Make Your Own Custom Impedance Coax

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Introduction

This article is about making a short length of 125 ohm coaxial cable for impedance matching purposes. The same technique could be used for other impedances as well. It all started with the purchase of VHF multi-loop antennas that turned out to be defective. See figure 1.

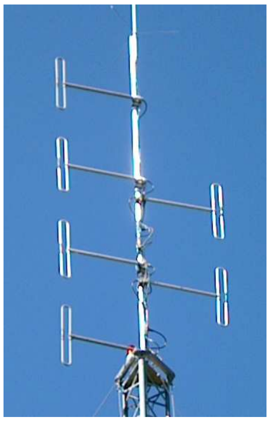

Figure 1 Multiloop antennas using folded dipoles

These loops are are folded dipoles which have their feed point impedance equal to 4 times the impedance of a standard dipole or 4 x 73 ohms = 292 ohms. Each loop must be matched to 50 ohms by means of a quarter wavelength cable. The required cable impedance Zc is:

$$Zc = \sqrt{50 \cdot 292} \cong 121 \ \ ohms$$

RG-63 cable is normally used since it has an impedance of 125 ohms, but it is expensive and available only in 1000 feet roll. So we decided to 'roll up' our own cable.
The cable diameter had to be essentially the same as an RG-213 so that it can fit inside the upper portion of the antenna elements. Looking at the specs of RG-62 and RG-63 cables showed that they both have a 25 mil diameter center conductor. The RG-63 has 285 mil insulation diameter, while RG-62 has an impedance of 93 ohms with 146 mil insulation diameter. Both cables have their velocity factor at 0.84, which means they have the same dielectric constant. Then all we need to do is to increase the size of the insulation from 146 mil to 285 mil, and voilà, we have our 125 ohm coaxial line.
The impedance of a coaxial cable is calculated as follows:

$$Zc = 138 \cdot \mathrm{Vf} \cdot \log\left(\frac{\mathrm{D}}{d}\right)$$

Where Vf is the velocity factor of the insulator, D and d are respectively the outer and inner diameters of the conductors. Note that with braided shields, the effective conductor diameter increases by about 5%. This means that the insulation diameter of 285 mil gives an effective conductor diameter of 299 mil.
For an effective outer conductor diameter of 299 mil and 25 mil inner conductor, we obtain the following impedances, as shown in table 1.

Velocity Factor: Vf	Cable Impedance: Zc
0.78	116
0.79	117.5
0.80	119
0.81	120.5
0.82	122
0.83	123.5
0.84	125

Table 1
Cable Impedance vs Velocity Factor

The added insulation must have a velocity factor from 0.78 to 0.84 to obtain an overall impedance between 120 and 125 ohms. See table 1. With a velocity factor of 0.78 for the added insulation, as found in foam RG-8 type cables, the combined velocity factor will be around 0.81, giving an impedance of 120.5 ohms.
A length of 13.5 in. is required to do the impedance transformation from 50 ohms to 292 ohms at 146 MHz.

Step by Step Procedure

The 125 ohm cable is connected at the end of a regular 50 ohm RG-213 cable. First remove the coax outer insulation over a length of ~27 inches, as shown in figure 2.

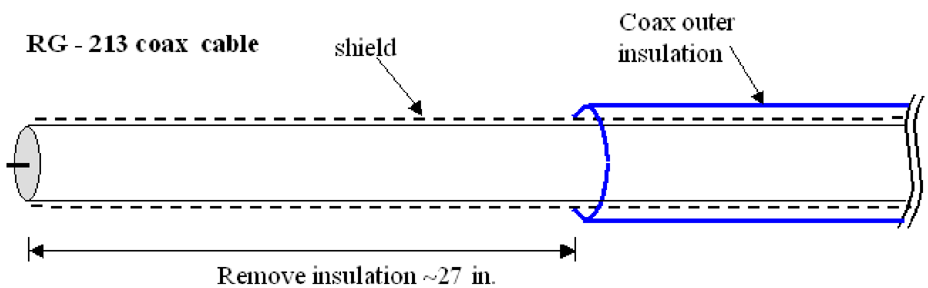

Figure 2

The shield is then pushed back to expose the coax outer insulation for about 15.5 inches as in figure 3. Use tape to temporarily hold the shield in place. Alternatively, the coax may be cut and re-soldered after the foam sleeves are installed.

