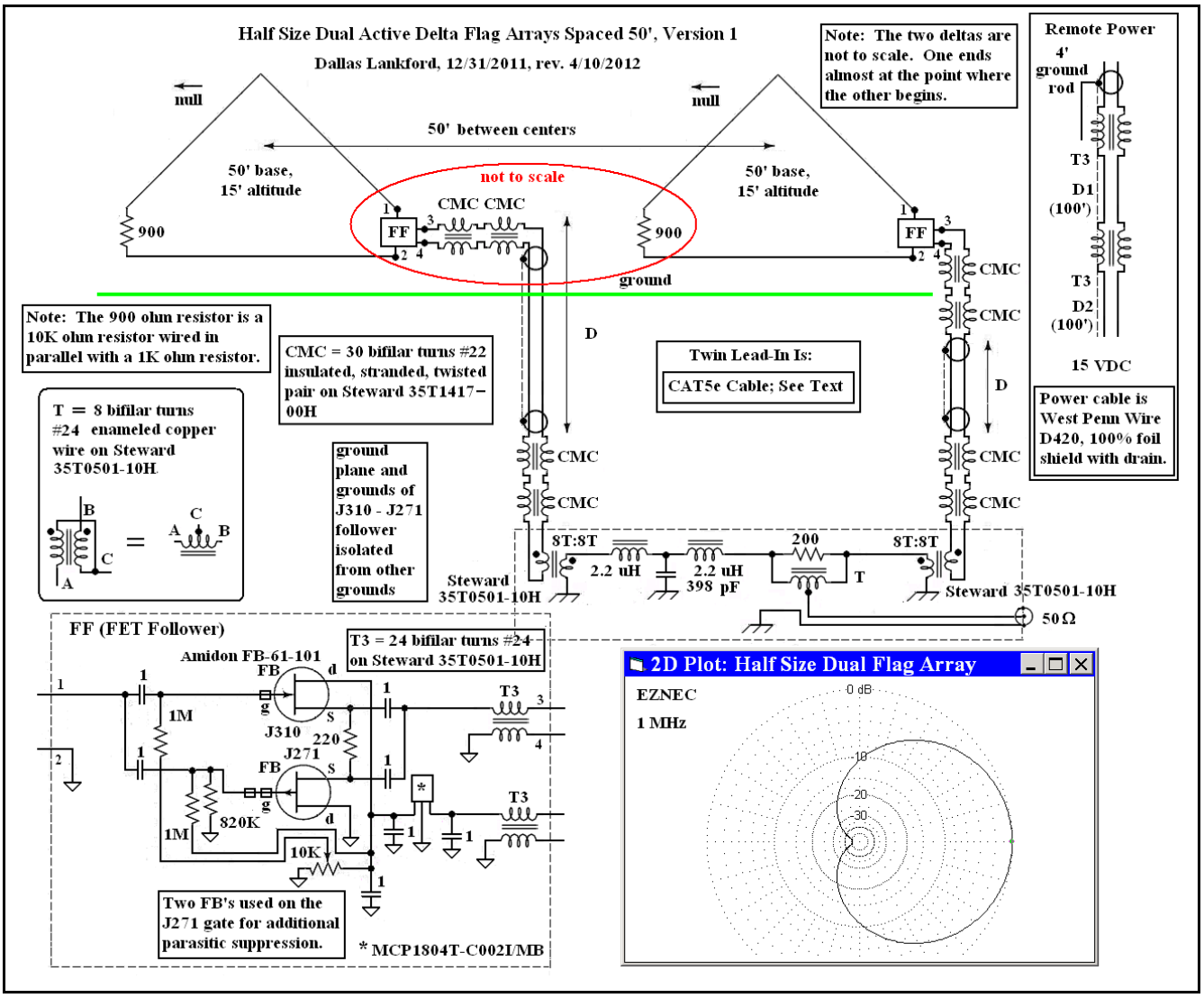
Half Size Dual Active Delta Flag Arrays

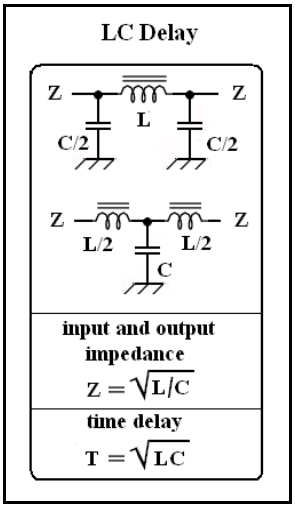
Dallas Lankford, 12/31/2011, rev. 5/16/2012



