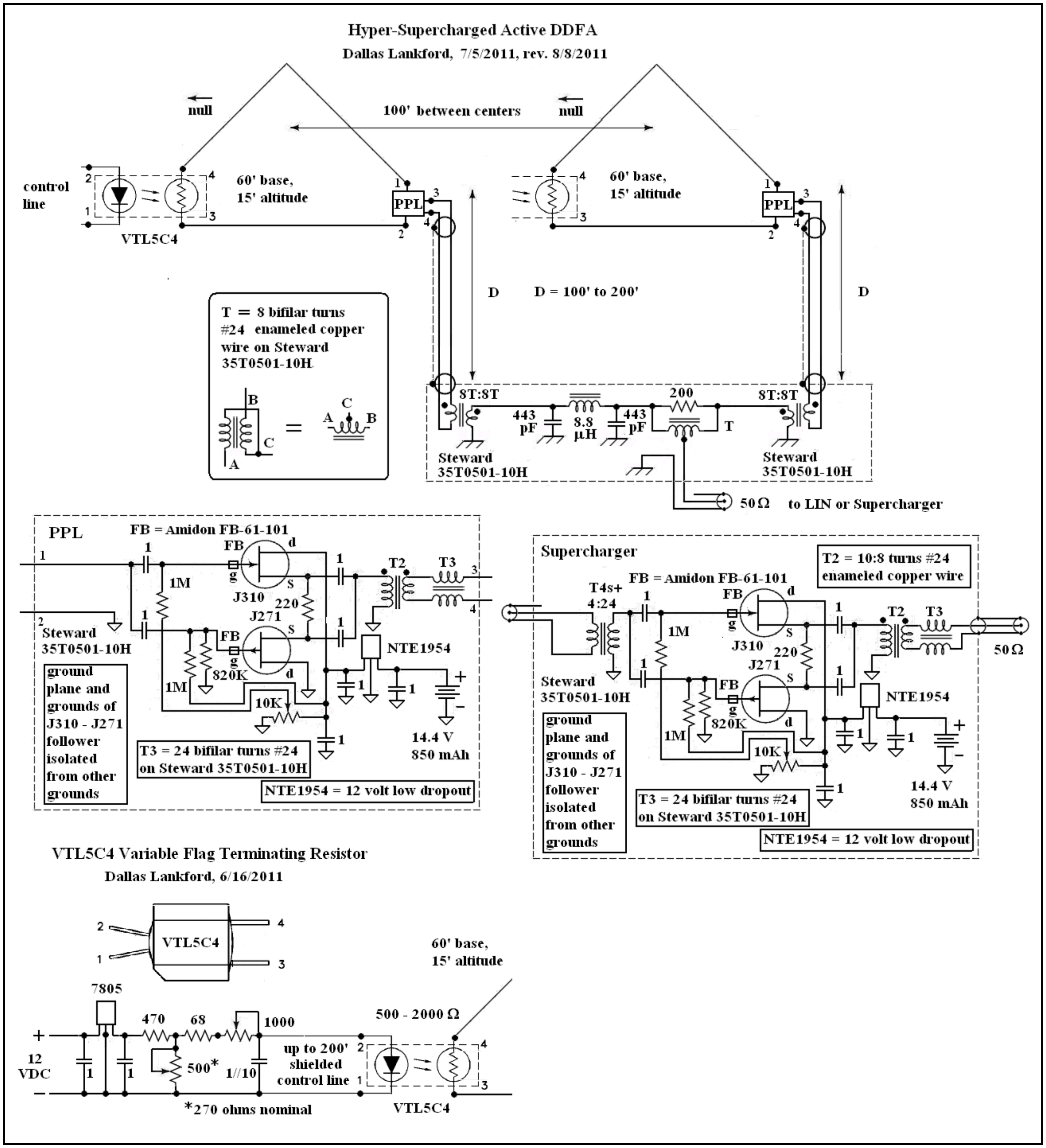
Hyper-Supercharged Active Dual Delta Flag Array

Dallas Lankford, 7/4/2011, rev. 8/8/2011



Originally, I developed a broadband 1x version of N4IS' high Q tuned LC front end 6x BF981 preamp and used it at the receiver end of the twin lead lead in, like he did. This lead me to a different amplifier, a broadband low noise high intercept J310 – J271 FET follower, which was basically the “active part” of a simple, but very good, active whip antenna. Later, when I began investigating the broadband high performance FET follower connected directly to the antenna elements, the gain was not as high as I wanted, which led me to the supercharged FET follower (a step up transformer between the antenna element and the input of the FET follower). This is, of course, merely a broadband version of N4IS' high Q tuned LC front end with 4:43 turn step up input for his 6x BF981 top band preamp. At first I used a 8:24 turn step up transformer, which gave about 9 dB increase in signal output. Since that was sufficient for my needs, I did not develop higher turns ratio superchargers at that time, although a brief test indicated that higher turns ratios did not increase signal output significantly (which later turned out to be incorrect).

But the difficulty of eliminating extraneous signal pickup from high Z FET followers, and the need for multiple FET followers for dual and quad arrays when the FET followers are placed at the antenna elements caused me to reconsider putting FET followers at the receiver end of the twinax lead in. If the FET followers are placed between the receiver end of the lead in and the phaser, a dual array requires two FET followers, and a quad array requires four FET followers. On the other hand, if the FET follower is placed immediately after the phaser and combiner, like N4IS did, then only one FET follower is required for a dual array, and only two FET followers are required for a quad array (or three if a FET follower is used after the phaser and combiner of the outputs of the two FET followers). For these reasons I decided to place a single FET follower after the combiner. If the thermal noise of full size dual delta flags was not "seen" clearly with this approach, then two FET followers preceding the phaser and combiner could be tested later.