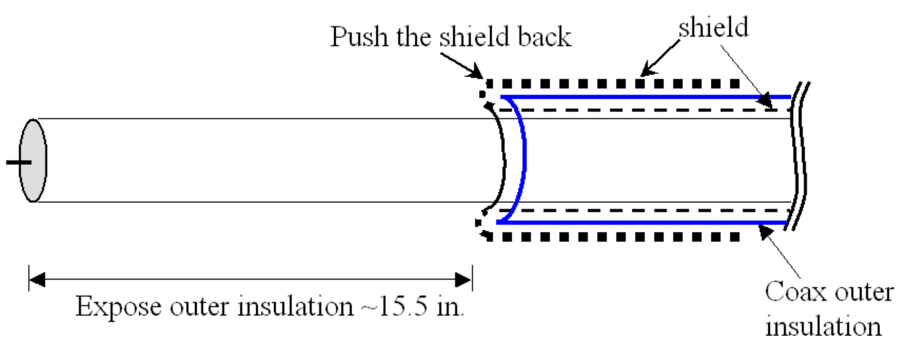

Figure 3

The coaxial insulation is removed for about 14.5 inches, as per figure 4. Cut the center conductor ¼ inch away from the RG-213 insulation.

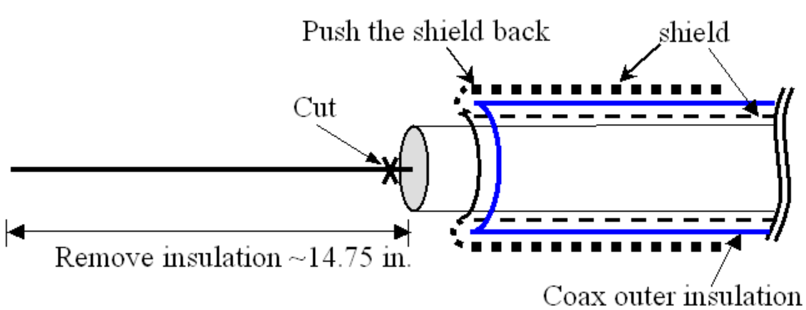

Figure 4

Then a 14.5 inch length of RG-62, with its shield removed is soldered at the end of the RG-213, as shown in figure 5. The length of the insulation of the RG-62 is ~14.5 inches.

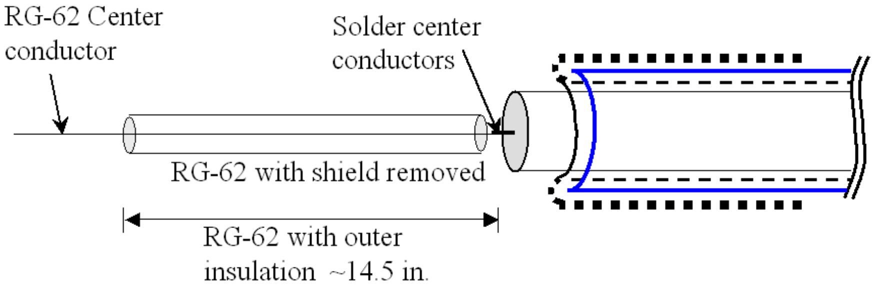

Figure 5

Making the foam sleeves.

The foam sleeves are made from RG-8 type foam coax.
Remove lengths of foam, approximately 1.25 to 2.5 inch long, using cable stripper pliers. Cut the ends flat and straight. See figure 6.

Figure 6

The foam sleeves are firmly held in a small home made fixture while being drilled with a 9/32 inch drill (or 0.154 inch), as shown in figure 7.

Figure 7

The sleeves are then inserted over the RG-62 insulation as in figure 8. The first sleeve is pushed over the solder joint. Notice that the shield was cut here, instead of being folded back. Note the 13.5 inch length required.