The toroids in the schematic above are specified as Steward toroids. If they are not available, Amidon FT-50-75 or -J may be used. The Amidon toroids should be insulated with plumbers Teflon tape because Amidon toroids are not insulated. For Steward 35T1417-00H use Amidon FT-114-75 or -J, and for Steward 35T0501 use Amidon FT-50-75 or -J.

The half size active dual flag array described in the graphic above requires only 100' (30.5 meters) of linear space, and so it is an excellent choice for MW DXers with limited space for antennas. Although small compared to previous high performance MW antenna arrays, it is a state of the art MW receiving antenna array, primarily because it uses true active delta flag antenna elements.

A true dual active flag or delta flag antenna array consists of active heads with high performance low noise FET followers. The signal output of the FET follower in the graphic above is only slightly less than the open source voltage output of the antenna elements. This means that there is no reduction in signal output compared to the tradition approach with step down transformers, and no additional 6 dB reduction in signal output due to impedance matching used by the traditional approach. Thus for flag arrays with 3:1 nominal voltage step down transformers, the increase in output voltage of the active design is about 16 dB. And because the noise voltage output of the FET follower is far below the thermal noise noise output of even a 1 dB noise figure preamplifier, the 16 dB gain of the active approach used here is effectively noise free. It is as if a 16 dB gain preamplifier with 0 dB noise figure has been used. **The FET follower in the schematic above is now available from Clifton Laboratories here.**



The true active delta flag approach may be (probably is) necessary if you do not have enough space in your yard to build a full size dual delta flag array but want almost equal performance. This article shows you how to do it. Almost all the information you need is in the graphic (above) at the beginning of this article.

For a dual array, two 100' length lead ins should be sufficient unless for some reason you want to put the dual array further away from your radio and preamps. The two lengths of lead in should also be equal lengths; otherwise the dual array will not work correctly. Let me repeat myself in case you missed or ignored it the first time: the lead ins of my dual array must be equal length in order for the dual array to work correctly.

A 100 ohm T circuit LC delay together with a 100 ohm combiner is used for the half size dual delta flag array. The output of the combiner is 50 ohms, so no step up transformer is needed. The standard T version of the LC delay for 50' spacing used 2.2 µH inductors and a 443 pF capacitor. The T-LC delay for the half size dual active delta flag array uses a non-standard 398 pF capacitor which gives it a slightly wider 30 dB null aperture

The half size dual active delta flag array spaced 50' between centers became operational about 3 pm this afternoon, 12/31/2011. I did not begin to realize how good it is until about an hour later. I was sitting on 1120 kHz listening to man made noise, waiting for something to appear. I kept hearing low level "whoosh" "whoosh" "whoosh" … wondering what it was, I took my souped-up omnidirectional Sony 2010 outside and tuned to 1120 kHz. There was KMOX St. Louis in the clear. Sunset transition was starting early. Went back inside, still heard "whoosh" "whoosh" "whoosh" … from the R-390A connected to the half size dual active delta flag array. Thinking there was something wrong with the antenna or R-390A, I went outside and jumped the 900 ohm terminating resistors to "open up" the array (make the array null poorer, like a Wellbrook dual unterminated loop array). Went back inside and there was KMOX in the clear. Nothing wrong with either the antenna or R-390A. The "whoosh" "whoosh" "whoosh" … was just the half size DADFA doing its thing (the SAH of heavily nulled signals on 1120 kHz were modulating man made noise). Went back outside, unjumped the 900 ohm terminating resistors, and continued enjoying the exceptional nulling ability of the half size DADFA. It is by far and away the best half size dual (or half size quad) array that I have implemented to date. Now if I can just find two telescoping 15' masts which collapse to 3' and fit comfortably in a suitcase, I will have my next DXpedition antenna.

