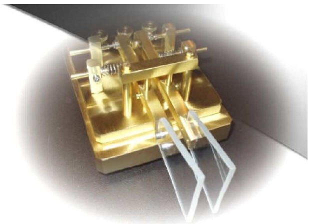


QRP EXPRESSIONS

Newsletter Date: August 5, 2005 [Revised January 18, 2007]

A Winning Antenna

By N. T. "Len" Carlson, K4IWL

A few years ago I rediscovered a facet of ham radio that I had long since forgotten about. I re-discovered QRP! That brought a renewed excitement to the hobby as well as a lot of satisfaction at accomplishing what many seem to think is the impossible or at the least improbable but has many times over shown the true "power" of QRP, not only as a fun experience, but in its ability to overcome the seemingly impossible odds of communicating around the globe … consistently.

I had originally tried QRP about 30-some years ago with a one transistor, crystal-controlled, transmitter of my own design running about 2 milliwatts and using my Hallicrafters SX-71 on the receive side. It was fun but in those days little was available to work with in building less than 1-watt transmitters.

The "official" definition of QRP is 5-watts or less output power for CW and 10-watts or less for SSB. Then there is QRPp which is generally accepted to be 1-watt or less out for CW.

As with all ham stations QRO or QRP, ten percent of a station's success in quality QSOs is the equipment and the operator. Ninety percent is the antenna. This is especially true in QRP since with very low power, by comparison to the Power Mongers, we need to get more ERP per watt out into the ether to be heard. So when I got back into QRP a few years ago I found the fascinating world of antennas and RF radiators to be an exciting challenge and a means to find the ***perfect*** antenna which I call the *New Carolina Windom.*.

One of my favorite pastimes is taking my QRP equipment into the woods or other exotic locations, like an Indian Reservation or a rare Grid Square, and operate my own QRP-xpedition. I have little interest in building or putting up a beam so I concentrate all of my antenna research and designs on verticals (that can be broken down into small packages) and wire antennas. In the field I typically use one of several homebrew verticals since they're easy to carry and setup. However, in the last few months as I've become much more active building and using QRPp equipment (like the RockMite) which I am using at the home QTH as well as in the field. My goal is to have a single wire antenna that will fit my yard and give me the most miles per watt.

I don't have room for an 80-meter dipole or long wire so I have to restrict the length to 100 feet or less. Besides my primary interests are working only CW on 40, 30, 20, and 15 meters.

Based upon these parameters, I have found what I consider to be the *perfect antenna.* The antenna I will show you how to build in this article evolved from a concept that had its beginning back in 1929. I will briefly discuss the history before showing you how to build the antenna I've chosen to be my main antenna for QRP and QRPp operation.

Let's back up 76 years and look at the Windom antenna that came into being when Loren G. Windom described his invention in the September issue of QST, 1929, pages 19-22.

The *Original Windom*, as I will call it, was the first known design of an off-center-fed antenna designed for use by amateurs on the ham bands. Its characteristics made it possible to use one antenna to cover all of the harmonically related ham bands. One of the drawbacks is that it requires an antenna tuner and a very good ground system. Although in those days with vacuum tube transmitters and receivers this was not a particular disadvantage.

The original Windom was 130 feet long with a single-wire feed line connected approximately at the 600-ohm impedance point on the radiator. The feed line also acts as a radiator. The original antenna was designed to be used on 80 meters and all of the harmonically related bands (40, 20, 15, and 10 meters) using an antenna tuner between the transmitter and the single-wire feed line. The feed point is 37.8% from one end of the radiator. This was where Loren Windom calculated the 600 ohm feed point would be located. Figure 1 is a graphic representation of the original Windom.

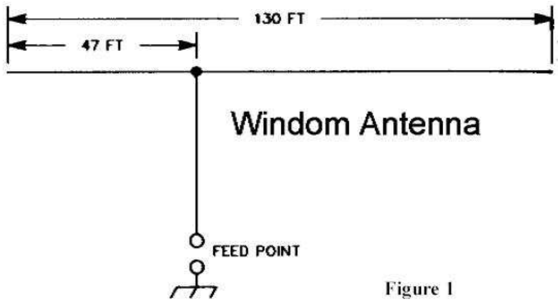


Figure 1

Let me briefly mention the G5RV which has been relatively popular for the past few years. I have tried the 102-foot [full size] version of this antenna with moderate success. Two things you need to know about the G5RV: (1) it is resonant on no ham band; (2) and requires a good antenna tuner to make it work. Both of these factors are not conducive to getting a good signal out when using low power. For this antenna I would classify low power as anything below 100 watts.

