OFF CENTER FED DIPOLE
CENTER BALUN/INSULATOR CONSTRUCTION
Antenna & Balun Concepts Education

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Project Description	Building center balun(s) / insulator similar to that of the multi-band B********r commercial off-center fed dipole, for a small fraction of the cost of that commercial antenna. User supplies their own wire / coax **1:1 Current balun** using FT-140-43 (Type #43 ferrite) (good up to 300 W) **Voltage Balun: either 4:1 or 6:1** with core choice for either type based on power level, as follows <table><tr><td>Power Level</td><td>Voltage Balun Core</td></tr><tr><td><100W SSB / 50-75W CW/Dig</td><td>FT-140-43 (Type 43 ferrite)</td></tr><tr><td><200 W SSB / 100W CW/Dig</td><td>FT-140-61 (Type 61 ferrite)</td></tr></table>
Goal of Project:	1. Provide user with a deployable or fixed multi-band HF antenna suitable (depending on wire length selected) for 80/40/30/20/etc or 40/30/20/etc. 2. Education on important manual skills of soldering / assembly / wire connections, antenna construction. 3. Education on transformer concepts, inductance concepts, radio frequency interference; coaxial cable effects; SWR (standing wave ratio); antenna impedance; off-center fed vs. center fed dipoles. Applicable to the U.S. General and Extra Class license examination preparation
Estimated Cost:	Less than $20 depending on hardware selected
Additional items to be supplied by the user:	• 135 (90, 45) feet of suitable wire if the antenna is to be used as low as 3.5 MHz. • 65 feet of suitable wire if the antenna is to be used as low as 7 MHz • Suitable coaxial cable • Any necessary tuner to more perfectly match to 50 ohm

	transmitter output (This system may work acceptably with no tuner or with a limited range tuner, but of course will benefit from a highly capable antenna tuner)
	• Additional 1:1 current mode balun for the radio end of the coax if RFI remains a problem (may or may not; the suggested build includes a 1:1 current balun).
	• Wire size depends on the application and may range from as large as #12 to as small as #24 (not recommended above 100 watts)
	•

UNDERSTANDING CORE DESIGNATIONS

EXAMPLE: FT – 140 – 43

FT	Ferrite Toroid (as opposed to iron power)
140	Outer Diameter = 1.40 inches
43	Ferrite material #43 (with a mu of approx 885 and a Curie Temperature of approx 150 C)

CENTER BALUN MAJOR PARTS

Typical components:

| QTY	Name	Comment
1	2" PVC Coupler	this could be cut from PVC if you wished to reduce cost even more
2	2" PVC Male Cap	makes top and bottom
3	1/4" zinc plated eye bolt (may use stainless steel if desired)	provide strain relief and vertical mounting points. NOT necessary for the electrical connections
1	RTV caulk or any other kind of caulk	To seal antenna wires
2	Short length of marine tinned #16 wire	To connect to antenna wires
2	Male terminal spade connectors	To connect to antenna wires
1	SO-239 female connector	To connect coax
4	#6 x 3/8" sheet metal screws	To secure the SO-239 socket in the PVC
1	PVC cement	standard type is fine. Clean dry parts don't need primer

PERFORMANCE

1. Pattern. Installed as an inverted Vee, the antenna will have components of horizontal and vertical polarization. On the band where it is a half-wave in length, it will have the typical two-lobed half wave dipole pattern with most radiation broadside and a null off the tips. On higher frquency bands it will develop a multi-lobed pattern. See antenna books for more information.
2. Gain: This antenna will function similarly to a dipole. The Balun will introduce loss (typically 1 dB). Coaxial cable will introduce additonal loss. This antenna may be expected to be comparable to typical dipole, trap-dipole or fan-dipole antennas. It will have lower loss than resistively-loaded "broadband" tilted-folded-wideband designs. It will have somewhat higher loss than a well constructed non-resonant dipole fed with high quality balanced window-line

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with a high quality higher-power manual antenna tuner.

### 3.	Standing Wave Ratio:

Actual performance obtained is variable from one build to another, and from one installation to another.   The information here is from a prototype construction:

Date:	2/12/2018 G. Gibby.
Balun	6:1 voltage balun only FT-140-43 material
Wire:	90 feet #18 ; 45 feet #18
Installation:	Inverted Vee, top approximately at 30 feet in oak tree, sides draped downwards to about 5 feet above earth.
Transmission line:	100 feet of RG8X. Note this smaller coax has some significant loss which makes SWR figures look better than they would, had it been measured at the antenna connection.
SWR measurement:	MJF-259B antenna analyzer
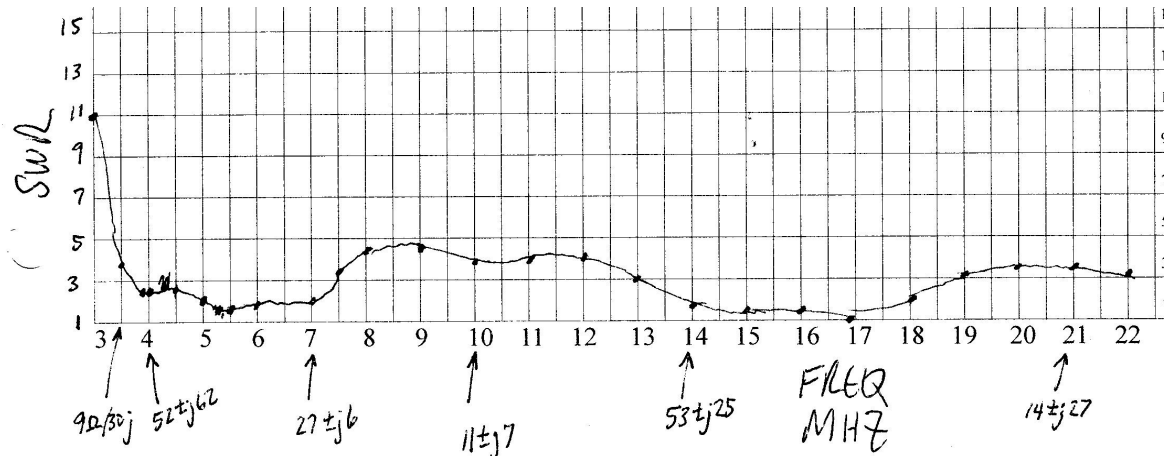
NOTE: this SWR graph is BETTER than expected --- which probably results from using the 100 feet of RG-8X (somewhat more lossy) coax --- and may also indicate a less-than-perfectly-low-loss voltage balun.   Remember that higher losses make SWRs look better!   One author went to far as to suggest a manufacturer of an end-loaded vertical antenna (fed by a high-turns-ratio transformer) chose high loss iron powder toroid in order to make the SWR look better! This homebrew design attempts to create minimal losses --- but without a huge research budget we may not equal the highest quality commercial product.

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CONSTRUCTION INSTRUCTIONS:

Building the 1:1 Current Balun.   This is in effect a series **common mode inductance block for unbalanced currents.** Normal balanced desired RF currents create NO magnetization of the core! Only the undesired currents magnetize the core.   We will use a high permeability FT-140-43 ferrite toroid for this balun; you can even build with with steel bolt (but I don't recommend it.)   Our construction is similar to that of a commercially available MFJ device.

1. ❒   Our group project kits will have an SO-239 already soldered to approximately 28" of two #18 teflon-coated, tinned wires.   Pass the wires through the pre-drilled bottom 2" PVC cap (SO-239 on the outside) and secure the SO-239 with self-tapping #6 screws.   Cover any sharp points sticking out with small bits of rubber tubing.
2. ❒   Using electrical tape, tightly bind the two wires closely together. Make the turns pitch of the tape large so that you use minimum tape and don't add a lot of thickness. The goal here is to have the red and white wires experience virtually the same field so that their magnetic field cancel for the desired opposite direction currents in the two wires.
3. ❒   Strip the insulation from approximately 3/8" from the ends. Teflon insulation is very difficult to remove, use care and sharp strippers
4. ❒   Wrap 12 turns around the FT-140-43 core.   These will fit fairly well and spacing isn't critical; you can bunch them up or spread them out.   The free ends will later connect to the VOLTAGE BALUN of your choice. .

1:1 current balun

INPUT WIRES	OUTPUT WIRES
White – to shield side of SO-239	White- to "shield" 50-ohm input of 4:1 or 6:1 balun (white wire)
Red – to center conductor of SO-239	Red – to "center conductor" 50-ohm input of 4:1 or 6:1 balun (red wire)11

See Appendix 1:1 Current Balun for the explanation of how this balun works.

