Six Meter Helical Duplexer
Design and Construction Information

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A couple of years ago I designed and constructed a duplexer system for a six meter amateur radio repeater station . Due to continuing questions about this project, I will present some of the pertinent information relating to the process.

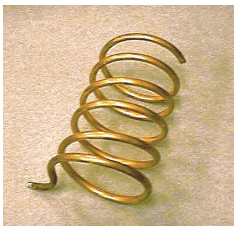
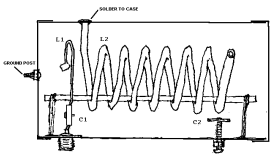
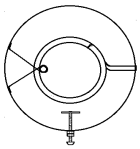
About the KT4QW Repeater

- Output Frequency: 53.250 MHz
- Input Frequency: 52.250 MHz
- Transmit power: 20 or 100 Watts
- Electronics: Hamtronics
- Antenna: 1/2 wave vertical end-fed @ 85 feet.

In the following table, I have tried to summarize the subject with a minimum of words and supporting material. While examining this summary, keep in mind that I have only limited experience in design and construction of duplexer systems. The first attempt at a large helical filter, I used a paint can as the shield. This effort resulted in smoke when I attempted to use it as a bandpass filter with my transceiver. The first duplexer project was using a copper quart size model. While the quart size worked as a filter, it did not have enough attenuation or the proper frequency characteristics...too broad. I then went to the copper gallon size can. The gallon size got the proper results.

There are other websites containing resources on this subject you should review. I found them it very informative. Take a look after you have reviewed this page.

Heliax Duplexer Design- WB5WPA	More Duplexer Information- KI7DX	More Information- KT4QW

SUMMARY

1. Three types of Helical Filters are used; Band Pass, TX Band Reject and RX Band Reject. All are similar in construction.

2. Each filter is contained in a completely enclosed copper can measuring 8" in and 5.6" diameter. The helix is formed with 7 turns of 1/4" copper tubing. Units provide frequency tuning for both notch frequency and and the favored side of the notch center.

3. Each Band Reject or notch filter unit (can) provides approximately 33 dB

attenuation at the notch frequency and a maximum of .5 dB attenuation at the side of the notch at 1MHz (plus or minus depending upon whether it is designed for transmit or receive side).

4. The notch filter's individual attenuation is additive when connected in a cascade fashion with quarter wave (electrical length) jumpers. Poor shielding characteristics the cans, connectors and coaxial cable greatly reduce the total amount of that can be achieved.

5. The Helical Band Pass unit provides approximately __ dB attenuation at the frequency and __ dB attenuation at plus or minus 1 MHz or greater from the center frequency.

6. Test and tune-up is accomplished on each filter can separately. When connected the chain arrangement using electrical quarter wave jumpers, the system will harmonize as one.

7. Design information for the Helical Filter was obtained primarily from the ARRL Handbook. Valuable information was obtained relating to the coupling, harnessing, and application of the filters as a group, from the WB5WPA Website.

Details

The interconnecting coaxial jumpers between the duplexer filter elements are an electrical quarter wave length. The length should be calculated based on whether it is upon the transmit or receive side. Keep in mind that you are dealing with the receive frequency on the transmit side and vice versa. Use of the quarter wave sections creates a condition whereby the attenuated notch of each filter is additive. The length of each jumper is determined as follows. L= 2950.68/MHz x VF L is length in inches, VF is the velocity factor of the coaxial cable expressed in decimal form (.75 in this case). This formula yields an answer of 41.56 inches for 53.250 MHz and 41.56 inches for 52.250 MHz. Measurements are made from the tip of the connector to the tip of the connector on the other end. RG-8X coax is used because it is very flexible and is therefore easy to form a compact coil for neat packaging. It is not, however, shielded well. As you will discover, use of poorly shielded components will severely limit the ultimate effectiveness of the duplexer system... and therefore the performance of the repeater.

Three Filter Can Types

There are three different types of filters used in this configuration, which are: (1) the Transmit Band Reject unit, (2) the Receiver Band Reject unit and (3) the Band Pass unit. While all three type filters are based on the same basic configuration of the helical filter, significant differences are incorporated.

