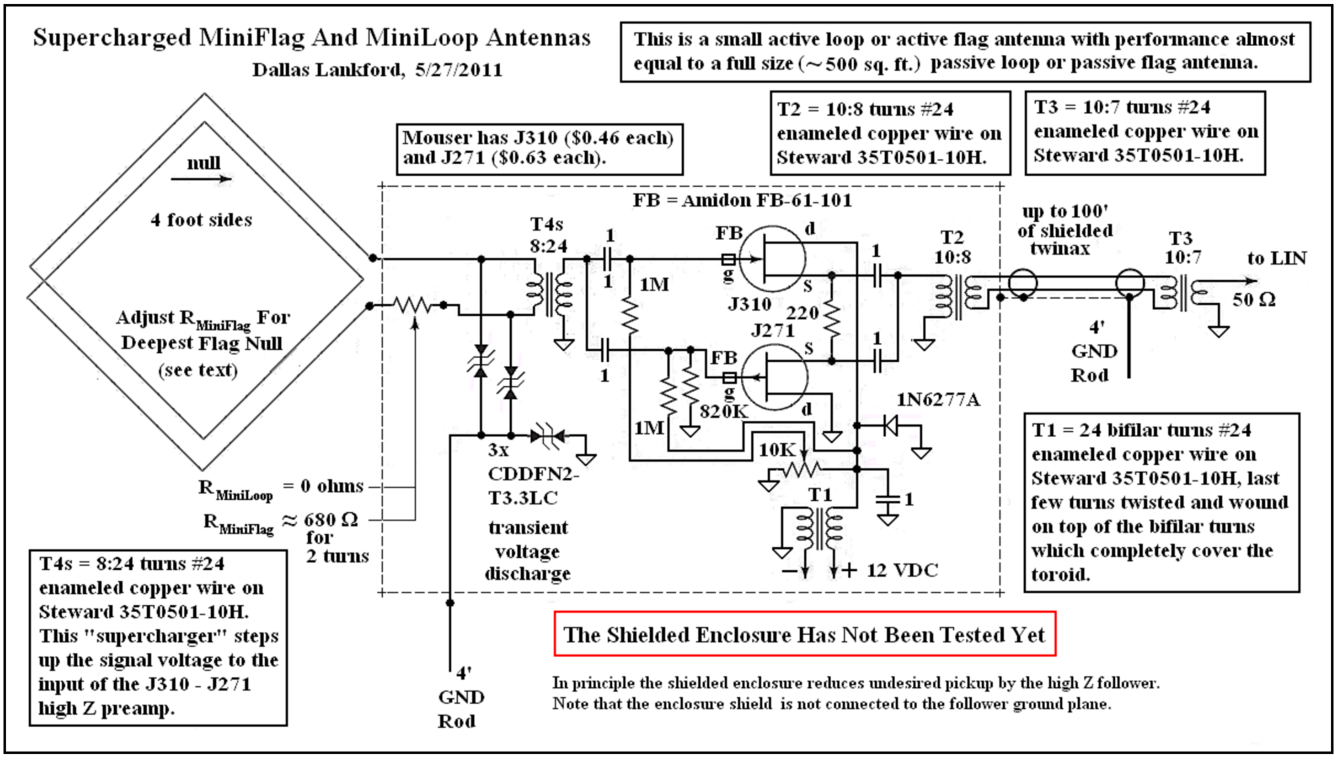
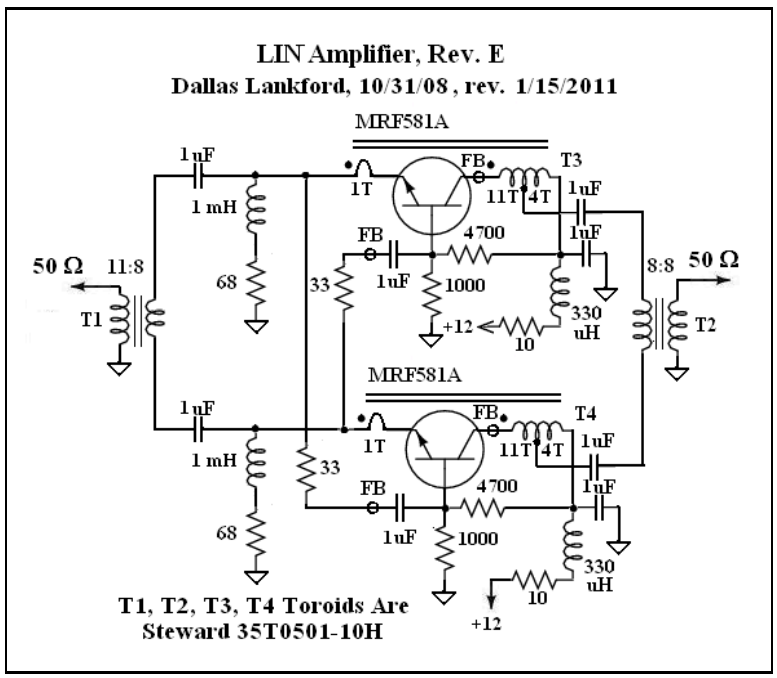
Supercharged Active MiniFlag and MiniLoop Antennas