Build the Voltage Balun – Choose either 4:1 or 6:1 step up ratio

Both are basically auto-transformers.   See schematics in this document.   The 6:1 is the type utilized in the commercial B********r off center fed dipole fed at the 33% mark; some people prefer the 4:1 (easier to build) balun, with feeding anywhere from the 33% point to the 38% point.   The 4:1 is much easier to build.   The 6:1 may provide a better match.
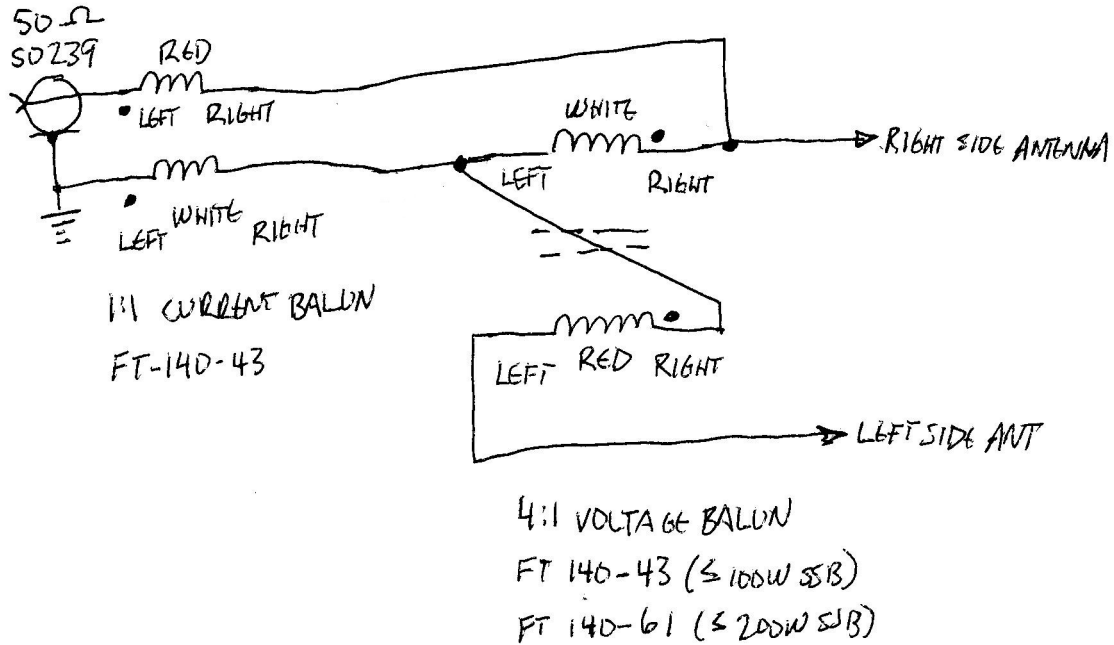
> **NOTE ON FERRITE CORES**
> There is a huge amount of both science and art to building these devices.   Older designs used iron-powder cores, but with their much lower permeability losses could be higher on the lower frequency bands.   Iron power cores tolerate over-powering much better than ferrites, however.   Ferrites when driven past their Curie Temperature (point at which they lose all magnetic effects) can (upon cooling) not be the same exact properties as they were before the thermal shock.   While type 43 (very high permeabillity) core may result in lower losses, it has a lower Curie Temperature of 130 deg C (still quite hot!!!) ; type 61 (high permeability) has a much higher Curie Temperature of 300 deg C. Therefore I recommend that Type 43 cores be used for 100 W SSB max, and 50-75 watts CW/digital --- to avoid over heating them.   If you want up to 200W SSB I suggest using the Type 61 ferrite core.

Building the 4:1 Voltage Balun
This balun is a step up autotransformer with two windings same number of turns in each (12) and wiring closely coupled for best power transfer.   Power is applied to one of the windings (12 turns) and the other winding is then connected in series with combining phase so that the antenna is fed from 24 turns --- twice the voltage, and ½ the current, hence 4 times the impedance.   This balun will convert 200 ohms into 50 ohms, and you can actually test this with an antenna analyzer and a 200 ohm resistor.   If the wires become an appreciable portion of a wavelength, some undesirable phase changes can occur that can degrade performance significantly. Therefore, to obtain the widest possible usable bandwidth we use the center connection of the two windings as the ground input, and one end as the center-conductor input.

See the APPENDIX: TRANSFORMERS & VOLTAGE BALUNS for a further explanation of how these devices work.

50 Ω
SO239   (RED)

• LEFT   RIGHT

WHITE

RIGHT SIDE ANTENNA

LEFT WHITE RIGHT

LEFT   RIGHT

1:1 CURRENT BALUN

FT-140-43

LEFT RED RIGHT

LEFT SIDE ANT

4:1 VOLTAGE BALUN

FT 140-43 (≤ 100W SSB)

FT 140-61 (≤ 200W SSB)

4:1 Schematic for Entire B********r-type   commercial clone system with 4:1 Voltage balun and 1:1 Current Balun

❑   Take two 28" teflon coated wires, one red and one white.   Strip insulation from approximately 3/8" off the end of each wire.

❑   Tightly bind the two wires together with black electrical tape.