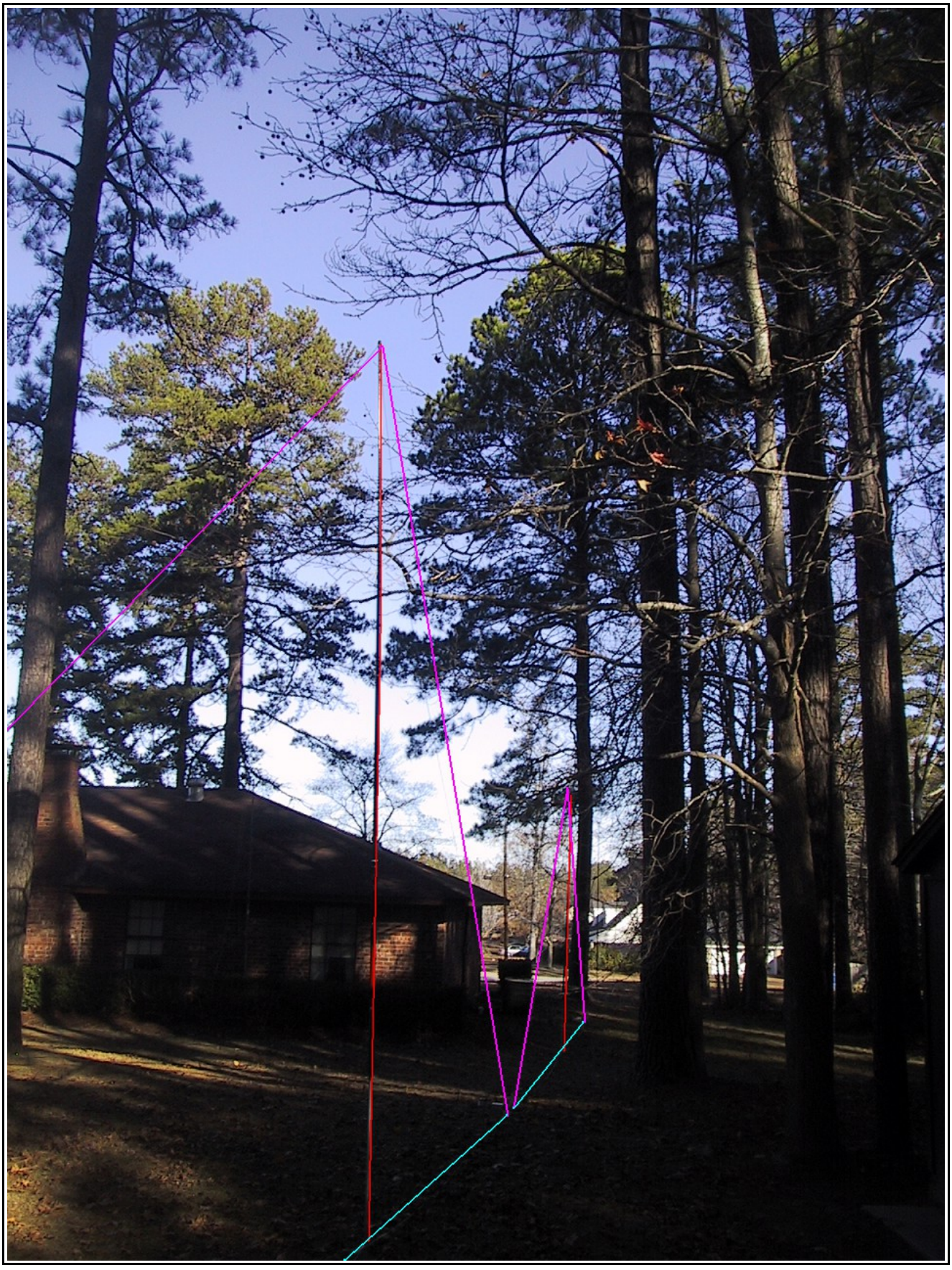
If you are wondering why I use an R-390A to test my antennas, it is because an R-390A is arguably the best analog receiver ever built and it does not introduce any noise from microprocessors, noise from a switching power supply, or noise from any other of the host of modern noise makers. It has accurately been said of the R-390A, "If you hear it, it is there."

