Bob's TechTalk #31
by Bob Eckweiler, AF6C

Building a W2DU HF Balun:

I had taken on an assignment when this article was written in the summer of 2004. John, K7KF, was flying from Asia to Arizona and had access to an HF radio in the aircraft. Communications was to be on 20 and 40 meters. Then I didn't have a 40 meter antenna so I assigned myself the task of putting up an inverted vee. This was a perfect opportunity for me to build a 1:1 balun to use with the antenna.

We covered baluns in the Bob's TechTalk #22 and #23. Here's a quick refresher: Balun stands for **BAL**anced/**UN**balanced. It is a device that matches an unbalanced circuit, such as coaxial cable and a balanced circuit, such as a dipole antenna. The balun works in both directions. Why is this necessary? In a lot of situations an antenna will work fine without a balun. In some situations though, not using a balun will result in a lot of RF floating around the shack, with resultant feedback problems, hot mikes, TVI and erratic operation - especially with newer solid-state rigs. The cause is related to the fact that RF travels along the surface of a conductor and not throughout the conductor. Thus in coaxial cable the energy from the transmitter travels along the inside of the shield and the outside of the center conductor, creating a field in the insulating dielectric. When the energy reaches a balanced load, such as an antenna the energy on the center conductor can only go to one side of the antenna. However, the energy on the shield can go not only to the other side of the antenna, it can also travel back down the outside of the shield, which looks like a separate wire to the RF. Whether it does or not depends upon what the impedance of the outer shield looks like to the RF. If the impedance is high compared to the antenna then little current will flow on the outer shield. However if it's low, then a lot of current will flow. A balun effectively isolates the inner and outer surfaces of the shield, either by using a transformer or a choke.

One very effective balun is the W2DU balun. In this balun the coaxial cable is passed through numerous ferrite beads. The ferrite has no effect on the RF in the coax, but creates a high impedance to RF flowing on the outside of the coax shield. The W2DU balun is the one I chose to build for my inverted vee.

Figure 1 - RG-142/U and bag of 50 FB-73-2401 ferrite beads. Dime is included for size comparison.

Ferrite beads are not inexpensive! Smaller sized beads that fit over RG-58 sized coax (0.192 in. OD) are less expensive than beads that fit over larger RG-8 (0.405 in. OD). Unfortunately, RG-58 cannot safely handle the legal power limit, especially if the SWR is less than ideal. Thus, I chose to use RG-142 (Belden 83242) which has the same diameter as RG-58 but has Teflon jacket and dielectric and two braided shields. It will also easily handle the maximum power allowed with

lot's of room to spare! It is not cheap either; but luckily you only need a piece about a foot long. The ferrite beads used in this balun are FB-73-2401. They measure 0.380" OD x 0.197" ID x 0.19H. I used 50 beads for a balun that will work on all the HF bands from 160 through 10 meters. Figure 1 shows the cable and beads.

I decided to build the balun in a piece of PVC pipe, similar to numerous commercial baluns. Finding a female UHF connector was a bit of a challenge. One was purchased from The Wireman (Part # 1147). It arrived with no instructions so some measurements with a pair of calipers had to be made. Figure 2 shows the connector, prepared cable and trimming measurements.

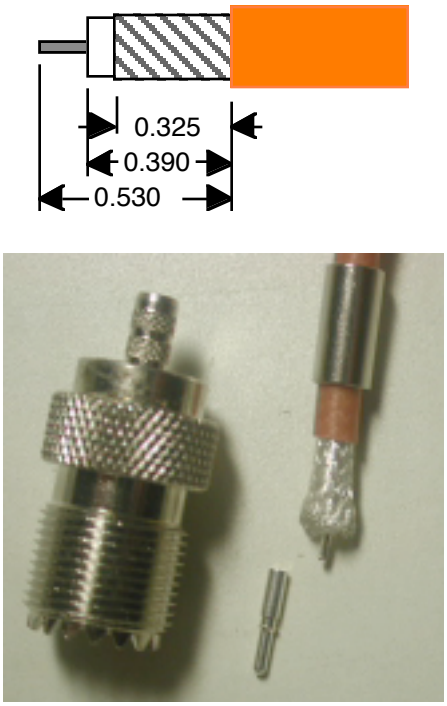

Figure 2 - Photo of prepared end of RG-142/U coax with trim dimensions for female UHF crimp connector (Wireman #1147)

Once the connector and cable were attached and weatherproofed with shrink tubing, electrical tape was wound around the cable at the connector to provide a cushion for the beads. A few rubber grommets would work as well. Next, the 50 beads were strung onto the cable and the other end of the cable was trimmed and prepared. Two lengths of #12 insulated wire were soldered to the end of the cable, one to the shield and one to the center connector; and that end of the cable was weatherproofed.

