The Iota (I) Antenna

A capacitive loaded and inductively center loaded vertical dipole with helical hairpin beta match.

Antenna installed at the author's QTH

The Iota (eye-o-ta) is an inexpensive and relatively easy to build vertical dipole that stands about 9 feet tall. It has been successfully operated on 10M through 40M. I am a relatively new HAM and overheard some members of the Tamiami Amateur Radio Club discussing a similar commercial antenna, and a couple members mentioned it worked inside their large lanai enclosures. The commercial versions were too costly for this frugal HAM, so I decided to build one from scratch. I would like to thank all the club members who encouraged and mentored (Elmered) me through this project.

Construction is greatly simplified by the use of standard easily available materials, and inexpensive fittings normally used in tarp canopy support frames. The first successful

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transmission was made after and investment of only about $30 and 3 hours. It has provided hours of fun tinkering and operating for several club members.

CAUTION: High voltages may be present on the antenna when operating. It must be located in a protected area where people and animals can not touch it.

The following details should provide enough information to allow construction and tuning guidance. Further development and innovation is always encouraged.

The Structure

The antenna structure is fabricated from ¾" EMT electrical conduit. Only 5 cuts are required from two 10' lengths. The "T" connections were ordered on eBay (search for ""canopy fitting").

The center insulator may be the most difficult part depending on the tooling available. The initial insulator was simply a length of ½" PVC pipe reduced in diameter to slide snugly into the conduit. This worked but was deemed too flexible for long term use. The ½" PVC pipe was then bored out to 5/8" and a piece of 5/8" hardwood dowel was inserted through the center. This created a stiffer center insulator. A center insulator has also been made from solid PVC bar. The ultimate center insulator would be made from fiberglass, but the raw material cost would almost double the initial cost of the structure. Reducing the diameter is the most difficult part of the project (unless you have a friend with a lathe). Lots of small machine shops are happy to help creative people as long as you provide them with enough detail so they can help you in a small amount of time.

Material sources: (always verify part numbers)

Conduit – Lowes part number 72713, ¾" EMT. ~$6 per 10' piece

Conduit Hangers – Lowes part number 75308, conduit hanger #1 size. $0.68 each

Canopy fittings – Purchased from eBay seller "buys4u". Part numbers FTA and FOTA. Send the seller a message asking for combined shipping. The shipping fee for one piece will cover at least four pieces. ~$6 each plus shipping.