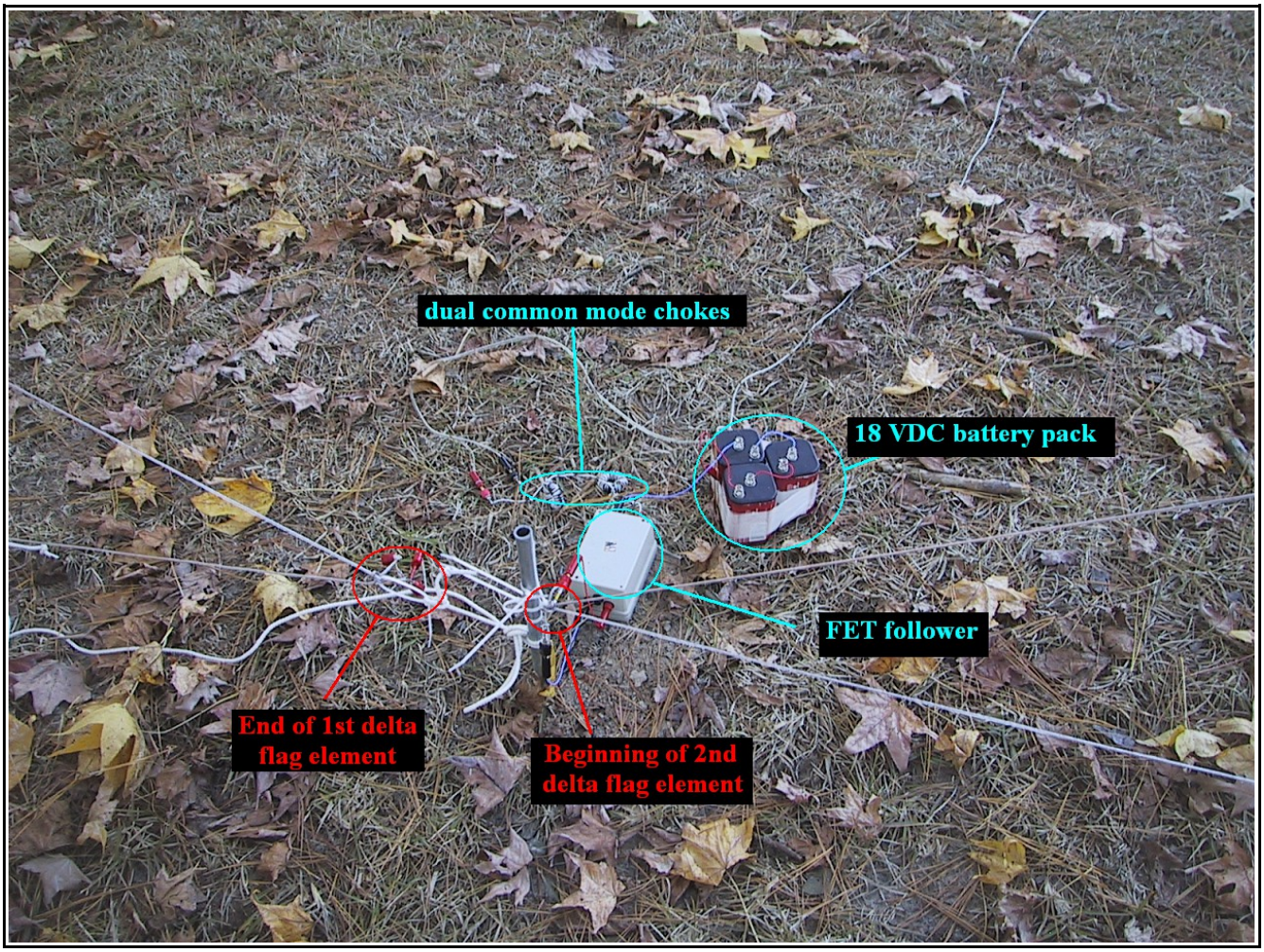
The low dropout 12 volt regulator MCP1804T recommended by Jack Smith, K8ZOA of Clifton Laboratories is excellent, and adds no noise to the signal. Earlier I learned the hard way (at Quoddy Head 2011) that you have to thoroughly test LDO regulators because some of them add noise to the signal, beginning towards the low end of the MW band, and increasing as frequency decreases. An interesting feature of Jack's SMD FET follower variant of my J310-J271 circuit is a relay which grounds the input when power is not applied. This provides added protection against transient voltages when the FET follower is not in use.