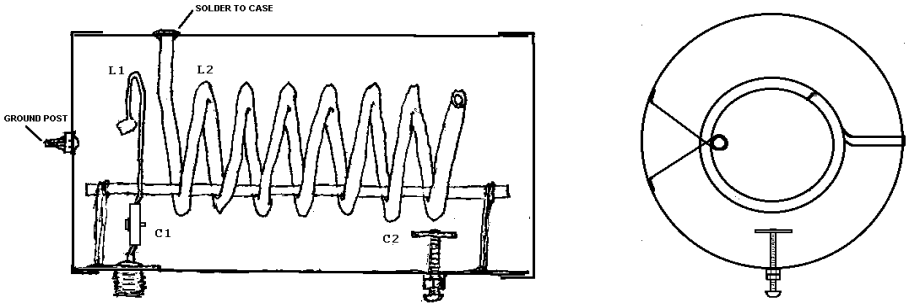
The Receive and Transmit Band Reject Units

In addition to the necessary frequency differences, the only other way the cans differ from each other is by their shunt reactances. A plain, simple notch will

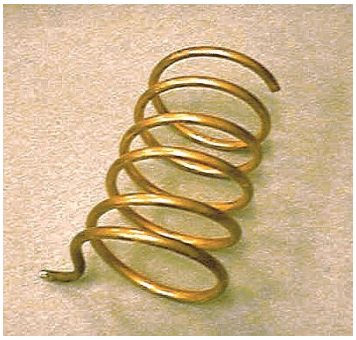
attenuate symmetrically above and below the center frequency of the notch. By adding a small amount of reactance, the attenuation pattern becomes asymmetrical with a clear low attenuation passband emerging on one side or the other of the notch. Shunting the input with an inductor reduces the attenuation *below* the notch frequency shunting the input with a capacitor reduces the attenuation *above* the notch frequency. The spacing between the passband center and the notch center is important to achieve optimum Tx/Rx isolation with minimum loss.

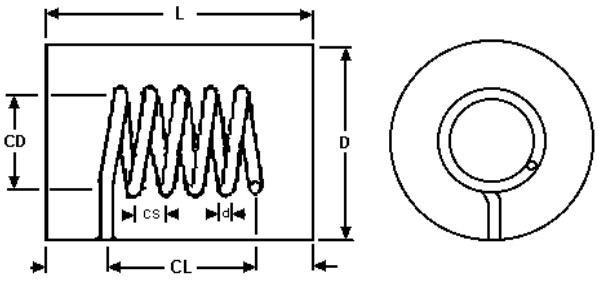
The Band Pass Units

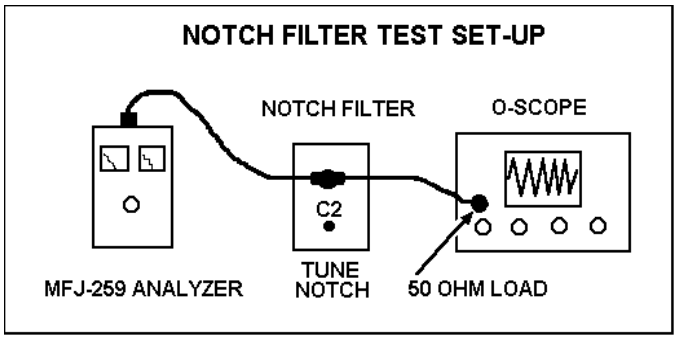
The Band Pass unit uses the same helical unit but with inductive coupling input and output. The Band Pass unit has two ports, one for the input and one for the output, whereas the Band Reject units have only one port. The input coupling is accomplished with a one-turn adjustable coupling loop to ground at the "cold" end of the helix. The output coupling is accomplished by direct tap at the 50 Ohm point of the helix. This unit, when, adjusted provides a narrow passband with only ___ dB insertion loss. The attenuation on each side of the passband is approximately ___ dB. The half power bandwidth is _____ kHz.



The can is made of 0.035 " copper sheet and the end caps are "oat meal box" type tops. The stiffener rod is 1/4 " fiberglass epoxied to the helix and supported on the end by copper wire loops made of # 12 copper wire soldered in place. The helix tuning is made of a copper penny soldered onto the end of a # 8 brass screw. The coupling loop is made of # 12 solid copper wire, which is fastened to the UHF connector on one end and the inside of the can on the other.







Using the MFJ-259 Antenna Analyzer as a frequency generator, set frequency to the desired notch frequency and tune C-2 for minimum indication of RF on the scope. Tuning across the notch is critical because it is narrow. Note that the connecting jumpers are made of RG-8x coaxial cable and should be approximately one quarter wave in length. By measuring the relative amplitude of the RF at the notch and at the desired pass band, the attenuation may be easily calculated. The 50 Ohm terminating resistor is a low wattage low reactance carbon film type resistor and should be measured to make certain it is actually 50 Ohms.

Do not epoxy the helix onto the stiffener rod until after you are assured that the helix is within the desired tuning range. Rough initial tuning can be accomplished by slightly compressing or expanding the helix. If too low, it may be necessary to trim the length of the helix. However once you tune the first one, you will be able to easily judge the following units.

"There's more... but that's yet to come"

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