Solid PVC rod - MSC Industrial item number 52422920

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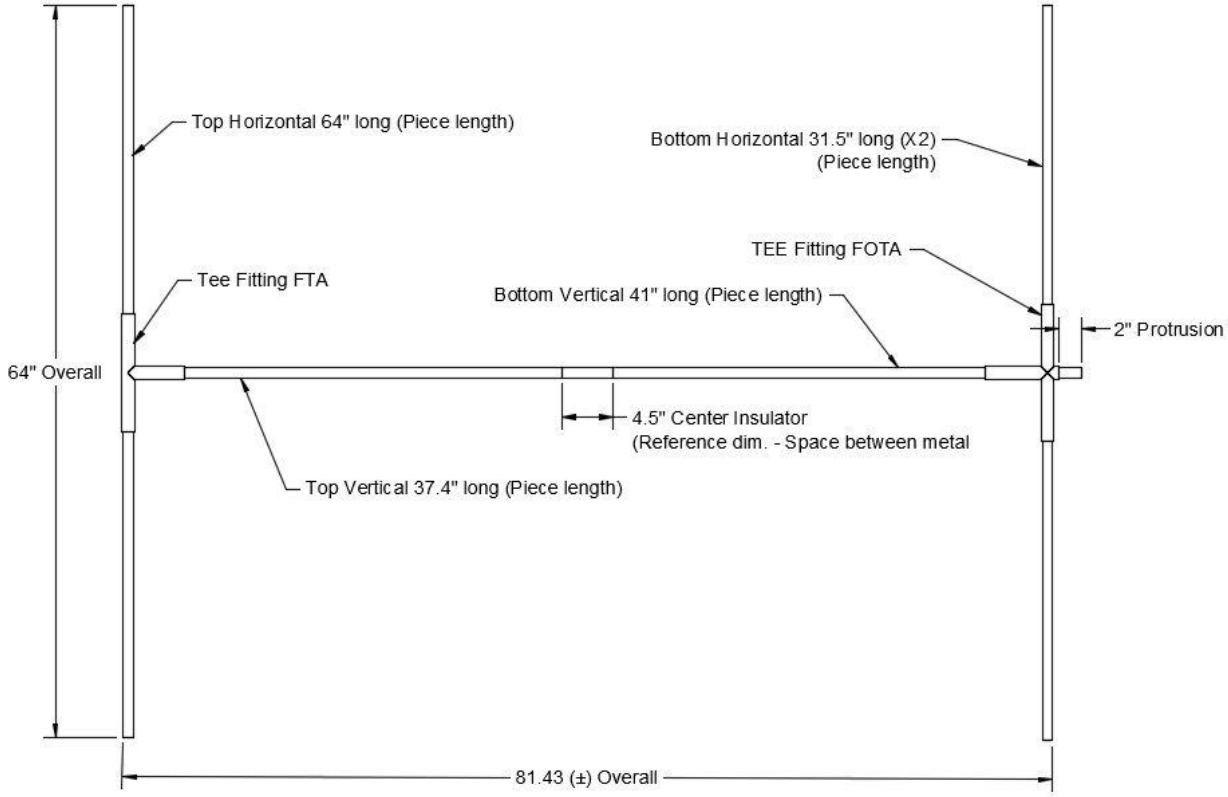
Canopy Tee Fittings

See the image below for dimensions and a cut plan for the EMT.

Assembly Drawing



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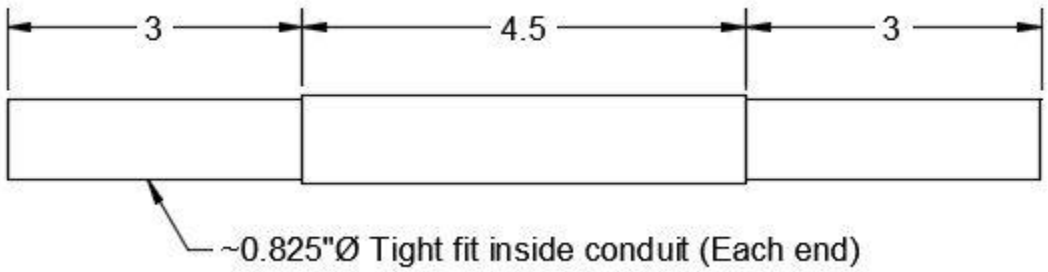
Center Insulator



The following lengths are cut from each piece of 10’ long conduit:

Conduit 1 – 64”, 41”

Conduit 2 – 37.4”, 31.5”, 31.5”

The Mount

The antenna should be mounted so the lower horizontal beam is two feet above the ground. The mount must be nonconductive. This can be accomplished in several ways. The ultimate mount would be a piece of rigid fiberglass rod inserted into the bottom of the vertical conduit. The rod could be supported by a tripod or by a mount inserted in the ground. Less costly mounting methods are shown below.

A simple PVC mounting pole can be made from 1” PVC pipe and two couplings. One coupling is glued to the end of the pipe and has 4 tapped holes around the perimeter very near the end. Four screws are used to center the bottom of the bottom tee fitting. The second coupling is sawed in half lengthwise, and then sawed in half crosswise. This creates two half collar pieces that are clued to the pipe just below the coupling on the end. The purpose of the collar is to provide additional thread length for four tapped holes 2 ¼” down from the top. These screws are used to engage the conduit stub protruding from the canopy tee. They can also be used to level the antenna a bit.

An improvement on the above mounting pole is to insert a bushing with 1 1/8” ID into the top of the coupling to eliminate the need for the centering screws at the end. The

bushing can be a bored out piece of 1” pipe or a solid 3D printed bushing. If additional strength is desired around the top edge, a hose clamp can be used.