None of my through hole FET followers have transient voltage protection, and none have been "killed" by transients to the best of my knowledge (although I have "killed" a few of the FET's, believed to be by careless handling). But as has been said, an ounce of prevention is worth a pound of cure. So I would recommend "opposed" 1N4148 diodes across the FET follower input, as well as "opposed 1N4148 diodes in parallel with a 47K ohm resistor from the ground plane of the FET follower to earth ground if there is any chance that transient voltages could "kill" your FET follower (frequent thunderstorms, blowing snow, and periods of cold with very low humidity are common "killers"). I am going to do this myself when I get around to it.

Even if I had a permanent active array, I doubt that I would use remote DC power. That is asking for trouble because it is so difficult to prevent noise ingress. I use 3x 6 volt lantern batteries because they are cheap and I don't listen a lot. One of the FET followers draws only 10 mA, and the LDO regulator adds to the draw, but not a lot. So batteries last me a long time. If I had a permanent installation, I would buy rechargeable batteries.

I used gold plated Nakamichi banana plugs for all my connectors to the FET follower box and buy the 0534A model here. I believe these are shipped directly from China. I have ordered Nakamichi banana plugs several times, and have always been satisfied with my purchases. The Nakamichi banana plugs I use are "unbranded." You can also buy "branded" Nakamichi banana plugs.





GASP!!! (1/1/2012) One of my branded Nakamichi banana plugs "sprang a leak" this afternoon. The pronged banana tip pulled out of the body. It is press fit into the body. A "no no." I am going to have to try to pull one of the unbranded Nakamichi banana plugs apart, and if it comes apart, it also will get a thumbs down, and I will have to start searching for better banana plugs.

I use Pomona gold plated banana jacks. They are not cheap, but they are as good as it gets, and once installed properly, seem to last forever. I buy them from Mouser (565-2854-0 black, and 565-2854-2 red), about $2.50 each. The plastic of these Pomona banana jacks is brittle, so I used faucet washers (with holes which I enlarged using a heavy duty 0.25 inch paper punch) as strain relief to prevent the plastic from cracking. And I made water tight seals using O-rings of appropriate size purchased at Lowes.

I found fancy watertight aluminum Hammond boxes on eBay for about 10 cents on the dollar. Standard Hammond water tight extruded aluminum boxes would be satisfactory. Plastic watertight boxes might might work fine... I do not know... but the metal boxes may help prevent the FET followers from picking up undesired signals or noises... although I suspect that the phaser-combiners are mainly responsible for suppressing the undesired FET follower pickup.

It is now 10 pm on 12/31/2011 and I have been listening to the new half size dual active delta flag array off and on for about 7 hours. Even during sunset transition the nulls were great. As I said above, this dual array is by far and away the best half size array, dual or quad, that I have developed yet in this marathon of new antenna array development. Most of the time tonight virtually all of my big hitters to the North of me (the direction of the null) have been totally and completely absent (perhaps one or two exceptions... I have not sat on the possible exceptions to determine their locations). There has rarely been any English heard from one end of the MW band to the other. It is as if I have been teleported to somewhere between Cuba, Mexico, and Central America.

