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From the Editor

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This issue marks the start of the 9th year of publication for QRPp. Thanks to all who have made it possible. Especially Jim Cates, the quiet gentleman who is my dearest friend and keeps me on the right path when I stray. Thank you Jim.

This issue is filled with one huge article, Jim Kortge's work on building and optimizing the Iowa QRP 10 that was published in the Fall 2000 issue of QRPp. Mike Fitzgibbon, N0MF was the original designer, and I asked Jim to reproduce the rig from QRPp. Jim found some ways to improve the rig, and with Mike's blessing they are included here. The pictures are all on the NorCal Web Site, and if you decide to build the rig, I strongly suggest that you go there and use those photos, which are in color, and much clearer than here. The URL is:

http://www.fix.net/norcal.html

Jerry Parker does a wonderful job on the page, and there is a ton of QRP information there. Visit it often.

Also, Paul Maciel, AK1P, our database manager has a new email address. If you have any questions about your subscription to QRPp, please check with him at ak1p@earthlink.com 72, Doug, KI6DS

Notes On Building the Iowa QRP 10 Transceiver

By *Jim Kortge*, K8IQY

My first step in building this transceiver was to do a somewhat quick inventory of the parts Doug, KI6DS had sent. After looking at these goodies, I proceeded to cut the sides down on a small cardboard box for making a parts holder. This technique was used back in the days of assembling Heath Kits, and still works well today, although the parts back then were a bit larger. In some instances with the smaller parts like diodes, several were bundled together and inserted in a single hole, to keep them from disappearing down one of the "cardboard tunnels". Once the parts were organized, my attention was focused on preparing the printed circuit board substrates that the three section of the transceiver would be built upon. The board material used was some older, phenolic based 1/16-inch double-sided board stock that was waiting to be used. I decided to use this instead of glass based board material, as it is easier to shear, and does less dulling of the cutting edge on the shear. I marked the board sizes at 2 X 5 inches, giving myself an extra inch of width, just in case I needed more room. One of the important axioms of Manhattan-style construction is to use a larger substrate than you think you will need. It's always easy to hack off the extra, and really difficult to add a piece and have it look good, if you run out of building space before the parts are gone.

When the boards were cut to size, one of them was marked off for building the VXO, +8 volt supply, and optional TiCK keyer. Additional

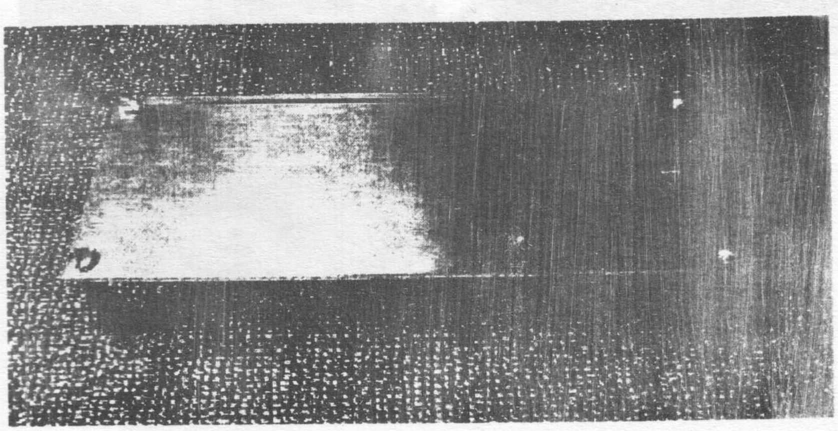


Fig. 1 VFO Board Substrate (1" oversized)

lines were drawn for the final cut at 2 X 4 inches, assuming all the parts would fit, and another line along the edge, 1/8 inch inboard, so that area would remain clear of parts and wiring. This was to allow a final cut for fitting the board into the supplied case, if indeed it is used. Mike, N0MF's boards apparently were 1 7/8 X 4 inches, but the QRPp illustrations show 2 X 4 inches. I believe the boards must be less than 2 inches wide to fit into the "Bud" minibox Doug provided.

Construction started with the +8 volt power supply, building it into the area marked on the substrate. It is always a good idea to start a Manhattan-style building project with a simpler part of a circuit. Even if you are an experienced builder, it takes some "parts orientation noodling", lead bending, fitting, and soldering to get your mind and hands into the flow. Once you're in the groove, building is much like a chess game, and you can see the next several steps that will happen. After completing the +8 volt supply, it was tested by applying 13.8 volts to the appropriate pad, and measuring the output. My regulator was putting out 7.96 volts. A note of caution, don't inadvertently short the output of the 8-volt regulator, they don't like that. I did it, and didn't let smoke out of the part, but I turned it into a 7.5 volt regulator after doing it a second time. It had to be replaced!

Since I built the +8 volt regulator farther to the right edge than Mike, I gained some space on the substrate that could be used for the VXO

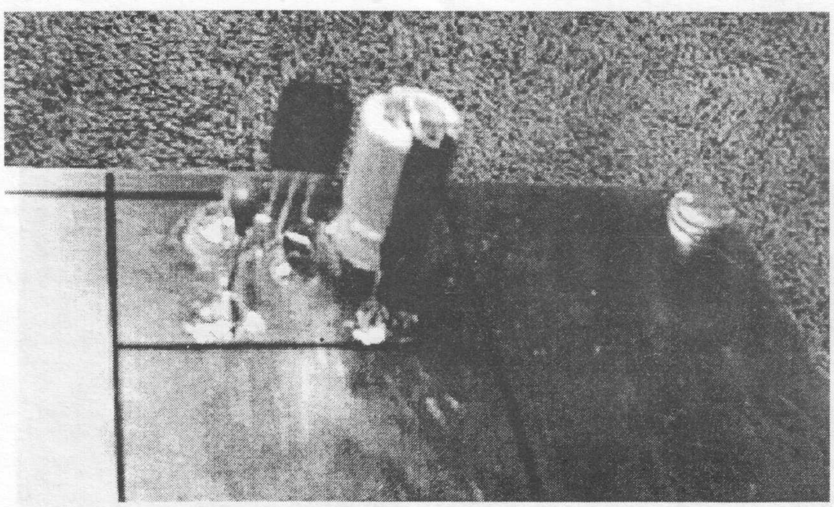


Fig. 2 U6 and associated components.

circuitry. VXO construction began by mounting Q4, oriented with the drain lead up, the gate lead down, and the source to the left. My basic plan was to have the frequency control components, X5 and RFC5, mounted across the shorter direction, and the diode doubler components along the longer direction. This would minimize crowding, and keep the frequency control components away from the higher-level r.f. output of the doubler. An extra pad was used between the gate lead and the crystal, just in case an extra capacitor was needed to set the VXO high end. [I've done this on other VXO based projects and was glad that I did. It's one of the benefits of many building projects I guess.] A 3.3 uH-molded inductor was used for inductor RFC5 instead of the T50-2 toroid. Having a large core inductor suspended by its leads could cause unwanted stability problems. The molded unit was mounted between two pads. A larger value inductor should work in this VXO for wider frequency coverage, but won't because of some design limitations.

Before testing could proceed, the MV209 varicap was tack soldered to the pad containing the junction for switch S1. The control point at the

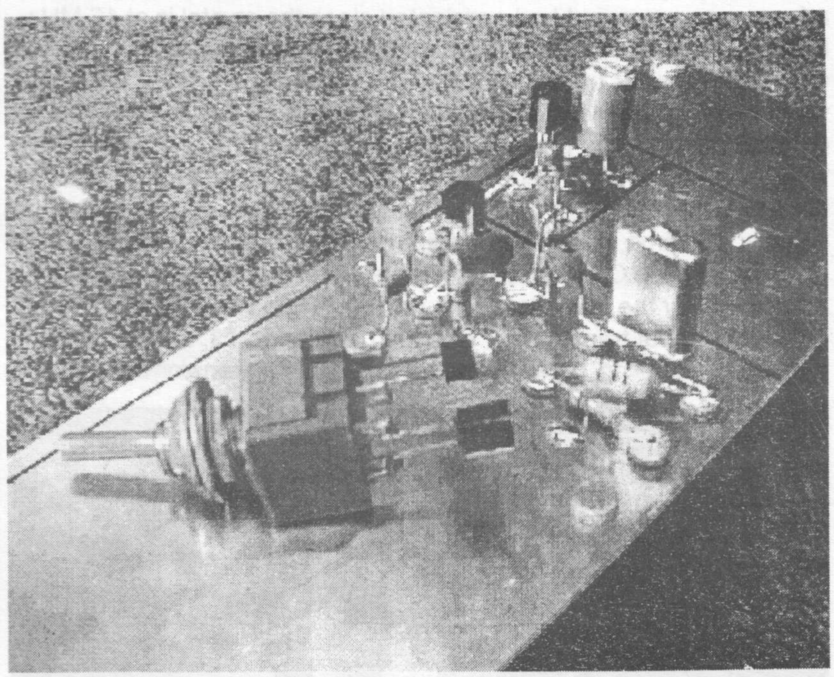


Fig. 3. Q4 and components.

end of R11 was grounded with a clip lead. Power was applied to the 12-volt terminal, and the VXO came to life. With the S1 control point at ground, the varicap is at maximum capacitance, and the output frequency was around 15.995 MHz, about where it needs to be to cover 28.06 MHz. What math was just done? Well, the VXO frequency is going to be doubled, so 15.995 MHz turns into 31.99 MHz. From this number, subtract off the i.f. frequency of the rig, or 3.9315 MHz to get 28.0585 MHz. How do I know that the i.f. frequency is 3.9315 MHz? The answer to that question will be addressed in detail later, when a "quick tutorial" on crystal matching takes place. For now, accept the fact that the crystals specified have their series resonance at nominally 3.9315 MHz. Getting back to testing, removing the S1 jumper from ground, and connecting it to the +8 volt supply raises the VXO up about 6 KHz, so 28.060 will be somewhere in the lower part of MV209 varicap tuning range. As the voltage is increased on a varicap, its capacitance decreases. To get a feeling for the total range covered by the VXO, a 470 pF capacitor can be placed across the MV209 leads while the S1 junction is at +8 volts. This capacitor will simulate the maximum capacitance of the 1SV149 varicap, and we'll get a peek at the VXO low end. On my rig, that will be around 28.055 MHz, actually not as wide of a frequency swing as I had anticipated since the crystal is at 16 MHz. Building the diode doubler circuitry began by winding the T3, T37-61 core with 10 bifilar turns. Since this core was wound with #28 gauged wire, the recommended method would be to twist the two strands together for 7 to 8 turns-per-inch of length, and wind the core with the two wire bundle. However, I didn't do it that way, but instead wound the 10 turns with parallel wires. I can do that more rapidly, and the results are virtually the same, if the leads are kept together. Once T3 was mounted on a line with the Q4 source lead, the remaining parts were soldered in approximately the same locations that Mike had used. However, I oriented the output transformer, T4 at 90 degrees to T3, to minimize any chance of coupling between these two. Output transformer T4 was

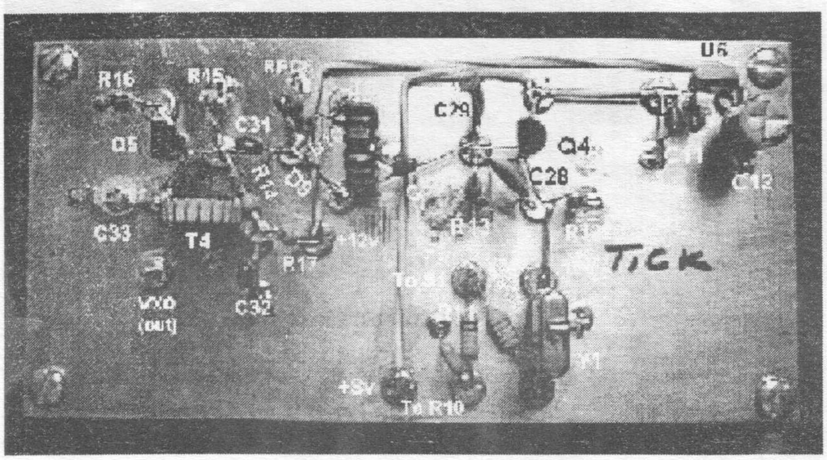


Fig. 4 VXO Board Layout

wound with a 16-turn primary, so its inductance would be the same as many of the other tuned circuits in the rig. For reference, the primary inductance was measured at 0.9 uH. Making this change allowed using a 5-50 pF trimmer capacitor at location C33, making this value common with all of the other trimmers. The secondary of T4 uses 2 turns instead of 3, to partially compensate for the fewer primary turns.

With this circuitry completed, applying 12-volt power produced nominal 32 MHz output from the VXO. Trimmer C33 had two relatively sharp

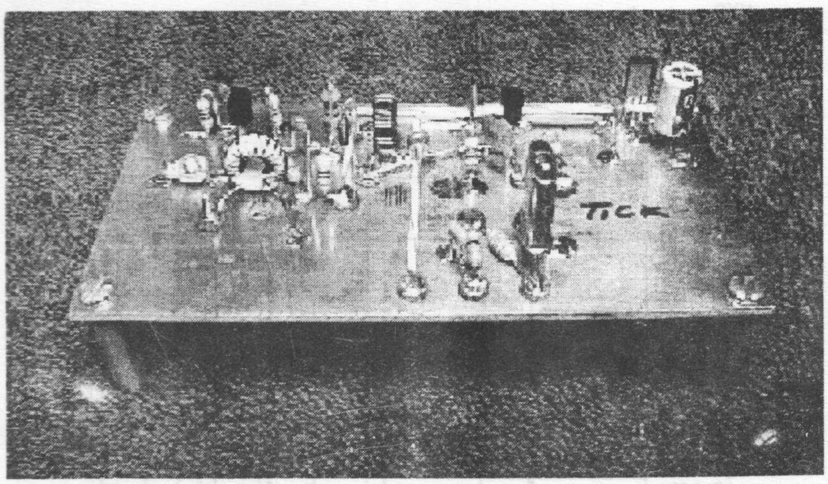


Fig. 5 View of completed VFO

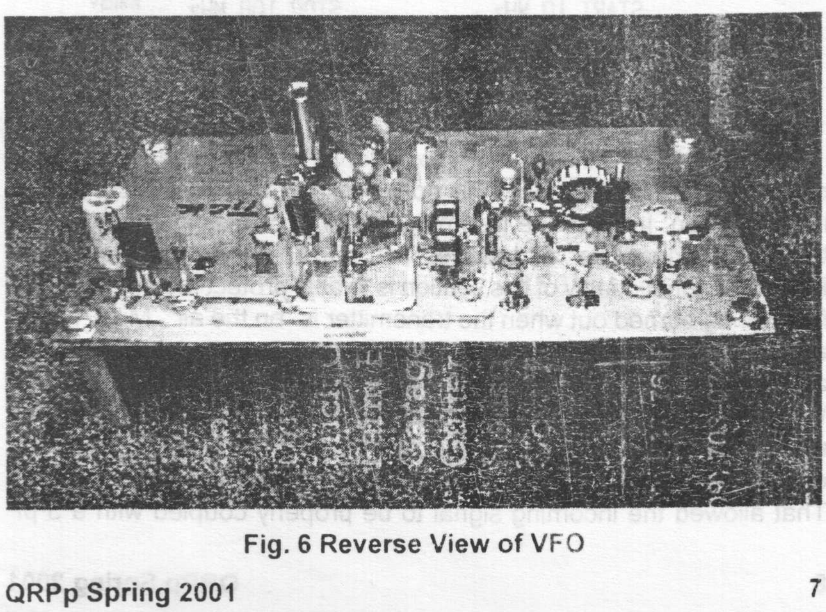


Fig. 6 Reverse View of VFO

peaks, and no instability was seen. The unloaded output is a clean sine wave, at a level of approximately 800 millivolts peak-peak, more than enough signal to drive the receive and transmit mixers. The 16 MHz fundamental signal driving the diode doubler is more than 30 dB down from the main signal at 32 MHz, and all harmonics and spurious signals are also better than 30 dB down.

IA QRP-10

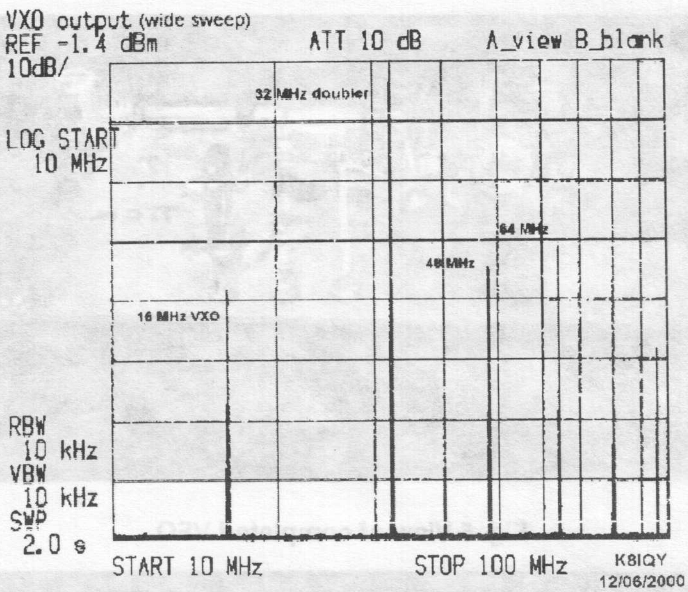


Fig. 7 VXO output spectrum plot

In this section, I'll discuss my experience building the input circuitry of the IA QRP-10. I'll refer to this portion as the Rx T/R Switch, as that is its function. It takes the incoming signal from the antenna, via the transmit low pass filter, and passes it on to the receive r.f. pre-amplifier. Part of the functionality of this section is to also protect the pre-amplifier from being burned out when the transmitter is "on the air". Mike, N0MF essentially carried over the original SST front-end, but in doing so missed an important aspect of Wayne Burdick, N6KR's original design intent. Wayne used the bias voltage from the NE602 input pin to supply current to the MPN3700 PIN diode during transmit. In addition, the input circuitry worked directly into the 1500-ohm impedance of the NE602. That allowed the incoming signal to be properly coupled with a 5 pF capacitor. The input circuitry employed in the QRP-10 does not provide a suitable bias source for the MPN3700 PIN diode, nor is the 5 pF coupling capacitor appropriate for working into a 50-ohm impedance. Some quick Electronic Workbench modeling shows that using the original input circuitry would result in a signal loss in excess of 25 dB, far more than the 8-10 dB gain provided by the pre-amplifier in the next stage. In addition, when the key line is grounded, no change in the signal level occurs. With that knowledge in hand, I felt compelled to make some minor changes to the configuration, and achieve better performance.

The final design kept both the 1N914 and MPN3700 diodes, and added an input trimmer capacitor, 1.5 uH molded inductor, 1.5 K ohm resistor, and another bypass capacitor. Included with the set of pictures for this write up is a revised schematic diagram showing what was built, along with two spectrum analyzer plots of the new Rx Input T/R Switch. Overall, the performance is markedly better. The measured signal loss is now only 0.4 dB during receive, and the attenuation during transmit is over 60 dB, well in excess of the amount needed to protect the pre-amplifier from being overloaded or burned out.

With a new input design in hand, the next step was to mark off the receiver substrate into sections, as was done with the VXO. To reiterate, partitioning the substrate lets you visualize the amount of space available for each section of the design. With some experience, you can sense whether the allotted areas are compatible with the complexity of a section and the number of parts to be soldered down. This substrate was essentially split in half, and each half was then partitioned into thirds, except for the input T/R and pre-amplifier, which shared a larger area. One of the pictures shows the partitioned substrate. Once this layout was done, there was an immediate concern that building the receiver on a 2 X 4 inch substrate wasn't going to work; that all the parts wouldn't fit with ease, and everything would be jammed together. When the VXO was built, the pads used were 5/32 inch in diameter. I placed several pads of this size on the receiver substrate, and immediately decided that this size pad was too big. Using a pad of this size would cause me to run out of room before all the parts were down. With that thought in mind, the dies in the Harbor Freight hand punch were changed to 1/8 inch, and several dozen pads of that size were made. This size still had more than enough room for several connections, and could be placed closer to each other, thereby allowing greater parts density, but without over crowding. Once this decision was made, actual building commenced.

Several pencil and paper sketches were doodled showing possible parts arrangements for the Rx T/R switch before any pads were glued down. On the third or forth layout, everything jelled, and I was ready to build. The first five pads were placed, and parts were soldered in, starting with the input trimmer capacitor, then the molded inductor, etc. After approximately half of the parts were mounted, the remaining two pads were cemented down, and those parts soldered. With all the parts on

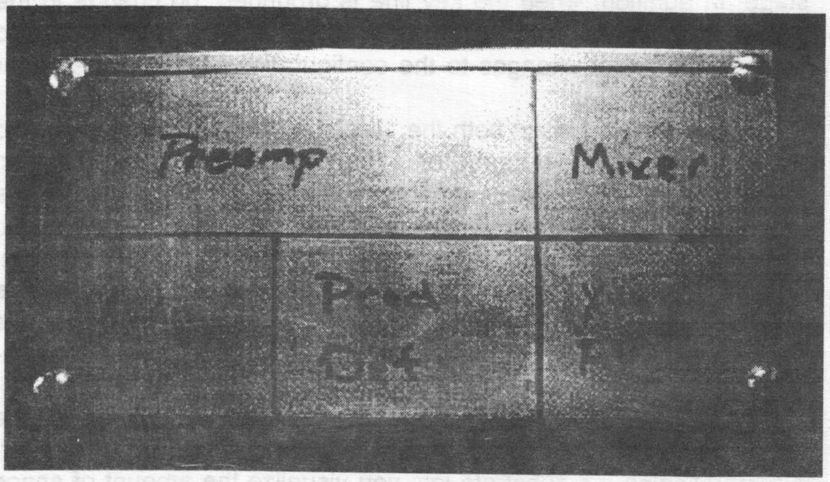


Fig. 8 Receiver Board Substrate

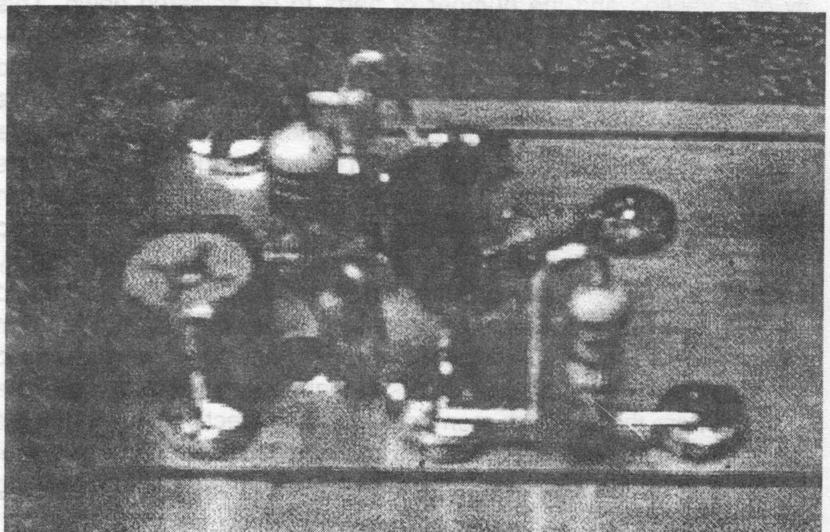


Fig. 9 RX T/R Switch

the substrate, the layout was given a final check against the schematic. There have been many times when I've built something entirely different than what was shown on the schematic. It happens to all of us; your brain gets tired, and you wander off to "Solder Land".

Once the input circuitry was finished, a few minutes of testing on the spectrum analyzer confirmed the robust performance of this new circuitry. Two spectrum analyzer plots have been included showing how well this circuitry works during receive and transmit.

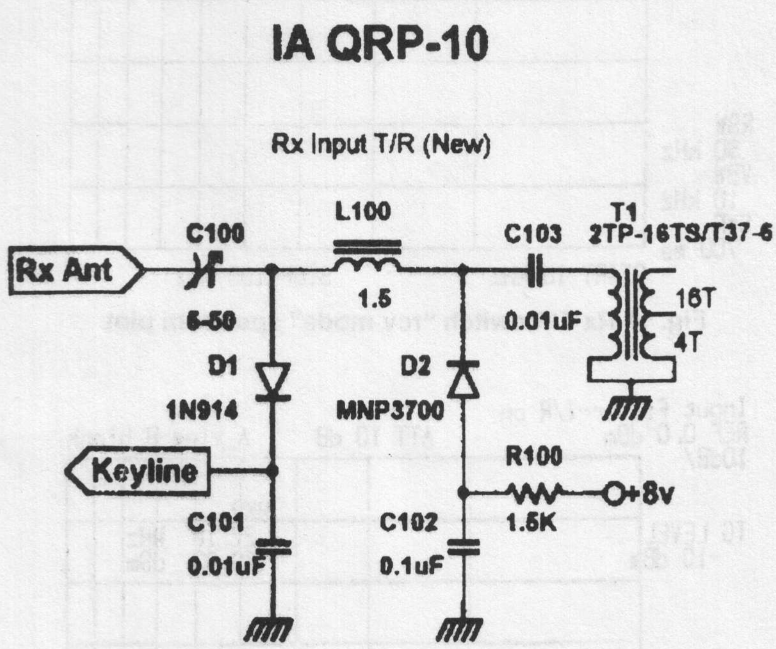


Fig. 10 Replacement T/R Switch Schematic. Note: R in ohms, C in pF, L in uH unless otherwise defined.

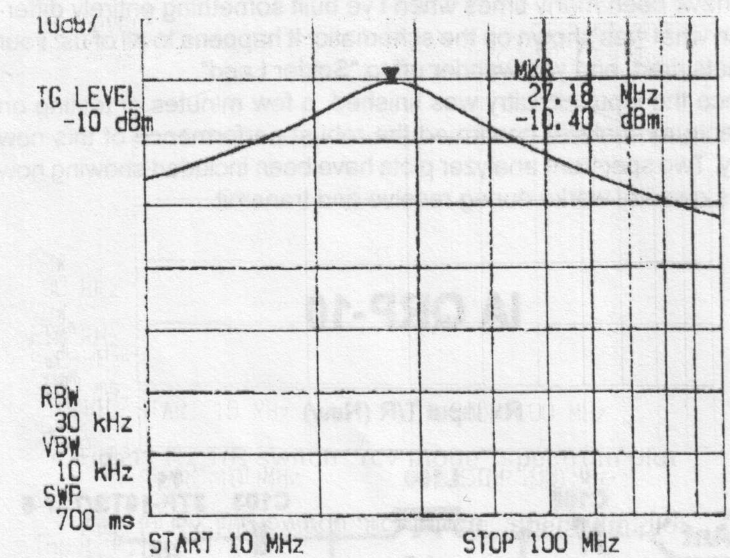


Fig. 11 Rx T/R switch "rcv mode" spectrum plot

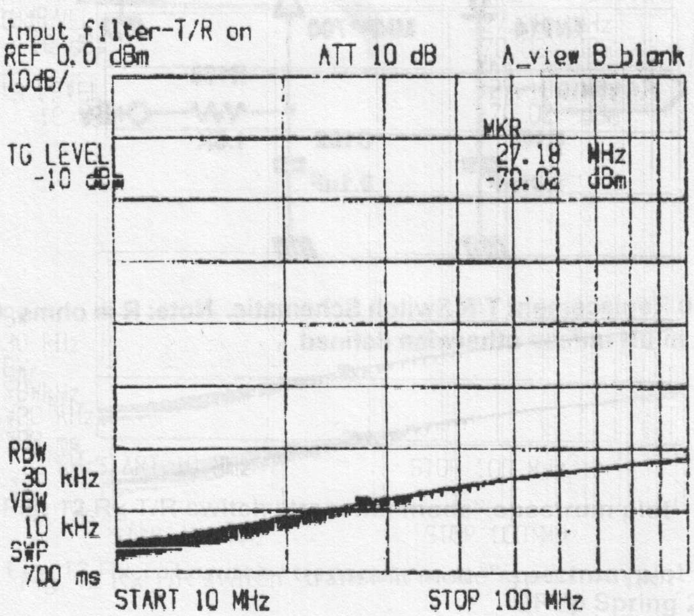


Fig. 12 Rx T/R switch "transmit mode" spectrum plot

Continuing construction of the rig began with winding transformer T1 with the appropriate number of turns. Since the input circuitry was changed to work with a low impedance (50 ohms), the primary winding on T1 was changed from 8 turns down to 2 turns. With the secondary tap at 4 turns, this presents approximately 200 ohms to the source of FET Q1, right in line with the input impedance of a grounded gate design using a J310. The transformer was wound with #26 gauge wire on the secondary, then the two turn primary winding was added using #28 gauge wire. As the secondary was being wound, after 12 turns were applied, a large loop was formed, twisted several times, and an addition 4 turns applied. The loop became the tap shown in the T1 detail picture. My usual winding technique is to hold the core in my left hand,

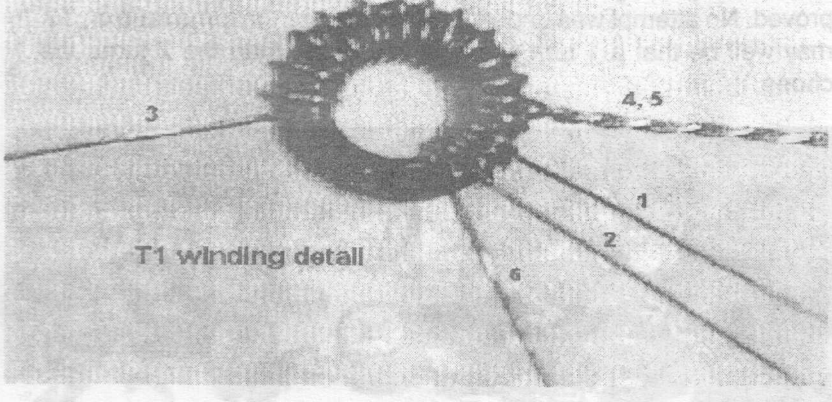


Fig. 13 T1 Winding detail

and wind the wire by pulling it through the core from the front side, while moving around the toroid in a clockwise direction. As it turn out, the transformer would have fit a bit better had I held the core in my right hand, and wound in a counter-clockwise direction, to place the winding ends on opposite sides of the core from where they ended up. I could have rewound T1, but just couldn't bring myself to spend the extra time for saving about 1/8 inch of space on the substrate.

Transformer T1 was mounted nearly identical to the position Mike, N0MF used, as was the trimmer capacitor, C3. The source lead resistor and capacitor, R1 and C4 respectively, were then soldered in place. A pad was placed for the drain lead for Q1, and it was then soldered into place. At this point, had I been thinking, resistor R2 should have been added, along with a pad for its opposite end. However, I was thinking about the need of winding T2, and completely forgot to put it in.

Fortunately, the pre-amplifier is very stable without it, so its need may not be very great.

Winding transformer T2 is very straight forward, as it doesn't have the complication of a tap. It was wound with 16 turns on the primary, and 2 turns on the secondary, instead of the 8 shown in the design. My rationale for making this change is that the output of T2 is driving a rather low impedance load consisting of a series resonant LC made up of capacitor C7 and inductor RFC1. RFC1 is r.f. grounded at one end by capacitor C9, so the total impedance seen by the secondary winding of T2 is the parallel loss resistance in inductor RFC1, and that's probably a few ohms at best. With the 4:1 winding ratio on the original T2 design, the transformed load to the drain of Q1 is 16 times the parallel loss value; probably no greater than 50 to 100 ohms at best. This low impedance would destroy the selectivity on the output side of the pre-amplifier. By using an 8:1 turns ratio, the selectivity is markedly improved. No attempt was undertaken to optimize the turns ratio on T2. It may well be that a 1 turn secondary is better than the 2 turns that I chose.

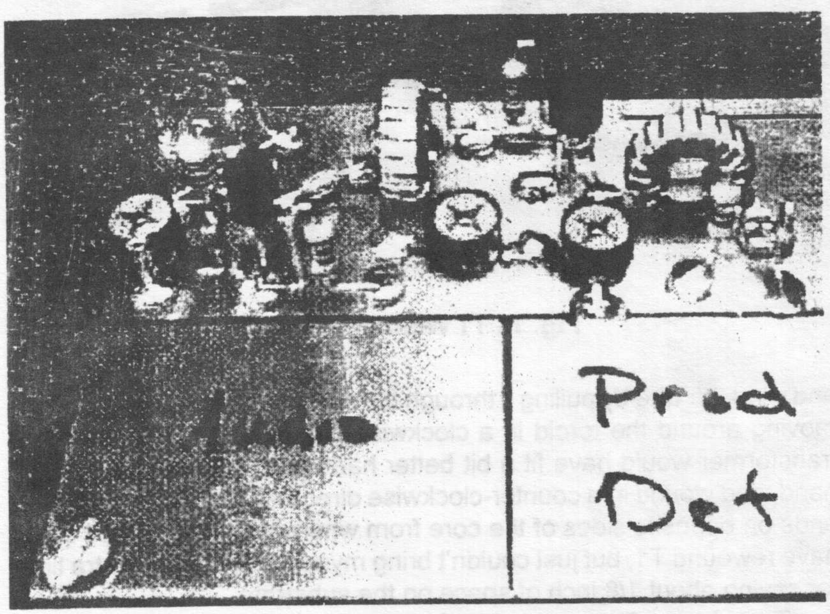


Fig. 14 Receiver Pre-Amp

After T2 was wound and installed, the completed receiver front-end was tested. In the first test, a signal from the tracking generator of the spectrum analyzer was connected to the "Rx Ant" terminal, and the input to the analyzer was connected to the secondary lead of T2. All

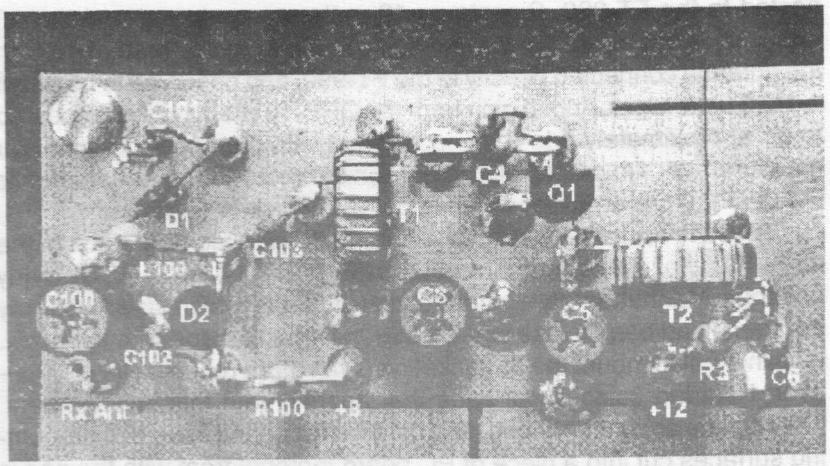


Fig. 15 Receiver Pre-Amp Layout

trimmer capacitors were peaked twice for optimal signal amplitude. The spectral plot shows the overall gain to be about 8 dB, so the pre-amplifier is running at about 8.5 dB, since there is a loss in the T/R switch of nominally 0.5 dB. The second test made use of my FT-990 receiver. An antenna was connected to the QRP-10, and the output from T2 con-

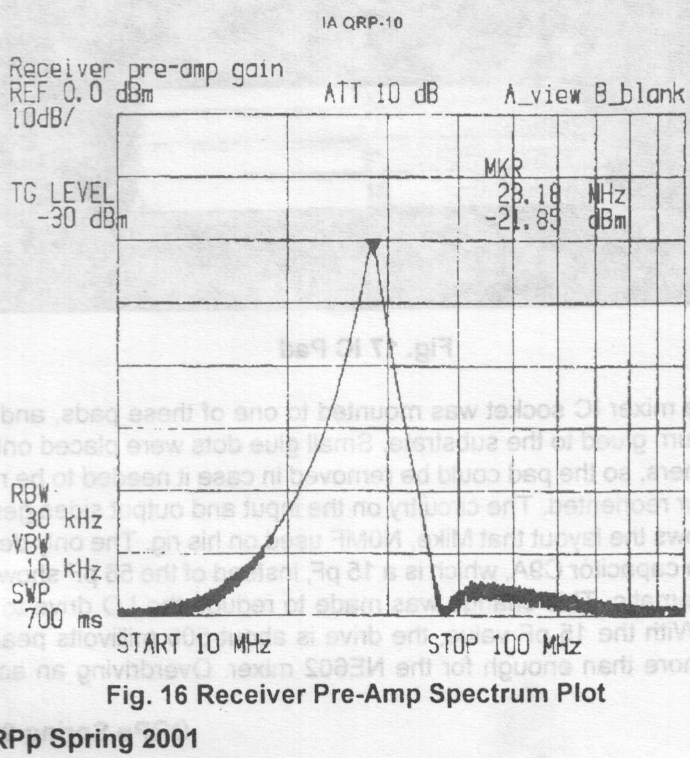


Fig. 16 Receiver Pre-Amp Spectrum Plot

nected to the FT-990. Signals on 10 meters were heard and their S meter readings noted. The same signals were then re-measured with the antenna connected directly to the FT-990, and observed to be about 1-1/2 S units lower. Added gain from the QRP-10 pre-amplifier appeared to be approximately 8 to 9 dB, consistent with the spectrum analyzer measurement. No detectable increase in the noise floor was noted while the QRP-10 pre-amplifier was being used, which is very good.

After the front-end was finished, it was time to tackle the first of the three ICs that make up the receive strip of the IA QRP-10. In many previous Manhattan-style construction projects which used ICs, my approach had been to use small rectangular pads made with the ADEL nibbling tool to mount the IC socket on. With more recent projects however, I started using small pads that approximate this arrangement. These pads are 0.6 inch long, and 0.4 inch wide, and have eight mounting surfaces cut into a piece of PC board material from with the pad is made. The cuts could be made with a small saw (a musical instrument fret saw would probably be excellent), milled with a milling machine if available, or etched as a small PC board if you have that capability using PnP Blue film or equivalent method. Mine were made on a drill press, using a milling table to control the X-Y movements. The cutter was a discarded dental burr.

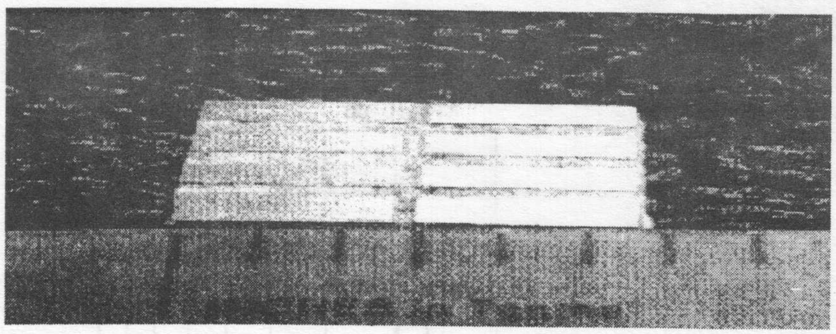


Fig. 17 IC Pad

The mixer IC socket was mounted to one of these pads, and the pad in turn glued to the substrate. Small glue dots were placed only at the corners, so the pad could be removed in case it needed to be relocated, or reoriented. The circuitry on the input and output sides generally follows the layout that Mike, N0MF used on his rig. The only deviation is in capacitor C9A, which is a 15 pF, instead of the 56 pF shown in the schematic. This change was made to reduce the LO drive to the mixer. With the 15 pF value, the drive is about 500 millivolts peak to peak, more than enough for the NE602 mixer. Overdriving an active

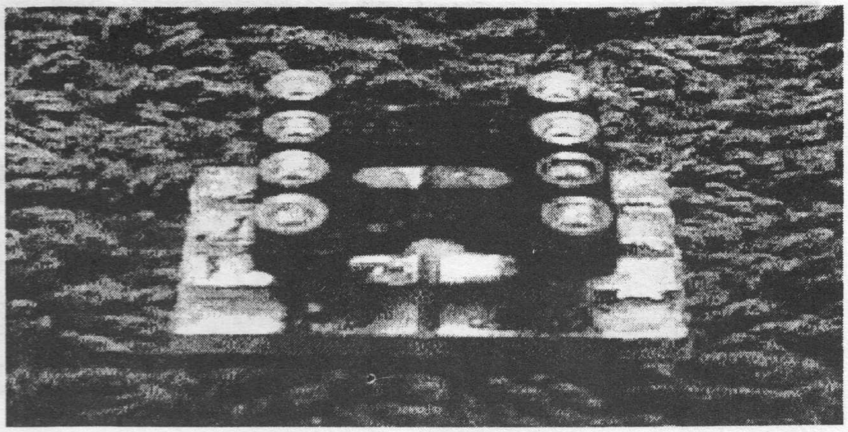


Fig. 18 IC Pad Mounted on IC Pad

mixer causes numerous spurious frequencies to be generated on the output.

After all of the parts are soldered in place, this much of the receive strip can be tested if you have a general coverage communications receiver. To test the operation, connect the VXO output to the VXO input terminal on your receive board. Then, temporarily solder a 0.01

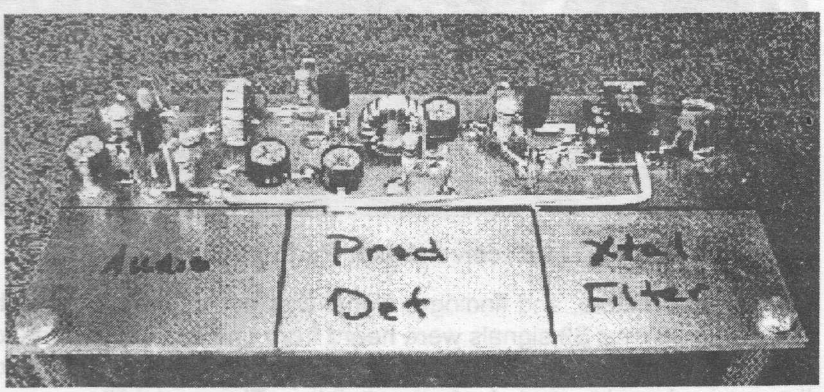


Fig. 19 Receiver Mixer, View 1

uF capacitor to either pin 4 or pin 5 of the IC socket, and connect the other end of this capacitor to the antenna input on your receiver using a piece of coax. Tune the communications receiver to 3.932 MHz. Place an antenna on the input of the QRP-10 and apply power so that the receive pre-amp and mixer are active. Peak all of the trimmers for maximum noise in the communications receiver. If 10 meters is open, you should be able to tune the communications receiver around 3.932 MHz, and hear a signal. When I performed this test, there was a contest

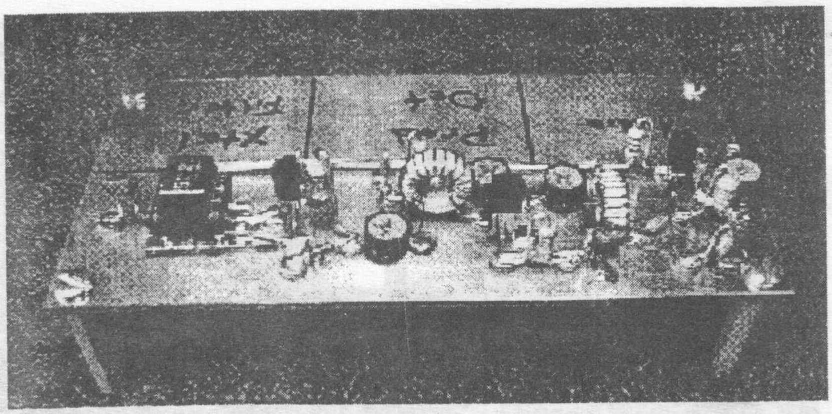


Fig. 20 Receiver Mixer, View 2

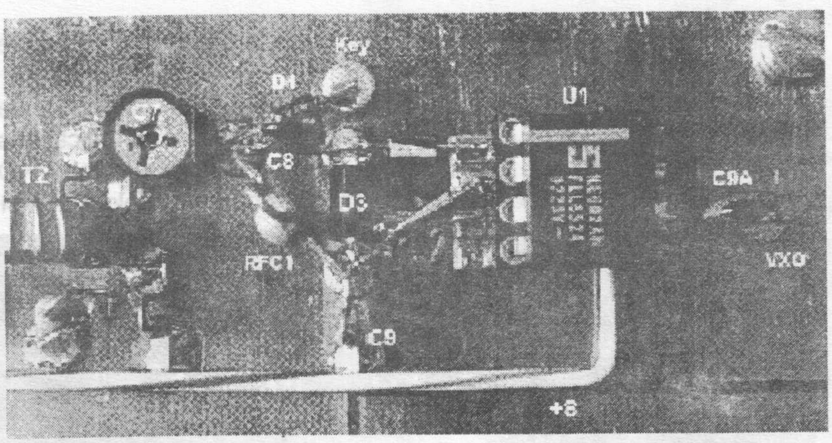


Fig. 21 Receiver Mixer Parts Layout

going on 10 meters, and finding a signal was not a problem. In fact, numerous 20 over S9 signals were heard from one end of the band to the other. Remove all of the temporary connections after this test, so the receive board is ready for further building. The crystal filter comes next.

These notes begin with a discussion on measuring crystals for use in the IA QRP-10 filter. My method for matching crystals is borne out of reading many articles on the subject, numerous experiments using various suggested methods, and some basic criteria that to my mind are invariant. This last item is probably the most important to the discussion. Based on all that I have read and found experimentally, it is clear that crystals in a filter are operating in a series resonant mode. This means they are exhibiting an "equivalent series resistance (ESR)" at the center of the filter pass band, and no reactive contributions. Above or below the center of the filter pass band, the crystal begins to exhibit greater reactance the farther away from the filter center one applies the excitation.

Given that the above statements are true, the only way one can measure the resonant condition of the crystal, i.e., no reactance, is to drive the crystal in a low impedance circuit, and find the condition where the output is a maximum. My test apparatus does just that. It consists of pair of 4:1 broadband transformers, one on the input, and one on the output. Ahead of the input transformer is a 4 dB attenuator, to provide isolation from the driving signal generator. The output transformer is terminated with a 51 ohm resistor, followed by a high impedance r.f. probe. Output from the r.f. probe is taken to an oscilloscope, which is used as the dc detector. The reason for using the oscilloscope is to take advantage of the screen graticule markings for setting up limits on acceptable ESR. Limits on what is acceptable as an ESR are determined with a small sample of crystals, since crystals of a given manufacturer and batch, as well as frequency, will exhibit differing ERS values. Normally, a marker is positioned at what appears to be the mean ESR for the group, and a second marker is then set at a value 3 dB lower. This marker becomes the lower limit at for which crystals will be accepted for filter use. Those that don't make this limit are destined for use in local oscillator service, assuming they have reasonable activity in an oscillator circuit.

The generator used to drive the tester is a RACAL-DANA 9087 digitally synthesized unit that has resolution down to 1 Hz. A short is placed across the crystal holder, the generator is set to the marked frequency on a sample crystal, and the amplitude of the generator is advanced until the trace on the oscilloscope is at full scale. A crystal is then inserted into the holder, and the generator frequency increased or decreased in 1 Hz steps until the oscilloscope display is again at a maximum. The trace location is recorded. A resistor is chosen from a low value set and inserted for the removed crystal. If the trace is higher, a the next higher resistor is selected, and the process repeated. Eventually, a resistor matching the ESR of the first sample crystal is found, and its value recorded. This process is repeated for the sample, which usually contains four to six crystals out of a batch of 50 to 100 units. The mean resistor value is then computed, and that value inserted into the tester. This output level then represents the median ESR for the batch, and a oscilloscope marker is set to this level. With the "mean ESR value" resistor still in place, the generator output is reduced by 3 dB, and a second marker is set. This marker then becomes the lower limit for accepting crystals from the batch for filter elements.

With the test fixture now calibrated, each crystal in the batch is measured by finding its series resonant frequency, and the last 3 digits of that frequency is marked on the crystal. Those whose ESR is below the lower limit, are marked "LO", and kept for use in local oscillator service. Occasionally, a crystal will exhibit really high ESR values, or cause the oscilloscope trace to continually wander in amplitude. These are rejected and not used at all.

Once all the crystals in a batch are measured, the leads are set into a foam board, with the crystals arranged from the lowest frequency to the highest, with spaces left for the sample set. The sample set is then further used to determine the characteristics of the batch in another test apparatus. Here is how that is done.

The second test apparatus consists of a Colpitts oscillator that uses 220 pF capacitors in the feedback positions and has a switch in the grounded leg of the crystal. Across this switch is a 12 pF capacitor. A sample crystal is inserted into the holder with the lower lead grounded. After a suitable amount of time for the crystal to stabilize, the frequency of oscillation recorded. Opening the switch places the 12 pF capacitor in series with the crystal, and its oscillating frequency increases. This new value is also recorded. Through the use of another switch on this test apparatus, the crystal is then placed into one arm of a resistive bridge circuit. The bridge is driven by the same 9087 generator that was used to excite the first apparatus. On the center nodes of this bridge are r.f. probes, one measuring the voltage drop across the crystal, and the other measuring the voltage drop across the reference lower bridge leg. This bridge leg is a 50 ohm, 20 turn non-inductive trimmer potentiometer. The generator is set to the frequency marked on the crystal, representing series resonance. It is moved up and down a few Hz just to verify a resonant condition. The resistor in the reference leg is then adjusted until the voltage drop across this leg and the crystal are the same. By operating another switch, the reference leg resistor is switched out of the bridge, and into a digital multimeter set to measure resistance. This value is recorded, and compared with the value obtained for ESR from the first test apparatus. The mean of these two values, measured by these two independent methods, along with the same set of measurements from the other samples becomes the crystal lot Rs value. To obtain the motional inductance, Lm, and motional capacitance, Cm values, and the Q of the crystal, requires a set of calculations. These are performed on a programmable TI-92 calculator. To obtain the holder capacitance, Co, of the crystal batch, each sample crystal is measure on an AADE digital L/C meter. The mean capacitance of the samples represents the Co value. The formulas used can be found in the paper "Refinements in Crystal Ladder Filter Design" by Wes Hayward, W7ZOI. This paper was published in the June 1995 issue of QEX magazine. The technique of using an oscillator circuit and derived formulas to obtain Lm and Cm values was developed by G3UUR.

Over the past several years, I have experiments with various oscillator circuits to simplify the process of matching crystals. None of them has worked satisfactorily. The best approximation to the accuracy that my present method provides is to use a Colpitts oscillator, with feedback capacitors that are very large. Values above 1000 pF will begin to yield approximately correct values for the actual series resonance in a given crystal. The feedback values have to be adjusted to match the frequency of the crystals being tested, with the limit being a capacitor value that just will let the circuit oscillate with the crystals being tested. As the feedback capacitance value is lowered, the measured series resonant frequency will begin to error upward in frequency, and the spread among the crystals being tested will reduce until they all measure nominally at the same frequency. By intuition, we know that cannot be correct.

The crystals supplied by Doug Hendricks, KI6DS for use in the IA QRP-10 building challenge have the following parameters:

Manufacturer	ECS
Marking	3.93-17

Measured characteristics (mean values)

Fo	3.931420 MHz
Rs	22.7 Ohms
Co	3.58 pF
Cm	9.61 X 10-15 Farad
Lm	0.1706 Henry
Q	185,600

Why are these parameters important? The answer is that they dictate how the final filter will be configured. While not going into all of the details, these parameters are used with other design criteria to define the actual topology of a given filter, and its theoretical performance such as bandwidth, input and output impedances, insertion loss etc. Without knowing them, we can only make educated guesses regarding terminating impedances, coupling capacitor values, and insertion loss. Certainly an optimal filter will not result without knowing the crystal's characteristics to some reasonable degree of accuracy.

Another nagging question that come ups often is "How close do the crystals have to be matched to work properly. There are two answers. The best filter would result with all of the crystals having exactly the same frequency. Practically, that isn't going to happen, so a better answer is to match them to within 10% of the desired filter bandwidth at the very worst, and to within 5% if at all possible. So for a filter with a 500 Hz bandwidth, the would mean the frequency spread within in the group should be no greater than 50 Hz, but 25 Hz would make a better filter. When a group of 50 to 100 crystals is available, getting many groups of 3 or 4 crystals within 5 to 10 Hz is quite easy. If you only have 10 or 20 units to start with, the 25 or 50 Hz targets are more realistic.

The set of crystals used in my QRP-10 unit had a total spread of 1 HZ. Two crystals were measured at 3.931282 MHz, and the other unit was one Hz lower in frequency. Within the 49 crystals in the group, there were at least 10 sets of 3 crystals which would meet the 5% criteria, for a filter with an assumed bandwidth of 250 Hz. That's quite typical for a lot of nominally 50 crystals. Of course if more elements are required in the filter, then fewer sets would be available.

Knowing the crystal parameters also allowed me to optimize the values used in the IA QRP-10 that I'm building. The topology was also changed a bit, which results in a better performing filter. One note of caution is in order. If you are building your rig from the QRPp Fall 2000 issue, there is a mistake in the illustration shown on page 26 regarding the crystal filter. The illustration shows capacitors C13 and C14 in series with the crystals X1 and X2, and X2 and X3 respectively. That isn't correct. One end of each of these capacitors is grounded, as shown in the schematic. My changes include adding a capacitor in series with RFC2 and X1, and another capacitor at the other end of the filter in series with X3 and RFC3. In addition, all of the filter coupling capacitors are 220 pF, which results in a filter that has a 250 Hz, 3 dB bandwidth. Making these changes also requires changing the value of RFC2 and RFC3 to 22 uH, and capacitors C10 and C16 to 56 pF to correctly match the input and output impedance of the filter at 270 ohms. The resulting filter looks very good when modeled with Electronic Workbench, and its measured performance on the spectrum analyzer isn't much different. Those plots have are available for viewing along with the construction pictures of this section.

Building the actual filter entails using a slightly different technique than the normal round pad that I have been using. The pads for the filter are 1/16 inch wide, and 3/8 inch long for the larger pads, and 1/16 inch wide, and 1/4 inch long for the shorter ones. The shorter pads were made with the trusty ADEL nibbling tool and the longer ones on the Harbor Freight shear. The pad pattern basically uses an offset of slightly less than 1/2 of the pads length on opposite sides of the layout. A spacing of 3/8 inch was used between the parallel pads. That can be seen in the pictures. All of the pads are laid first, and then the parts are added beginning in the middle of the pad array, and working toward the ends. This approach maximizes the space available for getting the soldering iron into the connection. The offsets are to accommodate the interior coupling capacitors, which for this rig are C13 and C14.

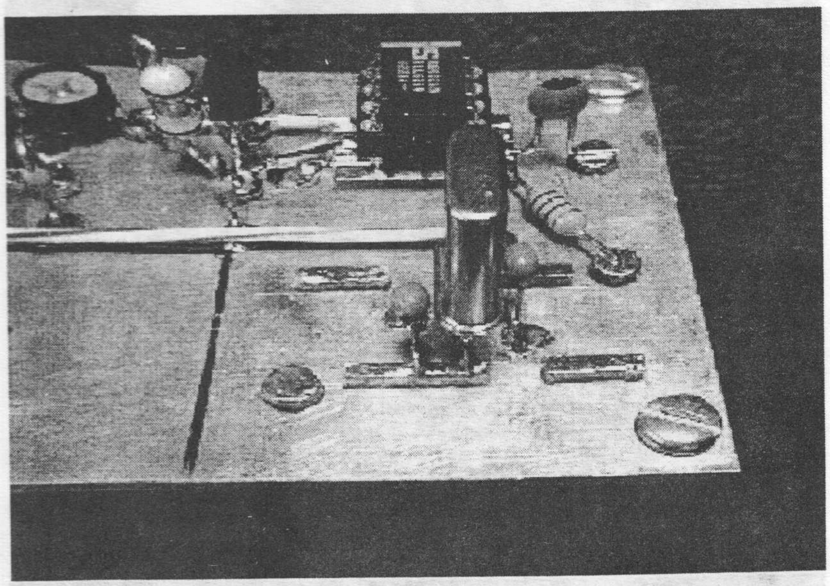


Fig. 22 Crystal Filter - Step 1

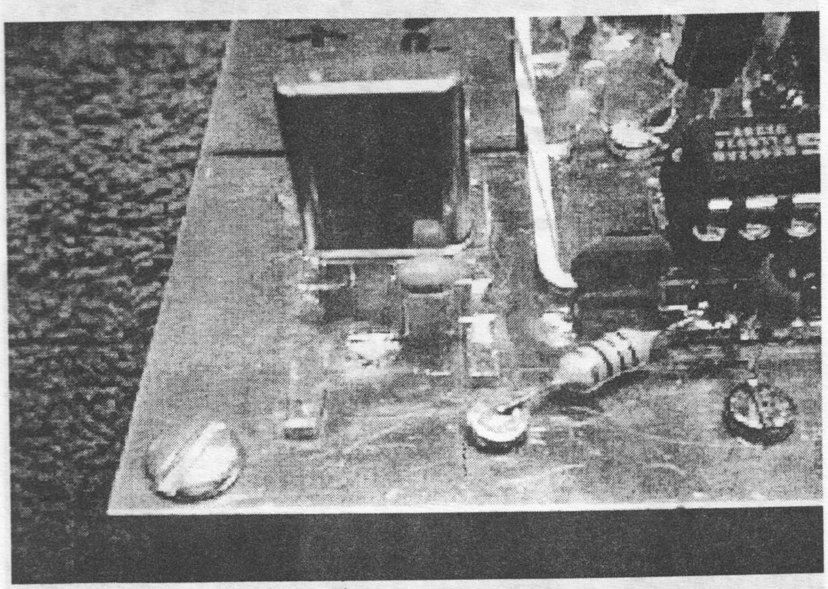


Fig. 23 Crystal Filter - Step 1, Another View

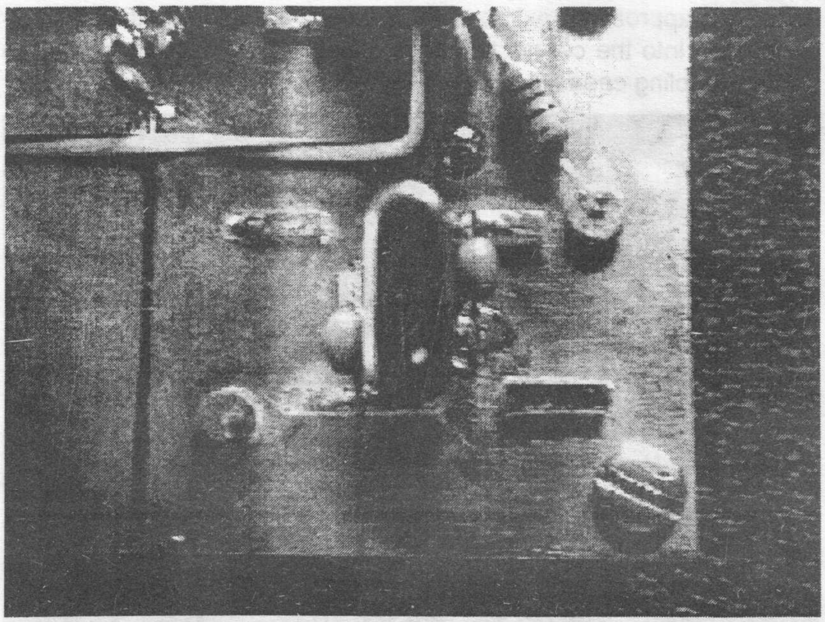


Fig. 24 Crystal Filter Step 1 Viewed from Above

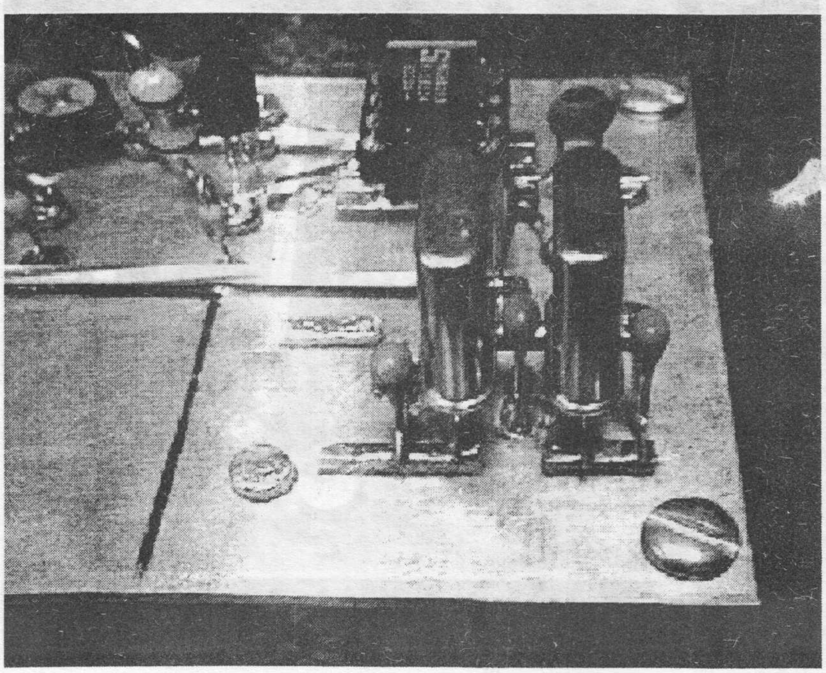


Fig. 25 Crystal Filter Step 2

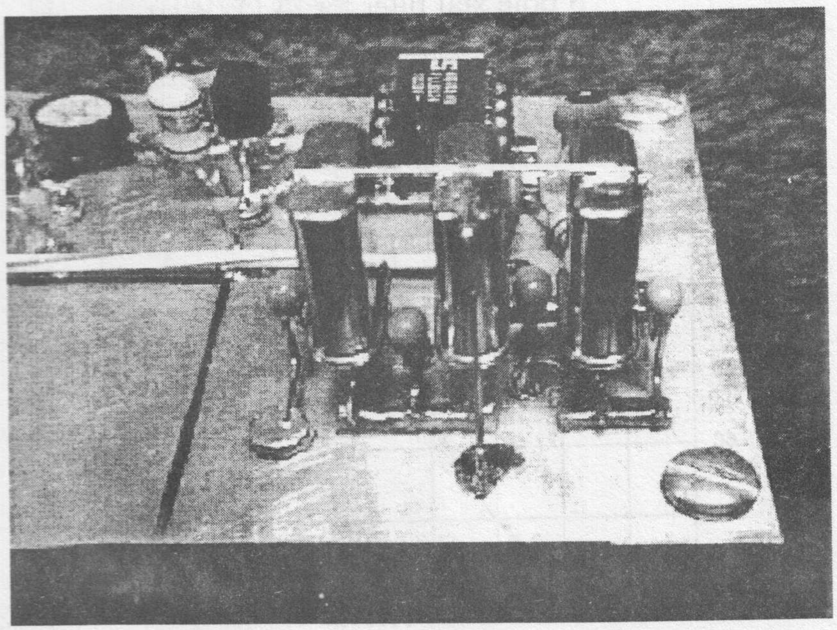


Fig. 25 Crystal Filter - Step 3

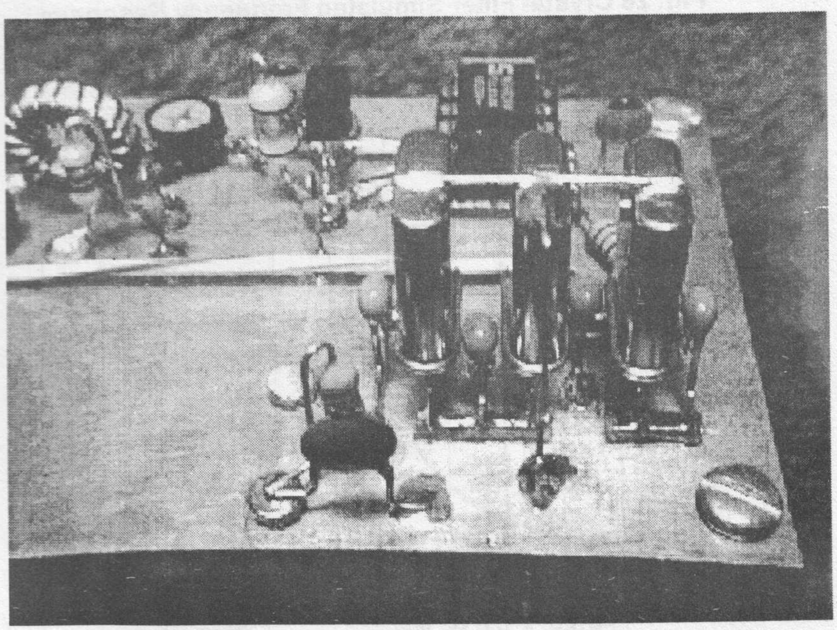


Fig. 27 Crystal Filter - Finished Version

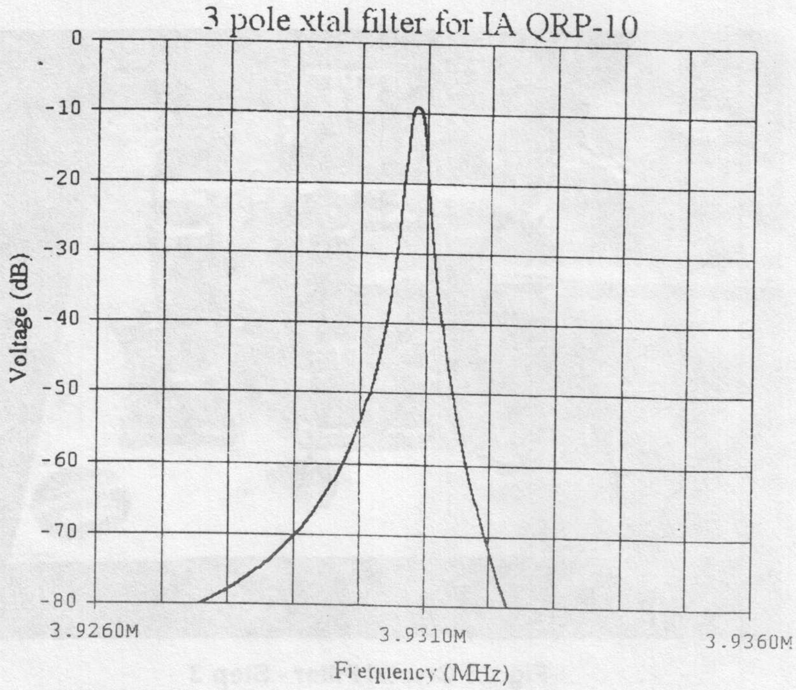


Fig. 28 Crystal Filter Simulated Frequency Response

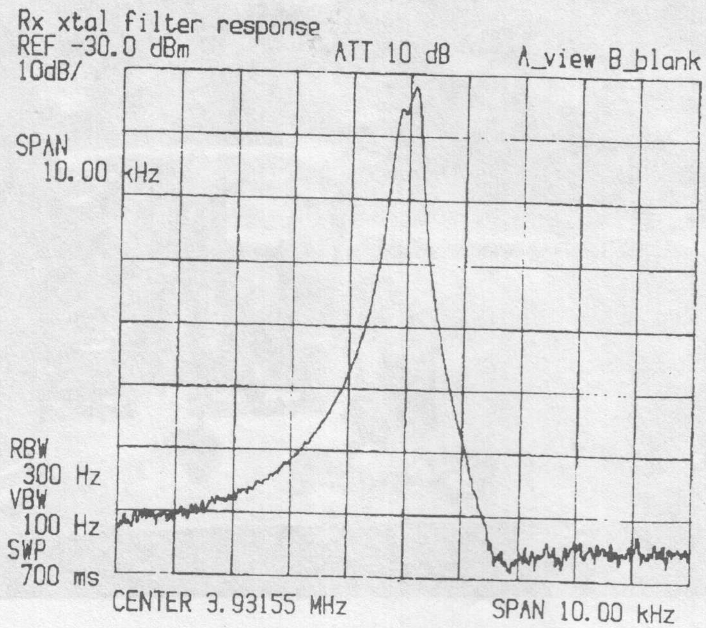


Fig. 29 Crystal Filter - Measured Frequency Response

This section covers the building of the receiver product detector section, which turned out to be easier than expected, as several modifications to the original design were made. Primarily, neither of the J310 FET switches were built, as the changes provided by the redesigned front-end T/R switch are expected to keep the monitored transmit signal level to something reasonable. If I'm wrong about that assumption, then some or all of those parts will be installed after the transmit section is completed and working. I would test that premise, but my good signal generator is out for repair, so I don't have a reliable 30 MHz source at the required amplitude to test the receiver "as built". Also, only one output from the product detector was sent to the audio amplifier, instead of driving the audio amplifier differentially. My feeling here was that the improvement in the receiver front-end more than compensated for this 6 dB loss.

As a bit of a refresher course on product detectors, here is what is going on in this stage. First of all, a product detector is essentially a mixer, with the output signals being the original incoming signals, and the sum and difference of these two. Usually in a mixer, the incoming signals are the r.f., from perhaps the antenna, and a local oscillator, differing from the incoming r.f. by several MHz. One of the output signals becomes the i.f. frequency, and the other is the image frequency, and is not used. A product detector operates in the same manner, but with one distinction. The difference between the incoming signal and the local oscillator is in the audio spectrum; a difference of only a few hundred Hz normally. The local oscillator operates at or very near the i.f. frequency, for the IA QRP-10, at about 3.932 MHz. With this rig, the local oscillator is above the center of the crystal filter by about 750 Hz. The actual amount is adjustable via trimmer C17. When C17 is adjusted correctly, an incoming signal centered in the crystal filter is heard as an audio note of 750 Hz. The image signal coming out of the product detector is the sum of the i.f. signal and the local oscillator, and is at about 2 times the local oscillator frequency, or 7.864 MHz. This r.f. signal is essentially shunted to ground by capacitor C24. The audio signal is passed to the audio amplifier, U3 by coupling capacitor C19.

One more comment is appropriate. Since the local oscillator frequency is above the center of the crystal filter, the crystal filter is operating as a lower sideband filter. That's appropriate for all ladder filters using the design employed in the QRP-10, where the upper skirt is steeper than and lower one.

The parts for the product detector are laid out in a similar manner to that used by Mike, N0MF, although I did have to rotate the NE602 socket to the right by 90 degrees to fit the available space. This then required the attached parts to rotate too. However, if you look at Mike's layout rotated 90 degrees clockwise, and mine, they are quite similar. On this section, as I did with the mixer, the power to the NE602 comes into the socket above the socket mounting substrate, and is soldered inside the socket pin, instead of on the outside of the pin. That's clearly shown in several of the photos.

The parts layout photo has the parts labeled for the crystal filter, as well as this section. I felt it was easier to visualize how these two sections fit together doing it that way. After the product detector is built, it can be tested if you have a small high gain audio amplifier around that you can press into service. If you do, and it has about 40 dB of gain or more, you can solder a 0.1 uF capacitor to one of the NE602 output pins, (either 4 or 5) and a short run of shielded wire from the other end of this capacitor to your audio amplifier. Attaching the receiver to either an antenna or a signal generator should produce some noise. Peak the noise by adjusting all of the input and r.f. amplifier trimmers, and then adjust trimmer C17 for the loudest audio. If the product detector is working, 10 meter signals can be heard, or at least, you should be able to hear your signal generator. Trimmer C17 can be tweaked for the strongest signal.

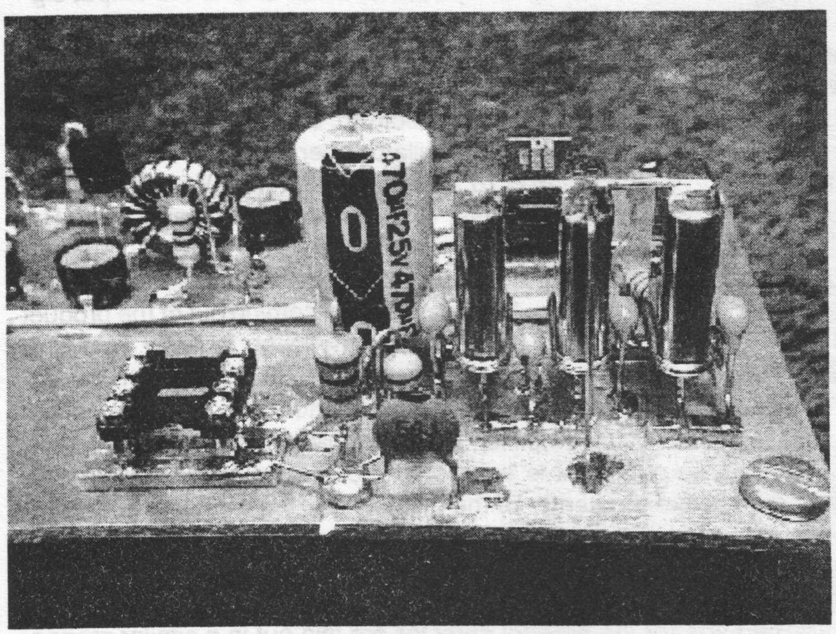


Fig. 30 Product Detector #1

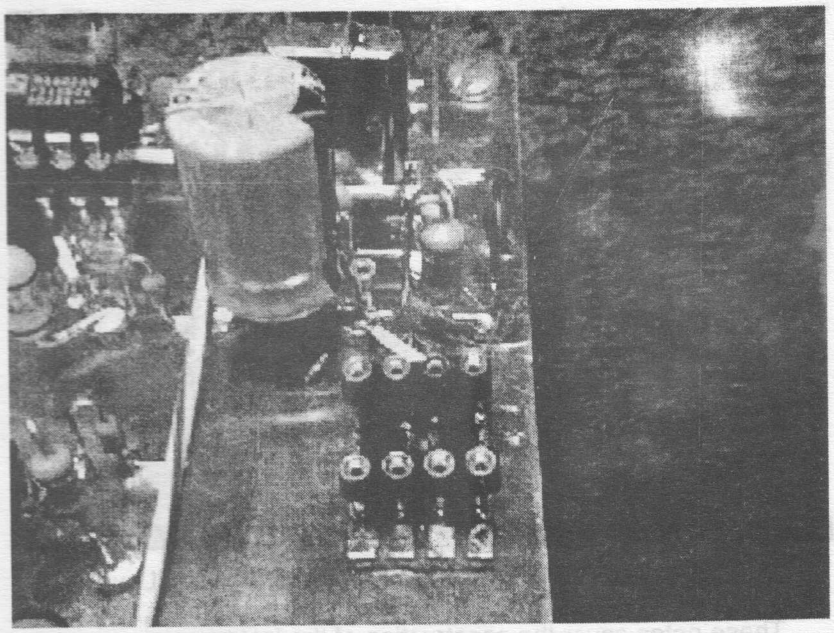


Fig. 31 Product Detector #2

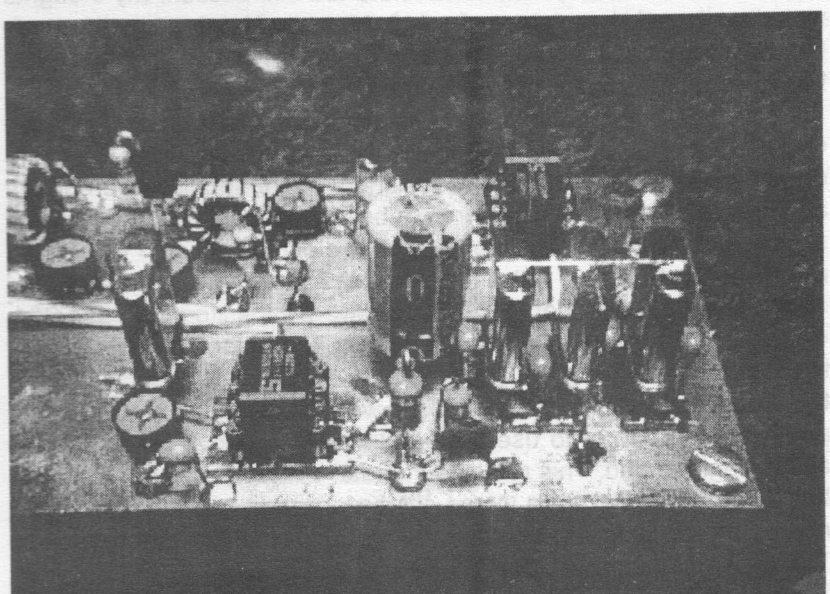


Fig. 32 Product Detector #3

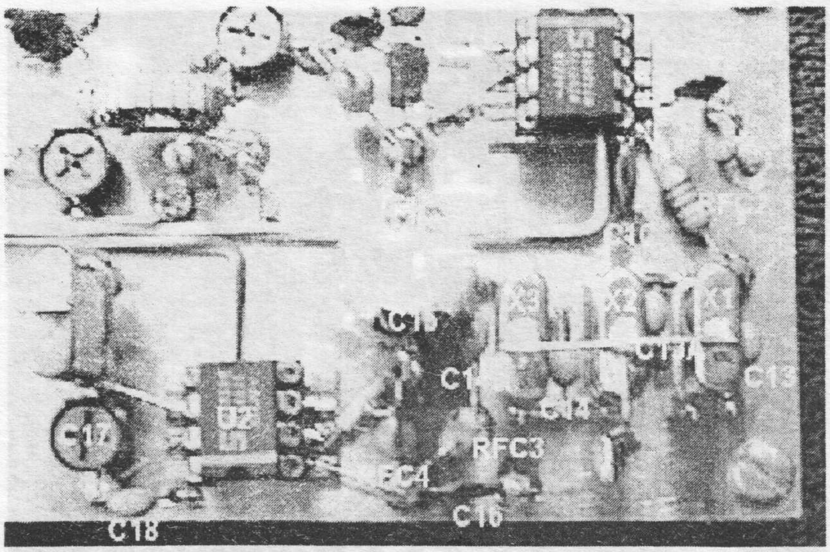


Fig. 33 Crystal Filter and Product Detector Parts Layout

These notes cover the construction of the last remaining receiver section, the audio amplifier. When I started this section, my thoughts were that it would be a "piece of cake". After all, it's only an audio amplifier. How hard could that be? Turns out this was the most difficult section to complete, and to get working properly. Read on....