❑   Leaving approximately 2" free, wind 12 turns around one of the FT-140-43 toroids. Again the spacing isn't that critical.   Have the beginning of the wires on the left side of your workspace and the ending on the right side of your workspace.

❑   Connect the wires as follows:

4:1 Voltage Balun

Left Side	Right Side
White wire goes to "shield" side output from 1:1 current balun, and also to the red wire on the right hand side of the toroid.	White wire connects to Right hand side of the antenna and also to "center conductor" output of the 1:1 balun. .
Red wire goes to the left hand side of the Antenna.	Right sided Red wire to the left hand side white wire and the shield output from the 1:1 balun.

Building the 6:1 Voltage Balun

This is actually a 6.25 step up auto-transformer, but everyone calls them "6:1".   It has five windings, all closely coupled and of five turns each.
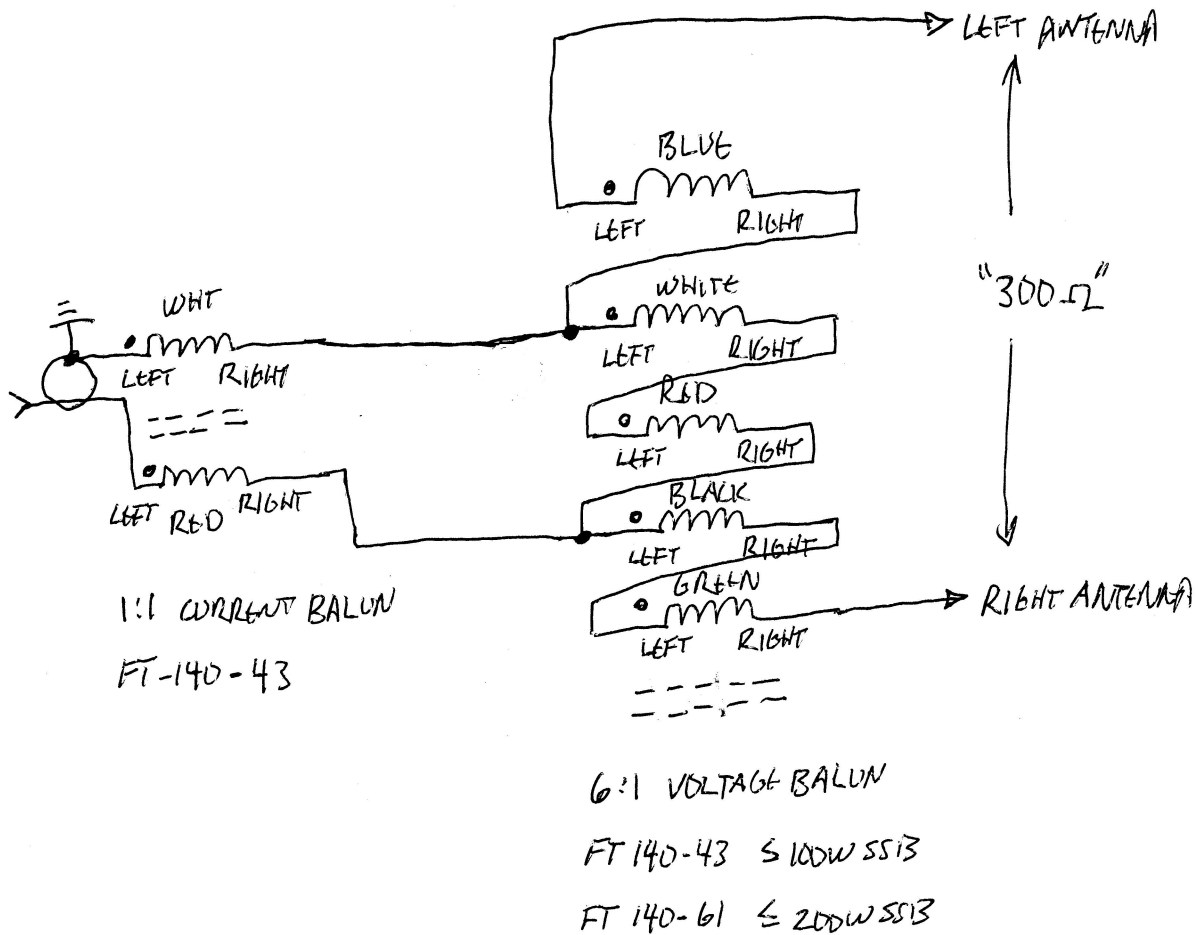
6:1 B********r commercial Clone with 6:1 Voltage Balun and 1:1 current Balun

All five windings will be wired in series in this AUTOTRANSFORMER where the primary is part of the secondary as well.   The accompanying schematic is laid out to make it easier to see how to connect the wire --- but note that all the windings are actually simply in series, with inner taps being used to get the 50 ohm connection.   The coaxial input will be wired to the 2nd and 3rd windings, and the antenna will be connected from the farthest end of the 1st and 5th windings.   Therefore the output voltage will be 5/2 of the input voltage, or 2.5 x input voltage.   The output current then will be (1/(2.5)) or 40% of the input current.   With output voltage 250% of the input, and output current 40% of the input the output impedance (V/I) is   (2.5/0.4) = 6.25 x the input impedance, and hence this is a 6:1 transformer.

