

HOW TO BUILD A THREE LEG TERMINATED DIPOLE

T3FD

COVERING 160 – 10Meters

Tony KA2UFO 8/2018 REV 1.0 8/29/2018

Introduction

Presented here are design and build notes for a Three Leg Terminated Dipole (T3FD) for 160 to 10 Meters based upon works by Cebik, the BUSHCOMM BBA100 series antenna, info from the HFLINK site and lots of experimentation on my part.

Shown are instructions with photos and guidelines to build a multi-band T3FD antenna for ALE use, a bill of major materials, cost information, ideas and test results.

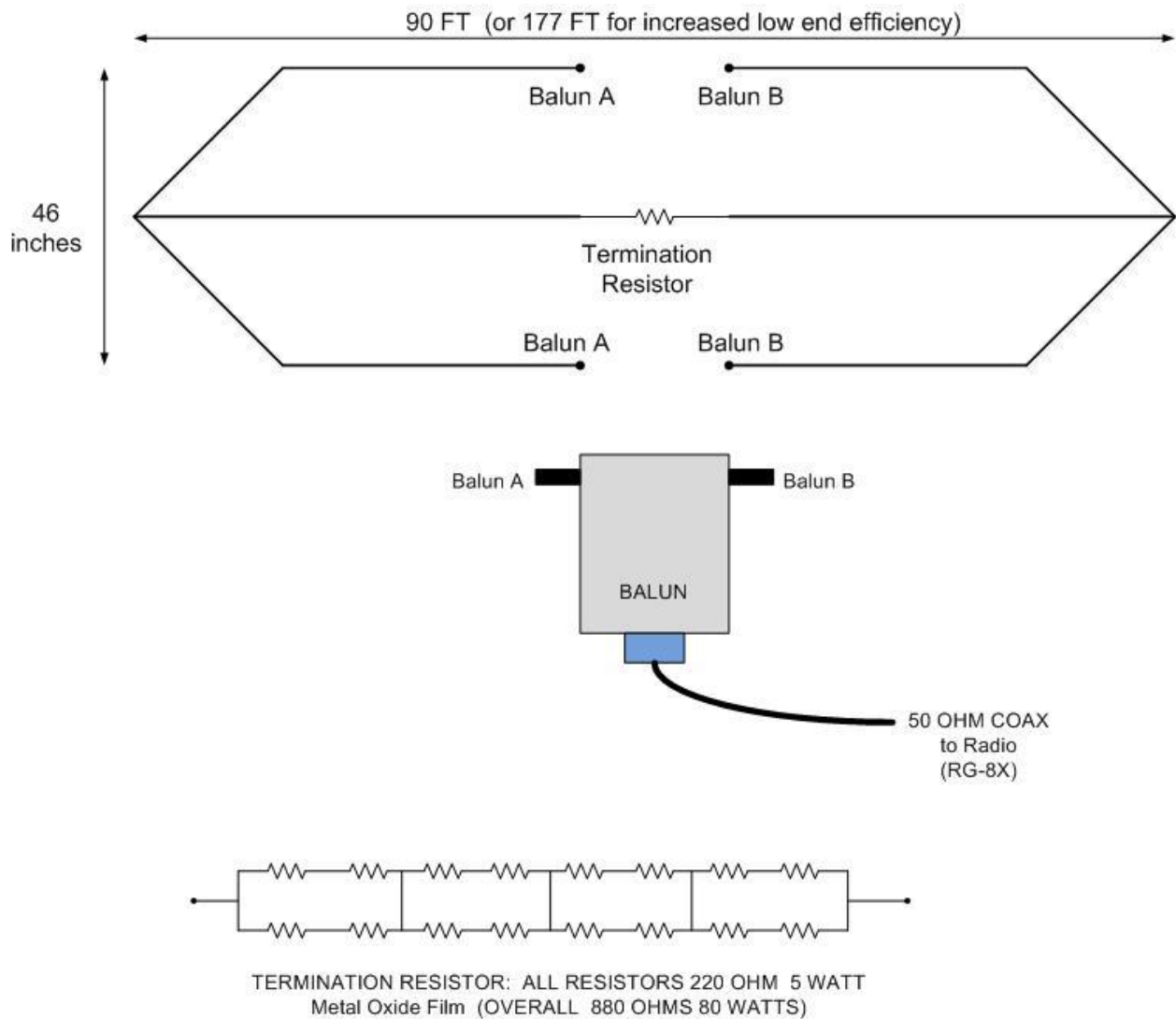
The goal is to help hams build it and have some fun with ALE.

This T3FD works well, and it's easy to build!! If you have room for a 90 FT dipole, try this T3FD.

The Balun and termination resistor construction have always been a bit of a mystery and there is plenty of junk science out there, even on some commercial ham sites. I read through everything I could find and experimented with designs found on various sites. The best compilation of information and history I have found is on the HFLINK site and, additionally, the document by Cebik (see ref). The termination resistor is my own concoction.

At first I experimented with the standard 2 leg version (T2FD) like B&W makes. I tried various Balun core types, transformer ratios, termination resistor values, lengths, height above ground, leg spacing, bench testing and on the air testing. The 2 leg version worked OK, but the VSWR was a bit higher on some bands than I expected. After all, the object is to have wide-band multi-band operation without the use of an antenna tuner. However, from what I have learned from building the T3FD, I can now make the appropriate improvements for the T2FD.

Larry N0OQA told me about his Bushcomm 3 leg terminated dipole (which he is very happy with) and was kind enough to send pictures, performance and VSWR data. After reading data by Cebik on multi-leg terminated dipoles, the three leg version is an efficiency improvement over the 2 leg and not as cumbersome as 4 or 5 leg versions. That's what I wanted to build and share.



T3FD OVERALL LAYOUT

The Three Leg Terminated Dipole can be built in a 27 meter (90 Ft) long or 54 meter (177 FT) long configuration. The 54 meter (177 Ft) long version will have increased low frequency efficiency. I built the 90 FT version due to space limitations and it works down to 160M, soundings are being heard and received on all active bands. These are not resonant antennas so the length and spacing is not very critical.

The spacers are made from 1" PVC pipe, 4 feet long. Spacing of the outside wires is 46 inches, again not too critical. End insulators and center spacer insulators are also 1" PVC pipe. I used a fiberglass rod to make the center support to hold the center insulator assembly in position. A piece of aluminum tubing would be better to prevent skewing from the coax weight. Suspended weight is a concern.

End insulators are 1 Ft long 1" PVC pipe. I drilled three sets of three holes longitudinally along the pipe about 1 inch apart on the antenna side. I then threaded the three wires through three holes each from the far end outside to the center and out the middle of the pipe. There the wires are soldered, a big crimp lug is crimped over the joint and it is wrapped with self-amalgamating rubber tape.

An improved joining method is shown in the pictures using cable clamps and end stop ferrules. A further improvement would be to use a large ferrule to trap all three wires instead of the clamps.

I used PVC for the insulators here as a test for the experiment. Birnbach #47 1W, 1 1/16 inch diameter x 13 inch ceramic insulators or Johnson 136-112 insulators would be best for a heavy duty antenna. Check your hamfests and ebay.