Two Screw Sets Mount

Mount with Bushing

A 2 foot long length of PVC pipe will be a bit flexible. To stiffen the pipe, fill it with Quikcrete or other material that will harden.

A mounting pole can also be made from a surplus fiberglass antenna or tent pole often see at ham fests. It uses a bushing inserted in the top and the same 4 leveling screws as above.

Antenna mounted in a surplus fiberglass tent pole

Mounting Pole Support

The mounting pole can be supported in a number of ways. The photo on page 1 shows a mounting pole directly inserted in the ground. A more portable mount is a

tripod/quadpod shown below. This wooden support was made from one 2x4 stud and one fence picket ripped down the middle. Very inexpensive.

A simple wood stand

The Loading and Matching Coils

Now for the more radio like part of the antenna. Also known as Voodoo.

As constructed, the antenna is resonant at about 30MHz. Coils are required to make the antenna work for amateur bands, but they can be very simple and don't require any heavy math or skill to make. A chart and other images below are enough information to make coils for 40M, 20M, and 10M operation. SWR plots of tuned coils are also shown to get an idea of tuning and band width. An antenna analyzer is highly recommended but it doesn't have to be an expensive one. Development and tuning was done using a $42 NanoVNA purchased on eBay. It will show return loss and SWR along with many other parameters. The plots shown below were created by free software connected to this analyzer. The NanoVNA (Vector Network Analyzer) is an amazing instrument considering its size and cost. There are hundreds of YouTube videos demonstrating its operation. With the addition of a capacitor and some test leads you can even measure the inductance of the coils you make.

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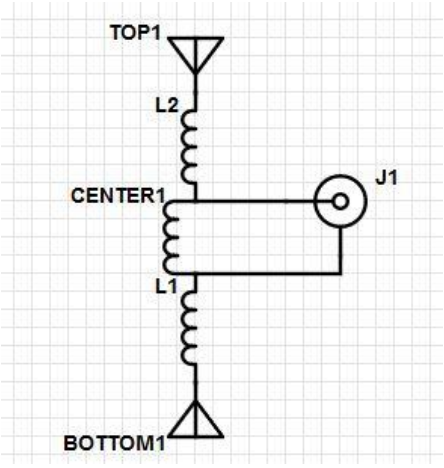
NanoVNA

Coils are mounted on coil boards that are affixed to the antenna at the center insulator by two common conduit hangers. The hangers serve as a mounting method and also provide the electrical connection from the coils to the antenna.

Image rotated 90 deg.

Coil board mounting

CIRCUIT DIAGRAM



The photo below shows three coil boards for 10M, 20M, and 40M. The 10M board was used to make the first transmissions and is simply a piece of ¼" plywood with an SO239 connector and coils made from scrap 14GA ROMEX wire. Wire on the back side of the