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In our case we have five different colors of wire but they are not all the same thickness. At 100 watts, the current in a 300 ohm antenna is found this way:

$$I * I * R = 100 \text{ watts}$$
$$I * I * (300) = 100$$
$$I * I = 0.3333$$
$$I = 0.57 \text{ amperes}$$

The smallest wire we have is #22 and is able to carry up to 5 amperes, so it will be completely sufficient for powers into the many hundreds of watts range.   (Furthermore, you can take two pieces of the #22 wire and twist them closely together with about 1 twist per inch, connect the ends, and consider it as one "thicker" wire if you wish.)

Either enameled solid wire, or various colors of Teflon-insulated wire can be used.   Enameled wire has the advantage that it hugs the toroid very closely once applied, but the enamel can be scratched --- if you choose to use enamel wire, wrap the toroid with teflon (plumber's) tape sufficiently to soften any sharp corners.

For the Alachua County LunchNLab we'll uses stranded teflon coated wire of five different colors. This insulation is practically impervious!   You'll need sharp strippers to remove the insulation. However, it is harder to get it to hug the toroid --- do the best you can.

❒	Cut five wires of 14-15 inches length each. 14 will work, 15 will give you some extra length.

❒	Strip just about 1/4"-3/8" of insulation off every end.

❒	Bundle them up (you don't have to twist, and they don't hold a twist very well anyway) and wrap tightly with black plastic ordinary electrical tape, going as far linearly with each turn as possible —you're just trying to wrap it, not make it any thicker!

❒	Wind five turns around the FT-140-43 core. Pick either direction and wind. ***Remember that every pass through the CENTER counts as a "turn"*** so it may look like 4 complete rotations to you when it is "5 turns." It turns out you do NOT need to use the entire circumference of the toroid, and you may actually get better bandwidth/performance if you somewhat scrunch the turns up in 1/2-3/4 of the circumference of the toroid. So do what whatever comes easiest and make the windings as reasonably snug and tight as you can.

❒	Arrange the beginning wire ends on the left and the ending wire ends on the right of your work space when you are done.

❒	Then make the required connections, as shown in the
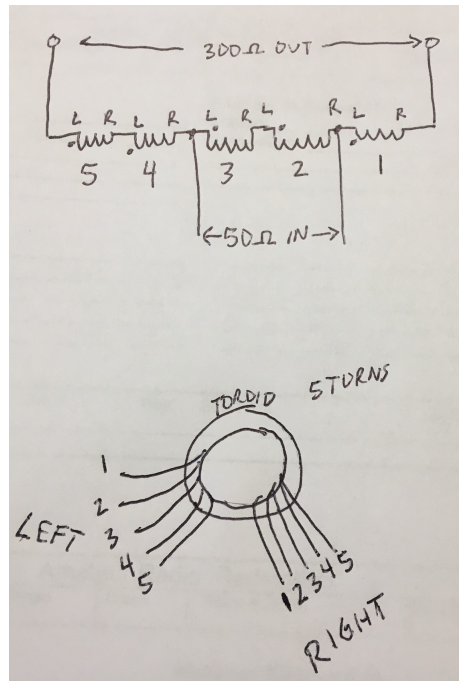
- *PHOTO below*
- *SCHEMATIC above and*
- *TABLE below.*

You can make those connections by just twisting the bare wires together and then soldering before they fall apart.   Insulate appropriately with either electrical tape or shrink wrap.
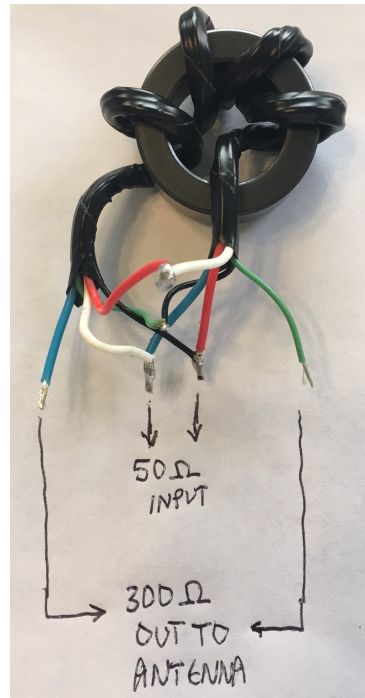
Schematic drawn to show how the windings form a series auto-transformer.