TERMINATION RESISTOR

The termination resistor is built from 16 – 220 Ohm 5 Watt Metal Oxide Film resistors in a parallel series array to produce an 880 Ohm 80 Watt load. These are soldered together as shown in the picture and inserted into the 1" PVC pipe....end wires are attached to the stainless screw lugs and the caps are held in place with stainless sheet metal screws. They are NOT glued on to allow repair or experimentation. 1/16" drain holes are drilled at the bottom edge of each end cap.

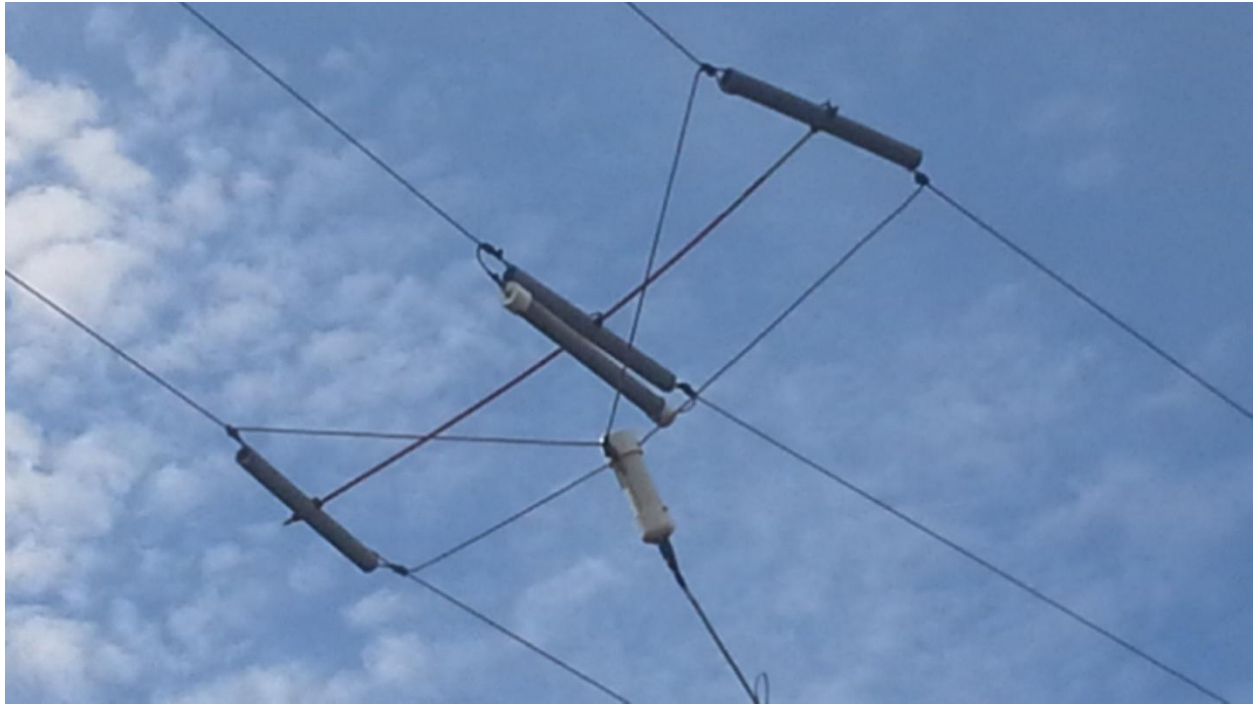
Note: The picture shows 20 resistors (5 banks of 4), one more bank of 4 resistors than is needed; the picture was from an earlier experiment. Be sure to use only 4 banks of 4 resistors and measure the assembly with an ohm meter before assembly. Mine measured 865 Ohms. See the diagram.



Termination Resistor Array (Note: This has 5 banks of 4, we want 4 banks of 4 resistors)



This is one end of the Termination Resistor pipe and Ring Lug. Hold the cap in place with a stainless screw and seal the cap with tape or coax seal. Also use coax seal on the bolt and ring lug and drill drain holes.



The Termination Resistor hangs below the center insulator. It's the gray pipe with white end caps.

BALUN

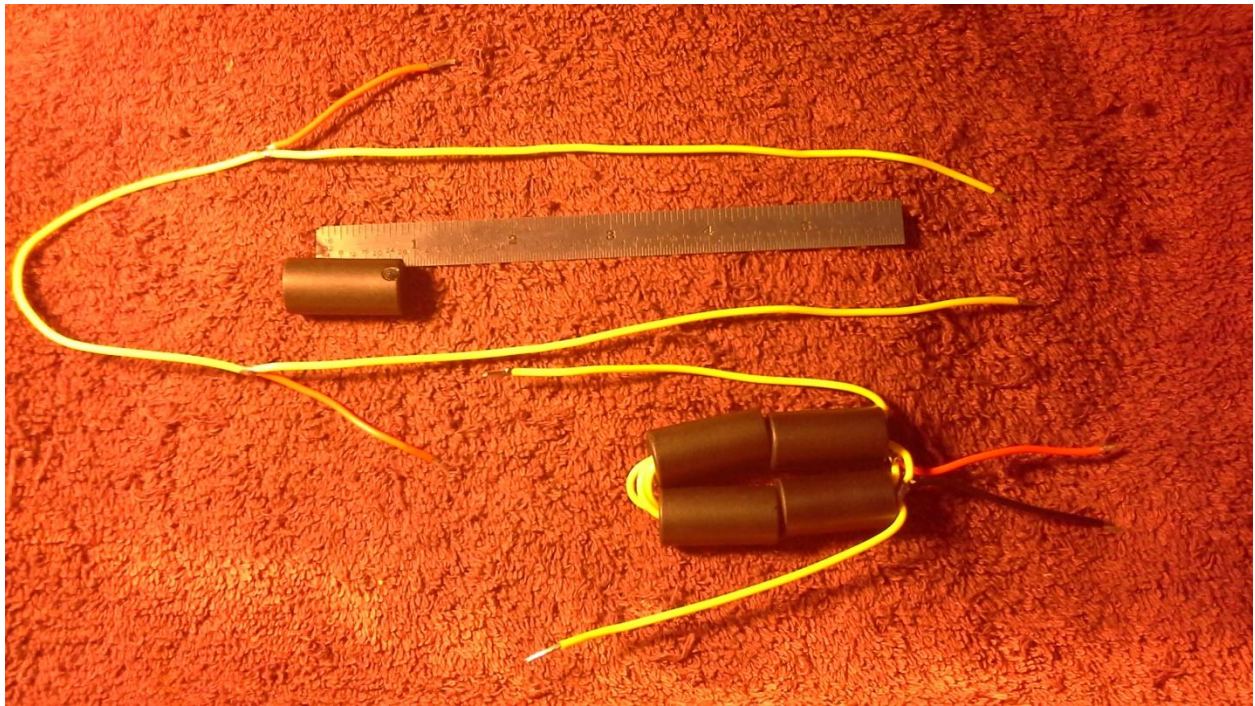
The Balun is a modified version of the KISS Balun by K6KBE which uses 4 #31 ferrite cores and 16ga Teflon coated wire. This Balun tested the best of all I have tried and is super easy to build. It actually works past 50 MHz!