Dallas Lankford, 5/27/2011, rev. 8/8/2011 II



MiniFlag and MiniLoop antennas were developed before the supercharger was discovered. So the original MiniFlag and MiniLoop antennas were unnecessarily complex, with LIN preamps immediately following the J310 – J271 high performance follower. With this new supercharged J310 – J271 high performance FET follower, additional preamplification, if necessary, can be done at the receiver end of the lead in. Preamplification will probably be necessary with insensitive SDR receivers, like Perseus, but not with more sensitive receivers, like an R-390A. Higher noise figure preamplifiers may also be satisfactory with supercharged MiniFlag and MiniLoop antennas when used with insensitive receivers.



EZNEC simulation does not calculate accurate terminating resistor values for good MiniFlag nulls. So you will have to use a potentiometer (I used a 1K pot) and wireless audio connected to your receiver and maximize the null depth on a distant (500 to 1000 miles) nighttime MW sky wave in the plane of the loop (I used Chicago on 720 kHz). The potentiometer should have a sufficiently long insulated shaft to minimize body interaction with the loop and high Z preamp. Once set, the null depth is more or less maximized from one end of the MW band to the other. I suspect that the low end MW frequencies are better than the high end MW frequencies for determining $R_{MiniFlag}$.

Once the null depth has been maximized (or should I say minimized?) with the potentiometer, take the pot inside, measure its resistance, and make a fixed resistor to install in your mini-flag by soldering together appropriate series and parallel resistors. For my two turn supercharged MiniFlag above the optimum resistor value was about 680 ohms.

You ***must*** find the terminating resistor value as described above. Otherwise the MiniFlag probably will not have as deep null depth as it is capable of, perhaps little or no null at all. (But later, 8/7/2011, an alternate method of adjusting the terminating resistor using a remotely adjusted VTL5C4 vactrol was developed which makes the wireless audio method unnecessary; see the discussion **Remote Variable Termination** below in this article.)

Nulls at the high end of the MW band are not as good as mid and low band nulls, probably because of multiple arrival rays. If high MW band nulls are important for you, a dual flag array will be required. Dual MiniFlag arrays have not been tested.

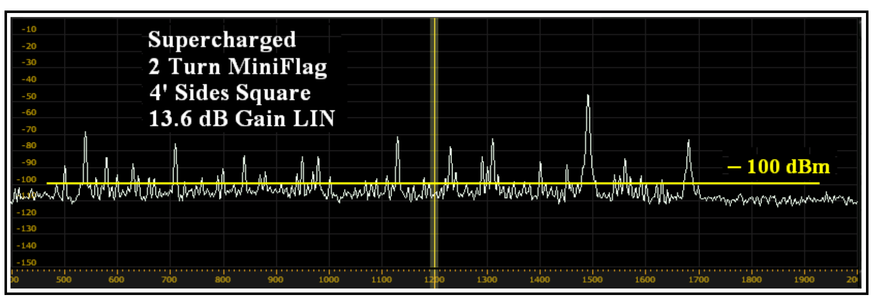
Other mini-flag antennas have been developed previously, such as by W2PM and WA1ION, but they both used 16:1 Z (800 ohms to 50 ohms) step down transformers. Preamps were undoubtedly used with those previous versions, but were not discussed in their descriptions. My MiniFlag above is a different design. There is no step down transformer, and there is a step-up supercharger transformer followed by a low noise high intercept complementary J310 – J271 FET follower.

I used a 2 turn loop head with 4' sides because it was on hand from previous tests several months ago with a J310 – J271 preamp sans supercharger. The (“capture”) area of the 2 turn loop is 32 square feet.

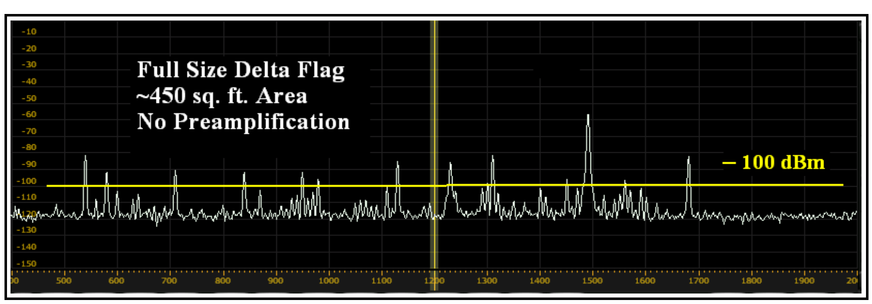
Based on previous tests of MiniFlag antennas sans supercharger, the terminating resistor for 3 or higher turn MiniFlag antennas will probably have a higher value, which will lower the signal to thermal noise ratio of the MiniFlag antenna. For this reason 3 or higher turn MiniFlag antennas may be undesirable. In any case, 3 or higher numbers of turns seem unnecessary when using the supercharger.