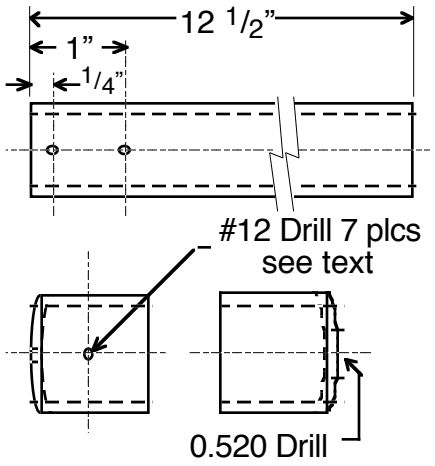

Figure 3 - Drill dimensions for 1" ID. PVC pipe and end caps for enclosure.

The enclosure was made from a piece of 1" ID schedule 40 PVC pipe cut to 12-1/2 inches. Two end caps were drilled as shown in Figure 3. Three 3/16" x 1-1/2" stainless eye bolts are attached to a PVC end cap. The eye bolt in the top hole was backed by a 3/16" fender washer; it is used to support the balun if needed. The two side eye bolts support the antenna wires. They pass through the end cap and the PVC pipe inside. To assure alignment, drill these holes with the end cap temporarily installed on the pipe. The nuts are attached to the inside of the PVC pipe by temporarily inserting the eye bolt with nut attached; holding the eye bolt in a vise; and heating the nut with a soldering iron until it begins to melt into the PVC. A wet towel is used to cool the nut, which should then be firmly adhered to the pipe. A little epoxy can be used to help hold the nuts, though I found it unnecessary. A 0.52 diame-

Figure 4 - The balun, with enclosure, ready for final assembly.

ter hole is drilled in the other end cap to form a tight fit for the coax connector. You can start with a 1/2" hole and carefully file it to fit. The connector is then epoxyed in place from the inside. A bead of epoxy along the outside helps to seal the hole and further secure the connector. Two holes are drilled about 3/4" below the two antenna eye bolts for the balun wires.

The balun can then be assembled. The two balanced wires connect to the antenna leads that are attached to the two horizontal eye bolts. I recommend using a wire thimble here. Buy extra stainless nuts that fit the eye bolts to tighten down on the outside of the enclosure. Also, use a stainless lock washer between the fender washer and the nut holding the top eye bolt so the bolt won't back out due to vibration.

This was a fun project and easy to build. You might consider making one as part of your next antenna project. They also work at VHF and UHF frequencies with fewer beads of a different (#43) material

Next month, maybe things will slow down and I can get back to designing a fancy code practice oscillator? Other ideas or topics are also welcome.

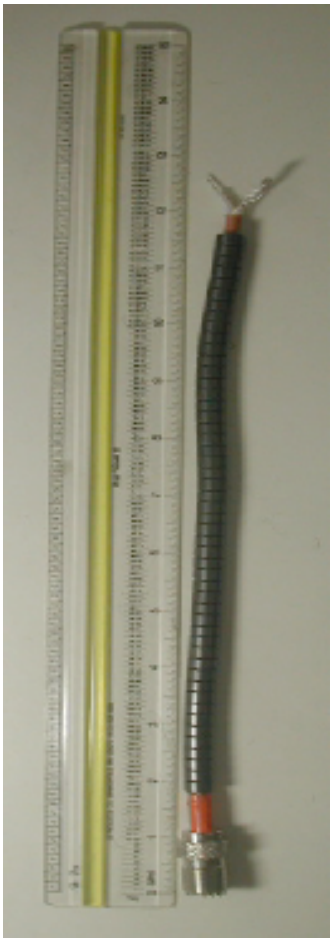

Figure 5 - The completed cable covered with 50 ferrite beads.

TechTalk Balun Parts List:

Available at the Hardware Store:

12.5"	PVC Pipe, 1" (ID), schedule – 40.
2 ea.	PVC End cap, 1"
3 ea.	Eye bolt, 3/16 x 1-1/2 (stainless steel)
8 ea.	Nut, 10-24, to fit eye bolts, (stainless)
1 ea.	Lockwasher, #10, (stainless)
1 ea	Fender Washer, #10, 1" OD
20"	wire, stranded copper, #12 AWG, insulated (#14 OK)
misc.	Electric tape, 5 Min. Epoxy, assorted shrink tubing

Available from **The Wireman** (see OCARC website Supplier's page)

50 ea.	Ferrite beads, FB-73-2401, The Wireman part # 912, $9.00 for 50 (Amidon or Palomar are alternate sources)
1 ea.	Connector, UHF, Female, cable crimp, The Wireman part #1147, $4.14
12"	Coax cable, RG-142/U, 50Ω, The Wireman part # 153, $1.50 / foot, (Belden 83242 is an alternate)

73, from AF6C

This article is based on the TechTalk article that originally appeared in the Month Year issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.