Two photos above show some of the details of the half size dual active delta flag array. The first photo (on the previous

page) of the half size dual delta flag array in my side yard contains outlines the delta antenna elements with colored lines to make them easier to see. If you magnify the first photo you can almost see the battery pack and FET follower on the ground near the junction of the two delta flag elements. The second photo immediately shows the close proximity of the two delta antenna elements, the FET follower, the battery pack, and the dual common mode chokes. Magnify the photo immediately above (by, say, 400) to get a better view of the dual common mode chokes in the twin lead line.

CAT5e Cable

CAT5e is an inexpensive shielded cable which has 4 (four) 100 ohm twisted pairs inside he shield. Tests which I did recently showed that when one of the twisted pairs is used as a substitute for shielded twinax, undesired signal and noise pick-up by 100' of lead in is the same as for shielded twinax. Thus the much more expensive twinax is not necessary for a state of the art MW phased array. CAT5e is available in a "direct burial" version which is supposed to be waterproof. It costs a little more, but is probably a good idea. The ends (where the twisted pairs exit the shield) should still be sealed with an automotive grade silicon adhesive or similar waterproof seal. CAT5e cable is not as flexible as shielded twinax, but is lighter weight and smaller size.

CAT5e Unused Twisted Pairs

Kazuhiro Gosui asked me, "What do we do with the 3 (three) unused twisted pairs?" I tried all of the combinations and found that an additional 6 dB reduction of pick-up with the lead-in was obtained at the high end of the MW band by soldering the 3 twisted pairs together and soldering them to the "shield wire" **at the antenna end of the CAT5e cable** (the shield appears to be aluminum foil coated with mylar on the outside, with a small tinned copper "shield wire" on the inside, separated from the twisted pairs with a thin transparent insulation). The reduction was not quite as much at the low end of the MW band, perhaps 4 dB. Soldering the 3 twisted pairs together and soldering them to the "shield wire" **at the receiver end of the CAT5e cable** did not reduce signal pick-up.

I recommend against using the other three twisted pairs for any other purpose.

Preamplifiers

An insensitive receiver like Perseus will need at least one, and probably two Norton transformer feedback amplifiers. Don't try to save money by building or buying one of the higher noise figure higher gain (20 dB nominal) preamps. Their higher noise figures will mask some of the weak DX you want to hear unless the ambient man made noise at your location is high. In that case, you should try a different hobby or move to a lower noise location. There are no shortcuts to a good MW DX antenna array.

Clifton Laboratories makes excellent Norton transformer feedback amplifiers available here. I like the Z10042a low noise figure version, but they are all excellent.