A few years ago, three hams, *Jim Wilkie (WY4R), Edgar Lambert (WA4LVB), and Joe Wright (W4UEB),* came up with an idea for an off-center-fed dipole that carried Windom's single feed line antenna to the next level. It has since become known as the Carolina Windom. I will call this the *Traditional Carolina Windom* since it was the first attempt at creating this specific type of multi-band antenna based loosely on Windom's original concept. The differences between this antenna and Windom's is that the *Original Windom* is not a dipole.

Figure 2 is the electrical equivalent of the Traditional Carolina Windom.

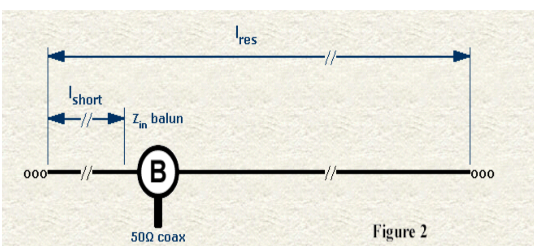


Figure 2

The Traditional Carolina Windom: Figure 3a is the true representation of the Traditional Carolina Windom antenna. The main characteristics are: (1) It is 66 feet in length and designed to cover the 40, 20, 15, and 10 meter bands without the need for a tuner; (2) It will also work quite well on 17 and 30 meters <u>with a tuner</u>; (3) it requires a 4:1 Balun at the transmitter end on all-bands except 15-meters and a 1:1 Balun/choke when working 15-meters. This antenna works very well and achieves excellent signal reports when up 24' or higher and when trimmed and tuned to frequency. You simply need to cut the antenna (always keeping the 37.8/62.2% ratio to the feed point) to frequency using the MFJ-259B or similar test equipment.

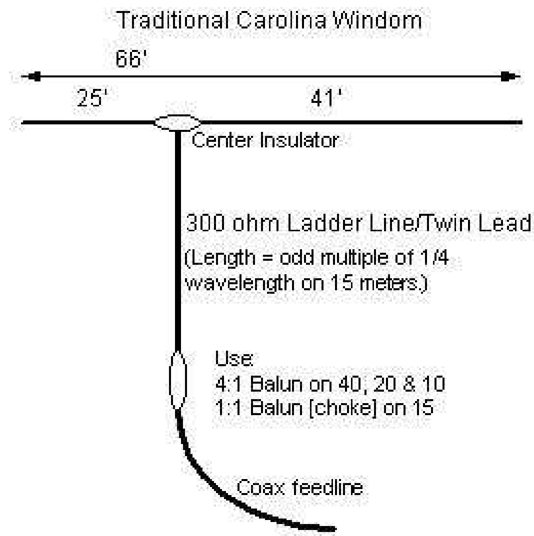


FIGURE 3a

The feed line from the radiator is 300-ohm twin lead or 300-ohm ladder-line (which is lighter and can be purchased at many hamfests). The twin lead must be cut to frequency for 15-meters. Its length must be an odd-multiple of a ¼ wave on 15-meters. To make that simpler, ¼ wave (in feet) at 21.060MHz is approximately 11 feet therefore the 3rd multiple is 33 feet and the 5th multiple is 55 feet and so on. I chose 55 feet since that was close to reaching my shack from where the antenna was hanging. Figure 3a shows a pictorial of the *Traditional Carolina Windom.* The 300-ohm twin lead actually is the primary radiator on 15-meters. As such, a choke or 1:1 Balun is used between the 300-ohm twin lead and the 50-ohm coax to the transmitter. A 4:1 Balun is required for the other bands in order to match the higher impedance of the antenna on 40, 20, and 10 meters.

The New Carolina Windom: Figure 3b is a pictorial of the *New Carolina Windom*. This more recent version has some very interesting characteristics. For one, the 4:1 Balun has been moved to the antenna radiator and is built into the center insulator. The other interesting feature is the 10 feet of coax from the Balun and terminated in a choke or line isolator. I have fitted the 10 foot stub with PL-259 UHF connectors on each end. This allows the coax vertical radiator to be easily removed if desired. It is designed to hang vertically which is one reason why this antenna is so effective. Look at the radiation patterns later in the next column. The radiation pattern when using the vertical radiator combines both horizontal and vertical radiation components and lowers the effective angle of radiation.