6:1 Balun Connections

Left connection	WIRE COLOR/SIZE	Right end connection
To left side of antenna (Please so mark)	Blue	To left end of white wire and **"shield" 50-ohm input** from 1:1 current balun
to right end of blue wire and **"shield" 50-ohm input** from the 1:1 current balun	WHITE	to left end of red wire
to right end of white wire	RED	to left end of black wire and to **center conductor of 50 ohm input**
to right end of red wire and **center conductor of 50 ohm input**	BLACK	to left end of GREENwire
to right end of black wire	GREEN	**to right side of antenna** (Please so mark)

CONNECTING THE VOLTAGE AND CURRENT BALUNS

❐   Place the 1:1 current balun you previously built on the 50 ohm side of your voltage balun (either 4:1 or 6:1) and connect the two baluns together, using the correct connections as described previously. Be certain to connect the wires as detailed in the tables and in the schematics.

PVC PHYSICAL CONSTRUCTION

❐   Glue the top cap to the 2" coupler.   The top cap will insert approximately **half way i**nto the coupler.

❐   Drill 3/16" or 7/32" holes in the top and two sides (slightly smaller than the 1/4" hardware, but easy to twist the eye bolts into PVC) – **making certain that**

a) the side holes are such that the side hardware will NOT touch the protruding top support bolt, but
b) the side eye-bolts WILL go through both the coupler AND the pvc of the top cap. These two side hold/eye bolts make the support physically very strong.

❐   Insert the eye bolts. Use a stainless steel washer on the INSIDE and tighten up their nuts firmly. Verify that all their ends are AT LEAST 1/4" away from each other.   Antenna voltages won't jump 1/4"   If you goof and they are too close, reposition the holes and fill the previous holes with caulk to make the assembly water tight.

We aren't going to use any of these bolts to make electrical connections – so they don't need to be corrosion-free stainless steel.   The top bolt is to suspend the weighty center insulator, and the two side

bolts are to take the tension (if any) of the antenna --- the electrical connections will be made separately with tinned marine wire coming from the baluns.

❒   Antenna wiring: Add approximately 8" of marine tinned insulated #16 wire to each of the left and right antenna voltage-balun outputs

❒   Drill appropriately sized holes (probably 1/8") below the side eye-bolts, and pass the wires through.   Water seal the holes with RTV.

❒   I suggest to add male spade terminal lugs on each of these wires and SOLDER those connections against corrosion.

If you haven't done this step already: Run the input wires from the 1:1 current balun through the hole for the SO-239 connector and solder, then mount the SO-239 with 4 #6 sheet metal screws.

❒   Before you seal the entire thing up for good, put a 200-ohm (for the 4:1) or 300 ohm (for the 6:1) non-inductive resistor across the output and verify with an antenna analyzer that you get a pretty good SWR (< 1.5 desirable) across the frequency ranges of interest). If not, review your wiring of the two baluns.

FINAL ASSEMBLY

❒   I recommend that you always install this balun/center insulator VERTICAL with the coax end downwards, and that you drill a 1/8" drain hole in the bottom just to make sure that any collected moisture can get OUT.

❒   Stuff the two toroid cores into the cavity, with some electrical tape, pieces of old rubber inner tube, or something else non-conductive, non-ferrous and relatively non-combustible to keep them from being damaged by the sharp edges of the eye-bolts. You can also cover the eye bolts with rubber tubing.

The toroid cores are fairly self-shielding so exact orientation isn't that important.   You can pack them in loosely with some shipping peanuts if you wish.   It is probably desirable to have at least a small gap between the two toroids.

❒   Secure the bottom cap with the SO-239 either by
- Gluing with pvc cement
- Screwed with two self taping screws chosen so as not to present sharp edges on the inside
- or pinned with a thru pin on a chord of the circumference

ANTENNA WIRE

WIRING FOR 80/40.....bands
Use 90 feet of wire on the left side – tie it to the left eye bolt and then connect to the left 300 ohm output.   I suggest using a female spade lug (and solder it).   Use 45 feet of wire on the right hand side --- tie it to the right eye bolt and then connect to the right 300 ohm output. Again, a female spade lug.

Wiring For 40m/20m//// (no 80 meter performance)
Use a total of approximately 65 feet and insert the balun at the 33% point (22feet, 44 feet).