The 8:24 turns ratio supercharger I had been using gave a lower signal output when the supercharged FET follower was placed after the phaser and combiner. So increased voltage input via a greater turns ratio step up transformer was needed if this approach was to succeed. It was easier to take 4 turns off the primary than to wind a new toroid supercharger, and this turned out to increase the signal output of the FET follower about 5 dB, to about the same signal level as when the FET follower with 8:24 turns ratio had been at the antenna element.

I used Steward high permeability toroids because they do not have to be insulated (they come already insulated with epoxy coatings). If you don't mind insulating Amidon 75 and J material toroids, you may use FT-50-75 and FT-114-J toroids for the amplifier toroids and antenna transformer toroids respectively.

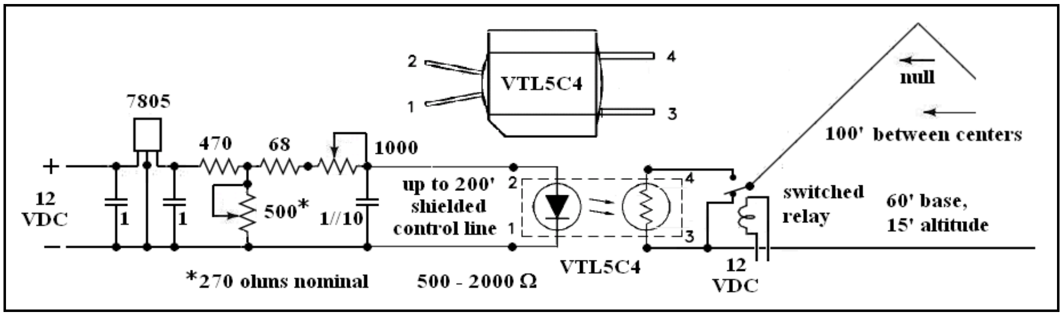
As pointed out in a previous article of mine, EZNEC does not accurately calculate the values of flag terminating resistors. I was somewhat dubious about adjusting two pots for the dual array using my wireless audio method (discussed in a previous article of mine), but it had to be done. First I listened for about an hour with two fixed ("EZNEC certified")1000 ohm resistors to several nighttime MW sky wave signals to establish some bench marks. KMOX 1120 (in the direction of maximum null) was doing its "usual thing," completely gone about 80% of the time, but occasionally resurfacing and occasionally on top of the Latin Americans on 1120 kHz. Then I went out with my wireless audio and headphones, and two 2500 ohm pots which replaced the 1000 ohm fixed pots. KMOX happened to be mixing with the Latin Americans at the time, which provided a good opportunity for evaluating pot adjustments. After several back and forth trips to the respective ends of the delta flag ends where the pots were alternately adjusted, KMOX was eventually nulled completely. Somewhat to my surprise, the optimum pot values turned out to differ by about 200 ohms. I went back inside and listened for another hour or so, and KMOX occasionally reappeared briefly, very weakly, not nearly as strong or as frequent as with the 1000 ohm fixed pots. Very little difference was noted between the 1000 ohm fixed and 1060 / 860 ohm pots for other frequencies, although problematic WLAC 1510 was observed to have better nulls with the pots than with the 1000 ohm fixed. To study the terminating resistors variations, a running tally is being kept for consecutive nights. It was found that the optimum terminating resistor varied considerably from one night to the next. Why? I do not know. Anyway, these results indicated that dual remote controlled VTL5C4's would be a useful addition.

The rather large variation in terminating resistors values for optimal KMOX 1120 and WLAC 1510 nulls from one night to the next, and the different resistor values required for best null depth for some mid band and high band signals, prompted me to implement dual remote variable flag terminating resistors using VTL5C4's. Single VTL5C4 remote variable resistors have been used before by others who said it was for null steering (but did not mention that flags nulls can only be steered vertically, not horizontally), but to the best of my knowledge this is the first use of dual VTL5C4's for a dual phased antenna array with the purpose of optimizing the null pattern. The schematic at the beginning of this article shows the two remote variable flag terminating resistors which I tested last night on my full size dual delta flag array.

Null adjustment of the VTL5C4 variable remote flag terminating resistors on KMOX was very smooth, with only 2 or 3 alternate adjustments of the indoor pots for deepest null. The adjustments can be made before "sunset transition" is complete, but probably should be touched up about 3 hours after sunset. When this was done, KMOX did not reappear; only Latin Americans were heard on 1120 kHz.

Further testing revealed that there is one potential advantage for connecting FET followers directly to the antenna elements, namely increased gain of the array, which in principle increases the signal to thermal noise ratio. Whether this is actually the case has not been determined because of the difficulty of measuring thermal noise for complex antenna interfaces. Nevertheless, this change is included in the schematic at the beginning of this article, and plans are being made to investigate it at a remote site.

The control cable I use has two (2) shielded twisted pairs. By adding relays the VTL5C4's can be bypassed, which converts the dual flag array to a dual loop array. In principle, a loop antenna element of the same size and shape as a flag antenna element has considerably lower thermal noise than the flag antenna element. However, the gain of an active loop in the maximum direction is 6 dB less than an active flag, and a dual loop array null aperture is not nearly as good as a dual flag null aperture. Nevertheless, it would be interesting to compare the two kinds of dual arrays, and the circuit below would permit comparison.



Additional 3 dB gain loss reduction for dual active flag arrays may be obtained by changing the LC delay and combiner from 50 ohms to 100 ohms as shown on the schematic at the beginning of this article. This has not yet been tested.