I made a comment in the last section that I was planning to leave out the FETs, Q2 and Q3 that do the audio switching, since the front-end of the receiver had been redesigned, and it should have enough attenuation to keep the receiver from being overloaded by the transmit signal. As I started the build of the receive audio section, I indeed left out those parts, along with the associated resistors, capacitors, and diode. The only parts that I actually used were capacitors C19 and C24. Capacitor C19 takes the audio from the output of the product detector to the input of the LM386, U3, and C24 bypasses any r.f. coming out of the product detector to ground. Along with not using Q2 and Q3 came another decision not to use both audio inputs on U3, but to run the audio single ended. This reduces the total audio gain by a factor of 2, but I was guessing there would still be an adequate amount, and it makes the building easier, especially if Q2 has to be added back in. The unused input pin on the LM386 was grounded.

After building the audio amplifier input circuitry, the output components were added, exactly as shown in the IA QRP-10 schematic, and in the same locations shown in the illustrations. The only components not installed were the LED in the AGC feedback circuit, and the audio output potentiometer, R9. The headphone jack was wired directly to the negative end of capacitor C27.

With this configuration, the receiver was powered up. My expectation was to hear some moderately loud audio noise, but not much was heard. I suspected a problem because this amplifier is running at a gain of 200 and that ought to produce some noise on the output. I looked over the circuitry again, just to make sure all of the connections were correct, and that I hadn't installed one or more of the electrolytic capacitors backwards, causing excessive leakage, and potential destruction. No problems were noted. This is the point in time when you're glad you have a fairly well equipped lab.

The oscilloscope was turned on, and the output probed. There was indeed a problem, a rather large sinusoidal signal (4 volts peak to peak) on the output, at a frequency of 10.1 MHz. Not at all like what is supposed to be there. I tried changing the values of R8 and C23 to see if that would help, since they are providing feedback from the output to an intermediate point of the LM386's input, but that didn't change the conditions much. I still had an oscillator, and I needed it to be an amplifier.

What to do? Go to the source, of course. I fired up my computer, connected to the National Semiconductor web page, and downloaded the product sheet for the LM386 device. In looking at the sample applications using this device, I kept noticing that each amplifier circuit had a 0.05uF capacitor and a 10-ohm resistor from the output (pin 5) to ground. It was there in every circuit except the one for a square wave oscillator. So those parts were added. With that change, the amplifier became very stable, and was producing noise, as it should be doing. The remaining change that I did was to remove the large electrolytic capacitor, C25 on pin 6 (power) and replace it with a 0.22uF tantalum capacitor. The large electrolytic didn't seem to be adding any stability to the circuit, and I felt the LM386 would operate better by having any r.f. on the +8 volt line bypassed to ground with the smaller capacitor. Ideally, both could be used, but space is at a premium at this point in the construction.

Having gotten the amplifier stage working, it was time to do some testing again. The receiver was powered up, and an antenna connected to the input. Immediately, 10-meter signals could be heard. They weren't very strong, and it turns out not from hams, but carriers from CB/Free Band operators running AM or FM. However, they were quite a good source to do some final peaking on the input trimmer. After that was done, the receiver was left operating. During the day, several CW signals, both DX and domestic were heard, some quite strong. I also found out the receiver will drive a small speaker with useable volume.

At this point we have two-thirds of the IA QRP-10 built and operating. When my signal generator gets back from the repair shop, I'll make some quantitative measurements on it. My guess is that the MDS is around 115 dBm, but it may be better than that. We'll also get some insight into whether the input attenuation is adequate to control the receive signal level during transmit without Q2 and Q3. I'll drive the input at +13 dBm, close the key line, and measure the audio output. While +13 dBm is below the signal level from the transmitter, it is at least in the ballpark. Once those measurements and others are done, I'll post an update.

Part 7 Update

Well, the UPS guy drove up the driveway this afternoon, and took this really big package off of his truck. It turned out to by my Racal-Dana 9087 signal generator that had to go back to New York for repair. I unpacked it, put it on the bench, and fired it up. Yes indeed! Working again like it was supposed to, and just in time for some timely measurements on the recently completed IA QRP-10 receiver.

Here are the measurements that I made, and my comments about them:

MDS = -130 dBm (That's less than 0.1 micro volt folks)
Filter Bandwidth = 230 Hz (Missed the design bogie by 20 Hz)
Minimum Opposite Sideband Rejection = 62 dB (Very good for a 3 pole filter)
IF Rejection = 110 dB (Excellent for any rig)
Image Rejection = 70 dB (Very good for a simple superhet design)
Rx Current Draw = 35 milliamps (VXO and receive strip combined)

Overall, this is really wonderful performance for a receiver as uncomplicated at this design. If you have been holding back on building this rig because you maybe thought it was "not that great", you ought to reconsider.

I'm really excited about getting started on the transmit strip, so I can see what the completed rig will do. It is a keeper in my book! I hope the gang is giving some serious consideration to providing a parts kit for this fine project.

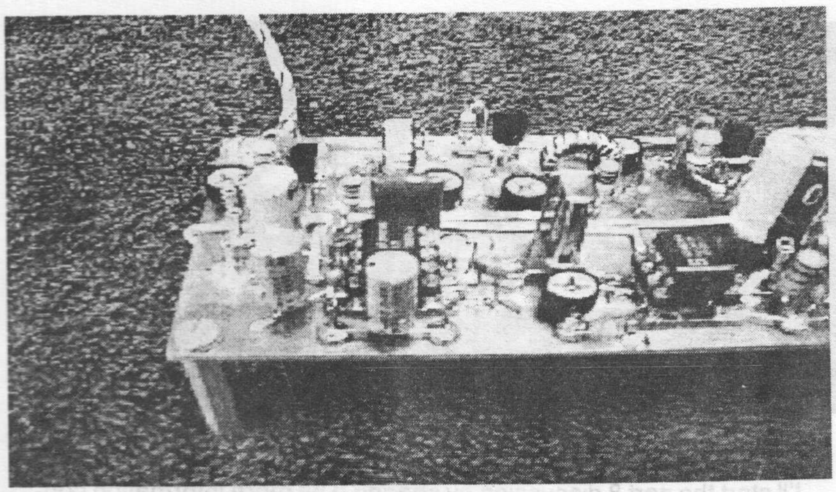


Fig. 34 Audio Amplifier

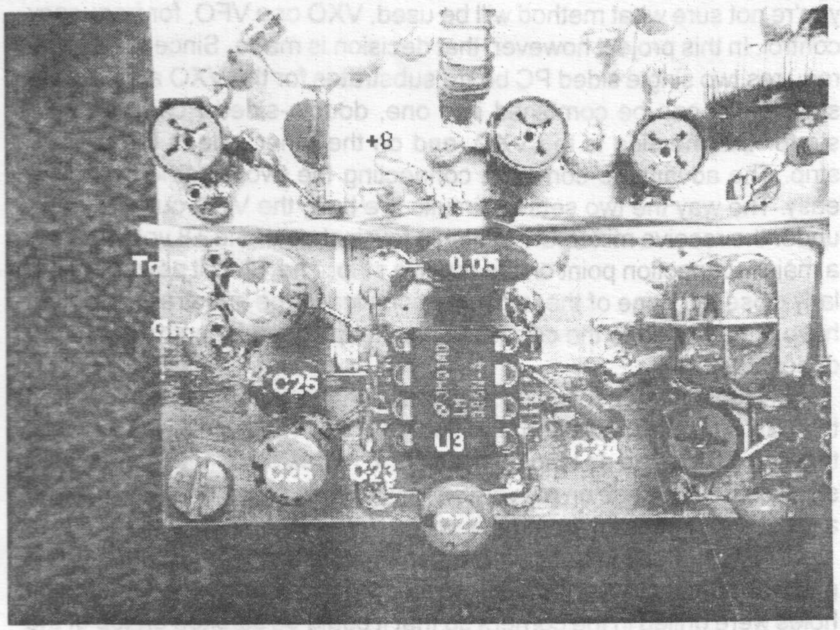


Fig. 35 Audio Amplifier Parts Layout

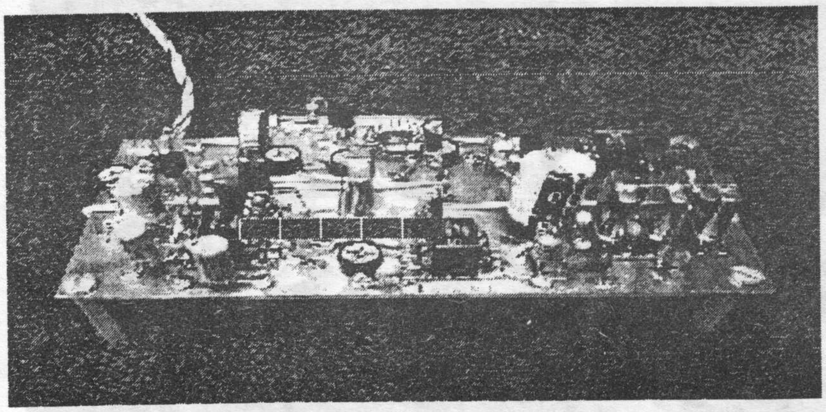


Fig. 36 Finished Receiver

I'll start the part 8 discussion by sharing a bit more information concerning how the VXO and receiver were integrated together. If you have followed this project to this point, you probably thought that the VXO and the receiver were built on separate substrates. That's the way Mike, N0MF built them. It is a good way, especially if you were to build a similar rig from scratch and not sure how much room is needed, or you're not sure what method will be used, VXO or a VFO, for frequency control. In this project however, that decision is made. Since the design requires two single sided PC board substrates for the VXO and receive strip, these can be combined into one, double-sided PC board substrate. On one side is the VXO, and on the other side is the receive strip. The advantage comes in connecting the two together, which is easy. The way the two sets of circuits are built, the VXO output is right under the receive mixer, U1. Within a few inches of the +8 volt power is a major connection point on the receive strip. The 12-volt power is similarly close by. None of these connections leave the substrate; they just have to be routed to the opposite side, keeping lead lengths short and direct.

My reason for mentioning all of this is that one of the first pictures in the part 8 group shows some of the VXO and receiver. I was keeping this detail secluded as long as possible in hopes of gaining a small, but significant advantage on my very worthy building opponent! It also made a lot of sense to build the rig this way.

The first steps in building the transmit section were to once again prepare another 2 X 4 inch substrate. This was done, and matching holes were drilled in the corners so that it could be stacked on top of the receiver/VXO board assemble during building. Why did I want it up there? Easy, so that the VXO signal would be close by during testing of the first stage of the transmit strip. Conveniently, the VXO output is also directly underneath the transmit mixer, U4. While the details have not been finalized, some set of mating connectors will be used take all of the signals to and from the transmit board, so that it can be removed from the stack.

After the transmit strip board was cut and drilled, four sections were marked on it, one each for the transmit mixer, transmit band pass filter, driver amplifier, and final amplifier/low pass filter assembly. As was done with the VXO and receiver, these areas help keep the layout clean and organized. While that is the goal, they are only lines drawn with a marking pen, so if a part needs to "spill" into an adjacent area to make it fit, let that happen.

With the transmit substrate ready for building, it's time to heat up the soldering iron, and get out the pads and glue.

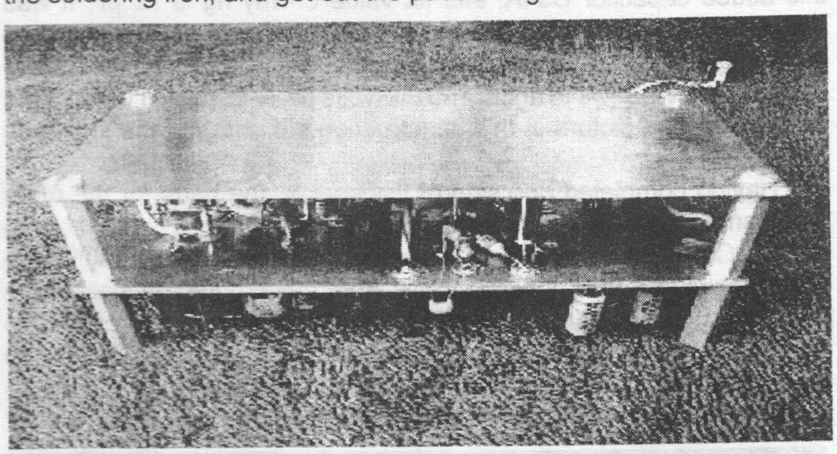


Fig. 36 Transmit Substrate On Top

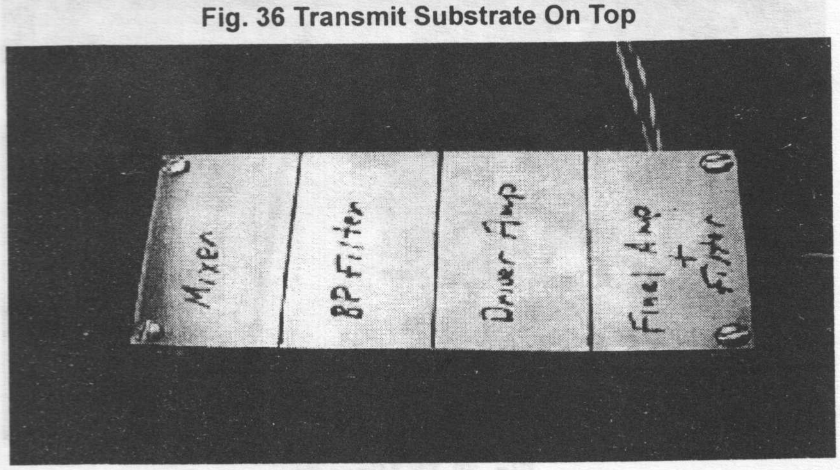


Fig. 37 Transmit Substrate Marked Off

Building the transmit mixer section starts with putting the IC socket on pads of some kind, or gluing down a socket/pad combo. My version uses the latter, and I won't go into details here, as that was already done in a prior discussion. There is at least one important consideration thought, and that is to place the socket away from the edge enough so that when the transmit band pass filter is added, (in part 10) there is room for either a trimmer capacitor or toroid. Following that approach will result in a neat layout.

After the socket for U4 is secured, the capacitors on pins 3 and 2 can be soldered in place. Don't worry about the keying lead that will also be soldered to pin 3. It will be added when the driver amplifier stage is built. U4 has an added capacitor soldered on pin 1, along with the 4.7-pF capacitor (C34) that is shown in the schematic. I've called this added capacitor C34A, and its value on my rig is 22 pF. It was added after some initial testing showed the r.f. drive level on U4 was too high. Capacitor C34A forms a voltage divider with capacitor C34 to reduce the level down to about 150 millivolts peak-to-peak. I've included an oscilloscope picture in this construction set showing the signal on pin 1 of U4.

Having completed one side of the socket, the parts for the other side can be added. Start by putting down the pads for the trimmer capacitor, C39. I made sure the pads were spaced enough apart that the trimmer body could fit between them. After these pads are placed, the leads on capacitor C55 (27 pF) can be bent so that it can be soldered to socket pins 6 and 7, with the remaining lead ends soldered to the C39 pads. Normally, I would use separate leads for this kind of a connection, but I felt the values that were shown in the schematic made sense,

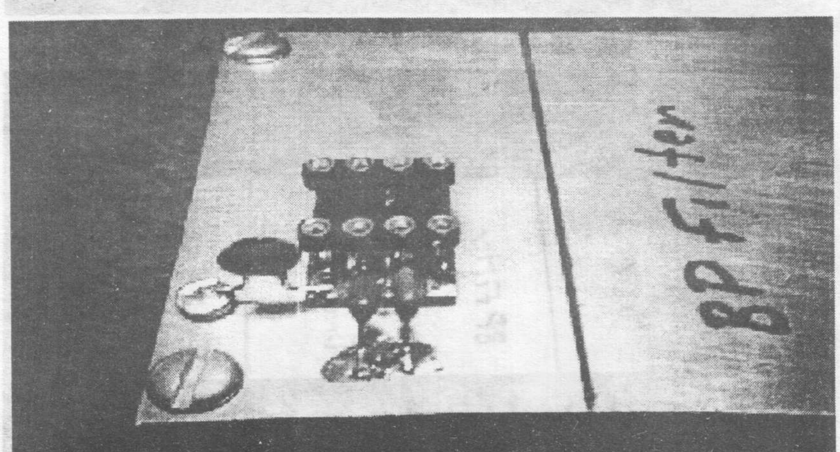


Fig. 38 TX Mixer #1

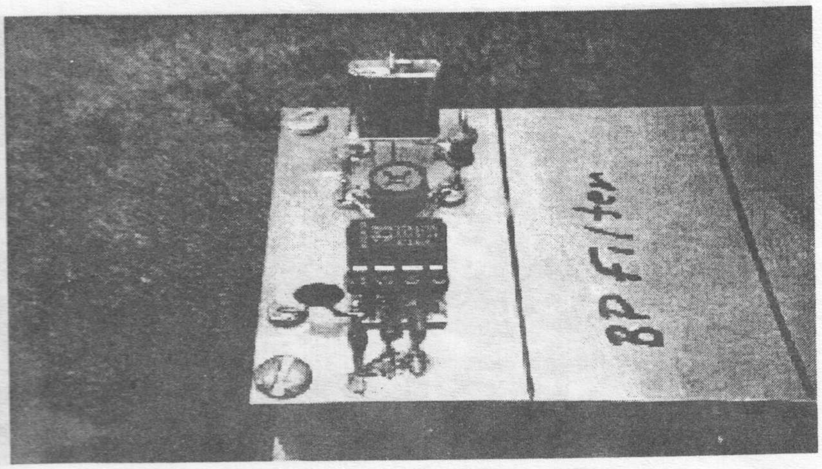


Fig. 38 TX Mixer #2

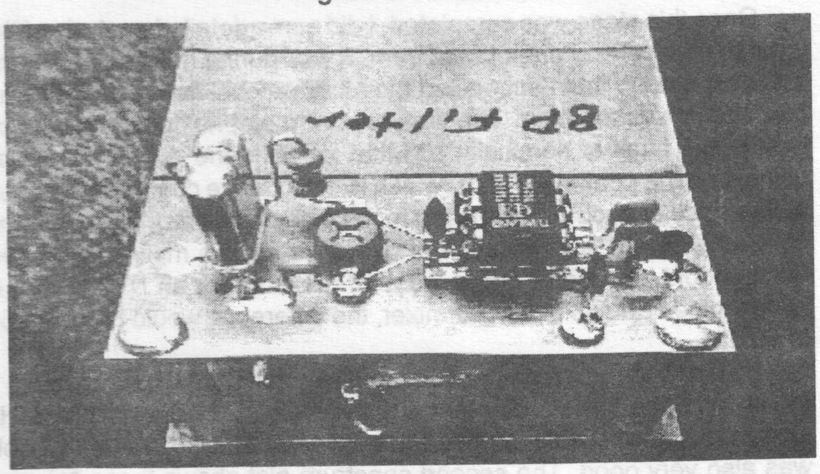


Fig. 39 TX Mixer #3

so there was little chance that C55 might need to be changed.

An additional pad is then placed for the mounting of inductor RFC7. Note in the pictures that this part, like most of the resistors and inductors, is oriented vertically with the upper loop end serving as a test point. After the inductor is soldered in place, the crystal leads can be bent, and it too soldered. The only remaining part to place is capacitor C40, and the pad for it is already there, since it shares a pad with trimmer capacitor C39.

As with the lead to pin 3, don't worry about adding the +8 volt power lead to pin 8 at this time. It will be easier to figure out the correct routing after the driver amplifier stage is finished.

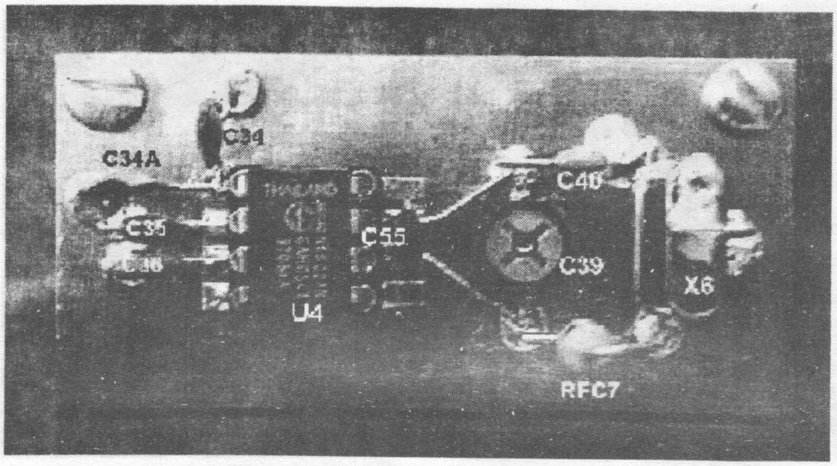


Fig. 40 TX Mixer Parts Layout

Once this stage was completed, I did some detailed analysis of the input drive level and output spectrum. It was during my first look at the output spectrum that I suspected the r.f. drive level from the VXO doubler circuit was too high. The first spectrum plot holds the key. If you look at the peak at nominally 28 MHz, which is the output we will be using, and the peak at 32 MHz, which is the r.f. drive coming in, you see a difference of about 12 dBm. Too much of the 32 MHz drive is showing up on the output, an indication of overdrive for this mixer. The difference should be greater but at least 10 dB or so for an NE602. If this were a diode double balanced mixer, the difference would be about 50 to 60 dB.

By trial and error mostly, capacitors were added to ground on pin 1 of U4, until the largest difference between the 28 MHz and 32 MHz signals occurred. That happened with C34A at 22 pF. A value of 27 pF was also very good. The second spectrum plot shows these two signals with the capacitor soldered in place. The 32 MHz drive signal is now at least 20 dB below the output level at 28 MHz. Also, notice that many of the higher order spurs are reduced significantly too. This is another key that the mixer was being over driven. The signal at 28 MHz is the "minus" output, the difference between the VXO at 32 MHz, and the local oscillator at 3.93+ MHz. Look also at the other signal on this plot at roughly 36 MHz. This is the other principal output from the mixing process, the "sum" signal. It is this signal and the r.f. drive feed through, that the band pass filter, which follows this stage, can effectively attenuate.

That last spectrum plot shows the desired 28 MHz signal in detail. All of the close in spurs are at least 40 dB below the desired signal.

These must be low, as the band pass filter will be tuned to 28 MHz, providing very little attenuation of these high order products. If the spurs were high at this point, they would be passed on to the driver stage, then to the final amplifier, and show up in the output.

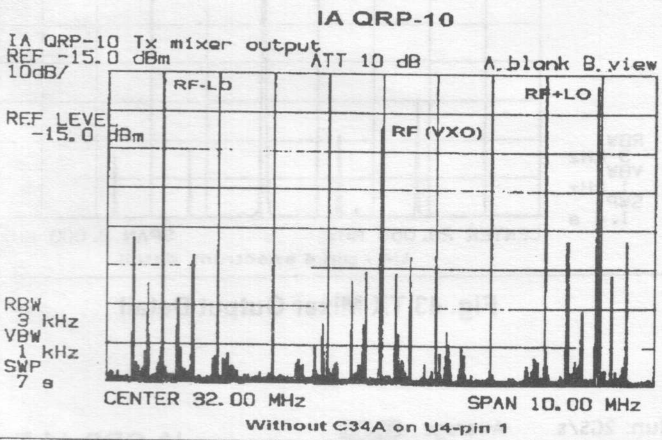


Fig. 41 TX Mixer Output Without C34A

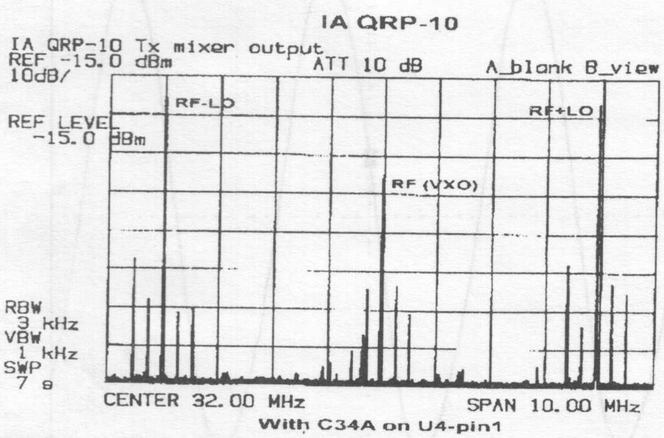


Fig. 42 TX Mixer Output with C34A

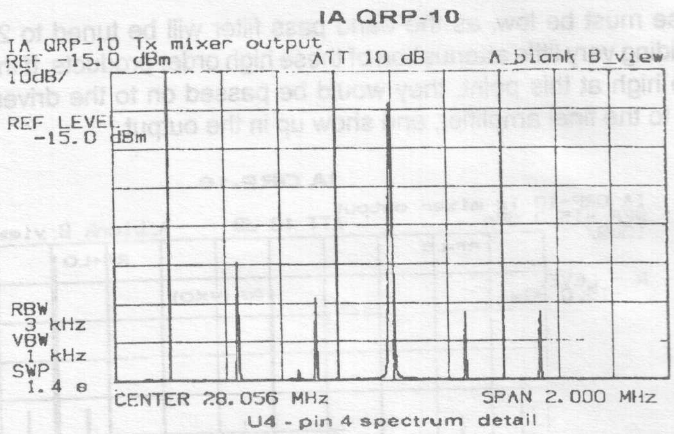


Fig. 43 TX Mixer Output Detail

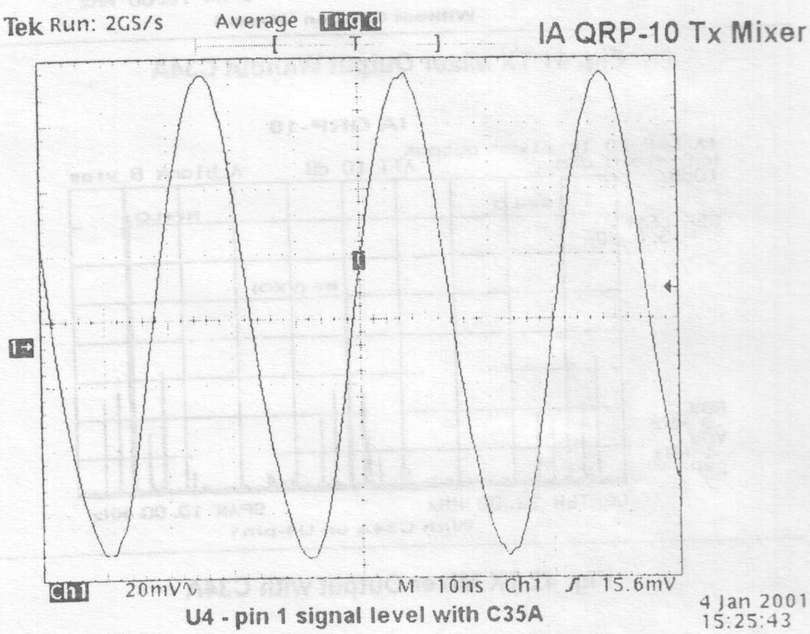


Fig. 44 TX Mixer Drive Level

In part 10, the transmit band pass filter gets constructed. Since this section has only a few parts, it won't take long to discuss it, nor very long to build.

As was mentioned in part 9, the location of the U4 socket was selected to allow sufficient room for a toroid to be placed between the board edge and its connecting pad. To get started building, a pad was glued just over the section separation line, and at the same height as pin 4 of U4. Across that opening is soldered capacitor C37, a 4.7 pF unit. Toroid L1 was then wound with 17 turns of #26 wire and measured on an AADE capacitance meter. The inductance for L1 was 0.972 uH. After cutting its leads to length, it was soldered from the C37 pad to ground. Opposite this inductor, trimmer capacitor C38, a 5-50 pF unit was soldered.

Next, another pad was laid, and capacitor C41 leads were formed and trimmed, and it was soldered from the C37 pad to this new pad. Trimmer capacitor C42 is also soldered to this pad, located between it and the side of the substrate, and parallel to inductor L1. Finally, inductor L2 was wound with 17 turns of #26, its inductance measured, and soldered in place adjacent to trimmer C38. Interestingly, both inductors were wound identically, but the measured value for L2 came out at 1.05 uH. That represents an 8 percent difference in inductance between the two unit, and is typical. The differences come about from subtle winding variations, and differences in core permeability. One might wonder why were the inductors mounted on opposite sides of the center line on signal path. That's to keep them separated so their magnetic fields can't link, thereby changing the coupling between the two sections. The coupling is controlled by capacitor C41.

To finish the buildup of the filter, an additional pad was placed and the output coupling capacitor, C43 was soldered into place. This last pad won't remain. It will be removed when the buffer amplifier socket is placed. In the meantime, having a terminus for C43 provides a stable point for connecting our test gear. With the filter constructed, it was time for another test.

I've only got one plot to show you for this section, but it reinforces the theory discussed in part 9. As a refresher, I commented that this filter would affect the level of the r.f. drive signal and mixer image output, but not the 28 MHz signal that remains. Indeed, if you look at the filter output plot, the r.f. drive level has been reduced by an additional 15 dB, and the image signal by 30 dB. If this transmit filter were even narrower in its frequency response, the two unwanted signal would be reduced more. Making it narrower involves reducing the value of capacitor C41. For this 28 MHz filter, 1 pF is probably the lowest practical value that can be used. However, doing that would make adjusting this filter more difficult. When we finally get the rig finished, if there is too much output of either of these two unwanted signals, we know exactly the place to go to make a change, and the part that is affected.

In the next part, we will build the buffer/driver amplifier.

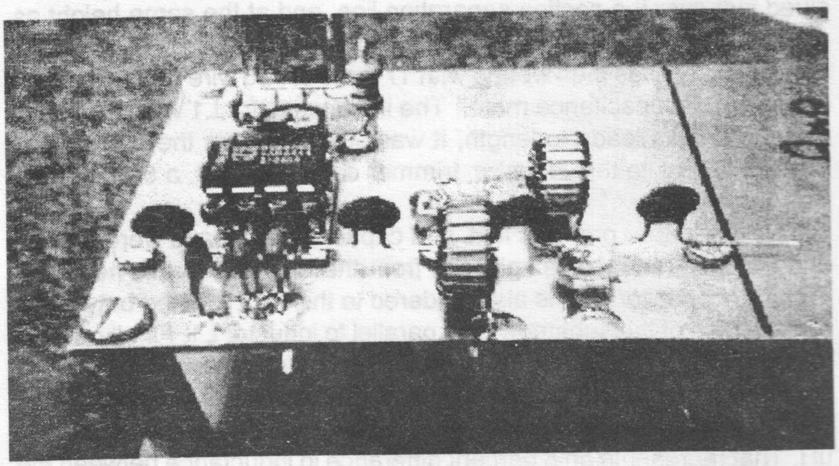
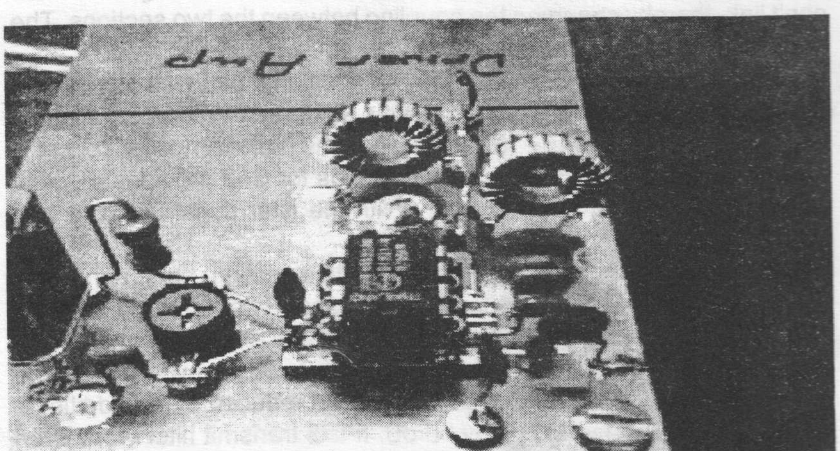


Fig. 45 TX Bandpass Filter #1



Fix 46 TX Bandpass Filter #2

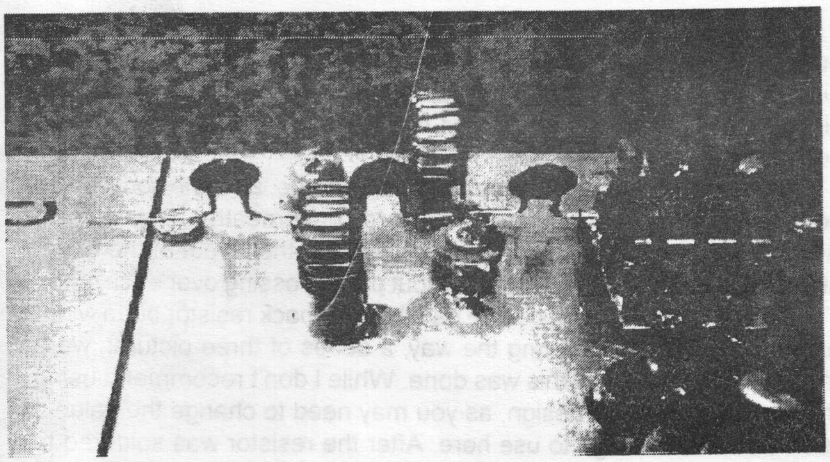


Fig. 47 TX Bandpass Filter #3

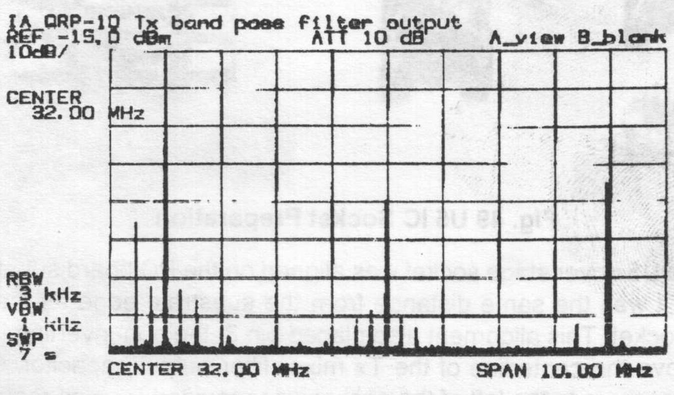


Fig. 48 TX Bandpass Filter Output Spectrum

In this part, we will do the construction and testing of the transmit buffer amplifier/driver stage. This stage is base on a rather unique IC, a Linear Technology LT1252 video amplifier. While not specifically designed for r.f. amplification work, it has enough gain-bandwidth to be very useable up to 10 meters.

Before starting the actual buildup of this stage, an 8-pin socket was configured with a 620-ohm resistor soldered underneath it between pins 6 and 2. The reason for doing this was to allow the layout of the driver stage to be more neatly built and without parts crossing over each other. That would not have been doable had this feedback resistor been wired external to the socket. Along the way, a series of three pictures were taken to document how this was done. While I don't recommend using this method for a new design, as you may need to change the value, I felt it was safe enough to use here. After the resistor was soldered to the socket pins, the socket was soldered to a header, similar to the other 8-pin sockets used in the construction.

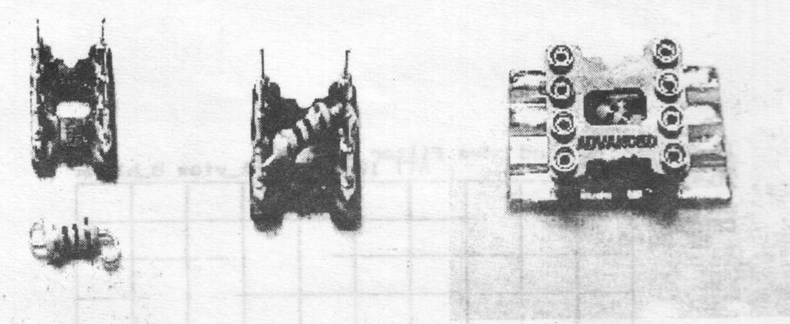


Fig. 49 U5 IC Socket Preparation

The U5 driver stage socket was aligned on the PC board substrate so that it was the same distance from the substrate edge as the U4 mixer socket. This alignment also placed pin 3, the non-inverting input just above the centerline of the Tx mixer filter output capacitor, C43. Sufficient room to the left of the socket was provided for bias resistors R18 and R19. A short jumper from the common pad containing these three components to pin 3 completes this part of the circuit.

The two remaining components, C44 and R20, which finish the feedback around the inverting input, were then added to pin 2. Resistor R62 was already in place, being the resistor soldered under the socket. Capacitor C46, an r.f. bypass for the Vcc line was installed on the pad containing the upper end of resistor R19. A short lead was taken from this pad to pin 7, the power pin for the IC.

To finish the wiring of this stage, capacitor C45 was then soldered between pin 6 and a pad secured to the right of the socket, and centered between pins 7 and 8. This pad also is one of two to which is soldered the 100 ohm trimmer resistor, R22. The trimmer used was a 1/4 inch diameter Bourns cermet type, and oriented so that the wiper moves away from the grounded end as the potentiometer is turned clockwise. That motion raises the drive level to the following stage. With the potentiometer mounted, the buildup of this stage is nearly complete. The remaining item is wiring pin 4 back to pin 3 of U4, the transmit mixer so that these two stages can be key together. I also added a 0.01 uF capacitor to pin 4 of U5, just to assure that any r.f. picked up on this lead would be bypassed to ground.

Testing can be accomplished by applying power to the rig and assuring that +8 volts and Vcc are on the appropriate chip pins. Since the output of the buffer/driver stage just built is a 100-ohm potentiometer, we already have a suitable dummy load for testing purposes. Grounding either U4, pin 3, or U5, pin 4 will cause both the transmit mixer and buffer/driver stages to be active. The junction of capacitor C45 and resistor R22 (the 100 ohm potentiometer) can be monitored with either an r.f. probe, or an oscilloscope. Trimmer capacitors C38 and C42 are adjusted until the output is peaked. If a receiver is available, or if the IA QRP-10 receiver is operating, the 10-meter signal being generated can be heard. I've included some spectrum plots in the picture set to show the output of this stage. The first plot shows the spectrum centered on the VXO frequency. I've show this plot format before after the transmit mixer and transmit band pass filter. This version shows the gain pro-

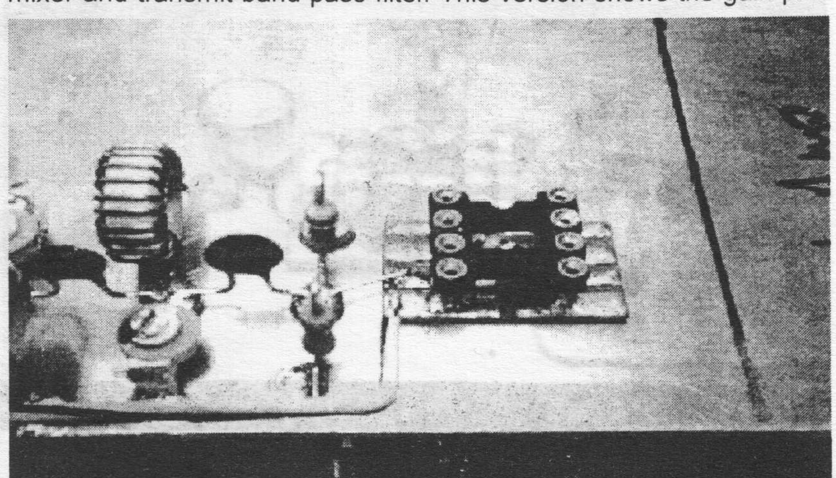


Fig. 50 Transmit Driver #1

vided by the buffer/driver stage. The second plot is centered on the 28 MHz output and shows the close in spurious responses.

In the next installment, we'll build the final amplifier and output low pass filter. When those are complete, the rig will be finished to the point that it can be put on the air.

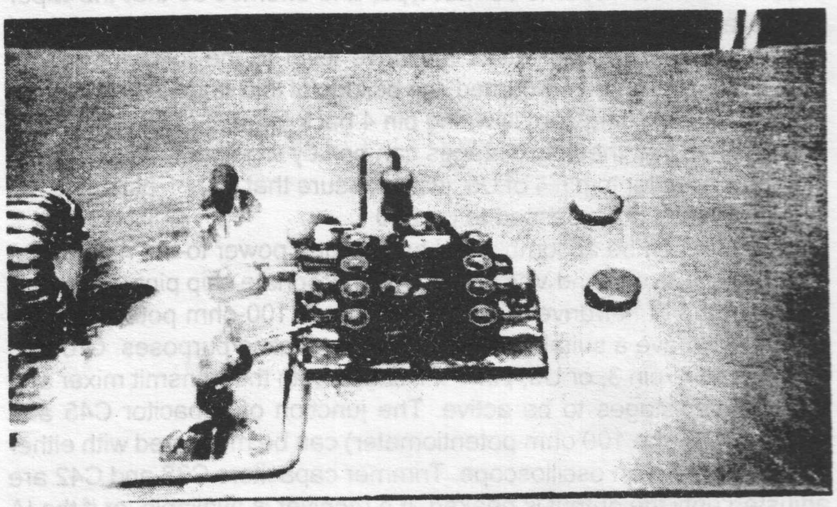


Fig. 51 Transmit Driver #2

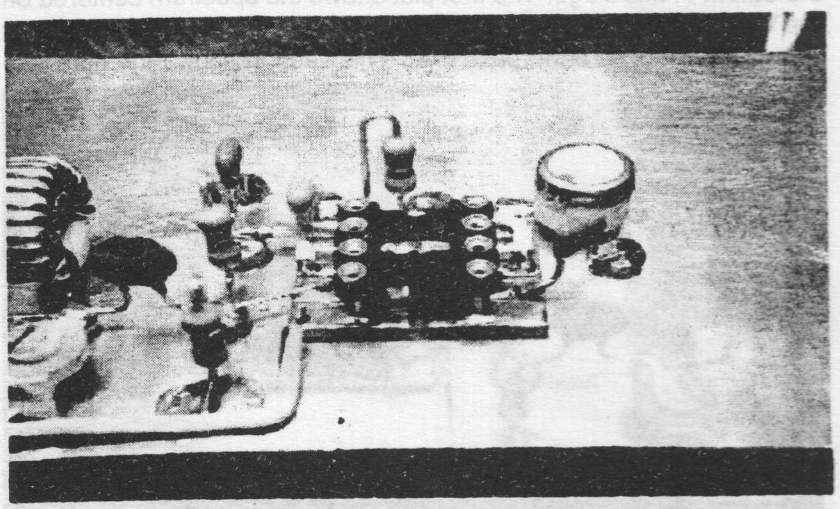


Fig. 52 Transmit Driver #3

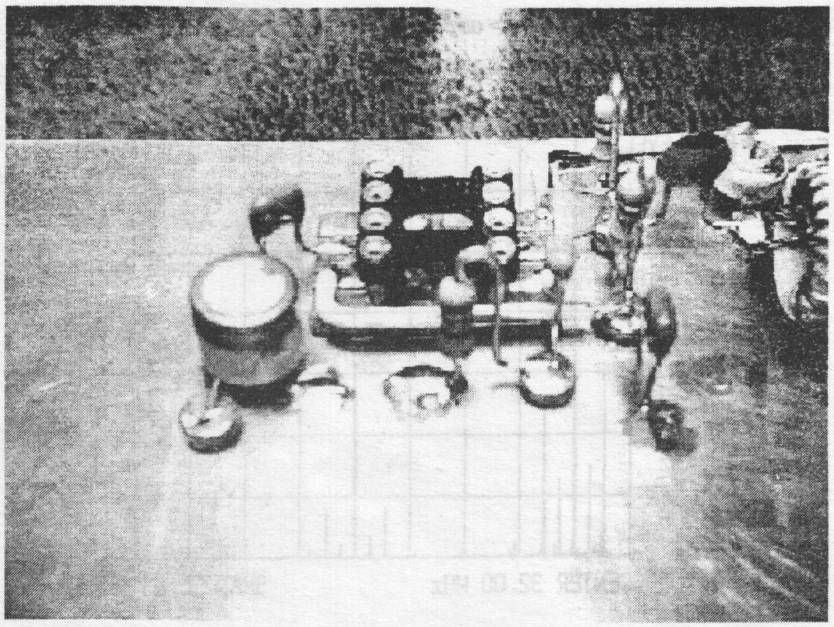


Fig. 53 Transmit Driver #4

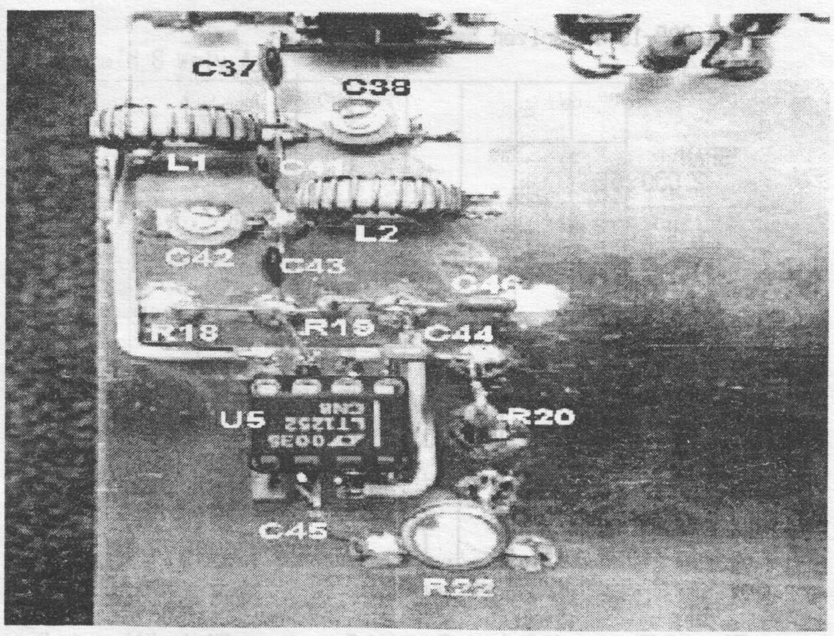


Fig. 54 Transmit Bandpass Filter and Driver Parts Layout

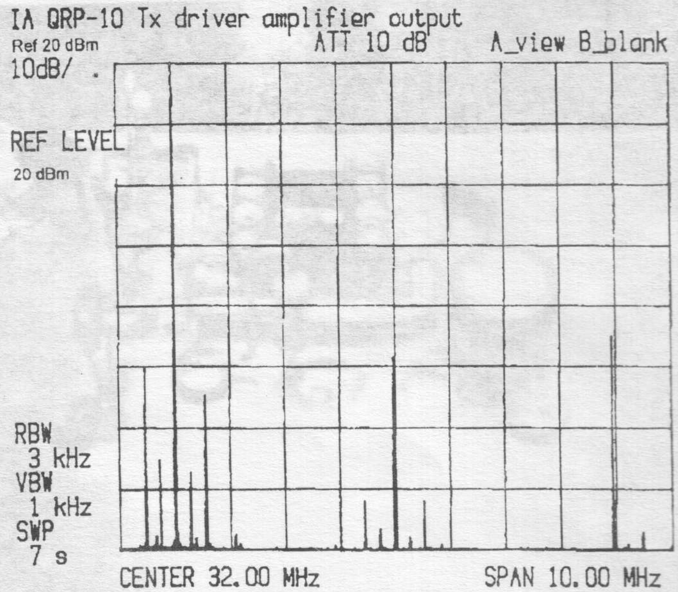


Fig. 55 Transmit Driver Output Spectrum Plot - "Wide"

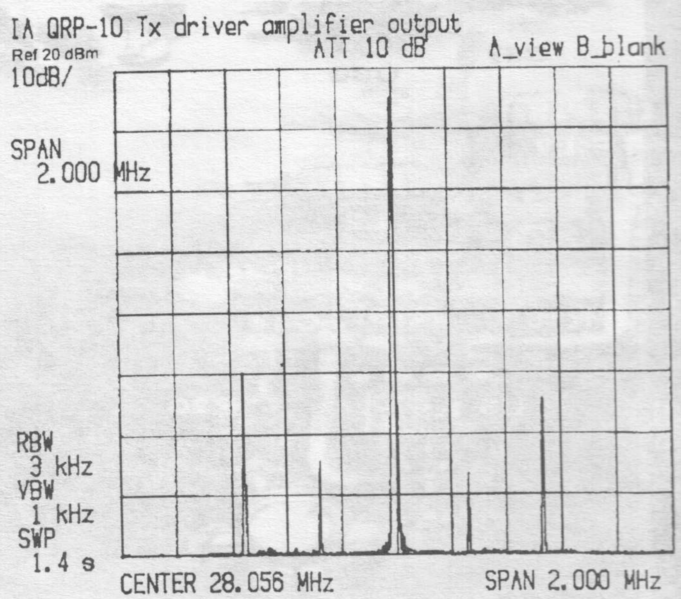


Fig. 56 Transmit Driver Output Spectrum Plot - "Narrow"

The final amplifier and low pass filter ... ard to believe we are nearing the end of this phase of the project. Let's get started.....

I tried to follow Mike's, N0MF layout for this section, since it was laid out well. My having U5 oriented 90 degrees clockwise from that used by Mike brought about the only departure. This changed the location of the drive potentiometer a bit, and moved Q6, the MRF237 final amplifier a little farther away from the right board edge. Another change that I made was in orienting the output inductors, L3 through L5 at 90-degree angles to each other, to prevent coupling among this set of inductors. I'm not sure that change was completely necessary, but that's how I did the buildup. As a point of reference, inductors L3 through L5 measured as follows: L3 = 0.35 uH, L4 = 0.42 uH, and L5 = 0.35 uH. My measurements were done with an AADE L/C meter.

My first approach to these sections was to build them with the components specified in the schematic with the exception of RFC8. I wanted to see how well the LT1252 would drive the final without adding this inductance. The early pictures don't show this part on the layout, and that's why.

Capacitor C48 is also missing in some of the early pictures. The reason for leaving this out was suspecting that the capacitance of the Zener diode, D12, had not been accounted for in selecting the 82-pF value for C48. After corresponding with Mike, my suspicions were confirmed. A quick measurement of D12 showed that it provided about 40 pF of capacitance. Another measurement of receive strip input trimmer C100 would be providing another 25 pF, leaving about 18 pF required to achieve the 82-pF value. This is probably still a bit high, as the MRF237 has about 15 pF of output capacitance for which no compensation has been provided. However, 18 pF was the value used for capacitor C48.

Another change that should be mentioned is the addition of a pair of r.f. bypass capacitors to the junction of Vcc and RFC9. The way the temporary wiring worked out made the Vcc lead quite long. Therefore, adding two additional capacitors here was appropriate. One of the capacitors was a 1000 pF unit, and the other, a 0.01 uF unit.

Inductor RFC9 is also shown in the early pictures was 6 turns on it, and it is wound on a FT37-61 core. The reason for do this was to provide a choke with about 10 times the collector impedance. Using a choke with 5 to 10 times the collector impedance is a common practice for achieving stable final amplifier configurations. Six turns on this core provides 2.2 uH of inductance, or an impedance of about 390 ohms. I used a collector impedance value of 38 ohms, i.e. 13.8 volts for the supply, and 2.5 watts of output power.

Once all of the parts were solder in, I was anxious to fire up the transmit strip, and see how well is was going to work. However, I quickly realized that I had used up all of the TO-5/TO-39 heat sinks in my parts inventory. Nuts! Time to build a TO-39 heat sink.

Building the heat sink actually turned out to be a fun diversion. I had previously purchased some 0.010-inch thick tin plated brass at the local hardware store along with a small sheet of 0.020-inch thick copper. I "guesstimated" the amount of tin sheet need to make a small cylinder the diameter of the MRF237, by 3/8 inch in height. Using the handle of an Xacto knife as a mandrel, I formed the cylinder, and trimmed off the excess. A little bit of "tin smithing" with a pair of round nose pliers got the final diameter to fit the transistor tightly. A piece of copper sheet about 3/4 inch wide and 1 1/4 inch long was then cut. After a bit of cleaning with a "Scotch Brite" pad, the two elements were ready for the soldering iron. The cylinder was positioned vertically and centered on the copper pad, and tack soldered in place. After this step, the cylinder was held in place with a small wooden stick, while additional solder was added, making a continuous joint around the perimeter of the cylinder. When the assembly had cooled, it was cleaned with some lacquer thinner on a cotton swab.

With the heat sink installed on the MRF237, is was "show time". First, a power meter with a dummy load on its output was connected to the rig with a coaxial cable. Next, potentiometer R22 was turned to its lowest drive position. Power was applied and pin 3 of IC U4 was grounded; keying the transmit strip. As R22 was increased, power began to be delivered to the dummy load. Trimmer capacitors C38 and C42 were alternately peaked for the highest power output with R22 adjusted for about 2 watts. After the rig had operated perhaps 15 seconds, I felt the heat sink. Wow! Much hotter than it ought to be for a final running class C was my first thought. In addition, peaking C38 and C42 was most difficult; they seemed much too sensitive. Some of that sensitivity had been observed when the band pass filter was first constructed and tested, and again when the LT1252 driver was added.

Looking at the output on the spectrum analyzer provided a starting point to unravel what was going on. When the rig was first keyed, everything looked normal, and would stay that way for a few seconds. However, as the final heated up, something was becoming unstable. A very high spur at nominally 16 MHz would appear in the display, and grow in size at the temperature increased. Additional lower level spurious outputs would also appear if the rig continued to operate and heat. What was not known now was the cause. Were the observations the result of a single problem, or several related problems, as is most often the case.

Solving this mystery turned out to be a bit time consuming, but not highly technical, and is the basis for the next installment of the IA QRP-

10 building saga. Until the next section is written, enjoy the pictures and spectrum plots. The two spectrum plots included with this set show the output when the rig is running in its stable mode. They show the output to be reasonably clean, and well within the FCC requirements for spurious outputs to be 30 dB below the main carrier. Also, compare these plots against those of the band pass filter, and LT1252 driver, noting the increasing power output. The reference for these plots is at +34 dBm, which is 2.5 watts. On the previous plots, we were seeing only +15 dBm, or about 32 milliwatts.

While the rig isn't quite ready to put on the air at this point, it is nearly so. The changes which will need to be made are actually rather minor, and typical of the kinds of things that are common with a brand new design. So, stay tuned.......

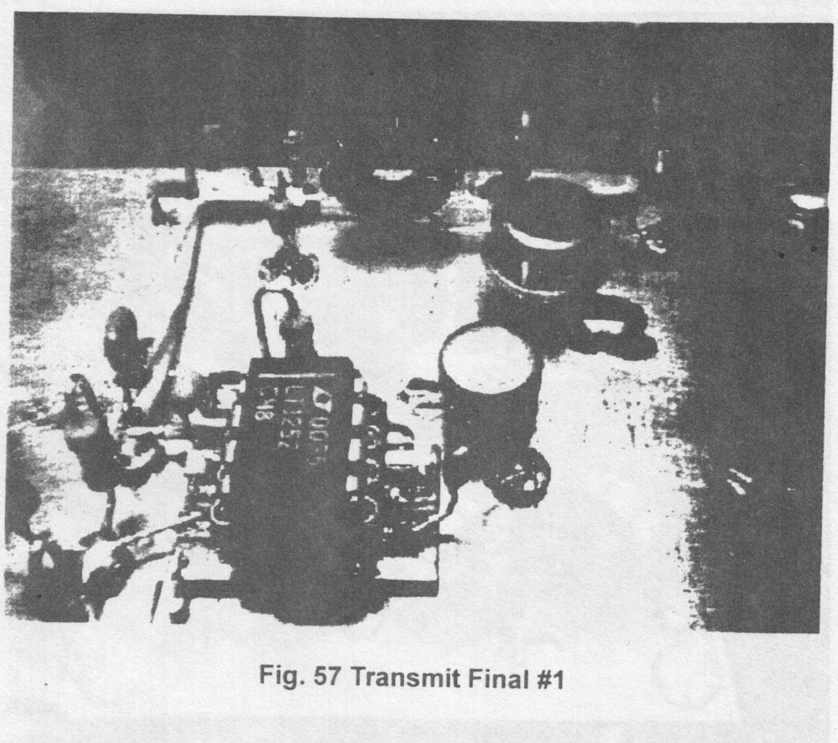


Fig. 57 Transmit Final #1

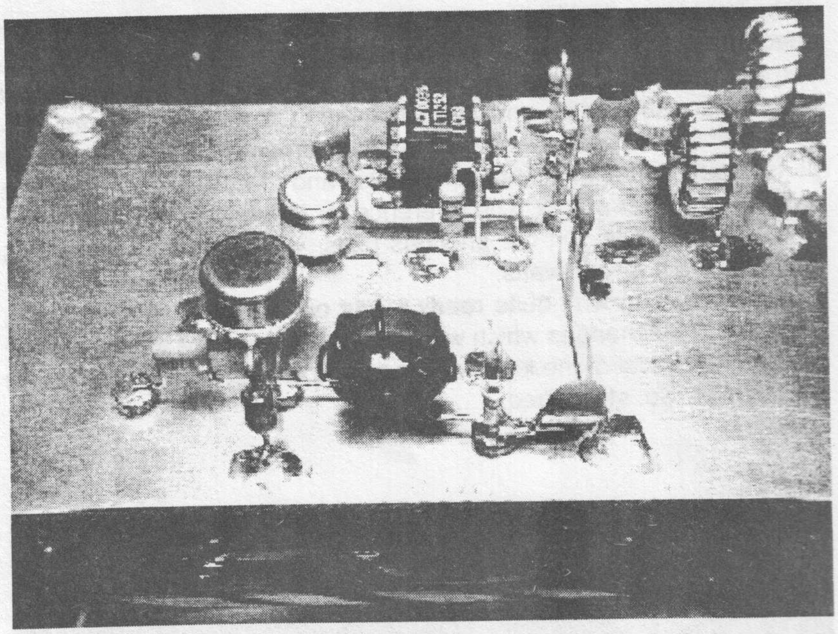


Fig. 58 Transmit Final #2

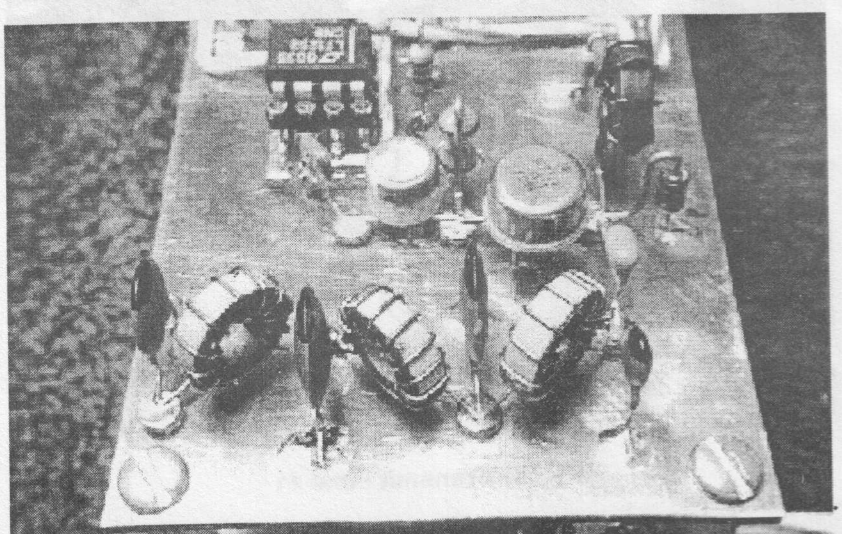


Fig. 59 Transmit Final #3

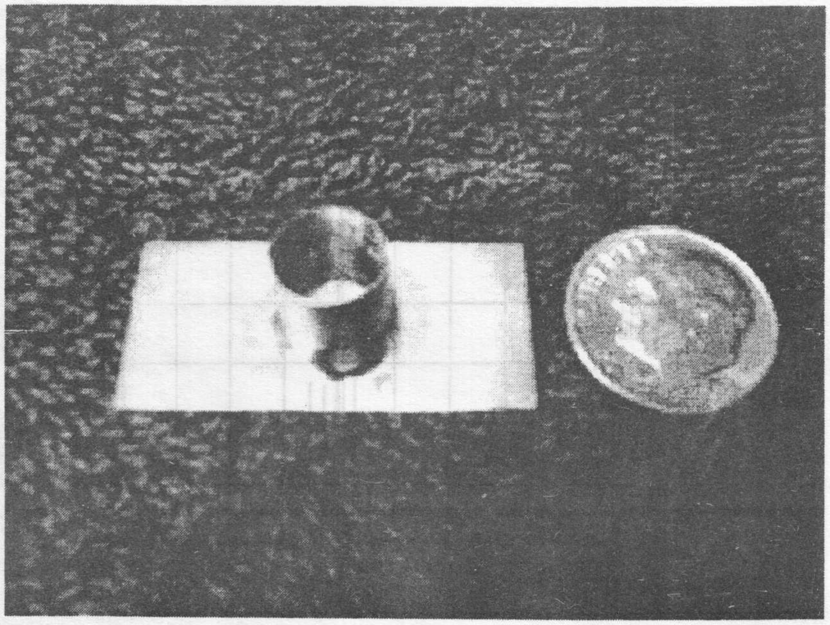


Fig. 60 Final Heat Sink Detail

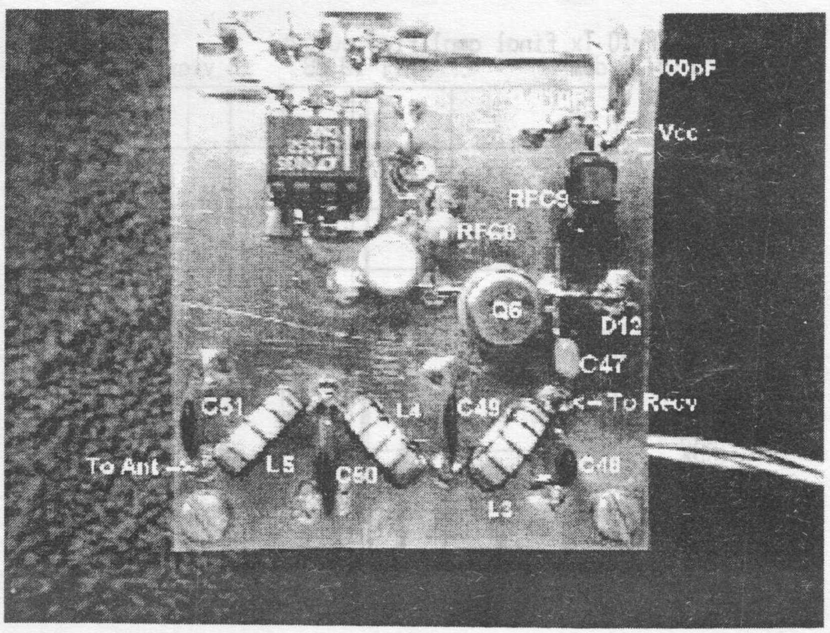


Fig. 61 Transmit Final Parts Layout .

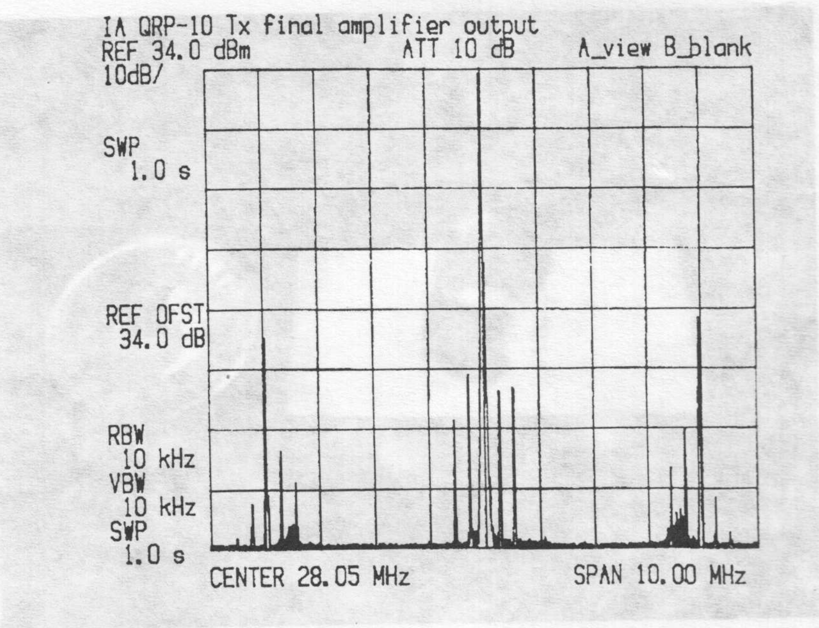


Fig. 62 Final Output Spectrum Plot - "Narrow"

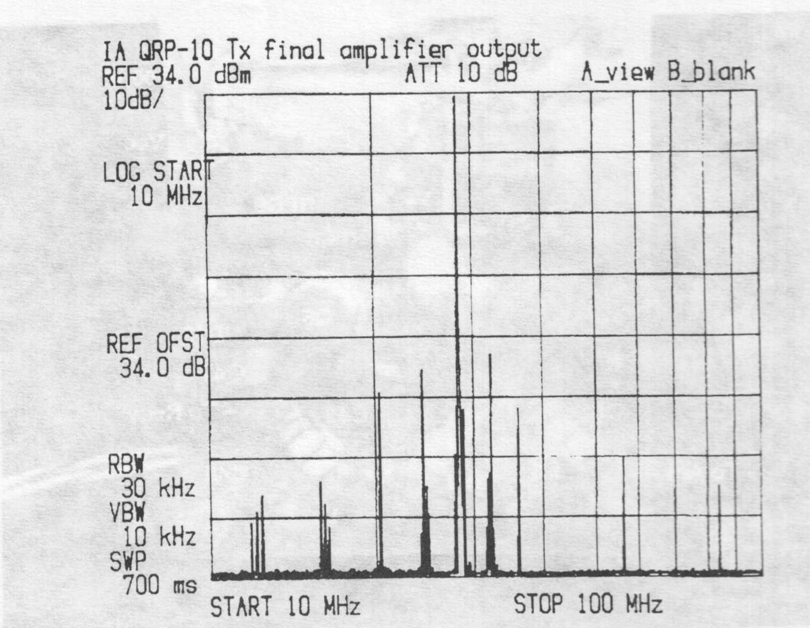


Fig. 63 Final Output Spectrum Plot - "Wide"

Our discussion is going to begin with a few general comments and pictures of the completed rig, built to the original schematic except for the receiver front-end, which has already been documented. If you have been following along, you've also seen the revised schematic for that section.

The first three pictures shows the rig with the boards stacked on top of each other, basically the configuration that is shown in the QRPp article. With the rig in this physical configuration, and the transmit strip built to the schematic, I could not get it to operate in an acceptable manner. There were three primary problems. First off, the tuning of the Tx band pass filter was much too sensitive. Getting trimmers C38 and C42 peaked was a maddening exercise. The solution to this problem was adding some fixed capacitance across each trimmer so that the trimmer capacitance was now a fraction of the total. However, to make this work well, and keep the trimmer somewhat centered in its tuning range required changing the number of turns on inductors L1 and L2. The added padding capacitors, labeled C38a and C42a on the revised schematic, were made 22 pF. This is nominally one-half the capacitance of the trimmer. Inductors L1 and L2 were then rewound with 13 turns of wire, and a resulting inductance value of 0.6 uH, as measured on an AADE capacitance meter. With these changes, the peaking of the Tx band pass filter could be easily accomplished, and was stable when the tuning tool was removed.

The next problem tackled was the overheating of the MRF237 final amplifier transistor. Solving this actually involved two areas of the circuitry. It was found that the gain of the LT1252 needed to be raised some and the value of the base r.f. choke needed to be lowered substantially. The gain of the LT1252 was raised to 11 by changing R20 from 120 ohms down to 62 ohms. Capacitor C44 was also changed to 1000 pF, but probably could be left at its original 820-pF value. My reason to making it 1000 pF was because that is the value used by Elecraft in the K1 design. They have much more experience using the LT1252 than do I, so I deferred to their value. The r.f. choke, RFC8, in the base circuit of the MRF237 was lowered to a final value of 0.56 uH. This value was found experimentally, based on finding a value, which raised the base drive, and consequently lowered the device temperature, without causing instability. Choke values below 0.47 uH caused the final amplifier to be unpredictable in its operation. Along with these changes, capacitor C45 was changed to 560 pF to reduce the coupling between the driver and the final. With these values "in circuit", the transmit strip operated with much greater stability, lower operating temperatures on the final transistor, and predictable and stable tuning. The final still gets hotter than I think it should running in class C, but attempts to reduce it more have failed. My advice is to put a rather large heat sink on it and keep the temperature down that way.

The last change to be made was discovered after the rig had been operated for a few days. During this time, the QSK keying was less than adequate, since the audio output contained significant "thump" when keying. The solution was to move the location of diode D11 from after the connection between U4, pin 3 to U5, pin 4, to between these two devices. With that change made, the keying was much improved. The downside, however, was that the higher reverse bias normally supplied by the current flowing out of U5, pin 4 was not there to reverse bias diodes D1 and D4. However, the reverse bias supplied by U4, pin 3 seems to be sufficient. The thump is gone, and the audio output during transmit is clean, undistorted, and at an appropriate level.

If you look at the "as built" transmit schematic that is included with this discussion, you will see all of the changes that have just been detailed.

The last item for this section is a final spectrum plot that was created after the above changes were in place. This plot shows the improvements resulting from the changes, especially the close in spurs that have been reduced in amplitude. The worst spur just above 21 MHz is down approximately 48 dBc, and everything else is down approximately 60 dBc. When this plot was made, the rig was operating at 2.5 watts into a 50-ohm dummy load.

While the rig still needs to be packaged, it is complete electrically and has been operated a few times. The first contact was with PA3CVR in the Netherlands with a 529 signal report. Subsequent contacts over the next few days included DX stations in Germany and Sweden. So far, 4 countries and 3 states, including Alaska have been worked, all at 2 to 2.5 watts into my 180 foot end-fed long wire antenna. All reported the rig sounded great.

The last installment for this project will detail the packaging used for this terrific little rig so come back for one more visit!