The MiniLoop version (no terminating resistor) works very well. Its nulls seem to be deeper on some signals than the MiniFlag. But its nulls are much narrower, so it might be more difficult to null undesired stations if a rotor is used. Also, the MiniFlag has a higher RDF than the MiniLoop.

Sensitivity and signal to noise ratios of the 2 turn 4' x 4' Supercharged Active MiniFlag from 500 kHz to 30 MHz were more or less identical to a 1 meter whip element active whip antenna amplified by a 13.6 dB gain LIN, even on the very weakest signals at the ambient man made noise floor. So the signal to thermal noise ratio of the MiniFlag seems more than adequate for my location in a semi-rural area of North Louisiana. “Buzzes” above 10 MHz from my neighbor's “noise makers” were considerably weaker or totally absent on the MiniFlag. Whether this was due to polarization or the MiniFlag null was not determined.



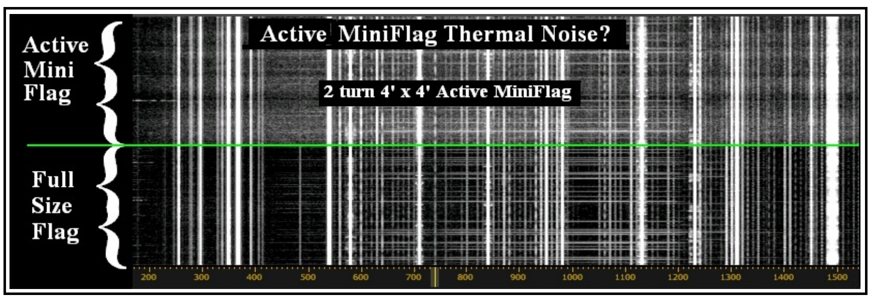
According to EZNEC, the null depth of a one turn 6' sides MiniFlag remains almost the same from 1 MHz to 10 MHz when optimized at 1 MHz. When optimized at 10 MHz (a stable signal source would be needed for determining the optimum terminating resistor value), EZNEC says that the null depth remains a constant 30 dB from at least 1 MHz to 10. If so, since the null width of a flag is much wider than the null width of a loop, a MiniFlag might have better nulling ability in the SW bands than a loop.



At right are Perseus displays of the daytime MW band at my location for a standard 450 sq. ft. area Delta Flag antenna with no amplification and a 32 sq. ft. area (2 turns, 4' sides square) Supercharged Active MiniFlag Antenna. The braid of the shielded twinax of the Supercharged Active MiniFlag is grounded by a separate earth ground (the ground plane of the Supercharged Active MiniFlag is ***not*** grounded). Without twinax braid grounding as described, noise spike about every 10 kHz above about 1700 kHz were observed on the MiniFlag display, even with multiple common mode chokes. The standard flag display did not show any obvious noise spikes above 1700 kHz or anywhere else. The MiniFlag was only 10' away from my house and pointed at my house. The full size delta flag was 50' to one side of my house pointed perpendicular to (away from) my house.

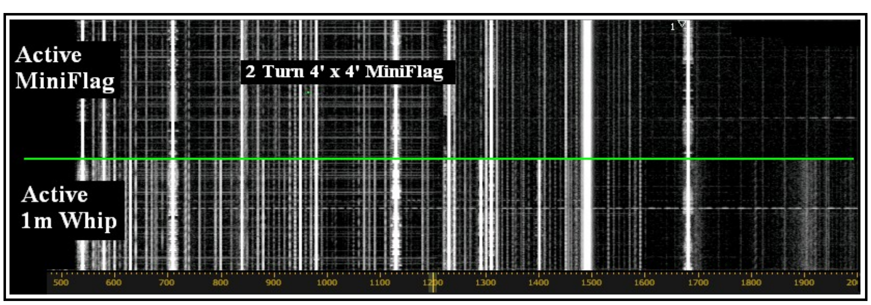
The previously described MiniFlags and MiniLoops were not supercharged, and have been retired for that and other reasons. The previous 3 turn "not supercharged" MiniFlag was reported by an amateur as "didn't work." After I investigated his claim, at first I tended to agree that my previous description of the not supercharged 3 turn MiniFlag was not correct, and posted a revision to that effect. However, later it occurred to me that my "re-implementation" of the previous not supercharged 3 turn MiniFlag was not "faithful." I neglected to use a LIN preamp immediately following the J310 – J271 high performance FET follower attached directly to the 3 turn loop. So now I am inclined to believe that the amateur did not faithfully implement the previous not supercharged design. The lesson here is that if you implement a variant of this design, then you must be prepared to move the location of the terminating resistor to various positions and the pot you use for adjustment of the null while listening to a daytime (ground wave) MW signal or night time (sky wave) MW signal while listening to the station via remote audio with the MiniFlag and its lead in attached to the receiver you are listening to should initially have a much broader range than 1000 ohms. But other explanations are possible as the following developments will reveal

FYI, I use XROCKER for my wireless audio feed.