See this link for more detail:

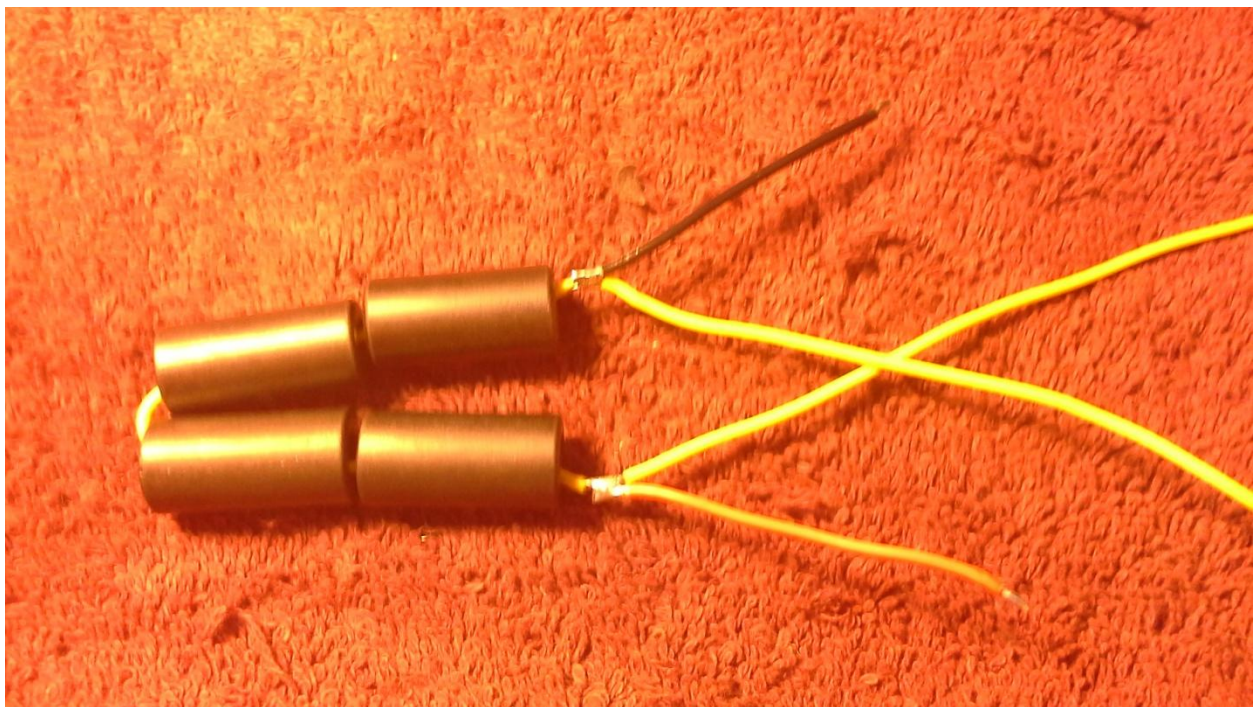
HFLINK.com/Antenna

The modification is to make it a 9:1 rather than a 16:1 ratio. This is simply done by making three passes through the cores instead of 4 passes. The transformer ratio is the square of the turns ratio, so a 4 turn is 16:1 and a 3 turn is 9:1. So easy.

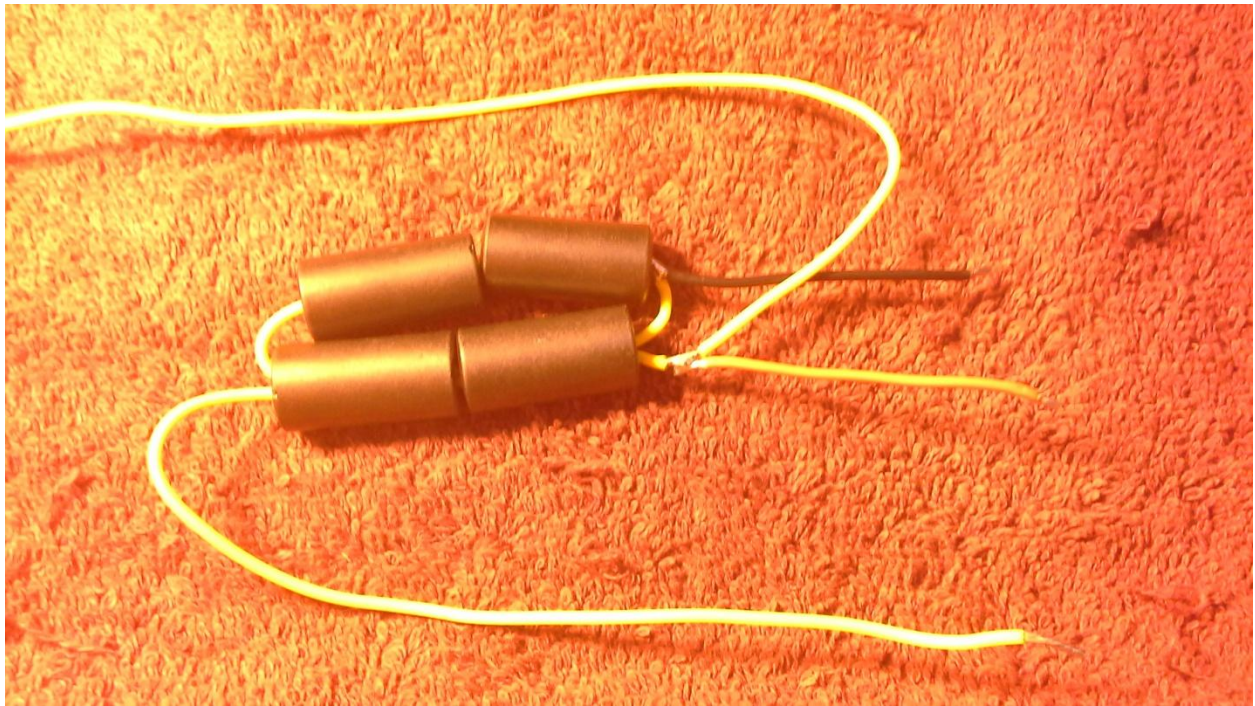
The Balun is built into a 1 1/2" PVC pipe with caps. The caps are held on with stainless screws, not glued, to allow for repair and experimentation. Drill two 1/16" drain holes in the bottom by the SO-239.