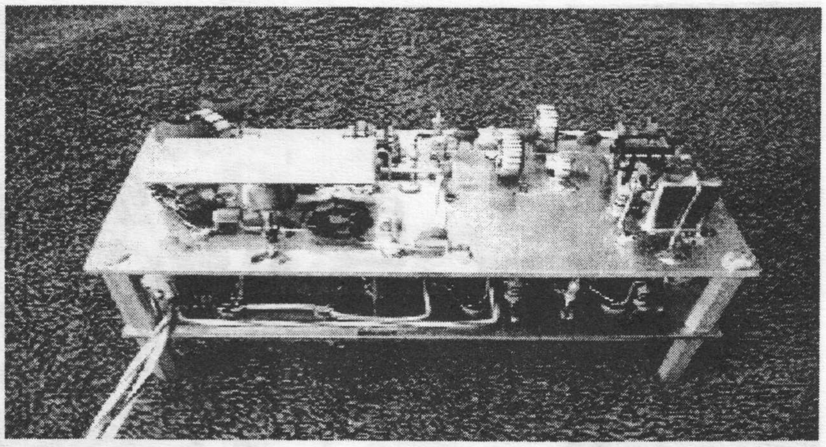


Fig. 64 The Finished Rig

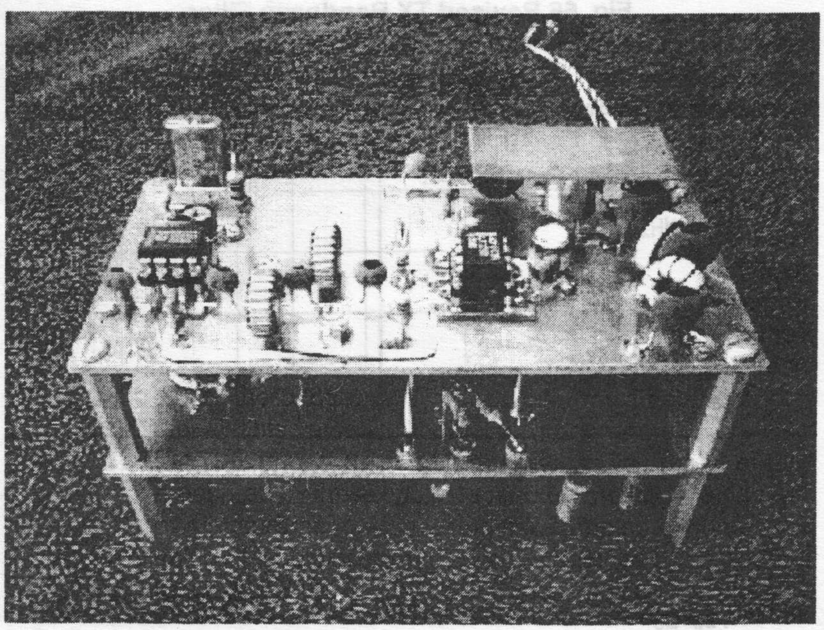


Fig. 65 The Finished Rig

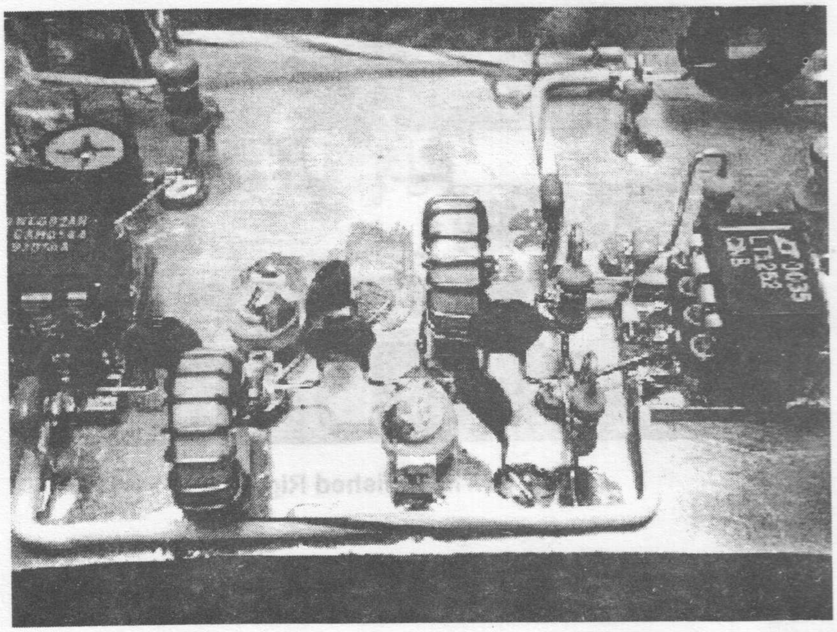


Fig. 66 Revised TX Bandpass Filter

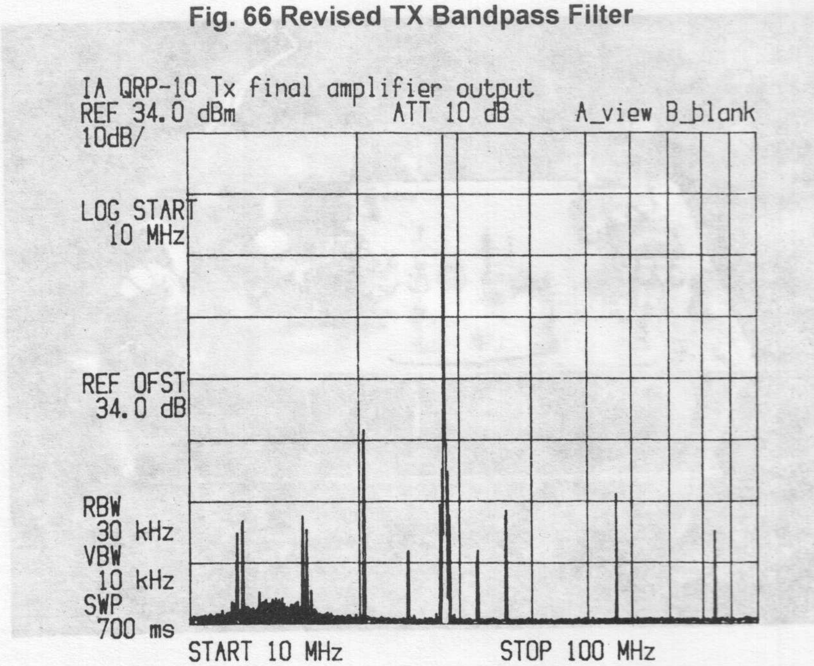


Fig. 66 Final Output Spectrum

Here we are at the end of what has been a delightful and interesting project for me. As always, I've learned some new things, had a blast building the IA QRP-10, and I hope, stimulated some desire on the part of many readers to build one. Modifying the design slightly has added to the robustness that Mike, N0MF had already built into the rig.

There are still some areas that could be improved, mainly in the way the VXO is done. If one were to add a buffer amplifier between the oscillator and the doubler circuit, loading of the oscillator would be minimized. This would allow a single crystal to be pulled over 25 KHz probably. By adding a second 16 MHz crystal in parallel, the tuning range could well reach 50 KHz. Certainly worth doing for the cost of another transistor and a few more parts.

Changing the physical layout would enhance the stability of the design. I'd like to see someone build the complete VXO and receiver on one side of a 3 X 5 or 4 X 6 inch substrate, and the transmit strip on the opposite side. Keeping the number of substrates down to two would minimize ground loop problems. Using three substrates allows smaller packaging, but aggravates r.f. stability with the multiple grounds required.

The remainder of this part will be short, and focus on the packaging of the rig. I decided not to use the same case as Mike, as I wanted more panel space for the nifty big knob that Doug, KI6DS, had sent with the box o' parts. After pawing around in my stash of cases, I found another TenTec TP-42, the same case used for the original 2N2/40 transceiver, and my 2N2/6 transverter. This case is 2 3/8 inches high, 5 3/4 inches wide, and 4 3/4 inches deep. After removing the spacers holding the QRP-10 boards together, it became clear that the transmit board would fit very nicely installed vertically at the back of the case, with the VXO/ receive board installed horizontally. This configuration gave access to all of the trimmers with those on the transmit board being through appropriately placed holes in the back panel. The boards were assembled in this configuration, and the first series of pictures is a walk-around that configuration. As can be seen in these pictures, all of the between-board wiring has been completed. There are also pigtails for the key line, antenna coaxial connector, and the tuning controls are wired.

Once the board assembly was interconnected, the case was drilled. Hole layouts were created with WinBoard, the schematic capture program that I use. Back and front panel layouts were printed and affixed to the respective panels, and the appropriate sized holes drilled. After deburring the holes, the case was ready for the electronics. Two pictures of the drilled case are included in the picture set. Painting will have to wait for warmer weather, as I don't spray paint in the house. It's just too noxious and dangerous.

The board assembly was then installed in the case and connectors added for which pigtails existed. An assembly consisting of the volume control, headphone jack, and AGC LED was then wired up using several pieces of flat, multi-conductor cable. Once this assembly was built, the controls were added to the front panel, and the ends plugged into the pin receptacles on the receive strip. As a refresher, the pin receptacles are single terminals removed from an IC socket. The final set of pictures is another walk-around of the completed IA QRP-10 rig installed in its case. The only missing item is the heat sink that will be used, which can handle more dissipation than the homemade unit shown in these pictures. When the rig is being used, the case is open, and a small fan is allowed to blow across the heat sink to keep the final transistor cool. The commercial heat sink is sized such that it will transfer part of the heat load to the rear panel.

We are at the end! Thanks to all who have followed along, and especially to those who took the time to send email with comments and encouragement. It is always gratifying to know that work you are doing is appreciated and being used. If you don't have a 10 meter QRP rig, consider this one. It is easy and fun to build, and even more fun to operate. 72, Jim, K8IQY

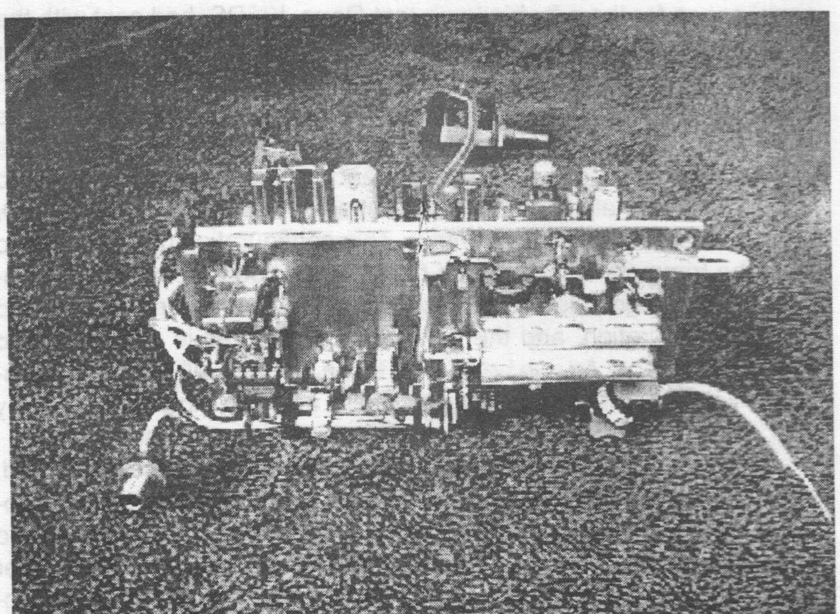


Fig. 67 The Finished Rig Ready for Packaging

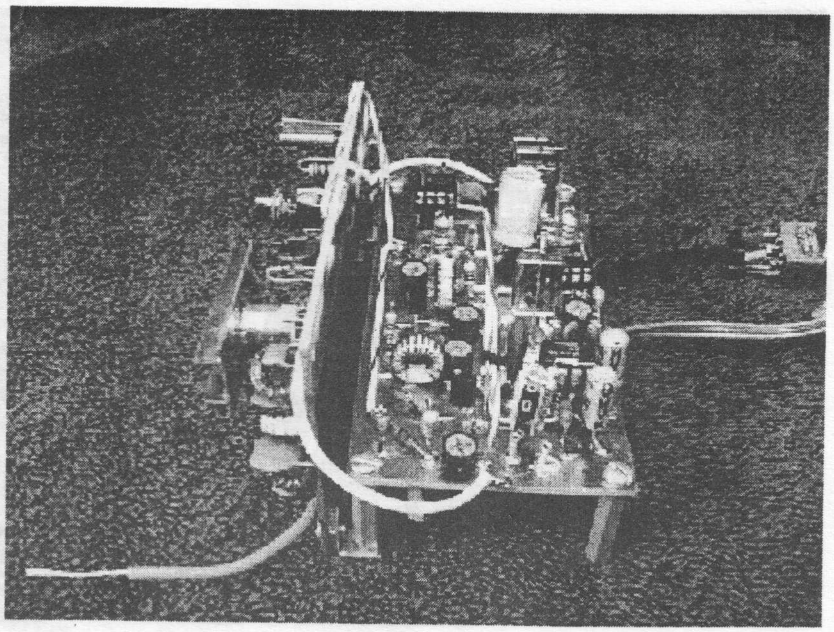


Fig. 68 The Finished Rig Ready for Packaging

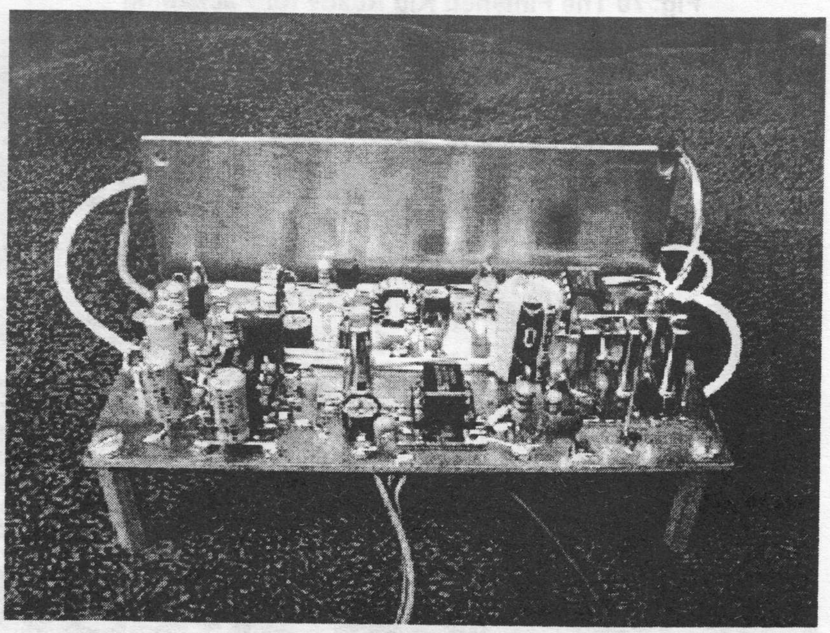


Fig. 69 The Finished Rig Ready for Packaging

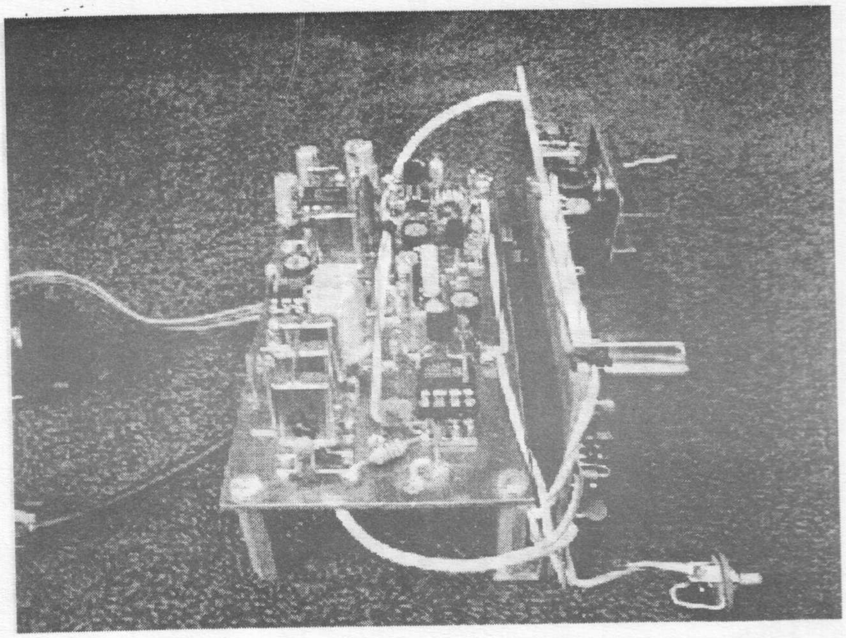


Fig. 70 The Finished Rig Ready for Packaging

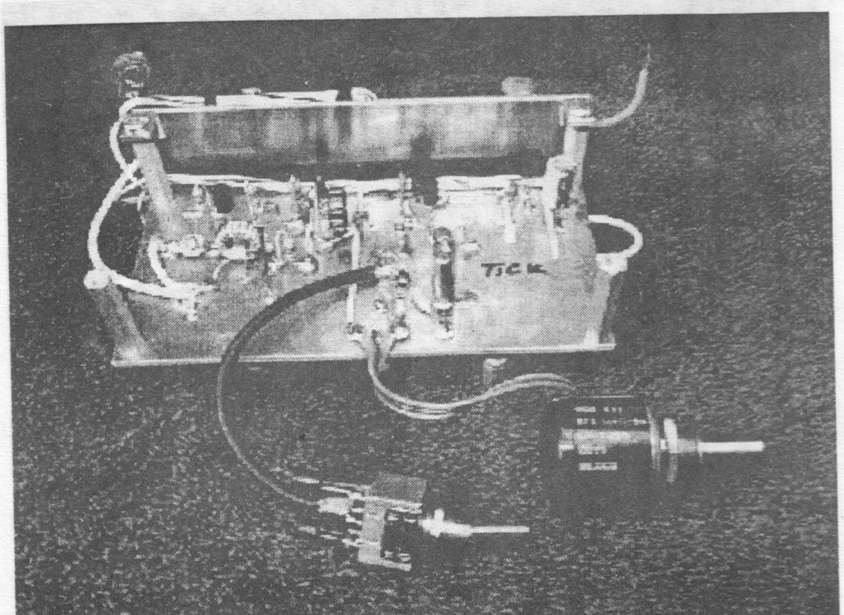


Fig. 71 The Finished Rig Ready for Packaging

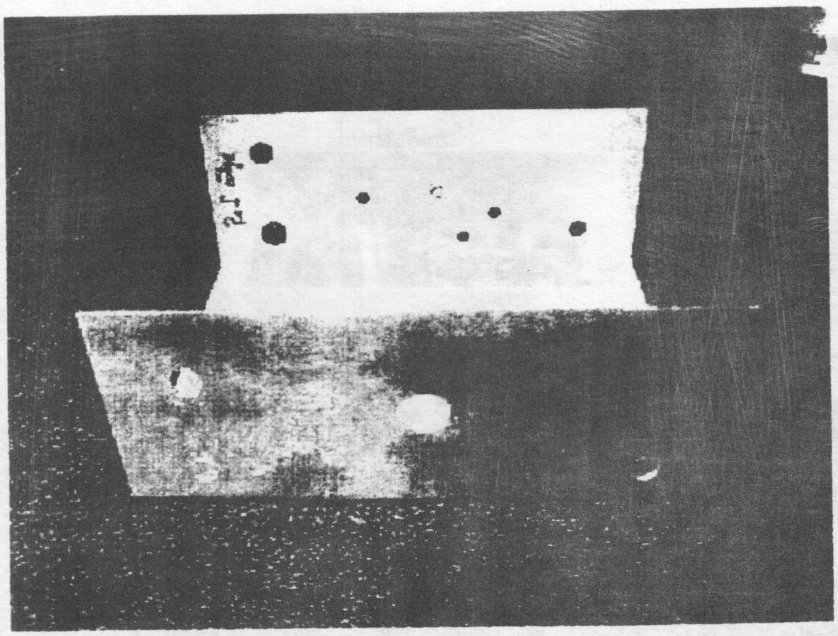


Fig. 72 The Drilled Case Front View

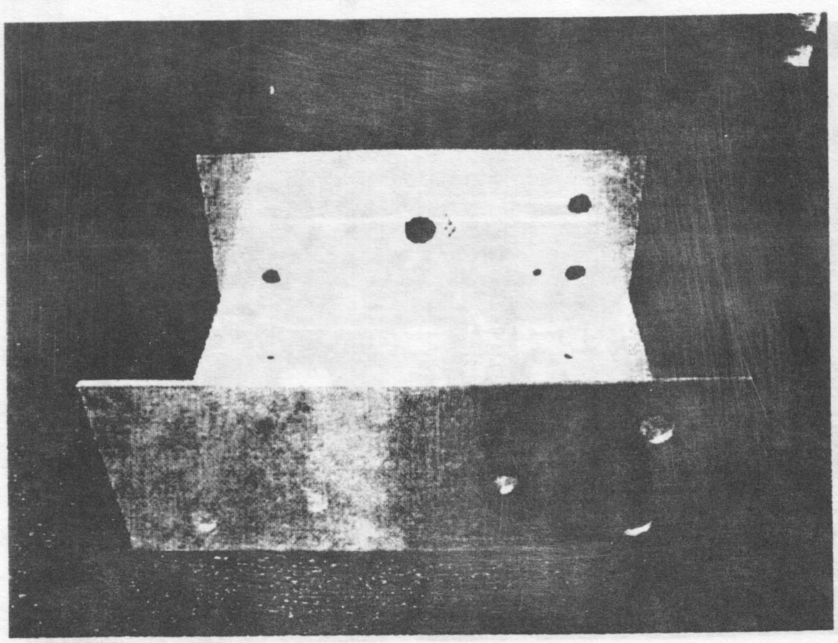


Fig. 73 The Drilled Case, Back View

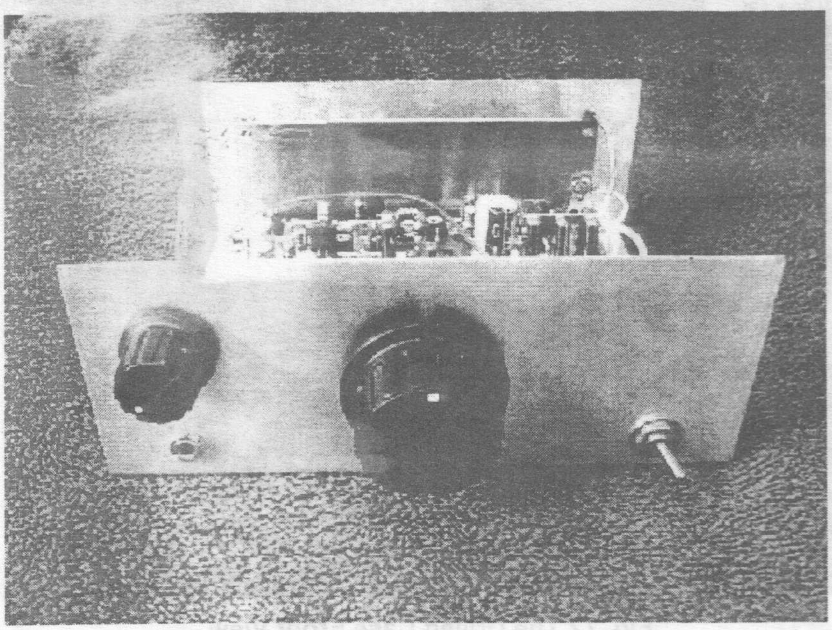


Fig. 74 The Competed Rig, Front View

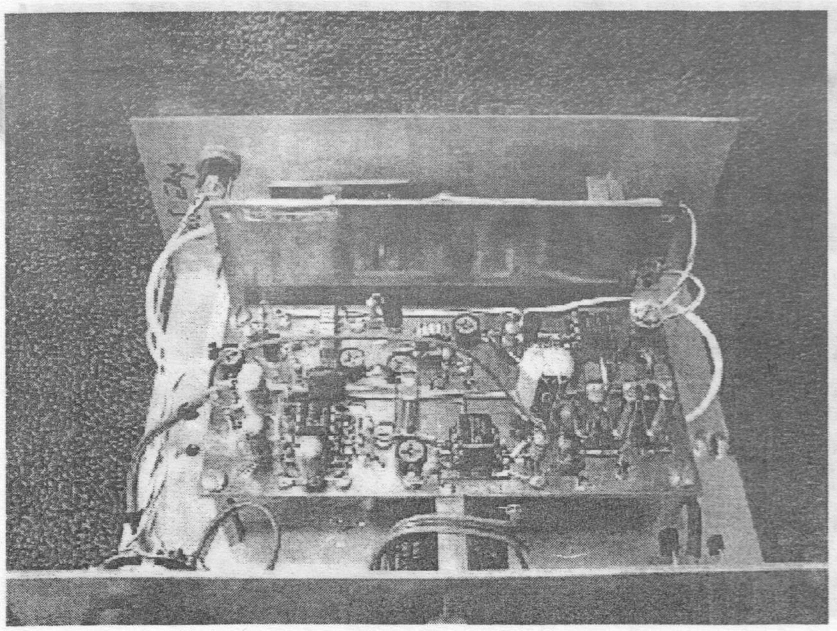


Fig. 75 The Complete Rig, Top Front View

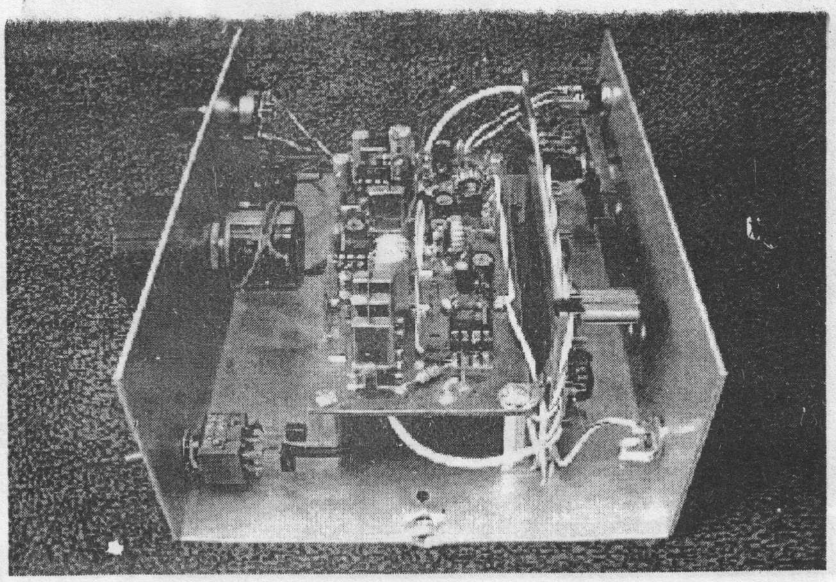


Fig. 76 Complete Rig Right View

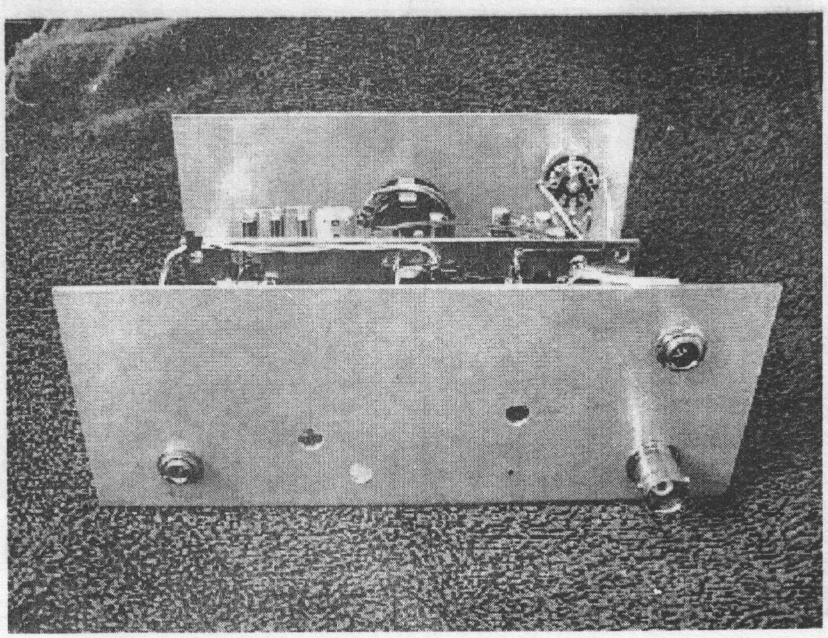


Fig. 77 Complete Rig Back View

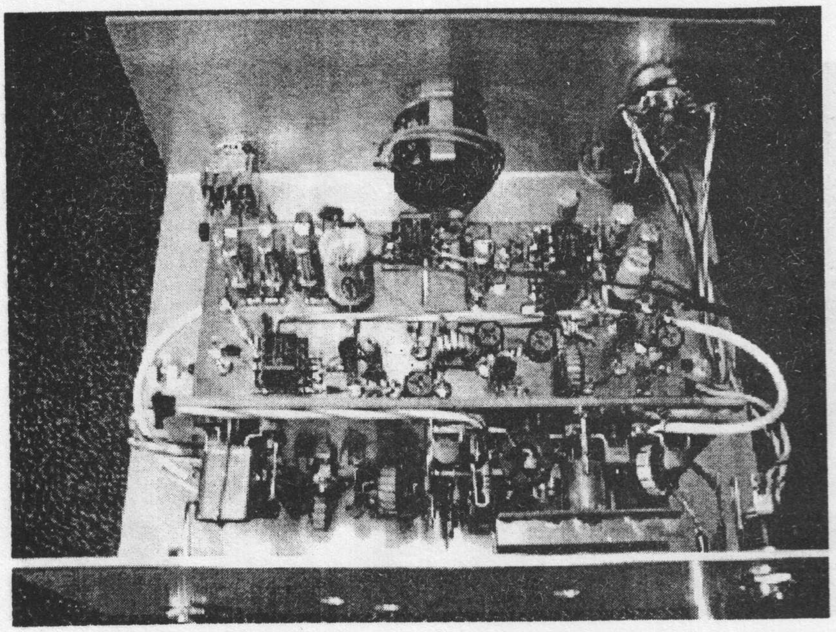


Fig. 78 Complete Rig Back Top View

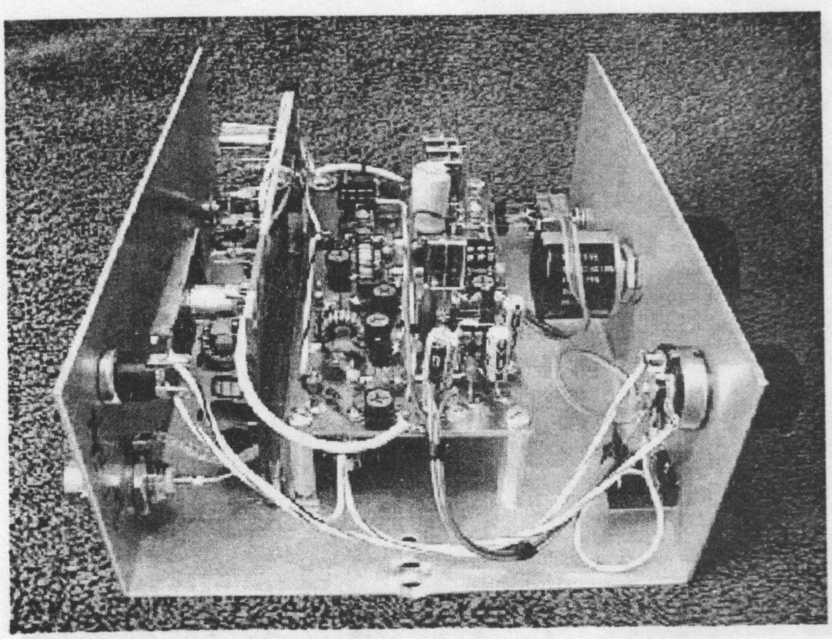


Fig. 79 Complete Rig Left View

Test equipment

That doesn't cost a mint!

By Tony Fishpool G4WIF/K4WIF

It's rare that a project that I build works first time due to perhaps a solder splash or a transistor round the wrong way and this is the point that beginners may get disillusioned - so it makes sense not to pile on further agony. When power is applied that solder splash may cause further damage unless precautions are taken.

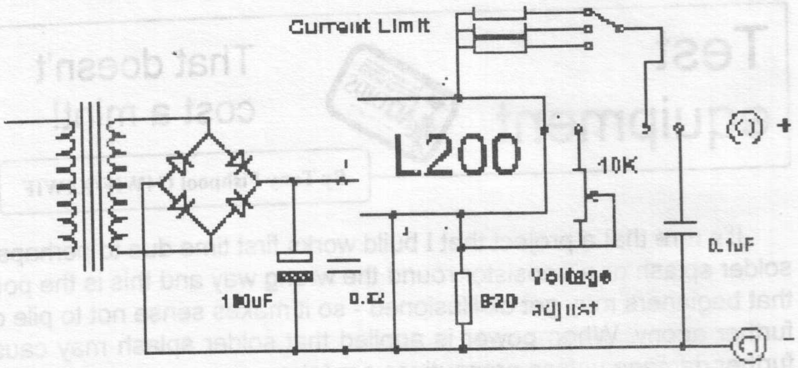
Rather than use the usual station 24 amp 12 volt power supply when testing my latest project, one of the first things I built was a variable voltage and variable current power supply. You can make these for peanuts. Adjustable voltage regulators like the L200 can source up to 36 volts at two amps, and short circuit protection is built in. Aside from the L200 needing a good heatsink you can more or less build it how you like - I mounted all the components on stripboard. Most parts will be found in the junkbox, for the bridge rectifier, choose a unit with plenty of voltage and current headroom.

Current limiting is controlled by the value of the resistor between pins 2 & 5 of the regulator. To calculate the resistor's value, the L200 data sheet gives the formula R=0.45/I(required limit). The resistors also carry virtually the same current as is being provided to the load, so bear this in mind when choosing the power dissipation rating (remember $P=I^2R$). I chose three resistors to give me approximately 10mA, 100mA, and 2 Amps. Using preferred values, that's 47, 4.7 and 0.22 ohms. When these values of current are exceeded, the output shuts down and smoke gets to stay inside transistors where it belongs.

Flea markets are the place to find a box to build it in. Look for something that already has a moving coil meter. With luck, it will be suitable for adding shunts and multipliers so that you can monitor both current and voltage out. The ARRL handbook contains a lot of information about how to work out the right values for your meter.

The diagram shows a simple arrangement where one meter can be used for measuring both current and voltage. The downside of this circuit is that when measuring voltage the shunt is left in circuit, but as it will be less than an ohm, it won't matter much. Look for something that is mains powered – it may just have a suitable transformer inside!

I built this power supply something like ten years ago. It still works fine, and surprisingly, after all this time, the L200 chip is still listed in U.K. catalogues, so I expect it's easily obtainable in the U.S..



G4WIF Power Supply

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Note that All Queries about your subscription should go to Paul Maciel, AK1P. Paul's email address is ak1p@earthlink.com

NorCal Web Page

http://www.fix.net/norcal.html

Jerry Parker has a wonderful Web Page full of QRP information that you don't want to miss. Check here for all of the latest NorCal information.

Test equipment That doesn't cost a mint!

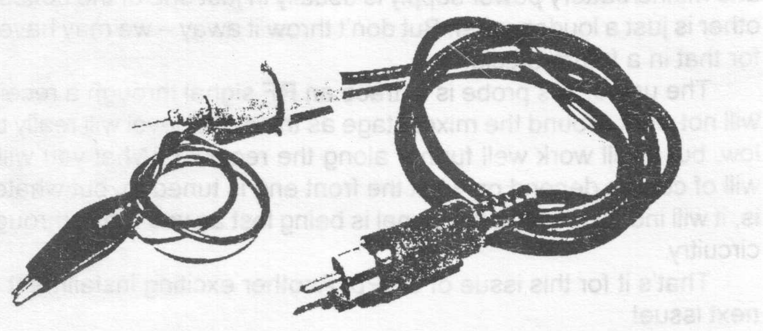
By Graham Firth G3MFJ/W3MFJ

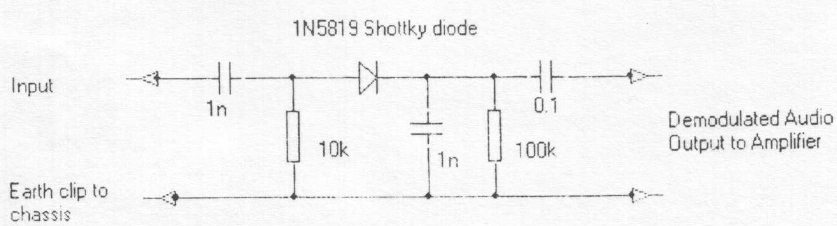
Part 2 - An AF probe

Hi again. This is the second part of my series of articles on simple test equipment. It's another piece of kit that I described at Pacificon in 2000, and also at Atlanticon & Arkiecon in 2001. This is another example to show that test equipment does not have to be complicated to be extremely useful.

Again, it is a very simple circuit and is very effective in use. It is based on the RF probe I showed in the last issue of QRPp, but this time the output is an audio signal, rather than a DC voltage.

The three capacitors can be any type available, although if you intend to use the probe on voltages higher than 24 volts, the input 1n (0.001uF) capacitor should able to withstand this. The diode specified is a Schottky diode. This was chosen as it operates well at HF, and it has a low voltage drop, thus making it more sensitive. Any equivalent diode will suffice. If a Schottky diode cannot be obtained, then I suggest a germanium, rather than a standard silicon diode.





The second 1n (0.001uF) capacitor is to remove any residual RF and the final 0.1uF capacitor is to remove any DC on the output, which could affect the following audio amplifier.

The case I used for the probe was originally a pen in a plotter! I removed the point & the ink felt, washed it out, and then I found a piece of wire that was the same thickness as the point, soldered a piece of wire to it & then pushed it, wire first, into the, after first smearing it with "krazy glue". The rest of the components were all soldered together, connected to this piece of wire & then pushed carefully into the body of the pen. Tape any connections that you think may short – no one is going to examine it when it is glued together!

The output screened lead had already been pushed through a suitable hole in the end cap; this was then fitted, again with a smear of glue. Finally, an RCA (phono) plug was fitted to the end of the lead. This plug suited my shack amplifier. You can fit a plug to suit your available amplifier

The amplifier I used was my "shack" amplifier – what – you don't have one? Well you will have to make one and there will be information on building such a beast in a future QRPp. Those of you without one, and who can't wait, can I suggest getting one of the amplifier/speaker setups you can buy at RS or any computer store and is intended to amplify the noises that come out of the kid's computer. These are incredibly cheap & you can just ignore the second channel – the amplifier and mains/battery power supply is usually in just one of the boxes – the other is just a loudspeaker. But don't throw it away – we may have a job for that in a future article!

The use of this probe is to trace an RF signal through a receiver. It will not work around the mixer stage as the signal level will really be too low, but it will work well further along the receiver. What you will hear will of course depend on what the front end is tuned to, but whatever it is, it will indicate where the signal is being lost as you move through the circuitry.

That's it for this issue of QRPp. Another exciting installment in the next issue!

QRP Operating News

By Richard Fisher, KI6SN
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KI6SN@yahoo.com

Milliwatting strategies for the CQWW

Jerry Scherkenbach, N9AW, writes from Hales Corners, WI, that "after working Rumi, LZ2RS, a couple of months back on 20 meters using about 200 milliwatts I was hooked.

"He worked me with only 50 milliwatts which he said was the first time he had worked the USA on 20 meters with that power level.

"Since I couldn't accurately measure my power at that low level, I bought a WM-2 wattmeter kit, built it and decided to try for DXCC using only milliwatts.

"For mostly work related reasons, my quest to start this personal challenge was delayed until (the CQWW DX contest in November 2000).

"I've always enjoyed the CQWW CW contest.

"In 1989, a few years after getting interested in QRP, I entered the contest as a single operator on 15 meters QRP.

"Well, that's a pretty limited category but I was really amazed to work 90 countries with 5 watts that weekend on 21 MHz.

"I was even more amazed when a No. 1 World certificate showed up for that effort.

"Like I said, its a pretty limited category - I think there were around 40 entries.

"Anyway, for the CQWW CW I decided to try milliwatting.

"So, with the WM-2 set to 900 milliwatts I started out on 10 meters on Saturday morning.

"When I look back, I was awful casual about not getting in until 1547Z (9:47 a.m. CST), however, I didn't think it would turn out this well.

"The next day (Sunday) I also got a late start. Now I wish I had started earlier.

"Maybe I could have gotten those 100 countries while milliwatting in one weekend.

"My goal was to work as many countries as I could, not QSOs or points. I mostly worked one QSO per country but did have a few extra QSOs with Japan, England, France and Hungary.

"The results at 900 milliwatts: 110 QSOs, 95 countries, 10/15/20 meters. Most QSOs were made on 10 meters.

"Worked all continents. Most QSOs were with common countries but also had some not-so-common ones: **3V, OX, JX, OH0, PY0F, JW, A3, 9G, KH0, 9H, FR, YJ, TZ, VP8/H and VR2**.

"My equipment? A Yaesu FT-1000MP, Oak Hills Research WM-2 wattmeter, Mosley Pro-57B antenna at 50 feet.

"The bottom line? This was really a lot of fun. I don't think I will be hesitant to operate in the 'less than 1 watt' category in future QRP ARCI contests.

"Observations:

+ Have patience: If you're not the type to be patient, milliwatting might not be for you.

+ CQing: Forget about it, I didn't even try.

+ Packet cluster: I used it but avoided newer spots where the pileups were likely to be big.

+ Rare countries: They were spotted on packet, always a big pileup, forget about it.

+ Stay with the highest open band: The QSOs were easier to make. Stay alert to propagation changes for your area. Jump around between the two highest bands when the highest band doesn't seem to be producing.

+ Generally, the louder they are, the faster the QSO unless there is a pileup.

+ Timing, as always in DXing, is key. There were a number of QSOs made where timing made the difference because there was always someone calling besides me. Not really a pileup but the higher power stations will almost always beat you.

+ Code speed: Don't be afraid to crank it up, if you're comfortable with higher speed that is.

I hear a lot a QRP ops slow way down, maybe thinking their signal will be easier to copy if their CW is slower because the signal is weaker than most. Not so, some of the DX ops have a rhythm they are trying to maintain and seem to answer stations that fit it.

+ Forget that you're running QRP. Remember, your QRP signal is not that far down in S units from the big guns, everything else being equal
(whenever that happens). 100 watts to 1.5 watts (or so) is theoretically 3 S units.

"I hope everyone that operated the contest had as much fun as I did."

More DX in the CQWW with a K2 at 5 watts

Bob Hightower, NK7M, writes from Chandler, AZ that he thought he'd "play around with CQWW this weekend, mainly to try out the latest version of Brian Kassel's QRPDupe.

"I've been using this for nearly a year now, in all its versions. This is a logging program that you need.

"It's primarily for QRP contests, but he has included the major contests, such as Field Day, CQWW DX, and so on. Very easy to use, and, with a simple interface, it will key your rig, and send your exchange.

"Anyway, I worked about 7.5 hours with the K2 at 5 watts, and, much to my surprise, got 101 QSOs, 80 multipliers and 16,320 points.

"That's not a great score, but plenty good for me. Among the DX worked were: **Cayman Islands, Cuba, Japan, Sweden, Belgium, Asiatic Russia, European Russia, Morocco, Philippines, Indonesia, Costa Rica, Norway, Finland, Brazil, Ecuador, Argentina, Panama, Chile, Guadeloupe, Uruguay, Ghana**

"So, the operation of the K2 makes me very happy. Some of the speeds were quite fast, but listening to a couple of contacts allowed me to get the call, and the rest was easy.

"Now I wish I'd spent more time at it, and maybe gotten QRP DXCC. But maybe next year.

"The antenna, by the way, was the Cushcraft D4 rotatable dipole."

NK7M's web site can be accessed at:
http://www.extremezone.com/~nk7m

CQWW QRP: A casual approach

Karl Larsen, K5DI, writes from Las Cruces, NM that "as I write this, after many false starts and CME changes, the CQWW DX contest will be history in 15 minutes.

"I took a very casual way with the contest because it has been many years since I last did it seriously.

"Of course it's my first running QRP - and more on that later.

"Since I live in Las Cruces, I'm closer to Japan than Europe. So I worked a lot of radio amateurs in Japan.

"I also found some South American stations who heard me well.

"So, of the 50 odd stations I worked, a large part are from Japan zone 25.

"But, of course there are a lot of hams there and they were all on 10 meters. I worked them from 28.020 to 28.108 MHz. They were all 599 and so was I.

"The QRP-Dupe software was very good. It took some getting used to but after that it was quite easy to make a contact: f/6, f/4. That is all it took.

"But if something odd happened, it was key f/9 and sending with the keyboard. My sending was real good!

"QRP DX chasing is real good practice for proper DX operating.

"You're not going to overpower anyone. You're not going to be heard if ANYONE else calls. So you must wait until - in the 100 milliseconds between his CQ ending and your pressing f/6 - no one calls that you can hear so YOU call.

"Bingo, another station worked.

"I stayed on 10 meters for the most part and that's a big clear band. But when there are that many stations operating, even a big, wide band can get crowded.

"I needed a very narrow receiver and didn't use my Kenwood TS-50 as I should have. This was due to my other problem with copy of fast CW.

"So planning for one year from now, some changes are going to be made. I will build a coupler so both my keyer and the computer can key the radio as I choose.

"I will have this all set to connect to my TS-50 . . . I will look for a good computer CW reader. I'm convinced most serious guys have this capability.

"And I will set up a schedule of what band to work at what time. This will help me find the DX."

On a short schedule, there's still plenty of DX to snag

Greg Harris, WB9MII, of Park Forest, IL, writes that he found interesting other operators' comments on the CQWW.

"Here's what went on here for the contest. Without putting in a whole lot of time I worked 14 zones, 37 QSOs.

"Used my MFJ 9020 and 9040 and Sunday morning I wanted to try 10 so I broke out my Century 21 at 5 watts.

"The antennas used (both indoors) were a compressed W3EDP on the inside of my windowsill and a floor to ceiling PVC pipe wrapped in wire. I did well on 20, on 10 I just worked **NP4A**.

"Seems to me that the DX operators on 10 and 40 were too busy hitting the automatic message buttons on their mega-dollar keyers to bother to listen if anyone might actually be answering them - but that is just my opinion.

"On 40 I worked a guy in NY for Zone 3, tried calling the EU stations and also a VE1, which turned out to be a near miss.

"No joy at all on the EU stations on 40. Best catch: **9G5AA** (they're sharp ops). Also worked **PJ, VM5, RU1, OH,** etc.

"I think that I'd have a better score if some spent a second or two listening for answers and not just constantly hitting keyer buttons to hold a frequency.

"All in all, after 27 years as a ham I'm still amazed with what can be done with low power and marginal antennas."

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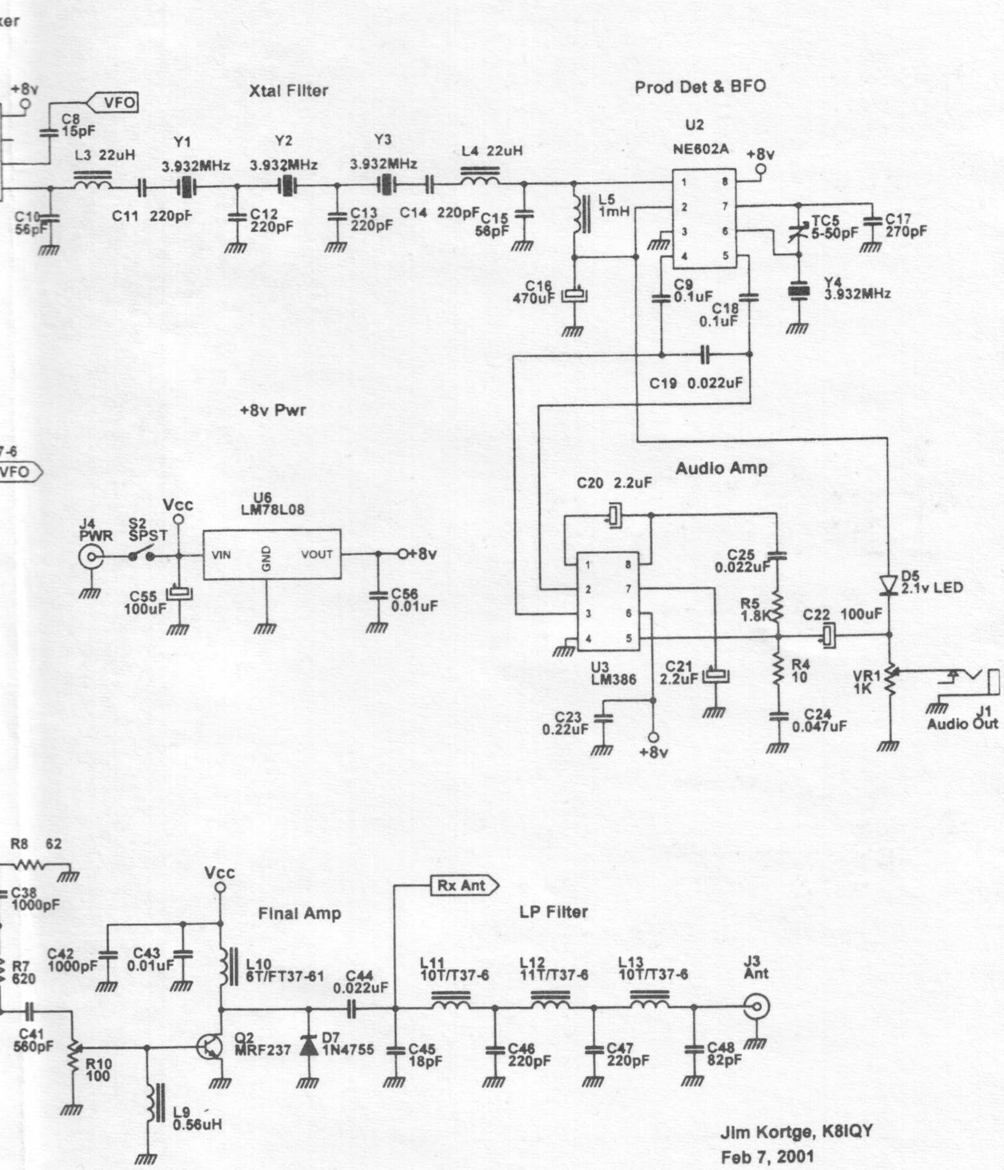
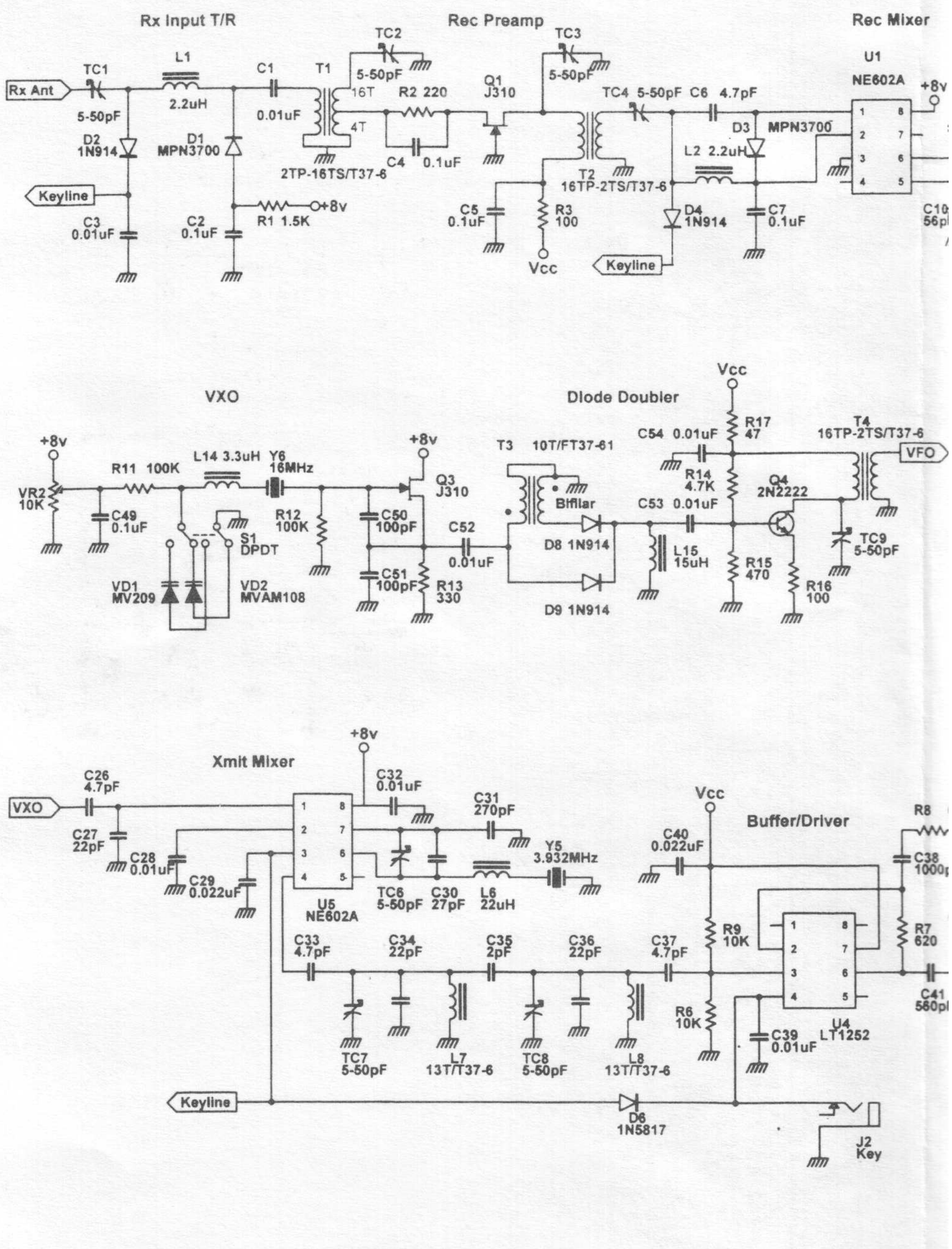


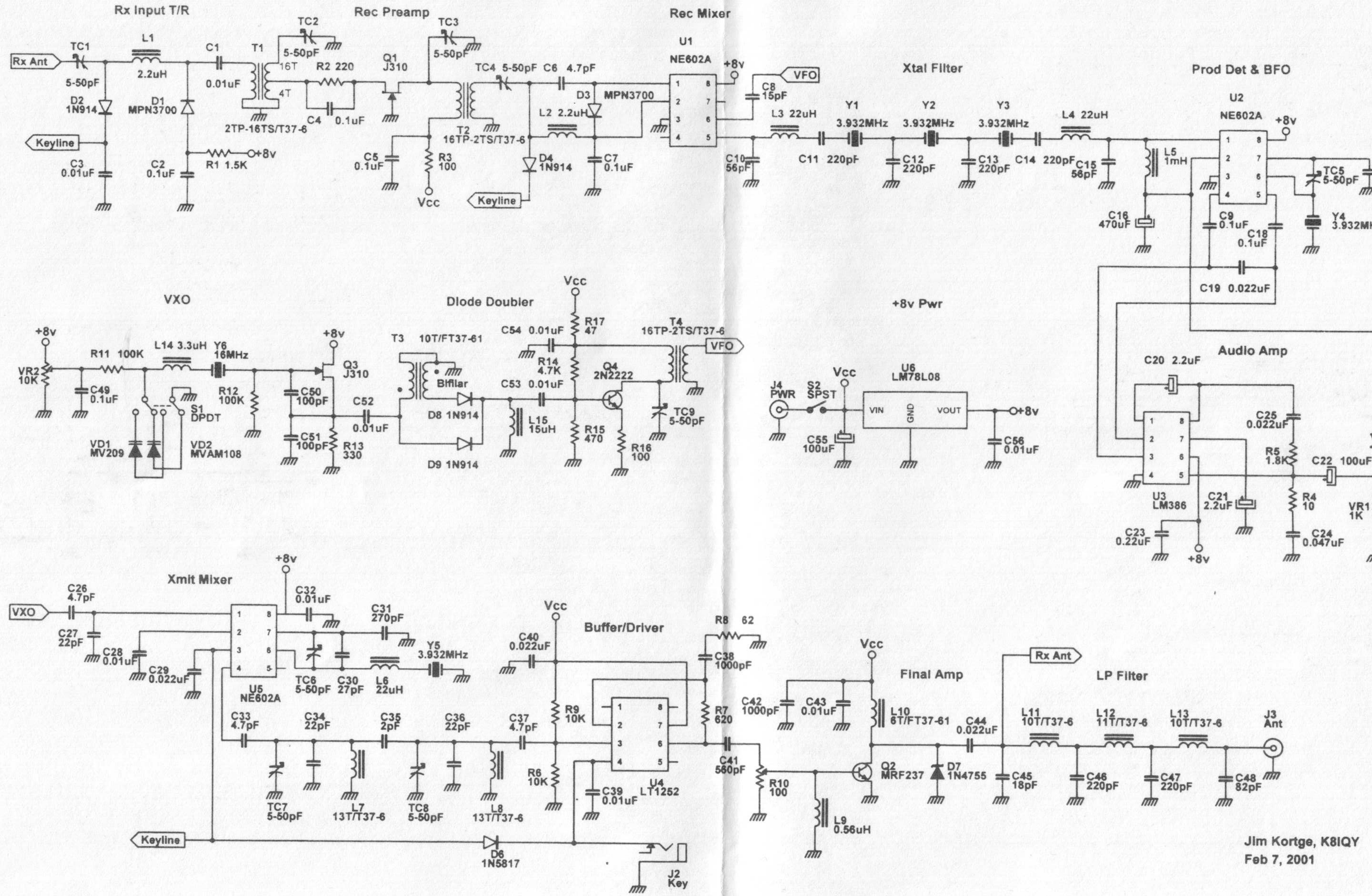
Jim Kortge, K8IQY
Feb 7, 2001

K8IQY's Ic



Rx Input T/R
Rec Preamp
Rec Mixer
Rx Ant
TC1
5-50pF
L1
2.2uH
C1
0.01uF
T1
16T
4T
2TP-16TS/T37-6
TC2
5-50pF
R2 220
C4 0.1uF
Q1
J310
TC3
5-50pF
TC4 5-50pF
C6 4.7pF
T2
16TP-2TS/T37-6
L2 2.2uH
D3
MPN3700
U1
NE602A
+8v
D2
1N914
D1
MPN3700
Keyline
C3
0.01uF
C2
0.1uF
R1 1.5K
+8v
C5
0.1uF
R3
100
Vcc
D4
1N914
C7
0.1uF
Keyline
VXO
Diode Doubler
Vcc
+8v
R11 100K
L14 3.3uH
Y6
16MHz
+8v
Q3
J310
T3
10T/FT37-61
Bifilar
C54 0.01uF
R17
47
T4
16TP-2TS/T37-6
VFO
VR2
10K
C49
0.1uF
S1
DPDT
R12
100K
C50
100pF
C52
0.01uF
R14
4.7K
Q4
2N2222
C53 0.01uF
D8 1N914
L15
15uH
R15
470
TC9
5-50pF
VD1
MV209
VD2
MVAM108
C51
100pF
R13
330
D9 1N914
R16
100
Xmit Mixer
+8v
C26
4.7pF
VXO
C32
0.01uF
C31
270pF
C27
22pF
C28
0.01uF
C29
0.022uF
U5
NE602A
TC6
5-50pF
C30
27pF
L6
22uH
Y5
3.932MHz
Vcc
Buffer/Driver
C40
0.022uF
R8
C38
1000p
R9
10K
R7
620
C33
4.7pF
C34
22pF
C35
2pF
C36
22pF
C37
4.7pF
U4
LT1252
C41
560p
R6
10K
C39
0.01uF
TC7
5-50pF
L7
13T/T37-6
TC8
5-50pF
L8
13T/T37-6
Keyline
D6
1N5817
J2
Key

K8IQY's Iowa QRP-10



Jim Kortge, K8IQY
Feb 7, 2001

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From the Editor

Doug Hendricks, KI6DS
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Dos Palos, CA 93620

This issue is another one of our "special ones" as it features the work of Chuck Adams, K7QO. Chuck takes one of the all time great kits, the Small Wonder Labs 30+ and shows you how to build it part by part. His photography is outstanding, and the time that he took to produce this work boggles the mind.

Thank you Chuck for all that you do for QRP and ham radio. You are truly one of the givers of our hobby.

The work is so good, that it will become a classic reference piece on construction using a circuit board. Even if you don't want to buld the SWL30+, the information in the article applies to any kit situation.

But I whole heartedly encourage you to buy a SW30+ kit from Dave Benson. The $55 postpaid price is one of the great bargains in ham radio, and the transceiver that you build will give you hours and hours of enjoyment, both building and operating.

Check out Dave Benson's website at the url mentioned in the article. I do not hesitate to endorse this kit as a great product.

Also, please read the article on page 3 about Gloria Ackerly and her work with the NorCal 20 project. The project is doing well, and even though it is slow, we are making progress getting the radios distributed. Thanks to all of you who supported the project. 72, Doug, KI6DS

The NorCal 20 Project - An Update

Norcal 20's in Romania – by Tony G4WIF

In late 1989 Romanians revolted against the dictatorship of Nicolae Ceausescu, Romania's president and Communist Party leader, and a temporary government was set up. Soon after, and particularly in Europe, we became aware of a great need for aid. In England many independent groups emerged and trucks full of much needed relief made the long trek overland. Teacher Robin Ackerley was among them and was to make several such journeys.

In 1995 Gloria Ackerley G3VUN accompanied Robin on one of his voluntary trips to Romania. She spent a week there sharing her skills as a "special needs teacher" with parents of children who have medical problems and learning difficulties at the Binecuvintati Copiii centre in Onesti.

She found from talking to the parents that there was a real need for contact, support and information on how (and from where) they could obtain help. During a trip in 1997, Gloria visited the Tulcea area where she spotted a street sign "STR. GLORIEI". This means "Road of Glory" in Romanian and her companions suggested that this would make a good name for the network. So she registered the U.K. charity "Network Gloria".

Right from the beginning Gloria was assisted by Romanian hams. Before email contact became available much of the contact with Romania was by radio. Indeed, in 1997 Gloria asked G4WIF to keep a sked with the late Andy YO3AC, who had been such a help to Gloria in the early days. The messages were passed on. Andy's CW was superb - just like music and he is much missed.

In 1999 Doug, KI6DS & Jim, WA6GER conceived the idea of making quality radio kits available to countries where hams just couldn't afford to buy them. Every Norcal 20 kit purchased financed another that would be donated for free. Doug arranged for all distribution to be via the GQRP club – supervised by Rev. George Dobbs G3RJV.

Gloria's charity work was known to some of the G-QRP club officers, so one day she was invited to visit Dick G0BPS to collect a consignment of Norcal 20's to be taken to Romania.

In October 2000, they were loaded onto a truck taking physiotherapy equipment and medical supplies. They also took textbooks and musical instruments for schools.

Dan Liviu YO3JX (from the Romanian Amateur Radio Federation) received the kits in Bucharest and invited Gloria to an official hand-over next time she was in Romania. This visit took place in February 2001 when a team from Network Gloria flew to Bucharest to hold a course on *"The Care and Behaviour Management of Children in Institutions"*. They visited Scoala Generala 175, a secondary school not far from the Gara Nord railway station. There, Gloria was greeted by the school radio club (YO3KWF and YO3KSB). The NC20's had already been assembled by Dan and he generously offered to repair them when necessary. The club is run by Vasile Capraru YO3AAJ and some of his students are proficient at speeds of 40 WPM. There is much enthusiasm among the children and their adult tutors.

As a postscript to this story, the Secretary of the FRR (Federation Romana de Radioamatorism - the national body) Vasile Ciorbanita YO3APG, declared Dan "Ham of the Week" (13.3.01) on the official FRR Internet page, as a result of the "Norcal Activity".

Two more NC20's have also been installed at an after-school radio club for novices run by instructor Burada Romeo YO9CFR. The school is at Turnu Magurele and is to the west of Zimnicea on the Danube / Bulgarian border and even their teacher Camelia Turcan is studying to become a radio amateur.

Without the partnership of Norcal, G-QRP and Gloria's charity, these children would not have the access to ham radio that they now enjoy. NC20's have been sent to various places through George Dobbs missionary contacts, many to places that can't be mentioned through risk of compromising the courier. However here is a list of those we can mention. Pakistan, India [three locations], Borneo, Indonesia, Bolivia, Venezuela, Ukraine, Gambia, Uganda, and Rwanda. If you bought a NC20 then you can be proud. There are people in the world that now have radios that didn't before. This is a long term project with many more kits left to distribute. If there are more stories that we can tell you will read about them in QRPp.

Keep up to date with Gloria's work at www.networkgloria.org.uk

NorCal 20 "Countries List"

Pakistan,
India [three locations],
Borneo,
Indonesia,
Bolivia,
Venezuela,
Ukraine,
Romania,
Gambia,
Uganda,
Rwanda,

Building the SW30+, A Course in Kit Building

by Chuck Adams, K7QO
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PRESCOTT AZ 86304-1840

Dave Benson, NN1G, has a company called Small Wonder Labs (SWL). He is located near ARRL headquarters in Newington CT and his web page is SWL home page.

http://www.smallwonderlabs.com/

Current information on his company, SWL, and the kits that he has available can be found there. Dave has kindly given me permission to use his SW-30+ design as a tool to use to help people learn and use the Manhattan Style of building for homebrew projects. As a starting point for that goal I have purchased one SWL SW-30+ transceiver from Dave. I already had one such transceiver in operation and am using it almost daily until November 11th, 2001 to work all states and a hundred countries at half of one watt to a vee-beam. I bought this kit in order to build it from scratch and document the process of how I would build a kit. This write up is to be used as a learning tool for those that have yet to build a complete kit. I'm a regular customer of Small Wonder Labs and Dave can tell you and I get no special deals for doing this. I am just interested in getting as many QRPers on 30 meters as I can and to also teach building at the same time. The schematic and the parts list are included. I will use digital pictures to show you how to build a kit and this article is written assuming that you have never built a kit. The series of pictures and written material shown here is for those that want to start with a kit first before moving on to more difficult projects. This material may be used by those that wish to instruct others on kit building also. This information is step by step and filled with details of the building process and some notes on what each stage of the transceiver does. Not in real gory detail but in enough detail to help you comfortable with the construction and operation of a rig. You do not have to be a licensed radio amateur to build anything, but you do have to have a license to operate this transceiver on a real antenna and on the air, i.e. transmit RF energy into free space outside your home.

If you are an experienced builder you might want to consider using this project to teach new hams or want to be hams the craft of building and having a life long hobby. In this day and age of computers and high tech toys the expense of approximately $100 for a complete transceiver that will last for years to come is a cheap investment, IMHO. Feel free to use this material and give credit where

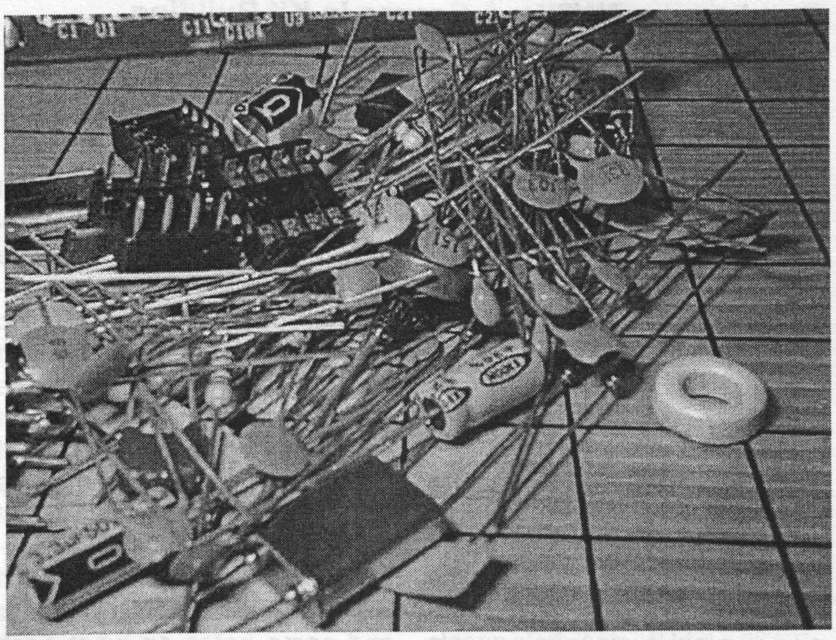


Fig. 1, Pile of parts for SWL30+ Transceiver Kit as they come from the bag.

due. Thanks and good luck.

When you get the kit from Small Wonder Labs the first thing you need to do is get organized. So let me tell you how I do it and you can either follow my suggestions or work out your own methods. My techniques are not the only way to solve a problem, but I have been building for many many years and these work for me. My success ratio is very high. In the package for the SW-30+ there are a number of bags. The clear zip lock, which I had in this kit, contains a large number of parts. Fig. 1 is a photo of them out of the bag and on a small surface in a pile.

The first thing that I do is break out the parts by type and put them in small bathroom Dixie cups (new and unused). But you can use muffin tins, small plastic cups, jars, etc. Do this with the zip lock baggie first. There is a another small black anti-static bag that you should not open yet.

The following pictures of the various parts will help you identify them if you have never done this before. I have given some references to the latest ARRL 2001 HB for reading material if you are very new at this and wish to learn more. Suggested reading is for all as you may have forgotten some of this stuff. If you do not own a 2001 HB, then any from 1995 to 2000 should work also.

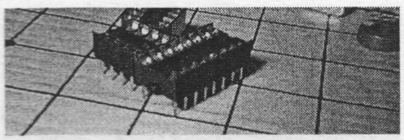


Fig. 2 Integrated Circuit (IC) Sockets HB 8.29-8.37

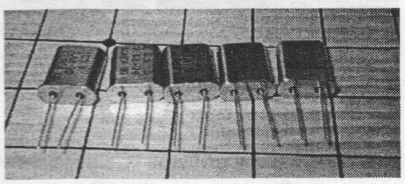


Fig. 3 Crystals HB 14.21-14.28

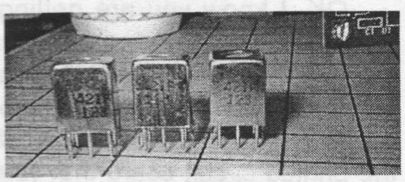


Fig. 4 Intermediate Frequency (IF) Cans HB 6.14-6.26, 6.42-6.50

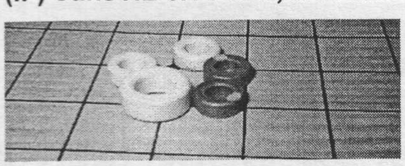


Fig. 5 Toroids HB 10.8-10.14, 25.23-25.24, 6.24-6.26

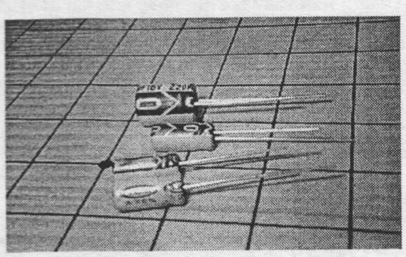


Fig. 6 Electrolytic Capacitors HB 6.7-6.14

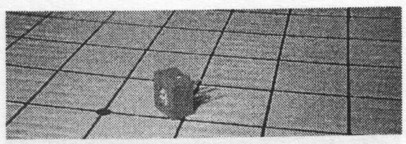


Fig. 7 Variable Resistor HB 5.2-5.6

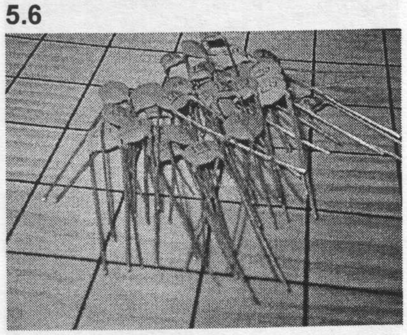


Fig. 8 Disc Capacitors HB 6.7-6.14

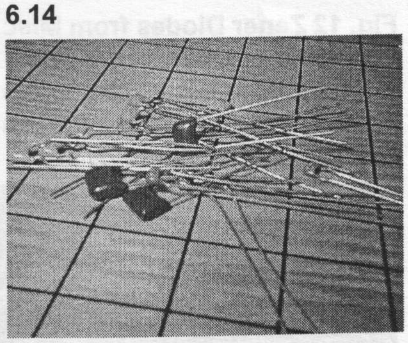


Fig. 9 Mono Caps HB 6.7-6.14

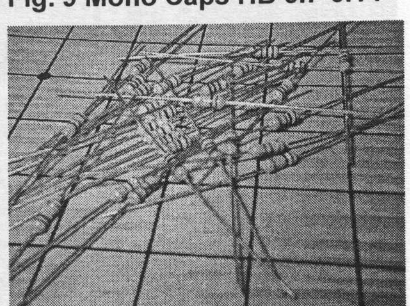


Fig. 10 1/4 Watt Resistors

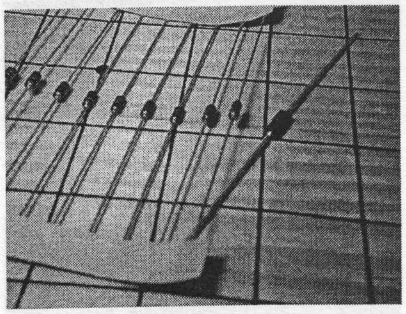


Fig. 11 Diodes

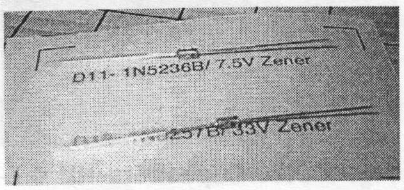


Fig. 12 Zener Diodes from Misc labeled envelope.

Do not remove these puppies from the paper. Just put them in a cup with the paper as they are.

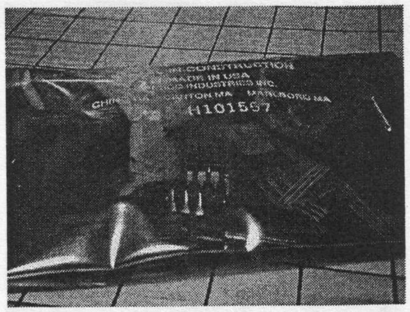


Fig. 13 Anti-static Bag

This bag contains ICs, transistors, etc. Do not open it at this time. Please.

OK, I know you are getting anxious to start building, so let's start slowly so that I can show you some tricks of the trade — so to speak. Here is a photo (Fig. 14) of the printed circuit board that you will building the transceiver kit from SWL on.

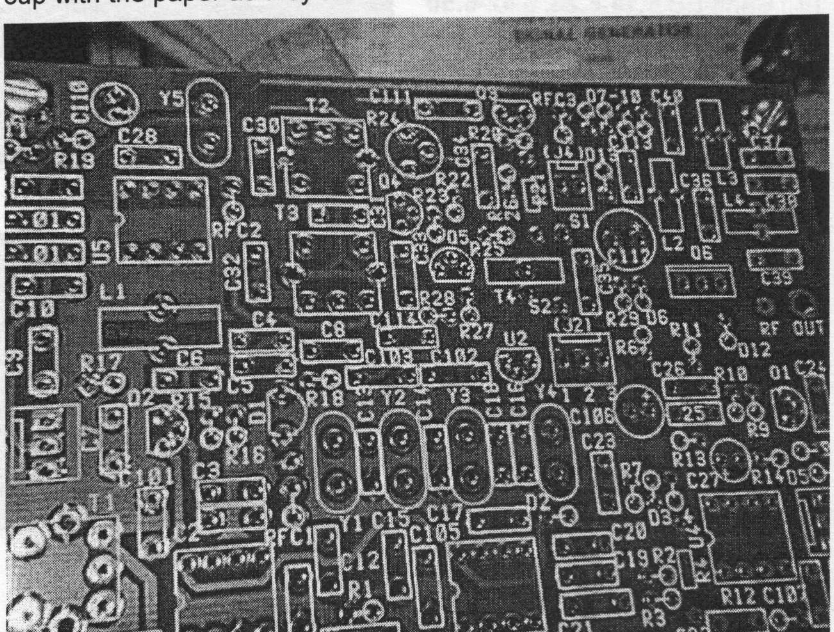


Fig. 14 SWL 30+ PC Board

Note that the printed circuit board for the SW30+ is what we call a double sided plated through board with silk screened outlines and labels on the component side. The component side is obviously the side upon which all the components that go on the board will be placed and soldered from the other side. Later in life you may run across a kit or kits where parts may also be placed on the bottom or underside of the board. We will not be concerned with that here. Note how nicely the board is done and don't be scared by the fact that the board looks crowded. You are going to place one part at a time on the board, so don't rush and just take your time and double check each step. Even as an experienced builder I double check my work as I go along. I find that it saves me a lot of trouble at the end trying to find simple mistakes.