Fake Active Arrays

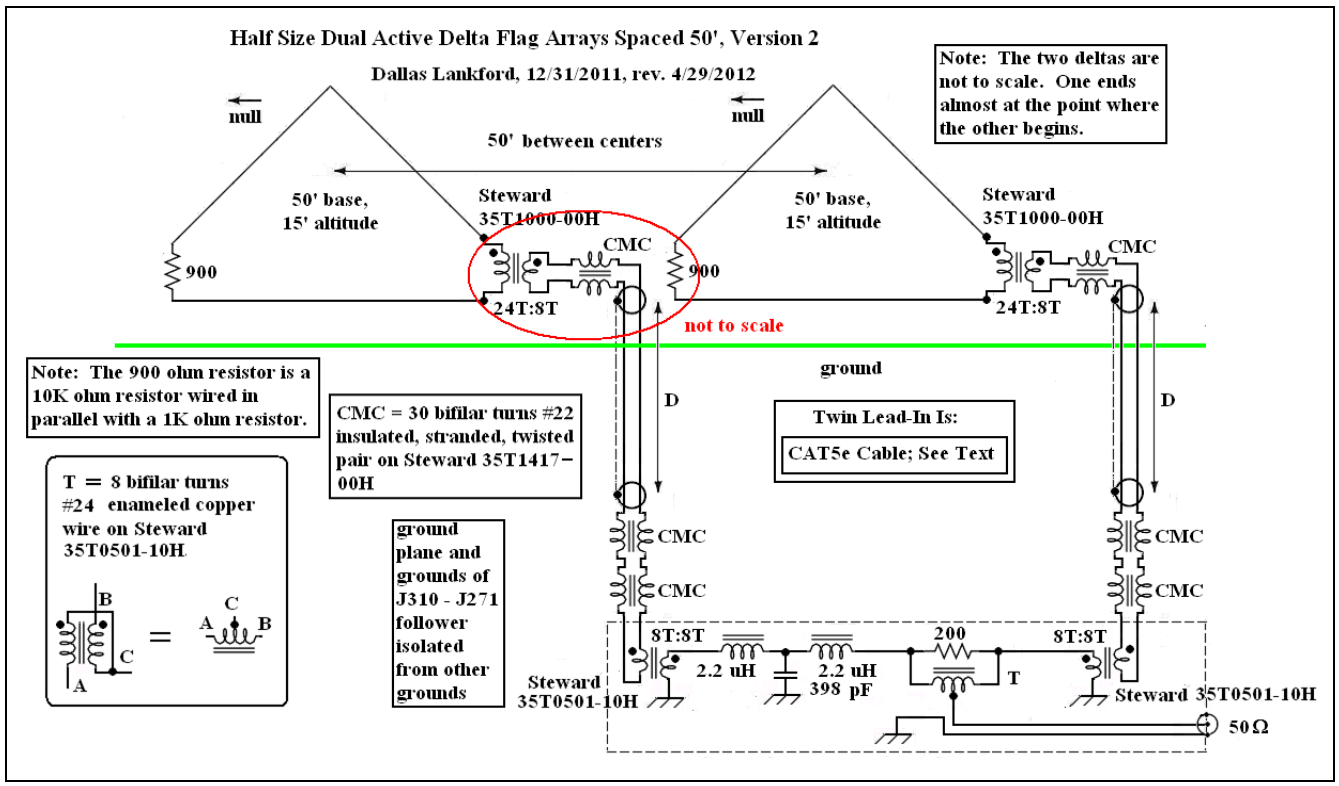
If you purchased a FLG100 thinking you had bought the "fixings" for an active flag or delta flag antenna, or if you purchased two FLG100's thinking you had bought the fixings for a dual active flag array or dual active delta flag array, you are sadly mistaken. The FLG100 is an ordinary 50 ohm input 50 ohm output amplifier with a 850 ohm to 50 ohm broadband step down transformer connected to the input of the amplifier, both of them sealed inside a box with potting material, with DC power coming from near your radio down the coax to the FLG100 amplifier at your antenna, and the desired signal going the other way from your antenna to your receiver. The DC supply also sends noise down the coax which is picked up by your antenna and sent back along the coax to your receiver. You may not hear that noise, but only because ambient man made noise at your location is greater than that noise. If you took your antenna and receiver to a low noise location, you would almost certainly hear the noise introduced by the FLG100 power supply.

The FLG100 approach is obviously not a good approach. You are better off winding your own step down transformer (with no amplifier out at your antenna), and buying or building a Norton transformer feedback amplifier or two to use at your receiver. It will deliver exactly the same or more signal to your receiver and will not introduce undesirable noise. You also should not use coax like the FLG100 uses, but instead use CAT5e cable.

Versions 2 And 3

Version 2 above may be suitable for urban locations where man made noise is higher than average. It is attractive because it does not require FET followers. It will probably require two Norton transformer feedback amplifiers if you use an insensitive receiver like Perseus. If it turns out that version 2 is amplifier noise limited at your location (in other words, if

you do not hear man made noise clearly from one end of the MW band to the other when using version 2), then version 2 can be converted into version 3 below, a dual active delta flag array with FET followers at the receiver ends of the lead-ins (inside your house, protected from the weather, and easy to remove to a safe location when there are thunder storms about).



Version 3 below is the preferred version.