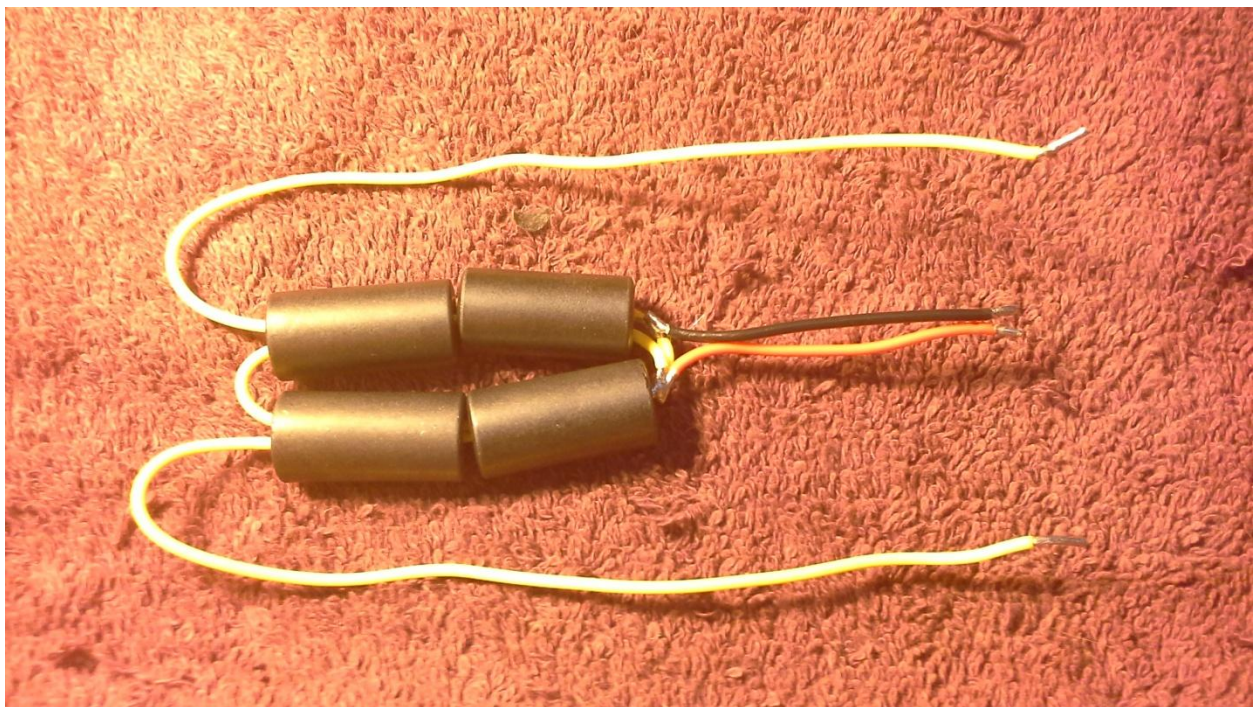
Overall view of the cores and Teflon coated wire assembly for the 9:1 version of the KISS Balun.



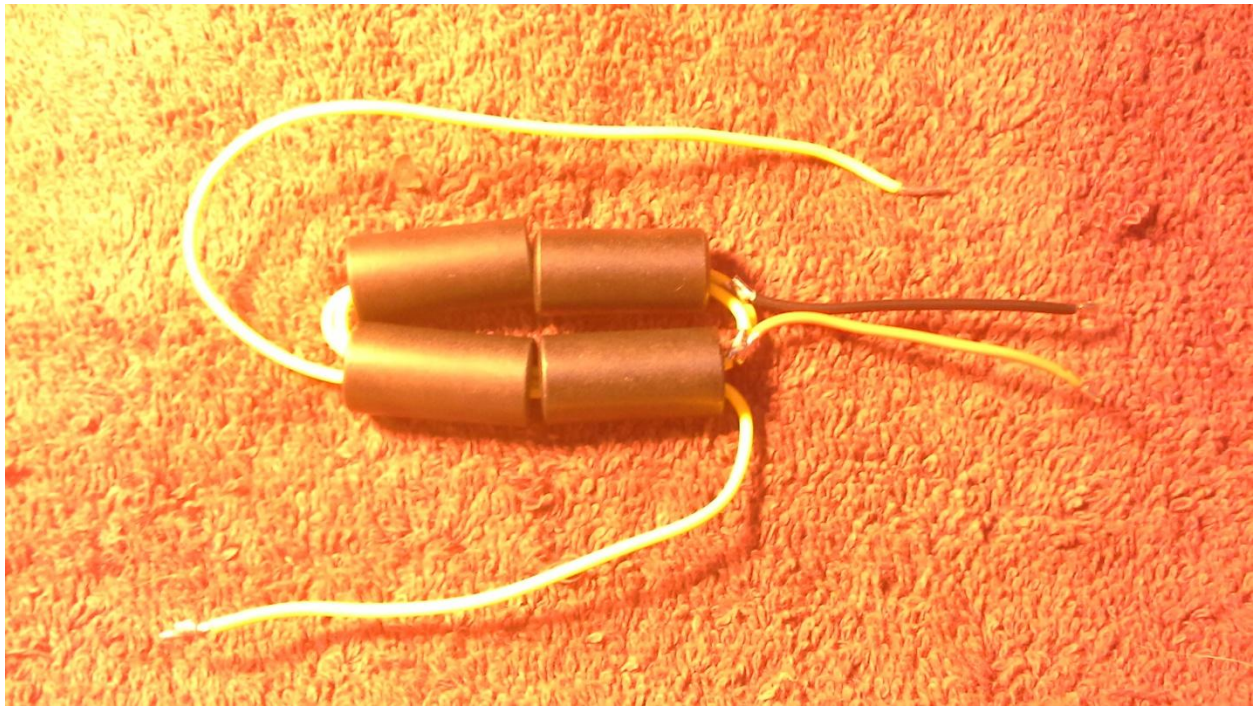
Step 1: Insert the wire assembly through the pairs of cores as shown. Keep wires snug.



Step 2: Take the upper tail and insert it through the bottom cores.



Step 3: Take the lower tail and insert it through the upper cores. Keep wires snug.



Step 4: Take upper tail and insert it through the lower cores.



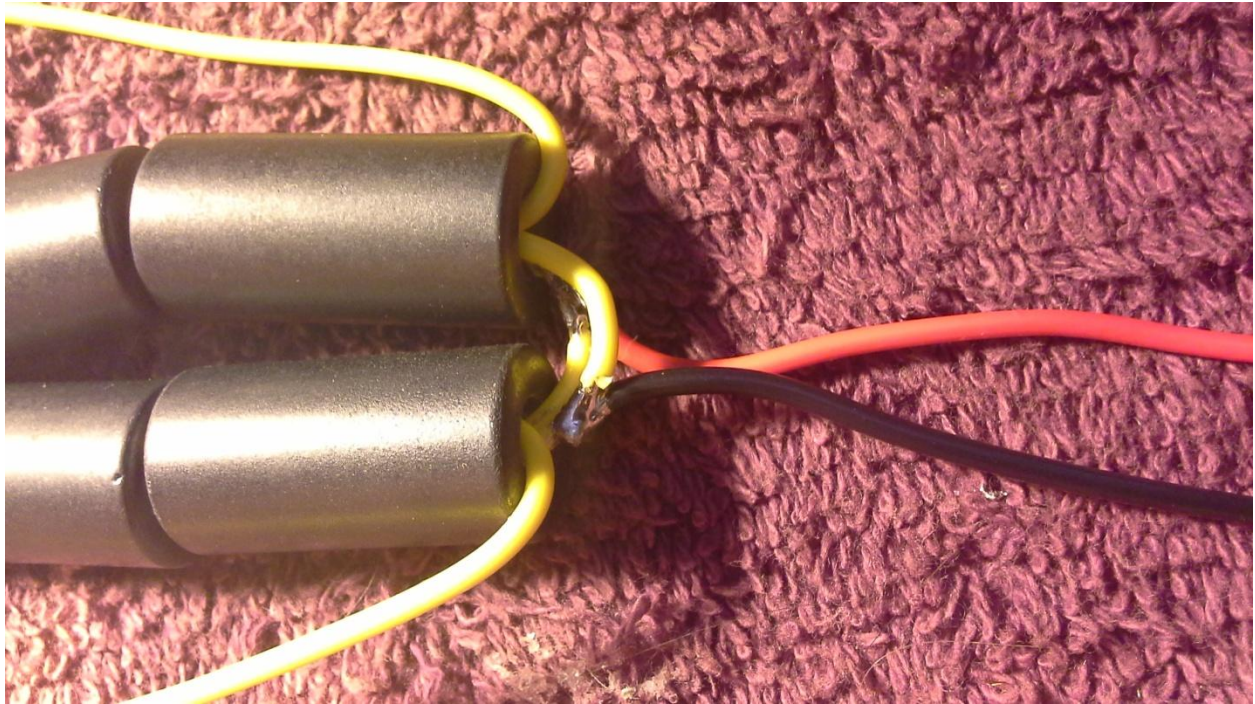
Step 5: Take lower tail and insert it through the upper cores. Snug up the wires. 9:1 Balun is complete.