I am a person that likes to build kits and electronic circuits in stages and test them as I go along. It gives me positive feedback that I am doing things correctly. It is also much more easy to find problems as they occur instead of getting to the end and not having a clue as to where something or several things went wrong. Also, by setting up a plan at the first I can learn more about the system as I go. You just have to do this a couple of times and you too can be an expert at doing this. So allow me to show you just how I think through this process using the SW30+ as an example.

First take the schematic for the rig and study it for a period of time. In a transceiver the three main building blocks are the variable frequency oscillator or VFO for short (also know as local oscillator LO). Then there is the receiver and the transmitter sections. These will be broken down even further into smaller sections. The entire rig is powered from some outside source in most cases. Dave gave me permission to reproduce his schematic and I have redrawn it using a program that I wrote. I have used dashed outlines for most of the sections to help identify them. There may be one or two components inclosed within a section that you can argue about it's belonging there, but this is not rocket science here and I'm not being picky.

I have come up with what I call the patented K7QO coordinate system for beginners. I know that the first time you do something like this you are totally overwhelmed by the amount of stuff you have to learn. Determining just where parts go on the board is difficult and even after many years of building I have difficulty with a new kit and components aren't where I assume that would be. Dave has a nice parts outline with the kit documentation and that helps, but there are still a couple of items that a tricky to locate at first. So here is what I'm going to do. With the board oriented with the labeling where you can read it, let's call the lower left hand corner of the PC board the origin, i.e. X=0.0 and Y=0.0 as in a

Cartesian coordinate system. I'll measure distances in centimeters (cm) from the corner and indicate a part location using the notation (X,Y) for distances in the horizontal direction (X) and the vertical direction (Y). Think of X as being the distance from the left hand edge going to your right and Y as being the distance from the bottom edge of the board (the edge closest to you when the board is in front of you). Again, all distances are measured in centimeters 'cuz I like the metric system a lot. So for something like D13 I'd indicate (7.5,5.5) and don't take the distances to mean that I got them exactly on the nose. They are just to get you as close as possible to make the part outline and label easy to find. OK? Neat idea if I do say so myself.

You might want to take the schematic and the PC board and study them together. See where each part on the schematic fits on the PC board. See if you can see the traces that correspond to the lines on the board. But don't start putting parts on the board yet. Let's do that together and in a specific order. Also read through Dave's manual as he has some excellent material. I am going to build this rig in a slightly different order and in detail to aid the beginners. If you have experience and you don't need me, then fire away and good luck.

Step 1 — Power Setup

For this article let's start with the power distribution. If you are using the schematic that came with the rig, look for J4 on the center right hand side of the page. In my schematic (the PDF link above) there is no power plug shown where J4 should be and the connection is shown as VIN just to the right of D13. This is where the 12 to 15V DC comes into the rig from the outside world. Before the supply voltage can get to any other part of the transceiver it must pass through D13. Several reasons for this diode. It is too easy for any one in the world to connect a battery or other power supply into the rig backwards, i.e. with the polarity reversed from the correct connection. If this reverse condition ever occurs there will be considerable damage done to the ICs, transistors and other parts immediately. So the diode prevents a reverse polarity on the input plug from doing any damage. The diode will also burn out at 1 amp of current so it will act as a fuse in some other cases but, unfortunately, if one ampere flows for even a short period of time for whatever reason there will most likely be some damage done to the rig. This is critical information. You will note in all of the following pictures that I have four standoffs each placed at one of the four corner mounting holes of the PC board. If you can at all do this, then do the same thing with either nylon standoffs or if you don't have anything else use some small 1/4" long screws and nuts to just place the board above the table surface when it is just sitting. Later we will be powering up the board, i.e. applying 12V to test things. The worst thing you can do is have the board sitting on a work surface when there are metal wires under the board and you apply power. These wires will cause short circuits and burn out traces on one or more sides of the board. This is an expensive error. Don't do it.

So let's install the diode **D13** first at (7.5,5.5). Here is the way I go about installing a part. First identify the part. In this case it is a black diode (in the diode cup) with 1N4001 printed on the body of the diode with a white band on one end. This white band is the cathode end of the diode and corresponds to the end of the schematic symbol with the line perpendicular to the arrow. All diodes in NN1G kits are installed with the band away from the PC board, i.e. that end is up. Here is a photo of the diode, the way it is bent, and the chain nosed pliars that I use.

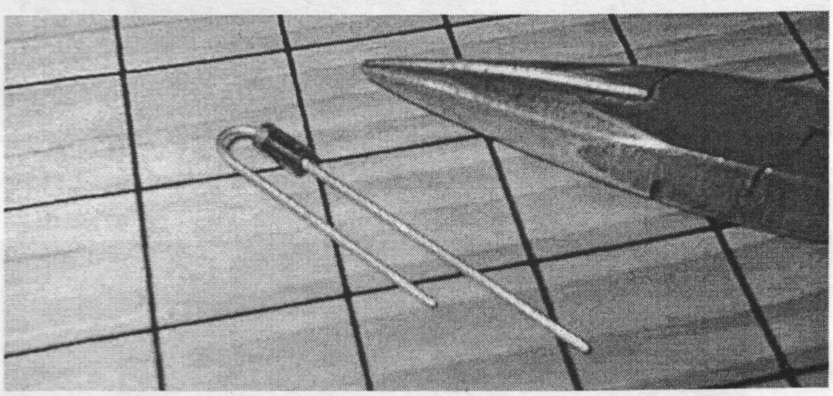


Fig. 15 Diode D13 bent for mounting on the PC board.

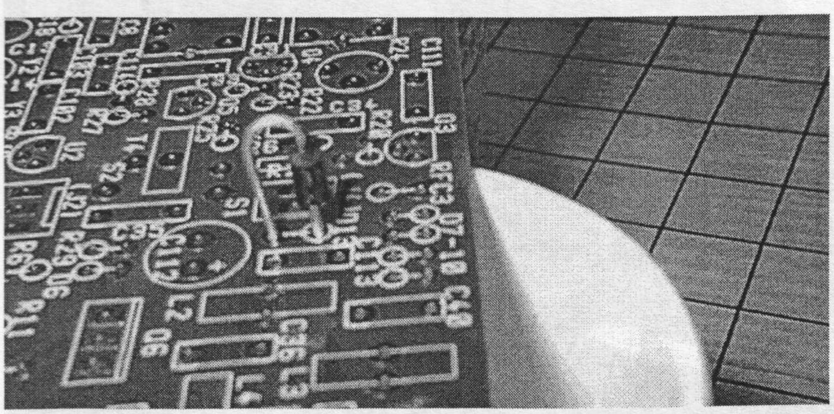


Fig. 16 Diode D13 on the PC board just before soldering.

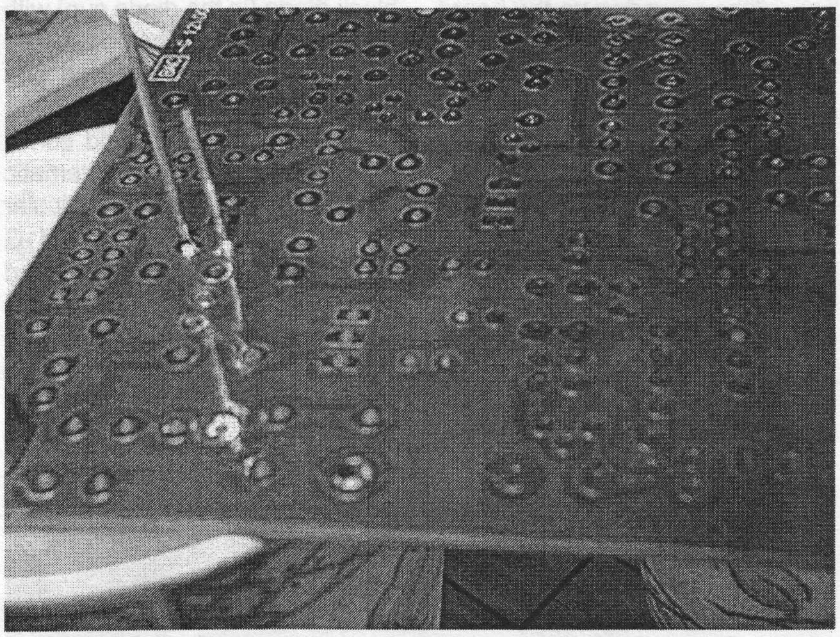


Fig. 17 Diode D13 on the bottom side of the PC board just before soldering.

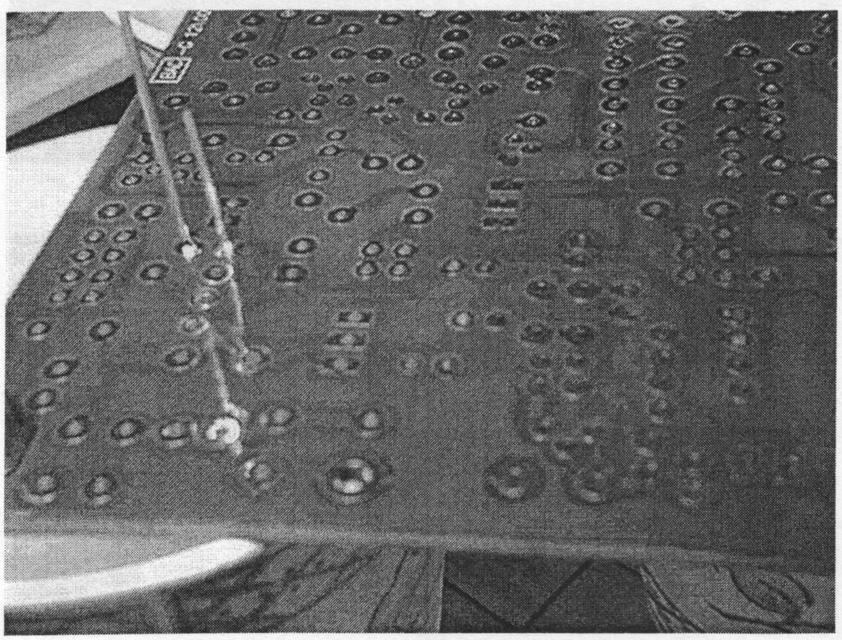


Fig. 18 Diode D13 bottom side of the PC board after being soldered.

A side note on my soldering technique. Since I use a solder from Kester that is 62/36/2 based and has a low melting point and a 2 percent silver content, I like to place the solder between the iron tip and the component lead and PC pad and then apply heat. I know that a lot of books including the ARRL Handbook suggest different. But I find that the melting of the solder distributes heat to the joint rapidly and I spend no more than three seconds (the K7QO 3-second rule) in soldering and I remove the heated tip of the iron. I get the solder to melt and flow in this time period and I don't over heat the part on the other side of the board. See the Manhattan Article on my web page for more details on what solder I use, etc.

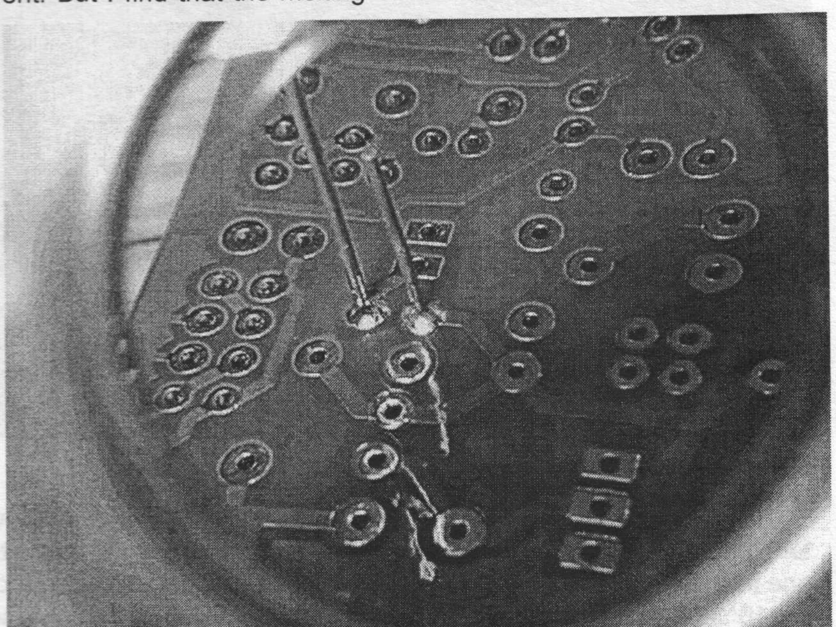


Fig. 19 Diode D13 bottom side of the PC board after being soldered.

This is a magnified view and the best that I have ever seen if I do say so myself. I used one of the lenses from a 8x Loupe to do this one. I love it.

Now that you have successfully installed the first part, let's do two more.

U2 at (6.0,3.5). U2 is a 78L08 8 volt voltage regulator. It is located in the black anti-static bag and use the techniques for working with these parts as described in Dave's manual. The 78L08 looks like a small transistor. It has three legs on the bottom. Install it at the location (6.0,3.5). Make sure you have the right part and make sure you put in the right direction by following the outline on the PC board.

See the photograph if you have any questions. You do not want to ruin this part or any other part for that matter. Since no one is timing you just take it slow and easy and double check everything that you do. You'll do OK.

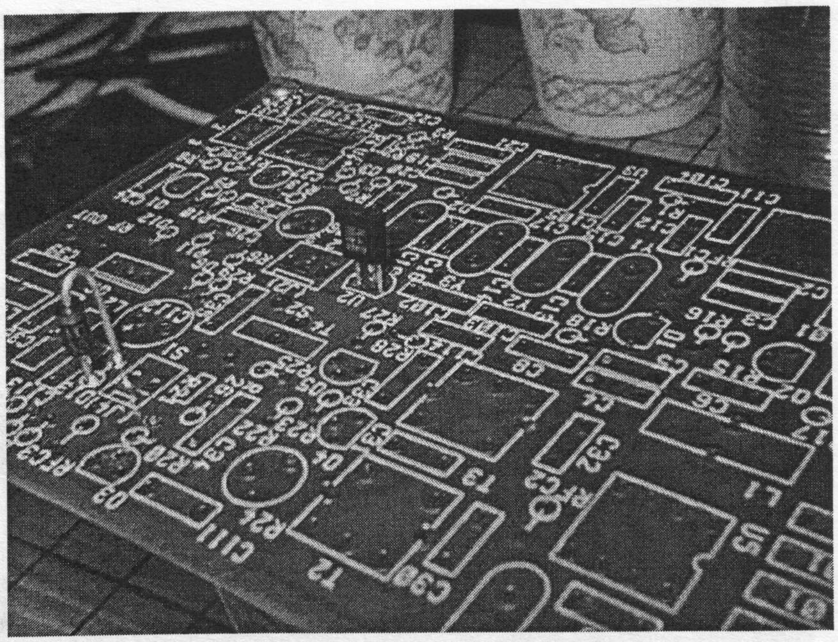


Fig. 20 78L08 in place center stage.

Now look in the disc capacitors (caps) and look at the side for one that has 103 on it (103 means 10x10^3 pF which is 10,000pF or 0.01uF. (A note: the British like to use nF for nanoFarads, which is what 1,000pF is, thus 10,000pF is 10nF and you'll see this notation used a lot in SPRAT and other British based publications.) This is a 0.01uF (microFarad) cap. Solder it in location (5.0,3.5) where C102 is labeled. Do not force the leads (legs) of the cap down into the holes so far that the covering material also is in the hole. I leave just a very very small amount of metal showing on the top side to allow the solder from the bottom side to wick or flow onto the top side of the pad. Don't leave a lot. I like the parts close to the board and not more than a few mm of bare lead above the board. Again look at the pictures next to see just how I do it. Do not force any part into the board. They break easily or you may create a small fracture that you will not see and the part(s) cease to work.

C102 to the left of the 78L08.

At this point I want to show you something. This will be difficult for me to go into every little detail on,

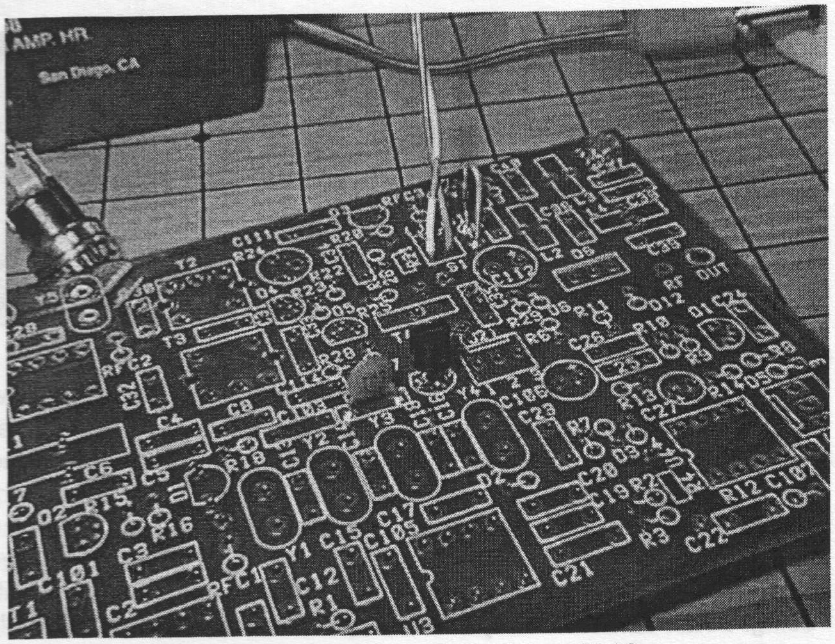


Fig. 21 C102 to the left of the 78L08.

but let me try to convey enough info that you can do this. I am assuming that this is your first time to build and I hope you want to learn as you go. Time spent here will aid you the rest of your life in building. If you purchased the case, mounting hardware, pots, etc. then you want to install J4 (the power plug) on the board. If you do not have the case, then I do the following.

Find two wires about 10 to 15 cm long. One red and one black. Lightly solder these into the two holes at J4 (7.0,6.0). The red one into the right hand hole and the black one into the left hand hole. With these two wires you can now apply a 12V supply to the board for testing. If you are building from the kit from SWL then look on page 15 to see the power connector setup at the top center of the figure. I use a 12V 0.8AHr gel cell for small rigs. I also use a plug and connector for battery supplies. All that is important you have a way to connect the battery to the transceiver for testing and hopefully you can disconnect rapidly if you need to in case of emergency. Also place a small fuse in the power line to prevent accidents and damage to parts. The center conductor is + and the outer conductor is -. Measure with a digital multimeter after wiring these. A word of warning. When working with batteries and I do this a lot. You must make extra sure that you do not short out the wires from the battery. If you are soldering wires to "live", i.e. charged batteries and you should always assume that they are

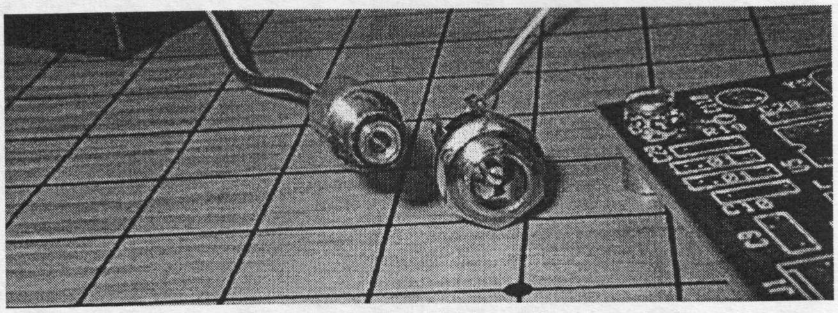


Fig. 22 Power plugs.

charged, you can get into serious trouble in a hurry. Some of these batteries can easily generate 100 amps of current for a short period of time and that is a fire hazard to say the least. Get expert help if you are not sure about what you are doing. Better safe than sorry.

Now get one of the glass diodes, a 1N4148, and solder it into place at D2 located at (6.0,1.5). Do it in a similar manner that you did D13. Be careful as the glass easily breaks. Be sure to read Dave's instructions that all diodes mounted vertically have the banded end at the top away from the baord. Proud to say that this was my suggestion years ago as the first kits had different orientation for some diodes and it could cause confusion.

If you are following these building instructions then it is time for your first test. Make sure the bottom of the board is above any conducting objects. Use standoffs please. Connect the battery to the transceiver at this time. Watch for signs of trouble and gently touch the 78L08 to see if it is hot or the wires from the battery are hot. This means that a lot of current is flowing and you have a short somewhere on the board. At this time with so few parts this should not occur, but I'm not there to help you. Make very sure that you always connect the + terminal of the battery to the wire that goes to Vsupply (+) and the negative battery terminal to GND or negative (-) lead from J4. Pay attention at all times and if you are tired then you should quit. The rig won't run off in the middle of the night. Another warning. Touching parts is a dangerous practice. I have touched metal transistors that at the time were running a lot of current and were over 100 degrees C and I wound up with a blister on my finger. So don't do this as a general habit. Please.

With power applied, use a digital multimeter in the VOLTAGE position and measure the voltage at J2 pin #1. This is at (6.5cm, 3.5cm) K7QO coordinates. You should read close to 8.00V. OH, you might not know about DMMs. The red lead should touch ONLY the point at which you wish to measure the voltage. The black lead should touch one of the standoff screws or one of the pads at the four corners. The pads are square and tin plated. I did get exactly 8.00V, but this does not mean that you will. Parts will vary slightly and you may read something like 7.89V or even 8.07V. Anything within a 5% or so is fine. This is not rocket science. Look back at your schematic to see at what point you are doing your measurement. I emphasize the point that you double check to see that your meter is in the voltage position. I have lost several fuses in the multimeter by having it in the wrong position.

At this time with very few parts on the board making measurements is easy. Touch the probe from the DMM to the center of the pad since there are no leads from parts soldered at this time. Later, when you have to make measurements in a crowded area you have to pay attention at all times and pay particular attention that you do not touch the lead(s) to more than one pad or lead at a time or you can cause a short and destroy one or more parts in the process. I don't mean to be always warning you of things but be careful at all times.

OK. Look on the board at (2.0,1.4) in the lower left quadrant and you will see a rectangular outline labeled U1. This is for an IC socket. See the left side and the round dimple on the outline? This is used to show how the IC will be installed. Starting at the bottom left the pins are numbered 1, 2, 3, and 4 for the bottom row. Continuing in a CCW direction the top row will be pins 5, 6, 7, and 8 from right to left. If you look at the schematic you will see that pin 8 (the upper left pad) is connected to V_r (read as V-sub-r) which comes from D2. Measure the voltage at pin 8 of U1. This voltage will be less than what you measured as the output from the 78L08 because of the voltage drop across D2. I get 7.72V. Look carefully at the PC board and you will see a conductor running under the green solder mask up from pin 8 to the bottom pad of Q2. This is the collector of Q2. Measure the voltage at this pad of Q2. You should get the same reading as you did previous at pin 8 of U1 (mine was 7.72V). Follow the PC board trace from pin 8 of U1 to the right and you'll see it winds around (technical talk for it does not make a straight line path) to pin 8 of U3. Measure the voltage there also. Get the same voltage as before? Good. Look back at the schematic and you should see a line from pin 8 of U3 to a crossing of lines and off to the left an arrow pointing to V_r. This means that a conductor or wire goes from this point to all other points labeled in the schematic as V_r. It saves clutter in the schematic and is done regularly. For the schematic that I produced for this rig I show the wire. No big deal.

I'm having you do this exercise now to help you see what is going on and to check out work as we progress. It makes building a lot easier, gives you positive feedback, and trains you to make careful measurements. You may wish to keep a journal on each step for future reference and to aid in asking for help later on. OK, now unplug everything from the rig (transceiver) before proceeding. Make it a regular habit to turn off things when you leave the lab or area you are working in and before going back to soldering parts into the board.

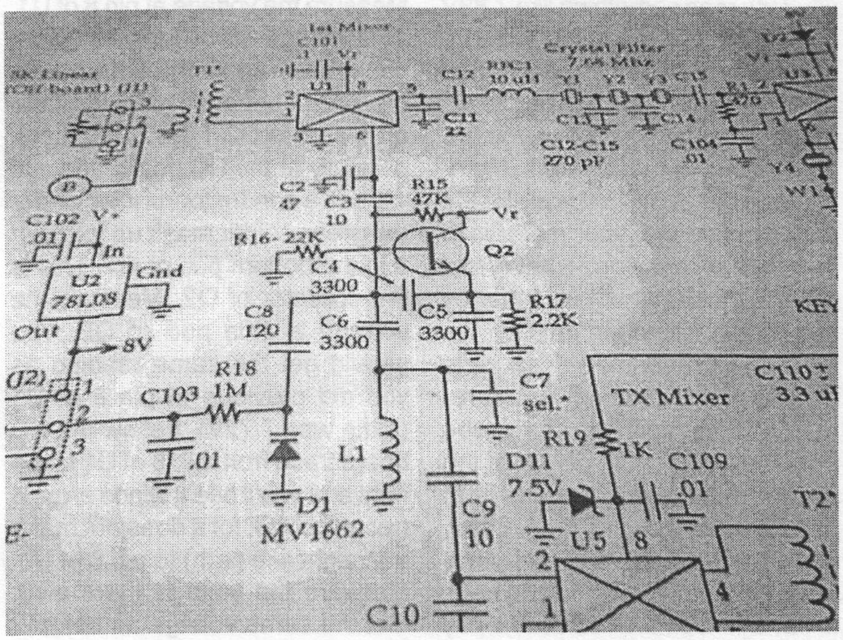


Fig. 22 VFO Schematic

Step 2 — VFO Section.

Before you begin building anything may I suggest something. Make a photocopy of the schematic. You don't have to do that here as you can easily go to my web page, bring up the Adobe PDF reader and print out the schematic that I have already done for you. Then with a highlighter of your favorite color you should highlight each component as you install it. It will keep you out of trouble. I did that, but I forgot in this writeup to put in L1 when I first published it on the web. This caused me some embarassment on QRP-L when someone brought it up publicly. In doing a rewrite and update here is what I did. I printed off this article (19+ pages on my printer) and with the highlighter and red pen corrected things and modified text as I went along. I also printed off another copy of the schematic and highlighted parts as they appeared on the page. This way I guaranteed myself that I left nothing out. Well, as much as one can guarantee things. :-)

We are now going to build the

variable frequency oscillator section of the transceiver. You may think of this as the heart of the transceiver. The oscillator will be used to determine the receiving and the transmitting frequencies while in operation. It is variable, i.e. the frequency may be changed. This is accomplished by using a variable capacitor (varicap) that is actually a diode with capacitance between the anode and cathode that is varied by applying a voltage across the diode. This diode is D1 and is a MV1662. C103 is a bypass cap to keep the radio frequency oscillations (RF) from the tuning variable resistor and the voltage regulator U2. R18 is a current limiting resistor and also serves as an isolation resistor so that the oscillator does not see C103 and the rest of the circuit to the left of D1 in the diagram. C8 keeps the DC voltage away from Q2 and the oscillator itself as C8 blocks the DC voltage from getting to the junction for R16, C3, R15, Q2 base, C4, and C6. More on the circuit in a bit.

Let's build up the VFO. I'll go from left to right in the schematic and just list the parts in order with their part designation, markings to help identify them, their actual values, and then their K7QO coordinates on the board. I will also at points show you a picture of what the board looks like at that point. This will scare you, but I will show you D1 in place but I will have it missing in a few pictures because I am going to do an experiment for the MH101 group. You install D1 when I show it in the following list.

C103 (103) 0.01uF disc cap (4.0,3.5) just to the left of C102 already installed.

R18 (brn-blk-grn) 1M resistor (3.5,3.5) just to the left of C103

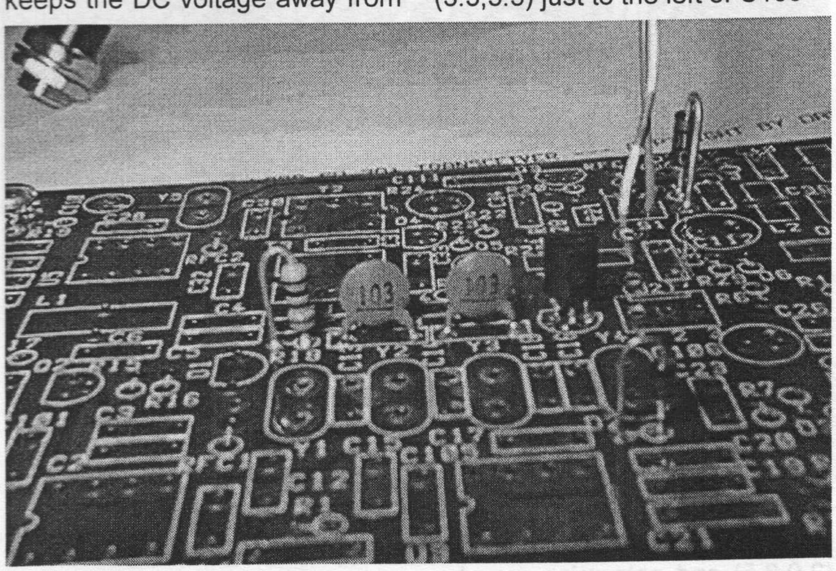


Fig. 23 C103 and R18 Installed

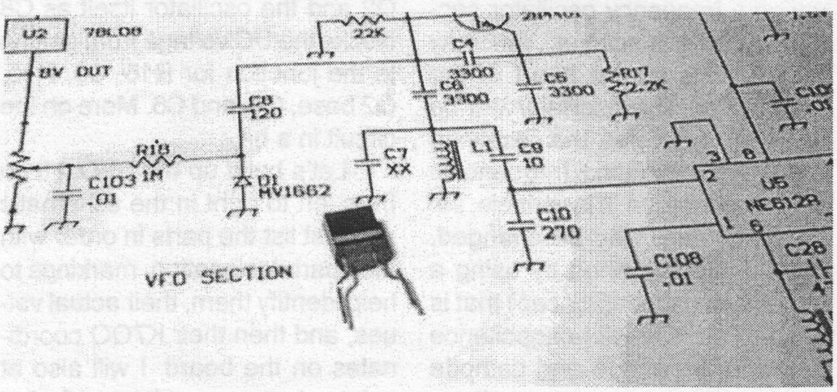


Fig. 24 MV1662 Diode

D1 (no markings) MV1662 diode (3.0,3.0) Make sure to follow part outline on the board with flat side of the diode aligned with the outline flat side.

C8 (120) 120pF NPO mono cap (has blue body with white markings) (3.5,3.6) just above R18

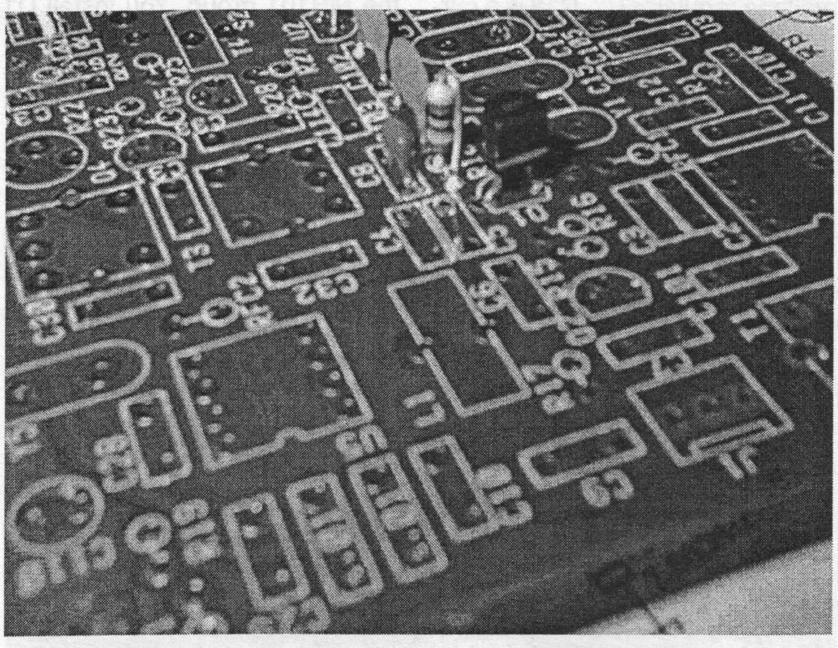


Fig. 25 D1 and C8 Installed

C6 (332) 3300pF NPO mono cap (2.0,3.5) and note mine may be slightly different than yours

C4 (332) 3300pF NPO mono cap (3.0,3.8)

C5 (332) 3300pF NPO mono cap

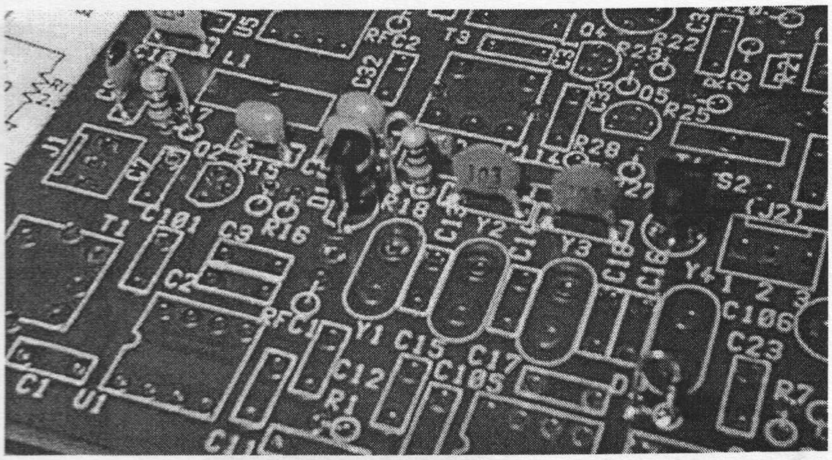


Fig. 26 R17, C9 & C10 Installed

(3.0,3.5) In the next step you will install R17. Before doing so look at its outline on the board and note the ground plane. You will install resistor reversed in order that the lead that is at the top will not be the ground plane just in case we need to measure this. If you have already installed the resistor in the direction on the board, then do not remove it. It will not affect the operation of the circuit at all.

R17 (red-red-red) 2.2K resistor (1.2,3.4) left of C6 and note installation opposite of outline on board. See Dave's note in manual on page 9 left hand side margin of the diagram.

C9 (10) 10pF disc cap (0.6,3.5) just to the left of R17

C10 (271J) 270pF disc cap (0.7,4.5) just above C9

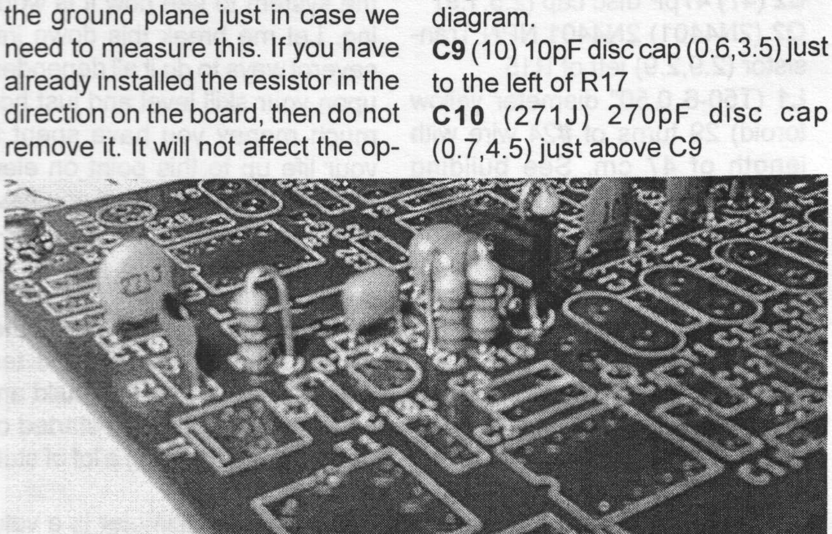


Fig. 27 R16 & R15 Installed

R16 (red-red-org) 22K resistor (2.6,2.8) just to the left of D1

R15 (yel-vlt-org) 47K resistor (2.4,2.8) just to the left of R16

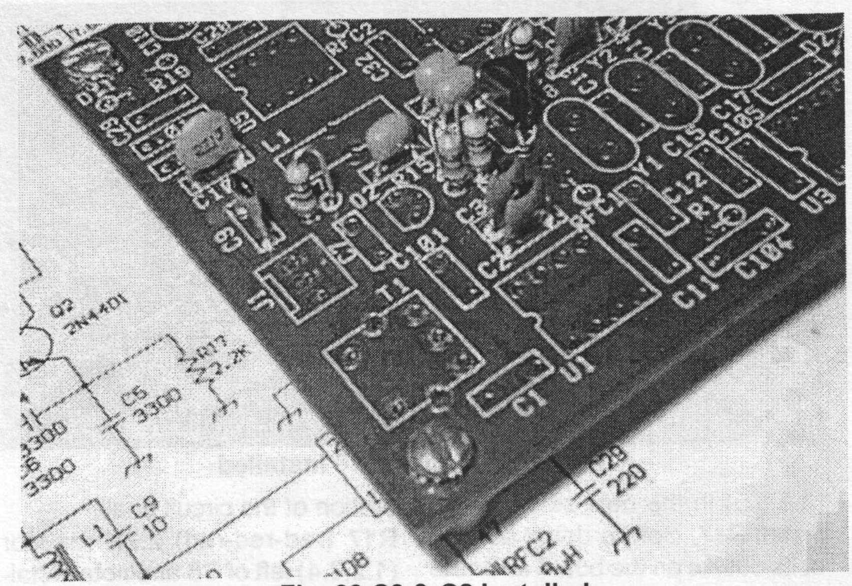


Fig. 28 C3 & C2 Installed

C3 (10) 10pF disc cap (2.5,2.1)
C2 (47) 47pF disc cap (2.5,1.9)
Q2 (2N4401) 2N4401 NPN Transistor (2.9,2.9) left of R15
L1 (T50-6 0.50" diameter yellow toroid) 29 turns of #24 wire with length of 47 cm. See building manual for details on toroids and winding or see the ARRL Handbook.

This completes the VFO section. Please note that we have not installed the capacitor at C7 yet. We have not connected the tuning pot that will be on the front panel yet. I prefer not to do this at this time in order to save the hassle of having it flop around during the rest of the assembly or having to unsolder it after doing some tests.

Step 3 — VFO Alignment

OK. Congratulations are in order. You have just completed a major project. It is now time to test the system to see how it is working. Let me break this down into several ways to do it all dependent upon your skill level and just how much money you have spent in your life up to this point on electronic test equipment. If you have been a regular lurker on QRP-L then you may have picked up some of the bargains that came along at Radio Shack and other places. Then there is some test equipment that you can build and this is how you can get started on the journey to building a lot of stuff.

DMM Only

A digital multimeter is a valuable tool and very inexpensive in this day and age. Harbor Freight just recently had one on sale for $9.99 and sometimes you can find DMMs on special sale at Radio Shack. Let me warn you. There are people out there that will give you 1,000 reasons why you should not use one or trust one. These individuals will tell you that doing a measurement will affect the circuit. Heisenberg, a famous physicist who may or may not have slept here or there, determined that if you measure anything you affect it. True here, but we are just trying to determine if things are working and this is not rocket science. So ignore every one but me. I do know what I'm doing here.

I am going to have you take some measurements with the power applied to the circuit thus far built. I will have to measure at points that are easy to reach. Please be careful and not drop the digital probe and make sure the pointy end thingy only touches one thing at any one time. Don't get distracted. Remember that the point at the end is a conductor made of metal. If you happen to allow it to touch more than one point at once then you can create a short circuit, i.e. 0 ohm resistance between two points, that might just cause a lot of current to flow and destroy all your work. Been there. Done that. It's not a pretty picture. I'm not trying to scare you here, just let you know that things do happen if you are not careful and even when you are and you think you know all there is to know about everything.

For these measurements use the negative lead (-) of the DMM to connect to one of the standoff ground pads at either of the four corners of the PC board. Then use the positive lead (+) of the DMM to make these measurements. With the components standing vertically on the PC board we will touch the probe to the lead at the top of the part. This is easy to do and not very dangerous compared to trying to get a probe to touch a lead at the base of the part and between other close parts where we could easily create a short circuit. I will give you the part number and the voltage that I get. You DO NOT have to get the same exact voltage that I do. Just in the ballpark will do. Problem with digital stuff is that people tend to take the numbers as the only correct ones.

We have not connected the tuning variable resistor to J2 and we don't need to. The oscillator will run just fine without it. We just can't adjust the frequency. We can do something later in this section if you have the equipment to do the adjustments.

R18 0.070V
R16 2.31V
R15 2.31V
R17 2.98V
D2 7.49V

The value of R17 will be close to this if you installed R17 differently from the outline on the PC board as per Dave's note on page 9 and my suggestion previously in this writing. Otherwise you will get 0.0V even if the circuit is operating properly.

If you got close to the above voltages then you have a working

VFO. In fact if you got a non-zero value at R18 then the oscillator is running. The diode D1 R18 and C103 combo acts like a RF probe and proves that RF currents and voltages are at work in the circuit!! Are we good or what? The A-team at work, you and me kid. If you don't have the equipment to do the following sections, then not to worry. Your VFO is working and you can move on to the next building section.

Frequency Counter Measurements

If you own a frequency counter, like the Radio Shack one that was on sale last year I believe. Model number 22-306 is the one that I have and I also have my trusty Heathkit IM-2410 that I dearly love. Anyway, using the frequency counter measure the frequency (while the VFO is powered up) at pin 6 of U1. If you look at the schematic you will see that we are getting output from the VFO through the coupling cap C3 which is very small, 10pF. This C3 cap helps keep the VFO somewhat isolated from the NE602/NE612 mixer chip but couples some of the RF energy to the local oscillator (LO) input of the mixer.

Also measure at pin 2 of U5, the transmitter mixer. You should get about the same thing. Because of the affect of the counter on the circuit may vary at the two places you won't get the exact same reading but pretty close.

The intermediate frequency (IF) for this rig is 7.680MHz. This means that in order to get the frequency range of 30 meters, 10.100MHz to 10.150MHz, you have to have the VFO working at 10.100MHz - 7.680MHz or 2.420MHz for the low end of the band and 10.150MHz - 7.680MHz or 2.470MHz for the high end. This tuning range is not possible with the SW-30+ VFO circuit as it is and I measured about 36KHz range, which is just fine.. As it turns out, without the tuning voltage applied to R18 and thus D1, the VFO is operating at its lowest frequency. The toroid that we wound with 29 turns, L1, helps determine the operating frequency of the VFO. After powering up my VFO and checking its frequency with the frequency counter I found that the frequency was 2.4748MHz which is too high. Since the frequency goes as 1/(2*pi*sqrt(L*C)), in order to lower the frequency we either increase L or increase C. Increasing L means removing the L1 toroid and rewinding with an added turn. Too much trouble I guarantee you. So Dave was smart enough to include in the kit some extra caps with values of 22pF, 47pF, 68pF, 82pF, 100pF, etc. These he shows in his parts list as C7A, C7B, etc. Here is what I do. Cut the leads on these parts to about 1.0cm and set their leads to slightly larger spacing than the two holes in the PC board for C7. I then put one cap in the C7 position with a friction fit to hold it in place on the board with the leads making contact. I then measure the resonant frequency of the VFO with the cap in place. That way I do not have to solder, measure, unsolder, solder the next cap into place, measure, unsolder, etc. Remember we are shooting for 2.420MHz here or within a few KHz.

Here is what I get for my VFO and the 3 caps that I had to use to get close.

C7=0pF 2.4748MHz
C7=22pF 2.4523MHz
C7=47pF 2.4260MHz
C7=68pF 2.4070MHz

So the 47pF is close enough. I soldered it in. Now comes the tricky part, well kinda the first time you do this. You can further change the frequency by "squeezing" the turns on L1 closer together. Please note. This does not change the inductance of the coil. If it did, I can get you a nobel prize in physics if you prove otherwise. What you do is change the distributed capacitance across the coil. By moving the turns closer together you increase this capacitance and you further lower the resonant frequency of the circuit. Try it with just a small movement of the turns. By spreading the turns out a little you lower the frequency. Go the way that you need to go to get to 2.420MHz as the measured frequency out of your VFO. This will be the lower tuning range of your VFO. Good work. Take a break.

If by any chance you start out with the frequency of the VFO less than 2.420MHz, then you will have to unsolder L1 and remove one turn and resolder it back in place. It may be that you wound one too many turns, but then again the variance in the magnetic properties of the cores may have caused the slight problem. But you can fix it easily.

Now if by chance you happen to own an oscilloscope then use it to measure the waveform at pin 6 of U1 and pin 2 of U5. You should see a nice sine wave at each point. They do not have to have the same magnitude. I may come back with this measurement later if I get a chance to remember to do it. It is just nice to see the waveforms and know exactly what they look like.

Step 4 — Receiver Audio and Testing

Since I am assuming here that you are a first time builder and also that you don't have a lot of expensive test equipment, then let's build this puppy in an order that will give you some feedback as you go. Since you my not own any other radio equipment I have to consider that possibility and you can build this transceiver without a lot of equipment. Just some thinking and some planning and I'll do that for you.

Look at the schematic for the transceiver. You do not want to build the transmitter first as you may not have everything to test it out properly, so let's build the receiver. We are going to use your ears as a piece of test equipment. So I am going to start at the audio output and build the receiver from right to left on the schematic. And I'll show you some neat tricks that I use even though I have the necessary test equipment. By building this way I can do a quick test and not have to drag out some equipment, and get set up.

So here is the order we'll do this building stage. We are working from the top right hand side of the schematic. Starting with R14.

R14 (brn-blk-blk) 10 ohm resistor (9.0, 2.1)
C27 (47uF) 47 uF electrolytic cap (8.5, 2.1) note the longest lead is the + lead and the short lead is the (-) lead. Also the side of the cylinder for the negative (-) lead has a black looking stripe, but if you look closely at it it is a black arrow with a minus sign in it. Neat stuff if you look close enough.
R13 (brn-blk-grn) 1M resistor (8.0, 2.4)
C25 (821J) 820pF mono cap (8.0, 2.9) just above R13 and this mono cap was a dark brown in color in the kit I got. Mileage may vary.
C26 (222J) 0.0022uF mono cap (8.0, 3.0)
R11 (grn-brn-yel) 510K resistor (8.2, 3.4)

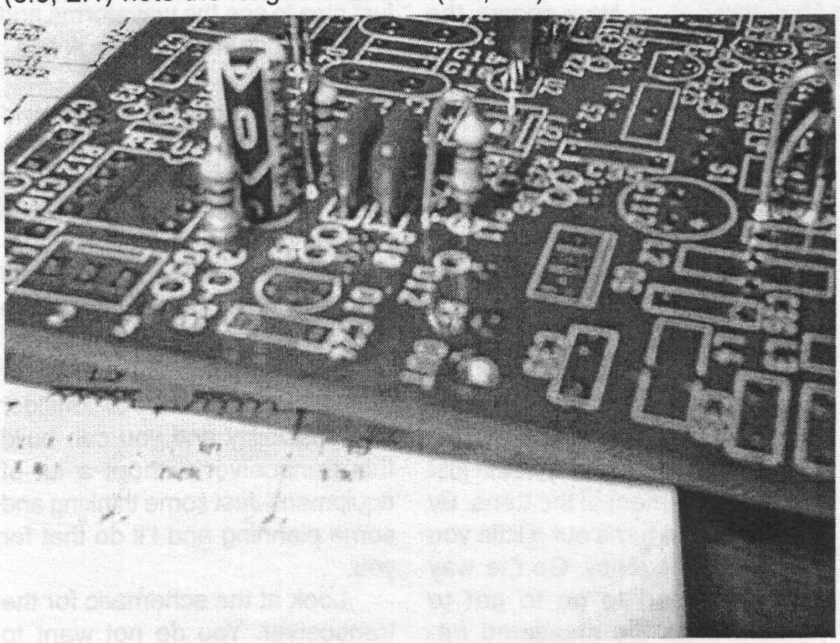


Fig. 29 R14, C27, R13, C25, C26 & R11 Installed

Sorry for the slight out of focus here, but you get the general idea. Continuing on....
R12 (brn-blk-grn) 1M resistor (8.7, 0.3) TRICKY. Low right corner near edge of board and between C107 and C22. The usual standing on edge resistor placement. Here is a picture to help. See Fig. 30.

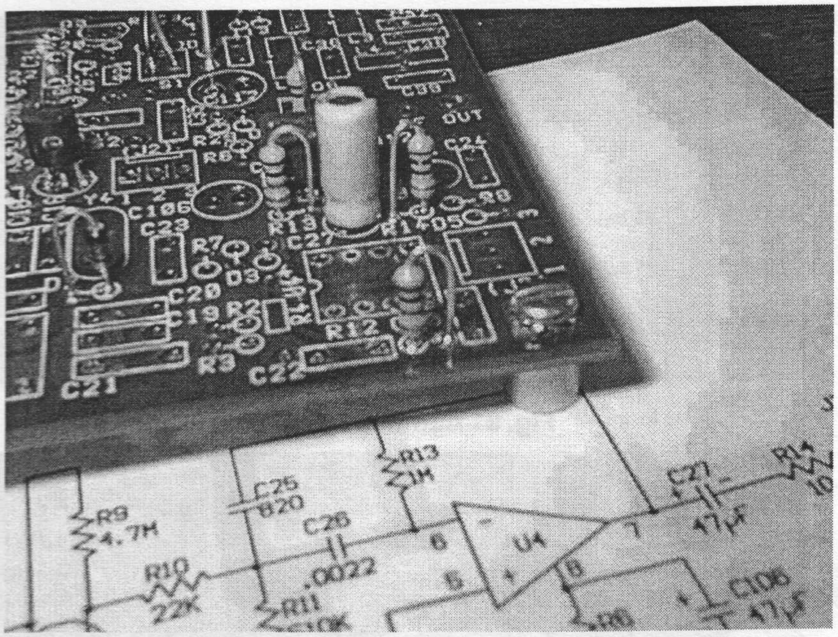


Fig. 30 Showing the placement of R12 near the edge of the board.

C107 (104) 0.1uF mono cap (9.1, 0.5)
R6 (brn-blk-blk) 10 ohm resistor (7.5, 3.5)
C106 (47uF 25V) 47uF electrolytic cap (7.4, 2.6)
8 pin socket at U4 in the middle of the stuff you just put in. Make sure the little half-moon shape in the socket end matches with the white outline on the board. Hold socket in place with some masking tape and the solder ONLY TWO pins. I choose two pins on opposite corners to solder. Then turn board back over and look at the socket. Is it in the right place? Does the half-moon match the silkscreen outline? Is the socket down on the board all the way. Reheat the pins to adjust the socket if necessary.

I put a stereo 3.5mm jack at J3, pins 1 and 2 by using some small wire and tack soldering for temporary installation. See the following pic. Pin 1 is ground and pin 2 is the audio output. For stereo phones you wire pin 2 to both right and left (tip and ring of the jack.

Look for the U4 IC labeled 5532. Mine was manufactured by Raytheon and had RC5532N on the top. Yours will most likely be the same or close to it. Note the small circular indentation on the top. This is pin 1 of the IC. It will go on the end where the half-moon is on the socket and board outline. Use Dave's instructions for making sure the pins are straight and carefully insert the IC into the socket. Do not force it with too much pressure. It may take a

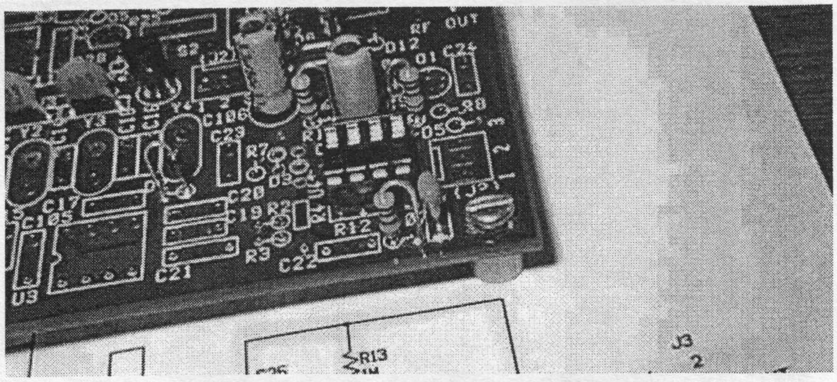


Fig. 31 Audio Stage Wired

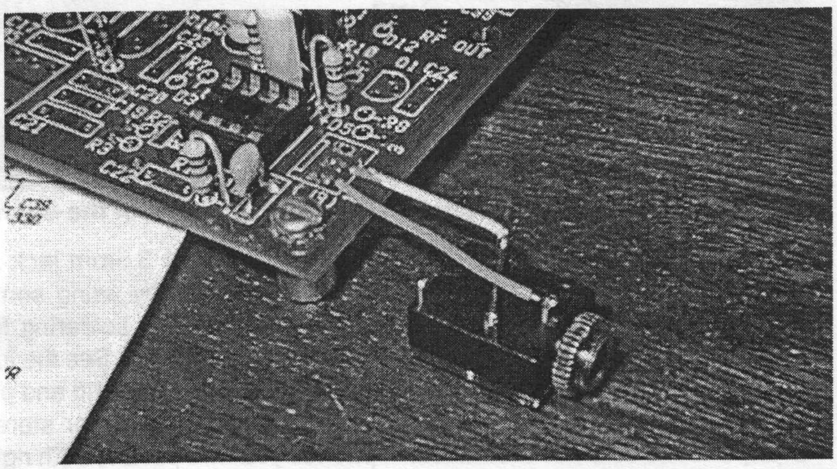


Fig. 32 Wiring of Stereo Jack

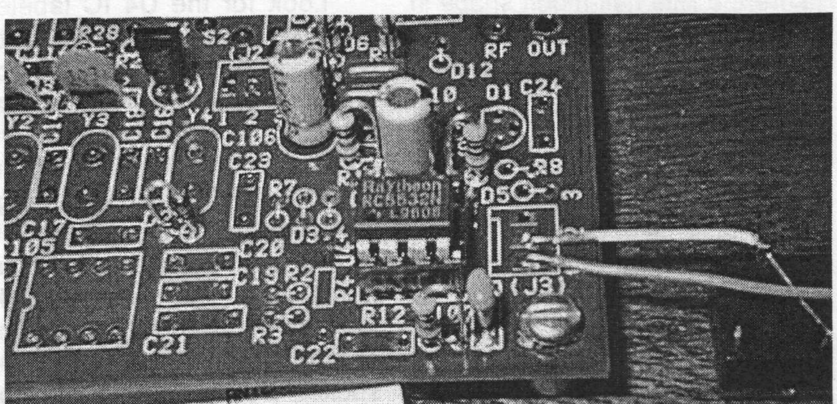


Fig. 33 IC in place.

pound or so if it is stubborn, but make sure the pins are in the right position in the socket before you really push.

Note the markings and you can see a dark circular dot that is the edge where pin 1 of the IC is located.

OK, take a break. Run off to the sink and wash your hands. You'll see why in a second.

Now the moment of truth. Plug in some Sony Walkman type headphones into the jack. Place the headphones just in front of the ears in case upon power up the audio stage starts screaming. Most likely it will not if you have been careful. Plug in the power source. In my case the gel-cell battery. You should hear a slight pop and then pretty much silence. OK. Lightly lick your pointing finger. (See why I had you wash your hands? Touch only the top of R11. You should hear some hum in the headphones at this time. Maybe a slight pop when you touch or rub the top of the lead to R11. This proves that your output audio stage is working correctly.

This pretty much concludes the building of the final audio stage of the receiver. Congratulations again on a fine job. We can now move on to the muting circuit next.

Step 5 — Muting Circuit and Testing

We now want to move to the next stage towards the front end of the receiver. This consists of Q1 and about 5 other parts so this goes quick. This circuit is something that Roy Lewallen, W7EL, came up with in his famous direct conversion rig for 40 meters. You'll see a lot of people using this circuit in their designs. By now you should be pretty comfortable identifying parts and figuring how just where they go on the PC board. Remember to concentrate and take your time. This is not a race.

R10 (red-red-org) 22K resistor (8.6, 2.8)
R9 (yel-vio-grn) 4.7M resistor (8.8, 2.8)
Q1 (MPF102 or 2N5485) JFET (9.3, 2.8) either part will work here and I had a 2N5485. Again, remember to place transistor oriented according to the board outline and do not force the transistor too far onto the board and break off one or more leads. I allow about 3 or 4 mm spacing above the board. (1/8")

C24 (104) 0.1uF mono cap (9.7, 2.8)
R8 (brn-blk-grn) 1M resistor (9.3, 2.2)
D5 (1N4148) 1N4148 Si diode (9.7, 2.0)

See, that went pretty fast. Now here are some pictures of the completed section from different angles. Note the schematic and the highlighted parts that were installed. I find that when I do this I don't miss things. Forces me to take more time and care in building.

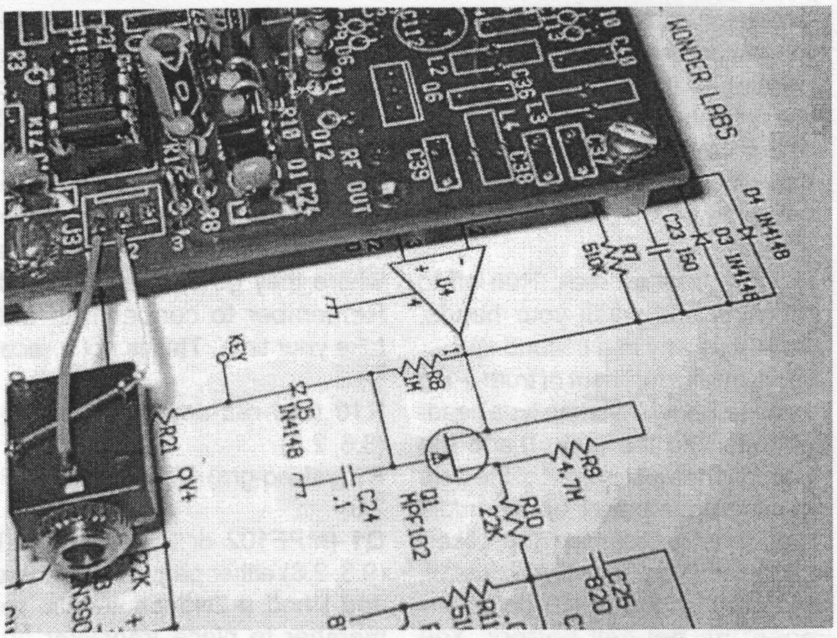


Fig. 34 Muting Circuit Installed

Now for testing. Hook up the headphones BUT DO NOT PUT THEM ON. This test will blow your ears off if you try to get ahead of me. Now hook up the battery or your power source. You should be able to hear a tone coming from the headphones. What we have built with the addition of the muting circuit is an audio oscillator. Pretty loud isn't it?

This next step must be done carefully. Find a short piece of wire about 2 cm long. Use it to connect pin 3 of J3 to pin 1 of J3. This in effect acts like a straight key and shorts the cathode of D5 to ground. This turns on the muting circuit and the tone in the earphones should stop. If it does you are home free. If it does not, then go back and check the parts that you just installed. Hopefully you did not zap the JFET with a static discharge. Check the underside of the board and look for bad solder connections, shorts, etc.

Step 6 — Audio Preamp Circuit and Testing

Moving right along we are now going to wire up the other half of the 5532 IC. This part of the receiver amplifies the audio generated by the U3 IC acting as a detector.

D4 (1N4148) 1N4148 Si diode (7.6, 1.8) just to the left of U4 the 5532 IC

D3 (1N4148) 1N4148 Si diode (7.3, 1.8)

R7 (grn-brn-yel) 510K resistor (7.1, 1.8)

CLEARLY NOT J3!

J1 Maybe?

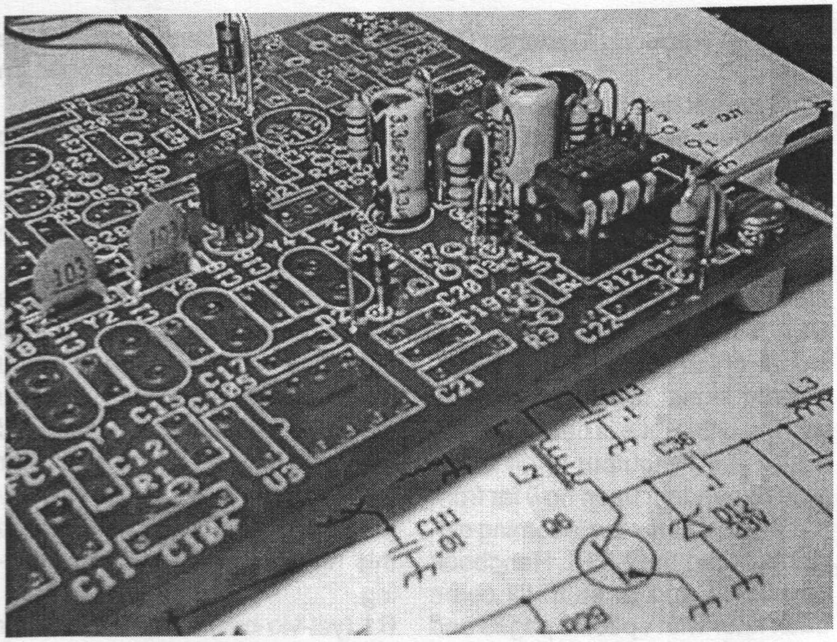


Fig. 35 D4 in place.

C23 (151) 150pF ceramic disk cap (6.8, 1.8)

C22 (151) 150pF ceramic disk cap (8.2, 0.3) just to the left of R12

OK, that again went pretty quick. Hook up headphones and battery and this time there should not be any tone coming from the headphones. Use your DMM probe and touch the pad just to the left of C22. This should cause a hum to be heard faintly in the headphones. Once again you are ever closer to the finish line. The PC board is looking pretty crowded in the lower right hand corner isn't it. And you did all that work yourself.

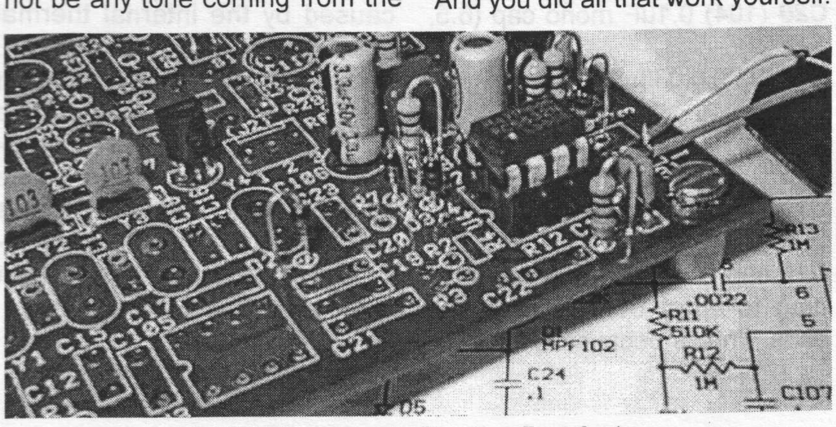


Fig. 36 The Board after the first 6 steps.

Step 7 — Receiver Detector Circuit

This section is the point in the receiver where the signal coming from the IF crystal filter (crystals Y1-Y3 and associated components is turned into audio tones. The NE612A (or its equivalent) has an internal oscillator which uses C17, C18, and Y4 to create a RF signal which is mixed with the incoming signal from pins 1 and 2 and the difference is output on pins 4 and 5. The output is an audio tone dependent upon how far from the Y4 frequency the incoming signal is. Read the ARRL Handbook on mixers and IF stuff. I'll come back later with specific pages and sections if you need me to do it for you. OK, so let's start building.

R4 (grn-brn-yel) 510K resistor (7.7, 1.0) and note that this resistor lies flat next to U4.
R2 (brn-blk-org) 10K resistor (7.2, 0.9)
R3 (brn-blk-org) 10K resistor (7.2, 0.5)
C20 (104) 0.1uF mono cap (6.5, 1.3)
C19 (333) 0.033uF mono cap (6.5, 1.0)
C21 (103) 0.01uF ceramic disk cap (6.5, 0.5)
C17 (68) 68pF ceramic disk cap (5.5, 1.6)
C16 and here we use a lead clipping to short between the two pads. This is because C16 is not used but is needed in some of the other bands that you can build on the same board.
C18 (151) 150pF ceramic disk cap (5.5, 2.3)
U3 8-pin IC socket at U3 (5.3, 1.0) and again note the half-moon notch position.
Y4 7.680 crystal (6.2, 2.3) and note I'm not going into detail on crystal matching for this project. If you want to get the best IF strip you can get from this kit then you need to build a series mode oscillator and measure the output frequency for each crystal. I'm going to build this rig without doing the matching.
R1 (yel-vio-brn) 470 ohm resistor (3.7, 0.8)
C105 (103) 0.01uF ceramic disk cap (4.6, 1.0) just to the left of the U3 socket
C104 (103) 0.01uF ceramic disk cap (4.0, 0.5)

OK, ready to test again. Hook up headphones and battery. You should hear a slightly louder hiss that in the previous steps. This is caused by the internal thermal noise generated by the NE612A. If you touch the top lead of R1 with the DMM probe you will hear the noise level increase further, especially if you hold your finger on the tip at the same time. This proves the circuit is working. Congratulations again. You are now just about at the expert level of building.

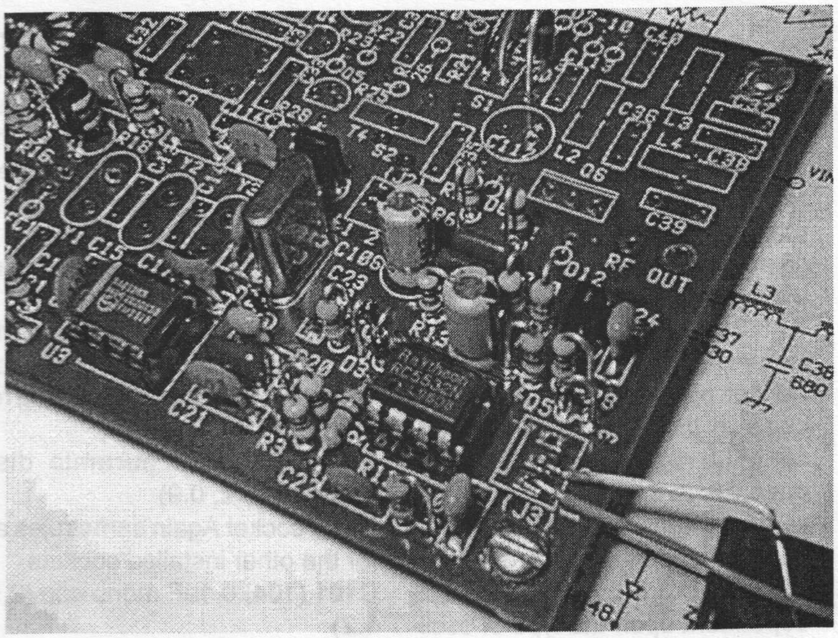


Fig. 37 The Board after Step 7

Step 8 — Receiver IF Crystal Filter Circuit

In this section we will be wiring up the 7.680MHz IF filter. There are not all that many parts.

C15 (271) 270pF ceramic disk cap (4.2, 1.2)
Y3 7.680MHz crystal (5.2, 2.3)
C14 (271) 270pF ceramic disk cap (4.7, 2.3)
Y2 7.680MHz crystal (4.4, 2.3)
C13 (271) 270pF ceramic disk cap (4.1, 2.3)
Y1 7.680MHz crystal (3.6, 2.3)
RFC1 (brn-blk-blk) 10uH molded choke (3.2, 1.9)
C12 (271) 270pF ceramic disk cap (3.5, 1.3)

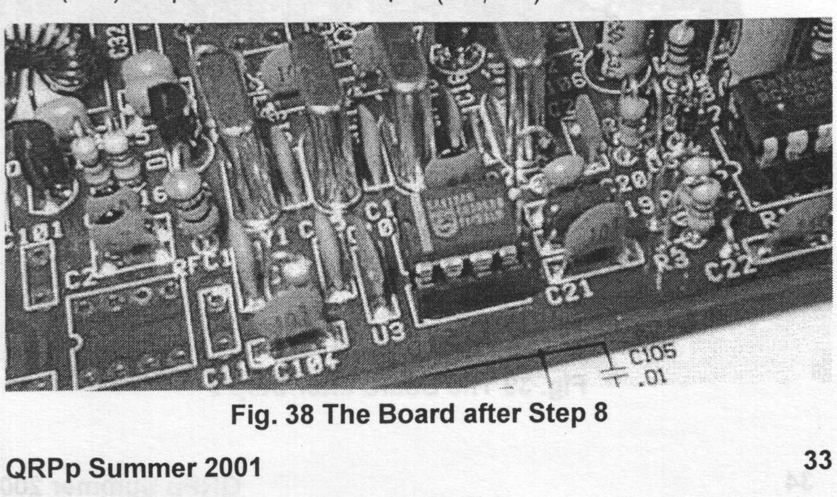


Fig. 38 The Board after Step 8

To test this installation, once again hook up the earphones and battery and listen and you should be hearing the hissing type noise that you heard in previous steps. Not much else we can do here to check this out unless you have a crystal tester or crystal oscillator that you can take the remaining 7.680MHz crystal and place in the tester and power it up. WARNING. Do not put the crystal tester too close to the receiver in the SW-30+. The receiver is running wide open, i.e. at maximum gain and is very very sensitive. You should be able to hear the crystal oscillator when you turn it on. The tone is dependent upon the type of oscillator circuit you have for the crystal tester and how close the frequency is to the frequency of the crystal in the detector circuit or crystal Y4. This concludes this test. Power off the rig and remove the earphones and proceed to the next wiring stage.

Step 9 — First Receiver Mixer Circuit

This wiring phase involves wiring the first mixer U1. After this you will pretty much have a working receiver.

C11 (22) 22pF ceramic disk cap&bsp (3.2, 0.9)

U1 IC socket Again same rules as for the other installed sockets.

C101 (104) 0.1uF mono cap (2.5, 1.2)

T1 (42IF123) 10.7MHz IF transformer

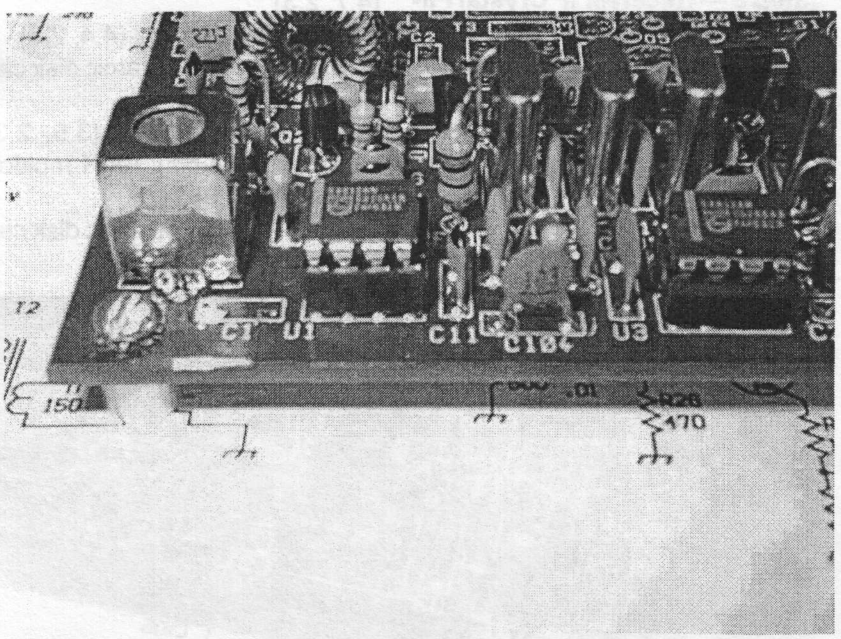


Fig. 39 The Board after Step 9

OK, now we have the receiver wired up. Connect earphones and battery and you should hear hiss/noise in earphones. Touch either pad where C1 would have gone next to T1. The noise level should increase. Also touch the top pad of J1. If you have a short piece of small wire, touch it to the top pad of J1 and the noise level should increase a bit more. Take a non-magnetic screwdriver or some plastic piece and adjust the tuning slug in T1 for maximum noise level with the wire at J1.

If you want to play just a little bit more here, you could power off the rig and temporarily solder leads from J2 to the tuning pot. See Dave's manual page 14 on where the 100K linear taper pot goes. But you may want to wait until the next stage to do this. It's all up to you and just how much you want to play around.

Step 10 Output Low Pass Filter
The following components will allow us to connect the receiver to an antenna and further check it out. It will also get us one step closer to getting the transmitter to work as this section has components common to both the receiver and the transmitter. I have put these in order that will make it easy to work in a small area and get the smaller/lower parts in first to avoid working crowded places.