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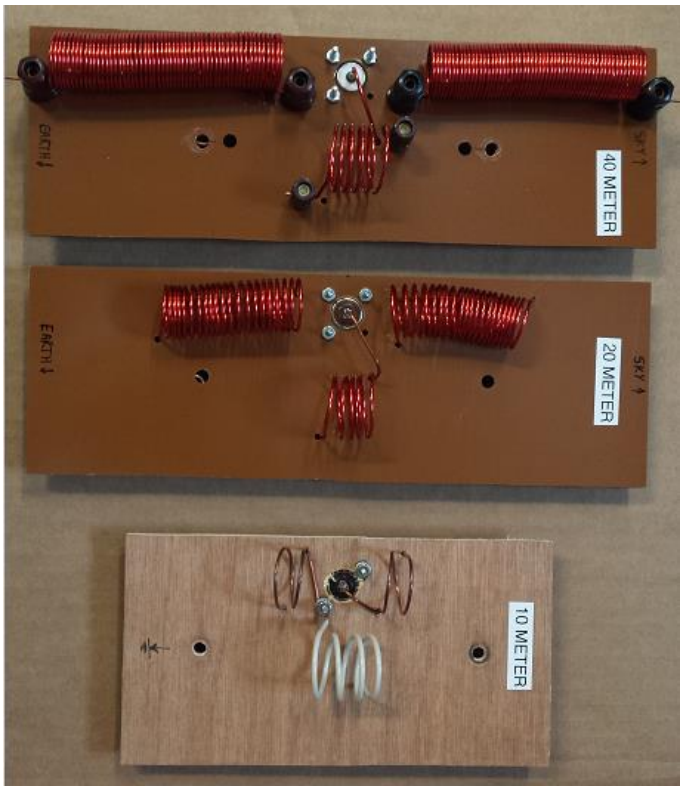
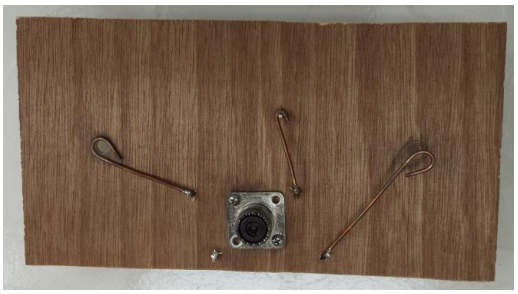
board connects the coils to the upper and lower sections of the antenna by sandwiching the wires between the board and the conduit hangers.





The 40M board above is made from 1/8” thick phenolic board (MSC Industrial Supply item 63414544 or 63410724), and the coils are mounted in binding posts. This proved to be a very effective method for testing various coils, and coils can be tuned by simply stretching them. The 20M coils shown were initially developed on the binding post board. They were wound tightly like an extension spring, then stretched between the posts to tune to the lowest SWR at the desired portion of the band. The photo below shows the initial set of 20M coils on a plywood board.

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Plywood is not a recommended material for long term use. Wood compresses and will eventually cause the posts and connections to the antenna to become loose.

For tightly spaced coils, enamel coated wire is necessary.

Below is a chart showing the characteristics of some coils as a starting point. All of these coils have been used successfully. Note that when tuning the coils the top and bottom coil must be tuned the same, as closely as possible. While the idea of bending two coils to be exactly the same seems a bit ridiculous, stretching two coils to the same length is a bit more practical. All the coils in the chart use 14GA wire.

Coil Chart

BAND	10M	20M	40M
Center Coil Dia.	1.2"	1.2"	1.2"
Center Coil Turns	2.5	3.5	4.5
Center Coil Length	1"	1"	1"
Loading coil Dia.	1.2"	0.94"	0.94"
Loading Coil Turns	1.5	20.5	55
Loading Coil Length	0.5"	2.6"	4.1"
Bandwidth	Entire Band	500 kHz	65 kHz

NOTES:

1) 1.2" coils were formed tightly on 3/4" PVC pipe.
2) 0.94" coils were formed thighly on 1/2" PVC pipe.
3) Coils with half turns start on one side and end on the opposite side.
4) Coils with whole number turns start and end at the center of each end.
5) These values were arrived at through experimentation.
6) Bandwidth is considered the range of frequency with SWR below 2:1

Below are some SWR plots of the various coils. As frequency goes down, the bandwidth decreases, as is typical for a coil loaded short antenna. This makes it necessary to tune the coils to the part of the band of interest.