The original KISS Balun with 4 turns through the cores for 16:1 ratio.



Pull one pass back out of the cores of the original design to make it 3 passes for a 9:1 Balun.



Red and Black go to the SO-239, Yellow go to the outer wires of the T3FD.



Three passes through the cores makes it a 9:1 Balun



Typical installation of a SO-239 into an end cap. Drill two drain holes as well.

ASSEMBLING THE ANTENNA

These are non resonant antennas so the length and spacing is not super critical. You will need some assistance. Lay out the spacers and insulators out on the lawn and stake them in place at the correct distances.

Regardless on the approach used to install the wires, three wires joining at the end insulator versus a continuous outer wire and separate center wire, it is important to remember to slide on the appropriate ferrules as you go.

Once the wires are in place temporarily wire (zip) tie them at the insulators so that everything can be measured and the wire lengths adjusted.

Crimp and finalize the end and center insulator connections first. You can slide the spreader back and forth a bit to equalize the tension on the three wires, then crimp the ferrules to hold it in place.

Leave at least 2 ft of wire after the center insulators to make the drop to the Balun which hangs below the center insulator system on the wires, and at least 1 ft of wire for the drop to the termination resistor.

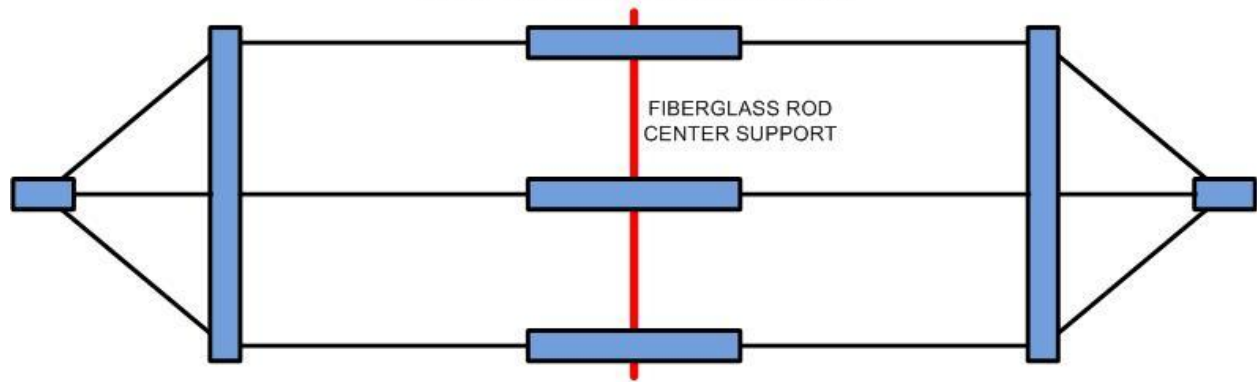
Place the termination resistor pipe a few inches below the center wire insulator and trim the tails on the center wire to reach the connection screws. Crimp on ring lugs, solder if you wish, and attach the lugs to

the termination resistor. Use coax seal and tape to seal up this connection. Make sure the tiny drain holes at the ends of the termination resistor are facing down.

Attach the Balun to the outer wires by cutting the wires to equal length where they all meet when held together below the center insulator assembly, so that the Balun will hang below the center assembly 18 to 24 inches, not critical. The outer wires from one end of the dipole get crimped together on a heavy duty ring lug, same for the other side. Wrap each pair with tape to enhance the mechanical integrity of the joint and attach to the lugs on the Balun. The weight of the Balun and coax hangs on these joints, so make sure they are solid.

The T3FD is now ready to erect and test. Use coax seal on the bolts and coax connector.

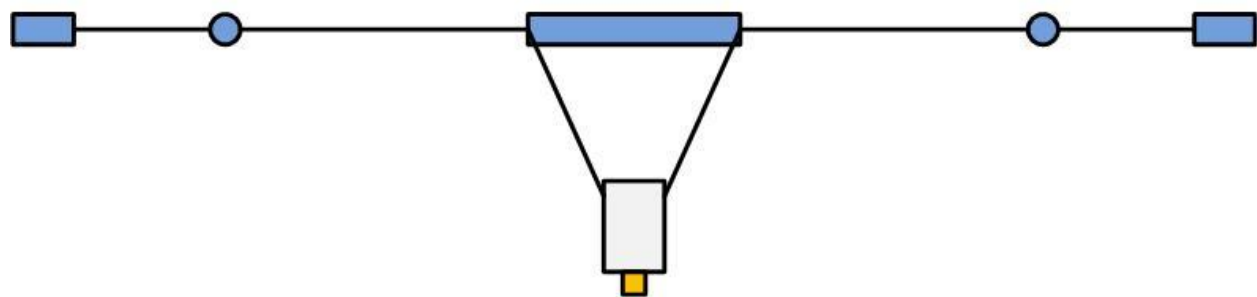
T3FD INSULATOR LOCATIONS



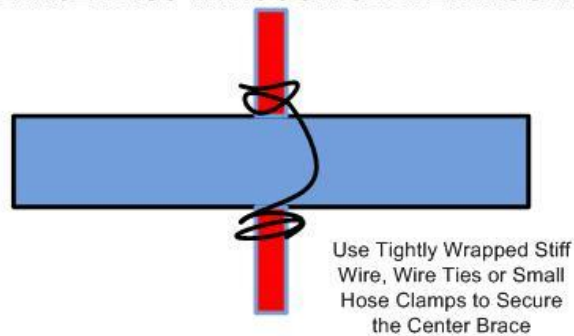
SIDE VIEW OF TERMINATION RESISTOR LOCATION

