6 M DIPOLE ANTENNA PROJECT

Project Objective:

Design and build an 6 m dipole antenna from aluminum, tubing, that resembles the active element of a yagi beam antenna.

Sunspots are appearing with increasing frequency, with improved propagation permitting effective communication on the 6 meter ham band. Conditions are expected to improve in the near future as Solar Cycle 24 progresses, so it seems a good time to add a 6 meter antenna.

Design considerations:

The design of this 6 m dipole antenna shall include the following design considerations:

- The antenna must be compact.
- The antenna must be durable and secure.
- The antenna shall be installed on a 1.25 inch galvanized steel mast.
- The antenna shall be supported from a single point at its center. It shall not employ rope to tether it to remote supports.
- The antenna shall be made from durable, weather worthy components.
- The antenna shall employ a 1:1 line isolation balun/ transformer, to minimize possible radiation from the shield conductor of the coaxial cable feed line.
- The antenna shall be reasonably inexpensive compared to the cost of a similar size wire dipole antenna.

To achieve these design considerations, I concluded my 6 m dipole antenna shall be be made from rigid aluminum elements, supported at its center on a single mast, utilizing a strong, light weight plastic element-to-boom plate. Using a center support mast obviates the need for multiple support masts, and avoids using end insulators and long support ropes which require appropriate distant tie-off points out in the yard.

Major Parts and Components:

I ordered the following parts from DX-Engineering in Akron, Ohio:

Quantit y	Part No.	Description	@ Price	Total Price
1	DXE-BEB-3	Insulated 1.25-1.75 in. Boom to Element Bracket - DXE-BEB-3	$ 4.95	$4.95
1	DXE-SEI-1	Split Element Insulator Designed for a 3/4 in. O.D. Aluminum Tube Being Used For a Driven Element	$.6.49	$6.49
2	DXE-SAD-075	3/4 in. Saddle Clamp, Stainless 1/4 in. U-Bolt & Hardware	$5.35	$10.70
1	DXE-SAD-125A	1-1/4 in. Saddle Clamp, Stainless 1/4 in. U-Bolt & Hardware	$6.55	$6.55
2	DXE-ECL-060	Element Clamp for 3/4 and 7/8 in. tube	$1.90	$3.80
2	DXE-AT1243	Aluminum Tubing 3' x 0.750" x 0.058" wall, one end slit	$4.80	$9.60
2	DXE-AT1242	Aluminum Tubing 3' x 0.625" x 0.058" wall, one end slit	$4.55	$9.10
2	DXE-AT1205	Aluminum Tubing 6' x 0.500" x 0.058 wall", one end slit	$6.60	$13.20
3	DXE-ECL-060	Element Clamp for 3/4 and 7/8 in. tube	$1.90	$5.70
3	DXE-ECL-040	Element Clamp for 5/8 in. tube	$1.90	$5.70
		TOTAL (LESS SHIPPING) :		$75.79

From Array Solutions, Inc., in Sunnyvale, TX, I purchased a Cal-Av Labs Model EB-21:1 Beaded Line Isolation Balun, which is rated to handle 2 kW PEP on SSB (higher for CW) and covering a n operative frequency range of 10 - 60 MHz, at a cost of $43.

Quantity	Part No.	Description	@ Price	Total Price
1	Model EB-2	Cal-Av Labs Model EB-21:1 Beaded Line Isolation Balun	$43.00	$43.00
		TOTAL (LESS SHIPPING) :		$43.00

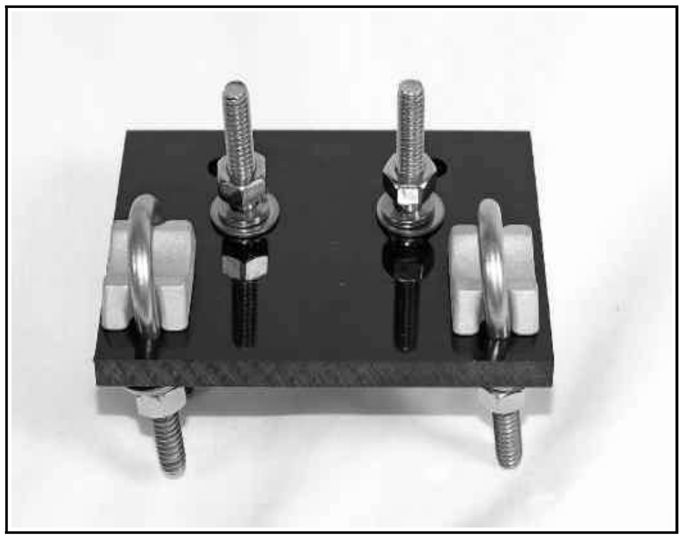
Incidental Parts and Components:

Two 2- 8-32 x 3/4" combo round machine screws with nuts and washers connect the wires from the balun to the aluminum antenna elements. Closed-end crimp lugs secure the balun wires to the machine screw connectors on the antenna elements. Stainless steel hose clamps secure the balun to the mast. Multiple plastic cable ties secure the feed line to the mast.

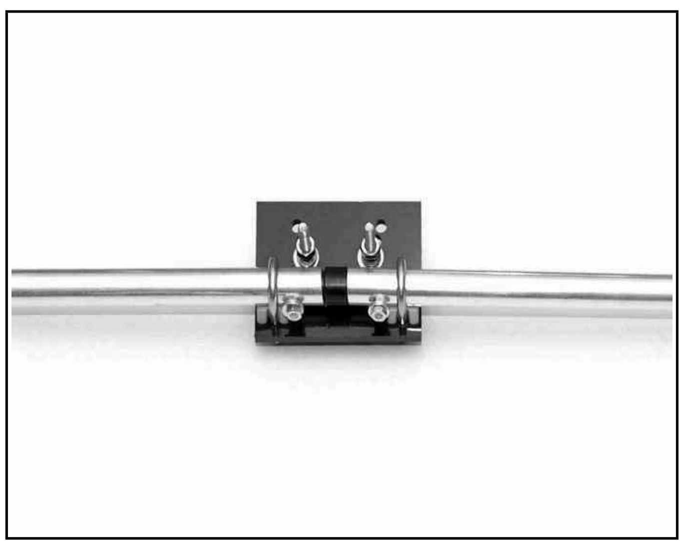
Quantity	Part No.	Description	@ Price	Total Price
2	N/A	Closed-end crimp style lugs	$0.05	$0.10
2	N/A	2" diameter stainless steel hose clamps	$1.30	$2.60
2	N/A	8-32 x 3/4" combo round machine screws with nuts and washers	$0.50	$1.00
5	N/A	Black plastic cable ties	$0.20	$1.00
		TOTAL (LESS SHIPPING) :		$4.70

Construction Notes:

First, I assembled the parts which attach to the plastic boom-to-mast plate. The two three-quarter-inch-diameter dipole antenna elements are attached to the plate with saddle clamps, and a saddle clamp is used to attach the whole assembly to the galvanized antenna mast.

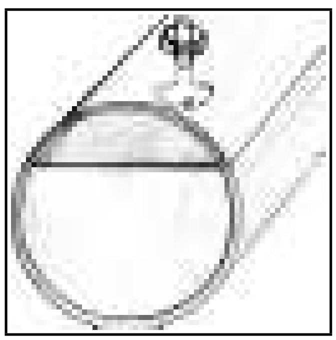


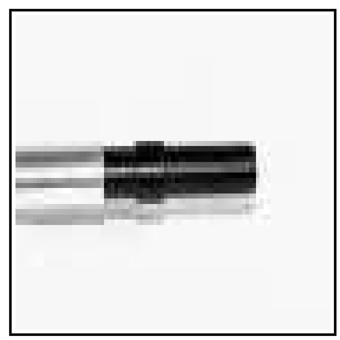
The two dipole elements Consist of a 30-inch-long, .750" diameter aluminum tube, and a 28-inch-long, .625" diameter aluminum tube. When assembled, the elements are approximately 54.5" long with an approximately 3.5" overlap that provides sufficient variation in the overall length to facilitate tuning in the field.



Two small holes were drilled approximately .5" inch from the center ends of each element to accommodate a small 8-32 x .75" machine screw that is secured Secured with a nut. On that were placed two small washers and another nut, to be used as a connector for the wires leading to the 1:1 line isolation choke/balun.