END INSULATORS

Can be made by cutting off 2-4" pieces of PVC pipe and drilling 1/4" holes, one side for antenna wire (which may be tied, or soldered) and the other side for supporting rope.   Ideally, arrange in an inverted Vee formation with the ends above head level to avoid possible harm to bystanders. (Relatively high RF voltages can be present at the ends of dipoles.)

ADJUSTMENT

Check SWR on desired band(s) .   This antenna is not likely to present a perfect 1:1 anywhere.   It is more likely to stay below 2:1 or 3:1 throughout several bands.   If you use low-loss coax, you'll see higher SWRs (because higher loss coax obscures the true SWR).   If the SWRs are higher than you desire, use an antenna tuner, or possibly adjust the lengths of the antenna.

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INVOLVEMENT (Please check your choice)

❑   Would like to come and watch/help (not build)
❑   Would like to build VOLTAGE BALUN (1-core) only: $14
❑   Would like to build both BALUNs (2 cores)   : $18

NAME: _____ Email: _____

REFERENCES:

https://vk6ysf.com/balun_6-1.htm
Extremely helpful discussion of voltage balun construction with lots of experimental data:
http://g8jnj.webs.com/Balun%20construction.pdf
http://www.rowand.net/shop/tech/wirecapacitychart.htm
http://vk5ajl.com/projects/baluns.php
https://www.vk4adc.com/web/images/UserFiles/File/balun/TBF400Balun.PDF

Appendix: 1:1 Current Balun

THEORY: The common mode inductance can be calculated --- common mode currents have to traversse 12 turns of the winding around a FT-140-43 core   ("140" = outside diameter = 1.4 inches;   43 = core type, with a mu of about 885)

You can use this online calculator: http://toroids.info/FT140-43.php   – it calculates to 127 microhenries.

Here's the formula: $uH=(AL*Turns^2)/1000$

AL = 885
Turns =   12
 uH =   (885 * 12 * 12)/1000 =   127 micro henries

Now 127 microhenries will have an inductive reactance (lower at lower frequencies, higher at higher frequencies).   Our WORST performance thus will be at 3.5 MHz.   Here's an inductive reactance calculator: http://www.66pacific.com/calculators/inductive-reactance-calculator.aspx Plugging in 3.5 MHz and 127 microhenries gives 2,793 ohms ---   or 56 times the 50 ohms in the input circuit --- so the common-mode RFI-inducing current will see almost 3,000 ohms, while the desired power will see the normal 50 ohms. That's how a 1:1 current balun works --- it puts a large impedance in the path of the common mode (undesired) current.

APPENDIX: TRANSFORMERS & VOLTAGE BALUNS

TRANSFORMER:
A transformer transfers electrical power from a primary winding to a secondary winding by way of inductive coupling.   The presence of a CORE with a higher MU than air may allow for better coupling (higher power transfer) between the primary and secondary windings. However, the CORE may also induce additional LOSSES.   Losses will be detectable by head produced. Losses may also result from the ohmic resistance of the wires utilized.   Typically one designs a transformer so that the inductive reactance of the primary wirnding by itself is significantly higher impedance than the apparent impedance recognized when power transfer is occurring. In other words, when there is no load on the secondary, one prefers to have the transformer consume MINIMAL CURRENT in the primary!   (Otherwise it is just wasting power).

The secondary windings may develop a higher or lower voltage than that impressed upon the primary.   The ratio of the secondary voltage to the prmary voltage will be the same as the ratio of the secondary number of TURNS to the primary number of TURNS of wire.   Since power is conserved, *if the secondary drives a simple resistor*, the currents in the primary and secondary will be INVERSE to that ratio of turns.   Since impedance is voltage divided by current, the IMPEDANCE ratio (voltage out/current out   divided by   voltage in/current in) will be related to the SQUARE of the turns ratio.   By this means one may raise or lower a voltage, or raise or lower an impedance.   For example, a transformer with twice the number of turns of wire in the secondary as in the primary will quadruple the impedance.   If a 200ohm resistance is placed across the secondary, the primary will appear to be a 50 ohm load.   Departures from desired performance will be seen as variations from this expected performance --- and can be reported as "SWR" on the primary side.

AUTOTRANSFORMER
In an autotransforer, the primary windings are actually part of the secondary windings a well --- so there is a DC path between the primary and the secondary.   The most common example of this has been the ignition coil in an older spark-based gasoline engine.   The ignition coil had a few turns of wire to which an intermittently broken 12-volt current was applied, connected to a much larger number of turns driving a spark plug.   The magnetic field initiated and broken by the varying current in the primary winding induced a far higher voltage in the secondary (but at a much reduced current) and created the spark needed to ignite the fuel on each compression stroke.