10M Band

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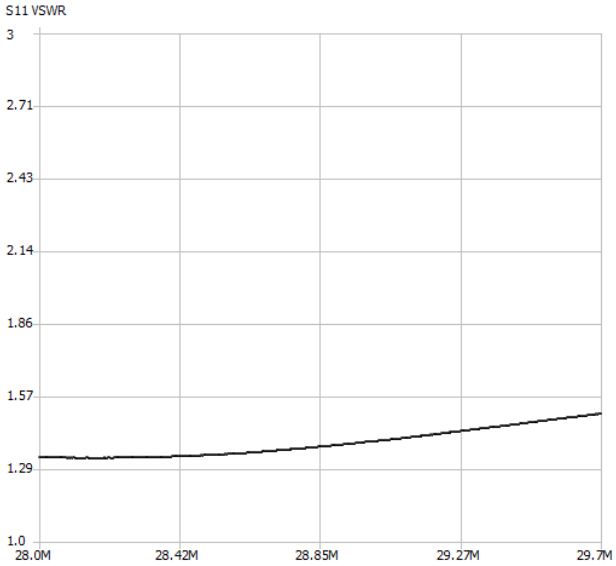
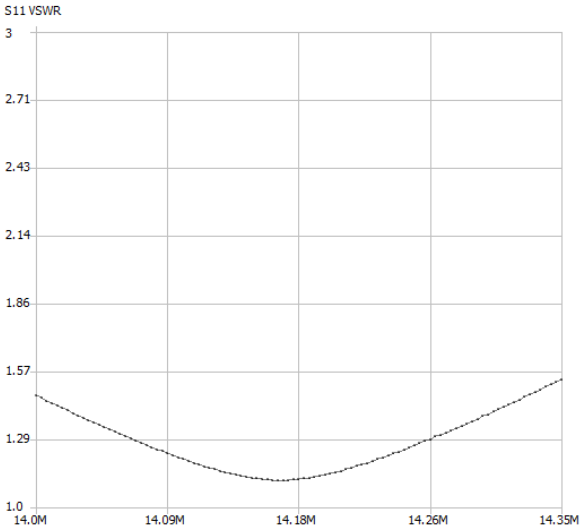


10M Band



20M Band

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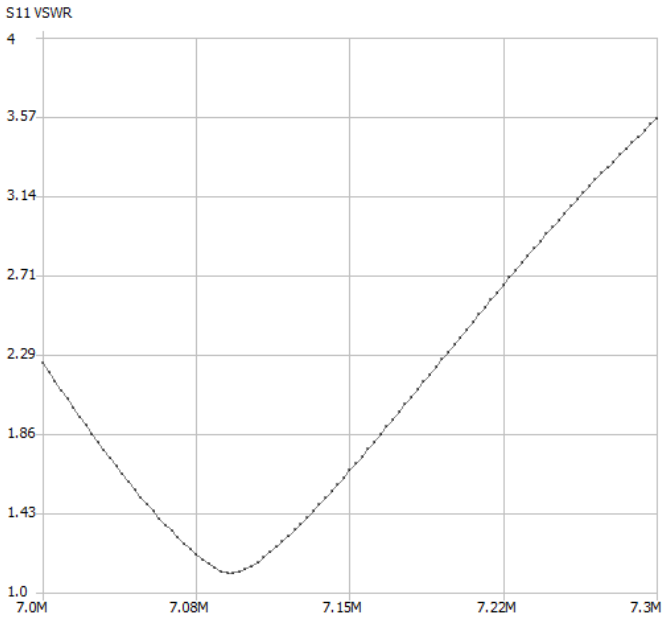
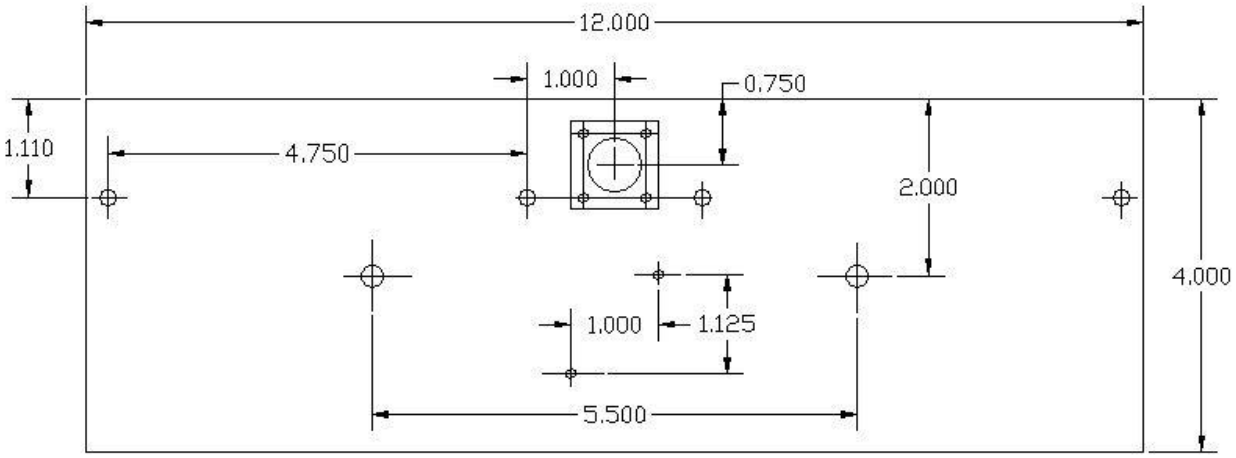