The aluminum dipole elements are separated and connected by a plastic rod which feels the inside of the aluminum tubes to prevent the saddle clamps from pinching or compressing (crushing) the aluminum tubes. It also serves as an insulated divider keeping the ends of the to tubular elements approximately 1 inch from each other.

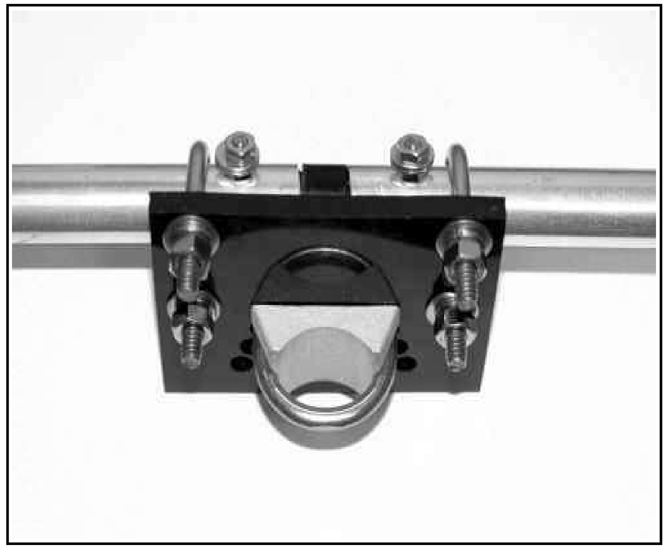




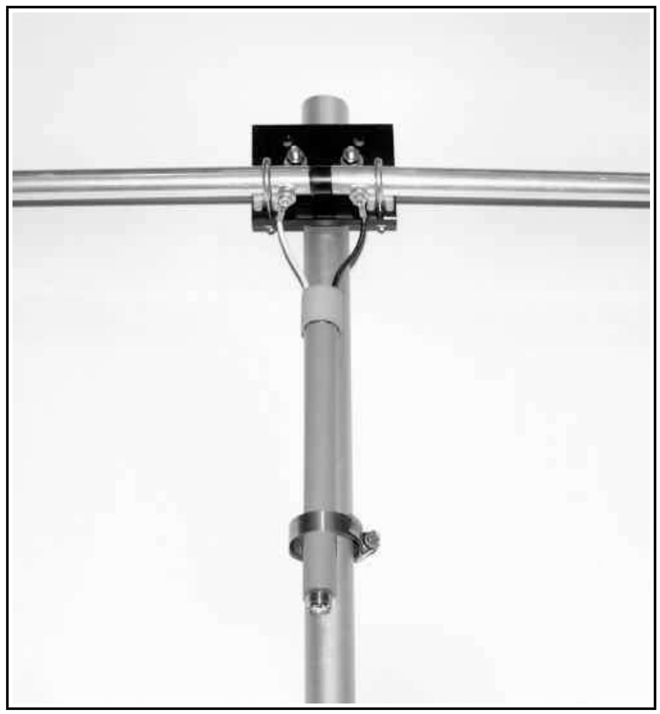
The round split element insulator was modified using a rotary grinder. It was flattened along its length to accommodate the head of the screw that constitutes the connector for the feed line. Care was taken in final assembly to assure it the rounded portion is lined up under the saddle clamps, so it does its job of keeping the saddle clamp form crushing or pinching the aluminum tubes, and yet accommodates the width of the screw head inside the tube. Just rotate the tube/insulator assembly so that the screw connector is pointing down, 90 degrees off the axis bisecting the saddle clamp U-bolt.

The to wires leading to the line isolation transformer/balun were trimmed. The ends were stripped and two closed-end lugs were crimped and soldered on the end of each lead wire.

The whole assembly is attached to a 1-1/4” galvanized steel television antenna mast with a saddle clamp.



The balun is attached to the mast with a 2” diameter steel hose clamp. The coax cable will be attached to the mast with black plastic cable ties to provide a neat finish, and provide cable strain relief.



Theory Behind the Line Isolation Balun:

A line isolation balun isolates the antenna elements from the coaxial transmission line so that power is radiated by the dipole antenna elements and not by the feed line. This is a current-type balun. The dipole should have equal RF currents at the feed point. This type of transformer is often called a "common mode choke."