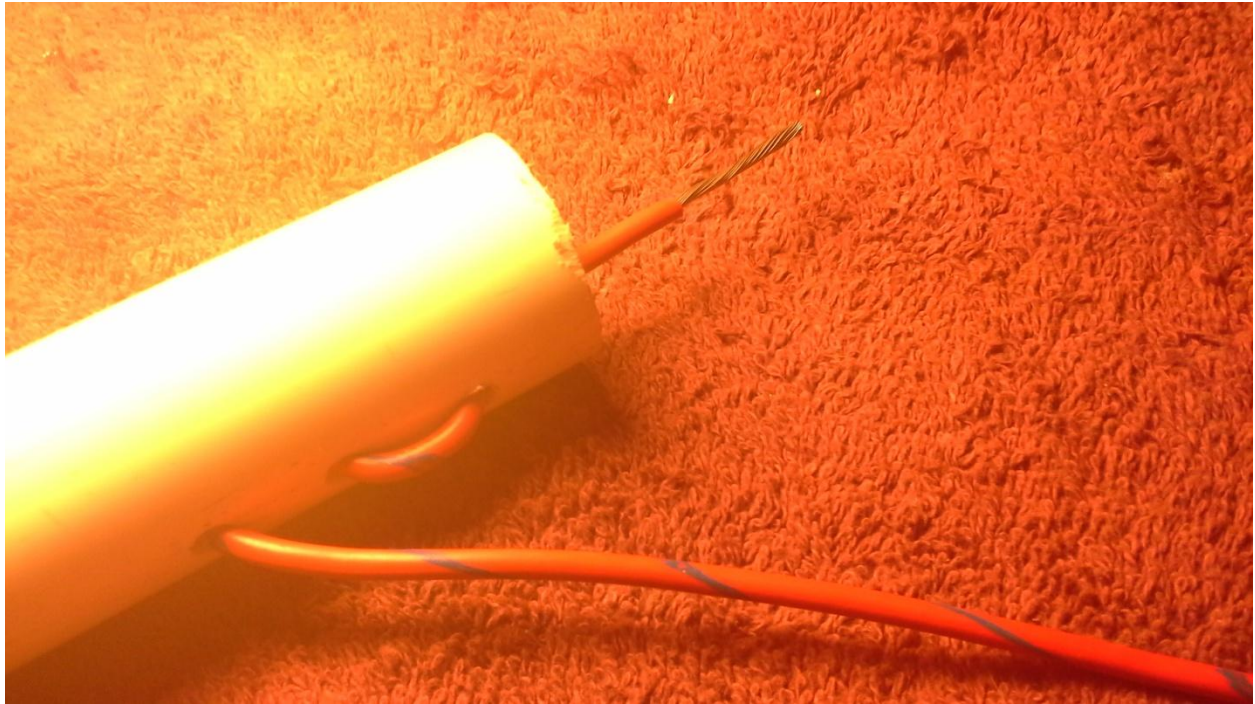


SIDE VIEW OF BALUN LOCATION



CENTER BRACE PASS THROUGH CENTER INSULATORS

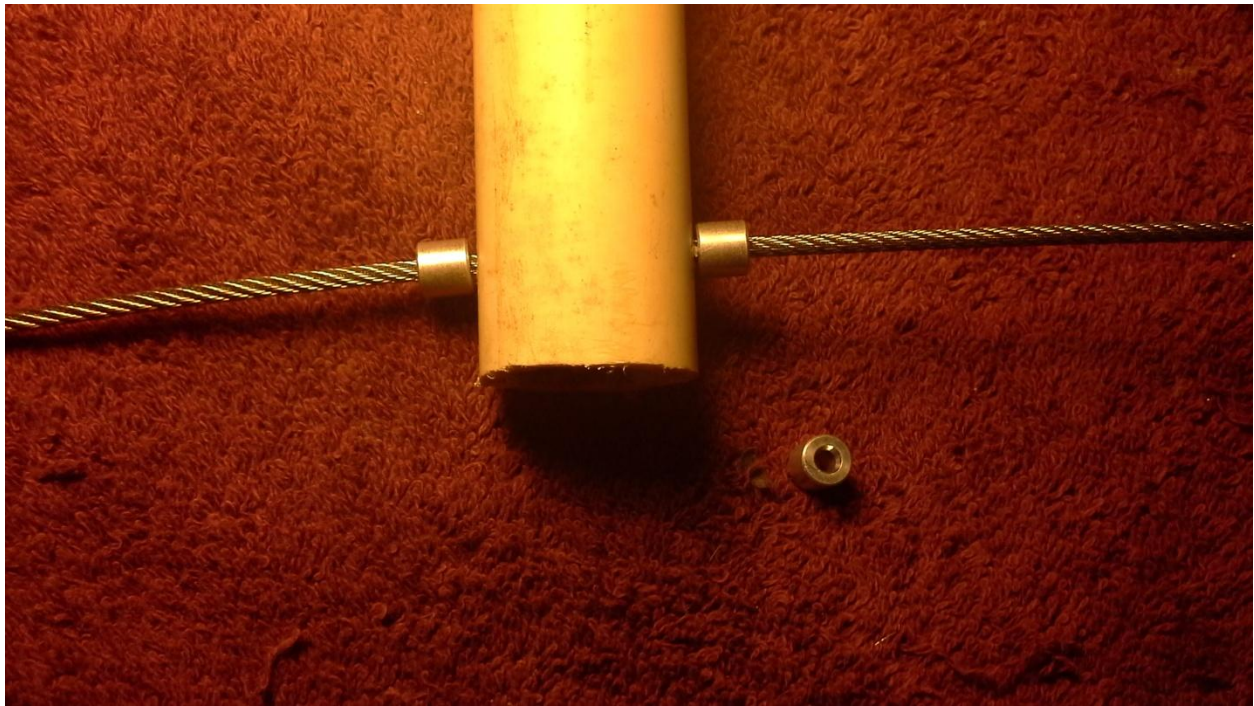




This is one way to make the three wire joint at the end insulator. Drill three sets of three holes around the pipe and thread the wire through as shown. Then solder the three wires together and tape. Tape over the end of the pipe where the wires thread through to help hold them in place.



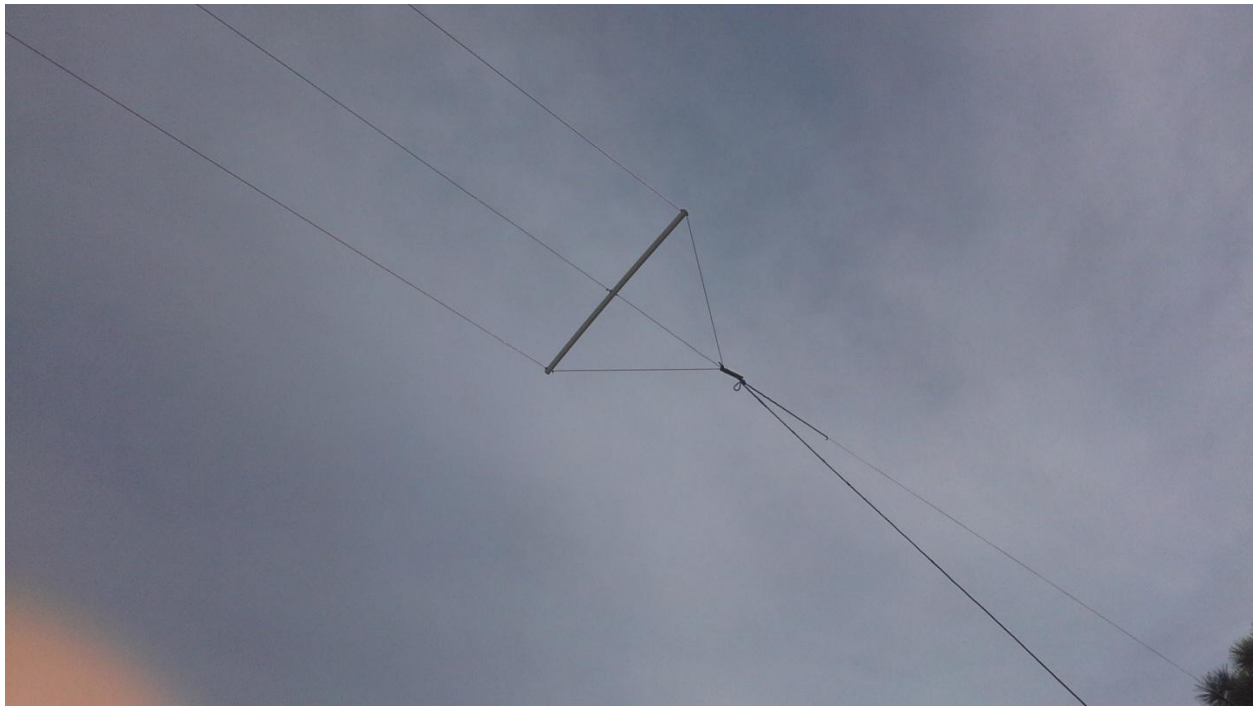
Another example of the end insulator apex connection using two cable clamps and end stops on the center lead. A larger ferrule or two would be better than the two clamps. The outer wire is one piece from the outer center insulator through the spreader, through the end insulator and back through the spreader to the other outer center insulator. Remember to slide on the ferrules as you go.