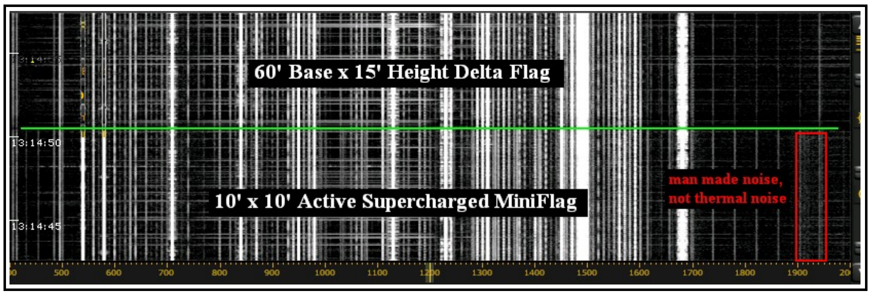
If the MW band is examined with the Perseus waterfall display, then it seems that the thermal noise of the 2 turn 4' sides Supercharged Active MiniFlag begins to emerge as shown on the Perseus waterfall display at right. The presumed thermal noise of the Supercharged Active MiniFlag is suggested by the hazier Perseus waterfall, and is evidenced by slight background hiss added to very weak signals and to ambient man made noise when no signal is present. The slight additional hiss can be mostly eliminated by an elliptic low pass audio filter. Ambient man made noise today (5/28) is much lower than usual. If ambient man made noise were at its usual level, the hiss would probably not have been heard. The display above right is for the MW band. In the SW bands, as frequency increases, the presumed thermal noise of the Supercharged Active MiniFlag decreases. At 10 MHz and higher, Supercharged Active MiniFlag presumed thermal noise is not an issue. This was anticipated because the signal to thermal noise ratio of a flag antenna increases as frequency increases.

A 2 turn 4' sides Supercharged Active MiniLoop would probably not have had any observed thermal noise in the MW band because the MiniLoop has a 4 dB better S/tN ratio at 1.9 MHz and 8 dB better at 600 kHz than a 2 turn 4' sides Supercharged MiniFlag antenna. So if the better null of the MiniFlag is not necessary for your uses, then the MiniLoop might be a better choice for you.