Illustration 1: Cal-AV EB-2 Line Isolation Choke – Balun.

A common mode choke is often used with coaxial cable transmission lines. Basic electric theory says a wire conductor has a "skin effect" whereby electricity flows on the outside of the wire conductor. It also means the inside and outside surface of the conductor can constitute two separate conductors along the same wire. Current flowing on the outside of the coaxial cable shield is sometimes considered a common mode signal. The outer shield conductor of coaxial cable is subject to stray EMI and RFI from its environment. Common mode current can cause problems by radiating this signal again further down the coax cable, which can distort antennas radiation patterns and can flow along the outside of the coaxial cable shield back to the shack, and can flow between station components in the shack.

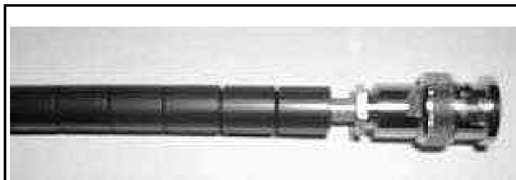


Illustration 2: Ferrite Bead Choke.

It is not practicable to isolate the shield from these effects. In contrast, it is practicable to block or disrupt current flowing on the outside of the coaxial shield by using a common mode choke. One way to accomplish this choking action is to string a number of high impedance ferrite beads along and surrounding the coaxial cable. Although these can be installed anywhere along the feed line, it is usually considered best placed as near the antenna feed point as possible. This bead choke is presumed to affect only the current flowing on the outside of the shield. Current flowing on the inside of the shield, and, especially on the cable's inner conductor, are presumed to be unaffected. This suppresses unwanted stray RFI and EMI affecting the transmission line. This calls for a ferrite material that is of high impedance and is also substantially resistive. No. 31 material is typically used at HF frequencies. No. 43 material is typically used at VHF and higher frequencies.

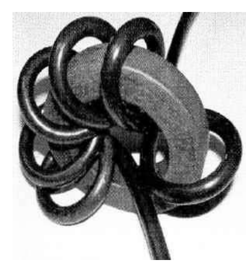


Illustration 3: Multi-Turn Toroid Core Choke.

A choke made from winding the coaxial line through a toroid core multiple times works best. Ferrite beads are considered a single-turn toroid core, or, and are less effective. Clamp-on or split core beads can be used, especially on cables where end conductors have previously been installed and it is considered inconvenient to remove them. At very high frequencies, a single bead may be sufficient. At lower frequencies, and especially at HF frequencies, multiple beads are necessary as they have cumulative effect and, together, may constitute an effective choke. At HF frequencies, it takes several beads to have the same effect as a few turns of cable through a large toroid core. Research indicates using several beads strung closely together can constitute an effective common mode choke.

Illustration 4: Another Style of Toroid Core Choke.

Specifications of the Cal-AV Labs EB-2 Line Isolation Balun:

The EB-2 Line Isolation Balun is constructed of a length of Teflon coaxial cable surrounded by a number of ferrite beads. At one end of the cable is a SO-239 UHF coax connector which accepts a common PL-259 connector. At the other end are two wire leads to which I installed round lug connectors to facilitate connecting the balun to the antenna elements. The wire leads are color-coded for ease of phasing in multi-element arrays.) This balun is vacuum impregnated and sealed against the weather. The balun is enclosed in gray PVC pipe, which can be painted.

> Note - This balun is not expected to improve SWR, as it is not part of a matching network. Also, this Balun is not expected to act as a lightning arrester, because the winding inductance is too low.

Some operators installing a line isolation transformer or at the transmitter end of a coaxial cable transmission line to avoid providing a ground path for RF current induced by the antenna's radiation field on the coaxial feed line. The length of the coax will be a factor in determining whether, and to what extent, RF might be induced on the feed line. A detailed discussion of this application is beyond the scope of this work.

This writer is not fully convinced this sort of line isolation transformer is as efficacious as some manufacturers and operators claim. He is fairly certain it won't have a deleterious effect on transmission or reception, and speculates its expected benefits are greater than its potential detriments, which are believed are de minimis. In other words, it *might* help, but *probably* won't hurt.

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