C37 (331) 330pF ceramic disk cap (9.8, 6.0)
C38 (681) 680pF mono cap (9.8,5.6)
C39 (331) 330pF ceramic disk cap (9.8, 4.6)
C40 (22) 22pF ceramic disk cap (8.4, 6.5)
D10 (1N4148) 1N4148 Si diode (8.0, 6.5)
D9 (1N4148) 1N4148 Si diode (7.7, 6.5)
D8 (1N4148) 1N4148 Si diode (7.5, 6.5)
D7 (1N4148) 1N4148 Si diode (7.2, 6.5)

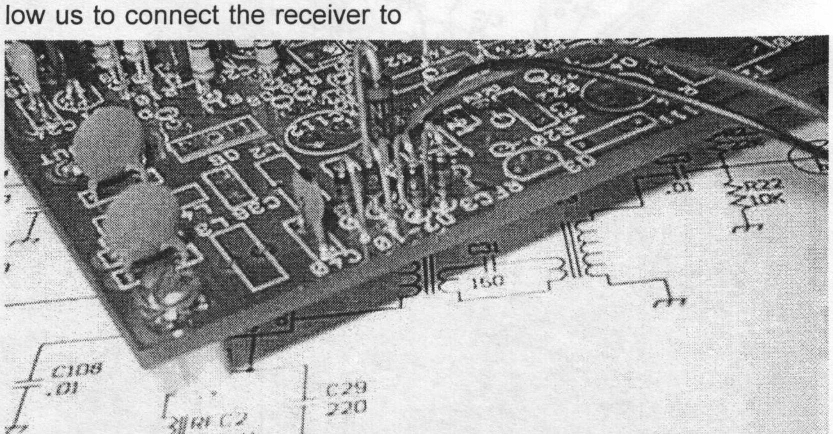


Fig. 40 Step 10 Parts C37 - D7 Installed

already installed - FIRST P11

C113 (104) 0.1uF mono cap (7.6, 5.8) just to the right of **D13** RFC3 (brn-blk-blk) 10uH molded choke (6.8,5.8)

C36 (104) 0.1uF mono cap (8.7, 5.3)

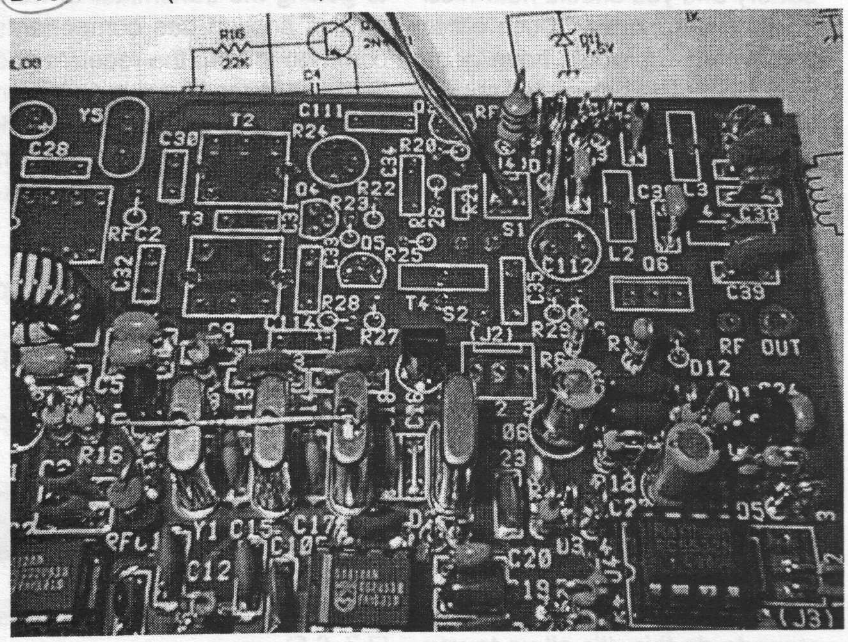


Fig. 41 Step 10 C113, D13 & C36 Installed

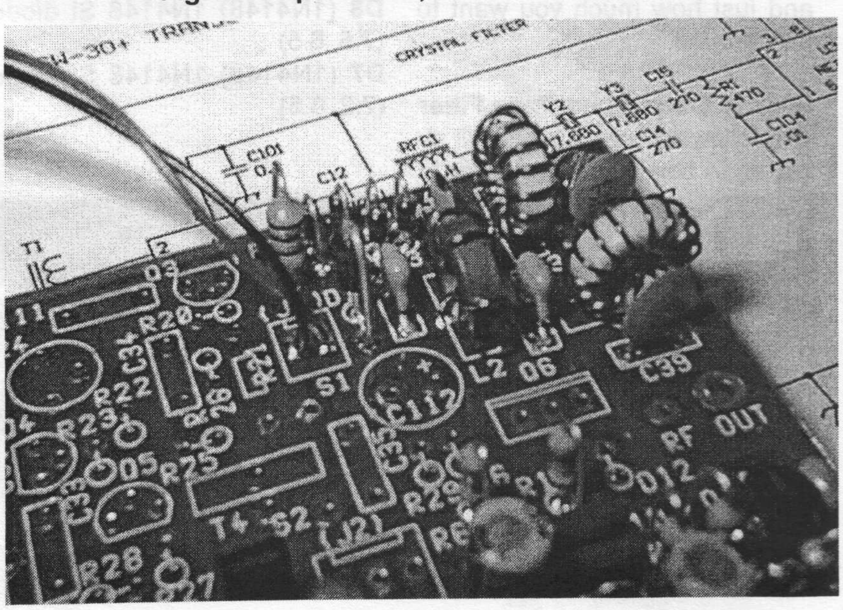


Fig. 42 Step 10 L2, L3 & L4 Installed

L2 (FT37-43 toroid) 6 turns of #24 wire of length 10cm on grey core (8.2, 5.5)
L3 (T37-6 toroid) 15 turns of #24 wire of length 25cm on yellow core (9.0, 6.5)
L4 (T37-6 toroid) 15 turns of #24 wire length 25cm on yellow core (9.4, 6.5)

OK, wiring is done. First test. Using ohmeter in continuity check (the DMM makes a beeping sound when you measure a very low resistance or short) put one lead at pad labeled RF (the smaller pad at RF OUT) at (9.2, 4.0). Using the other lead see if you get continuity to each of the pads at L3 and L4. This insures that the leads are cleaned and soldered properly.

Second check. Test continuity from the top lead of RFC3 to center pad of J1.

And an optional more advanced test. Take a small clip lead and bend it and friction fit it into the two top pads of J1. What this does is feed input of receiver direct to RFC3 and from there to the antenna connection. Take a small insulated wire of length one meter or so with a small part of the end stripped and tinned and insert it into the RF pad just above the right hand center of the board near C39. This wire will be a temporary antenna. I would not solder it, just let it sit in the hole and make contact. Now power up the SW-30+ and connect earphones. You should be hearing some atmospheric noise, especially if there are thunderstorms somewhere in the US. Removing wire should cause a drop in noise level in the headphones. Tune T1 for maximum noise level with the antenna attached. And if you have the tuning pot (100K) hooked up you just might be able to tune around and hear signals. The 30 meter band for hams is from 10.100MHz to 10.150MHz and if you had a frequency counter and were able to set the VFO range you can hear in this range. If not, then we will have to solve the problem another way later on. Congratulations — You have a 30 meter receiver working.

Step 11 — Keying Circuit

In this section we are going to wire up the parts that cause the transceiver to switch from receive to transmit whenever a key or keyer is used. The receiver never really completely turns off during transmit, but the muting circuit prevents the receiver front end output from getting to the final audio amplifier and only just a small fraction of the energy passes and provides us with a sidetone.

Q3 (2N3906) 2N3906 PNP Transistor (6.3, 6.5)
C111 (104) 0.1uF mono cap (5.5, 6.6)
R20 (red-red-org) 22K resistor (6.2, 6.2)
R21 (brn-blk-org) 10K resistor (6.4, 5.5) lays flat on board
C112 (220uF) 220uF electrolytic cap (7.5, 5.0) + terminal to the right, - lead to the left
C110 (47uF) 47uF electrolytic cap

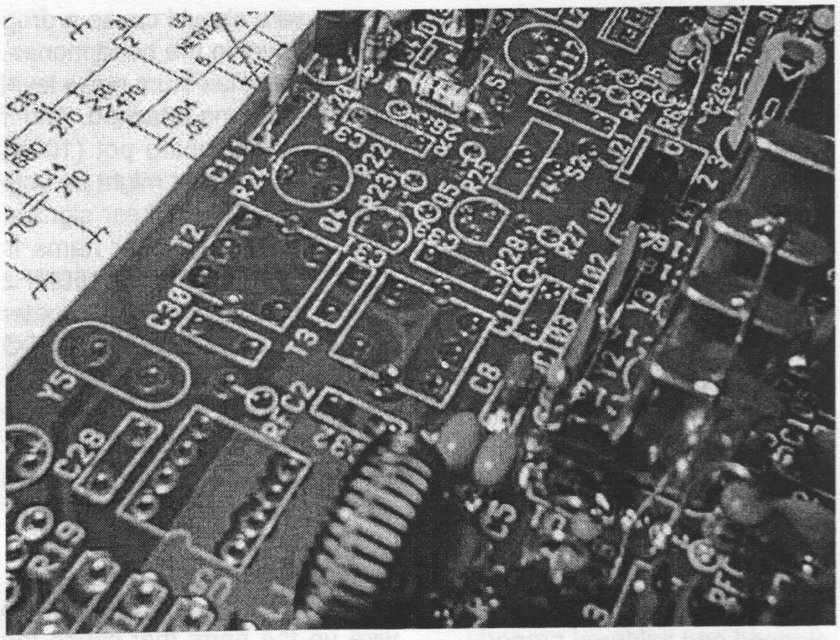


Fig. 43 The Board after Step 11

(1.5, 6.5) located upper left hand corner of board
R19 (brn-blk-red) 1K resistor (1.0, 6.0) left below
C110 in previous step
D11 (1N5236B) 7.5V Zener Diode (0.5, 6.0) diode taped on the yellow slip of paper
C109 (103) 0.01uF ceramic disk cap just above C10 and labeled just 0.01
C108 (103) 0.01uF ceramic disk cap just above C109 and labeled just 0.01 Note that this cap is not part of this circuit but put in because I don't want you to get confused and miss C109.

OK, testing time again. Hook up headphones and battery. You'll hear some background hissing type noise in the headphones as in previous steps.

Test 1: Short pin 3 of J3 to pin 1 of J3. This simulates a key down condition. You should hear the audio in the headphones mute, i.e. disappear or get real quiet.

Test 2: Take DMM and measure voltage at pin 8 of U5. With key up condition you get almost 0.0V. With the key down condition, short 3 to 1 of J3, the voltage should exceed 7V. I got 10.87V and this because we don't have an IC in yet. When you release the key down condition you will note that the voltage does not immediately decrease to 0V, but takes some time. This is due to no high current drain on the caps in the circuit as we don't have an IC online at this time.

If the above two tests pass, then the circuit is working properly.

NO!

Congratulations again.

Step 12 — First Transmitter Mixer Circuit

In this section we will start from the front of the transmitter section and work our way to the final power amplifier (PA).

C28 (47) 47pF ceramic disk cap (1.8, 6.0)
C29 (221) 220pF ceramic disk cap (0.7, 0.7)
RFC2 (blu-gry-gld) 6.8uH molded choke (2.7, 5.5)
Y5 7.680MHz crystal (2.5, 6.5)
IC socket at U5 (2.0, 5.0) and by now you are an expert, so no instructions needed here install the NE612A IC into the socket

OK, back to testing again. Hook up battery and headphones. Now, redo the key down condition, i.e. short pin 3 of J3 to pin 1 of J3. This time you should hear a very weak tone in the headphones. This means that the VFO frequency is combined with 7.680MHz to generate a 10.1XX MHz RF signal. You first part of your transmitter is now working. If you want to play around just a second like a kid that I know you are, try sending some code using the wire that you have for shorting pin 3 to pin 1. OK, that's enough, back to work. Remove the battery and the headphones and get back to soldering. You are so good.

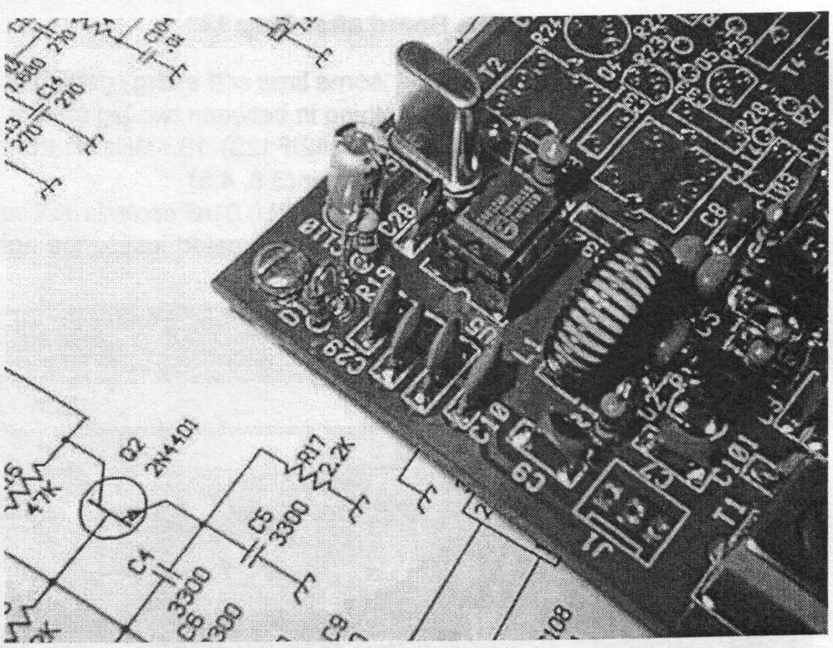


Fig. 44 Picture of the board showing the xmitter mixer area wired up.

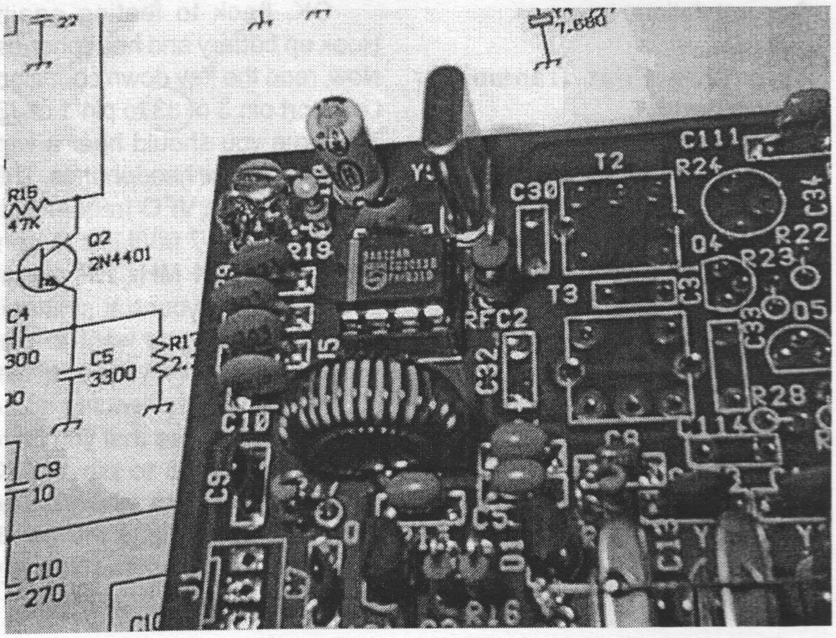


Fig. 45 The Board after Step 12

Step 13 — Transmitter Bandpass Circuit

T2 (42IF123) 10.7MHz IF transformer (3.8, 6.0)

C31 (151) 150pF ceramic disk cap (3.0, 5.2) note we did this before the next transformer to save you some time and energy getting this thing in between two big critters

T3 (42IF123) 10.7MHz IF transformer (3.8, 4.5)

C33 (103) 0.01uF ceramic disk cap (4.5, 4.5) located just to the right of T3

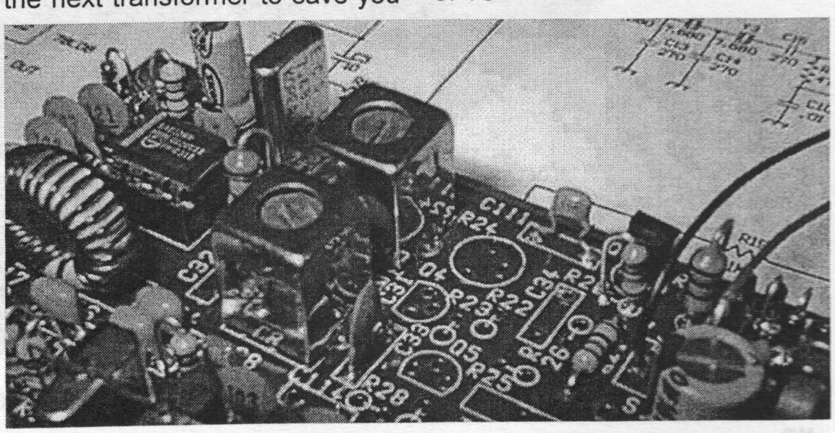


Fig. 46 After Step 13. Note that C31 is between the 2 IF cans, T2 & T3.

OK, back to testing again. Power up and put on the headphones. Once again, key down and you should hear the tone in the phones. You might adjust T2 and T3 for a maximum, but it won't make too much difference at this time. You're done for this test. Unhook battery and phones and continue wiring.

Step 14 — Transmitter Buffer/RF Amplifier Circuit

Q4 (2N4401) 2N4401 NPN Transistor (4.7, 5.4) just to the RHS of center of T2/T3 locations

R23 (red-red-org) 22K resistor (5.0, 5.1) R22 (brn-blk-org) 10K resistor (5.1, 5.2)

R24 (3 legged blue critter) 500 ohm variable resistor (5.0, 6.1)

C34 (103) 0.01uF ceramic disk cap (5.8, 5.8)

Carefully turn the adjustment of R24 (the variable resistor) fully counter clockwise (CCW). This makes the output from this circuit a minimum.

OK, headphones back on and batter connected. Key down and you should hear a tone. No need to mess with the variable as it won't do anything to effect the volume of the tone at this time.

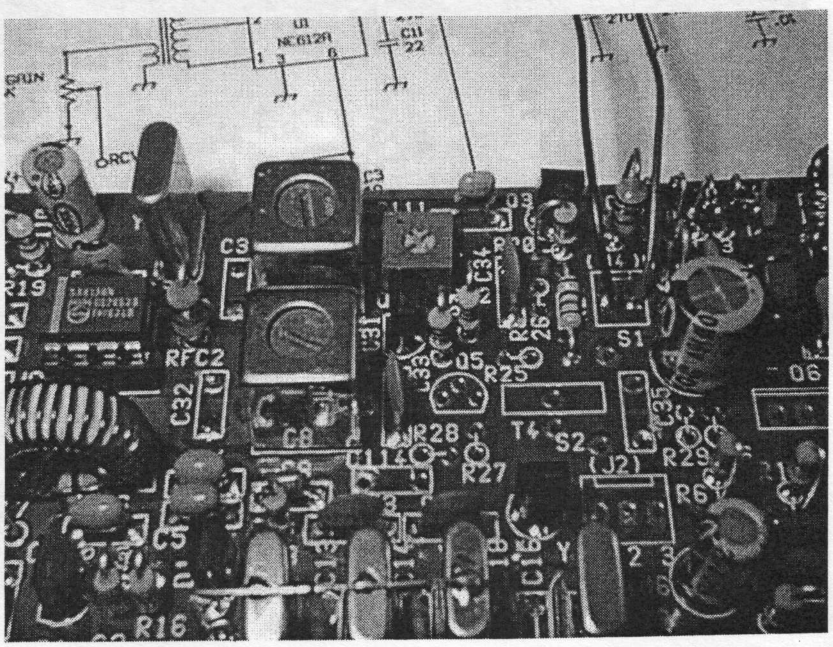


Fig. 47 After Step 14

Step 15 — Transmitter Buffer/RF Amplifier Circuit

R26 (yel-vio-brn) 470 ohm resistor (6.1, 5.6)

R25 (red-red-red) 2.2K resistor (6.1, 5.6)

Q5 (2N4401) 2N4401 NPN Transistor (5.2, 4.6)

C114 (104) 001uF mono cap (4.6, 3.8)

R28 (grn-brn-blk) 51 ohm resistor (5.0, 4.0)

R27 (brn-blk-blk) 10 ohm resistor (5.3, 4.1)

T4 (FT37-43) (6.2, 4.4) 10T:1T primary to secondary turns ratio with #26 wire for the primary. See manual on this one. For the MH101 crew that is doing it Manhattan style I will do a detailed write up. It's just not needed here for this group.

C35 (103) 0.01uF ceramic disk cap (7.0, 4.4)

Once it again it is time to test our wiring. Power up and key down and you should still hear a tone. That's all we can do at this time unless you have an RF probe or O'scope and look for RF out on the secondary winding or at C35.

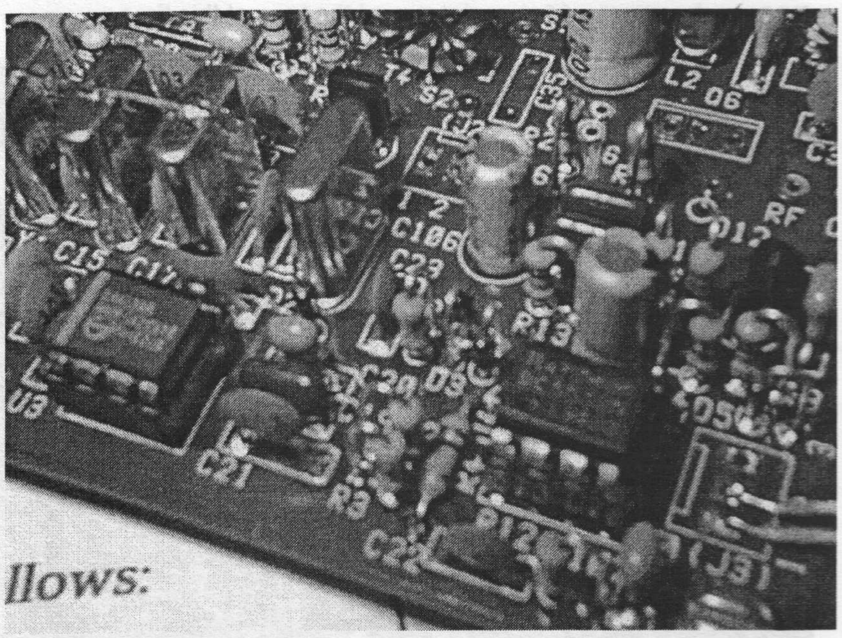


Fig. 48 After Step 15

Step 16 — Transmitter Power Amplifier Circuit

This is it. You are four parts away from being done with the on board wiring and soldering. And I won't show the K7QO coordinates for these parts as it is obvious at this point where you are and where they go.

R29 (grn-brn-blk) 51 ohm resistor
D6 (1N4148) 1N4148 Si Diode
D12 (1N5257B 33V Zener diode, the last one on the yellow slip of paper
Q6 (2SC2078 or C2166) Final PA transistor. Read the manual on putting this puppy in. It mounts straight up on the board and the metal tab is towards the back of the board. See the outline on the PC board and double check. Look at the pictures before installing if you are not sure.

Well that's all there is for now. PLEASE. Do not power up at this time. You can ruin the final PA if you operate this transceiver without a dummy load or a good antenna for 30 meters attached. I'll add a section here pretty quick as soon as my paint dries on my homebrew case and I'll show you how to install into a case. If you bought the case and pots from Dave, NN1G, then follow his instructions on installing the transceiver into his case. It is a good one as I own two myself.

Congratulations to you for building this transceiver.

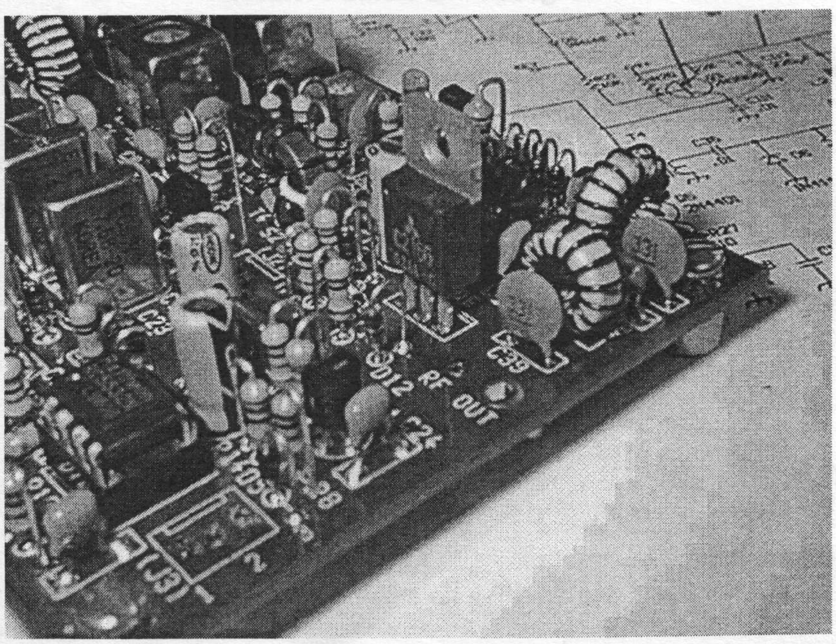


Fig. 49 Mounting detail of final transistor, Q6

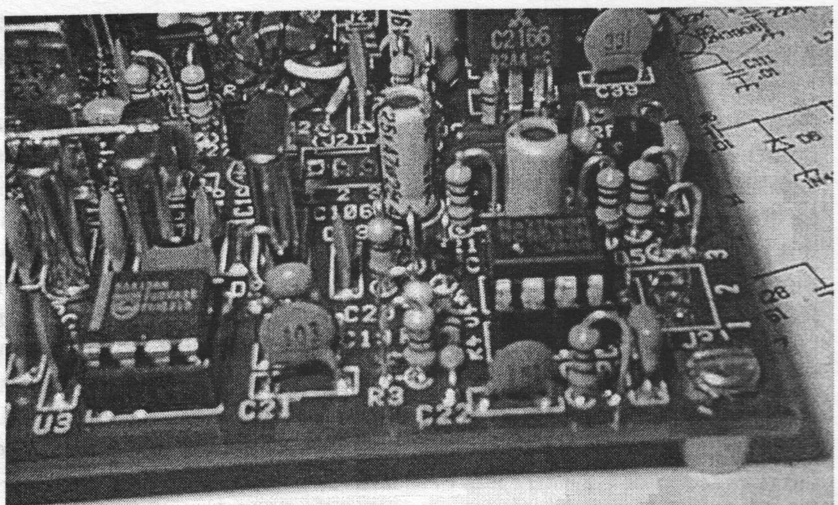


Fig. 50 Final Board Pictures

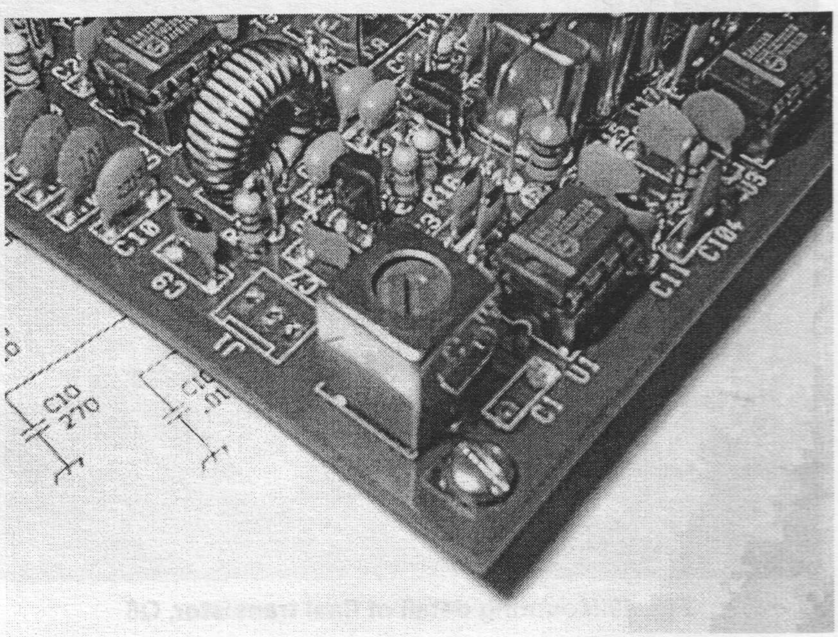


Fig. 51 Final Board Pictures

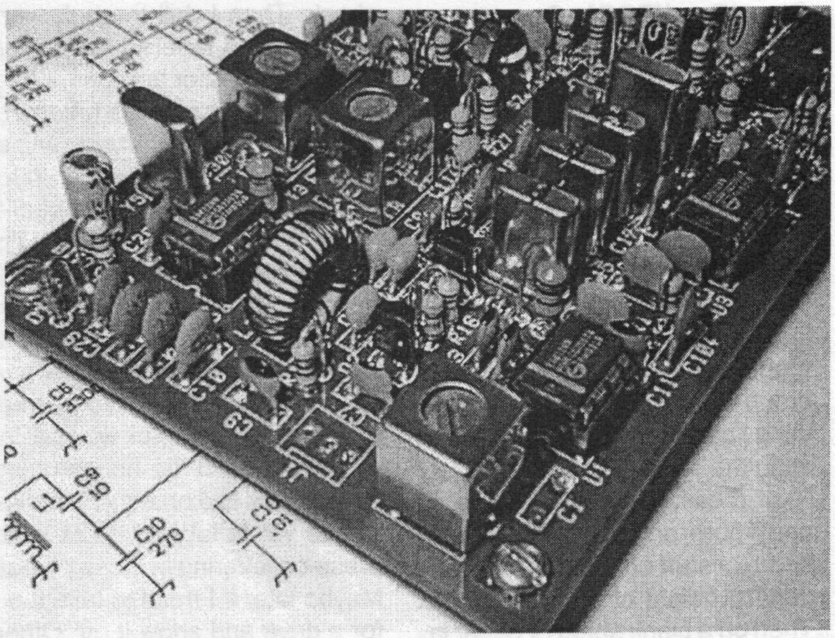


Fig. 52 Final Board Pictures

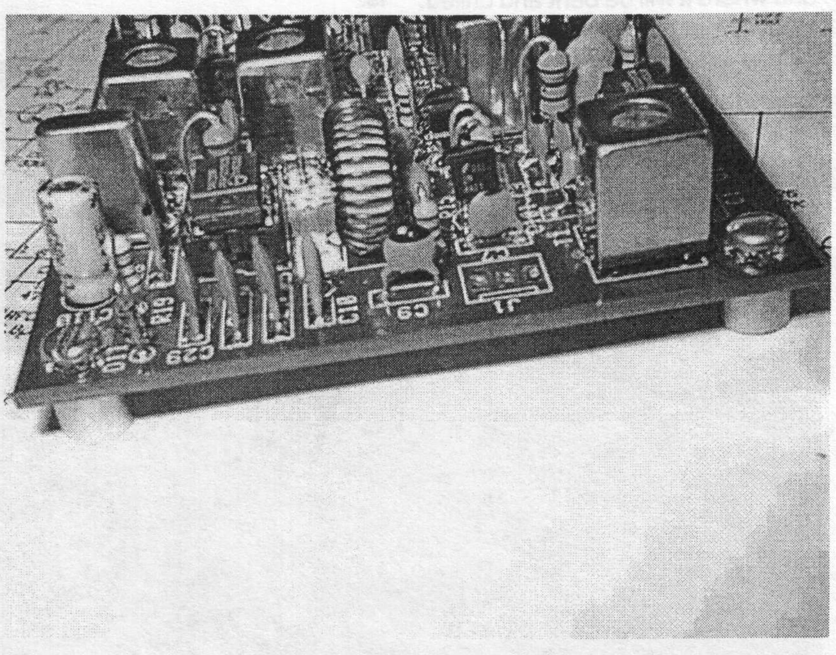


Fig. 53 Final Board Pictures

Step 17 — K7QO's Case

Here are some photos to illustrate what I do to put a rig into a case. I use a Harbor Freight shear/brake/roller that will handle up to 12" sized metal sheets. I get my 0.040" thick aluminum sheet as one of the surplus metal places in Phoenix about 130 km away from Prescott. I go down there (meaning that it is south of me) once a month for the AZ sQRPion QRP group meetings, so if I need something I can drop by their and pick it up in the same trip.

I measure the size of the rig and figure on how much room I need for stuff on the front and rear panels, height of the panels, etc. Then on a blank sheet of paper lay out the total size of a sheet of metal and where it will be bent and drilled. I cut it out, bend it and double check. Then I drill the holes and using a hand tapered reamer enlarge the holes for the control sizes and start putting things together. I hope from the photos you can see how I do it. Ask questions if you have any and I'll try to add stuff to the photos and what I'm doing. The case costs me about $1.00 US to make in materials and paint. I get some OEM Krylon paint from Wal-Mart for less than a buck a can. Nice paint. I cook it at 170 degrees F in an electric oven with all the exhaust fans in the house going. Take Phyllis to dinner and a movie. I have yet to label the case with press-on lettering in these photos. Maybe later if I need to take it out for a drive and show it off. Otherwise it will probably stay the way it is.

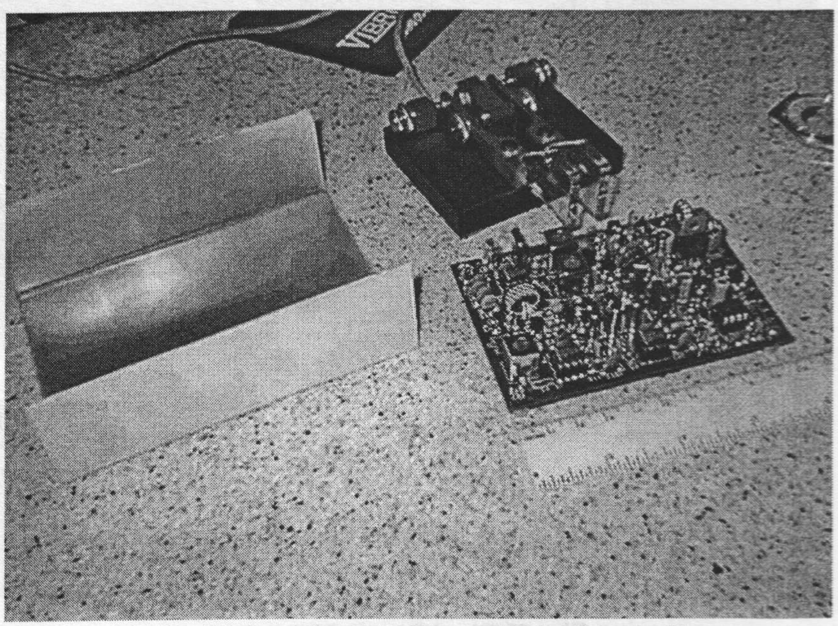


Fig. 54 Case bent to shape for bottom half.

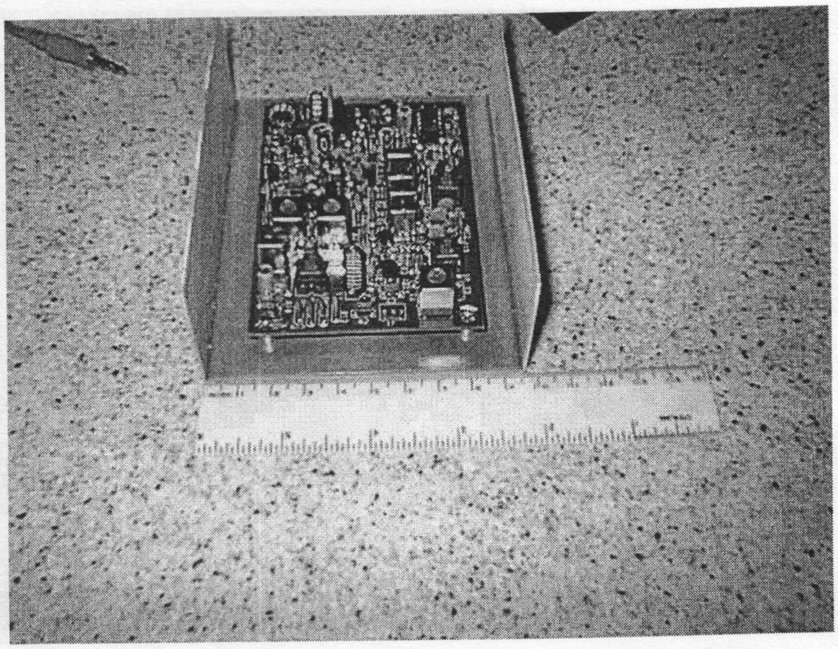


Fig. 55 PC Board in case to check fit.

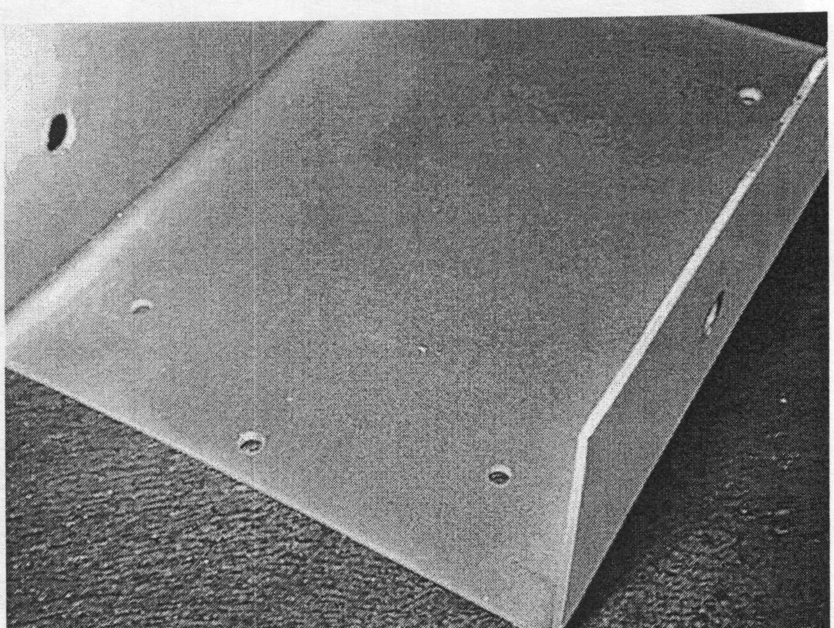


Fig. 56 Case Bottom with holes drilled.

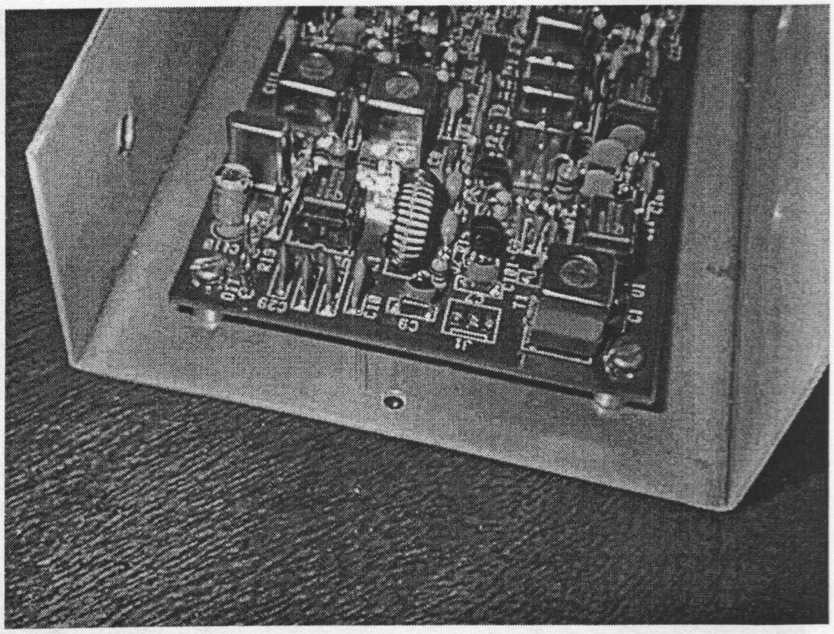


Fig. 57 Case Bottom with PC Board Mounted on Standoffs.

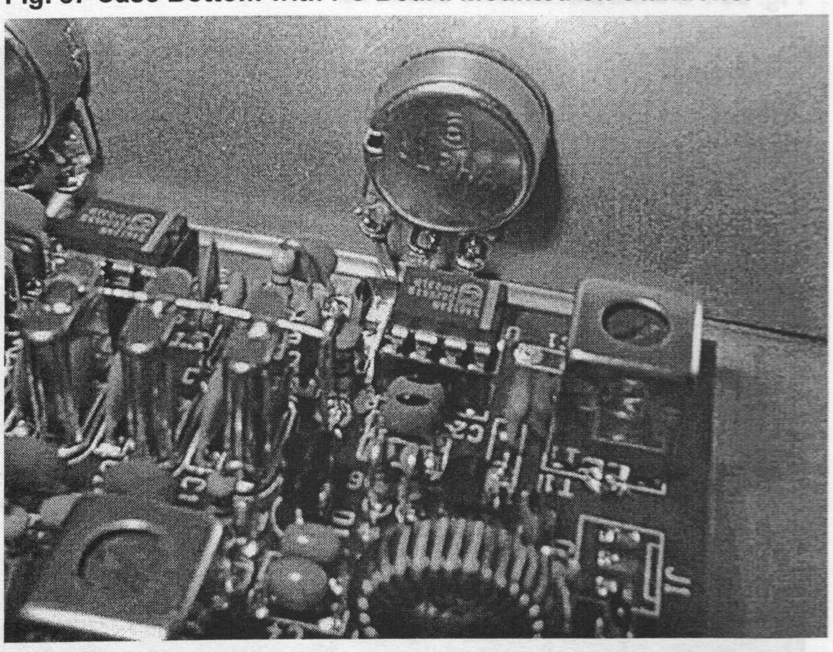


Fig. 58 Gain control pot (Mouser 10K) in place. I chose to route the computer cable connections under the board and I don't use the Molex connectors.

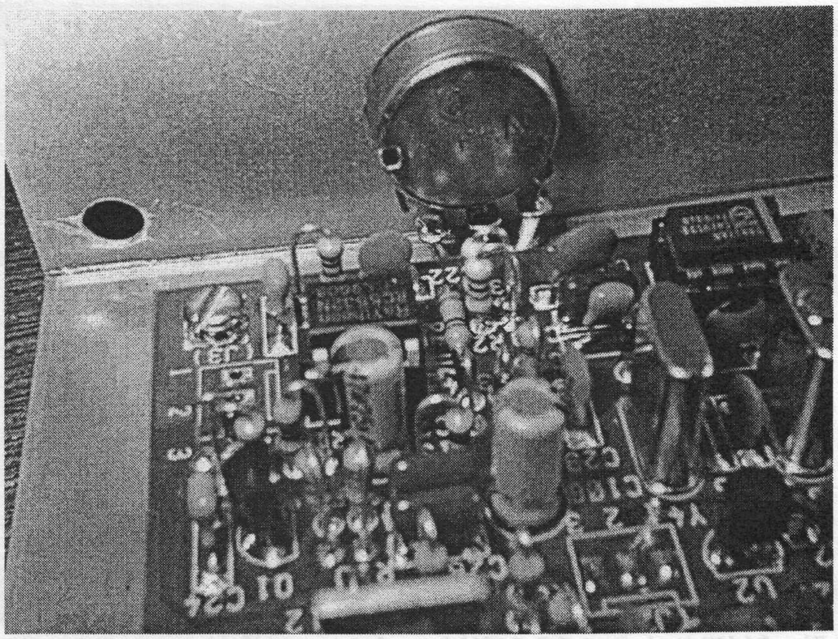


Fig. 59 Tuning control pot (Mouser 100K) in place.

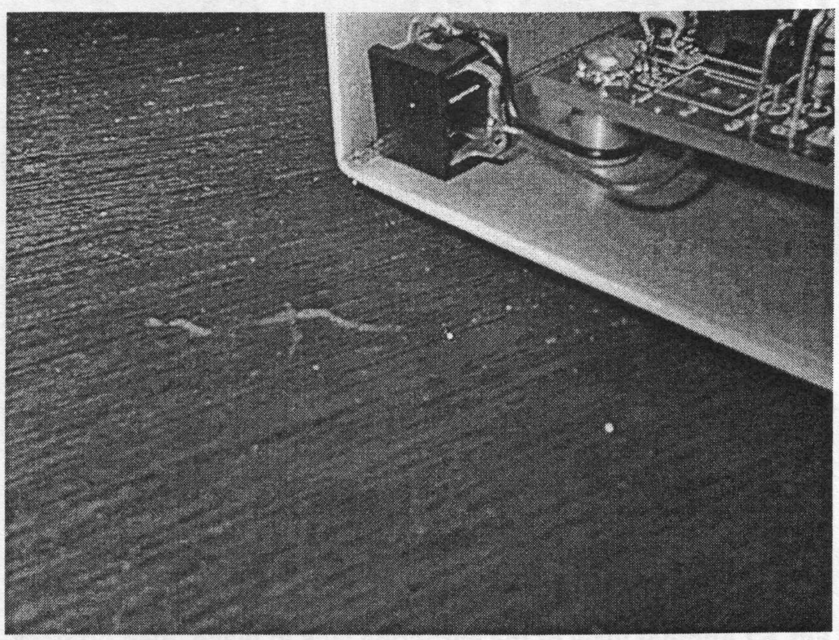


Fig. 60 Earphone jack in place.

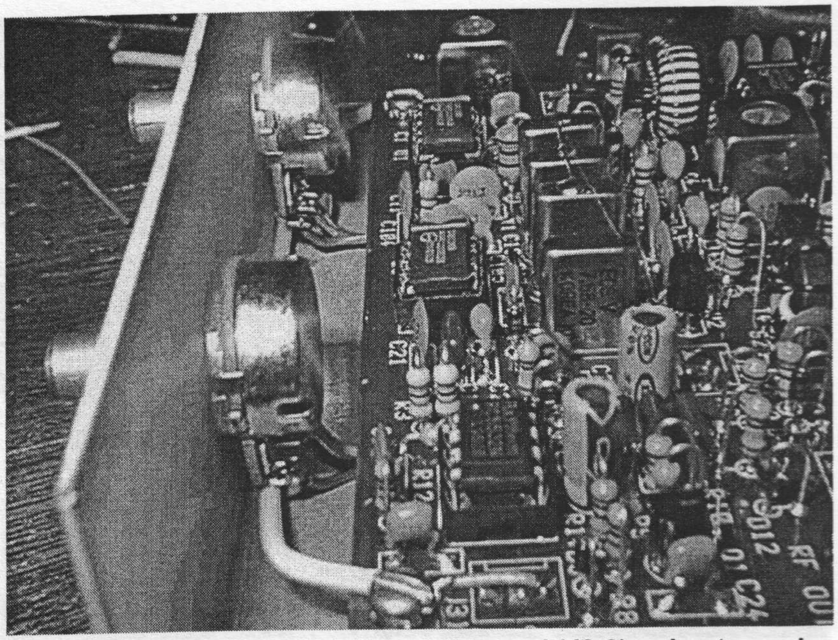


Fig. 61 White teflon RG-316U from key pad (J3-3) going towards the side where RCA jack is located on back panel.

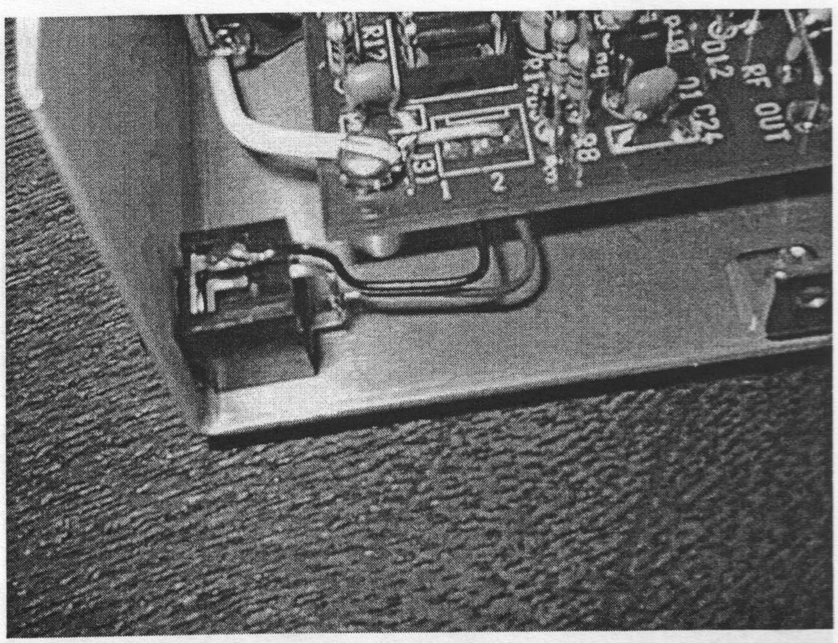


Fig. 62 Another view of the earphone jack in place. Also note the white teflon coax. I love that stuff.

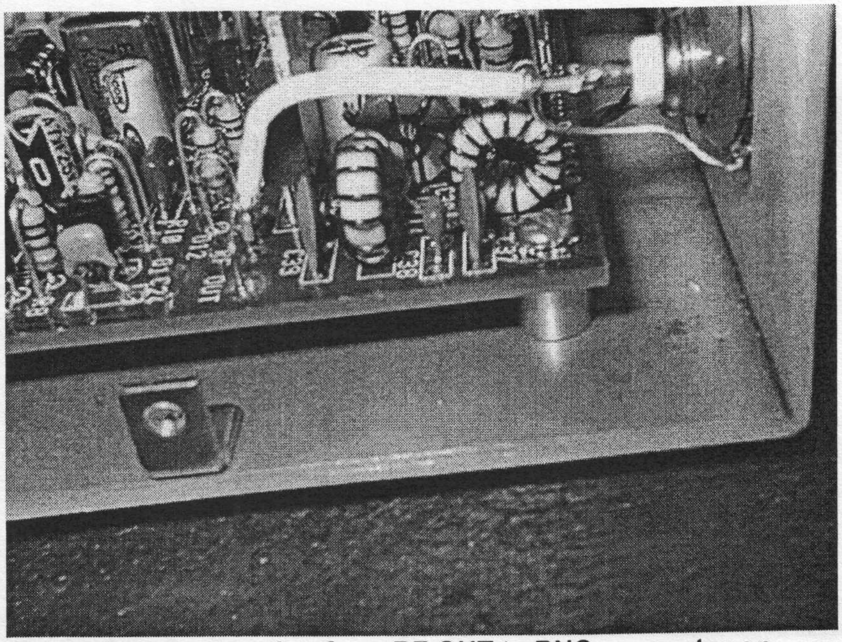


Fig. 63 Coax connection from RF OUT to BNC connector on back panel. Note the small right angle (Mouser part number 534-621) that will hold the top.

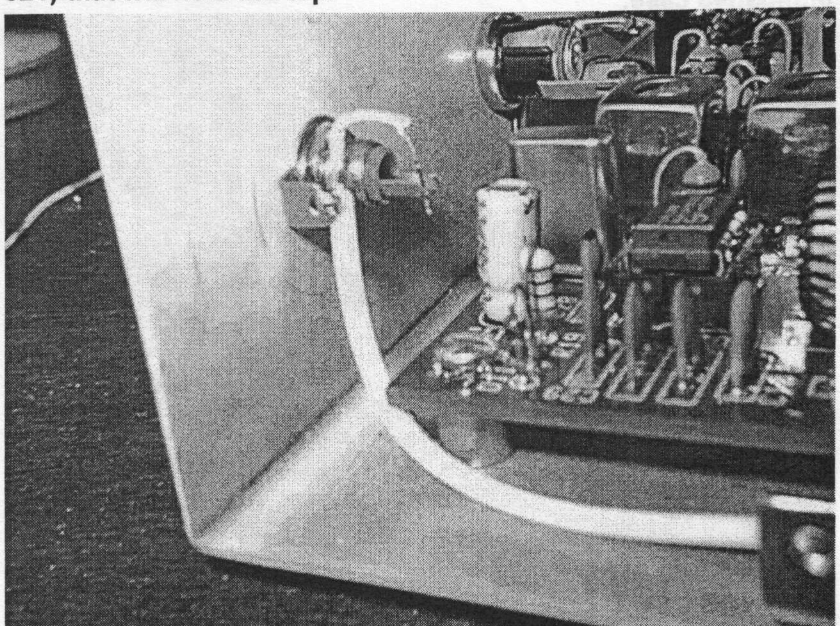


Fig. 64 This is the other end of the coax from the key connection to the RCA jack.

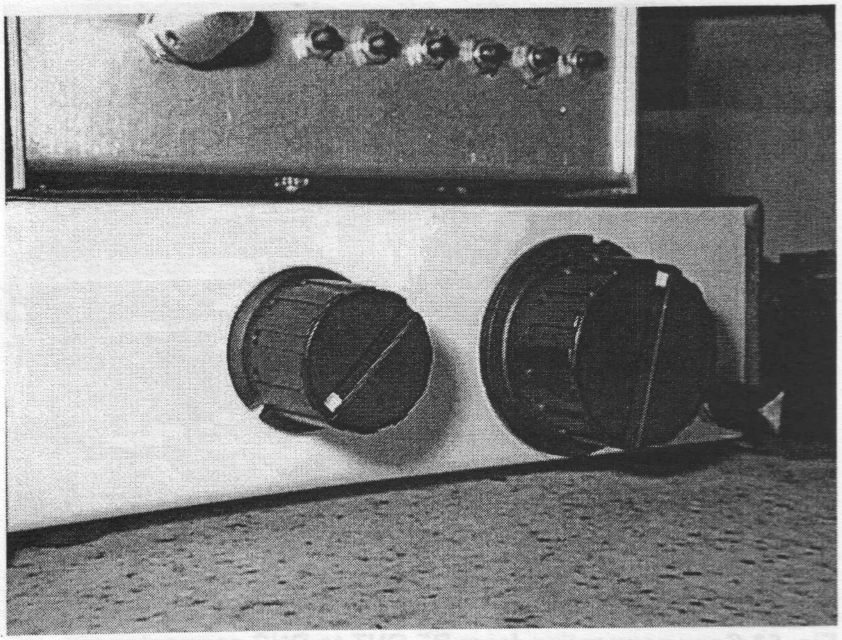


Fig. 65 Front view of rig with cover installed and the usual Mouser knobs that every one else uses. CMOS III on the top in its still unfinished case.

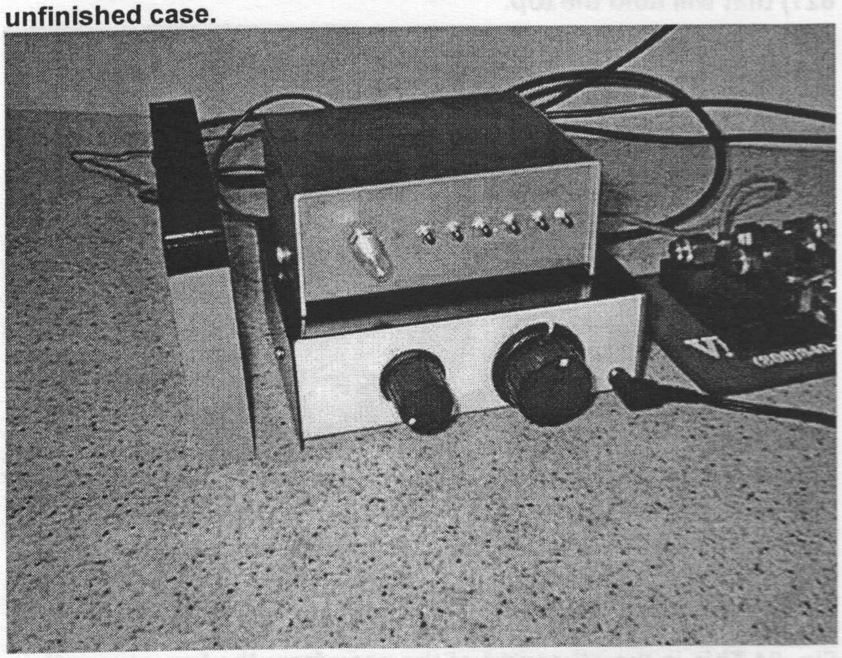


Fig. 66 Another angle view of the front. That's the earphone cable coming out the front right.

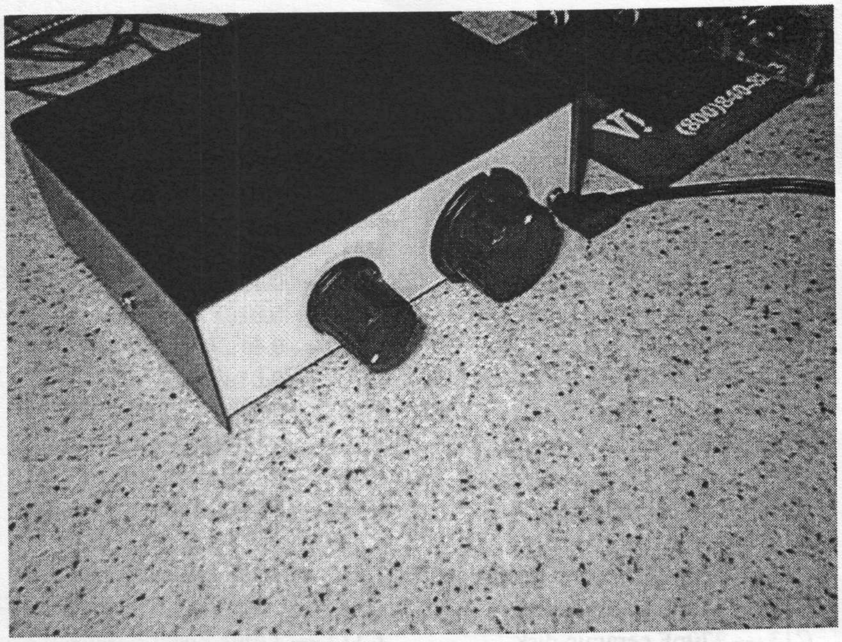


Fig. 67 The Completed SW30+

SWL30+ Parts List
Revision 1.000 April 30th, 2001 by K7QO, Chuck Adams

Capacitors
C1 — not used
C2 — 47pF ceramic disk cap
C3 — 10pF ceramic disk cap
C4 — 3300pF NPO mono cap
C5 — 3300pF NPO mono cap
C6 — 3300pF NPO mono cap
C7 — To Be Determined (select from 22, 47, 68, 82, 100, 120 or 150pF NPO mono caps
C8 — 120pF NPO mono cap
C9 — 10pF ceramic disk
C10 — 270pF ceramic disk
C11 — 22pF NPO ceramic disk
C12 — 270pF ceramic disk
C13 — 270pF ceramic disk
C14 — 270pF ceramic disk
C15 — 270pF ceramic disk
C16 — W1, i.e. short out for 30m only
C17 — 68pF NPO ceramic disk
C18 — 150pF ceramic disk
C19 — 0.033uF ceramic disk or monolithic cap
C20 — 0.1uF mono cap
C21 — 0.01uF ceramic disk
C22 — 150pF ceramic disk
C23 — 150pF ceramic disk
C24 — 0.1uF mono cap
C25 — 820pF ceramic disk
C26 — 0.0022uF disk or mylar cap
C27 — 47uF electrolytic cap
C28 — 47pF NPO ceramic disk
C29 — 220pF ceramic disk
C30 — not used
C31 — 150pF ceramic disk
C32 — not used
C33 — 0.01uF ceramic disk
C34 — 0.01uF ceramic disk
C35 — 0.01uF ceramic disk
C35 — 0.01uF ceramic disk or mono cap
C36 — 0.01uF ceramic disk
C37 — 330pF ceramic disk
C38 — 680pF ceramic disk
C39 — 330pF ceramic disk
C40 — 22pF ceramic disk
C41 - C100 — not used
C101 — 0.1uF mono cap
C102 — 0.01uF ceramic disk
C103 — 0.01uF ceramic disk
C104 — 0.01uF ceramic disk
C105 — 0.01uF ceramic disk
C106 — 47uF electrolytic cap
C107 — 0.1uF mono cap
C108 — 0.01uF ceramic disk
C109 — 0.01uF ceramic disk
C110 — 3.3uF electrolytic cap
C111 — 0.01uF ceramic disk
C112 — 220uF electrolytic cap
C113 — 0.1uF mono cap
C114 — 0.1uF mono cap

Resistors
R1 — 470 ohms
R2 — 10K
R3 — 10K
R4 — 510K
R5 — not used
R6 — 10 ohms
R7 — 510K
R8 — 1M
R9 — 4.7M
R10 — 22K
R11 — 510K
R12 — 1M
R13 — 1M
R14 — 10
R15 — 47K
R16 — 22K
R17 — 2.2K
R18 — 1M
R19 — 1K

R20 — 22K
R21 — 10K
R22 — 10K
R23 — 22K
R24 — 500 ohm variable
R25 — 2.2K
R26 — 470
R27 — 10
R28 — 51
R29 — 51

IC's
U1 — NE602A/NE612A/SA612A mixer IC
U2 — 78L08 8V voltage regulator
U3 — NE612A/... mixer IC
U4 — NE5532 dual op amp
U5 — NE612A/... mixer IC

Transistors
Q1 — MF102 JFET
Q2 — 2N4401 NPN
Q3 — 2N3906 PNP
Q4 — 2N4401 NPN
Q5 — 2N4401 NPN
Q6 — 2SC2078 NPN PA transistor

Crystals
Y1-Y5 — 7.680MHz

Chokes
RFC1 — 10uH molded inductor
RFC2 — 6.8uH molded inductor
RFC3 — 10uH molded inductor

Diodes
D1 — MV1662 variactor diode or other variactor
D2 — 1N4148 small signal diode
D3 — 1N4148 small signal diode
D4 — 1N4148 small signal diode
D5 — 1N4148 small signal diode
D6 — 1N4148 small signal diode
D7 — 1N4148 small signal diode
D8 — 1N4148 small signal diode
D9 — 1N4148 small signal diode
D10 — 1N4148 small signal diode
D11 — 1N5236 7.5V 0.5W Zener diode
D12 1N5257 33V 0.5W Zener diode
D13 — 1N4001 1amp Si diode

Transformers
T1 — 10.7MHz IF transformer Mouser 42IF123
T2 — 10.7MHz IF transformer Mouser 42IF123
T3 — 10.7MHz IF transformer Mouser 42IF123
Toroids
T4 — FT37-43 10T:1T Primary to secondary ratio
L1 — T50-6 0.50" yellow 29T #24 wire
L2 — FT37-43 0.37" dark grey 6T #24 wire
L3 — T37-6 0.37" yellow 15T #24 wire
L4 — T37-6 0.37" yellow 15T #24 wire

Variable Pots off board
5K — RF gain
100K — Tuning

QRP Operating News

By Richard Fisher, KI6SN
1940 Wetherly Way
Riverside, CA 92506
KI6SN@yahoo.com

Revelations of a tenderfoot milliwatter

Monty Northrup, N5FC, of Austin, TX writes that "since building my 10 dB transmitting attenuator, I have been having a ball with milliwatting.

At first, I used the attenuator to switch my power from 5 watts to 500 mW. I was getting such good results, (recently) I decided I would crank the Century 21 down to 500 mW, and use the attenuator to give me 50 mW.

My strategy has been to answer 599 stations calling CQ (579 if they sign '/QRP').

As long as I don't have to compete with somebody else, I've almost always been getting answers. After completing the first exchange at 50 mW, I'll switch the attenuator out to QRO to 500mW, or to 5W if necessary (so the operator on the other side doesn't have to suffer).

If the band is open but activity is slow, I'll park on a clear frequency and call CQ at 50 mW. Recently on 15 meters, I never had to call CQ more than six times before getting an answer. How about that?

Best 50 mW DX to date is AL7FS, on 15 meters for 3,144 miles and 63,000 miles/watt! (and conditions weren't that good) . . . thanks, Jim, for digging me out.

OK, so you're thinking I have a whiz-bang antenna, huh? Nope. For 40 and 15 I use an inverted V fed with 300-ohm ladder line, cut for 40 meters, mounted on a mast strapped to my chimney, with the apex at 30 feet, and the ends just 10 feet off the ground.

For 20 and 10, I use a horizontal delta loop on my roof at 20 feet. I'm hoping ol' Sol will arrange conditions so I can work JA, or maybe even VK at 50 mW. Wouldn't that be a hoot?

I hope this encourages some of you to build an attenuator, and explore what you can do with QRPp. It's a blast!"

QRPing along the Appalachian Trail

Ron Polityka, WB3AAL, writes from Reading, PA that in March he made his way "through three inches of snow and in some places the mud to my operating location on the Appalachian Trail.

The weather forecast said the temperature was to be in the 50F range, but it changed overnight.

The weather forecast in the morning said it was going to be cloudy with some rain in the afternoon. Operating temperature was around 38F and very windy.

A branch came crashing down on me when just after I switched over to 20 meters. All was OK with me, but I got out of there before any other larger branches came crashing down.

I'm sorry that I could not stay longer but the wind chill was around 15F and the clouds were closing in.

Some freezing rain was coming down and that was the deciding factor to make me pack up and leave.

I did get a chance to make one schedule QSO on 40 meters, six QSOs on 15 meters and one QSO on 20 meters.

I also was looking for someone on 17 meters but I had no luck in locating that station.

Hopefully the weather will be much better as spring comes in. I will be able to go out earlier and stay much longer in springtime.

The 15 meter band was open to the western United States. I did listen around for the Europeans but I did not hear anyone. So hopefully the conditions will be better in April.

Thanks to all who made a QSO with me on the Appalachian Trail in Pennsylvania."

Good QRPer advice for snagging DX

Rod Cerkoney, N0RC, writes from Fort Collins, CO that "I've heard this happen enough that I feel it's worth mentioning. When chasing DX, don't tune up or call on the DX station's transmit frequency. You may be interfering with others trying to hear their call.

Listen for a while. A good DX operator will announce where he is listening. For example, recently I heard 3G0Y calling '3G0Y UP,' and tuning up the band 1kHz I heard the pack. I listened there for a while, selected a good transmit frequency, and set up my rig for split operation: the receiver in VFO A; the transmitter in VFO B.

Then I started calling. I selected the transmitting frequency based on where I heard others being heard and a relative quiet spot, usually on one edge or the other of the main pack.

If I'm using a rig without split, but with RIT or XIT, I do a similar thing, adjusting the rig to transmit on one frequency and listen on the DX frequency.

Now, sometimes the DX station is not working split. But I STILL DON'T call on his frequency.

First I zero beat my receive with his transmit, and then I use my XIT to call up 200-500Hz, starting 500 up and working down. Only on rare occasions, after many calls, will I get within 100Hz of his transmit frequency.

This keeps me within his passband without QRMing (hopefully) his transmissions."

QRP operating in the best of 'stealth'

John Raynsford, AL7JK, from Eagle River, Alaska, offers advice for putting up and maintaining stealth antennas.

Amazing as it may sound, even here in Alaska an urban environment is taking hold.

No-antenna urban development neighborhoods are popping up all over. In fact most of the new construction in the past few years is exactly that.

I lived in such an area back in 1978 in Anchorage. Having access to several supports - trees, light pole - I strung up Christmas lights which I had no intention of ever illuminating (outdoor type).

I had added another wire same color as the others (green). This additional wire was secured using tape (I should have used green colored wire ties) that was my antenna wire.

Prior to this extensive Christmas light installation, the local 'condo commandos' removed several different wire antennas I'd installed. At a secondhand store there was a telephone box (the identical type used by our local municipal phone company). I used that for a long time for a lead-in attachment point I'd mounted outside my window.

This worked for a whole winter. 'Hey, what are you doing screwing around with my telephone?'

"I'm not a fan of enamel coated magnet wire that can be purchased in bulk. Sunlight reflects off the enamel too well. Grey primer spray paint does wonders but a roll 26ga stranded gray insulated wire from Radio Shack is the ultimate.

"(Stealth antenna users) only come out at night. If I had to live in a third floor or higher apartment / condo environment, I'd build a telescoping element that would be 'deployed' out a window, deck, fire escape - any opening that would allow a piece of tubing to be projected through.

I've built such a portable antenna for ease of transport that telescopes out to 40 feet in height. It's six feet long when collapsed. The base insulator is from the base section of an old discarded (wind damaged) Cushcraft R5.

Never pass up tubing from damaged or unwanted antennas. I'd build a sturdy mount for the element (counterweighted) and 'deploy' the 'tundra vertical ' horizontally at night.

You folks down in the states have it made. It gets dark year around. Again, be sure to use gray primer spray paint to remove reflectivity. Tune with your favorite tuner.

QRP and a blissful blizzard

Steve Galchutt, N0TU, writes from Monument, CO that he recently "woke up to a BLIZZARD! We were snowed in with three to four foot drifts in the driveway.

I worked from home for about four hours via ISDN. Then decided to flexi-off and switched to debugging my scratch SST while feeding logs to my hungry wood stove.

Thanks to John Evans, N0HJ, of Colorado Springs, for his loan of a real 20 meter SST. I measured the voltages IC to IC and found the product detector's input on mine was a volt down.

Hmmm? Then I discovered a shorted LED (AGC diode) was pulling it down or so it seemed.

Replaced it and BAMB! 20 meter signals! Woohoo!

I'm listening to the receiver right now as I write this e-mail and I can't begin to tell you all how good it sounds. Just knowing I took a hand full of parts using Wayne Burdick's, N6KR, GREAT design built this thing from scratch "uglihattan" style makes it sound REALLY special!

Out of all the fun things I've done with this cool hobby, this tops it. (I hope not?) I must admit I've gained some great experience from building the Sierra, K2, DWS, NC20 - the list goes on.

If I can do this, though, anyone can do it! I'm not an electrical engineer! I really do not understand the physics of how this rig works but in concept I get it. That is, how the micro-volt signals arriving at the antenna get mixed down and detected to audio seems pretty basic. Well, sort of (in concept).

I've tried to learn the electronic theory and got lost at the "holes and electrons" stage. That stuff just flew over my windshield. But give me a hot iron and a schematic and now your talking my language!

Only a few other issues with the SST - like it breaks into a howl a full volume and some intermittent thingy in the crystal filter. But, man, it's alive! YES! and I built it from scratch! Amazing!

Next is the SST transmitter section and then the FIRST QSO!

I can hardly wait.

Maybe I'll make it a trial-side QSO. My goal is some day to build a really good high-performance all band receiver from scratch! Seems as far away to me as landing a man on Mars right now!

Test equipment That doesn't cost a mint!

By Graham Firth G3MFJ/W3MFJ

Part 3 – A Noise Generator

Hi again. This is the third part of my series of articles on simple test equipment. It's yet another piece of kit that I described at Pacificon in 2000, and also at Atlanticon & Arkiecon in 2001. This is another example to show that test equipment does not have to be complicated to be extremely useful.

Again, it is a very simple circuit and is very effective in use. The circuit is taken (with minor changes) from the ARRL handbook of a few years ago. The noise generator itself is a zener diode. These things are very noisy when reverse biased – I often wonder if, when we use them to stabilise voltages, they are

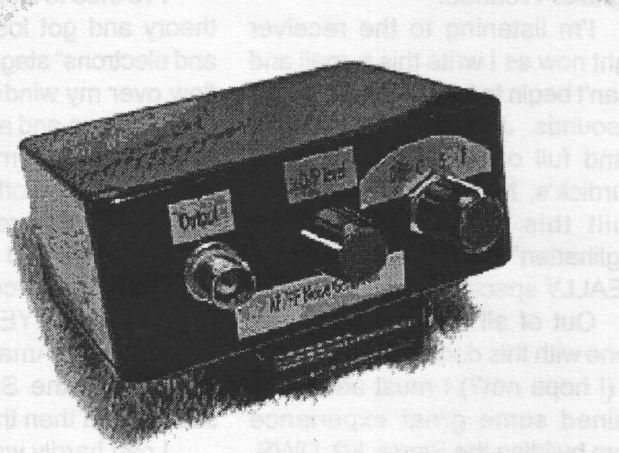


Fig. 1 G3MFJ's Noise Generator

generating lots of noise! The output is amplified by a couple of 2N222 transistors, and the output as taken from a 1K potentiometer to give some control of the output.

The supply for the zener diode is taken from the output of a 555 timer IC via a 50K variable resistor. The 555 has a switched capacitor which gives timing periods of around 500mS and 3mS. The idea of this is to interrupt the noise so that it can be better identified when using the noise generator to align a receiver. The 500mS period turns the noise on & off every second, and the 2mS period interrupts it at an audio frequency, again to aid in alignment.

The four way switch has two banks, one is used as an on/off switch, and the other to change the capacitor. The short circuit position, makes the 555 remain on and thus gives continuous noise where required.

There is nothing critical about any of the components, I have shown a 6.8v zener because one was to hand, but any value around this will do. The 50K variable is used to peak the noise output from the zener. The output bandwidth varies from audio, right through the hf spectrum.

I used stripboard to build mine, but any method can be used – ugly style, or Manhattan being particularly suitable. If care is taken to reduce stray capacitance, the output should be useable even at low vhf – even 2 meters!

That's it! The noise generator is very useful when aligning receivers, the output should be reduced as alignment progresses – it is amazing how easily the interrupted noise can be heard – even at low audio levels.

A noise generator can also be used in conjunction with a noise bridge, to check the impedance of

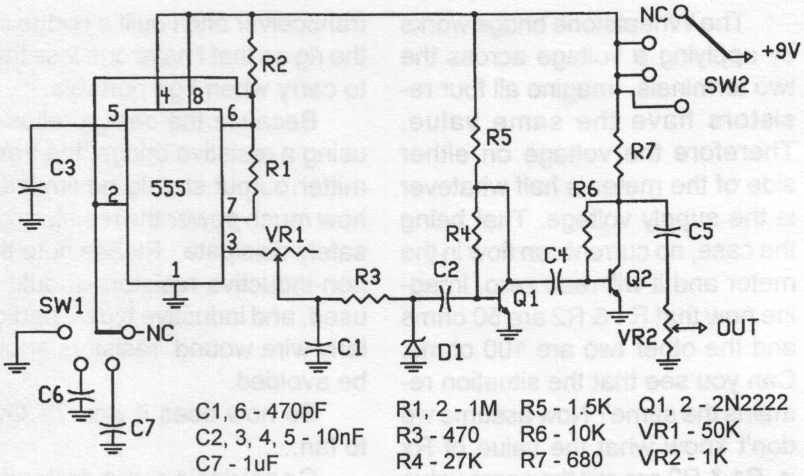


Fig. 2 Schematic for G3MFJ Noise Generator

an antenna, and Tony will be showing a circuit for a noise bridge in a separate article.

The case I used for this was a plastic box bought at my local component shop. The knobs came from there too.

That's it for this issue of QRPp. Another exciting installment in the next issue!

Test equipment

That doesn't cost a mint!

By Tony Fishpool G4WIF/K4WIF

The resistive SWR bridge (see Figure 2) has been published before but I've yet to see a really good explanation of how it works. So I roped in Ian Keyser, the GQRP club technical guru, and together we've hopefully achieved that. Those familiar with the Wheatstone bridge will have an inkling - but by looking at Figure 2 you somehow can't see it. After all, the meter goes down to deck, while in the Wheatstone bridge (see Figure 1), it's across the two arms.

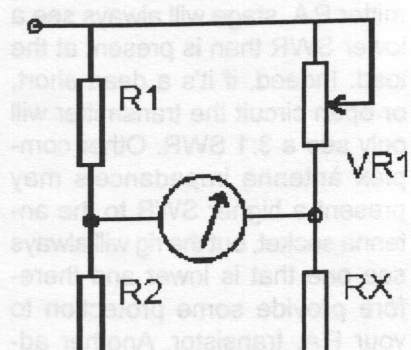


Figure 1

The Wheatstone bridge works by applying a voltage across the two terminals. Imagine all four resistors have the same value. Therefore the voltage on either side of the meter is half whatever is the supply voltage. That being the case, no current can flow in the meter and it will read zero. Imagine now that R1 & R2 are 50 ohms and the other two are 100 ohms. Can you see that the situation remains the same? Now assume we don't know what the value of Rx is, R1 & R2 are still the same value (what they are doesn't matter) and we adjust VR1 until the meter reads zero again. From what we've seen above, VR1 must now have the same value as the unknown resistance Rx. If VR1 had calibration markings we would know the value of Rx. The resistive SWR bridge works on this principle.

Using the resistive SWR Bridge:

Referring to figure 2, when the bridge is set to position 2 to enable tuning of the Antenna System Matching Unit (ASMU), the transmitter P.A. stage will always see a lower SWR than is present at the load. Indeed, if it's a dead short, or open circuit the transmitter will only see a 3:1 SWR. Other complex antenna impedance's may present a higher SWR to the antenna socket, but the rig will always see one that is lower and therefore provide some protection to your P.A. transistor. Another advantage is that they are cheap and easy to build. I've have just finished building the NJQRP PSK31 80m transceiver and I built a bridge into the rig so that I have one less thing to carry when I go portable.