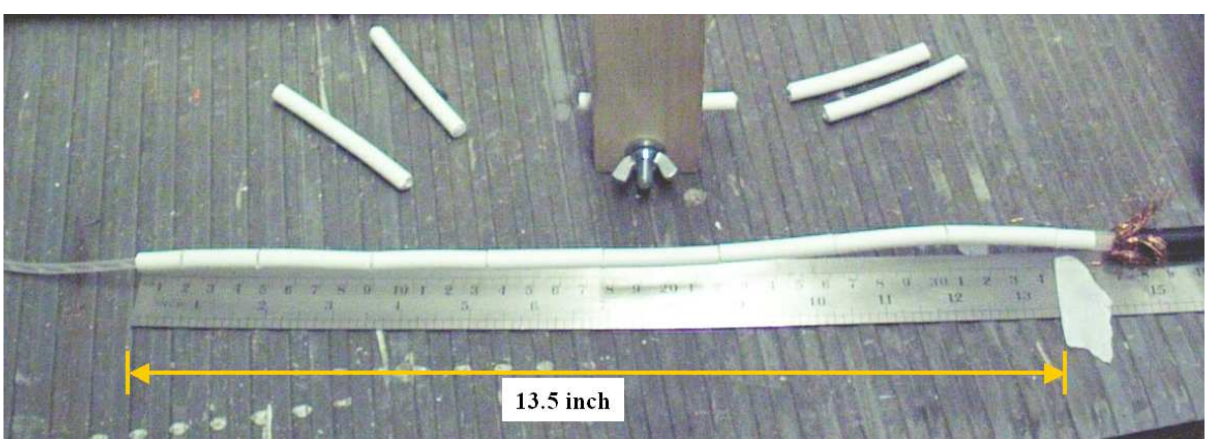

Figure 8

The shield may now be pushed back over the RG-213 insulation and over the sleeves. A length of heat skrinkable tubing is installed over the exposed shield and over the existing RG-213 outer insulation as shown in figure 9.

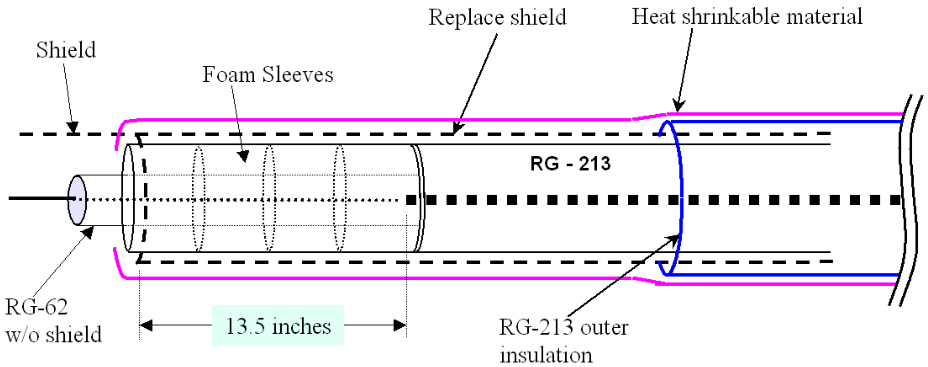

Figure 9

Final assembly

The completed coaxial assembly is slipped into the aluminum tubing of the folded dipole as shown in figure 10. Stainless steel hardware is used to connect the coax shield to the aluminum pipe. A flexible lead is attached at the end of the coax center conductor and connected to the other side of the feed point. The completed antenna should be checked for SWR. It should give a minimum SWR in the range of 135 to 165 MHz.

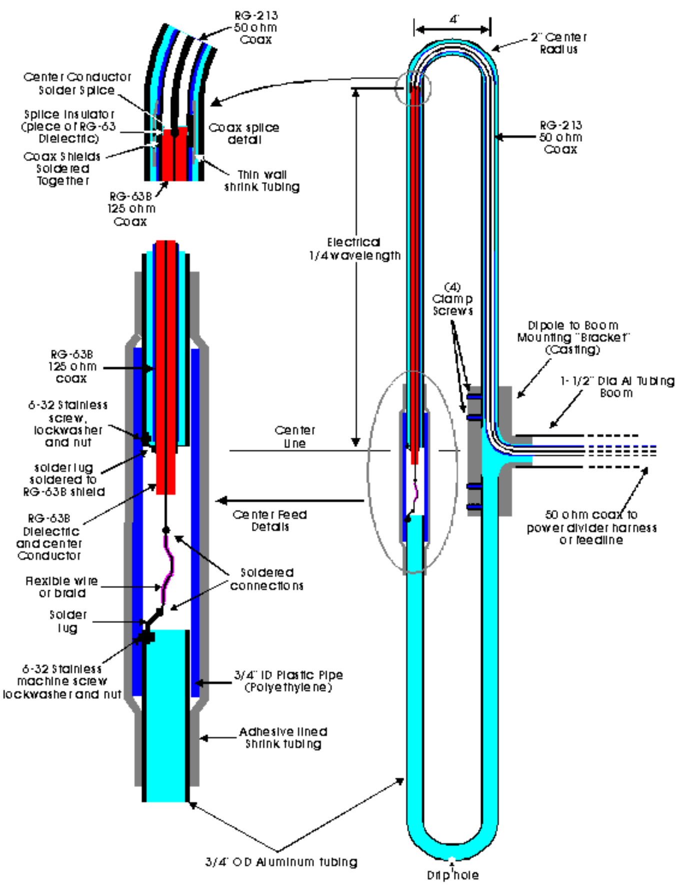

Figure 10

Final assembly of the coax into the folded dipole. Drawing comes from Bert, VE2BMQ.

This technique has been successfully used to repair a number of commercial loop antennas. They make excellent repeater antennas, thanks to their low noise characteristics.