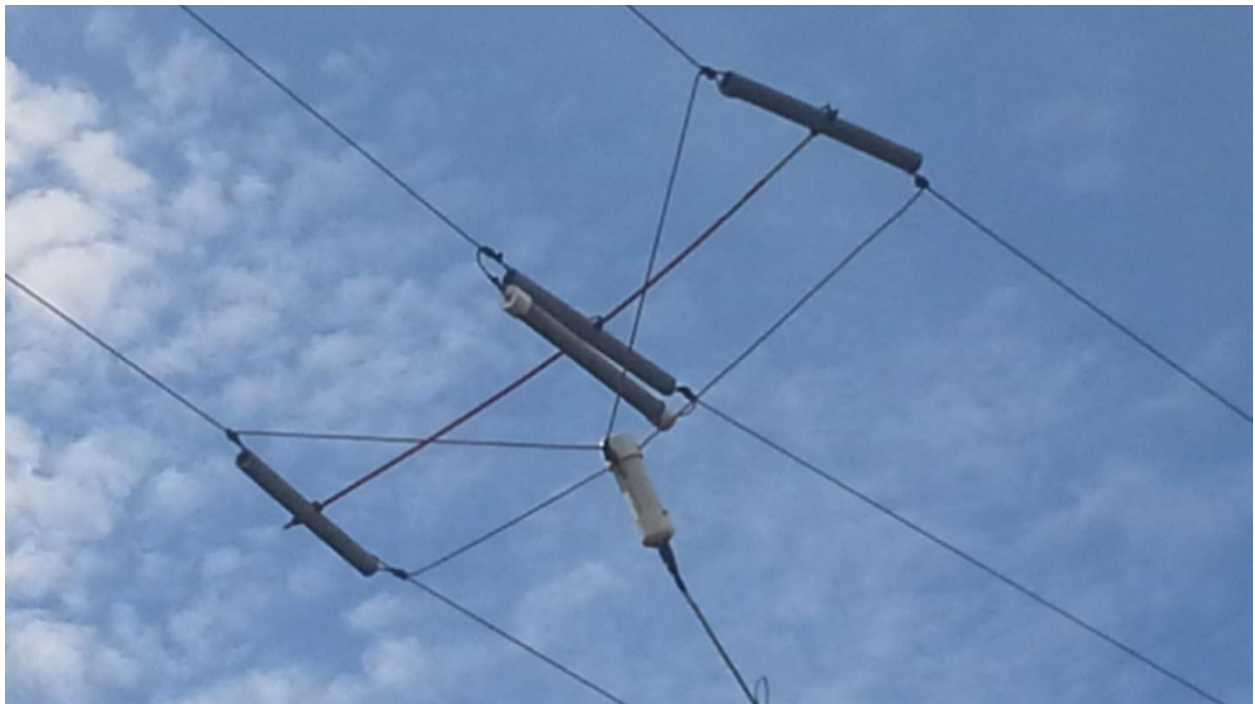
Use end stop ferrules to lock the spreader in place.



Here is an example of a connection tail. Use a ferrule to lock the wire in place and crimp the appropriate ring terminal on the end. Remember, the tails going to the Balun are at longer than what is shown. This is the tail going to the termination resistor.



Looking up at one of the 4 ft wide end spreaders and end insulator.



Here is a close up of the installed center section. The Termination Resistor is hanging below the center insulator and the Balun is hanging below that on the legs of the outer wires. The fiberglass rod center support is bending a bit from the stress of the coax weight and pull off center. A piece of aluminum tubing would be better.



Here is the installed view of the T3FD Antenna and other parts of the KA2UFO Aluminum Flying Circus. The 90FT version has only one spreader on each end, no intermediate spreaders except for center support.

T3FD PERFORMANCE

Typical VSWR Measurements for the T3FD on the ALE HFN frequencies are shown in the table. The antenna ends are about 30 feet up with the center sagging down to about 25 feet. I've been using an ICOM M710 150W PEP radio with this antenna for ALE PC-ALE / ALE^STAT. For ALE, SelCal and WinLink I have been using a BARRETT 2050 125W PEP radio, so far no smoke ;=). Under current propagation conditions, Soundings are being heard throughout the US and at times into Europe. See the HFLink live map for more data, and the Cebik document for in depth information on design, efficiency etc.

BAND	VSWR
160M	1.2:1
80M	1.2:1
60M	1.5:1
40M	1.6:1
30M	1.3:1
20M	1.3:1
17M	1.3:1
15M	1.3:1
12M	1.1:1
10M	1.4:1

OTHER EXPERIMENTS AND IDEAS

Here is a Portable T2FD antenna which rolls up and fits in a hydration pack bag. This has the 4 core 9:1 Balun as the T3FD and a 40 Watt 900 Ohm Termination. Spreaders are 14 inches, overall length 60 ft. The center Termination Balun section is made from 1" electrical conduit with that nice flare on the end to fit the Balun cores. Not shown are tiny carabineer style clips to attach the wires to the eyebolts.



Portable T2FD Antenna fits in Hydration Bag. Spreaders are made from fiberglass tent poles.

This is the first Termination and Balun setup I built for the 2 leg terminated dipole experiment. Both the core and termination resistors are in the same assembly. This setup would work nicely for the bowtie antennas with the correct Balun and termination value.