Because the design relies on using a resistive bridge, the transmitter output should be limited to how much power the resistors can safely dissipate. Please note that non-inductive resistors should be used, and inductive types, particularly wire wound resistors should be avoided.

So how does it work? - Over to Ian....

Considering the following statements will help with the following explanation:

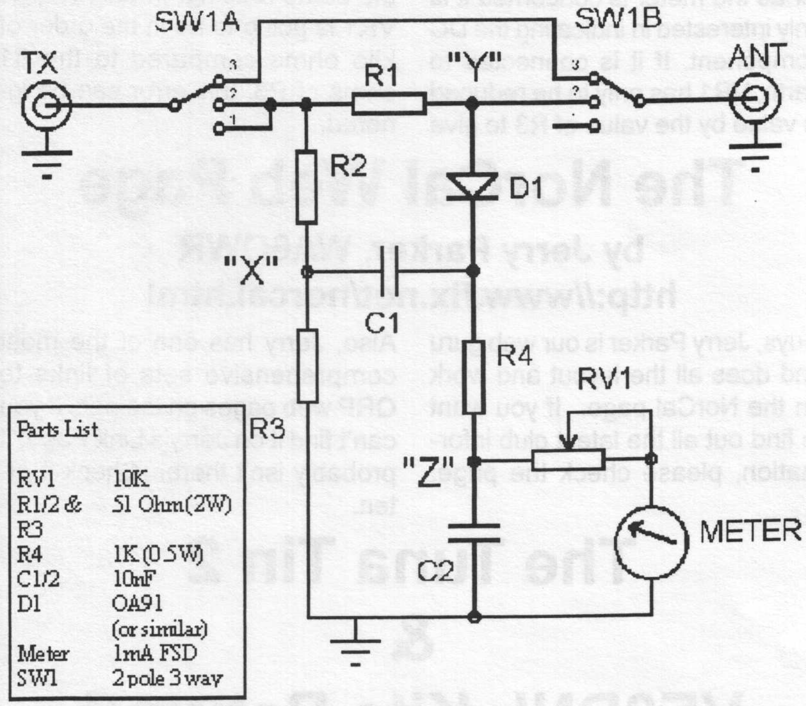
In the interest of simplicity we will assume that the meter draws no current and there is no phase difference between points X and Y.

When RF is applied to the input of the 'bridge' the potential at point X will be at half the total RF potential applied to the bridge, and this will remain so at all times.

D1, C1, R4 and C2 form a peak voltage detector. Reading the potential at point Y in relation to point X.

We will consider three possible scenarios,

1. In switch position 1 no load (i.e. antenna) is applied and so the bridge is now reading the peak RF input voltage via R1 [50 Ohms], this will have no noticeable effect on the reading. This position can be used to adjust VR1 for Full Scale Deflection.
2. In switch position 2 and with a load of high impedance the RF



Parts List	
RV1	10K
R1/2 & R3	51 Ohm(2W)
R4	1K(0.5W)
C1/2	10nF
D1	OA91 (or similar)
Meter	1mA FSD
SW1	2 pole 3 way

Figure 2

potential at point Y is very nearly the same as the input RF voltage. In this instance the peak DC voltage at point Z will be almost half the peak RF voltage applied (RF volts input - RF Volts/2 [point X]). Alternatively, if the load impedance is now made very low (say 1 Ohm), RF volts at point Y is almost zero so the peak detector will again read about half the RF input voltage - (RF volts input/2 [point X] - point Y (zero volts [almost]).

Between the above two extremes, if the load impedance is 50 Ohms, the voltage at point Y will now be half input RF voltage. As now point X and Y are at half RF input voltage the potential difference between them is zero.

This is the point of 1:1 SWR, and as we deviate from this ideal, the voltage detected will rise until the two other scenarios are reached.

3. Having tuned the ASMU (with the switch in position 2), to indicate 1:1 (zero volts), the switch should now be moved to position 3 to remove the bridge and it will connect the ASMU directly to the transmitter. To leave it in circuit in position 2 would divide the R.F power between the antenna and the resistors in the bridge.

The aspect that catches most out is the fact that the meter is connected to ground and not to point X.

The reason for this is that as

far as the meter is concerned it is only interested in indicating the DC component. If it is connected to earth, VR1 has only to be reduced in value by the value of R3 to give the same reading. In practice, as VR1 is going to be in the order of kilo ohms compared to the 51 ohms of R3, this error can be ignored.

The NorCal Web Page

by Jerry Parker, WA6OWR

http://www.fix.net/norcal.html

Guys, Jerry Parker is our web guru and does all the layout and work on the NorCal page. If you want to find out all the latest club information, please check the page. Also, Jerry has one of the most comprehensive sets of links to QRP web pages on the net. If you can't find it on Jerry's Link Page, it probably isn't there. Check it often.

The Tuna Tin 2 & VE3DNL Kits Return!!

Jay Bromley, W5JAY has done it again. The Fort Smith QRP Group, those great guys who put on Arkiecon have brought back two of the greatest kits ever, the Tuna Tin 2 and the VE3DNL. Both kits are so cheap that you won't believe the price. $12 each postage paid to your door!! ($15 DX)

Ordering a kit is simple. Just send JayBob a check or money order for $12 for one kit or $24 for two (one of each special deal) and he will ship it right away. NO waiting. JayBob has the kits in stock ready to ship.

Plus, the great news is that the VE3DNL Board has been redone. Yes, Dave Fifield, AD6A redid the board, and is now a professionally done board with silk screening, soldermask and plated through holes. 1" x 1.5" in size, with 2 mounting holes!

To order and yes, multiple orders are ok, send $12 per kit, either the Tuna Tin 2 or the VE3DNL to:

JayBob Bromley
9505 Bryn Mawr Circle
Ft. Smith, AR. 72908

Please include a self addressed mailing label and don't forget to tell JayBob which kit you are ordering. Make all checks and money orders out to Jay Bromley.

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Oct.19th, 20th, 21st
Concord, California
Sheraton Hotel

Friday Night: No Host Dinner at Fuddrucker's, 6:00 PM
Hospitality Room Opens @ 7:00
Pacificon QRP QSO Party 7:30 - 8:30 Any Radio, any band, any mode. Antenna limited to 6 feet total length, end to end.

Saturday: 4 World Famous QRP Speakers with plenty of time to visit the exhibits and flea market. Hospitality Room Opens @ 7:30 PM.

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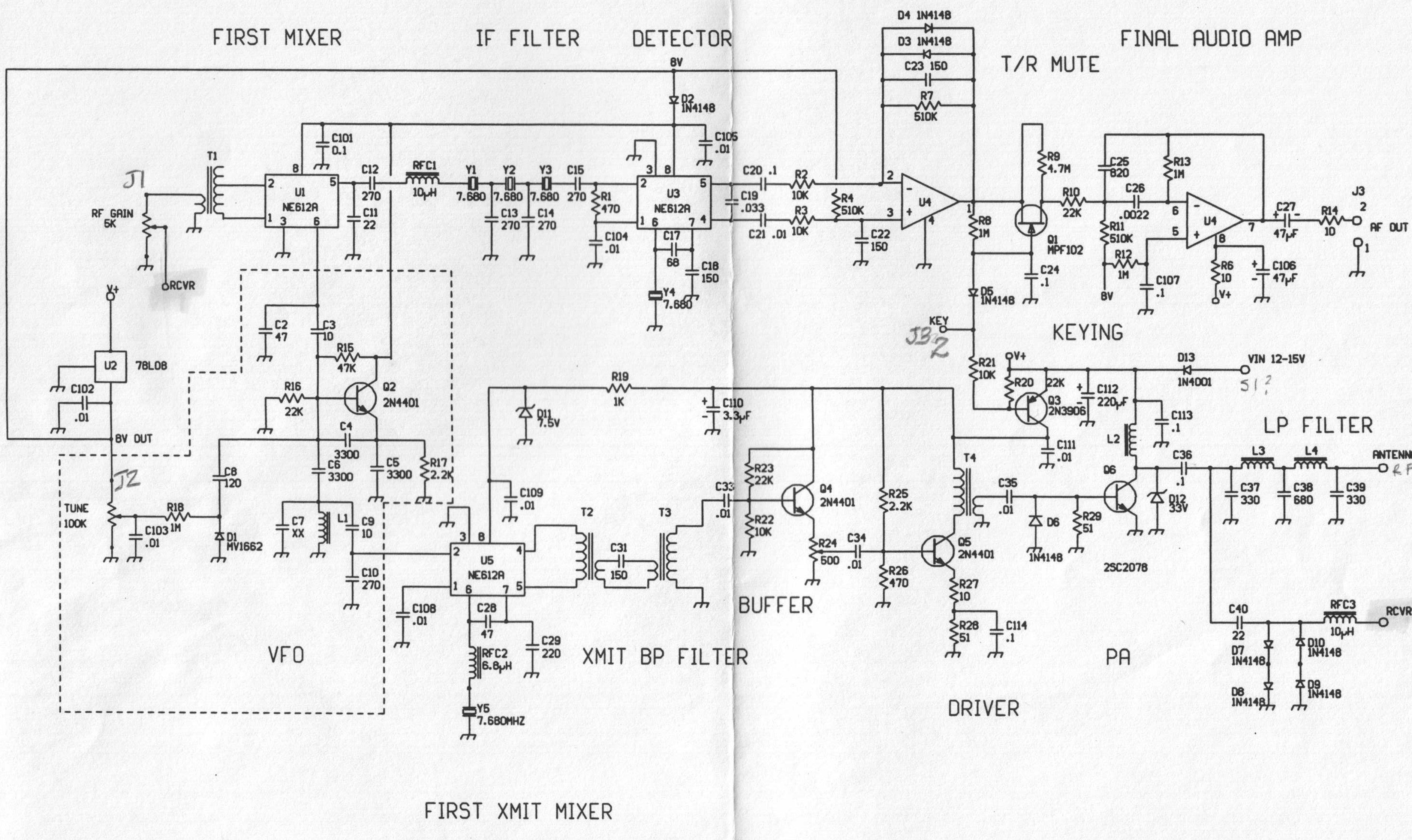

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QRPp

Journal of the Northern California QRP Club

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From the Editor
by Doug Hendricks, KI6DS

This issue is special to me. The theme for this issue was one page articles of interest to QRP. Some are a little longer, but I think you will agree that all belong in this issue. A simple idea, turned into a really big experience for qrpers. Enjoy the issue, and have fun on the air, building, or whatever you do to be a qrper. The credit for this issue must go to the authors. Thank you from a grateful editor for your contributions.
72, Doug, KI6DS

ArkieCon 2002 Will Be Very, Very Special

by JayBob Bromley, W5JAY
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Arkiecon 2002 is gonna be another great time in Ft. Smith. We have had some outstanding speakers at past Arkiecons, Dave Gauding, Jim Kortge, Doug Hendricks, Chuck Adams, Jim Duffey, Glen Leinweber, George Heron, Sir Tony Fishpool, and Lord Graham Firth. This year we have a special treat for all of the hams in the midwest. Rev. George Dobbs, G3RJV, is probably the most famous qrper in the world, (sorry Tony, you are still number 2). George has found time in his very busy schedule to fly to Fort Smith and be the headline speaker for Arkiecon 2002. George has spoken at just about every qrp event in the world, and we are thrilled that he has accepted our invitation to come to Fort Smith. Also, Ed Manual, N5EM who was a headliner at Pacificon is confirmed, and we are working on getting 2 more world class speakers to come. Trust me when I tell you that we will get the best to come to Arkiecon. Arkiecon is a unique experience, the down home hospitality of the local group is an experience that you will never forget. Hanging Judge Kelsey Mikel, Governor Win Dooley, Keith "the builder" Newman, Nick Kennedy, Dub Thornton, Burl Keeton, Dennis Foster, Dennis Schaeffer, all will be there. Then you add in the guys from Missouri, the great bunch from Texas, the Iowa and Nebraska guys, the Kansas QRPers and you have a great mix of qrp friends having a blast.

Arkiecon is not just forum speakers. There is a great flea market and hamfest which is INDOORS!! The facility is fabulous, and the weekend is filled with activities. Friday night has a no host dinner featuring Turkey Fries and Fried Cukes as appetizers. Saturday afternoon and evening we set up stations for you to operate and try the rigs and antennas out. We will have a 4 band K1 and an 817 with the filters so you can check them out. You will be able to try a Vern Wright MP-1 antenna. And we will have well known Qrpers there from all over the US. Jim Cates, Doug Hendricks and Vern Wright are definitely coming from California, Jim Duffey will be hear from New Mexico, Dave Yarnes from Arizona. All will be here renewing old acquaintances and making new ones.

The Guest House motel will again be the qrp headquarters, and you will get a great room in a motel that is just 3 years old, and the price is right!! Plus, it is only a half mile from the convention center.

Please take this as your personal invitation to join us this year at ArkieCon 4 in Ft. Smith, Arkansas on April 6th.
See you there. 72, JayBob

QRP Fixed Attenuators, Manhattan Style

by Mike Schettler WA6MER
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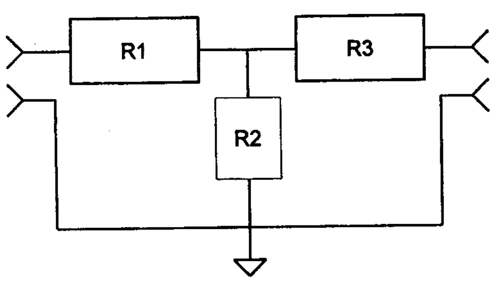
Ever need a fixed attenuator for reducing the output of a QRP transmitter, or perhaps to check your receiver sensitivity? It's getting difficult to find a source of non-inductive power resistors. Radio Shack sells inexpensive 1 Watt metal-oxide resistors at 2 for 49 cents. However, R/S only stocks 10, 100, and 1K ohm values.

A look at the ARRL Handbook attenuator table was intriguing. The calculated values for a 4 dB, an 8 dB, and a 14 dB T-pad were very close to those you can make from the R/S parts, using simple series-parallel combinations. I built up an 8 dB T-attenuator using two of the 10 ohm resistors for each series element, and two of the 100 ohm resistors in parallel for the shunt element. This yields 20 ohms for each series element, and 50 ohms for the shunt element. A little math shows the impedance looking into this pad is about 49.2 ohms. Plenty close enough! The most power dissipated by any resistor (assuming a 4.9 Watt input) is about 1 Watt.

I built one Manhattan style on a small piece of copper-clad board and checked it out using an MFJ SWR analyzer. SWR is less than 1.1:1 up to about 11 MHz. It rises to about 1.2:1 at 20 MHz, and 1.25:1 at 30 MHz. Keep those resistor leads short! I measured attenuation at 7.8 dB up to about 12 MHz, and 7.5 dB at 30 MHz. Enclose the attenuator in more copper-clad board or a small housing of your choice.



So what do you get for $1.50 worth of R/S resistors? (OK, plus connectors). A 7.5 dB attenuator capable of handling 4.9 Watts, and good up thru HF. It will reduce a transmitter output from 4.9W to 870 mW. Add a second one for another 7.5 dB reduction, you're down to 155 mW. Much safer for feeding into a piece of test equipment or trying

QRPp. Building a 3.6 dB T-attenuator takes only two of the 10 ohm resistors and a single 100 ohm. It should handle 3.4 Watts input. See the table below for the details.

Atten.	R1 Series	R2 Shunt	R3 Series	Max Input
3.6 dB	(1) 10 ohm	(1) 100 ohm	(1) 10 ohm	3.4 Watts
7.5 dB	(2) 10 ohm in series	(2) 100 ohm in parallel	(2) 10 ohm in series	4.9 Watts
14dB	(3) 100 ohm in parallel	(2) 10 ohm in series	(3) 100 ohm in parallel	4.3 Watts

Tweaking The Warbler

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Here are the mods I made to my New Jersey QRP Club PSK-80 Warbler:

IMD Improvement Mods

1) Cut the trace (on the top of the board) that connects the emitters of Q5 and Q6. It goes between R13 and R13A. This separates the degeneration circuits.
2) Replace R12 with a 1N4001 diode with the cathode going to ground. Mount the diode on the under side of the board.
3) Above the board, solder a 100uF, 6.3V Tantalum capacitor to the same pads as the diode, negative to ground.
4) Change R11 to a 150-Ohm, 1 Watt resistor. Stand it up vertically.
Changes 2, 3, and 4 stabilize the bias voltage on Q5 and Q6.

Filter Improvement Mods

In my rig the following filter changes gave me a very flat TX bandpass, and a lower-ripple RX bandpass. My TX 90% power points are 3.5801MHz and 3.5809MHz. My RX 70% power points are 3.5799MHz and 3.5809MHz.

1) Change R6 to 1.2k. This makes a better output termination for the TX filter.
2) Add a 5.6k, 1/8W resistor from pin 3 to pin 5 of U1, directly above

the IC. This makes a better input termination for the TX filter.
3) Change R15 to 1.0k. This makes a better input termination for the RX filter.
4) Add a 2.2k Ohm resistor from pin 1 to pin 2 of U2 under the board. This makes a better RX filter output termination.
5) Change R17 to 330 Ohms to restore the gain lost in step 3.

TX Audio Gain Reduction

I needed to reduce the TX audio gain to suit my sound card. This mod
accomplishes that in addition to providing a 600-Ohm load. Just cut the trace going from C101 to J2 on the top side of the board, and solder a 510-Ohm resistor from the ungrounded pad of C101 to the nearest pad on J2 on the bottom side of the board. Then solder a 100-Ohm resistor across C101 (Bottom of board).

Extended Rolloffs for RX Audio

Most of the original corner frequencies were too low at high audio frequencies, and too high at low audio frequencies, degrading the filter response. These changes move the rolloffs outside the filter bandwidth:

1) Change C21 to a 0.47uF (474) mono capacitor.
2) Change C20 to a 0.001uF (102) disk ceramic capacitor.
3) Change C22 to an 8.2pF mono or disk ceramic capacitor.

Other Mods

1) Change C10 to 330pF for a better match. This increases output power. (From the NJ QRP Club website)
2) Change R5 to 220 Ohms. This maintains 7.5V regulation under varying loads. (From Mike Gipe, K1MG)
3) Change D6 to a 1N5817 (1A Schottky). This reduces voltage drop by about 0.35V.
4) If the RX gain is not high enough to suit you, add a 0.01uF (103) disk ceramic capacitor across R17 on the bottom side of the board. If this change increases the gain too much in your system, reduce the value of R24 to suit your taste.

These "tweaks" made a great little rig even better for me. If you try them, I hope you like the results, too. 72, Dave

Airport Security and Pacificon 2001

by Dave Redfern, N4ELM
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With all the changes to airport security in the last few weeks, I was unsure about carrying radio gear on the plane for Pacificon. I would be flying from Dallas' DFW Airport to Oakland International Airport and back. I checked the airline carrier's web page for the latest updates and decided on a plan, I would pack most of the hardware in checked baggage and carry-on the main radios and computer.

I wanted to operate HF and display some gear in the hospitality room so I settled on three bags. The first bag was a RubberMaid "Action Packer" bin (~20X13X11 inches) with a locking top and contained radio gear. The second bag was a standard roll-on bag and contained antenna parts, misc. items, and clothes. The third bag was a double compartment Targus computer bag and was used to carry-on the computers, and radios. I also used a fold up wheeled cart to bungee all the bags together and roll as one unit.

All the radio and computer gear including power supplies, cables, tools, cases, and connectors was distributed among the three bags. I made sure that the third bag (carry-on) did not have any of the prohibited sharp objects and that the radios, PC, and cell phone had batteries so that they could be turned on if necessary. The first bag contained: NorCal/RedHot 20, Red Hot Box, Wilderness Sierra and band modules, Elecraft K1 with case, two NiMH battery chargers, 30 ft. RG-8X coax, 12 ft 300 ohm twinlead, 32 ft. 18ga. Wire, connectors, power cables, screwdriver, & pliers. The second bag contained: clothes and toiletries, MP-1 antenna, MP-1 mast extension, ground stake mount for MP-1, RS switching power supply, and a Kent iambic paddle & case. The third bag (carry-on) contained: a Libretto 100CT laptop, PSK-31 interface, Yaesu FT-817, LDG Z-11 tuner, KK5PY Te-Ne-Key, Yaesu VX-5R HT, Nokia cell phone, Palm IIIe, 2 baluns, mike, power supplies, and cables.

On the outbound trip to Oakland, in Dallas, the first two bags and the cart were checked luggage at the ticket counter. These bags and the cart were run through a large x-ray scanner beside the ticket counter. No questions or problems. I carried the third bag through security to the gate. Per the written instructions, I removed the PC and ran it through the x-ray scanner separately from the bag. Again, no questions or problems. Even with a lot of lines in the busy midmorning, from the start of the ticket counter line until I got to the concourse only took about 1.5

hours.

After a great two days at Pacificon, late Saturday night I discovered that I had acquired several more items to try and fit into my already bulging luggage for the return trip. Like many others, I could not resist the new 4 band module for the K1. In fact I brought back two, one for me and one for a friend, along with a KAF-1 for his K2. I also got a couple of Jerry Parker's very colorful shirts, Vern Wright gave me a nice 12 volt gel cell battery, and I scored some 1800 mah NiMH batteries for my K1 and a Wilderness Ops case for the FT-817/Z-11. I managed to cram all the new stuff into bags 1 & 2.

The return trip through the Oakland airport was a little more interesting. Due the large crowds and confusion seen on my arrival on Thursday, I got to the airport about four hours early on Sunday. Again, I checked the first two bags and the cart at the ticket counter with no problem. The line down the hall to the security checkpoint was long but moved well. Again per the written instructions, I had removed the PC to pass through the scanner separately. This time, the scanner operator yelled at me that I had to remove the computer from the bag (this was after he watched me take out the Libretto in the first place). When I explained that I had already removed the computer, after basically implying that I was not telling the truth, he asked what was in the bag. He seemed puzzled with the answer of "radio gear" and finally decided that the FT-817 and the Z-11 needed to go through separately. With that hurdle cleared, entire trip from the beginning of the ticket line to the concourse took about 2 hours. The rest of the trip back to Dallas was pretty uneventful.

For this trip, due to the Pacificon activities, I was carrying more radio équipment than usual but most of it was in checked baggage. My carry-on bag contained about what I usually take when traveling and carrying radio gear. Since it appears that the rules differ slightly from airport to airport my best suggestion is to be flexible and polite at the security checkpoints. In general though, I was successful in taking all the different equipment which added an extra highlight to my participation in the QRP activities at Pacificon.
Dave Redfearn, N4ELM

MP-1 Ground Stake Mount

by Dave Redfern, N4ELM
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Vern Wright's MP-1 is an excellent antenna system for portable use. The tripod mount works very well but the antenna may tip over on a windy day. As an alternative, I have built a stake mount for the MP-1

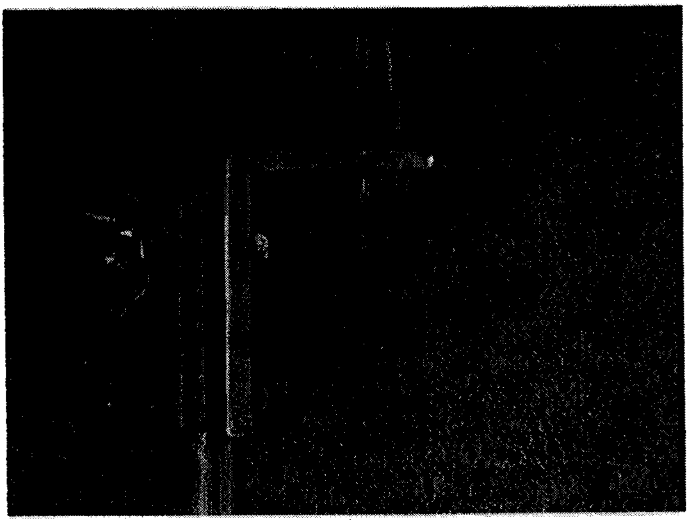

Fig. 1 Close up of the Mount to the Stake

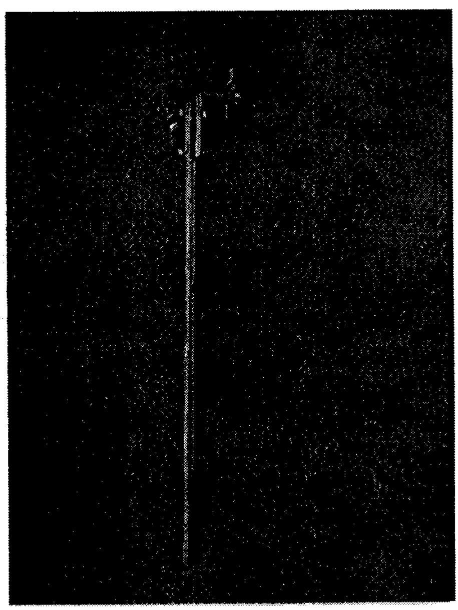

Fig. 2 Full Length View

that can be pushed into the ground and will hold up the antenna under windier conditions.

To make the mount, I bought a mirror mount with a SO-239 to 3/8 X 24 threaded socket. This style mirror mount has a "V" groove on one of the mounting plates, which can be positioned vertically. These may be available from Radio Shack, Amateur suppliers, or CB shops. At a local hardware store, I purchased a 1/2" solid aluminum rod, 36 inches long that would fit in the mirror mount. I cut the aluminum rod in half (18"), attached one end to the mirror mount, vertically, then sharpened the other end with a bench grinder (or file). I mounted a lug under one of the mirror mount bolts to accept the connector from the MP-1 radials.

To use the stake mount, push it into the ground, attach the coax to the SO-239, plug in and fan out the radials, and thread the MP-1 base into the 3/8 X 24 socket. Tune-up the MP-1 as normal.

Total cost for this project was about $15.00 and I was able to use the remaining aluminum rod for a second stake mount.

This mount can also be used for other HF antennas that use 3/8 X 24 threaded mounts, like HamSticks, Outbackers, or Hustlers.

Dave Redfearn, N4ELM

QRP Usage of Fixed Attenuators

by Mike Schettler WA6MER
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OK, so you bought or built a resistive attenuator. Now what? And what are those 'dB' things all about? This article will attempt to provide some guidelines and a little math that will help answer some of your questions. A little high school algebra never hurt anyone, right Doug?

Attenuators are used to reduce a power level to a lower power level. Similar to resistive voltage dividers, they instead are designed to maintain a fixed impedance. For our QRP discussions, I will assume that we are talking about a 50 ohm impedance, as found in RF transmission lines. Why would anyone want to reduce an RF power level? A few examples: 1) to try QRPp; 2) to check out a receiver's sensitivity; 3) feed a transmitter output into a spectrum analyzer to determine harmonic and spurious content.

Now for the math. (A simple calculator is needed. You can do this!) An attenuator is described in terms of its decibel or 'dB' rating. This is given by the equation:

$$dB = 10 * \log (P2 / P1)$$

where P1 and P2 are the power levels before and after the attenuator, and log refers to the 'log' key on your calculator.

So if I want to reduce a power level by a factor of one-half,

$$dB = 10 * \log (1/2).$$

If you do the math, you come up with –3.01 dB. This is an important example to remember. A 3 dB attenuator reduces the power by a factor of one-half. Another example to remember is that a 10 dB attenuator reduces the power by a factor of one-tenth. The proof is left for you to verify. Attenuators can be strung together to yield greater reduction in power. Putting a pair of 3 dB attenuators in series will produce a power reduction of one-fourth of the input power, or a 6 dB reduction.

But what if I have an 8 dB attenuator and want to determine its effect on my 2.5 Watt transmitter? The equation above can be re-written as:

$$(P2 / P1) = 10 \text{ \^{} } (dB / 10)$$

The '^' symbol means "to raise to the power of". So using the 8 dB example, we get: (and don't forget to put the negative sign in the equation for the attenuator value)

$$(P2 / 2.5) = 10 \text{ \^{} } (-8 / 10)$$

This can be re-written as

$$(P2 / 2.5) = 10 \text{ \^{} } (-0.8) = 0.153$$

$$\text{If } (P2 / 2.5) = 0.153, \text{ then } P2 = 0.396 \text{ Watts}$$

That's all there is to it. If you use an attenuator to try QRPp, don't leave it in ahead of your receiver input!

Record 80 Meter Tuna Caught Off Shores of Ft. Smith

by Nick Kennedy, WA5BDU
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When our club decided to build some Ft. Smith tuna-tins as a group project, I couldn't resist getting in on it. But I already have a TT-2 on 40, so I decided to convert to another band. Since winter is coming, and the only QRP crystal I have is for 80, I decided that would be the band.

A few guys asked how I would approach making the change, so I'm going to describe it below.

Generally, it's those frequency sensitive L's and C's that have to change. And the simplified approach is to use the ratio of the old frequency to the new frequency as a multiplier. So take 7 MHz divided by 3.5 MHz, times the values of C and L. That keeps their reactance the same as the band changes. This is called frequency scaling. Of course, I used the actual ratio of 7.04/3.579, but just plain two would have worked for most
of them.

Like I said, that's the simplified approach. Now some of the capacitors are for bypassing—they're selected to look like a short circuit compared to the component they bypass. That would be all of the 0.01 uF and 0.1 uF capacitors. I left these as-is. There reactance is still acceptably low on 80 meters. If you wanted to crank 'em up to 0.02 and 0.2 uF, that would be OK. You could do a reasonableness check by calculating the reactance of these components. So 0.01 and 0.1 uF are 2.2 and 0.2 ohms reactance respectively on 40 meters. On 80, they'd be twice that. So look at some of the resistances they bypass: 220 and 100 ohms bypassed by 0.01uF, and 56 ohms bypassed by 0.1 uF. So the reactances at 80 meters are still small with respect to those resistances. I didn't change 'em.

Now look at the components between the oscillator and amplifier. C2 (100 pf) is part of the oscillator feedback network, per Doug Demaw. The oscillator would probably be fine with no change here, but I figure when in doubt, keep the same reactance. So I doubled the capacitance. Now 200 pF isn't exactly a standard value, so I'd go with 180 pF or 220 pF, whatever's in the drawer.

L1 is just a choke, shunt feeding DC to the oscillator. Again, when in doubt, use the ratio thing. Now one handy thing to recall about toroids is that the inductance is proportional to the square of the number of turns. This one has 7 turns. Seven squared is 49. It doesn't take a whole lot of head scratching to come up with the fact that ten squared is

100, almost exactly twice 49. So I just bumped up the turns count from 7 to 10 to double the inductance of L1.

C4 at 220 pF couples the oscillator to the base of the amplifier. Again using the "when in doubt" rule, I doubled it. Since 440 pF isn't a standard value, I used 470 pF.

Moving further to the right, the next component is T1. We didn't talk about transformers. This one just transforms the 50 ohm load resistance to the desired resistance for the amplifier. This ratio actually sets approximately how much power you'll get from the amplifier. I don't want to change that, so I won't change the ratio. But is the transformer broadband enough to work on 80? Probably is, but let me see if I can tweak it a little. The primary has 10 turns and the secondary has 5. I can change those to 14 and 7. That will keep the ratio at 2:1, so I won't mess up the impedance transformation. But now the inductances of primary and secondary are now almost exactly twice what they were before, per the turns-squared rule. So the reactances of the windings on 80 will be the same as the were on 40. So I made that change. (One rule on transformers is for the reactance of the windings to be large compared with the connected load. That's why I chose not to let it drop as frequency dropped.)

Next comes the output filter. Things get a little trickier in filters and resonant circuits. Previously, keeping approximately the same value of reactance was OK. Here you might need to be a little more careful. There are several ways to go. One is to use the scaling technique described earlier. But resulting values might be hard to match with standard components. Another might be to select (or design) a lowpass filter from ARRL handbook tables. Or you could try the scaling technique, substituting standard values and verifying the results. I use a circuit analysis program called Electronic Workbench. There are many others that would work as well. Alternately, you could breadboard the filter, hook a 50 ohm resistor to the output and shoot through it with your MFJ-259B. Or your QRP rig and SWR meter. That might not tell you the attenuation at harmonics, but it would at least insure negligible insertion loss at the desired frequency. Near 1:1 SWR means things should be OK.

I did my cut-and-try with Electronic Workbench. This is a T37-6 core with 17 turns on it. Using standard numbers and formulas from the handbook or Amidon, that's 0.867 uH. That scales up to 1.71 uH.

Calculating back the other direction gives almost exactly 24 turns required for the 80 meter version. But I did something a little compulsive—I notice that the type 6 (yellow) cores are said to be for 3 to 50 MHz—which is OK, but the type 2 (red) ones are good for 1 to 30 MHz.

So 80 is a bit more well-centered in the type 2 core's range. So I swapped to a red core since I have lot's of 'em in my junk box. But don't special order one—the yellow should do fine. With all my trial and error work, I finally came up with a value of 1.6 uH, using 20 turns on the T37-2 core. (That's one more nice thing about electronic simulation—you can do "sensitivity checks" to see if it really matters much whether you the exact value or one that's merely close.)

Going through similar measures, I came up with a value of 768 pF (I actually had one in my junk box!) for C6 and 910 pF (but 1000 pf or 0.001 uF would have worked OK) for C7.

Whew! Takes longer to describe it than to do it. Finally, that cap across the backbone of the filter—C11. You'll see this in some designs but not in others. It forms a parallel resonant circuit with L2 to give extra attenuation on the 2nd harmonic. I was surprised when I first saw this—surprised you could do something so simple and not mess up the performance of the filter in other respects. But it works. I'd select C11 rather carefully to make sure it resonates L2 at exactly twice your operating frequency. I used a value of 330 pF. It won't hurt things much if you're off here, you just won't get the maximum value out of this extra feature.

I was amazed and gratified when I powered the thing up and it looked fine right off the bat—nice clean sine wave and about 700 mW output.

I wired up my can with the two UHF connecters and the toggle switch T/R switch (hey—just like back in 1962). I also put a 1/4 phone jack in the can for my key and a coaxial type power connector from radio shack.

Then I did the "chirp elimination mod". But that's not what I'd call it. My 40 meter TT2 didn't chirp that badly. But I didn't like the fact that both sides of the key had to be insulated from ground in the basic design. I wanted to use my keyer but didn't want to have to worry about whether it's case touches ground. With the modification, the shell side of the keying connector is at ground just like on any other rig. On my TT2/40—I did this mod manhattan style on the back side of the board. But I'd misplaced my super glue while doing the TT2/80, so I did the mod "islander style", using that island cutter sold by the NJ group. It worked fine. Those islands are kinda teeny, but I managed so solder four leads to one.

I still haven't described the toughest component choice I had to make. My wife saved me two cans—a BumbleBee and a Chicken of the Sea. But on close inspection, the CotS wins hands down. It's got that pretty little blonde mermaid. She's stirring the ionosphere with what looks like a quarter wave monopole. You can seen the positive ions swirling. Remove the label carefully before doing the metal work. Then cut out the mermaid and glue her back on. Also, I cut out the tiny "dolphin safe" sticker and stuck it on the board, so my environmentally conscious kids would know that no friendly creatures were harmed in the making of this transmitter.

I always skip through equipment reviews to get to the on-the-air description at the end. Well folks, there's hardly anybody that's moved down to 80 meters yet. It's still too early in the low-QRN months of fall/winter I guess. I pounded the brass in vain yesterday and last night and finally sent an email to milliwatt-king Jim, KJ5FT. He agreed to listen for me this morning as soon as he could get a cuppa coffee. We had a good QSO. Jim had to go QRO (2 watts!) to overcome my noise, but the QSO is much appreciated. Jim is trying to scare me up a 3560 crystal for the AR QRP net, but I'm thinking I may try to build a VFO for this thing. Or else I'll just QRP the FT-1000.

Now, so you'll never have to wade through all that mess again, let me summarize the component changes necessary to build the TT2/80:

Component	**Old**	**New**
C2	100p	180 to 220p
L1	7 turns	10 turns
C4	220p	430 to 270p
T1	10T/5T	14T/7T
L2	17turns	24 turns OR ...
L2	T37-6	T37-2 with 20 turns
C6	390p	768p or thereabouts
C7	470p	910p or 1000p

Unchanged—all resistors, C1, C3, C5, C8, C10, C9

Oh yeah, a couple more handy things for homebrewers. Those calculated values for toroids are kinda ballpark ... usually OK, but sometimes you need to get close. The AADE L/C Meter IIB is sure handy when you want to get close to a critical value. I think I ended up adjusting my L2 by one turn ...

Another thing that's handy is a spreadsheet set up to automate calculations of resonant frequency, reactance, toroid turns and a bunch of other stuff that you use a lot. It's good to make your own, adding stuff as you encounter and learn about it. But if you want mine, let me know. Requires Excel 97 or later.

72 & see you on 80—Nick, WA5BDU

THE 360-DEGREE OPERATING CHALLENGE

By Paul L. Conant, Jr., WQ5X
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QRP enthusiasts compensate for low power with superior skill. They adorn their walls with all the awards of which QRO operators boast, but hang them up beneath their 1000 Mile per Watt award. This article describes the 360-degree operating challenge, another way to demonstrate amateur radio accomplishment on the HF bands.

Subscribers to the QRP-L e-mail reflector have access to a useful command: **run qrp-l x calls2dist <your_callsign> <their_callsign>**. This command responds via e-mail with the heading and distance to stations you have worked. Enter this data in an Excel spreadsheet and display it in a scatter chart. You will likely see a dense cluster of points in one general direction. The remaining points are thinly spread around the rest of the chart, separated by conspicuous open areas. The challenge is to fill in the gaps and the goal is to log QSOs at each of the 360 points of the compass. That accomplished, print off your scatter chart for a customized award and unique demonstration of your operating skill. Along the way, you can take pleasure in intermediate accomplishments like having worked stations at 0, 90, 180, and 270 degrees, and other principal points on the compass.

The 360-degree challenge will require you to evaluate the effects of your operating habits. Varying the time of day that you operate may be the single most important factor in filling the gaps on your scatter chart. The performance of your antenna system will be highlighted. You will become increasingly conscious of what it takes to fine-tune your capability to communicate in every direction.

Logging heading and distance to your contacts will reveal interesting geographical connections. You may be surprised at the cities and countries that lie along a particular path. You will begin to associate compass headings with distant locations, even if you do not have an antenna rotator. You may investigate what locations lie along paths you have not worked and actively seek them out.

Completing the 360-degree operating challenge would be a significant accomplishment for any station at any power level. At QRP power levels, you will enter the ranks of truly distinguished radio amateurs. Along the way, you will have mastered an impressive body of knowledge, but more importantly, your will have had an immeasurable amount of fun. I look forward to working each of you while working on my 360-degree challenge. 72 de WQ5X!

Vectronics QRP Transmitter and Receiver Kits

By Paul L. Conant, Jr., WQ5X
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Grand Prairie, TX 75052-1634

You may have seen them in ads in QST, on display at the MFJ booth at hamfests, or in the Radio Shack catalog. The Vectronics VEC-1230K QRP transmitter and companion VEC-1130K receiver kits are priced at $29.95 each. They occasionally appear on sale at $19.95. Enclosure kits can be ordered separately. How well do they work?

This writer built both kits, with enclosures, for 30-meters. The VXO controlled one-watt transmitter tunes several kilohertz around 10.108 MHz. There is a switch for an optional crystal, not provided, that extends the range of the transmitter. The receiver covers the entire 30-meter band. Based on the popular NE612, it is quite sensitive, but has little selectivity. Don't let that turn you off. Adjusting RF gain controls receiver volume. The transmitter can be connected to the antenna through a T-R switch in the receiver. An internally mounted 9-V battery powers the receiver. An external 12 to 15-V power supply, not included with the kit, provides transmit power from QRPp levels to more than a watt. Each kit goes together in just a few hours. The instruction manuals are very well written. Even an inexperienced builder like me can follow them easily and reasonably expect to complete a rig that works the first time.

On-air results are what really count. These kits exceeded my expectations in dozens of contacts with ranges up to 1500+ miles. I received numerous positive comments on the sound of the transmitter. More often than not, I received reports of signal strength between S4 and S6. One must turn the receiver RF gain control all the way down when sending. This is a crude, but effective, way to save the ears. The poor selectivity of the receiver allows the operator to monitor a range of frequencies simultaneously. This makes it easy to pounce when you hear a station you want to work. The transmitter can quickly be zero beat with a received signal by turning its tuning knob while sending a series of very brief dits.

These kits are great confidence boosters for first-time builders. They do work and can provide many hours of on-the-air fun on 80, 40, 30, or 20 meters. Experienced builders will find plenty of room for performance-enhancing mods. Don't hesitate to experience the thrill of QRP with these little kits. For making contacts across town or across the country, these rigs are fun to build and operate. 72!

The Slide-wire Bridge

By Paul L. Conant, Jr., WQ5X
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Do you need a simple, accurate way to measure reactances? This writer ran across a neat device in Drake's Radio Cyclopedia (1931). The slide-wire bridge measures inductance and capacitance. It can be constructed with nothing more than a piece of wood, some screws, hook-up wire, alligator clips, a high-impedance earphone, some resistance wire (i.e. Nichrome), and an audio oscillator.

Fasten a 25" piece of Nichrome wire to a wooden board and make a mark on the board every quarter inch. Number the marks from 1 to 100. The ends of the Nichrome are terminals A and C of your bridge. Connect your audio oscillator to these terminals. Connect your known reactance between terminal C and D, and the unknown between D and A. Connect one lead of the earphone to terminal D, between the unknown and known reactances. Terminal B is the point of contact between the Nichrome wire and the other lead of the earphone. Move it along the Nichrome wire until you detect a null. This is the point at which the bridge is in balance.

The ratio between terminals A and B and terminals B and C, along with the value of the known reactance, are used to figure the value of the unknown component. For measuring inductance, if A-B is 25, B-C is 75, and the known inductance is 100 uH, then 25/75=x/100, and x=33 uH. The ratio is flipped when measuring capacitance. If A-B is 25, B-C is 75, and the known capacitance is 100 pF, then 75/25= x/100, and x=300 pF.

You can construct this simple, but accurate, bridge using any convenient dimensions. You will not find Nichrome wire at Radio Shack, but you might try recovering it from discarded hair dryers or curling irons. Other resistance wires, like Kalvan, can be used, also. You may substitute an audio amplifier, like the Ten-Tec Utility Audio Amplifier kit, that has a high impedance input for the earphone. You can also use your DVM to detect a null along the resistance wire. This simple, low-cost, or no-cost, instrument takes the guesswork out of winding coils and toroids for your QRP projects. Have fun and 72!

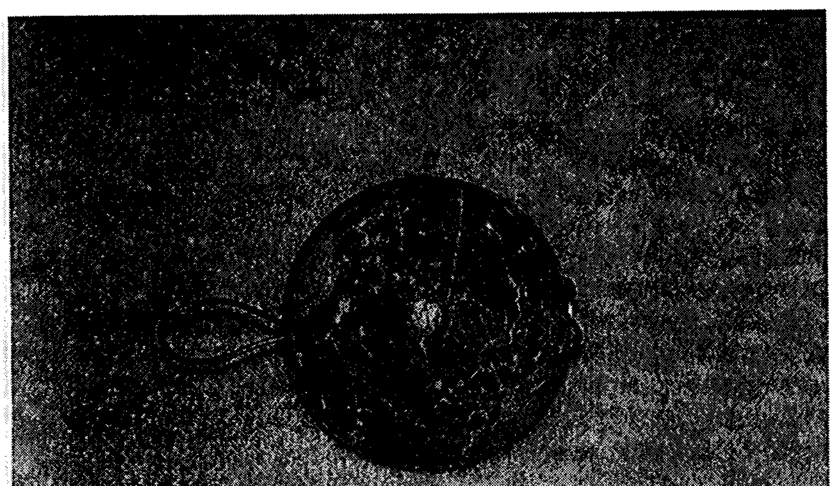
The QRP Rubber Biscuit

by Dave Redfern, N4ELM

The past couple of weeks I've been carrying a radio to work to operate during lunch, kind-of-a QRP lunch bag. The K1 includes the battery pack, tuner, and a 20/17 meter band module for a complete QRP CW station. I also use a KK5PY mini Te-Ne-Key and earphones. The antenna is a 33 foot wire with a BNC on one end. Additionally, I use a 30 foot piece of nylon carpenter's line to help hold up the antenna and have a 16 foot radial wire.

I usually set up on a picnic table next to a moderately sized tree and can deploy the wire as an inverted L antenna with a 16 foot radial. Due to the blustery wind conditions around the building, occasionally I had problems getting the antenna wire over the tree. In the past, I have used rocks or lead weights to pull a line over a tree but this was a semi-public area near the parking lot and I did not want to risk bashing a co-worker, a car, or get a rock and line hopelessly tangled in the company's tree. Also, the landscaping did not include rocks.

I found a possible solution in a box of old dog toys. I came up with



Dave Redfern's Rubber "Biscuit" Antenna Launcher

a 2 1/2" diameter rubber ball. The rubber ball is easy to throw and has enough weight to pull the carpenter's line over a tree. Unfortunately, it is not easy to tie the line to the ball. After several attempts, I could not come up with a way to consistently tie the line to the ball without it slipping off.

Eventually, I decided to push a wire through the ball, make a loop at one end, and attach the wire to a stop at the other end. I used an 8" piece of wire and bent it in half forming a loop at one end. I pushed the other ends through the ball and wrapped them around a ¼" flat washer to keep the wire from pulling back through the ball.

To use it, one end of the line is attached to the loop on the ball; the other end of the line is attached to the end of the antenna and the ball is thrown over the tree. Then with the BNC end connected to the radio, the antenna is pulled over the tree. The line is untied from the ball and then tied off to a nearby bush to complete the inverted L antenna.
The rubber ball can usually be purchased at a toy store or pet store and a visit to the hardware store will get the wire and washer if these items are not in the junk box. Altogether, it should run around $5.00 or less for all new parts.

Dave Redfearn, N4ELM

Parts Scrounging for Fun and Profit!

By: Steve Smith, WB6TNL
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Consumer electronics items are produced by the millions and sold relatively inexpensively. When a consumer product fails more often than not it is simply discarded rather than repaired, a boon to those of us who enjoy experimenting and homebrewing Ham equipment.

Here are just a few examples of gems that can be found lurking within today's consumer electronics products.

Television sets: Although today's solid-state sets are highly integrated they can still be the source of many usefull goodies. The deflection yoke alone will yield hundreds of feet of small-gauge magnet wire handy for winding coils and for "stealth" antennas. Many transistors can be used as final amplifiers for QRP rigs, at least on the lower bands. Every set has an audio amplifier and speaker, sometimes two, which can be excised for use as utility amps. or in a HB RX. Some sets still use analog control pots that can be robbed.

VCRs: Many RF parts, especially miniature chokes and capacitors. Older units contain linear power supplies that handle the current requirements of a 5 Watt rig. Also lots of metric hardware. Watch for large ferrite beads & binocular cores in the 300 Ohm to 75 Ohm transformer.

Satellite Receivers: Another treasure trove of R.F. parts. The older 4 GHz receivers are being junked right and left. More coils, capacitors, trimmers, power supplies, broad-band amps -and- if you're real lucky...NE602s! Yup, more than one set I've scrounged has had several. Ooooh!

Cellular Phones: Old analog mobiles have may R.F. plus regulator I.C.s. The handset usually contains a nice audio amp. I.C., speaker and electret mic. Handheld phones have surface-mount parts like audio I.C.s, chokes and capacitors which can be removed and re-used.

Have fun scrounging and by all means: Snort Rosin!

Antenna Analyzer Secrets

by Joe Everhart, N2CX
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Antenna analyzers as sold by test equipment makers like MFJ and Autek are quite popular these days but rather pricey. In this article we will look at the basic ideas behind them and some thoughts on how to roll your own for a very small outlay. In this short piece I don't have space to give any circuits, but I'll point you toward some examples.

The underlying principles are really quite simple. Figure 1 shows the extremely simple block diagram. A tunable oscillator supplies a signal at the frequency where you will be measuring SWR. This supplies a signal to the SWR bridge which, in turn, is connected to the antenna through a coaxial cable. The bridge balance is sensed by a detector and displayed on a meter. In the case of the MFJ units this is an analog meter while the Autek line uses a microprocessor chip feeding an LCD display. Some of the MFJ units and all of the Autek devices provide other information, but that is beyond the scope of this article.

The bridge is the real key to these devices. It consists simply of several resistors arranged in a modified Wheatstone bridge configuration. Its operation is described in the Test Equipment section of any recent ARRL Radio Amateur Handbook. The bridge compares the antenna impedance to a fixed 51 ohm resistor. A simple diode detector acts as an RF detector across the bridge arms providing a DC output voltage proportional to the bridge unbalance.

There is a very simple relationship between bridge unbalance and SWR. If you want the details check the Test Equi-pent section of the ARRL Handbook but the basics are that the unbalance can be interpreted as the ratio between forward and reflected voltage. Table 1 gives SWR for typical ratios.

Now if you check out a common SWR meter you can see this allows it to be directly calibrated. This same calibration is exactly how the MFJ SWR analyzers display SWR on their meters. And while in common in-line SWR meters you have to manually set the full scale reading on forward power, the analyzers do it automatically. They can do this since their internal oscillators always drive the bridge circuit with exactly the same RF level and that corresponds to a full-scale reading. They do this by sampling the level and adjusting it to always be the same. So then the bridge unbalance displayed on the meter reads directly in SWR with no manual level setting. Not only that, but if they set the meter level high enough that high SWR is above full scale, then the interesting low SWR readings are spread over most of the meter scale.

So SWR analyzer operating principles are really simple. The actual SWR measuring bridge is really a basic combination of resistors and a familiar diode detector feeding a suitably calibrated meter. The difficult part of the whole device is a tunable oscillator that covers a wide frequency range and uses special feedback circuits that sense the output level and keep it constant over the entire tuning range. Plus, it has to have very distortion or they would give faulty SWR readings. Sounds simple but it really isn't! And that's why the analyzers cost as much as they do.

It is 'way beyond the scope of this article to tell you how to do it, but you **can** make an oscillator that covers a narrow range such as one ham band that comes close. And at low frequencies well below the broadcast band you can use special oscillators that do perform over wide ranges. Some examples can be seen on the K0LR web site at http://www.lwca.org/library/articles/k0lr/lfanalyz/lfanalyz.htm.

And you never know, I just may show you how make your own single-band version in a future article...

72/73, Joe E., N2CX

Build the PSK31 Audio Beacon

by George Heron, N2APB, email: n2apb@amsat.org
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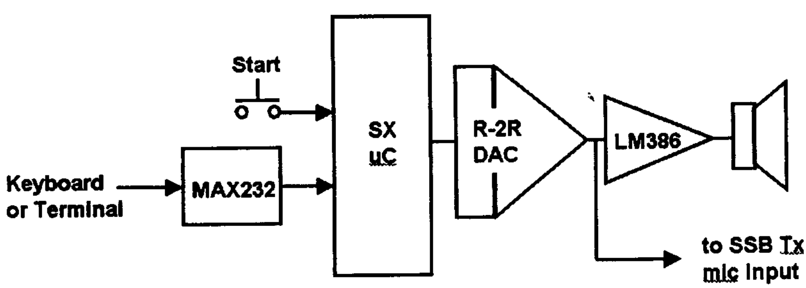
Forest Hill, MD 21050

This small, stand-alone board generates PSK31-encoded audio tones that can be delivered to the input of any SSB transmitter to serve as a PSK31 beacon. When decoded on the receive side, the pre-programmed text string is displayed on the screen of a computer running DigiPan or any other PSK31 software package.

A fast SX microcontroller constructs encoded audio tones using a simple "R-2R" DAC. This audio waveform, generated by using PSK31 algorithms, is fed to an LM386 amp that drives a speaker - *voila*, the familiar PSK31 warble is heard. When presented as input to a PSK31 receiving system such as DigiPan, these modulated audio tones are decoded and the pre-programmed beacon string is displayed as text on the computer screen. The beacon string may be played a single time by pressing a pushbutton, or it may be jumper-selected to play continuously. Other jumpers select which of the 24 different audio carriers are to be used. A keyboard or data terminal can provide input of real-time textual data to the PSK31 Audio Beacon, allowing the project to serve as a more dynamic "signal generator", and the board can be electrically connected to the input of an SSB transmitter to be used as an RF PSK31 transmitter.



PSK31 Audio Beacon – Block diagram

The Beacon is also ideally suited for groups wishing to have some fun during meetings. Club members could operate their audio beacons while others attempt to copy the beacon strings using a laptop equipped with DigiPan software. Construction is straightforward and you'll have immediate feedback on how it works when you plug in a 9V battery and speaker.

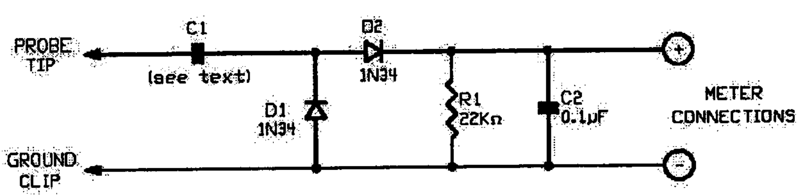
NOTE: The PSK31 Audio Beacon project was described in great detail in August 2001 QST. A complete description, schematic, board layout and source code can be found at http://www.njqrp.org/psk31beacon, and a complete kit of parts is available for $25 from the NJQRP.

An Improved Diode Probe Design

By Dave Fifield, AD6A

Many of you constructors/tinkerers will have used a simple diode probe to test for the presence of RF signals in your newly built homebrew/kit radio. Several kits have single diode RF probe circuits built into them to make life easier for the constructor (for example, the Wilderness Sierra and the Red Hot 20). However, all of these RF diode probe detector circuits suffer from the disadvantage that they are only half-wave rectifiers. As such, they are only about half as sensitive as they could be.

With the addition of another diode, most of these half-wave detectors can be converted into full-wave detectors with a subsequent boost in sensitivity. The circuit of a simple full-wave diode probe RF detector is presented below. This is about as simple as you can make it. For HF use, the input capacitor (C1) should be 100pF. For VHF, make it 10pF. The GND clip lead and the input probe lengths should be kept to a minimum for best performance and minimum affect on the circuit being measured. Although for best sensitivity the use of a modern digital multimeter to measure the DC voltage at the output of the detector is best (as they have a very high input resistance) for most ham applications, such as tuning up a transmitter bandpass filter, it is much easier to use an analog multimeter. If you do use an analog meter, make sure it is a good one with an input resistance of at least 20KOhm per volt otherwise the diode probe sensitivity will be too low to be of any use.



Note the use of germanium diodes in the diode probe circuit. These have a forward voltage drop of about 0.3V. The use of silicon signal diodes is not recommended (e.g. 1N914, 1N4148) as they have a much higher forward voltage drop of about 0.7V. If you can find them, feel free to use some Schottky barrier diodes (or hot carrier diodes as they are sometimes called). These have a forward voltage drop of only about 0.2V or 0.25V depending on type.

Of course, there are other improvements that can be made, such as the inclusion of an op-amp to remove the diode's forward voltage drop and linearize the output. These can be the subject of another short article in a future edition of QRPp.

QRPifficciency

By Brad Mitchell
N8YG (Formerly WB8YGG).

Some time ago I was reading the milliwatt re-print that I had ordered, and was very much interested in the ongoing discussion between many names like Jim Cates, and Wes Hayward regarding The defacto means of measuring power for QRP.

The debate surrounded the idea that the traditional Input Power measurement was not valid for doing things like miles per watt etc. It seems that there were lines in the sand drawn, but the Pout measurement prevailed.

Time went on and my day job got very involved with designing the power system for a portable digital camera at Kodak. I used the latest technology for designing the camera's power system so that it would be cost and power efficient. I of course used switching regulators for any relative high power systems in the camera.

This experience started a chain of events in my thought process. First why do we never see switching power supplies used in QRP rigs so that we can operate from multitudes of voltages input to the rig, with high efficiency conversion? I know that the old noise excuse is no longer valid with the latest technology!

And finally I started thinking why don't we specify the power conversion efficiency of QRP rigs?

This made me think for a moment that if we had not dropped the Input Power measurement as the standard for measuring QRP rigs, we may have forced more efficient designs!! This was almost enough in my mind to start up the original Milliwatt debate of Power input vs Power output for Miles per watt etc.

What I propose is that we not reinitiate the debate of Pout vs Pin , as I believe it probably is counterproductive, but to encourage a specification for power conversion efficiency for QRP rigs. There are many cases where we see the specs for receiver current draw, but I believe that we should look at the specs for the Tx efficiency, across the full battery input voltage for the radio as well.

What this would mean is that we could come up with a conversion efficiency for a rig at 14V when the battery is new, and then one for say 05. v increments, down to the useful operating voltage of the rig. This information would be very useful to those that would like to operate QRP portable, and I believe that there are many. It would certainly help predict the number of batteries necessary, and if we started using such a standard, we might actually encourage more efficient designs in the future.

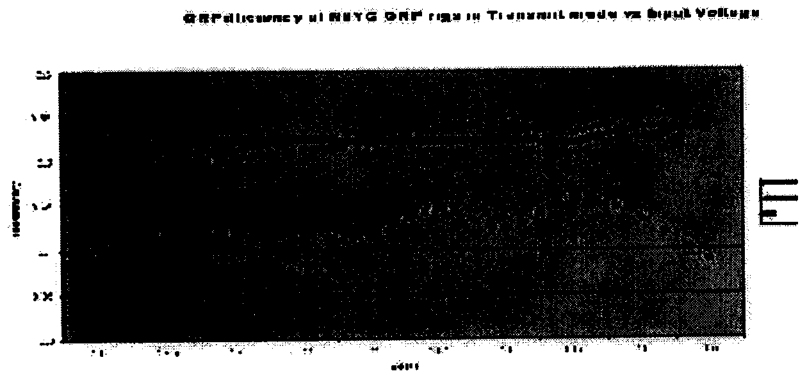
For example if someone came out with a rig that had all the bells and whistles in it, synthesized, fit in an altoids tin, only drew say 10 mA in receive mode, and put out 5 watts on all bands, we would all want one. But alas maybe it really is quite inefficient in transmit mode, and would be a great conversation piece in the shack, but not so great for the field. (unless you just listen). More efficient designs would lead to less batteries required to drag along into the woods for operating QRP. Now.. who doesn't want that?

As a simple test I took 3 of my portable QRP rigs, and did a simple test from 14 volts down to 9 volts input.

The chart shows the QRPifficiency of each of these rigs over the range of voltages that I used. The data for each of the rigs is shown in the 3 tables. The QRPifficiency ranges from 38% to 55% Realistically these figures are very poor as far as general efficiency numbers are concerned. How good are they relative to the rest of the rigs? Only time and further testing will tell. The challenge is set to come up with the most QRPifficient design.

By the way.. My Sierra, is highly modified, the 38S has the high power mod, and the SW-40 is not modified at all.

Brad N8YG



Sierra

Vin	I in	Pin	V p-p	Pout	Qrpifficiency
14	0.77	10.78	48	5.76	0.53
13.5	0.75	10.125	45	5.06	0.50
13	0.74	9.62	44	4.84	0.50
12.5	0.72	9	43	4.62	0.51
12	0.71	8.52	42	4.41	0.52
11.5	0.68	7.82	41	4.20	0.54
11	0.67	7.37	40	4.00	0.54
10.5	0.65	6.825	38	3.61	0.53
10	0.62	6.2	37	3.42	0.55
9.5	0.62	5.89	36	3.24	0.55
9	0.6	5.4	34	2.89	0.54

38s

Vin	I in	Pin	Vp-p	Pout	QRPifficiency
14	1.15	16.1	60	9.00	0.56
13.5	1.15	15.53	57	8.12	0.52
13	1.11	14.43	55	7.56	0.52
12.5	1.07	13.38	53	7.02	0.52
12	1.04	12.48	51	6.50	0.52
11.5	1	11.5	49	6.00	0.52
11	0.96	10.56	47	5.52	0.52
10.5	0.93	9.77	45	5.06	0.52
10	0.9	9	44	4.84	0.54
9.5	0.87	8.27	42	4.41	0.53
9	2.64	23.76	0	0	0

SW-40

Vin	Iin	Pin	Vp-p	Pout	QRPifficiency
14	0.32	4.48	27	1.82	0.41
13.5	0.32	4.32	27	1.82	0.42
13	0.31	4.03	26	1.69	0.42
12.5	0.3	3.75	25	1.56	0.42
12	0.29	3.48	24	1.44	0.41
11.5	0.28	3.22	24	1.44	0.45
11	0.26	2.86	22	1.21	0.42
10.5	0.24	2.52	21.5	1.16	0.46
10	0.23	2.3	20	1.00	0.43
9.5	0.22	2.09	18	0.81	0.39
9	0.2	1.8	18	0.81	0.45

Test equipment That doesn't cost a mint!

By Tony Fishpool G4WIF/K4WIF

My favourite part of Radcom is Pat Hawker's "Technical Topics" column. Recently, he mentioned a new chip - the LTC 1799 that can generate square waves over a wide frequency range and more or less, left it at that – but I was intrigued. I managed to scrounge a couple out of Linear Technologies. The LTC 1799 is intended for clock applications on a preset frequency.

The fixed resistor allows selection of any frequency between 1KHz to 30MHz. So got to thinking – why not a variable resistor?

The frequency is determined by the following formula:-

$$F = \frac{10^3}{N.R}$$

Where N is the division factor and R is the resistor value.

As the frequency is inversely proportional to resistance the upper limit is not affected by choice of potentiometer but the lower frequency will be. A ten turn pot with a value of 20k turned up in the junk box. This resulted in a swing of 4 to 30 MHz in the "divide by 1" position. The tuning was rather course so a 100 ohm pot was added in series for fine adjustment. Stability was surprisingly good and at 30 MHz only the kilohertz digit tended to wander. I wouldn't claim this to be a signal generator – more an adjustable marker generator. It would certainly fit in a mint tin but I added a frequency counter to make it more useful. The datasheet does warn that the resistance should not fall below 2.2K so a fixed resistor was also added in series with the potentiometer.

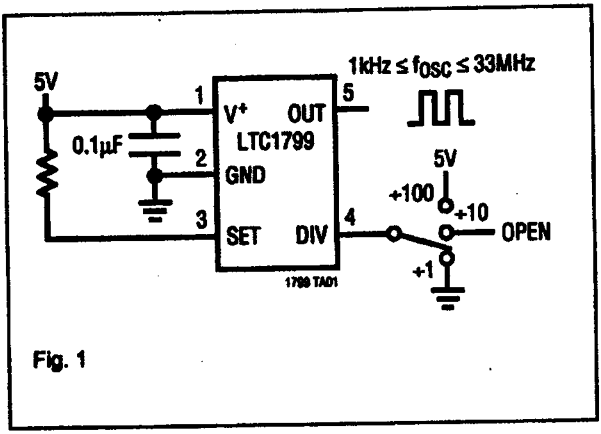


Fig. 1

Construction.

The LTC1799 is a SOT23 surface mount chip. It is very tiny and conventional construction methods become quite a challenge. Ted Williams G0ULL is a master at producing surface mount PCBs using photographic methods. It's not rocket science when you have the equipment and Ted has been commissioned by KI6DS to write an article on the subject for QRPp. I used the superb ARES software to design a board and e-mailed it to Ted who quickly sent a pcb back via "r-mail", (my wife Ruth is second clarinet in Ted's orchestra!). The board was less than an inch square and I used some double-sided tape to fix it to a piece of copper board. Using skills obtained from building the SMK-1 (and a large magnifying glass) I positioned and soldered the chip, then the rest was plain sailing as I tacked wires to the pads (see Fig 2) and

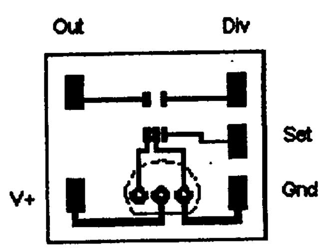


Fig. 2

mounted the other components "ugly style". I used a 5 volt regulator (which you can see on the PCB) to ensure that the LTC 1799 didn't get fried. It will work from 2.2 volts to 5.5 volts.

Performance.

At frequencies below 14 MHz the circuit is remarkably stable but as you get closer to 30MHz it will start to wander around 2 to 3 kHz. Aside from the chip just getting close to it's maximum, I think it had a lot to do with the quality of potentiometer used.

Refer to Fig 3. The graph shows how little change in resistance at the high end results in quite a large frequency swing. This had led me to want to play with digital potentiometers as there will be the very predictable resistive steps - perhaps that will spawn another article? To save my poor brain as I sorted through the junk box and found 10 turn pots with different resistances, I constructed an Excel spreadsheet so I could calculate the upper and lower frequency each would give. I can email it on request to anyone who wants to experiment further.

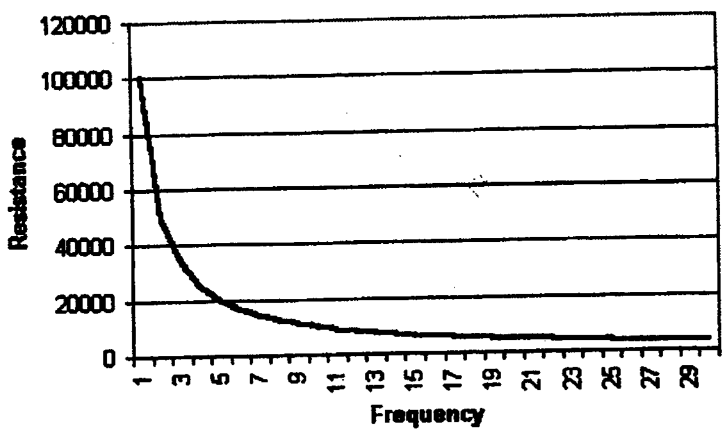


Fig. 3

Test equipment

That doesn't cost a mint!

By Graham Firth G3MFJ/W3MFJ

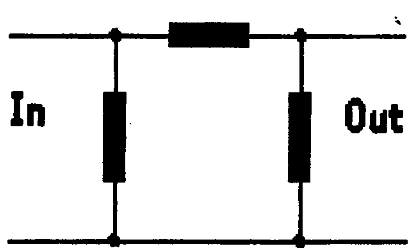
Part 4 – An Attenuator

Hi again. This is the fourth part of my series of articles on simple test equipment. It's yet another piece of kit that I described at Pacificon in 2000, and also at Atlanticon & Arkiecon in 2001. This is another example to show that test equipment does not have to be complicated to be extremely useful.

This is a very simple circuit, but looks a little more complicated because it is repeated a number of times. Like the noise generator I described in the last issue, the circuit is taken (with minor changes) from the ARRL handbook of a few years ago. It's amazing how many simple test equipment circuits are around if you look for them!

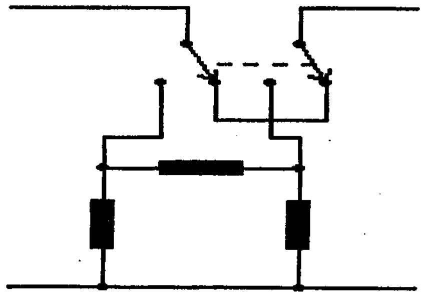
Each stage of the attenuator attenuates the signal by a fixed amount. At one end of the complete attenuator, each stage attenuates by a small amount, and at the other end, by a large amount. Each stage has its own switch and any value of attenuation – up to the maximum - can be set by operating the appropriate switches.

The basic circuit of a stage of the attenuator uses three resistors thus:

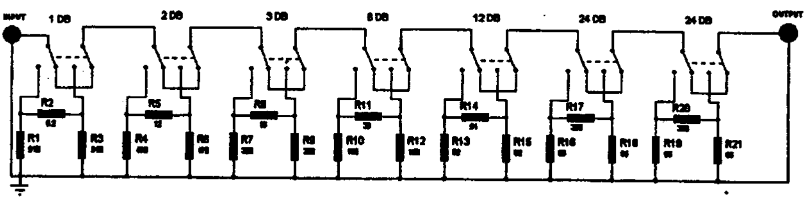


The values of the three resistors are chosen to give both the required attenuation, and the required impedance such as 50 ohm. This means the stage can be inserted into an antenna circuit and not change the matching.

If a switch is added:



Each stage can then be switched in or out as required thus: The circuit of the completed attenuator is now:



The values of the resistors in ohms are:

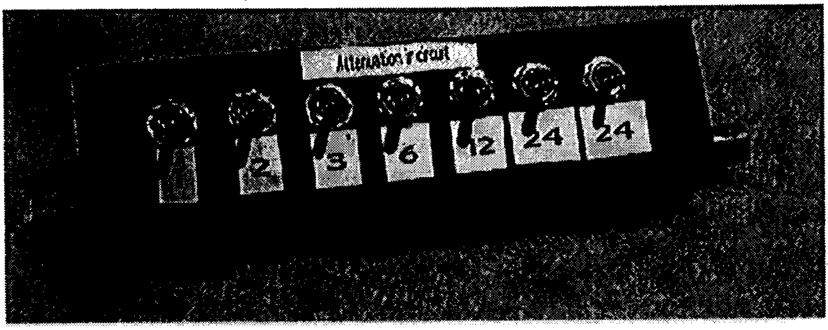
R1 R3	910	R2	62	Attenuation – 1dB
R4 R6	470	R5	12	Attenuation – 2dB
R7 R9	300	R8	91	Attenuation – 3dB
R10 R12	150	R11	39	Attenuation – 6dB
R13 R15	82	R14	91	Attenuation – 12dB
R16 R18	56	R17	390	Attenuation – 24dB
R19 R21	56	R20	390	Attenuation – 24dB

These are all preferred values from the E24 range and because of this, do not give the exact attenuation value, but are all within 10%.

This circuit is really intended for receiver testing in conjunction with a noise generator, or signal generator. However, for the dedicated QRPp enthusiast, providing the resistors are rated appropriately, it can be used with a transmitter to give milliwatt or even microwatt outputs! Don't forget that the resistors have to dissipate the unwanted power

I built mine in a box made from scrap PCB and covered in "sticky-backed plastic" to disguise this!

Here is the completed attenuator with BNC sockets at each end:



Either end can be the input or the output.

That's it for this time – see you in the next issue of QRPp

Shiny Teeth, Cheap Knobs

by Michael A. Gipe K1MG
12770 Lika Ct
Saratoga, CA 95070

OK, I'll admit it. I've had an obsession with knobs since I was twelve years old. I would pull out the Sears catalog late at night in the privacy of my room, and flip quickly through the pages – past the men's sportswear, past the ladies' winter coats, until I reached all those wonderful models with the *knobs*. S38, HQ180...the whole *Hallicrafters* line of receivers and transmitters was there, and every one of them was covered with knobs! I dreamt of having one of those receivers of my very own to tune and turn and twist until Uzbekistan came in like the BBC. Since then, knobs have continued to be a special part of all my construction projects. No common Radio Shack or Mouser knobs would do for *my* homebrew radios; the knobs had to be *special,* often homemade. Here is one of my tricks for making cheap and easy knobs.

First, collect the raw materials by saving the caps from toothpaste tubes, ointment tubes, and *Jif* peanut butter jars. When modified to hold a control shaft, these make great knobs. Toothpaste knobs come in attractive colors, are just the right size for diminutive QRP rigs, and have good non-slip ribbing. The caps from my favorite brand, *Tom's Toothpaste*, even have a recess on the top to fit a second stacked knob for dual controls, just like on a *Tektronix* scope. For the top knob, a cap from an ointment tube is usually a perfect fit. The *Jif* jars have a nice large plastic top with ribbed sides that is great for main tuning dials or large antenna tuner knobs. Once you have collected your raw materials, clean them thoroughly and dry.

Next you will need to purchase some casting epoxy, available from plastics stores, auto parts stores, and crafts stores. Place the collected caps on a level work surface with the inside up. Mix up a batch of epoxy, and carefully pour it into the caps until it reaches the very top edge. Avoid air bubbles. Let the epoxy harden for at least a day – it needs to be very hard for the next step, which is to drill a center hole for the control shaft. Standard sizes for shafts are ¼", 6 mm, and 1/8". Select the drill to match the control you will be using the knob on. Next drill a hole from the side of the knob through to the center hole for a setscrew. Allen head setscrews can be purchased from local hardware stores and mail order companies such as Digikey. Tap the side hole, insert the setscrew, and you have a custom knob! If you don't like the color, you can paint the knobs with a couple coats of *Krylon*. Twiddle to your heart's content.

Honey... The Dog Ate The Krazy Glue!

By Darrel Swenson, KØAWB
327 N. 153rd Circle
Omaha, NE 68154

This tale won Doug Hendricks' award for the "Ugliest Story" at ArkieCon 2001. (I think Doug was just being kind... and didn't want to call my "Manhattan Construction" attempt UGLY!)

While working on my IA-QRP10 this last winter I decided to remove a couple of pads and reposition a couple of components. Two or three minutes later when I was ready to glue down the pads, I was unable to find the glue! Apparently when I removed the pads, the small plastic tube of "Krazy Glue" rolled off my work bench and onto the floor.

Our best guess is that my wife's PRIZE Shetland Sheep Dog ('Sheltie'... her hobby...!) wandered into my shack, spotted the glue under my chair, thought it was a treat, and "wolfed it down."

After a trip to the 'doggie emergency room'... x-rays... a phone call to the glue manufacture... a phone call to the poison control center... a trip to the regular vet... and more x-rays... the dog is OK. According to the people that make the glue... the good news is the glue is not toxic... the bad news is it is not stomach acid soluble.

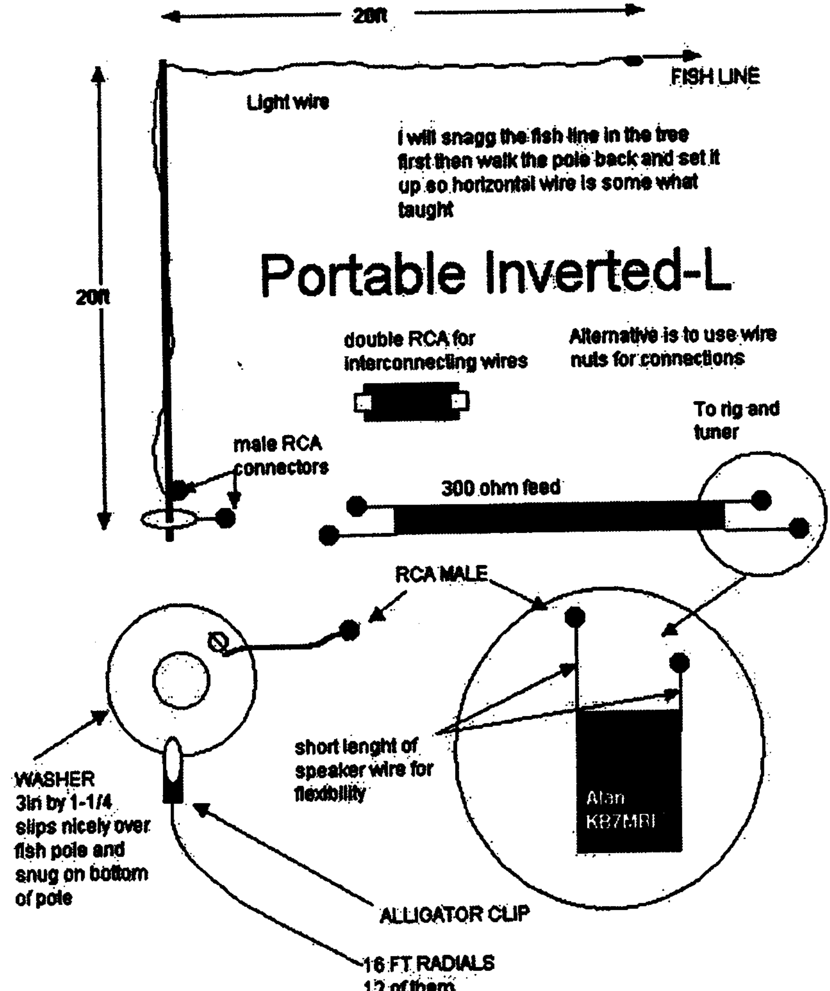
My wife's little puppy lucked out. His tummy was full of dog food from supper. When I looked down, he must have thought he was going to get in trouble, so he swallowed the tube whole instead of chewing on it. Two days latter he 'passed' a small chunk of dog food glued together in the size and shape of the plastic glue tube.