This antenna is in use the world over by DX'ers and DX'peditions. In one Navassa DX'pedition, of the 33,000 QSOs made, more than 27,000 were accomplished with this antenna. The DX'pedition team also had a beam and verticals, but the *New Carolina Windom* was the antenna they used. Its reputation for excellent performance is so good that it served as one of the antennas in setting two 40 meter "mile-per-watt" world records of nearly 4,000,000 miles-per-watt.

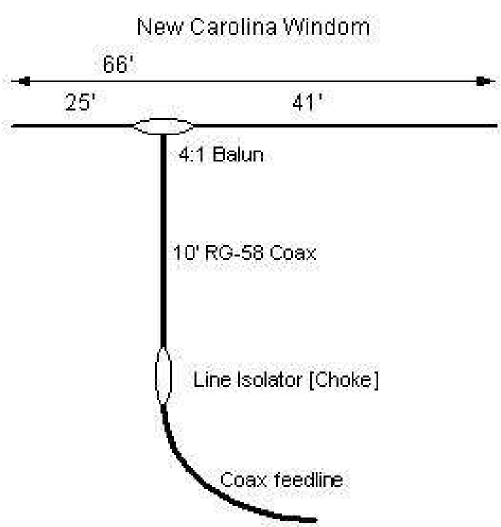
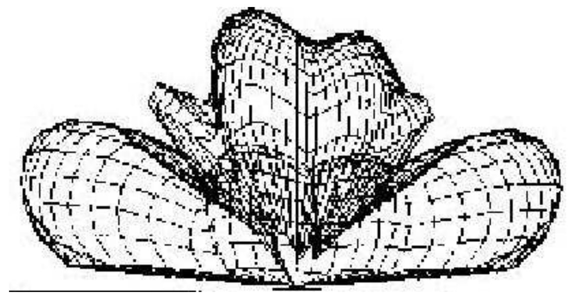


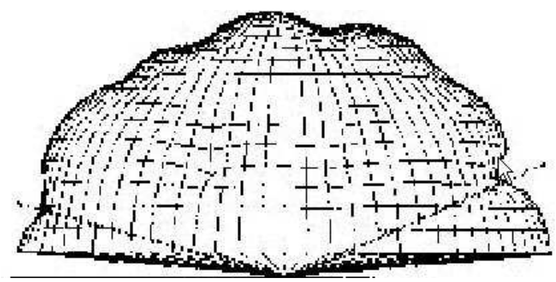
FIGURE 3b

The antenna can be used without the vertical radiator but the radiation pattern will lose the low angle component and may make the antenna less effective. If the vertical radiator is removed then you should move the line isolator to the bottom of the balun.

The following shows the radiation pattern with no vertical radiator.



The following radiation pattern is with the vertical radiator in-line.



This antenna should not need a tuner on the 40, 20, 15, and 10 meter bands although you may use one if you feel the need to. It will operate on 80, 30, and 17 meters but will require a tuner for these bands.

The following details the making of the Balun and the Line Isolator. The Balun is made from 1¼" Schedule-40 PVC cap and plug plus some additional hardware [Figure 4].

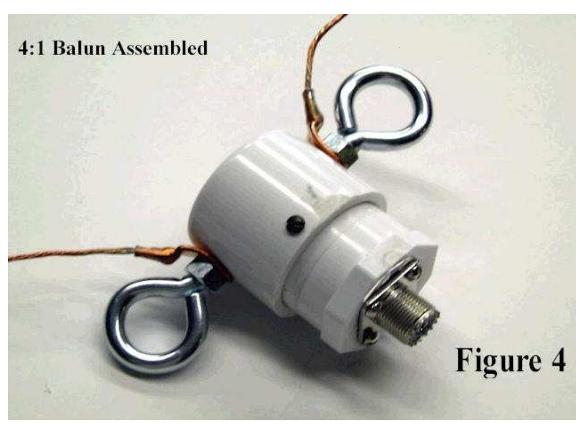


Figure 4

The figures 5a and 5b show the 4:1 Balun schematic followed by the pictorial. When winding the balun it is very important to follow the schematic and pictorial examples so that the two windings are connected in the correct direction.