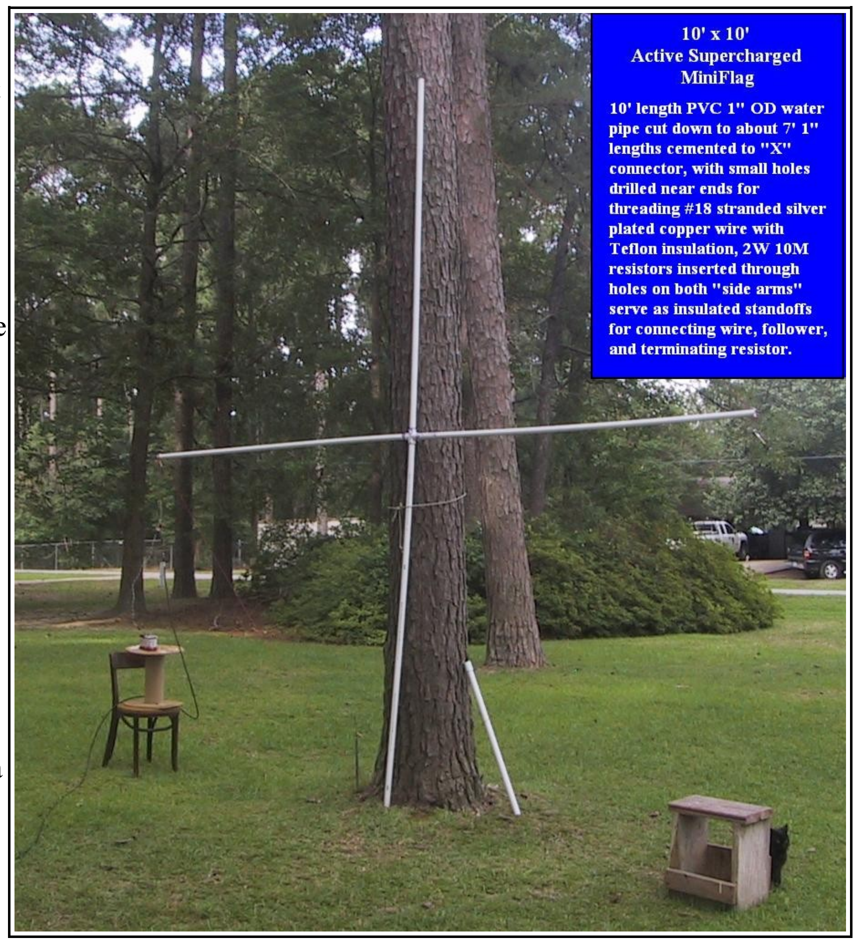


How about an active whip with 1 meter whip element? The waterfall display at right tells us little. The extra fuzzies of the whip could be nothing more than the null of the flag giving the flag the advantage. In fact, my ears told me that the 1 meter whip has a slightly better signal to thermal noise ratio at lower MW frequencies. Number crunching with theoretical S/tN formulas (from the "High Z PPL Flag Arrays" article) implies that the 1 meter whip has a 16 dB better S/tN ratio than the 2 turn 4' square MiniFlag. If ambient man made noise at my location today was about 3 µV per meter (considerably higher than the 1 meter whip)thermal noise floor, then that would agree with what I heard. The MiniFlag generally had a better signal to man made noise ratio (because it has a higher RDF than the 1 meter whip), so the edge in hearability when to the MiniFlag.

All of the above comparisons are for the MW band. For the SW bands, the MiniFlag S/tN ratio improves as frequency increases, so it usually had better overall S/N ratios than the 1 meter whip, and often had better S/N ratios than the full size Flag because of its better pattern. (the full size Flag at higher SW frequencies tends towards omnidirectional).



What a difference a few feet makes. The waterfall display at right shows no evidence of thermal noise for the 10' by 10' active supercharged MiniFlag. A slight amount of MiniFlag noise between 1900 and 1950 kHz where the full size Flag exhibits almost none is due to the 15 dB higher signal output of the active supercharged MiniFlag. The higher signal output of the MiniFlag is also seen at 540 and 580 kHz for Monroe, LA and Alexandria, LA stations. The 10' x 10' MiniFlag has 9.9 dB greater S/tN than the 4' x 4' MiniFlag due to larger area of the 10^2. The lower value terminating resistor of the 10^2 also increases its S/tN.



At right is a photo of the 10' by 10' supercharged active MiniFlag antenna. It is a prototype. Note the 1000 ohm pot (adjusted to 470 ohms) attached to the end of the "right hand arm" of the MiniFlag. If you magnify the photo you can almost see the wood dowel used as an insulated shaft to minimize hand capacitance effect when adjusting the pot. The supercharged high performance FET follower is dangling off the end of the "left hand arm"with shielded twinax draping down to the ground, and 12 volt battery elevated by a chair and empty cable spool. Helper Muffy is guarding the pot adjustment stool.

Lest We Forget

The 10' by 10' MiniFlag has an area of 100 square feet. The original (dual) Waller Flag (array) antenna elements were 7' by 14', which is an area of 98 square feet, almost exactly the same area as the 10^2 MiniFlag discussed in this article. Moreover, the terminating resistors of the original WF antenna elements were 400 ohms, very close to the 470 ohms of the 10^2 MiniFlag. So the question of whether the S/tN ratio of a 10^2 MiniFlag sufficient for a state of the art top band receive antenna is equivalent to the question of whether the S/tN ratio of a WF is sufficient for a state of the art WF. If the answer is not yes, it is very nearly yes as demonstrated unequivocally by the top band records of Doug, NX4D and Carlos N4IS. In recent years they replaced their original WF's by somewhat larger WF's, and replaced their preamps with Carlos' extremely low NF 6x BF981 high Q LC tuned input preamp. Originally with WF's, and more recently with Big and Giant WF's and the N4IS 6x BF981 high Q LC tuned preamp they have achieved outstanding top band accomplishments, “WAZ minus 1” I am told. There could be no more convincing proof of the performance of WF's because their accomplishments were achieved on small urban lots.