Dogs are not covered under health insurance... so my billfold is a LOT LIGHTER... (about the price of a K2!) But the dog is OK. He went on to win 1st and 2nd place at several dog shows this summer.

72... Darrel, KØAWB

Inverted L Antenna

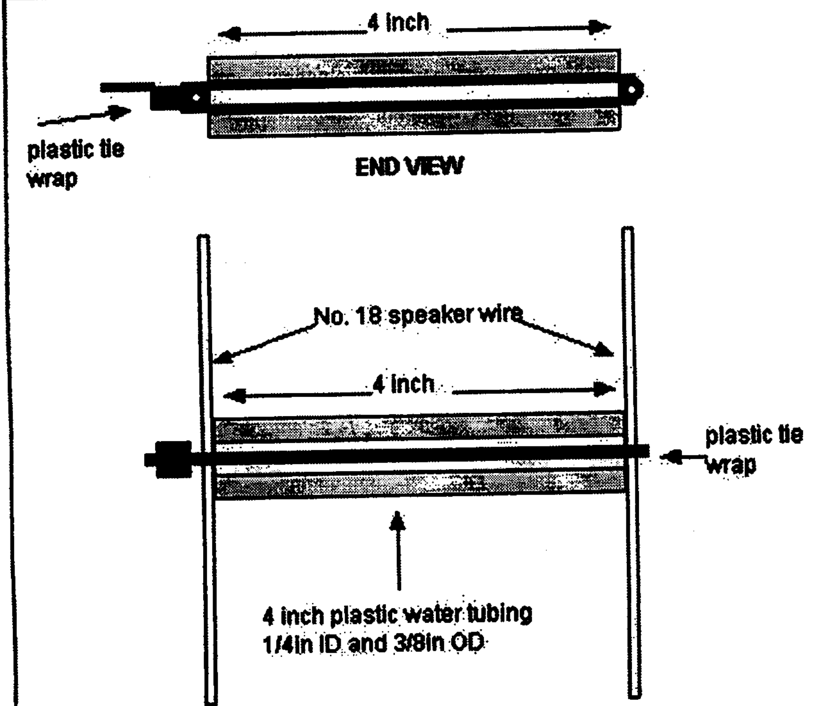
by Alan Dujenski, KB7MBI



Pole is supported in several ways. I have one of those spuds that stick into the end of a paint roler and the other end screws on to a short paint roller extension handle. I drive the handle into ground and screw on spud and slip pole end over spud. For snug fit I put a few wraps of electrical tape on the spud. Also you can guy at about 4ft level and rest pole on ground or bungy cord to a post or other handy item

Quick & Easy Ladder Line

by Alan Dujenski, KB7MBI



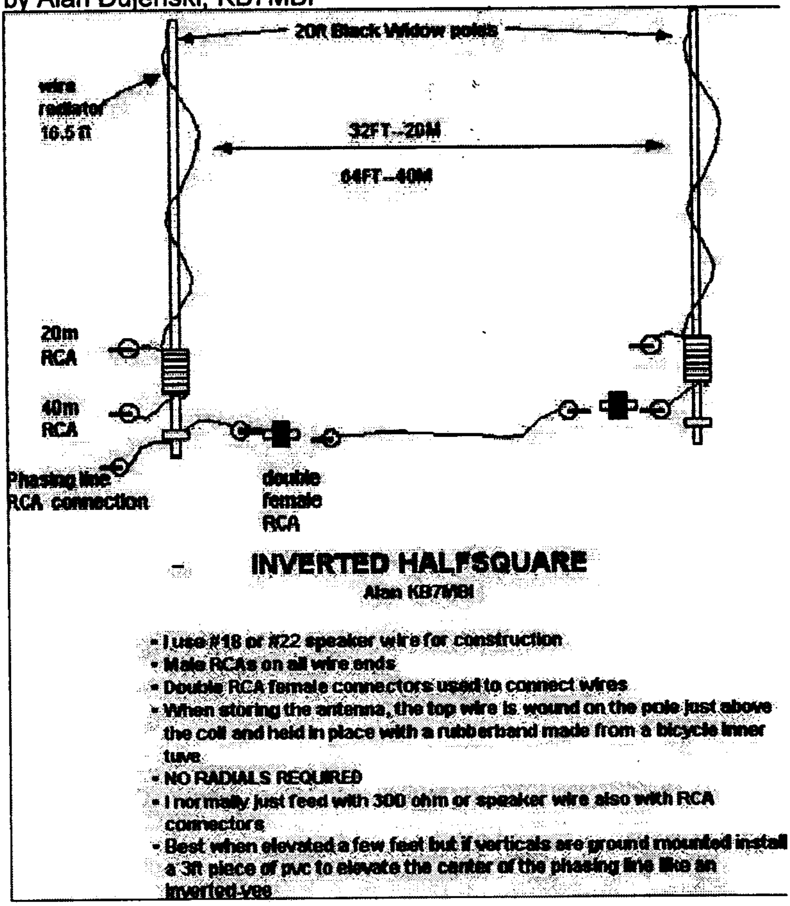
Quick Ladder Line

Pass the plastic tie wrap thru the tubing and around wire and feed back thru and wrap around other wire. Cinch tight. Space as needed--about 16" to 18".

Alan KB7MBI

Inverted Half Square Antenna System

by Alan Dujenski, KB7MBI



I use #18 or #22 speaker wire for construction
Male RCA's on all wire ends
Double RCA female connectgors used to connect wires
When storing the antenna, the top wire is wound on the pole just above the coil and held in place with a rubberband made from a bicycle inner tube.
No Radials Required
I normally just feed with 300 ohm or speaker wire also with RCA connectors
Best when elevated a few feet but if verticals are ground mounted install a 3 ft. piece of PVC to elevate the center of the phasing line like an inverted vee.

Twinlead Dipole for Portable Operation

by Dave Benson, K1SWL

Over the past few years, I've been on a number of portable HF, and the antennas have always posed a challenge. At worst, I recall a makeshift vertical antenna where we tripped over the ground radials several times and dragged the rig off the operating table. That outing truly illustrated an old scientific maxim: "No experiment is ever a complete failure- it can always serve as an example!"

As a result, my patience for having extra equipment along- tuners and SWR indicators- is diminishing. For the past several years, I've been using an RG-174-fed dipole connected directly to a rig. While it works well enough, I'm not happy with the thought of giving away several dB of line loss. The antenna described in this article approaches the problem differently. While it's a single-band approach, for me the tradeoff is a good one in terms of operating convenience.

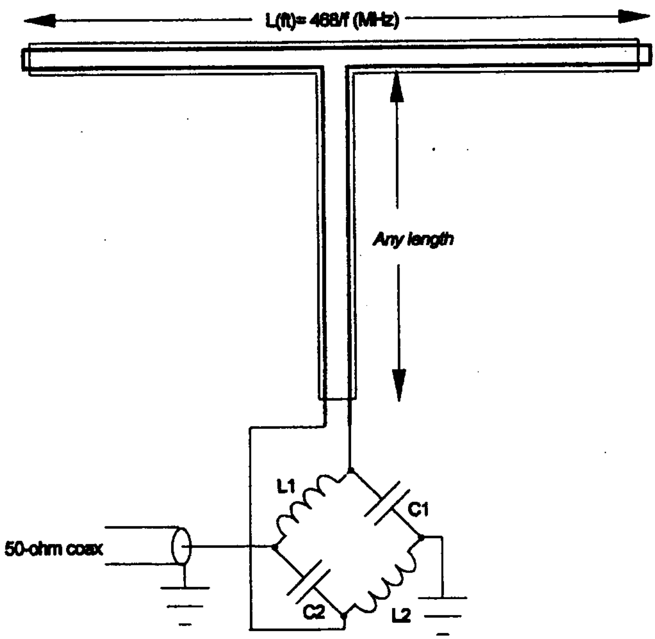
The antenna consists of a 300-ohm twinlead dipole and feed line. The dipole length uses the standard formula, and the twin lead wires at the dipole-ends are connected together. The feedpoint impedance is quite close to 300 ohms, so a twin lead feed line of arbitrary length may be used.

The antenna I've just described is inherently balanced. I considered a 1:1 balun and matching network and put it aside when I found the circuit shown below. It combines both balun conversion and impedance-matching functions in one. Each L-C pair in this bridge is calculated as an L-network, in this case for a conversion from 50 to 300 ohms. I take no credit for this circuit- it was described to me by Wade Holcomb, W1HGU. He noted that it had appeared in the amateur literature in the late '50s, but the specific reference was unknown. *Use good quality (NPO/COG) capacitors for this.*

The matching network is constructed on a 1" x 1.5" piece of circuit board. I used one half of a 6-foot RG-174 BNC cable (Jameco Electronics) as a transition to a transceiver. I strain-relieved the RG-174 with a short length of shrink-tubing (necessary to increase its outside diameter) and clamped it to the circuit board with a 1/8" nylon cable clamp. At the other end of the circuit board is a pair of wing nuts for connecting the feed line to the network. Because the feed line length is arbitrary, this line may be cut to length once the antenna's up, stripped and attached. If you have a more permanent setup in mind, it might be practical to clamp the feed line to the board with a washer and hardware and then solder it directly to the board. I sleeved the circuit board with a length of 1" shrink-tubing to improve the circuit's durability under field conditions. *Also a good idea- a piece of scrap plastic pressed into service as a center insulator/strain relief at the antenna's center. I drilled a trio of 1/8" holes through the twinlead and corresponding holes through the scrap and used #4-40 nylon fastening hardware.*

As evaluated at my home station with a temporary antenna up about 25', SWR measured 1.1:1 or less across a 200 Khz slice of 20 Meters. I used this antenna during last September's QRP Afield outing. I'd love to report the field results- I did have an SWR meter along for curiosity's sake. *Naturally, one of the interconnect cables failed, thus neatly proving my point about extra doodads!*

When it's time to pack up your operation and hit the trail, this antenna can be wadded up and stuffed into a backpack. So, for that matter, can a wire dipole, but your chances of untangling and reusing the wire are pretty slim- the twin lead lends itself nicely to being unsnarled and reused.

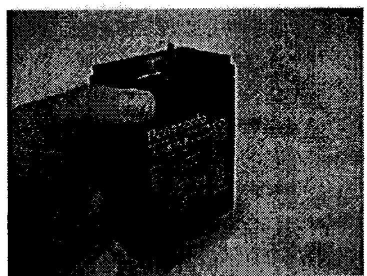


(values shown for 20M)
L1, L2= 1.27 uH 18 turns T37-2
C1, C2= 82 pF NPO

RECYCLE A DEAD GEL-CELL INTO A QRP CABINET

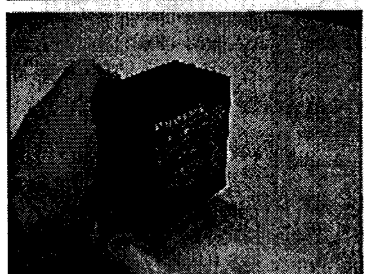
By Bill Jones – KD7S
83 Redwood Avenue
Sanger, CA 93657

STEP 1



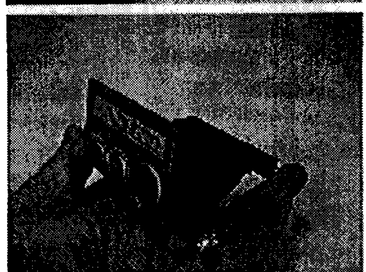
Cut the top off a dead gel-cell. Dispose of the insides properly. Use caution when handling the cell material. There is no liquid inside but the paste can be very caustic. Wear gloves and eye protection.

STEP 2



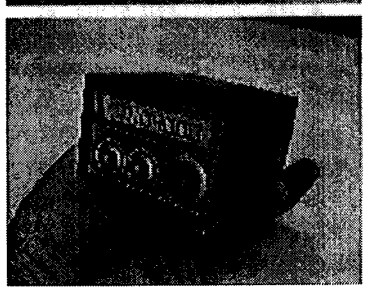
Wash the case out with soap and water. Remove the partitions with a pair of sharp scissors, side cutters or even tin snips. Use long nose pliers to the partitions from the bottom of the case.

STEP 3



Use a file and some sandpaper to smooth the leftover edges of the partitions. Use more sandpaper and some fine steel wool to remove the writing from the outside of the battery case.

STEP 4



Make front and rear panels and a chassis from ABS plastic or double sided PC board material.

STEP 5

Finish the cabinet with a little black paint or auto polish. Add stick-on rubber feet and computer generated labels and you have a great little cabinet at little or no cost.

Rig and Antenna Connection Switching - Simplified

by Bill Lazure W2EB
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East Syracuse, NY 13057

I run 8 separate antennas, have 4 rigs at my operating position, and use a large variety of antenna testing/tuning devices. Switching between all of these devices was pretty tough. The cost of commercial antenna switches seemed high considering I would need a few of them! To solve this problem, I borrowed an idea from the commercial RF world...I made a Patch Panel.

I built a box out of fiberglass panels in a wood frame. I obtained the fiberglass by stripping the copper off of heavy copper-clad PCB material. The box dimensions are about 16" wide by 5" high by 6" deep. On both the front and rear panels, I drilled two rows of 12 holes, one row over the other. The front panel is for the patch cable connections, and the rear is for the equipment connections.

I then made the internal connecting cables using RG-58 and crimp Bulkhead panel-mount BNC connectors. I mounted one connector on the front panel, and the other on the corresponding hole on the rear of the panel. I chose BNC connectors because of their constant impedance, easy connect/disconnect, secure connection, and common availability.

While I wanted all of the "patch" connections on the front panel to be BNC, I needed some UHF connectors on the rear for antennas. I couldn't find any inexpensive shielded UHF bulkhead connectors, so I simply soldered the cable onto the connectors as you would within a rig: center conductor to center pin, and shield to lug on mounting screw. Additionally, If you need other connectors for your equipment such as RCA jacks, or ¼" jacks, place these on the rear panel and connect to a corresponding BNC jack on the front.

I then connected all of my rigs, antennas, and test pieces to the rear panel connectors, and made up 6 patch cables. The patch cables were about 18" long with BNC plugs on both ends.

Operation is a breeze. On the front panel, simply run a patch cable between a rig's BNC connector, and an antenna's BNC connector. If you need a SWR meter in line, run a patch cable from the rig's connector to the SWR meter's input connector, and another cable from the SWR meter's output connector to the antenna's connector. Want a tuner as well? Simply insert it after the SWR meter by using more patch cables.

Patch panels like this can also be used for Audio, Keying, and even Mic connections.

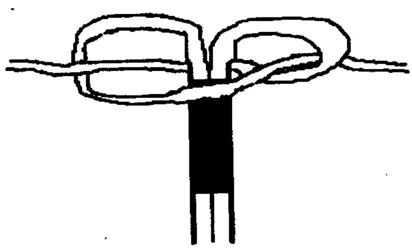
My Favorite Trail Antenna

By Murphy (Sandy) Chesney, KB3EOF
7220 Burkittsville Rd
Middletown, MD 21769

Backpacking with a ham radio is a great way to connect with the great outdoors without leaving your other favorite hobby behind. It can also save your life if you get lost, hurt, stranded or caught in bad weather. Nobody wants to burden themselves with a heavy setup on the way to the outback. So, here is the setup that fits in my backpack and leaves room for food, raingear, water and all the other goodies you need for an overnighter.

Antenna:

A 40 meter half-wavelength dipole with its own built in feedline is perfect for this purpose. RadioShack sells a 60-ft spool of 18 gage speaker wire for a few bucks that is ideal but plain old zip-cord will work as well. Measure off 234/7.04 = 33 ft, 3 inches of speaker wire and mark it with tape, but don't cut it. Now split the end and pull the two strands apart all the way to the tape to form the full 66 ft, 6 inch dipole. Reinforce the center feedpoint with duct tape wrapped around for a sturdy T and further keep the strands from pulling apart by tying an



electrician's knot at the juncture (see figure). Now you have about 30 feet of feedline left that you can terminate with two banana clips. This will fit into 5 way binding posts on your balanced line tuner or 4:1 balun. Coil the feedline and two legs of the dipole, secure with twist-ties, and you have a lightweight antenna that works like a dream and can be shoved with impunity to the bottom of the roughest rucksack.

Deployment:

I use an SD-20 collapsible fishing pole both as a walking stick and to support the center of the dipole. Find a location with two sapling trees about 50-60 feet apart and a stump or something you can tie the SD-20 to in the center. Grab a sapling and bend it over until you have the tip of the tree to which you attach one end of the dipole. Let the tree spring back up and *Eureka* instant dipole end deployment up 15 feet or more. Since the wire is insulated I just tie it to the tree directly and all is well. Repeat with the other end and then prop up the center with the SD-20 fishing pole/walking stick. The process takes about 5-10 minutes and gives you a nice flat top or mildly inverted V up about 20 feet. The feedline dangles to the ground with enough to spare to comfortably set up your rig and tent in a good spot.

Matching and Performance:

Zip cord type antennas have an impedance of about 105-ohms and attenuate about 1.7 decibels per 100 ft at 7 MHz (See Zip-Cord Antennas- Do they Work? by K1TD from QST, March 1979). That means with a 30 foot feedline you have about 0.5 decibel loss, which is not discernable at the receiving end. I have found that a 4:1 balun from LDG will give me 1:1 SWR over average ground with this setup, but my favorite method of matching is with the NorCal Balanced Line Tuner (BLT) by W6JJZ. This tuner fits in the palm of your hand, requires no external power, and is available in kit form from the NorCal web site. The antenna tunes up easily, and with my NorCal 40A putting out 1.5 watts I can easily work CW stations up and down the East coast during the day. Forty meters is almost always open and away from civilization the signals come flooding in clear as a bell with this antenna. Higher frequencies start to have higher loss with this feedline but it is difficult to ask a DX station to dial 911 for you anyway. For 40 meters this is all the antenna you need for that end of the trail rag chew or fast call for help.

My Favorite Trail Power Supply

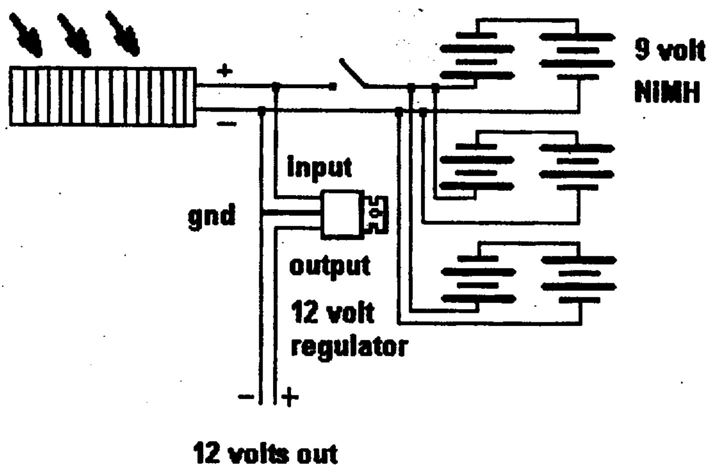
By Murphy (Sandy) Chesney, KB3EOF
7220 Burkittsville Rd
Middletown, MD 21769

Picture this: You and your hunting buddy have been dropped off on a pristine lake in the Alaskan wilderness by a float plane. After a week of glorious hunting, fishing, and camping, the plane is supposed to come back to return you to civilization, but NO PLANE! Batteries that were fully charged at the beginning of the trip are now flat and your trusty ham radio sits there without juice. No problem, you whip out your portable, lightweight, solar powered DC power supply, switch it on and presto, you have 12 reliable volts of DC power. After using it to power up your GPS and record your precise location, you plug in your QRP radio and ask a ham in Anchorage to pass along a message to your family for another float plane. You do have an emergency man-portable solar powered supply, right? Something that will fit in a side pocket of your pack, right? If the answer is no, fear not, here is a lightweight power supply your back will love.

Materials: Solar battery charger of the type used to trickle charge a car battery. ICP makes one called the BatterySAVER PLUS that is about a foot long, 4 inches wide and 1 inch deep for around $30 (RadioShack cat # 980-0561). But watch RadioShack or Harbor Freight Tools as these or similar items often go on sale for $10 or less. It puts out about 125 mAmps at 15 volts in direct sunlight, not enough to overcharge your battery but at 1.8 watts not a bad source for a QRP transceiver. For batteries use six 9 volt rechargeable NiMH. A 12 volt DC voltage regulator, #276-1771, in a TO-220 case hangs on the wall of your local RadioShack, plus a small slide switch, several (maybe 10) feet of speaker wire, six 9 volt battery connectors and a male power plug of your choice. Make sure the plug fits your QRP rig.

Construction: The first thing I did was (*Warning, this may invalidate your warrantee, HI HI*) unscrew the back and remove that annoying blinking red LED these manufacturers seem to think is cute, leaving in the blocking diode. Remove the power cord and save it for a project that needs a cigarette plug and cord. Test your panel in full sunlight to make sure you have near 20-24 volts DC unloaded. Wire it as per the diagram with the slide switch outside and the voltage regulator inside the solar panel. The ICP BatterySAVER PLUS has a nice power cord mono plug receptacle you can use, or drill a hole and knot the cord just inside the panel. You will need a separate hole and cord for the battery pack. You could put everything outside, I just prefer the security of the regulator snug inside the panel. Not one for fancy enclosures, I used a strip of duct tape to put the 6 batteries in a row on the back of the panel and wrap the power cord around the panel for storage. Since NiMH 9 volt batteries can get expensive, I scrounged and put a Frankenstein mixture of old and new NiMH and NiCAD batteries together so I didn't have to shell out $60 for all new batteries. I can hear the purists scream about mixing NiCAD and NiMH but the thing has worked flawlessly for me in the field for almost a year.

Operation and Performance: A typical NiMH runs at 7.2 volts. Two in series will run 14.4 volts and when charged with the above solar panel they will go over 15 volts, a tad high for most QRP rigs. The low drain 12 volt regulator brings the voltage down to a happy range for the rig while the batteries continue to see whatever the solar panel can dish out. Three of these paired batteries in parallel will give you 450 mAH in the dark, not a bad source for a 1 or 2 watt QRP rig. Of course, in full sunlight you get indefinite receive time and much extended transmit time. I have full power when the panel is in direct sunlight even after a couple of hours of listening and sending the day before on my NorCal 40A running 1 watt CW. When not charging I turn the switch off to prevent a slow discharge of the batteries through the regulator. This arrangement may not last for an all day contest style event but it would last for a good part of it, depending on the clouds. You could always add more battery pairs in parallel for more capacity, but I have never exceeded the need for 6 in the field. That keeps the weight down to just over 1 pound. For a few casual daily contacts and listening to the mail this power supply will keep you going indefinitely on the trail.



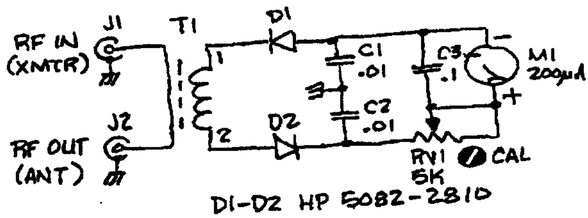
A Prototype Power Meter, A Work in Progress

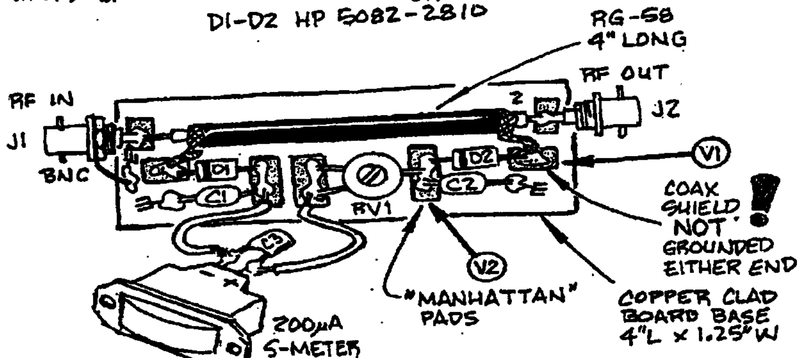
by Paul Harden, NA5N

[This article was originally published in the November 2001 issue of the Peanut Whistle, the Journal of the St. Louis QRP Society, and is reprinted here with permission.]

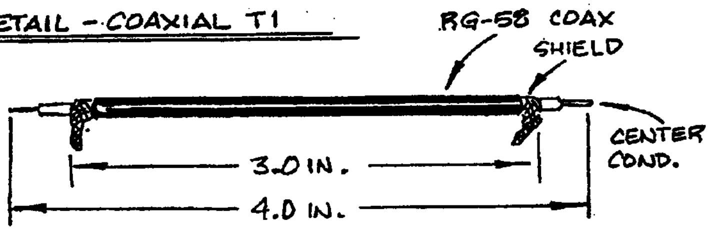
There are a couple of interesting points about this meter. The 200uA meter is the exact meter used for the original St. Louis Tuner in 1995. The voltage readings at 10 mW suggest that readily available silicon or germanium diodes will work in the circuit. Calibration curves using 1N914 and 1N34A Diodes will be included in the next installment. Using the ungrounded shield as the transformer along a 4" piece of coax means the cable can be bent into a "U" or literally tied into a knot and still work. Therefore the project can be tucked easily inside of a rig as long as there is panel space for the meter.

PROTOTYPE





DETAIL - COAXIAL T1



CALIBRATION DATA (PWR IN ON J1, 50Ω LOAD ON J2)

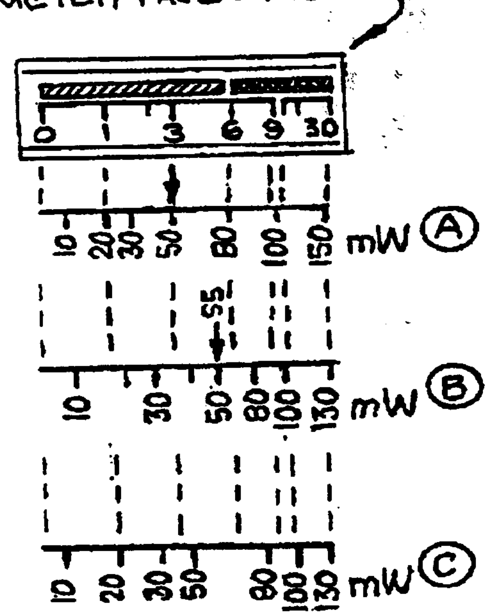
POWER IN (J1)	(V1)	(V2)
100mW (+20dBm)	4.6Vpp	0.66VDC
80mW (+19dBm)	3.7Vpp	.58 VDC
64mW (+18dBm)	3.4Vpp	.48 VDC
50mW (+17dBm)	3.0 Vpp	.40 VDC
40mW (+16dBm)	2.6Vpp	.33 VDC
32mW (+15dBm)	2.4Vpp	.18 VDC
25mW (+14dBm)	2.1 Vpp	.14 VDC
20mW (+13dBm)	1.9 Vpp	.11 VDC
16mW (+12dBm)	1.7 Vpp	.08VDC
12mW (+11dBm)	1.5Vpp	.06VDC
10mW (+10dBm)	1.3Vpp	.04VDC

(V1) AS MEASURED BY TEK 475 OSCOPE

(V2) MEASURED WITH RADIO SHACK 3A7 D.V.M.

VOLTAGES MEASURED AT 3.5, 7, 10, 14 AND 21 MHZ WITH VERY SIMILAR RESULTS. VALUES SHOWN FOR 10.10 MHZ.

200µA S-METER
METER FACE: 13/8"W x 9/16"H



METHOD A (PREFERRED)

SET SIG. GEN. OR XMTR FOR 3.0Vpp AT V1 (D2) WITH 50Ω DUMMY LOAD ON J2. THIS IS 50mW INPUT (+17dBm).

ADJUST RV1 FOR S3 READING. 10-150mW USE SCALE "A"

METHOD B

SAME AS ABOVE, EXCEPT SET RV1 FOR S5 AND SCALE "B". FOR BETTER RESOLUTION BELOW 50mW.

METHOD C

SET XMTR TO 100mW OUTPUT. (~4.6Vpp AT V1 OR +20dBm IN)
SET RV1 FOR S9+10dB READING AND USE SCALE "C"

72, Paul NA5N

The Perfect Kit

by James R. Duffey KK6MC/5
30 Casa Loma Road
Cedar Crest, NM 87008

The VE3DNL marker kit is as near to a perfect kit as you can get. If you are starting the Elmer 101 project you may wish to build one of these first. It is a useful piece of test equipment, and if you are a new comer to kit building, this simple kit will teach you many of the skills necessary to build a successful kit. It has few parts, is easy to trouble-shoot and is nearly foolproof.

What is the VE3DNL marker kit? It consists of an oscillator/divider IC and a crystal that generates your choice of 5, 10, 20, or 40 kHz markers through at least 30 MHz.

What use is such a thing?

Well, you can use it as a poor man's signal generator to align receivers. It can also be used as a frequency meter to calibrate your receiver. Say you want to mark 7040 on your SWL-40+. Tune in a W1AW code practice session. Switch the antenna input to your VE3DNL marker. Use the 40 kHz output. Tune down from the W1AW frequency until you hear the marker generator. Mark 7040 on the dial. Then switch to the 5kHz position and mark those positions on the dial. Voila! A calibrated dial. Plus, if you zero beat the crystal to WWV, your calibration is traceable to NIST! Sit your rig on 7040 kHz and peak up the input bandpass filter for maximum response. Keep it there and tweak the BFO trimmer for the best offset. I also keep one in the shack. I can use it to see if the band is dead, or if there is a problem with my rig.

For further details and a picture, see the NorCal site:

http://www.fix.net/~jparker/norcal/marker/marker.html

This simple, invaluable piece of test gear is brought to you by the Ft. Smith QRP group. They use the proceeds to fund speakers for Arkiecon, an amazingly wonderful gathering of QRPers held each spring in Ft.Smith, Arkansas. Go if you are within a days drive of Ft.Smith.

You can buy this miracle for only $12, including shipping. Order it from:

Jay Bromley W5JAY
9505 Bryn Mawr Circle
Fort Smith, AR 72908-9276

Now, you really should order more than one of these. It is an ideal way to get new hams (and old ones for that matter) into building. Buy a couple and pass them out to new hams when they show up with their new license. When the new licensee passes his test, put one of these in his/her hand and say; Welcome to ham radio, now you can find out about the joy of building your own equipment. When somebody complains that they would buuild, but test gear is too expensive, turn them on to the VE3DNL.

They also make a great group project for your club meeting. They are quite inexpensive, the success rate is high, it only takes a half hour to build, and they are easy to trouble shoot.

The quality of the kit is high. Dave Fifield, AD6A, laid out the PCB. Dave is noted for his first pass successes. The instruction manual is clear and concise.

If you don't have one of the VE3DNL marker kits order one now. If you already have one, order another one for a new ham. They make great gifts. I have three of them. Don't get me started on how great a kit the Tuna Tin 2 is! Stay tuned. - Dr. Megacycle KK6MC/5 "Radio Green Chile"

Do You Know How Great A Kit the Tuna Tin Two Is?

by James R. Duffey KK6MC/5
30 Casa Loma Road
Cedar Crest, NM 87008

If you have been reading the recent posts about all the fun that people are having with their Tuna-Tin 2s and are wondering how you can join in, wonder no longer! The Tuna Tin 2 kit is available from the Ft.Smith QRP group for $12 including shipping. See:

http://www.fix.net/~jparker/norcal/bttfut/bttfut.htm

The Tuna Tin 2 is one of those timeless pieces of gear. Designed and built by Doug DeMaw, W1FB and described in the May 1976 QST, it has all the parts necessary to function, but no more. A tuna fish can serves as the case. In an emergency catfood, pineapple, or smoked almond cans can be substituted. The Tuna Tin 2 was updated by Dave Meacham, W6EMD, at Doug's, KI6DS, urging a few years back. They did a great job updating it with modern components and now it works better than the original. It will attract comments from whomever you show it to, ham or not.

It is a good way to learn about oscillators and amplifiers. The 2 in the name stands for 2 transistors. The first is used as a crystal oscillator and the second as a power amplifier. The manual and web page contain explanations of what all the parts do, so it is an ideal kit to learn why rigs have those 0.1 uF caps everywhere. Finger tip T/R switching is provided, so all you need to get on the air is a receiver. The receiver portion of any HF transceiver will do.

So send your $12 ($15 US for DX) to:

Jay Bromley W5JAY
9505 Bryn Mawr Circle
Fort Smith, AR 72908-9276

If you can corner Jay at a Hamfest he will sell you one for $10 as he doesn't have to pay the shipping. Buy him a diet Dr. Pepper for providing this service.

Now Jay will ship 10 or more of these kits to one address for $10 a piece. They go together in an hour or two, are easy to trouble shoot, and make a good group building project. These also make great gifts, door prizes, awards, and incentive rewards for upgrading. Help Santa put one of these in your favorite ham's stocking. It might be the ideal way to thank that Elmer that got you started in Ham Radio or building.

I guess that I am sounding like a bit like a shill for the Ft.Smith QRP group these days, but they do offer two simple ways to get into QRP building. Buy both. And they fund Arkiecon with the proceeds. See you at Arkiecon in April. - Dr. Megacycle KK6MC/5 "Radio Green Chile"

MY ANTENNA FARM

by Eric Silverthorn... NM5M

My entry into to the world of low power operation occurred about three years ago. My family and I moved to a new home located in a suburb just north of Dallas and, as expected, the new neighborhood deed restrictions prohibited all visible antennae. I knew that in order to comply with the deed restrictions a stealth antenna would be necessary.

I envisioned building a random length dipole that would lie on the shingles of my roof and could be fed off center with a 450 Ohm ladder line. The ladder line would be connected to a 4:1 balun that would allow me to run a short length of coaxial cable into my shack. Our home is two stories tall with the roof peaking at about 20 feet.

Three weeks after moving in, under the cover of darkness, I climbed out a second floor window onto the roof, armed with the materials and hand tools necessary to build the antenna. I located a vent pipe at a peak of the roof that looked ideal for a feed point support. I secured the ladderline to the vent pipe with ty-wraps and tape and attached one leg of the dipole that slopes about 25 feet down the roof. Once the second leg of the dipole was connected to the feed point I attached a weight to the wire and tossed it across the highest point of the roof. This allowed the wire to run 20 feet horizontal and 15 feet vertical off of the side of the house. (Figure 1) The installation took about 20 minutes and, after running the coax through a window, I was ready to connect the antenna to my transceiver.

I decided to try 20 meters. Listening across the band I heard many loud stations throughout Europe. With the transceiver output power at 100 watts I called a station in Russia. He answered my call and gave me a 589 report. While running 100 watts I knew that I was interfering with the television, and phones in our home. I began to reduce power and found that at 20 watts there was not a trace of RFI/TVI. I worked two stations in Europe while running 20 watts, and received reports of 569/579. I had never tried QRP before so I thought that it would be interesting to drop the power to 5 watts to see if I could work anyone. I heard a strong station calling CQ from the Czech Republic. I called him once and he answered! From that point on I have been hooked on QRP!

Since installing my stealth dipole three years ago, I have completed QRP WAS, and have 56 countries confirmed towards DXCC on 10 through 40 meters. My best contacts so far are 3B8CF in Mauritius, and several stations in Central Asia.

I cannot provide evidence that my antenna has specific technical attributes that make it better than anything anyone else is using, however it works for me. I encourage those in a similar situation to "throw some wire across the roof" and get on the air, you might be surprised with the result!

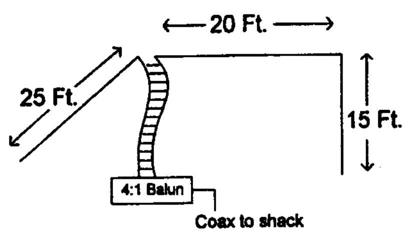


FIGURE 1

PRINTED CIRCUIT BOARDS FOR HAMS

by Ted Williams, G0ULL

Introduction

Thanks to the ubiquitous Personal Computer, the task of producing artwork for printed circuit boards has become much easier than hitherto, for professional and amateur alike.

The problem of manual layout and messy tape masters is now history; ease and precision are presently available for a very modest investment in computer programmes.

However, the production of hardware, actual boards, is currently beyond the pc's ability, and it this area which I propose to explore in this article.

The Artwork

The starting point is a print-out of the computer-aided design for the printed board, on an acetate sheet. I use an inkjet printer, and have found it essential to use the correct recommended material, and to print onto the correct face, which has a roughish coating.

Tip 1: Don't finger it, and don't use water or other solvents on it - it will wash the surface off - I found out the hard way.

Tip 2: The acetate film is relatively expensive, and my pcb programme prints the layout smack in the middle of an A4 sheet. For a small board, that's an awful lot of waste, so I do a print onto paper first, then cut out a bit of acetate a bit bigger than the print and tape it down on top of the print. Put through the printer again (right side down, dummy) and with luck and a following wind you should have an economy print. Give it a few seconds to dry fully

A laser printer is probably even better, but once again, don't be a cheapskate on the acetate sheet - you could wreck the printer. (low melting-point transparencies can fuse to the drum)

The quality of the artwork should be checked by looking through it at a bright light. Any bare patches or large pinholes can be blotted out with a water-based black marker, a fine tip being ideal.

Which way up?

Artwork programmes allow you to put components on the front, and look 'through' the board to see the copper layer. Now, remember it is vital when printing on to the copper to ensure that the INK side of the artwork is against the copper. The apparently small thickness of the acetate sheet is enough to disperse the exposure light, giving poor definition on the final print.

If you think about it, you will realise that this means the copper layer shown in the screen layout WILL NEED TO BE MIRROR IMAGE to print correctly.

Tip 3: Put a bit of text on the artwork, it will help to get it sorted in the mind.

The copper-coated board

There is a range of materials and thicknesses, but for most purposes I have found it best to use standard one-sixteenth of an inch (1.6 mm) fibreglass board (a sort of greeny colour), either single or double sided copper according to requirements. I have needed thinner material on the odd occasion, and there is some 1 mm board around.

Sensitising the board

It is necessary to coat the copper with a suitable resist, i.e. a coating which is changed when ultra violet light falls on it, such that is soluble in an appropriate chemical, while unexposed portions are not soluble.

I buy board ready coated - it's a relatively small outlay for the ease and certainty of printing. So far, I've not had problems of shelf life; indeed I have successfully used coated board which was several years old. (more than I can say for the cans of resist).

The alternative is to coat your own board, and positive resist is available in spray aerosols of around 200 ml (about 7 ounces for colonials). Before coating, the board must be SCRUPULOUSLY clean. I use a small abrasive block designed for the purpose which is cheap enough, a tiny bit of detergent initially and lots of water until the water runs off cleanly from the surface. (NO, not wire wool or carborundum, but 'Scotchbrite' is o.k.).

Tip 4: KEEP YOUR GREASY FINGERS OFF THE SURFACE - that could be enough to wreck your final print.

After drying THOROUGHLY, you can spray the board in subdued lighting, no bright sun or high intensity lights, according to the instructions provided with the resist.

Again, the coated board must be allowed to dry thoroughly, as recommended, in a dark place. It can be speeded up by heating, but remember a domestic oven, particularly gas fired, is not a dark place

Exposure

Here we need a source of ultra violet light, and the most convenient form is a uv tube, or tubes, mounted in a box behind a glass plate. I made my own using two 6 inch tubes, a rescued choke and a starter switch. Exposure, established by trial and error, is about 4 minutes. The uv boxes are available commercially, but are a bit pricey in the UK. I have used available sunlight on a board 2 feet long by 9 inches wide, with total success (about 20 minutes exposure here to the midday sun

- I can't answer for yours). Tony, G4WIF, intends trying an e-prom eraser, which may be suitable for small boards'

Using a uv box, first the artwork is put on the glass top, ink side up, then a suitable sized piece of sensitised board is put on top and the lid closed, a pressure pad ensuring the two are held in close contact. The uv is switched on for the appropriate time. If you don't know the timing, use the photographic test strip technique with a piece of scrap board, exposing a number of portions for increasing times, then pick the best on development.

An ordinary clock is alright for timing - we are not looking for precision - but if you fancy designing a timer you can automate the process. That could be your first project.

Development

Still maintaining the subdued lighting conditions, the board is immersed in a developing solution and gently rocked. A photographic dish is ideal, but any flat-bottomed dish will do. There are commercial reagents, but I use a 2 percent solution of Sodium hydroxide, or caustic soda. Development takes about a minute or so, and you can see the pattern emerging as the exposed resist is removed. Just ensure the pattern is clear, then wash in plenty of water. You can now revert to normal lighting.

The chemical is available in commercial quality flake or pellet form at hardware stores, and it is cheap. A suitable solution is about a level teaspoonful in a pint of water, and it gets slightly warm on dissolving. (Don't use the best cutlery; use glass or plastic to stir)

Tip 5: Keep the Sodium hydroxide stock tightly sealed, the flakes will absorb water from the atmosphere very quickly and deliquesce.

Tip 6: This stuff is corrosive, and proper precautions should be taken. It will dissolve finger prints (which could be an advantage) and eye splashes must be avoided, preferably using protective goggles - use plenty of water in case of splashes. These are sensible precautions, and in many years of handling it I've never had an accident.

Tip 7: Keep your fingers off the copper, still.

Etchants

It is necessary to use a suitable acid for etching, and the materials normally used are-

(a) Ferric chloride, available as hexahydrate crystals from electronic supply houses (Maplin or Farnell in the UK). 500 grammes makes about a litre of etchant - or follow the instructions if provided.

Tip 8: This is a dirty brown solution, and will stain anything - make sure it's not you.

(b) Sodium persulphate or Ammonium persulphate, preferably with a few drops of saturated Mercuric chloride solution as a catalyst, but it doesn't matter if you've not got it (It's very poisonous). 200 gm per litre of the persulphate works fine.

Tip 9: Both solutions are strongly acidic, and safety precautions against splashes should be taken. They are quite happy to etch holes in clothing as a bonus, so be warned. Also, DO NOT stir with a metal implement, although platinum or gold are o.k.

Etching

Most of the time, a photographic developing dish is perfect to contain the etchant. Use enough to submerge the board, and keep it in motion by rocking, just as in photographic developing - don't splash. Warming the solution will speed up the process - I float the dish on hot water in a larger bowl. This operation is performed in full light, and with fresh etchant you can reckon on something like 20 minutes for completion

If you can afford it, a small tank is available commercially for the amateur, with agitation provided by blowing bubbles through the solution using a small air pump (as used for fish tanks, get the larger one if you make your own). A fish tank heater is included in the kit, and etching times are really reduced – say, to 5 minutes or so.

Now is the moment of truth. Give the board a thorough wash in plenty of water and examine the result critically. If there is the odd whisker remaining, it can be removed with a scalpel or 50 amps; I prefer the scalpel.

At this stage, you have a perfectly useable board, and the unetched copper still has resist on it. This can be removed with a solvent such as acetone, or exposed to uv and developed off in the caustic soda solution.

Tip 10: I leave the resist on, and I find it makes a fine flux as well as keeping the copper clean.

Tin plating

On through component boards, I find this unnecessary. For surface mount boards, it is essential to coat the board, either solder coat with a soldering iron for small boards, or use electroless plating salts for larger boards.

Tip 11: When coating with a soldering iron, use extra flux so the solder flows evenly, then wipe the lot off while molten with a piece of cotton rag, leaving a thin, even coat.

Plating involves cleaning the copper surface thoroughly - back to the abrasive block and water, or develop the resist off, as mentioned. Then dunk the board for about 20 minutes in a solution of a commercial 'Immerse Tin' powder - it's as simple as that. (Farnell and Maplin again in the UK, but watch the quantity - 5 gallons is TOO MUCH, even for a

Texan).

...and in Conclusion......

I've used a lot of words to describe what is essentially a very simple process, but I've done it in enough detail to pretty well guarantee success. I've described single sided board preparation, but double sided is feasible, though I have never needed to do this. (Hint: you need locating points).

I have succeeded in producing very fine tracks with good definition from inkjet artwork, and have had no significant problems.

Ted Williams, G0ULL

Hotel Portable QRP Operating

By David Bixler WØCH
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Seneca, MO 64865
www.qsl.net/w0ch

One of the fun aspects of QRP is the ability to pack along a compact portable station when traveling. My wife and I enjoy traveling, both overseas and here in the US, and on most trips I have a little rig nestled down in a corner of the suitcase. In the evenings while Nancy reads or watches TV, I enjoy the challenge of getting on the air from our hotel room.

Hotel operating is often not easy and a bit of luck is needed to get a situation where a workable antenna can be deployed. Many of the newer US hotels are concrete and steel RF-proof boxes with windows that may or may not open. I usually try to avoid high-rise buildings and choose two or three story hotel structures with internal corridors. By requesting a quiet, upper floor room on the "back side", most of the time I can get an opportunity to get a wire out of the window.

In Europe, I have found that older hotels are much more RF transparent due to less steel reinforced concrete in their construction. Indoor wires seem to work better there than in the US. Also, many European hotels do not have window screens, making antenna deployment easier.

I try to set up a covert portable station to avoid confronting the management or disturbing other hotel guests. By restricting operation to after sunset, an antenna can be deployed out the window without attracting attention. My usual choice for an inconspicuous antenna is 33 feet of very thin wire lowered out the window or pitched into a nearby tree or bush. I use wire removed from the ringer coil of an old mechanical telephone ringer. I don't know for sure what the wire gauge is, but it is so thin that I have trouble seeing it in the room and it is invisible outside.

A 33-foot length of outdoor wire can be used on either 20 or 40 meters. Inside the room, I lay out a counterpoise wire of either 16 feet (for 20 meters) or 33 feet (for 40 meters). If the situation won't permit the full 33 feet of wire outside the window, I make the wire as long as possible. An Emtech ZM-2 tuner works great to tune any combination or length of wires.

Window mounted whips like the W6MMA MP-1 or the B&W Travel Antenna should work well on higher bands but are more visible. Being a typical ham, I built a homebrew copy of the B&W antenna and have used it on several trips for 20 and 40 meter operation.

I have used many different QRP rigs over the years when traveling including Heath HW-8, NorCal 40A, NorCal 20, SW-20+ and the Elecraft K1 and K2's. All are fine rigs, but I have found that 5-watt rigs are a bit better in producing contacts using marginal antennas. Currently, I use an Elecraft K1 on most trips with pretty good results. The internal battery and antenna tuner make the K1 an excellent travel rig, plus it works my favorite two bands.

Always use headphone to prevent disturbing the neighboring rooms. As for a power source, most of the time I use batteries to reduce AC power line noise. After the operating session, the batteries are recharged using a wall wart power supply. If AC line operation is desired, the compact CUP-12 power supply from Milestone Technologies is a good choice to run that 5-watt rig.

Working QRP hotel portable is challenging, to say the least, but it beats watching TV on those evenings when you are on the road. Give it a try on one of your next trips.

IS SMD OK 4 QRP?

Some comments on surface mount components.

by Ted Williams, G0ULL

The electronics manufacturing world is increasingly turning to surface mount technology in circuit board assembly, so clearly it must offer certain advantages.

Some fairly obvious ones for the industry are:-

- No board drilling
- Small size components, i.e. compact

- Relatively small assemblies, reducing board costs.
- Easy automatic placement (no lead bending, insertion or cropping)
- Easy reflow soldering (under infra red)

Apart from the last item, these advantages are still more or less relevant to the amateur.

Costs

As far as I can see, SM components tend to be cheaper than their through-hole counterparts, even in modest quantities, no doubt because the lead attachment problem and associated cost is avoided.
Components can be recovered from junk populated boards, but it is never clear quite what they are, viz, no tolerance, power or voltage ratings. New is generally a more reliable choice.

Range

Components available include R, C & L, and there are SMD equivalents of most common ICs, transistors and diodes; indeed an increasing number of semiconductors are available only in SMD form, such as DDS chips. There are already indications that a number of leaded components are being phased out as the demand polarises in favour of SM assembly.

Component size

There are a number of fairly standard sizes, for example resistors range from the massive 1206 case (0.12 inches long by 0.06 wide - roughly an eighth by a sixteenth of an inch) down to half this size - 0603. Just don't sneeze.

A 0.1 uF capacitor at 50 v working is no larger than a resistor. Transistors and ICs are also smaller than the leaded types, and space between leads-out can be reduced to a half millimetre. Note that due to the size, there not enough space to code many of the components, so that care is needed to store them without losing their identification.

Circuit advantages

From the circuit design viewpoint, the small physical size of the components means that the strays associated with larger components are largely avoided, i.e. low added inductance due to short component body and no leads, lower self capacity due to the small profile and shorter path lengths on the circuit board.

The effect is that circuit performance, particularly at high frequencies, is enhanced and much closer to theoretical design parameters. Further, the low profile is a help in reducing cross coupling, though normal layout precautions should be observed (like avoiding earth loops).

Can Hams use them?

Certainly from my own experience in assembling SMD kits and some home brew, the answer is entirely positive. Even board layout seems easier, and simple boards can be cut with a hobby knife rather than etched. Crossovers can be achieved by using resistors coded '000' – yes, zero ohm resistors.

A soldering iron with a fine tip, say ½ mm diameter, makes life fairly easy. A silver-loaded solder is preferred to avoid leaching the silver from the component ends, though ordinary solder will serve. A recent advance has been to apply a nickel flash to the silver end connections before tinning, which reduces the leaching problem. Small diameter solder is essential in my view to control the amount applied, and 26 swg is about right. (0.018 inch dia., about 25 AWG) Many people may find a magnifier helpful, and the combination of a bright light and a headband magnifier makes life fairly easy. The affluent may prefer an Anglepoise type lamp, using a circular fluorescent lamp round a large diameter lens. (I bought one advertised in Practical Electronics for £50 – excellent value). The fluorescent lamp has the advantage of running cooler than an incandescent lamp – a considerable advantage in the summer months.

An essential tool is something to hold the component in place while soldering. At a pinch, an orange stick will serve, but I made a spring-loaded plunger tipped with PTFE which seems to work well. Tony, G4WIF, uses a converted wire coat hanger to good effect (easier on the pockets?)

Summary

Yes, SMD is readily useable by the Ham community, indeed it may have to be taken on board by confirmed home-brewers if the reported shortage of leaded types becomes serious. My personal view is that it is actually easier to lay out a board, quicker to fit components and gives better results than through hole assembly. The range of components in your armoury is increased.

Ted, G0ULL

Build a Logging Frequency Counter (using your PSK Audio Beacon circuit board)

by George Heron, N2APB, email: n2apb@amsat.org
2419 Feather Mae Court
Forest Hill, MD 21050

One of my great fascinations is finding multiple uses for any given radio, accessory or project. And even more so if the project happens to have a microcontroller because of the flexibility offered by being able to install new software to give the project new features.

Such is the case with the NJQRP "PSK31 Audio Beacon" project, described in August QST and elsewhere in this QRPp issue. With some new software and a single transistor, you can turn the Beacon circuit board into a frequency counter with a real unique capability.

You see, many other PIC-based projects provide the frequency counting feature. It's really pretty simple to do – the PIC software just counts up the number of cycles occurring in the input signal during a fixed time interval, performs a little math, and *bingo*, you've got the frequency. The digits of the frequency are then usually displayed on an LCD or on some LEDs, annunciated by audio Morse, etc.

I've whipped up some new software for the Beacon project that performs that frequency counting function. But since the Beacon pcb has a built-in RS-232 serial port, it is able to send the numbers out the serial port at 9600 bps to a logging terminal, printer or computer running a terminal emulator program like PROCOMM. Additionally, since the serial port is bi-directional, the operator can use the terminal keyboard to send simple commands to the Frequency Counter board – commands like: change sample time intervals and frequency resolution, select continuous sample & report or one-time sample, set delays between continuous samples, and more.

The simple circuit shown below is added to the PSK31 Beacon board to shape the signal being measured. Just make this 15 minute mod, download the software from the NJQRP website (or order a new pre-programmed SX chip) and you'll be measuring frequencies of your favorite project on the bench and logging it to a text screen on your computer! Full details and source code can be found at:

www.njqrp.org/freqcntr.

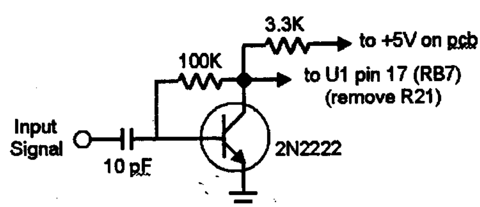


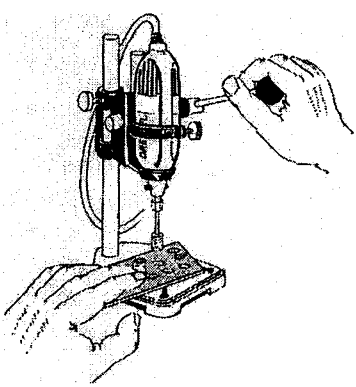
Fig. 1 Mods to PSK31 Beacon

NJQRP "Islander" Pad Cutter

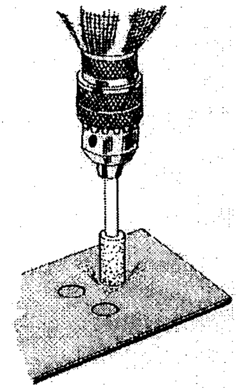
by George Heron, N2APB, email: n2apb@amsat.org
2419 Feather Mae Court
Forest Hill, MD 21050 USA

Here's a handy and inexpensive end mill that can be used to cut "islands" into copper clad circuit board material. This technique of cutting small isolated pads right on the copper ground plane is an alternative to the Manhattan-style construction technique of creating separate pads that are glued down. The Islander pad cutter tool was envisioned by a member of the New Jersey QRP Club (**Dov Rabinowitz, AD0V**) while sitting in a dentist's chair during a regular check-up. He later hunted down a manufacturer of a little 5mm-diameter diamond-tipped end mill, and then worked with the NJQRP to place a bulk purchase so the club could sell to homebrewing QRPers everywhere. Master illustrator **Paul Harden, NA5N** graciously agreed to help us document use of the end mill, and Manhattan-style expert **Jim Kortge, K8IQY** provided some sample circuits and photos to use in the article as well as the "manual" we provided with the pad cutters.

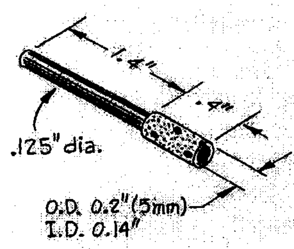
NJ Islander bit can be chucked up in a bench mounted drill press, or just as easily in a hobbyist's Dremel tool and inexpensive tool stand.



It's important to drill the islands perpendicular to the board to prevent "bit walking". A little water on the cutting surface helps. Be careful not to cut all the way through the fiberboard substrate, and to carefully clean out the drilling debris from the circular holes. (Check for shorts with an ohmmeter.)

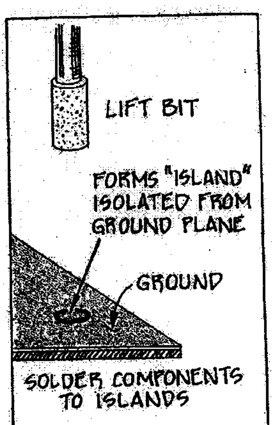


NJQRP Islander Pad Cutter dimensions

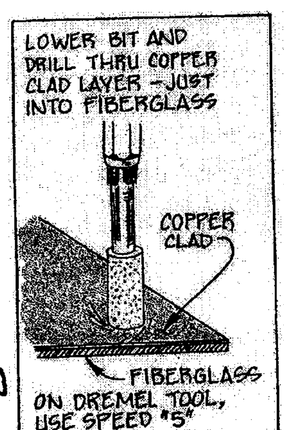


NJ Islander bit creates an "island" from the surrounding ground plane. Components may be soldered to the island just like when using Manhattan pads.

Make the island cuts at 90-degrees at Dremel speed "5". It's helpful to use a little soapy water to keep the soft copper from clogging the diamond edges.



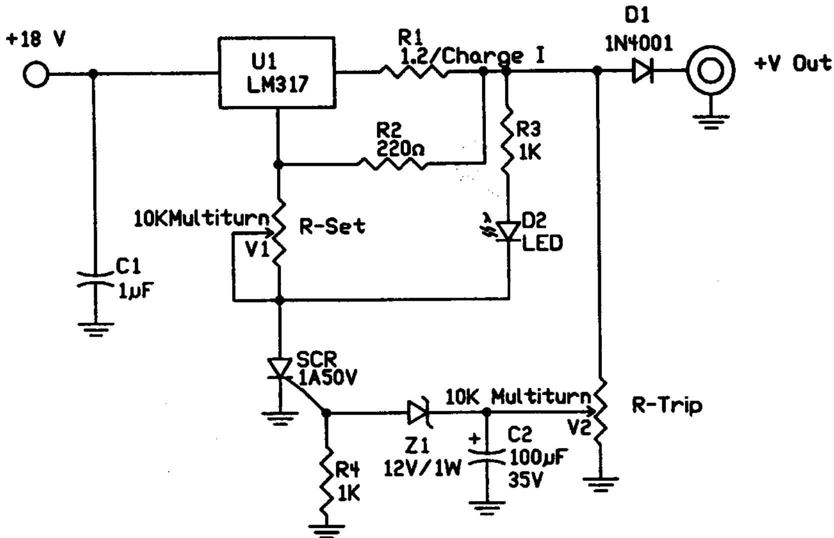
72, Paul NA5N



An Automatic 12V Gel Cell Charger

by Jim Duffey, KK6MC/5

This circuit first appeared in Sky & Telescope in 1989. Hainer wrote the article, and it is unique in that all of the parts are available from Radio Shack. It lends itself perfectly to Manhattan style construction. Enjoy. 72, Dr. Megacycle



1. Charge current can be 0.1 to 0.3 times C where C is amp hour capacity.

2. R should be rated > I^2R, where I is charging current.

3. Set R-Set for 13.8V with LED lit. Use digital voltmeter. If LED is not lit adjust R-Trip until it is.

4. Connect battery and start charging. Monitor Battery Voltage. Adjust R-Trip so that LED lights at 14.4V

5. Parts available at Radio Shack

6. Low dropout regulator may be used.

Put your SMK-1 on 80 Or 160 Meters

By Wayne McFee, NB6M

Having had enough fun with my VFO equipped and 5 Watt Mod equipped SMK-1s on 40 meters to want to try something different, I thought, with 80 and 160 Meters now open during the winter, why not put an SMK-1 on one of the lower bands and see what activity I could scare up.

By staying with crystal control, the SMK-1 can quickly and easily be put on a different band by making appropriate changes to the receiver's tuned input circuit, changing a few capacitor values in the oscillator feedback circuits and changing the values in the transmitter's output network. Crystals for either 80 or 160 Meter operation are readily available from Radio Shack, either online or by calling 1-800-THE SHACK. The rest of the parts needed to make the change may well rest, awaiting use, in your parts bins.

In addition, the circuit can very easily be modified to provide for a separate receiver RF input so that the low noise advantage of a small, tuned loop antenna with an appropriate RF preamp could be realized, especially on 160 Meters.

Sure, the amount of tunable frequency range will be even less on 80 or 160 than it is on 40, but the SMK-1 is basically a rockbound, single frequency transmitter with a slightly wider bandwidth receiver anyway, so the limitation is really not all that constricting. Think of it as having a rockbound transmitter and a rockbound receiver with RIT. My 80 Meter SMK-1's receiver has just over 1.5 Khz of frequency range.

As observed with the 40 Meter SMK-1, the receiver's Local Oscillator drops out of oscillation past a certain point of VR2's range. This doesn't really hurt anything, but is something to be aware of, especially when you first turn the rig on after modification. Start with the pot all the way to the left, counterclockwise, and it will be oscillating just fine.

Also, as the SMK-1 is known for its characteristic small amount of transmitter chirp, especially on the higher end of the transmitter's tuning range, stability is improved, resulting in no chirp, by disabling the transmitter's tuning circuit. Since there was very little transmitter tuning range anyway, and there will be even less on 80 or 160, this is no loss and your signal will sound much better. The transmitter's tuning circuit can be disabled easily by removing C16. Or, if you are just getting around to building your SMK-1 and want to put it on either 80 or 160 Meters, don't install C16, D6, D7, R7 and VR3.

Color burst crystals for 3.579 Mhz are commonly available, but with PSK-31 and other digital activity now in that part of the 80 Meter band, there seems to be little or no CW operation there. Radio Shack part number 900-5085, a crystal for 3.686 Mhz, at $1.18, would make a much better choice, as that frequency falls right into the old Novice portion of 80 Meters. More CW activity has recently been heard in that frequency range than in the low end of the band.

Crystals for 160 meters, 1.843 Mhz, Radio Shack part number 900-5089, are available for $2.00 each.

Here are the changes I made in my SMK-1 to put it on 80 Meters:

Change X1 and X2 to 3.686 Mhz crystals
Add 130 pf NP0 across TC1
Change C1 to 160 pf
Change C2 to 940 pf
Add 240 pf NP0 across L2
Change C4 to 390 pf NP0 (probably should be 470 pr or so, but I used the 390 that was the old C24)
Change C5 to 150 pf NP0
Change C18 to 270
Change C24 to 820 pf, Silver Mica or NP0
Change C25 to 160 pf, Silver Mica or NP0
Change C26 to 1000 pf, Silver Mica or NP0
Change L5 to 2 uh, 22 T # 24 on T37-2

Note that wherever a capacitance value is increased, rather than having to remove parts, another capacitor of appropriate value can be soldered across the existing part. In this way, only L5 would actually need to be physically removed.

If that approach is taken, in addition to changing the crystals, do the following for 80 Meter operation:

Add 130 pf NP0 across TC1
Add 82 pf NP0 across C1
Add 470 pf NP0 across C2
Add 240 pf NP0 across L2
Add 270 pf NP0 across C4
Add 82 pf NP0 across C5
Add 100 pf across C18
Add 470 pf Silver Mica or NP0 across C24
Add 82 pf Silver Mica or NP0 across C25
Add 470 pf Silver Mica or NP0 across C26
Remove L5 and replace with 22 T # 24 on a T37-2 toroid

The 130 pf across TC1 was added in order to resonate the TC1, L1 combo to 80 Meters.

C1 and C2 changes, while perhaps not absolutely necessary, were made so as to maintain the same impedances seen by the signal coming from VR1 on 3.5 Mhz as was seen on 7 Mhz.
Probably, since the impedance of a parallel tuned circuit is very high at resonance, only the impedance ratio between C1 and C2 is important, and added capacitance wasn't needed. You are welcome to experiment. 240 pf was added across L2 to resonate the TC2, L2, C1 and C2 combo to 80 meters.

With these changes, TC1 and TC2 seem to peak the signal/noise level quite well on 80 Meters, but some experimentation may still be in order as to the exact value of capacitance to add across TC1 and L2 in order to get the "double peak" in the tuning range of the two trimmers, which should be there in order to indicate true resonance of the circuit.

In this case, the approximate values needed were determined by the simple expedient of first wiring an air variable capacitor across TC1, tuning for maximum signal, removing the air variable and measuring the resultant value of capacitance. An appropriate value fixed capacitor was then soldered across TC1, and the same procedure was used to determine the approximate value needed across L2.

Since C4 and C5 determine the feedback necessary to the oscillator in SA612, their values were changed so that their individual impedances would be the same on 3.5 Mhz as they were on 7 Mhz, in order to be sure that a sufficient amount of feedback for reliable oscillation was provided. C18, in the transmitter's oscillator circuit, was changed for the same reason. Again, you are welcome to experiment.

The remaining changes, to the transmitter's output network, were made in order to scale the values from 40 to 80 Meters.

Although the one quarter to one third of a watt normally realized from an SMK-1 should be enough to have many enjoyable QSOs on 80 meters, more than that may well be needed on 160. To increase the transmitter power output of the SMK-1, there are at least a couple of ways to go. One very simple modification which raises the transmitter output to around a half watt on 40 Meters, and results in three quarters of a watt of output on my 80 Meter SMK-1, is simply to lower the value of R-14 in the PA circuit.

Carl, K5HK, simply bridged R14 in his SMK-1 with a wire, directly grounding the emitter of his PA transistor. As he reported no obvious problems after several months of operation with R14 bridged, I gave it a try as well. This very simple mod raised the output of my VFO equipped 40 Meter SMK-1 from one quarter to one half a watt. Not earthshaking, but a significant improvement for very little effort. After several months of operation now with that mod in place, no overheating or other adverse effects on the PA transistor have been observed.

I tried running the emitter of the PA transistor in my 80 Meter SMK-1 directly to ground as well, and realized just over .8 Watt. Due to the higher gain of the transistor on 3.5 Mhz, and wanting to forestall any possible problems of overheating or instability, I ended up bridging R14 with a 2.2 Ohm Resistor, which resulted in .76 Watt output into a 50 Ohm dummy load, with the little rig operating from an eight AA battery pack. No overheating or other problems with the PA transistor have been observed, and on-the-air signal reports are good. If you do this mod and your PA shows either any signs of instability or heating, try changing the 2.2 Ohm resistor to a higher value, perhaps 4.7 or even 10 Ohms. You should still be able to realize a higher power output than the stock SMK-1, with no overheating or other problems with the PA stage.

If you care to operate at the QRP Gallon level, a 5 Watt Mod as performed on the 40 Meter SMK-1 could be added to the rig. Suggested output network values are listed below:

	C1	L1	C2	L2	C3
80 Meters	820pf	21T#24 T50-2	1600pf	25T#24 T50-2	910 pf
160 Meters	1600	30T#24 T-50-2 or 28T#24 T68-2	2-1600pf in parallel	35T#24 T50-2 or 32T#24 T68-2	1800 pf

To put the SMK-1 on 160 Meters, the following changes are suggested:

Change X1 and X2 to 1.843 Mhz crystals
Add 590 pf NPO across TC1
Change C1 to 330 pf
Change C2 to 1800 pf
Add 1430 pf NPO across L2
Change C4 to 820 pf NPO
Change C5 to 330 pf NPO
Change C18 to 390 pf NPO

Change C24 to 1600 pf, Silver Mica or NP0
Change C25 to 330 pf, Silver Mica or NP0
Change C26 to 1800 pf, Silver Mica or NP0
Change L5 to 4.4 uh, 30 T # 24 on T37-2

As noted above, except for the removal and replacement of L5, capacitors of appropriate value can be soldered across existing parts to make the necessary value changes.

And, as indicated for the 80 Meter version, some amount of experimentation may be needed in order to bring the receiver's tuned input circuits within the range of the two trimmer capacitors.

How you effect these changes will depend on how well stocked your parts bins are. You may need to remove some parts and solder in the correct value, and you may be able to add the necessary value across other parts by soldering on additional capacitors. Surface mount parts are very easily removed by the use of two low wattage soldering irons at once. A handy damp cloth is recommended for wiping the removed part off of whichever iron it sticks to when it comes off the board.

If you, too, have had enough fun with your SMK-1 on 40 Meters to want a change, warm up your soldering irons and make the simple changes needed to put the little rig on 80 or 160. I hope to see you on the air. Enjoy. Wayne, NB6M

NorCal St. Aidan's Benefit Raffle Raises $2745.00!

by Doug Hendricks, KI6DS

This year's annual St. Aidan's Benefit Raffle at Pacificon was a huge success. We raised $2745 to send to St. Aidan's Church in England. This is the parish where Rev. George Dobbs is the Vicar. Rev. Dobbs, G3RJV, is perhaps the world's most famous QRPer, and has appeared at almost every QRP Forum in the world. He was a guest at Pacificon in 1998 and drew a huge crowd. George's parish has been very lenient in allowing him to travel to support QRP, and NorCal has sponsored a raffle the past 2 years with the proceeds going to the church as our way of saying thank you..

The raffle this year featured a K2 as the grand prize, donated by Elecraft. Red Hot Radio donated a Red Hot 40, Dave Benson of Small Wonder Labs donated a DSW20+, Martin Jue of MFJ donated a MFJ Cub 15 Meter kit, Vern Wright of Super Antennas donated a MP1 and an MP2 antenna, the St. Louis QRP Club gave a St. Louis Quickie Antenna Kit, NJ QRP Club gave several kits, including a Warbler, and a

Joe Everhart Gusher Antenna, Ft. Smith QRP Group gave away a Tuna Tin 2 and a VE3DNL Kit, the Arizona ScQRPions gave away a SSS Frequency Counter Kit, Dennis Foster gave away a TeNeKey, and NorCal QRP Club gave away a BLT Tuner Kit, the very last SMK-1 Kit, and a Toroid kit. As you can imagine, the parish was quite please to receive the donation, as they had no idea it was coming. Below is a picture of George Dobbs handing over a check for the raffle proceeds to the parish treasurer. I received a very nice thank you letter from her which I have reprinted here.

Debra Buckley, Treasurer of St. Aidan's accepts a check from the St. Aidan's Benefit Raffle Proceeds from Rev. George Dobbs, G3RJV.

Dear Mr Hendricks

As treasurer of St Aidans PCC (Parochial Church Council), I would like to thank you very much for organising your recent raffle in aid of St Aidans Church. The proceeds which you generously donated to us amounted to the grand sum of £1,875.43 and are very much appreciated. I speak on behalf of the PCC, and indeed the people of St Aidans, who at a recent meeting were very grateful and delighted at the announcement of your donation.

It would take a lot of hard work over a long period of time for

the PCC to be able to raise such a large amount of funds which are greatly needed for the life and work of our church.

As I am sure you are aware, it becomes increasingly difficult to meet our financial obligations and maintain the fabric of the church, whilst sustaining its life and work. Such a large and unexpected donation is a great surprise and very welcome.

Thank you once again.

Kind regards,
Debra Buckley
Treasurer

Many of you will receive this during the Christmas Holidays. What a great time to reflect on doing good deeds for others. Thank you for supporting the raffle with your ticket purchases. Thanks again to all of the vendors and clubs who donated every prize fully. Every penny raised went to the Church, nothing went for expenses, which were covered by NorCal, Jim and I. We will plan on doing another raffle next year. George, please keep up the good work in your day job too!! 72, Doug

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Enjoy the issue!! 72, Doug

WHAT CAN YOU DO WITH A 10-METER POLE?

Ed Manuel, N5EM

Amateur radio operators are fascinated by antennas. We are always searching for a sky-wire that will outperform whatever we have up today. While at Dayton a few years ago, I came across the DK9SQ 10-meter mast. As I played with this mast it became apparent to me that this device presented unique opportunities for the amateur operating from portable locations.

There are many masts available for the amateur today. One can find military surplus, high tech aluminum, simple fishing poles, painter's poles, electrical lineman's poles, etc. What makes the DK9SQ (and also the MFJ) 10 meter pole especially attractive is that, in addition to its nearly 33-foot length, it collapses into a highly portable, lightweight device that is under 4 feet long. That is important to a hiker or backpacker as it can be strapped to the side of a pack frame. For the car camper, it is much easier to put this pole in your trunk or backseat than many of the longer poles.

The DK9SQ mast is made from fiberglass and is a non-conductor. It does not require special considerations for insulation or interaction with antennas that are supported by it. The length of 10 meters seems to be the largest pole of this type available today. At nearly 33 feet long, this is a substantial item. It is not easily erected in high winds. The wind-load of such a long structure is significant. Fortunately, my use of this antenna support is for portable and temporary antennas. I generally will not try to get on the air if the conditions are unfavorable. Many hams with which I have spoken brave the elements with this mast. One just has to consider the environment to have fun.

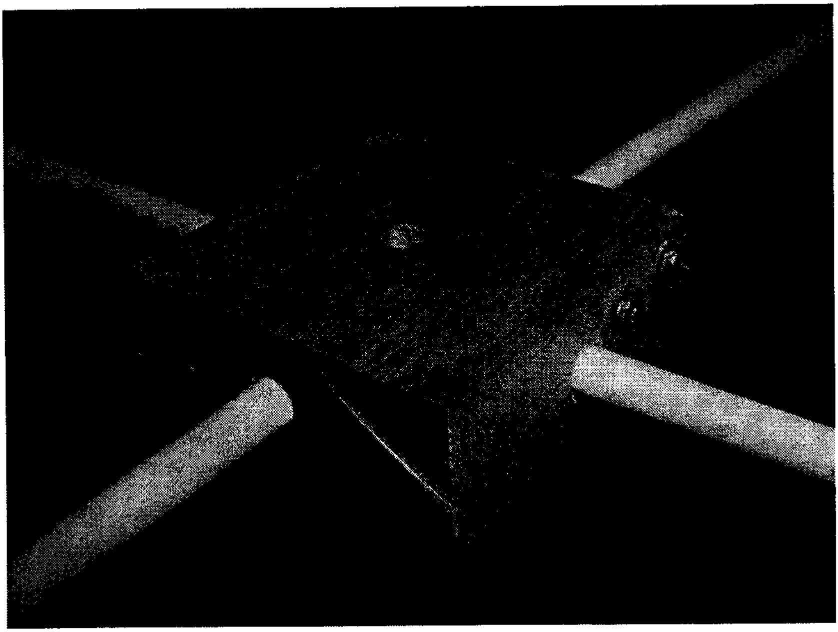
The 10-meter pole immediately suggests vertical antennas. This is the most obvious use from a visual stand-point - the pole is a tall vertical support. A 40-meter vertical is simply a wire from bottom to top with a small loading inductor (The 10-meter pole is actually 9.93 meters - 32 feet 7 inches. A quarter wavelength at 7.040 kHz is 33.25 feet.).