4:1 Balun Schematic

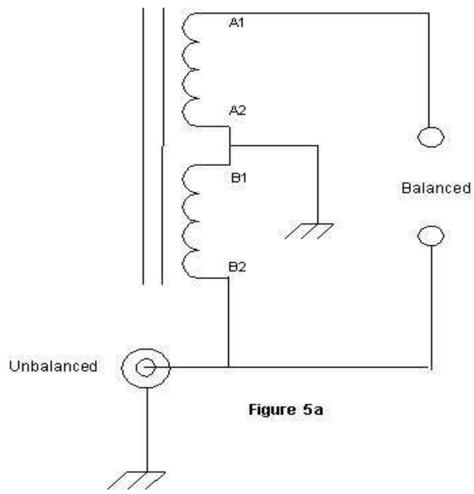


Figure 5a

4:1 Balun Pictorial

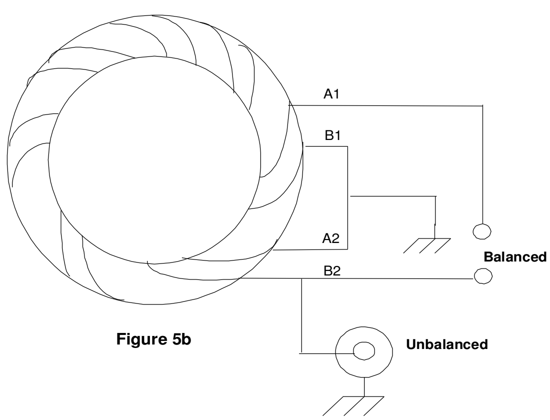


Figure 5b

Figure 6 shows a correctly wound Balun and ready to be wired according to Figures 5a and 5b. For those who have not had a lot of experience at winding toroids here are a few tips. To count the number of turns, each time the wire passes through the center of the core, is counted as a turn. For example, if you simply push the wire through the core it's counted as 1 turn.

To wind this balun you will need one T106-2 toroid core. The wire must be 28 or 30 gauge enameled magnet wire. This toroid will be wound with 19-21 bifilar turns which simply means that it is two coils wound together on one core. To do that look at Figure 6. Pull 60 inches of wire off the spool of enameled magnet wire and bend it back on itself at the middle so that you have two 30 inch lengths of wire side-by-side. Do not cut the two lengths of wire apart until after the core is wound as in Figure 6. You must wind the balun by pushing the two parallel wires through the core for each turn. After each turn pull the wire tight and space the turns so that when finished there is about a 30-degree spacing between the ends. Try to keep the two wires from crossing over each other as you wind them together. When finished cut the wires apart where they were folded over. Be sure to use your ohmmeter to determine which wires are the A1, A2, and B1, B2 ends as shown in Figures 5a and 5b. Label these. It is important that the "sense" of the wires be correct so that all the A and B leads go to the right places according to Figures 5a and 5b. If you reverse any of the wires, the balun will not work properly. The test configuration that you will setup in Figure 7a will verify if it's working correctly or not before you install it in the PVC cap..

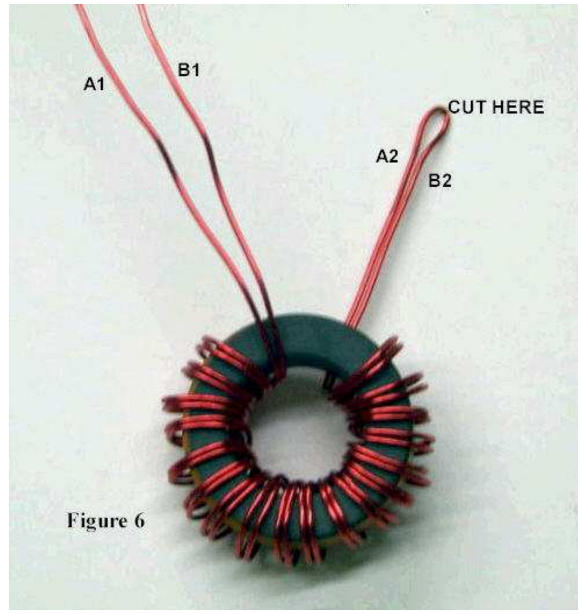
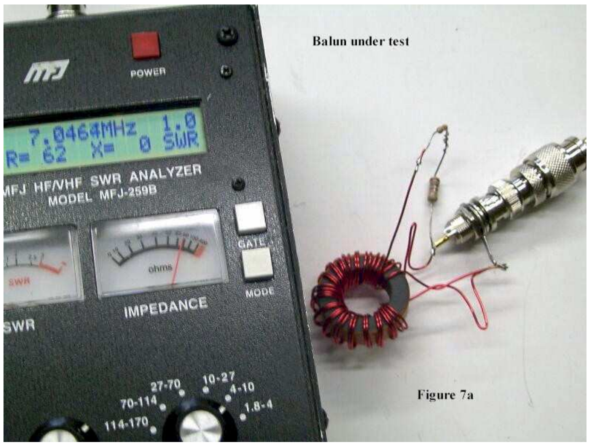