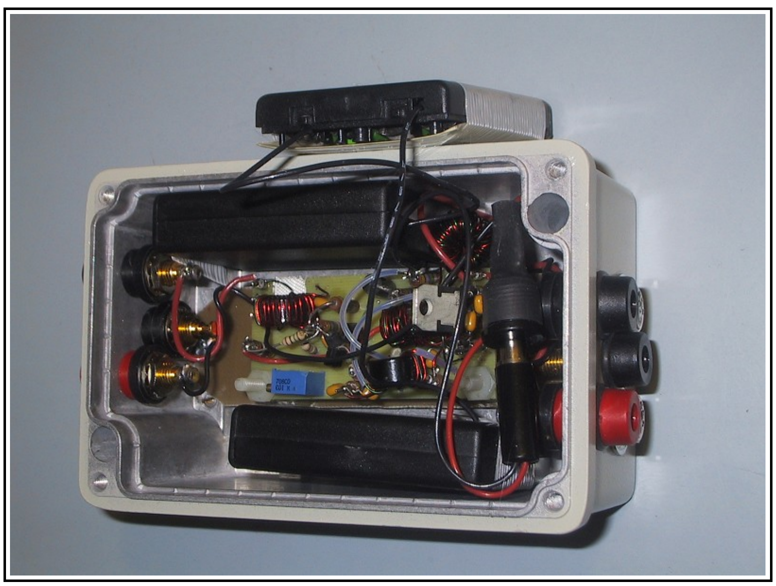
Then The Fun Began

As can be seen from the photo above, the 10' x 10' Supercharged Active MiniFlag is a prototype, not a finished product. It is battery powered, and the battery is only a few feet away from the active head, with the high Z high performance J310 – J271 FET follower dangling from one arm of the MiniFlag. The wires to the battery are decoupled from the follower with a high Z common mode choke, and the input to the follower is decoupled from the follower by the supercharger. Further testing with the follower inside a cardboard box wrapped in aluminum foil indicated that the supercharger decoupling was effective, but the battery decoupling was not.

DC power feed through the shielded twinax signal lead in was tried, but only made matters worse... the terminating resistor had to be changed every few 100 kHz for optimum null and pattern.

Shielded twin lead power feed separated from the shielded twinax lead in was tried, with the battery or AC-DC power source 100' away near the receiver. This was much better, with nulls and pattern almost as good as a standard full size delta Flag throughout the entire MW band when the terminating resistor values were set once at mid band for each antenna element.

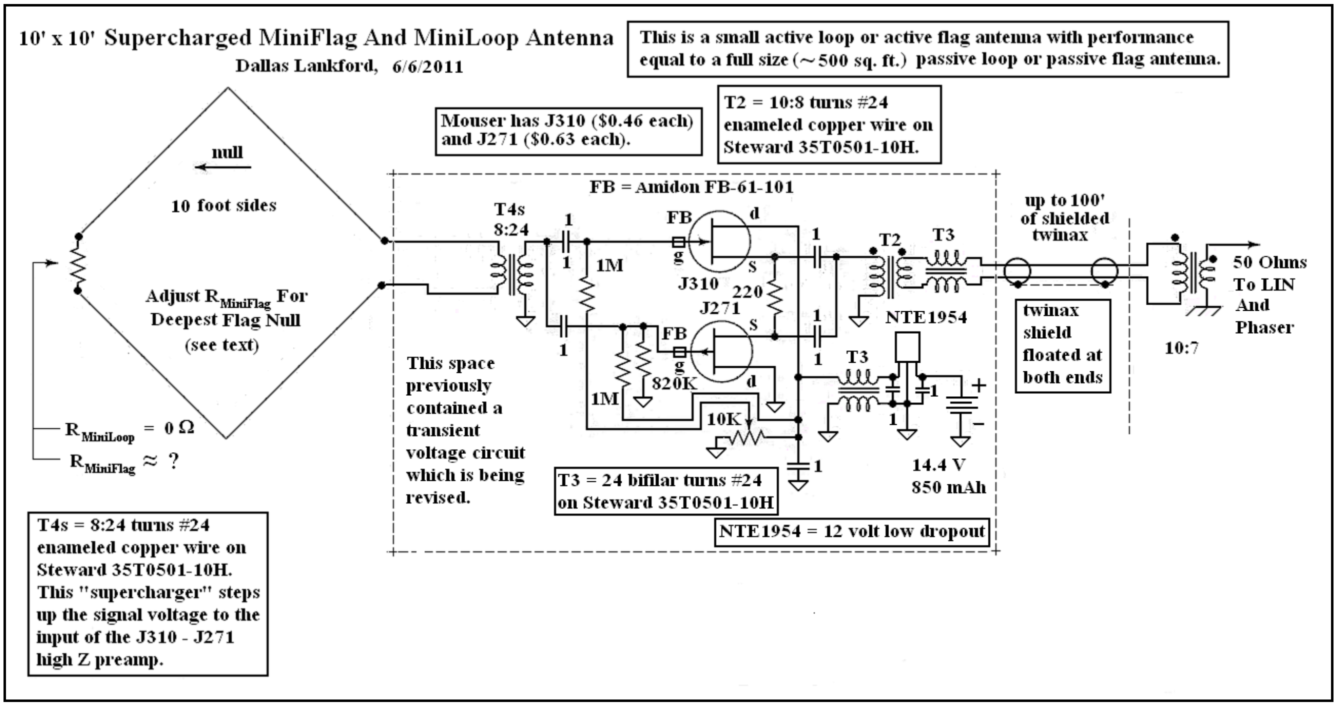
During these tests it was discovered that EZNEC does not accurately calculate the optimum resistor value either for the MiniFlag (which I already knew) or (SURPRISE!) for the full size delta Flag. Measured optimum terminating resistor value for the full size Flag (using wireless audio and a 2500 ohm pot) was about 1400 ohms, not the nominal 1000 ohms calculated by EZNEC.