In this antenna, a 6:1 balun is utilized where the secondary has 5 turns for every 2 turns of the primary (voltage ratio 2.5; impedance ratio 6.25) – but the primary windings are also part of the secondary windings.   This is called a VOLTAGE balun because the output VOLTAGE is considered to be controlled by balun.   For reasons that are beyond the scope of this discussion, the voltage balun driving a non-symmetrical set of antenna wires, can result in non-equal **currents** at its two output terminals. (The output is not a simple resistor, but is instead two non-symmetrical pieces of wire, each of which may be considered to be its own separate—and

non-equal---antenna input impedances as each wire consumes and radiates power! So the situation is considerably more complicated than the simple resistor on the output of a transformer.)   CONCEPT: These non-equal currents can be considered as the sum of two equal and opposite currents, plus a third "common" current.   For example, one output terminal may produce 2A and the other 1A, which is the same as

Terminal 1 having   0.5 Amps,
Terminal 2 having   0.5 Amps opposite direction
and both terminals having 1.5 amps in the first direction

These add to produce: Terminal 1 = 0.5 + 1.5 = 2Amps
                        Terminal 2 =   -0.5 + 1.5 = 1 Amps

This common mode current is undesirable as it (or a current related to it) can propagate down the OUTSIDE of the feeding coax and cause undesirable voltages and currents on equipment supposedly all at equal "ground" potential.

> CONCEPT: While two pieces of equipment connnected by a "ground wire" to their two chassis may be at nearly the exact same DC potential, things are much different if there is a 7 MHz RF current flowing between the two pieces of equipment.   In this case, 24 inches of wire may have a very significant inductive reactance and there may be a quite significant voltage drop across that 24 inches of wire, leading the two pieces of equipment to be at VERY DIFFERENT voltages every few hundred nanoseconds!   "Ground" isn't easy to find at shortwave frequencies!!   Thus any current flowing in a "ground" wire is undesirable.

This antenna design reduces that common mode current (allowed by the VOLTAGE type balun) by inserting a CURRENT type balun (common-mode inductive impedance) into the system.

The names VOLTAGE BALUN and CURRENT BALUN are historical in nature and are an attempt to explain complex electrical concepts in simple English words.   The key concept to know is that a VOLTAGE balun may allow feedline radiation and unbalanced currents that can wreck havoc with sensitive transistorized digital equipment; and a CURRENT balun can reduce or eliminate these issues.

APPENDIX: Checking Flux Density

REFERENCE:
https://www.vkham.com/Info/ferro/tut_3.html

From: https://www.vkham.com/Info/ferro/tut_3.html:

"The following flux density limits for **both ferrite and iron powder cores** can be used as an **initial** guide when making calculations for core size.

Frequency (MHz):	0.1	1	7	14	21	28
AC Flux Density (gauss):	250	150	57	42	36	30

Note: 10000 gauss = 1 Tesla = 1000 mTesla "

FT-140-43 6:1 Voltage Balun

$$Bmax = (E * 10^2) / (4.44 * f * N * Ae) + (N * Idc * AL) / 10 * Ae$$

Assume 100 watts @ 50 ohms ==> 71 V RMS @ RF.
Assume DC current is 0   (terms after the "+" disappear)

Now finding the values for each of the portions of the equation (assuming 0 dc current)
E = 71 Volts RMS @ 100 watts.
f = 3 (MHz) to 30 (MHz)   (in formula above, f is in MHz)
N = number of turns = 10 for two center windings in series
Ae = cross sectional area in cm for FT-140-43 toroid is 1.6 cm*cm
Bmax =   71 * 100 / (4.44 * 3 * 10 * 1.6)
Bmax = 33 gauss   which is quite acceptable! at 3 MHz

Repeating for 30 MHz:
Bmax = 71 * 100/ (4.44 * 30 * 10 * 1.6) = 3.3 also well within limits.

FT-140-61 6:1 voltage-balun

$$Bmax = (E * 10^2) / (4.44 * f * N * Ae) + (N * Idc * AL) / 10 * Ae$$

Assume 200 watts @ 50 ohms ==> 100 V RMS @ RF.
Assume DC current is 0   (terms after the "+" disappear)

Now finding the values for each of the portions of the equation (assuming 0 dc current)

E = 100 Volts RMS @ 100 watts.

f = 3 (MHz) to 30 (MHz)   (in formula above, f is in MHz)

N = number of turns = 10 for two center windings in series

Ae = cross sectional area in cm for FT-140-43 toroid is 1.6 cm*cm

Bmax =   100 * 100 / (4.44 * 3 * 10 * 1.6)

Bmax = 46 gauss   which is still quite acceptable! at 3 MHz