Figure 6

In order to test the balun you will need to wire it as it will be wired in the final balun housing shown in Figure 4. Use a BNC connector and a 200 ohm resistor network (1/4 watt resistors are sufficient for the test) and make sure that they are wired as shown in Figures 5a and 5b. The BNC coax connector will be connected to the MFJ-259B and the 200-ohm resistance represents the antenna and are connected across the balanced leads A1 and B2. Turn the MFJ on, set the frequency to 3 MHz and check the SWR reading. It should read 1.0 SWR. Then change the frequency to 7 MHz and so on moving up the spectrum. The reading should be flat 1.0 SWR until you get to about 49 MHz. The 200 ohm resistive load across the core is 4 times the expected 50 ohms at

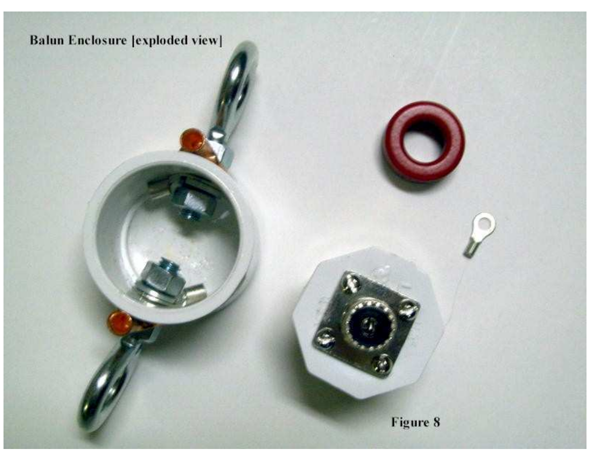


Balun under test

Figure 7a

the BNC connector. Hence the 4:1 balun is working as it should if you see an SWR of 1.0. If you add 100 ohms of resistance (300 ohms) to the load you'll see about 1.2 SWR and at 400 ohms you'll see 1.5 to 1. The 400 ohm load will translate to 100 ohms at the BNC connector since the MFJ-259 (and your rig) is expecting to see 50 ohms. Figure 7a Shows the balun under test with the MFJ-259B.

Figure 8 shows the components of the Balun.



Balun Enclosure [exploded view]

Figure 8

See the parts list for more details.
Refer back to Figure 4 for the completed balun.

As shown in Figure 3b, there's a line isolator which is really a choke to prevent the RF present on the shield of the vertical radiator from migrating down the coax feed line to the transmitter. The next photo shows the components of the isolator and its enclosure. See the parts list at the end of this article for the parts details.

The Line Isolator is nothing more than a 30 inch length of coax folded back on itself with 7-10 ferrite tubular cores slipped over the coax. Put an SO-239 (female) UHF connector on each end of the coaxial choke. I enclosed it in a CPVC pipe with two end caps and used barrel-type SO-239s . This allows the 10' vertical radiator and the feed line from the rig to plug into the ends. If you remove the vertical radiator and want to plug the Line Isolator directly in to the balun, use a dual PL-259 adaptor.

We are now ready to make the Isolator or Choke. The basic components are shown in the photograph on Page 6. I used 1-inch CPVC pipe cut to 8-inches in length, two CPVC end-caps, a number of Ferrite tubular cores, two barrel type SO-239 coax connectors, and a 30" length of RG-58 coax.

I chose the CPVC pipe instead of Schedule-40 white PVC due to the lighter weight and the thinner walls which allows a slightly larger area for sliding in the choke [shown later in this article] and since the barrel type SO-239 connectors are fairly short they mount nicely with enough of the connector exposed to screw on standard PL-259 coax connectors.

To make the choke, cut a 30" length of RG-58 and bend it so that it forms three areas. Two legs and a center section. The center section should be about 6" long. If your center section, due to different length cores than what I used, is longer than 6-inches make sure that the CPVC pipe section is 2-inches longer than your choke bundle to allow room for mounting the coax connectors. Alternately slide 1" and 3/8" long tubular ferrite cores over the coax until they fill the entire middle section. I used a pair of pliers to crimp the bends in the coax so they fold back tightly over the cores. This is necessary so that the assembly

will slide into the CPVC tube.