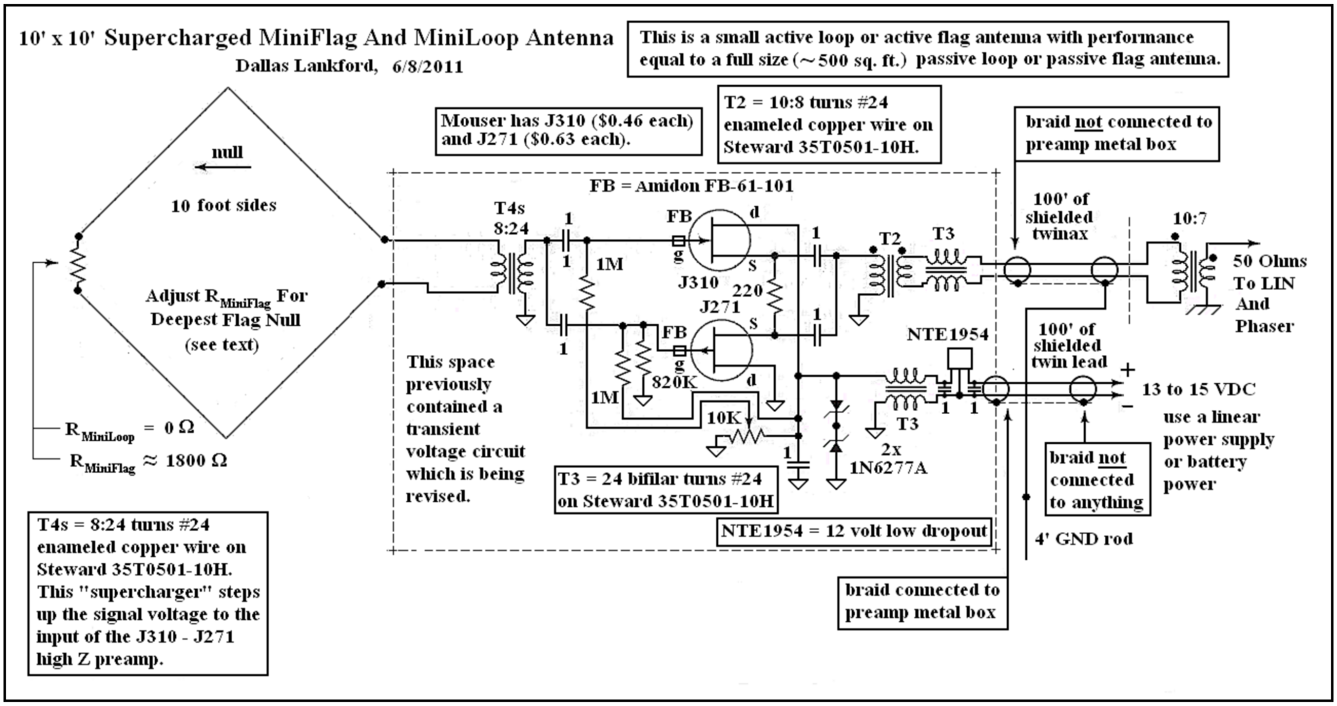
To determine if the Supercharger Active MiniFlag null and pattern could be improved, it was installed inside a Hammond-Rolec watertight (mostly) RF tight box with battery inside as shown in the photo at right.

The (mostly) RF tight box was attached to the 10' x 10' MiniFlag Head with nylon cable ties as shown in the photo below, following the schematic. Helper Muffy is still guarding the pot adjustment stool. The chair with empty cable spool is below the opposite end of the MiniFlag, but not used (note that only one shielded twinax goes to the (mostly) RF tight box.

A schematic of the internal battery version of the 10' x 10' Supercharged Active MiniFlag is shown below. The optimum value of the terminating resistor could not be determined last night because of unstable sky wave propagation due to the strong solar flare yesterday (June 6). Daytime tests yesterday with a dummy antenna shower that the internal battery version has 10 dB less extraneous signal pick up than the external separate twin lead power feed version. The 12 volt low dropout voltage regulator was used to prevent battery voltage variation from degrading IIP2.


10' x 10' Supercharged MiniFlag And MiniLoop Antenna
Dallas Lankford, 6/6/2011
This is a small active loop or active flag antenna with performance equal to a full size (~500 sq. ft.) passive loop or passive flag antenna.
null
10 foot sides
Adjust $R_{MiniFlag}$ For Deepest Flag Null (see text)
$R_{MiniLoop}$ = 0 Ω
$R_{MiniFlag}$ ≈ ?
Mouser has J310 ($0.46 each) and J271 ($0.63 each).
T2 = 10:8 turns #24 enameled copper wire on Steward 35T0501-10H.
FB = Amidon FB-61-101
T4s 8:24
FB
d
g
s
J310
J271
220
1M
820K
10K
1
T2
T3
NTE1954
14.4 V
850 mAh
up to 100' of shielded twinax
twinax shield floated at both ends
50 Ohms To LIN And Phaser
10:7
This space previously contained a transient voltage circuit which is being revised.
T3 = 24 bifilar turns #24 on Steward 35T0501-10H
NTE1954 = 12 volt low dropout
T4s = 8:24 turns #24 enameled copper wire on Steward 35T0501-10H. This "supercharger" steps up the signal voltage to the input of the J310 - J271 high Z preamp.