40M Band

Below are some drawings with dimensions for the coil boards.



The binding post board

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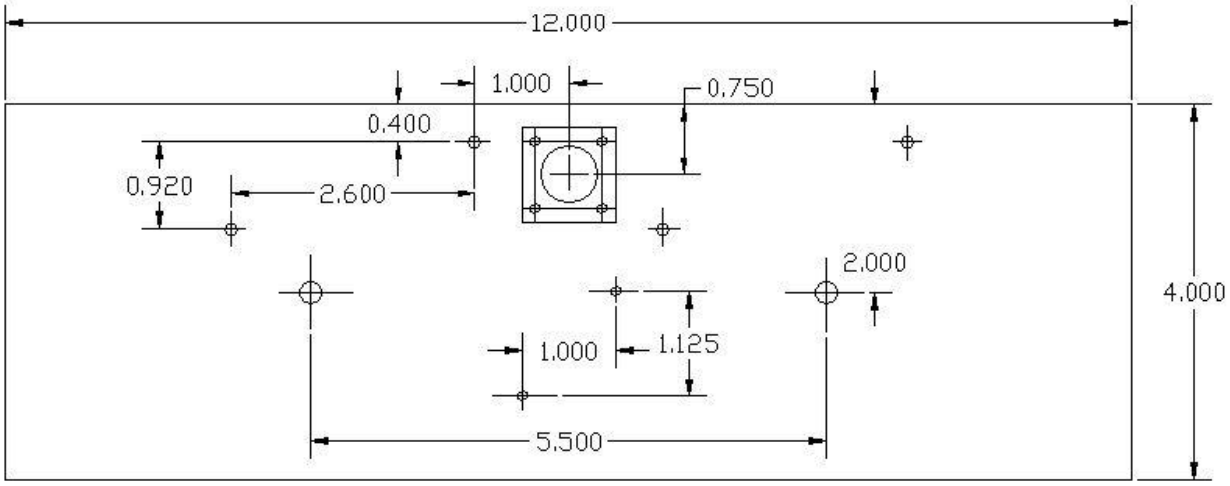

The 20M fixed length coil board

Feedline and Placement

The feedline used for development was about 80’ of old RG8. From the connection on the antenna, the feed line slopes to the ground at about a 45 degree angle. No Balun is required. All measurements were taken at the radio end of the feedline.

The antenna should be placed as far away from other structures as possible. Relocation may require retuning. This antenna has only been tested up to 100W. Some modifications may be necessary for use above 100W.

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Future Development

Future areas for development include:

- A multi band coil board
- Remote band switching
- Remote band tuning

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- Dimensions for resonance at 10M without coils

Operating Observations

“How good is it?” is a very subjective question. Without extensive and expensive testing a true quantitative answer is not possible. From Florida, it has been used to make FT8 contacts from New Zealand to Ukraine. It compares about equally to an end fed half wave installed at about 25’ elevation. Sometimes better. Sometimes worse. Many factors will affect its performance including proximity to other things, feed line, band conditions, spousal complaining, cosmic rays, etc. There have been some reports of it working within a large lanai (HOA friendly). Our club conducted an antenna shootout at a local park. The entries included this antenna as well as two generations of commercial versions like it. The judges declared this antenna to be just as good as the commercial versions!

Build one ant try it! Birds love it too.


Added capacitance