When all the cores are in place, fold the ends back over the cores and use three very small cable-ties to hold it all together as shown. Make sure that the coax ends are tightly held against the cores for a couple of reasons, so you will be able to slide the bundle into the tube and also to increase the absorption of any radiation by the cores. See the photo above to see how the filter will slide into the tube. When completely in the tube you should only see the

ends sticking out. The next thing you will need to do is to trim the ends to the best length so that the end caps will slide onto the tube without bending the coax ends. Solder the barrel coax connectors on each end as shown below. Then slide the end caps over them. Before you start soldering ensure that you

have the ground solder ring slid over the barrel connector. This is what you will solder the shield to.

Drill the 3/4” holes in the end caps for the barrel connectors before assembly. After soldering the coax connectors to the bundle ends, slide the assembly into the pipe so that both coax connectors are in place for the final assembly. Slip the end caps over the coax connectors and onto the pipe. Allow enough overlap so that two 1/4” long sheet metal screws can be used to fasten the end caps to the pipe. I did not glue mine together since I might need to disassemble it some time in the future for maintenance.

PARTS LIST	
QTY	**DESCRIPTION**
66’	Antenna Wire. #14 AWG braided copper wire.
2	Antenna Insulators (for the ends)
1	Balun: 1 1/4” PVC End Cap (slip type)
1	Balun: 1 1/4” PVC Plug (slip type)
2	Balun: 5/16” x 3” Eyebolt (Cutoff thread to 1”)
4	Balun: 5/16” Nuts
2	Balun: 5/16” Split Lock Washers
2	Balun: 5/16” Tubular Lugs (Outside of PVC Cap)
2	Balun: 5/16” Terminal Lugs (Inside of PVC Cap)
1	Balun: SO-239 panel mount coax connector
4	Balun: 6-32 screws, nuts. For SO-239
1	Balun: T-106-2 (red) powdered iron toroid core
6’	Balun: 30 gauge enameled magnet wire
10	Choke: Ferrite Tubes. (slide over RG-58U)
30”	Choke: RG-58U.
2	Choke: SO-239 barrel type connectors. (Fair Radio)
8”-10”	Choke: CPVC 1” pipe. Cut to length of RG-58 with Ferrite Tubes + 2 inches
2	Choke: CPVC 1” end caps.

BONUS

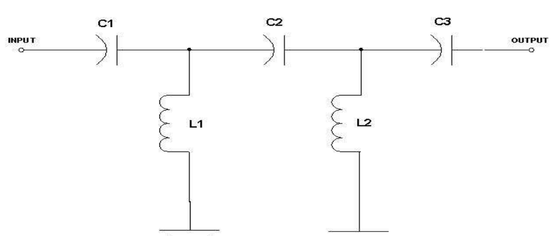
Tchebysheff High-Pass Filter

Here's a RockMite tip:
Actually this can be used with any low-power transceiver less than 2-watts that has a direct conversion receiver, such as, the RockMite. The RockMite receiver can experience front-end overload from low frequency sources like AM broadcast stations.

In my case, after building a 40-meter RockMite, I connected it to my antenna and turned it on to see if it was working when all I heard was a local AM broadcast station about 2000db over S9. No other signals could be heard. I started researching this and how to cure it. After Googling for a couple of hours, I discovered the Tchebysheff high-pass filter so I decided to build one and put it between the Rockmite and the antenna. After building it, I turned the RockMite on and the broadcast station had totally disappeared and there were CW signals everywhere … loud and clear.

The filter is very easy to build and now, instead of building the outboard version [as shown in the photos], I always include it in the box with each RockMite.

There is one caution. This should not be used with the 80-meter RockMite (or any other rig that you want to use on 80) since the cutoff frequency is about 3.8 MHz. But for 40 and above, it works great.



You will need the following parts:

C1, C3	820pf disc ceramic, 35 wvdc
C2	470pf disc ceramic, 35 wvdc
L2, L2	Use T37-2 (red) toroid cores, #26 enameled magnet wire, 20 turns.

Simply wind the cores and wire the components according to the schematic and you will get instant gratification.

The following two photos show how I made the external filter. I used a very small piece of vector board to hold the components in place. There is a female BNC connector at each end of the tin and a dual-BNC-male adaptor on the input side so I can connect it directly to the antenna connector on the 'Mites.

That's it! Enjoy broadcast free QRP!