Because of the solar flare yesterday, the 7th was spent making minor changes to test an external DC voltage feed separate from the shielded twinax signal feed which was overlooked previously, namely the shield of the twin lead DC power feed connected to the preamp metal box, and the shield of the signal twin lead not connected to the preamp metal box. The schematic below shows those changes.

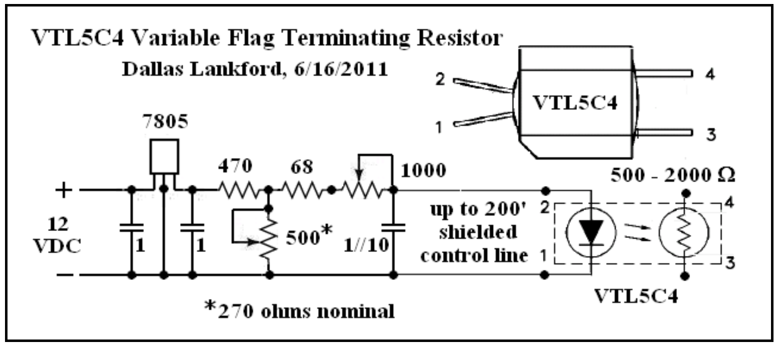


Testing of this new variant for extraneous signal pickup began the afternoon of the 7th. Initially the shield of the signal twinax was not grounded to an earth ground because in the past, floating the braid of the signal twinax had produced the least extraneous signal pickup. However, with this new configuration, grounding the signal twinax braid at the receiver end of the twinax reduced extraneous signal pickup by 3 or 4 dB, to less than the signal twinax alone (not connected to the active follower).

The night of the 7th several hours of A – B comparisons of MW sky wave nulls of the Supercharged Active MiniFlag to a standard full size (passive) Delta Flag were made. About an hour was spent A – B ing 1120 kHz, KMOX, St. Louis. Even on good propagation nights the nulls of KMOX on a single full size Flag are unstable, with alternating (approximately 50% – 50%) periods of KMOX being inaudible and weakly audible (with dual Flag arrays KMOX is completely nulled more than 95% of the time). Fast A – B ing revealed no difference in the nulls between the Supercharged Active MiniFlag and the standard passive Flag. When KMOX was completely gone it was a pleasure to listen to the mix of Latin Americans on 1120 kHz, a favorite pastime of mine. After sunset transition passed (about 2 hours after sundown) Supercharged Active MiniFlag nulls of other big hitters to the North were excellent, with Chicago 670, 720, 780, and 890 never heard, and only Latin Americans heard on those frequencies. Louisville 840 kHz was occasional heard weakly underneath Latin Americans on both the MiniFlag and standard passive Flag. Des Moines 1040 kHz did not reappear after sunset transition. Nashville 650 and 1510 were observed alternately trading places with Latin Americans on both the MiniFlag and standard Flag as is typically the case for single Flags pointed due North (with dual flags they are completely nulled more than 95% of the time).

With an unshielded linear AC - DC power supply extraneous signal pickup was only a few dB worse than with a shielded battery DC power supply (with the power supply shield connected to the shielded DC supply twin lead shield). I have not tried shielding a linear AC – DC power supply because in my opinion an unshielded linear AC – DC power supply is entirely satisfactory.

Remote Variable Termination



Single vactrol variable resistors have been used before by others, for remote variable termination of beverages, and for remote termination of single mini flags. The remote variable termination VTL5C4 at right was developed for remote variable termination of full size dual active flag arrays. After the dual remote dual variable termination VTL5C4 had been used with a full size dual active delta flag array for several weeks, it occurred to me that a single remote variable termination VTL5C4 might be useful for single active mini-flag antennas, such as for simplifying the termination tune-up previously done via wireless audio. This was implemented and tested for the past two nights with the 10' x 10' miniflag described above. The null adjustment of the VTL5C4 variable remote flag terminating resistor in the schematic above was very smooth. Remote variable termination was also useful for vertical null steering as the arrival angle of an undesired signal varied due to propagation variation. Some have claimed that vactrols can steer flag nulls horizontally, but EZNEC says they are mistaken. Based on my experiences with remote variable vactrols, I tend to agree with EZNEC. The termination resistance for optimal null was about 750 ohms, near the minimum of the pot adjust. The control cable and twin lead were affixed to the loop “arms” with nylon cable ties, which makes it feasible to use the 10' x 10' miniflag with a rotor if desired.