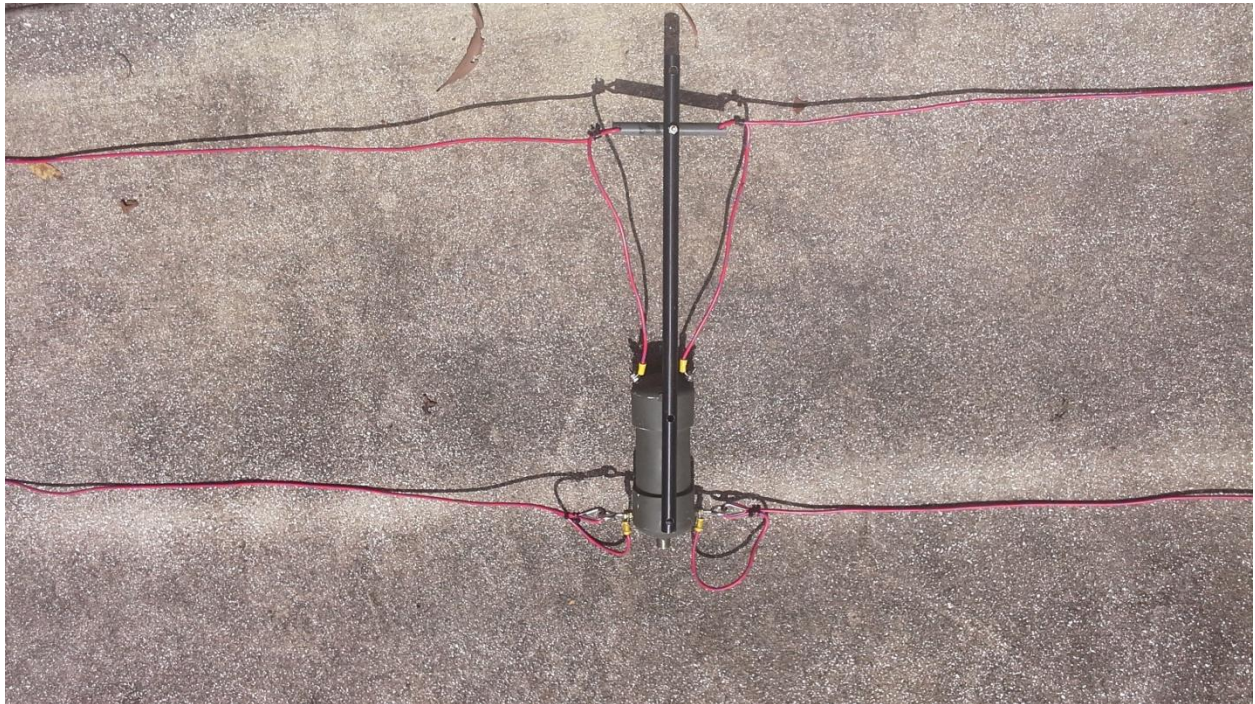
Beginnings of a 9:1 Balun and 450 Ohm Termination center assembly for 2 leg T2FD



Finished Balun Termination assembly. I learned not to glue things together!



Attached spreader and insulator to the Balun termination assembly



Center section for the T2FD antenna experiment. Spreaders are 18 inches.

REFERENCES

L. B. Cebik, Notes on Wide Band Multi Wire Folded Dipoles 4/3/2010

<http://www.antentop.org/w4rnl.001/radio.html>

<http://www.cebik.com/content/a10/wire/wbmw.html>

HFLINK site for BALUN instructions

Modified version of the KISS Balun by K6KBE uses 4 #31 ferrite cores, 16ga Teflon coated wire

<http://www.HFLINK.com/Antenna>

BUSHCOMM for the 3 leg commercial version

BBA 100 Series – 27 meter (89 FT) or 54 meter (177 Ft) long three leg terminated dipoles

<https://www.bushcomm.com.au/brochurelibrary/DB00538R6%20-%20BBA%20HF%20Broadband%20dipole%20series%20Overview.pdf>

BILL OF MAJOR MATERIALS

Part	Source	Qty	Price ea	Price Extended
PVC Pipe 1" x 10FT	Home Depot	2	\$4.00	\$8.00
PVC Pipe Cap 1"	Home Depot	2	\$0.83	\$1.66
PVC Pipe 1 ½" x 6"	Home Depot	1	\$2.00	\$2.00
PVC Pipe Cap 1 ½"	Home Depot	2	\$1.14	\$2.28
Reflective Rod 48 inch fiberglass rod	Home Depot Model# 848638	1	\$1.99	\$1.99
Stainless Screw #10 x24 x 1 ½ 3 per bag	Home Depot Model # 801571	2	\$1.18	\$2.36

	Internet #204596473 Store SKU #462738			
Stainless Nuts #10 x 24 aircraft nut 4 per bag	Home Depot Model # 800121 Internet #204274165 Store SKU #316908	2	\$1.18	\$2.36
Stainless Flat Washer #10 12 in a pack	Home Depot Model # 800331 Internet #204276461 Store SKU #369332	1	\$1.18	\$1.18
Stainless Sheet metal Screw #8 x 1/2 50 in pack	Home Depot Model # 802912 Internet #204275048 Store SKU #442305	1	\$4.24	\$4.24
Stainless Screw #4-40 x 1 1/2 5 in pack	Home Depot Model # 801701 Internet #204282633 Store SKU #493824	1	\$1.18	\$1.18
Stainless #4-40 nut 4 in pack	Home Depot Model # 08681 Internet #203436213 Store SKU #982441	1	\$1.18	\$1.18

Stainless Washer 12 in pack	Home Depot Model # 800311 Internet #204276459 Store SKU #380250	1	\$1.18	\$1.18
Ring Terminals 12 - 10 AWG #8 - 10 Stud Size 15 in a pack	Home Depot Model # 15-106 Internet #202522865 Store SKU #431390	1	\$2.62	\$2.62
Ferrite Cores for Balun PACK OF 6 17.5 X 10 X 28MM Ferrite Cores	AMAZON AEXIT T1712144065 ASIN: B07BWC5ZDR	1	\$12.76	\$12.76
Teflon Coated #16 Wire for Balun Solid Blue PTFE, stranded 19/29, 300v, 150°C, 0.015" Mfg: Rubadue	Surplus Sales of Nebraska (WTF)UL1199BK16	4	\$0.55	\$2.20
Metal Oxide Film Resistors 10 in pack 220 Ohm 5 Watt Need 2 packs	AMAZON Electronics Salon	2	\$9.49	\$18.98
SO-239 Connector	Junk Box!	1		\$5.00
Toughcoat 'Silky' 13 AWG, 19 strand 40% copper-clad steel (OD 0.0795") with tough, high density, low-gloss polyethylene (Nominal OD, 0.120" including 0.020" jacket. Break strength 400lbs PN 531	The Wireman	300	\$0.35	\$105.00
APPROXIMATE TOTAL COST w/o Tax or shipping	90ft T3FD			\$177.00

Teflon Coated Wire for Balun (and those big ceramic insulators!)

<http://www.surplussales.com/wire-cable/Wire4.html>

Antenna wire

<https://thewireman.com/antennap.html>

A Lower cost alternative for the antenna wire

543	FLEXWEAVE™ 12 AWG, 259 strand bare copper ultra-flexible antenna wire, for heavier applications. Break strength 170 lbs.	300	0.28	\$84

Yet another idea to save money is to use the 13 gauge Silky wire for the center wire. You can set up the alignment so that all the tension is on that center wire which has a 400lb breaking strength and use #12 insulated wire or other cheaper wire for the outer wires.

CONCLUSION

I hope this helps you build a T3FD antenna and have some fun with ALE. If you have any comments or suggestions, please let me know. Your mileage may vary. Tony KA2UFO@comcast.net West Palm Beach, Florida.