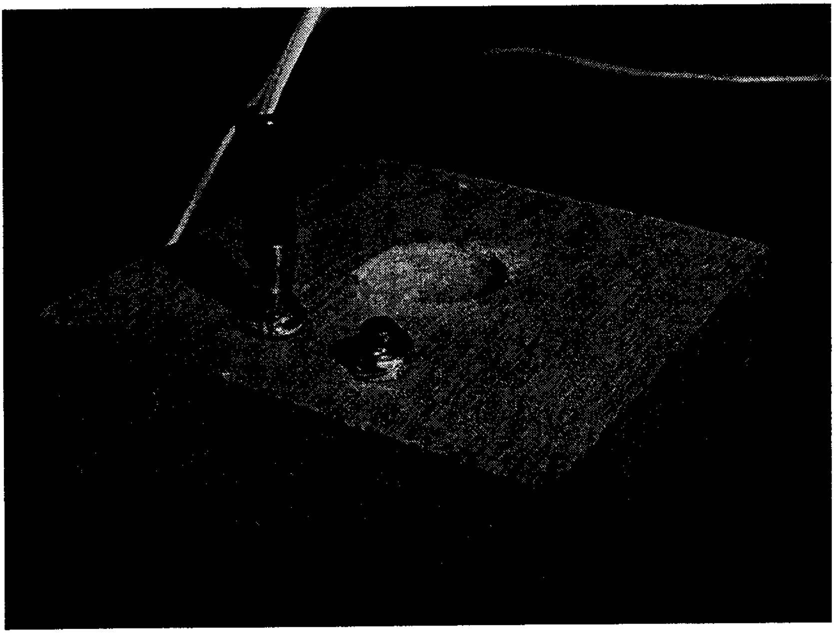
A few personal considerations are important when discussing any antenna configuration. I have already mentioned that I prefer using the mast as a portable or temporary support. Additionally, I generally desire good DX performance. That translates into low angles of radiation. Given that the support is only 33 feet tall, horizontal antennas on the bands below 20 meters will not generally give low angles of radiation at this low height. Vertical antennas will provide better DX performance. As the operating band is increased, it becomes possible to use horizontally polarized antennas to good DX effect.

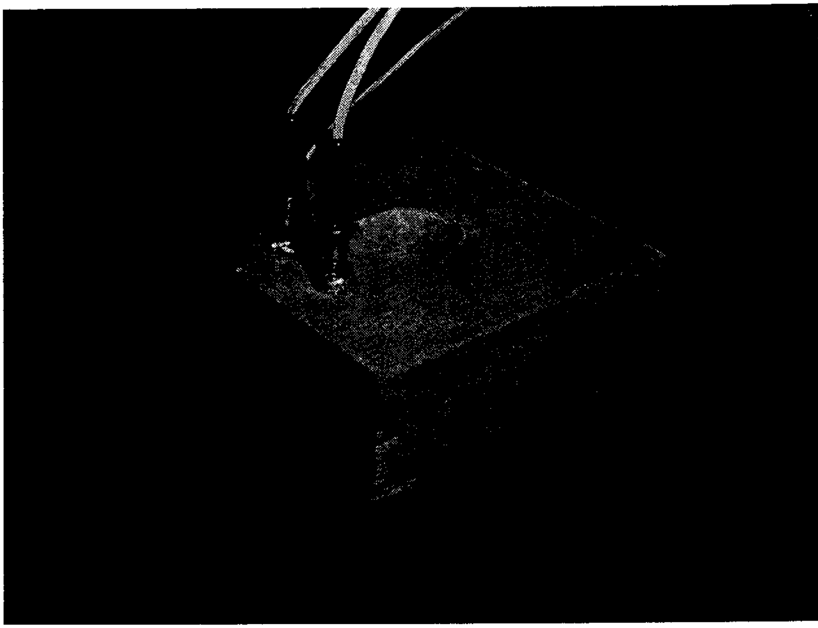
When considering an antenna configuration that is limited or based on an available support, the best performance can be obtained if the entire mast is used. That is, if there is a way to use the entire aperture of the mast, the highest radiated signal will be obtained. At 40 meters, the pole supports a quarter-wave vertical or, perhaps, a loaded half-wave antenna. The 10-meter limitation does not allow us to obtain any gain over a conventional vertical or dipole. But at higher frequencies this should be a consideration. At 10-meters where a half-wavelength is approximately 5 meters, it becomes possible to create antennas that have gain over a half-wave dipole.

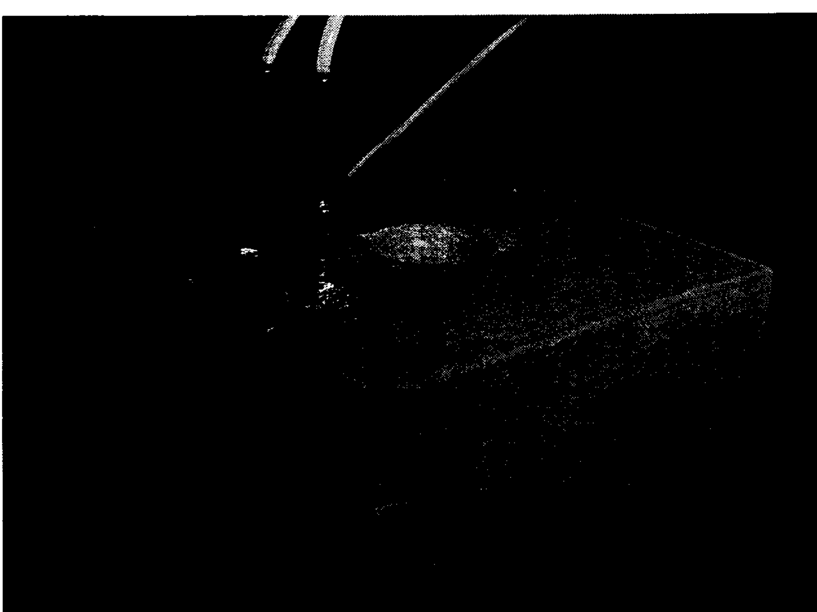
In experimenting with antennas using a long pole, it is desirable to be able to create different configurations, using lengths of wire, inductors, capacitors, traps, phasing lines, etc. and be able to easily configure these items in different locations on the mast. One might want to experiment with a base loading arrangement one day, then try a center loaded one the next. To make this kind of experimentation easier, I developed a small, wooden mounting block that facilitates adding these various components into different configurations.

The 10-meter mast is comprised of 10, tapered sections. Fortunately, the taper on these sections is very gentle. I prefer to install my blocks sitting right on the top of a section. This requires drilling a hole that corresponds to the ID of the lower section (OD of the upper section). A verbal description of these blocks becomes very complicated so I refer you to the attached photo of several of these. I make these blocks out of whatever 2x4 material is lying around as scrap. Use a table saw to make the sections perfectly square. Mine are relatively small - and therefore lightweight. You can put a number of these on the mast without significantly adding weight or wind load. A typical vertical antenna may only require one or two of these, but having a set of them for most of the junctions on the mast makes future experimentation a snap. It's easy to make a bunch once you get the table saw setup.









After we have made the blocks and drilled them for our different mast diameters, we need some way to conveniently attach antenna wires and components. The familiar banana plug is a useful component for plug and play antenna work. In particular, I like the mini-banana plugs. Rather than the larger 0.75-inch spacing between jacks, the dual mini-banana plugs are on 0.5-inch centers. I like the more compact arrangement. You could of course use any method that allows you to be creative. I could not find a supply of dual, mini-banana

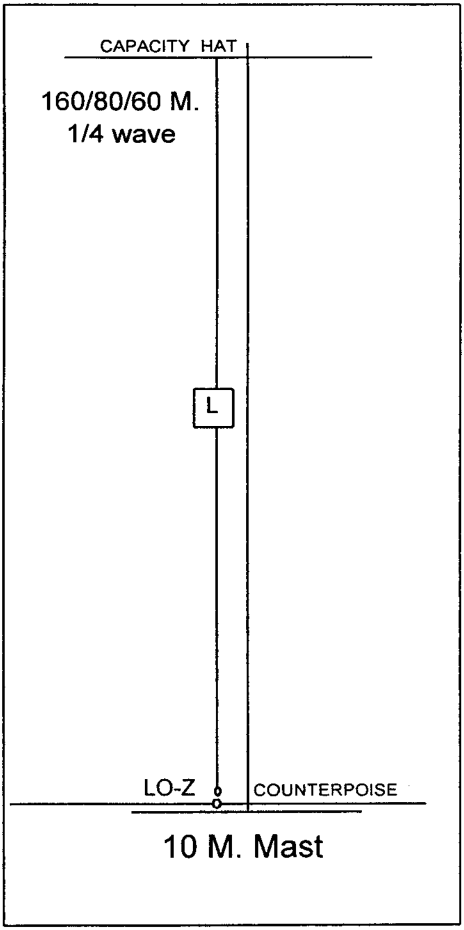


Figure 1

jacks when working on this project and came up with a more useful solution. One-eight inch brass tubing is the perfect ID for the mini-banana jack. By installing two lengths through your block, carefully spaced 0.5-inch apart, you have a dual jack on the top and on the bottom of the jack. By examining the photos you will see how useful an arrangement this is.

The top block is made differently. Instead of installing the brass tubing in a vertical arrangement, I chose to install it horizontally. The top block is specially used in certain configurations to support a capacity hat to top load some verticals and to support some special antennas on the higher bands. More on that later.

Now, let's start at the beginning, as they say and talk about specific antennas that can be use with our 10-meter mast.

160 Meters

One might question the success to be had with a short vertical, especially in portable operations, for 160 meters. On the other hand, portable operation often takes us to places that allow extravagances we may not have at home. We should all know that quarter-wavelength verticals (and anything electrically shorter) are fundamentally dependent on the ground under them. Ground losses can become a significant part of the total radiation resistance our transmitter sees. One way to help overcome this basic limitation is to use a set of radials or counterpoise wires. The problem is that a few wires help, but not a lot. To really start to see the benefit studies indicate that we need to exceed 8, and better yet, 12 radials to start bring down that ground loss. Another problem is that the low angles of radiation that we would really like to have for good DX performance are a function of the conductivity of the ground as well. The problem of radiation resistance is a close in problem. The radials within one-eighth wavelength of the antenna significantly help this problem. As to low angle of radiation, that is a contribution of the ground conductivity significantly further out - and there isn't much we can do about it. Well, not short of operating on the beach - always a good idea!

But remember one absolute rule of antennas. Something is always better than nothing. So, if a short vertical is all we can manage and we want to operate 160 meters, then a short vertical it is.

If we are going to make the best of a short vertical for 160 meters we need to be smart and make the best use of our 10-meter mast. First of all, we want the inductor as high as possible - probably in the middle of the mast. The inductor will be larger there, but the efficiency goes up significantly over base loading. Second, we want to use capacitive top-loading. These two techniques, along with as many ground radials as you care to carry and deploy will provide the best single support antenna that our pole can provide.

If you want a better solution and have a support for the loose end of the antenna, an inverted-L configuration will be great. This antenna retains the vertical polarization but relies on the length of the top section to attain resonance. Remember that the same requirements for good ground apply to the inverted-L as to the short monopole.

80 meter (60 meters)

While these bands are higher, the same basic limitations guide us to the same antennas as on 160 meters. Of course, we require less loading inductance and our 10-meter length provides higher and higher efficiencies as we go up in frequency. On the new 60 meter band, a full length quarter wavelength is only 15 meters. We should be able to perform very well with our 10-meter antenna, loaded to become the electrical equivalent of the required 15 meters. Again, use top loading first, then add inductance as required. That will provide the best efficiency.

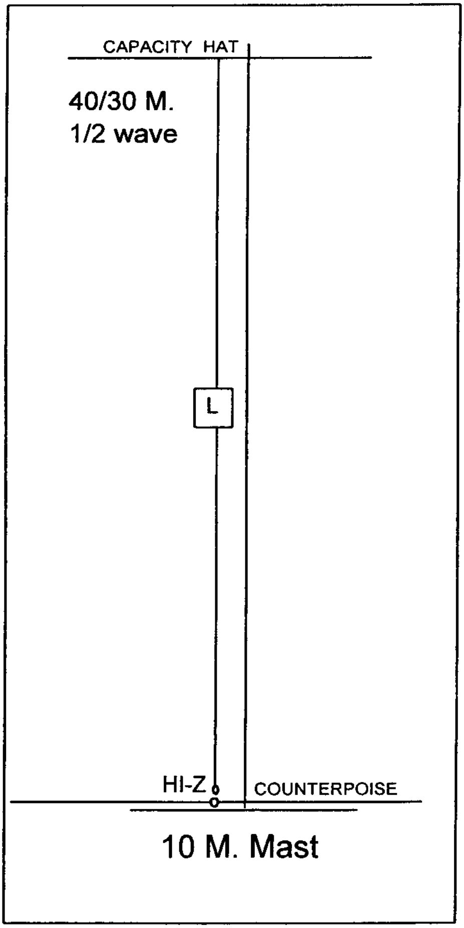


Figure 2

40 meters

At 40 meters and above, the natural length of our pole really starts to shine. As pointed out earlier, a nearly full-length quarter wave antenna can be erected with only minimal loading required. This antenna, over a proper counterpoise system will do well, given the limitations imposed by the local ground. Again, even with the higher efficiency gained by a full size antenna, our monopole will always be dependent on the ground for its low angle radiation performance.

There is another possibility. Consider the half wave antenna for a moment. An end-fed, half wavelength antenna is a complete antenna, requiring only a minor counterpoise to function as a highly efficient radiator. (In fact, recent empirical work done by Wes Hayward indicates that the presence or absence of a counterpoise does not necessarily create problems: http://www.easystreet.com/~w7zoi/endfeed.html). The antenna feed point presents a high impedance requiring a matching network at the base but this problem is easily solved by a simple tuner. If we had room for a full size antenna (approximately 20 meters) this would clearly be a superior radiator. Unfortunately, we have only half that space. But, if we chose to center load the quarter wavelength radiator and apply the same capacity hat loading we used for the lower bands, it would certainly be possible to make our pole look electrically as a half wave. Heck, we already did that when we tuned it to 80 meters! So, ultimately, we have a choice to make. Should we use the quarter wave monopole, requiring a counterpoise to achieve good efficiency, or do we apply loading to achieve an electrical half wave - relying on the independence from ground to balance the losses we introduce to load the antenna. I will tell you that my preference is to use the half wave antenna. But, having a choice provides more options for us. If you are on top of solid rock (a good example being the Texas hill country), the half wave antenna would probably be a better choice. On the other hand, if you are operating from the beach, go for the quarter wave antenna.

Remember one other thing. The far field effects of ground on the angle of radiation are independent of the type of vertical antenna chosen. Keep these two effects of ground (efficiency/radiation resistance and low take-off angle) separate when evaluating your choices.

30 meters

Again, we have the same choices as on 40 meters. We can deploy a full-size, quarter wavelength vertical - even choosing to elevate the feed point 7 feet above ground or we can provide loading to make the full length of our mast look electrically like a half wavelength radiator. Here, the choice is not so clear. An elevated feed point allows the counterpoise system to be removed from close proximately from ground. This enhances its performance, particularly for a small counterpoise system (2 - 4 radial wires). Our antenna now could be called a ground plane antenna, since we are providing the artificial ground. This is clearly the easiest to deploy, not requiring any loading to achieve resonance. Still, the half wave resonator could be used and might be a better choice in some locations where any radial wire might be a nuisance. Again, the good news is that we have choices.

20 meters

At 20 meters, the picture clearly changes. Now, we can deploy a full size half wavelength wire on our 10-meter mast. Clearly, this is the easiest to implement and takes full advantage of our support. But we could also deploy our ground plane (monopole with elevated feed and counterpoise system) to good effect. The circumstances or your particular situation will dictate whether one might be a better choice than the other.

There is another possibility that should not be overlooked. At 20 meters, our pole is a full half wavelength. Horizontally polarized antennas start to provide better low angle performance at these heights. Our vertical will probably still provide better DX performance, but a dipole or inverted-V antenna will be an adequate solution. Also, we now have the vertical room to deploy a delta loop. The bottom of the loop will be 12 feet above the ground. This is an excellent choice but does require that the ends of the delta loop be pulled out with lightweight cord and staked out. If one is careful, this can be done without putting downward pressure on the mast and causing it to collapse.

There is a downside to feeding antennas with elevated or top feed points. A 10-meter length of conventional coaxial

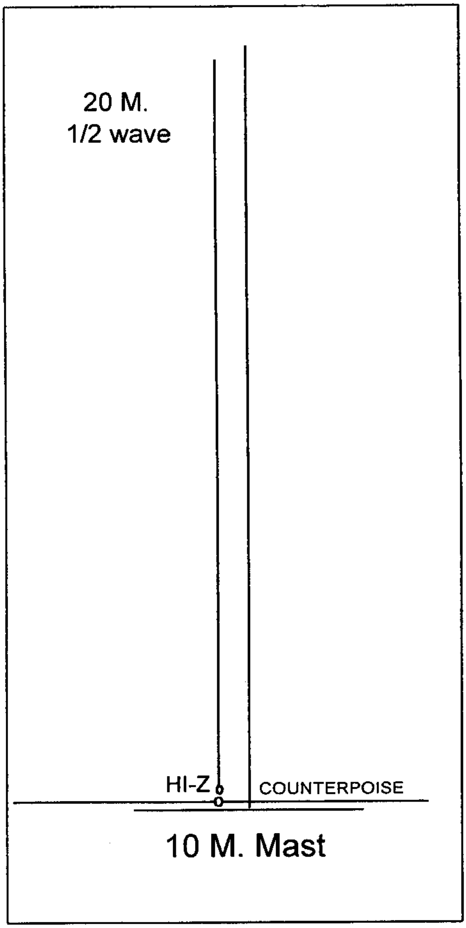


Figure 3

feed line will be somewhat lossy (RG-174) or heavy. A good solution here would be to use a length of 300-ohm twinlead or ladder line and a tuner with a balance output (I prefer an Emtech ZM-2 Z-Match). This provides both a low-loss arrangement and a lightweight one.

Additionally, the very popular NorCal Doublet is made from inexpensive ribbon cable and uses that same ribbon cable as a relatively low-loss feedline. It can be made for pocket change and packed in a Zip-Lock sandwich bag. Details of its construction can be found in previous issues of QRPp, the quarterly publication of the Northern California QRP Club (NorCal). The use of a doublet antenna does require that we support the ends with lightweight cord. This requires additional supports or an inverted-V arrangement.

17 meters

The only difference between 20 meters and 17 meters is one of degree. Everything that can be done on 20 will work on 17. One excellent antenna is the elevated feed half-wavelength vertical. The feed-point will be 7 feet above the ground, isolating the counterpoise from real ground.

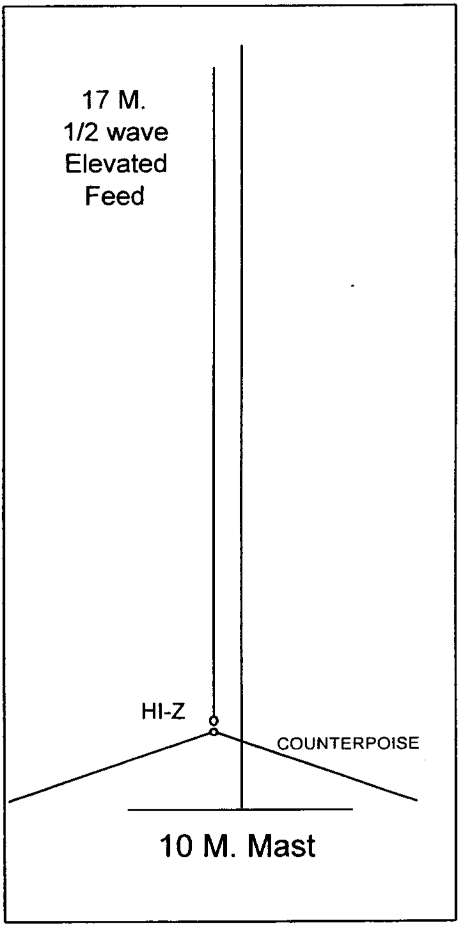


Figure 4

Another variation is the full wave loop. On 20 meters, we needed to use the Delta loop configuration but here we can deploy a full four-sided loop, erected as a diamond. With the bottom of the diamond over 12 feet above ground, we can take advantage of the pattern of the loop to good effect.

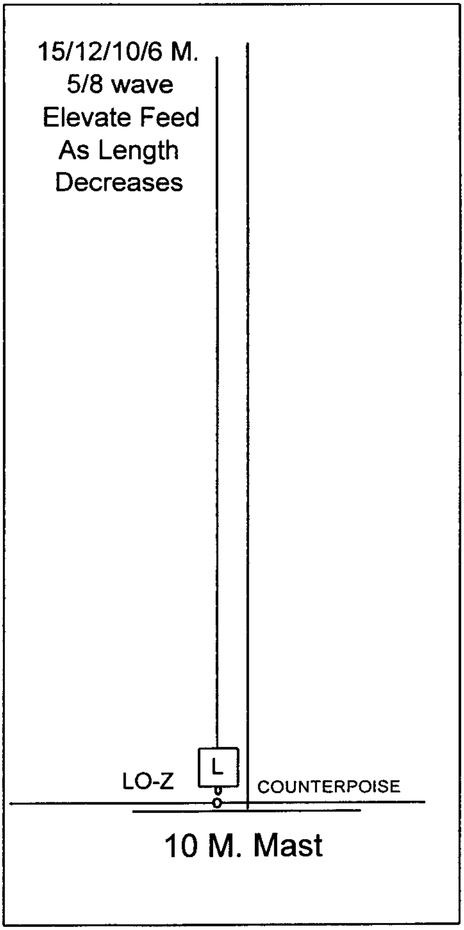


Figure 5

15 meters

At 15 meters a new configuration is added to the already growing list. Not too many hams are familiar with the 5/8 wavelength vertical at HF. Common on VHF, this antenna has the unique property of having the lowest angle of radiation of any single element antenna. Of course, the impedance is not convenient. The 5/8 wave antenna is loaded at the base with a small inductor until it appears electrically to be a ¾ wave antenna. This naturally matches to a 50-ohm feed-line. Remember that the 5/8 wave antenna requires the presence of ground to become a complete structure. In that respect, its like the quarter-wave monopole. At 15 meters, the length of the radiator is approximately 27.8 feet, requiring nearly all the mast. Still, its natural low angle radiation will serve the DXer well.

(Note: Subsequent discussion of the length of a 5/8 wave radiator has brought forth some questions. One the one hand, a well respected QRPer has suggested that the magic 5/8 wavelength can be obtained using loading, not requiring the full physical length. On the other hand, a broadcast engineer has said that it is the current distribution over the entire length of wire that gives the low angle of radiation. I do not have a definitive answer. However, I certainly have an opinion! In the absence of actual field strength measurements (that will certainly be a project) I think that modeling could provide answers. I think that the benefits to be gained going from a half wave to a 5/8 wave radiator will not be achieved unless the physical length is actually there.)

Now, a radical change in thought process. It is possible to assemble small, lightweight beam antennas using wire as the elements. Most of us think of HF beams as huge structures that are heavy. There has been certain work done to develop directional beams that defy our conventional notions. One of these is the VK2ABQ button beam. This antenna is equivalent in size to a horizontal full wave loop. It is possible to reduce the size of this antenna by folding the elements. If you review the diagram you will see the possibilities of having a two element beam that is small enough and light enough to sit atop the 10-meter pole and be rotated by turning the bottom of the pole. And, you can pack the whole thing in a space four-feet long and about 4 inches in diameter.

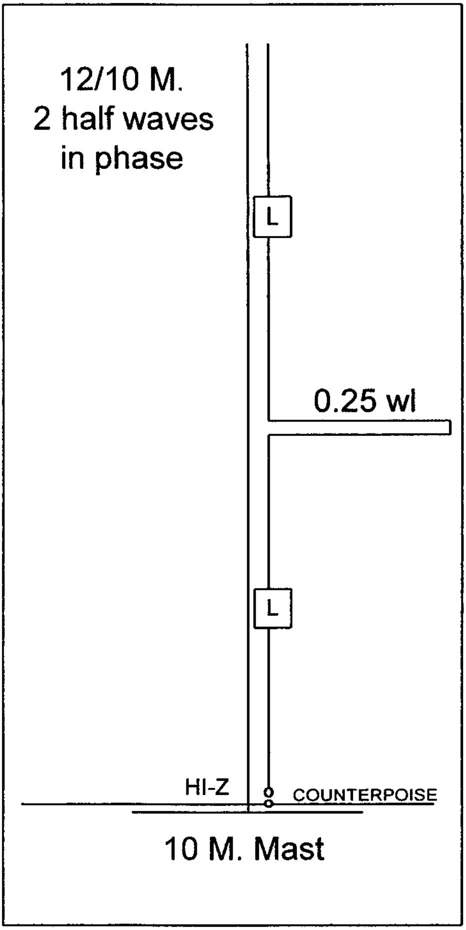


Figure 6

12 meters

At 12 meters we have even more possibilities. Consider that a half wave antenna is approximately 6 meters long. Our pole is 10 meters long. If we were to stack two half waves, we would need 12 meters. By loading each segment we can electrically have our two half waves. By phasing these two together and feeding at the bottom, we can have gain over a dipole. We are using the entire length or aperture of the mast to our full advantage.

We really have some choices now. We can make a small two element beam from wire and have it 5/6 wave lengths above ground (Figure 7), or we can have a vertical antenna with great low angle radiation and gain. How sweet it is.

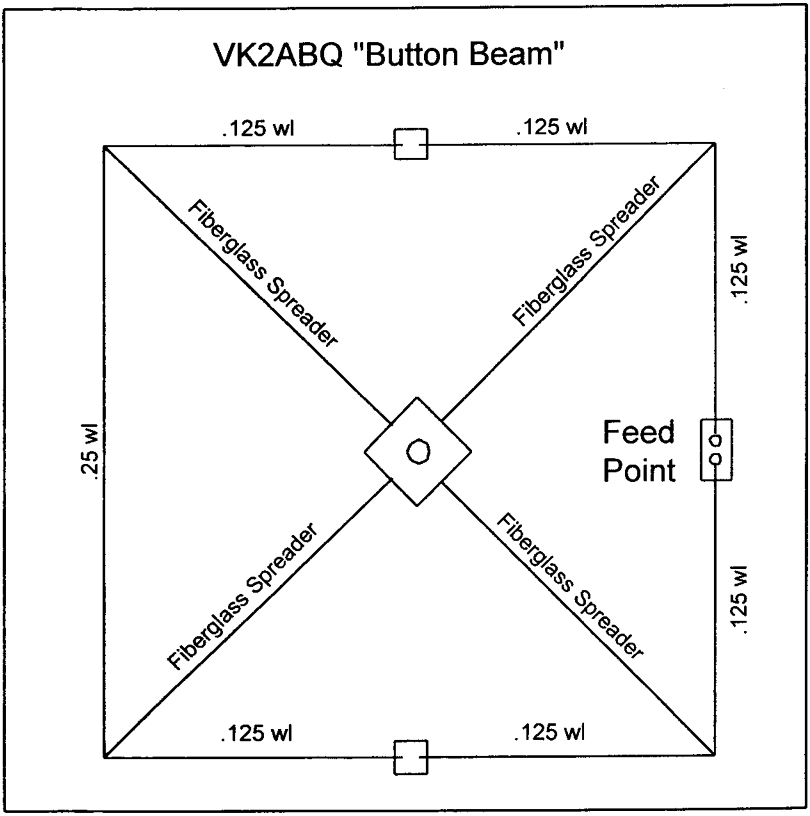


Figure 7

10 meters

There is no real difference between 10 meters and 12 meters, except that we don't require as much loading for the phased vertical segments as we do on 12.

6 meters

Of course we can do the same things on 6. Our two-element wire beam gets even smaller and lighter and its now 5/3 wavelengths above ground. And, we now have room for three stacked half wavelength segments, providing even more gain than the two half waves in phase.

2 meters

On 2 meters we now are more interested in supporting an antenna than deploying it along the mast. There is certainly no reason why one can't create a wire antenna of stacked/phased sections but the real advantage on 2 meters is that we can get a small antenna up around 30 feet above the ground. Typical antennas that we might use are small beams and ground planes. Consider also that for sideband work, a small horizontally polarized loop style antenna would provide a better solution working terrestrial sideband stations. For low-weight, highly portable solutions, a good solution is the coaxial dipole if vertical polarization is all that is needed (FM and repeaters). That antenna can be stored in a baggie and weighs only a few ounces.

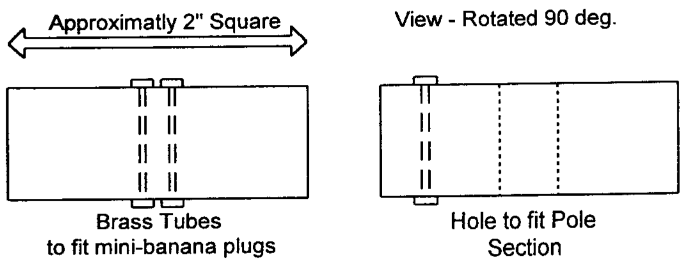
The immediate problem on 2 meters is the choice of feed-line. If we choose RG-174 we get low weight, and lots of loss. If we pick RG-58, we get tolerable loss but too much weight. While carrying 30 - 35 feet of RG-58 isn't necessarily a big problem, the weight hanging from the DK9SQ mast will be a problem. A very good solution would be to use a piece of 300 ohm twin-lead, carefully cut to be a multiple of a half-wavelength at 2 meters. This will provide a lightweight, low-loss solution. It does not matter what the feed-point impedance of the antenna is; the feed-line repeats it from load to source.

220 and up

Most QRPers would have traditionally asked "Why?" when we discuss these bands. But the FT-817 changed all that. We now have a super portable rig that has both 2 meters and 70 cm. This makes the 10-meter mast a real useful tool for portable VHF small signal work. All the same concepts that were discussed on 2 meters can also be used on these frequencies. When at Dayton the year the DK9SQ was introduced, the folks at the booth also had a neat dual band (2m/70cm) log periodic antenna that folded up into a very small, transportable package.

Special Fixtures for Experimentation

I mentioned earlier the special fixtures made from small wooden blocks that allow flexible experimentation. Below is a drawing of one.



1. Custom Blocks, cut from available wood (2x4 works nice)
2. Use Table saw to make square and appx. 3/4" thick
3. Drill center hole to sit on top of target section of 10M pole
4. Use small brass tubing to make jacks for mini-banana plugs
5. Drill holes to use as spreader in each side for 1/4" fiberglass rod.

Figure 8

Summary

You probably were not prepared to start at 160 meters and go all the way to 70 cm. Most of us have specific operating habits. We may prefer to operate 40 meter CW, 20 meter SSB, 10 meters, etc. We may not have much need for more than a few bands on any particular outing. But when you become aware of the possibilities, you realize that the 10 meter mast is much more than a support for a simple vertical. It can become a central component in a system that provides options for any operating need. Furthermore, with some thought and engineering, you can package a multi-band capable system in a package not significantly bigger than the mast alone. The key is to have reusable elements that can be configured for more than one use.

This has been a work-in-progress for me. It is far from over. It's easy to create antennas that use trees or towers to erect. I prefer to have solutions that do not sacrifice performance but allow light, portable options for the traveling operator. If you *can* take it with you, you are more apt to *actually* take it. That's when the fun really starts. In that vain, I have packed my FT-817 into a portable case that is always ready to go. When the whole station, mic/key to antenna can be grabbed on the fly and one knows everything is in there, you don't even have to think about it. You just do it.

There are a number of further developments that I continue to work on. One is to model the various designs to validate and document the actual patterns. To that end, I'm slowly learning EZNEC. As that work is completed, EZNEC models will be added to this paper. A second project is to develop a comprehensive table that lists all the lengths and values I have found in my experimentation. A final portion of the project is the most ambitious part. A good friend (AG5RS, Ron Sparks) has a farm to the West of Houston. There we have room to actually erect an HF antenna range designed to measure field strength at various heights to validate actual take-off angles. This will require RF sensors mounted on a tall tower. Don't expect these results in the near future.

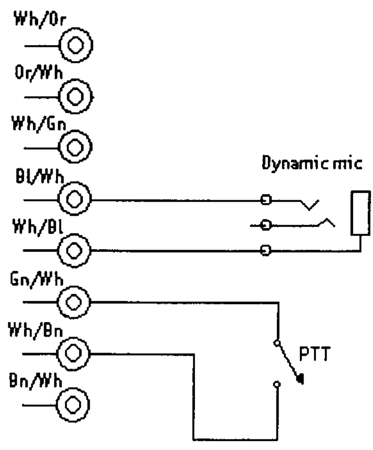
I am always interested in your ideas on this subject. I am certainly not the expert here. I am only sharing my ideas and thoughts. Let's hear yours.

Ed Manuel, N5EM, n5em@amsat.org

Interfacing an external headset to the FT817

by Graham F Firth G3MFJ/W3MFJ

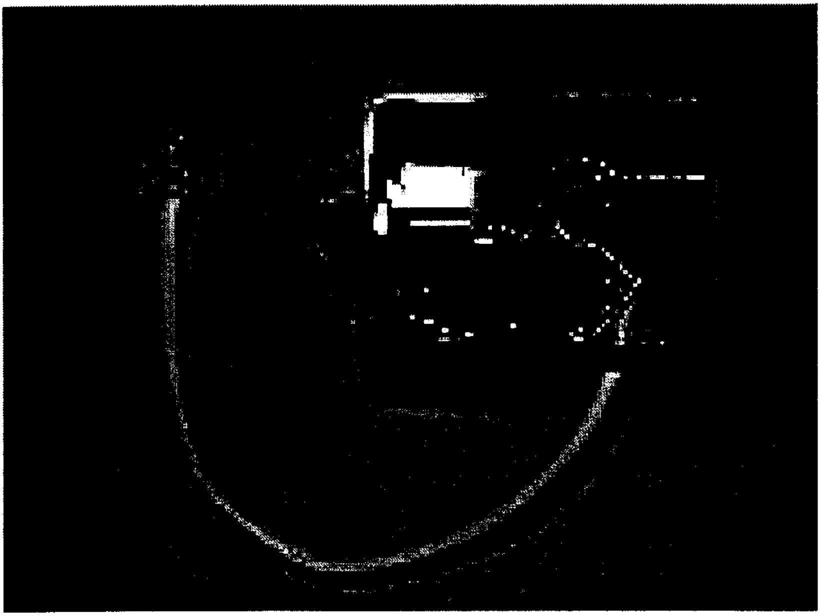
During a series of e-mail discussions with Jay (W5JAY), we discussed external microphones/headsets, and their connection to the FT817. He said that he had obtained a couple of combination headsets (with boom microphone) from Radio Shack & he sent me one.



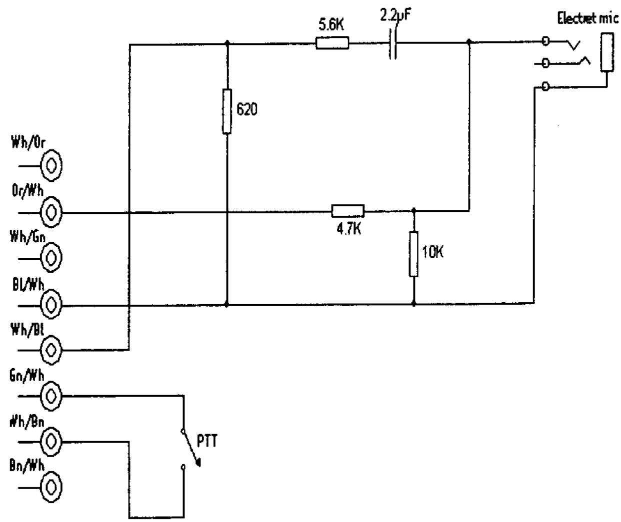
I looked at the possibilities of connecting this to my FT817. The FT817 has a stereo 1/8" (3.5mm) jack on the side for a headset and as the Radio Shack headset came with the appropriate plug, that solved half the problem.

However, the microphone socket is an RJ45 crimped type plug and I wondered how I would find a plug for this until

I realised that the 10base4 computer networking plugs were ideal. Tony (G4WIF) gave me a double-ended lead, so I had my plug - 2 in fact! The colours shown in the diagram are mine - yours may vary, but every one I have checked seems to be the same. Looking into the mike socket of the FT817, the brown/white connection is the bottom left.



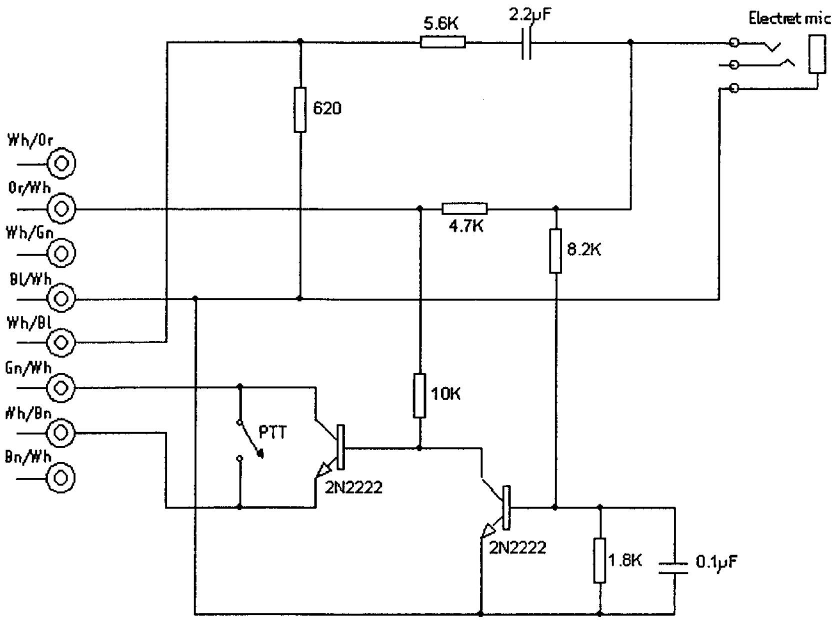
This first interface was built in a small box with a locking push button for PTT (press to talk), and the circuit is very simple



This got me thinking. I also had an electret microphone and I wondered if this would work with the FT817. Further studies revealed that the white/green lead had the main supply voltage on it (9.6 to 13.6 volts) which was available to provide the polarising voltage for this microphone (via the 4.7k resistor). The output of an electret capsule is higher than a dynamic microphone, so I needed a little attenuation. This is given by the 5.6k and the 620ohm resistors. The capacitor is to isolate the polarising voltage from the 817 microphone input.

Out came another small plastic box, and this became a practical proposition. Good job I had two RJ45 plugs and leads!

Flushed with success with this venture, I then wondered if the external speaker/mike for my little Icom handy would work with the 817. I took the Icom mike (MH75) apart to study its circuit & saw that the PTT button was in series with the electret capsule.

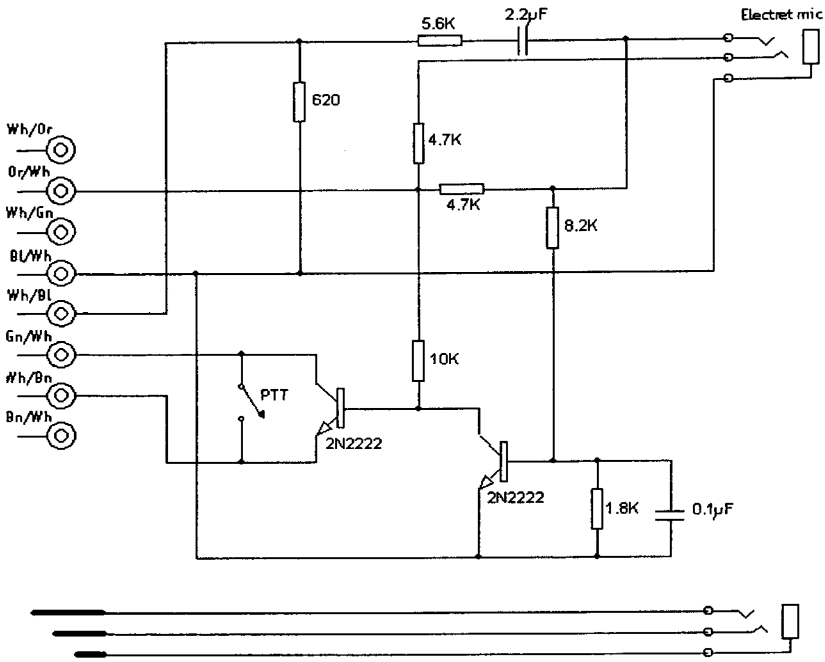


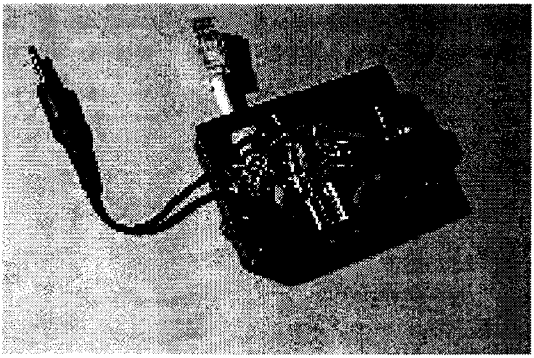
When I connected this to the circuit above, there was a voltage change at the junction of the 4.7k and the 10k resistors due to the load of the electret capsule. Ah, I thought, if I can detect that change, I could use it to switch a transistor on & thus put the 817 on to transmit. A few components later, I had this circuit.

I split the 10k resistor & put a 2N2222 base/ emitter junction across the lower part with a 10k collector load, and put a second 2N2222 to detect when this transistor was off, and then used this to energise the PTT. (The Wh/Bn and Bl/ Wh leads are both chassis/0v).

I actually used UK equivalents of the 2N2222 - a BC547, but any general purpose NPN will do.

Next, I thought what about the speaker part of the speaker/mike - that was easy. The MH75 has a moulded double mini-jack with the 3.5mm plug as the mike, and the 2.5mm plug as the speaker. There is also an LED in the speaker/mike - no real function - but it looks good!





So I duplicated the 817 headphone socket on my little interface box at the requisite distance (½") from the electret mike socket.

This gave me this final circuit. The 4.7k resistor to the ring of the mike socket will light the LED on the speaker/mike

Interfacing PSK31 to the FT817

By Graham F Firth G3MFJ/W3MFJ

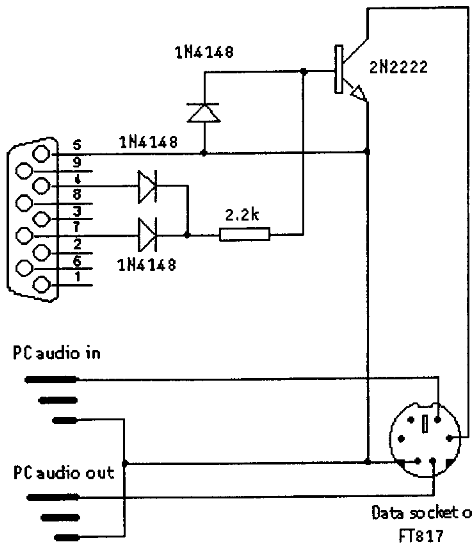
The FT817 is a very easy rig to use for PSK31. All you need, besides a suitable PC of course, is the appropriate plugs, a suitable transistor, and a few "junk box" components. The PC must have a sound card fitted of course, as this is the way the audio gets into and out of the PC.

Much of what I say here will apply to many other SSB transceivers, all that is required of them, is a suitable audio input (you can use the mike input if necessary), and an audio output (the phones socket will do).

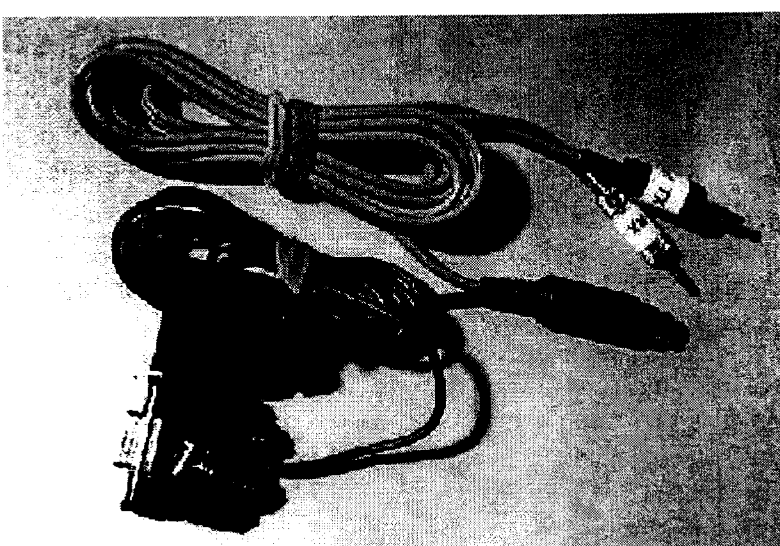
Here is the circuit diagram of the simplest version of the interface.

As you can see, there is nothing to it! I have shown a 2N2222, but any NPN transistor that is suitable to operate the TX/RX relay (350mA in the case of the FT817) will do. I used a BC547 which is a UK equivalent.

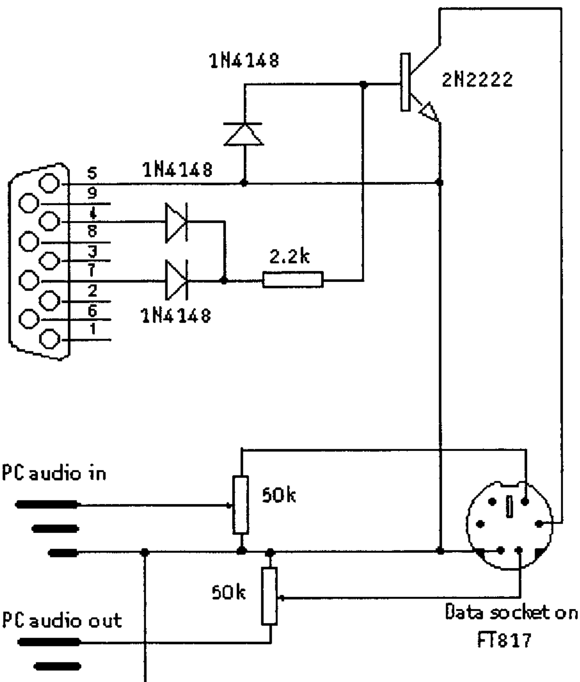
All PSK31 software that I have found will lift either the DTR (pin 4), or the RTS (pin 7), of the appropriate COM port of the PC to +ve on transmit. This will turn the transistor on, thus putting



the rig to transmit. I built the transistor circuit into a 9 pin D plug. The audio connections assume that the output level matches the input level both ways. In my case this is fine as my PC has a line level input as well as a microphone input. If you have to use



the microphone input of the PC, or the microphone input of the transceiver, then you will probably need some attenuation in one or both directions. Here is the above circuit with some variable attenuation in both directions.



Il used 50k presets because that is what I had to hand, but any value 5 to 50 k will do.

Now the software. There is lots of this available on the internet some of it freeware, some shareware, and some you have to buy. Here is a list of the software I found recently:

WinPSK223e
http://www.imiwebs.com/winpskse/

WinWarbler
http://www.qsl.net/winwarbler/download.htm
Psk31sbw
http://www.qsl.net/wm2u/psk31.html
W1SQLpsk
http://www.w1sql.com/download.htm
Zakanaka
http://www.qsl.net/kc4elo/
Digipan
http://members.home.com/hteller/digipan/
WinPSK21
http://www.qsl.net/ae4jy/

The above interface will work with all the above software, when it is loaded on your PC, you will need to customise it by inserting your own call, location & station. The only other thing will be to get the levels right. Firstly, I set the appropriate option by selecting PSK-U on menu 26. Secondly, I adjust the audio input so that the green noise is just showing (you'll see what I mean when you do it! Finally, I set the audio input volume to the transmitter whilst watching the ALC level and setting it to half-way. Very unscientific I know, but it works for me! That's it! Enjoy some PSK31

Gel-Cell Charger 700 mA Max - 2001 version

By Bill Hickox, K5BDZ
k5bdz@aol.com

[Originally printed in the Peanut Whistle, St. Louis QRP Society. Reprinted with permission]

The 2001 design version of the Gel-Cell Charger is first and foremost a "battery charger" for gel-cells and small lead acid type batteries. It is not recommended for any other battery types. This gel-cell charger includes monitoring for Heavy Charge-Current Limiting, Normal Charging and Float functions. Best of all, it uses easy to find junk box parts and is simple to build!

This circuit has some significant differences (and improvements) in concept and operation over my previous designs. It's more "user friendly" and "goof proof". All control functions are now in the positive line and the negative circuit throughout is at ground potential. This allows multiple connections, uses, etc. without damaging charger parts. The explanations will show how the individual circuits are applicable to other doo-dads too. I've built mine into a portable AC/DC power supply box. It will "automatically" cut over to Battery DC in the event AC is lost, yet will not allow the operating AC supply to connect to or harm the battery and charger.

A 73 Magazine charger article from several years ago had some of the same design aspects. Those recognizing the similarities will be correct. However, a comparison of the two circuits is both interesting and informative. I trust this design will prove to be the preferred circuit to all builders.

Theory of Operation:

The basic charger, without monitoring circuits, is a simple, regulated voltage power supply. AC voltage in should be at least 12 VAC (bringing 16.8 volts DC to the output of the bridge circuit rectifier) and no more than 16 VAC. Voltage control is determined by the 2 x 470 W resistors, VR1 (coarse adjustment) and VR2 (fine adjustment). Heat sinking of the 7805 is essential!

Charge Monitor Circuit:

This circuit is made up of D5, D6, 4.3W resistor, 150W resistor, Q1, Q4, Q5, yellow LED and Q3. As the charger current exceeds roughly 100 mA, the resistance of the 4.3W resistor is greater than the two series diodes D5 and D6, turning on these diodes. Q1 (PNP) is connected to turn on when the ~ 1.2 volt voltage drop via D5 and D6 happens. Q1 then turns on Q4. Q4 shorts to ground the two circuits fed by the 10K resistor, i.e. the Q2 Green LED (Float) as well as shorting VR2. Shorting VR2 lowers the ground resistance to the U1 regulator common pin, thus raising the charger voltage to overcome the ~ 1.2 volt drop through D5 and D6 and maintain the correct charge voltage.

Maximum Charge Current Circuit:

This circuit is made up of the two parallel 2.7 W resistors, VR3, Q6 and the red LED. When over-current or maximum current through the two 2.7 W resistors and VR3 is detected, Q6 completes the LED circuit, turning it on. The LED is connected to the circuit before D5 and D6 to provide the necessary 1.2 volt differential, minus Q6 voltage drop, equaling » .6 or .7 volts necessary to turn on the LED. VR3 is adjusted to turn on at the maximum charger current the builder requires, but not to exceed 800 mA output with the component values indicated here.

Float Monitor Circuit:

This simple circuit is Q2, Green LED and associated resistors. The circuit is turned on as long as the charger is providing voltage, except when turned off by Q1 during heavy charging periods in excess of approximately 100 mA. "Float" charging basically tells you that the proper voltage is present for the gel-cell battery to "use what it wants whenever it wants" to stay charged. D7 protects the overall circuit from improper reverse battery connections. D7 also keeps the battery from lighting the green LED from when the battery charger is turned off (prevents "false" indications).

Uninterruptable Power Supply connections:

Most "12 volt" power supplies deliver 13.8 volts. For typical amateur rigs, this voltage should not be exceeded. Assuming you have a supply delivering 13.8 volts, connect the supply to the output ports of the charger as shown.

If this is your connection preference, the charging voltage to the battery should be set to 13.6 volts. With the D8 causing a circuit voltage drop of .2 volts or less (depending on type diode used) the higher 13.8 volts from the main power supply will effectively "turn off", i.e. reverse bias D8 when in use. In the event of main power failure and the 13.8 volt supply is lost, D5 is immediately turned on connecting the battery with no loss of power to the rig. D8 must be a heavy-stud germanium, schottky barrier or similar diode type. Remember, D5 should exceed the current rating of your needs (1 Amp minimum!).

Charger adjustments and voltage settings:

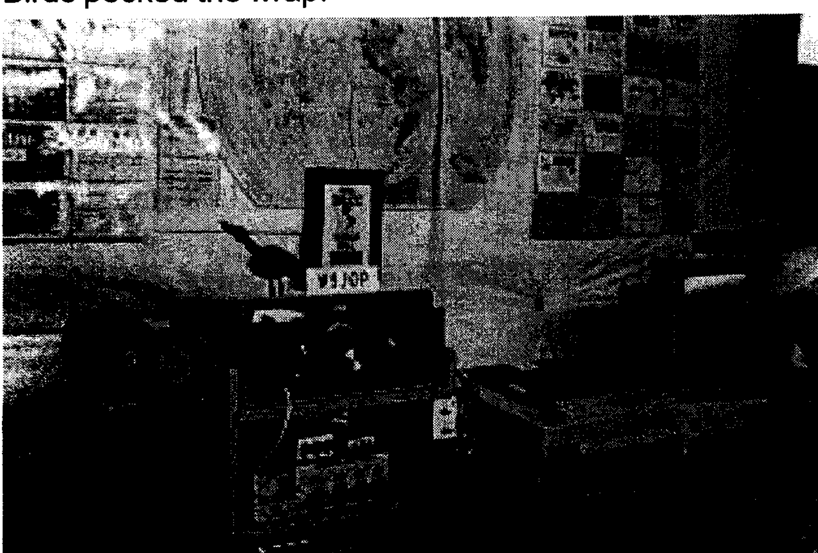
Refer to Schematic Drawing page. Please note when performing voltage checks beginning at U1 and continuing at various points to the battery output, allow for higher voltage at U1 output due to the resulting voltage drops caused by the in-series D5, D6, and D7 as the circuit flows to the battery.

Final comments:

For "battery charger only" usage, and with no power supply connections to the output, the maximum preferred battery charging voltage is 13.8 volts. D8 is still recommended for circuit protection, especially if the builder uses binding posts for "universal" power output battery connections. Hope you now understand each separate circuit and can use them in many of your future homebrew projects. Have fun with your building!! ***K5BDZ -30-***

QRPing with the TunaTin 2 and the SMK-1
by Robert Chapman, W9JOP/4

I was first licensed in 1954, while stationed in Scotland with the USAF, and of course unable to operate there, since no agreements. Finally became active in 1956, from California, running a Heathkit AT-1, VFO-1 and AC-1 coupler, vertical, made of beer cans. (scrounged from the dump). Big radiating surface!. (40 mtr CW). Had my share of ARC-5 equipment, which was plentiful , still being in the USAF. This equipment of course ran pretty low power, depending on what parts you could scrounge for the power supply. Had a young family at that time, and about $12-15 bucks weekly budgeted for food., thus the emphasis on scrounging. Built a 2EL 15mtr beam, made of bamboo poles wrapped in Reynolds wrap. Birds pecked the wrap.



Bob sitting at the operators position of his shack.

Time passed and we left the service. Power now up to 100 Watts. Played with DX, and RS-12 . Second attempt at the 2 EL, 15mtr beam from bamboo poles, covered with Reynolds FREEZER wrap, so no more bird problem.

Sold the station in 1995, saved one Receiver and moved to W9JOP/4. Cooped up in a small, home, no ant space. Did a stealth job and fastened a 15 mtr dipole to inside of wooden fence. SWL, SWL. Then read about the Tuna Tin 2. Gonna build that for a fun project, (not knowing what excitement lay ahead of me).

I still have the welts on my arms where the ole QRPp[Bug got me! My Tuna Tin went together just fine, and was looking good into a dummy load.

Time out , from thinking radio, (for 14 months, while Son and I built our new home). Yes, we put it right in the middle of a grove of antennas, oops, I mean trees.! Never saw so much dry-wall , wiring, plumbing, etc in my life . XYL, Joy , KA9TTB was my Big helper, through-out. Finally arrived at age 66.

Put a G5RV up at 50ft, with mother natures help. MFJ tuner to keep the TT2 happy. First year was spent crystal controlled on 7043 kcs. A keying ckt was incorporated into the Tuna Tin, giving my wrist a long needed vacation from an old J-38, (liberated from the USAF.)

Now after a year and 709 QSOs later it was time to QSY! In comes the SMK-1. Read about it, sent for, and built it. My, My, what small parts! First contact with SMK-1 came on Feb 28, with Larry, W8CCY, of MI. We're in hog heaven, having the capability of two freqs. Wanna QSY?, buy another rig! (The SMK-1, is a 40 mtr Xcvr, Surface Mount Kit, that WAS offered by NORCAL at that time. Their purpose, being to introduce the Ham community to the art of surface mount constrution .)) WILL HAVE TO SAY IT WAS AN INTERESTING BUILDING PROJECT! Let's prod NORCAL into something new!!

At present, our paper log shows 1352 QRPp contacts. Have worked/confirmed 48 States, as recognized by QRPARCI W.A.S., cert # 486, (48 States, all QRPp 250mw or less). Lack KL7 And KH6.

The SMK-1 has 48 States and 6 DX (Eur) stns to its credit. TT2, coming in at a close second, with 46 States and 3 DX Stns.

Just finished building another TT2, (from the schematic of the first), layed out to look like the schematic. Also incorporated the keying transistor 2N3906, to facilitate using the Tick Kyr. Seems to be doing alright, except for the Digital QRM so close to 14060 kcs.

This is my story, and I have been invited, by Doug, KI6DS, to share it with you. Just a reminder that THERE IS LIFE BELOW 1 watt! Want to thank all the Fellow Hams who did their best to pull me through. TKS FELLOWS.

We have no QRO rig in the house, just three QRPp rigs. However, I am cheating just a little bit! (Using a 51S1 for my hearing aid, with the TT2), and under hvy QRM, condx, with the SMK-1.

Am now hanging-out on 14060, trying to hold my own. Just reached 69 yrs, still ditting!

72 es TKS
Bob W9JOP/4 QRPp Stn pix on QRZ.COM

Wilderness Sierra SWR Indicator

By Kory Hamzeh, AC6RN

Circuit Description

Right off the bat, I need to say that this circuit was adapted from the article entitled ScQRPion Visual SWR Indicator by Dan Tayloe N7VE in the Spring 97 issue of QRPp. Instead of using the LED to indicate SWR, I removed the LED and added a diode detector and a voltage divider.

This schematic is a relative SWR indicator. I say "relative" here because it does not indicate the true SWR value, but can tell you how close you are to a perfect 50 ohms match. It is designed to work with the Wilderness KC2 Keyer/Wattmeter. If you do not have a KC2 installed in your Sierra, you can use the original circuit by N7VE.

LED D1 is totally optional. It is one of those self contained blinking LEDs that I plan to put on the front panel to let me know what the SWR bridge is "spliced" in. If you decide to use a standard LED, make sure you include a current limiting resistor!

R1, R2, and R3 and 50 ohm 2 watts carbon (non-inductive) resistors. Keep these resistors as close to 50 ohms as possible or the accuracy of the bridge may suffer.

T1 is a FT37-43 ferrite core. The primary is 12 turns and the secondary is 36 turns on #28 enamel wire.

Hookup and Installation

The "RF" port is the current location that the KC-2 taps for RF power. It is the output from the RF power detector on the main Sierra board.

The "RF Meter" port is pin 13 on the KC2.

The "Antenna" and "PA Out" ports need to be spliced in right before the antenna BNC connector. This requires that you cut a trace on the circuit board.

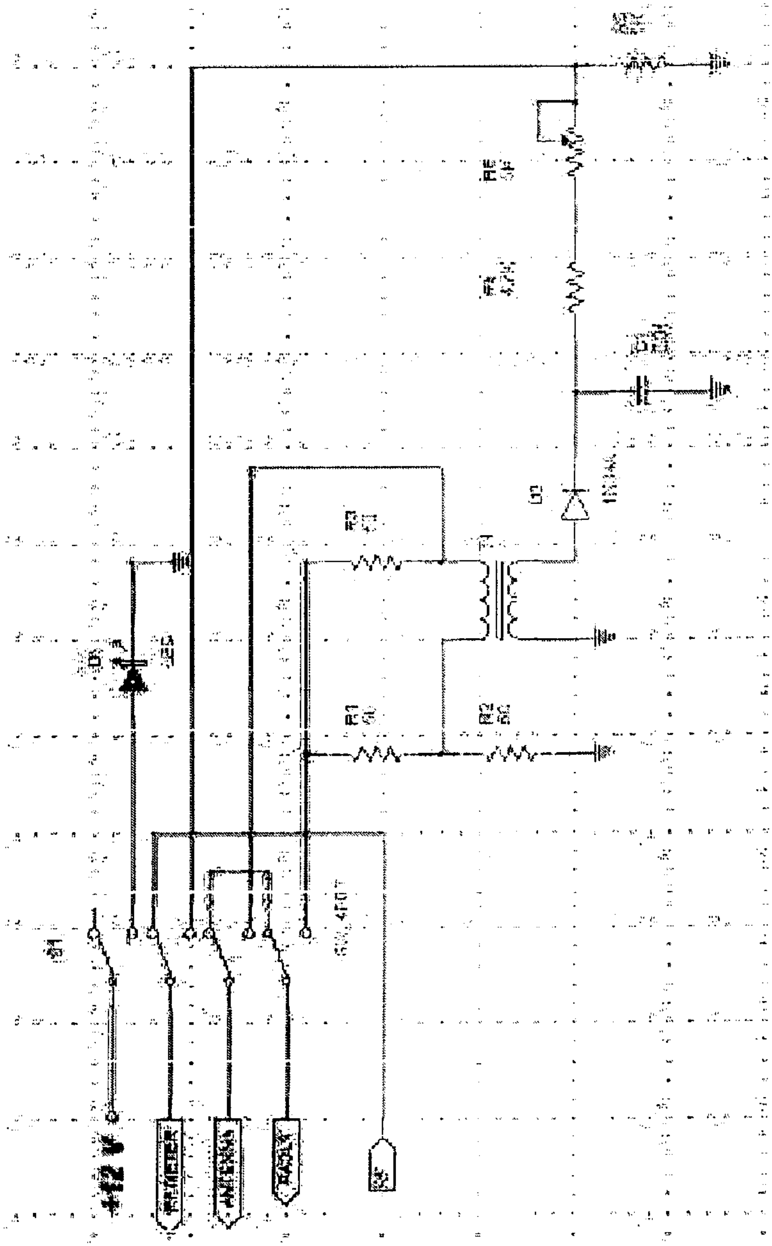
Install the circuit board as close to the antenna connector as possible. Use shielded coax cable such as RG-174 (must be 50 ohms).

Calibration

To calibrate this circuit, switch SW1 to the ON position, disconnect your antenna, and press "SPD +" and "SPD -" simultaneously. Now, adjust R5 to get a "9.8" reading on the KC2. Don't worry, this circuit will never let the SWR exceed 2:1, however, don't leave it in this state for to long either, the finals may over heat. Now, hook up a 50 dummy load, and it should read close to 0.0. If it's way off, then you did something wrong.

Normal Operation

When S1 is in the OFF position (as in the diagram above), this circuit is bypassed. Pressing "SPD +" and "SPD


+12 V
RECEIVER
ANTENNA
RADIO

-" on the KC2 will operate as before. With S1 on the ON position, the circuit will get spliced in. When "SPD +" and "SPD -" is pressed, the KC2 will display a relative number describing how close you are to a 50 ohm load. You want to adjust your tuner to get the lower reading. A value of 0.0 indicates a perfect 50 ohm match.

This circuit is an "SWR Absorbing" type bridge. The circuit will not allow the SWR to ever exceed 2:1 during tune up. This is very important for QRP rigs that do not have high SWR protection circuitry. The down side of this on this type of a circuit is that you can not operate with the bridge in line because of the 6 dB insertion loss. That's the reason I decide to include a blinking LED on the front panel to let me know that the bridge is inline.

Anyway, try it out and have fun. Let me know how things go! I can be reach at kory@avatar.com. Good luck de Kory AC6RN.

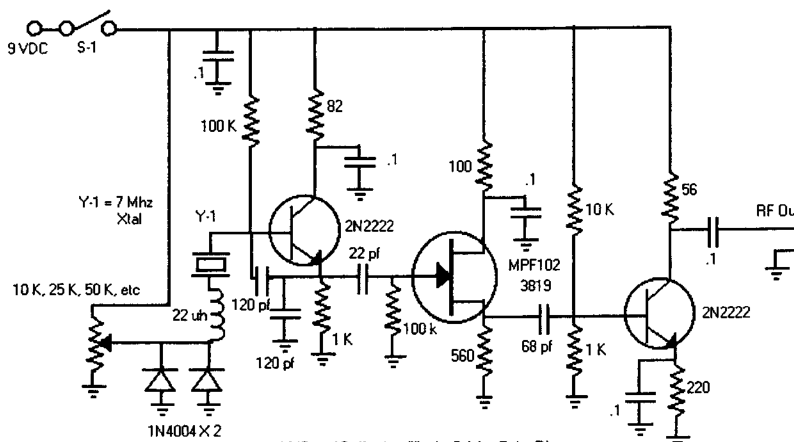
VXO and Buffer Amplifier, For driving Tube Rigs

By Wayne McFee, NB6M

The accompanying VXO and buffer circuit details should provide anyone who has a small parts bin with a very useful accessory which will allow the use of smaller, modern crystal types to control and provide drive for tube rigs.

I use this VXO and buffer to drive my old Heathkit DX-40, and it provides stable operation over about a 4.4 Khz segment of the 40 Meter band, from 7037.5 to 7041.9 Khz.

You could try paralleling the crystal with another one of the same frequency, and perhaps double the frequency swing. However, in tests I have made with parallel crystals in this circuit, the frequency jumps around at places in the tuning range, and I have elected to stay with the smaller tuning range of one crystal. You are welcome to experiment.



VXO and Buffer Amplifier for Driving Tube Rigs

by Wayne NB6M 2001

The complete circuit, including the 9 Volt battery used to power it, can be very easily built into an Altoids tin. Any of a number of transistor types could be substituted. For the bipolars, either 2N2222, 2N3904, 2N4401, or similar NPNs could be used. For the FET, MPF102, 2N3819, J310, 2N4416, or similar could be used. If you don't have the exact resistance or capacitance specified, try something close. For the bypass capacitors, anything from .01s to .33s would work fine.

This circuit may work just fine on other bands with no changes. If need be, the feedback capacitors in the oscillator circuit could be changed. If you try an 80 Meter crystal and the oscillator doesn't perform properly, doubling the capacitance to 240 or 270 pf would probably work. For higher bands, the capacitance could be scaled accordingly, by simply figuring the Xc of the 120 pfs on 40, and using a capacitance value that would give close to that same amount of reactance on the band of choice.

As the circuit is drawn, it is necessary to switch the circuit off, using S-1, during periods of reception, and then switch it back on before transmitting. A simple electronically switched keying circuit or offset circuit could be built in, if desired.

In order to spot the operating frequency in the receiver, within the tuning range of the oscillator, first tune the receiver to the clear frequency or the frequency of a station calling, switch the circuit on, tune the VXO, and then, if transmission is not planned immediately, turn the circuit off. If transmission is planned immediately, the circuit is left on, and then turned off to quiet the oscillator during receive.

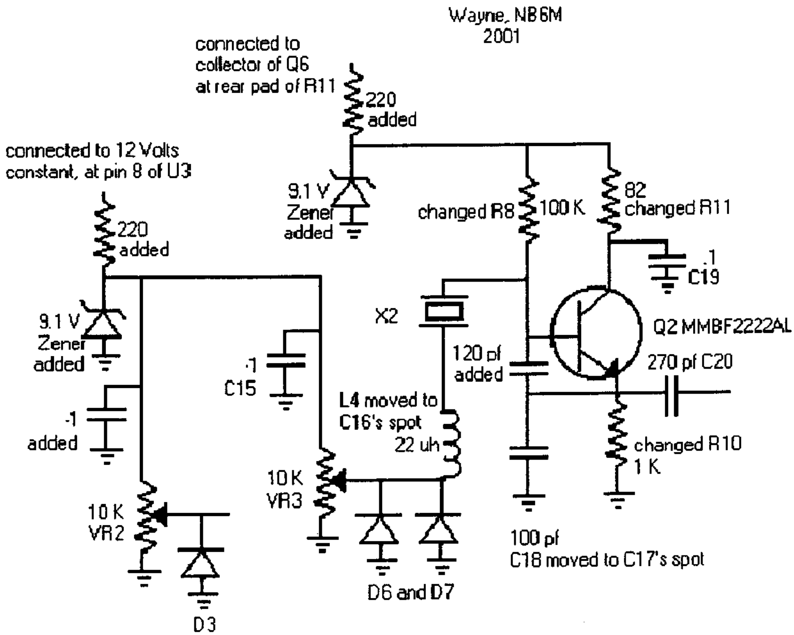
Enjoy. Wayne NB6M

Extend the SMK-1's TX tuning range, And clean up the TX note

By Wayne McFee, NB6M

Never having been satisfied with the very limited tuning range of the SMK-1's transmitter, and wanting to clean up the transmitted signal's keying note a bit at the same time, I decided to change the oscillator circuit in the transmitter to a different configuration which would allow the stock tuning elements to provide for about a 4.5 Khz tuning range, and provide for voltage regulation of the supply for the TX oscillator itself and both the TX and RX tuning pots.

This involved moving some of the existing parts in the oscillator circuit to other locations, cutting a few traces to accommodate the new configuration, and adding a few parts. The result, to me, is more than worth the effort involved. After modification, the tuning range of the transmitter, from zero



Modified SMK-1 Transmitter Oscillator for extended tuning range and better stability.

beat to zero beat, is from 7036.4 to 7041.0 Khz. And, as a bonus, the note is cleaner, throughout the tuning range. On the air contacts have reported no chirp.

Now, the tuning range of the transmitter equals and nearly matches the tuning range of the receiver, and makes the little rig that much more useful in terms of dodging QRM and finding a clear frequency for a CQ, or answering other calls.

Reducing the voltage applied to the receiver's tuning pot has not reduced its tuning range, and now the receiver's LO does not drop out of oscillation at the high end of the tuning range. As modified, the receiver's tuning range, from zero beat to zero beat, is from 7036.3 to 7040.9 Khz, only one tenth of a Khz different than the transmitter. In addition, since the receiver's LO frequency is more stable during keying of the transmitter, there is no false indication of instability in the transmitter.

Here is the schematic of the "Mod", including the changes to the TX oscillator circuit and the added voltage regulation both for the TX oscillator and the tuning pots for the receiver and transmitter.

Two, low-wattage soldering irons are a must for this project. Solder wick will also be needed, and thin solder with silver content is recommended. In order to modify the transmitter's oscillator circuit to this configuration, it is first necessary to remove the following parts:

R8
R9
R10
R11
C16
C17

Have a moistened cloth pad ready to wipe the removed part off of whichever soldering iron it sticks to. You may want to tape the parts to a sheet of paper, labeling them as you do so, as they may well be usable for another project.

Clean the pads for C16 and C17 with solder wick, move L4 to C16's spot and move C18 to C17's spot.

You will need the following new parts to add to the circuit:

2	9.1 Volt Zener diodes, added
2	220 Ohm, 1/4 w resistors, added
1	100 K Ohm, 1/4 w resistor, to replace R8
1	82 Ohm, 1/4 w resistor, to replace R11
1	1 K Ohm, 1/4 w resistor, to replace R10
1	120 pf NP0 capacitor, added
1	.1 uf bypass capacitor, added from top of VR2 to ground

In the following descriptions of solder pad locations, the three 10 K Ohm pots are the front of the board, the wire connections are the rear.

In order to accommodate the changed oscillator configuration, cut these traces:

The 12 volt trace between the printed copyright C and C15.

The 12 volt trace between where it branches off from the one just cut above and VR2. Cut this trace close to the nearest leg of VR2, so that the main trace is still good to VR3.

The trace between the rear pad for the removed R9 and X2, right at the R9 lettering.

The trace between X2 and C20, between the junction of the trace that goes to L4's pad and C20. We want the trace to still connect from X2 to L4's pad, but not to C20 or the collector of Q2.

Move C18 so that it connects between the rear pad for C18 and the left pad (closest to Q2) for C17. This is necessary because the output of the oscillator is now taken from the emitter instead of the collector.

Add the 120 pf NP0 cap between the base of Q2 and the left pad (closest to Q2) for R10. The base of Q2 is the contact of Q2 closest to X2, on the side of the transistor that has two contacts. This capacitor, along with the 100 pf cap that was moved from C18's spot to C17's old spot, provide the feedback necessary for Q2 to oscillate.

Solder the 1 K Ohm resistor in R10's location, with the leads cut as short as possible.

Solder a short piece of insulated hookup wire from the rear pad for R9 and the right pad for L4 (the L4 pad closest to the edge of the board). This connects X2 in series with the 22 uh choke that is now in C16's old spot.

Cut the anode leads for the Zener diodes, one lead for the .1 uf capacitor and one lead of each of the remaining resistors to about 3/16" length.

Solder the anode lead of one 9.1 volt Zener diode to the front pad for C19 (ground).

Solder the short lead of the 82 Ohm resistor to the front pad for R11.

Solder the short lead of one 220 Ohm resistor to the rear pad for R11.

Solder the short lead of the 100 K Ohm resistor to the front pad for R8.

Bring the loose leads of that Zener diode, the 220 Ohm resistor, the 82 Ohm resistor, and the 100 K Ohm resistor together, to form a junction as close to the bodies of the parts as is practical. Cut the free leads of all four parts so that there is just enough length for a good solder joint between the four. Solder the leads together.

In my rig, the four parts just described lean over towards U3, leaving a low profile of parts, but also leaving enough room between the soldered joint between the four parts and the circuit board so as to ensure that there are no shorts.

Solder a short piece of insulated hookup wire between the front pad for R11 (where the 82 Ohm resistor is attached), and the front pad for C20 (now unoccupied). This supplies operating voltage from the 82 Ohm resistor to the collector of Q2.

Solder the short lead of the .1 uf capacitor to the front pad of C15 (ground). The other lead, left long for the moment, is soldered, close to the capacitor's body, to the nearest leg of VR2, leaving the remainder of the long lead free.

Solder the short, anode lead of the remaining 9.1 Volt Zener diode to the front pad of C15 (ground). The cathode lead attaches to the junction of the nearest leg of VR2 and the .1 cap just attached there. Bend the free leg of the capacitor out at a 90 degree angle from the leg of VR2 and cut the cathode lead of the 9.1 Zener so that it just overlaps the lead of the capacitor. Trim the capacitor lead.

The short lead of the remaining 220 Ohm resistor connects to the junction of the cathode of the 9.1 Volt Zener diode and .1 cap just installed. Position the short lead of the 220 Ohm resistor at that junction and solder it in place.

Now, in order to supply 12 volts to the regulating circuit for the two tuning pots, the remaining lead of the 220 Ohm resistor must be connected to an "always on" 12 Volt source. In my rig, I ran it to pin 8 of U3 and soldered it there.

You will need to be sure the bare lead is not close enough to any other contact to short out, and cut it so that it is just long enough to form a good solder joint on top of pin 8 of U3.

If you do the same, just use a small amount of solder and check carefully for a solder bridge from pin 8 to pin 7 of U3 before applying power. If you are concerned about attaching the lead there, you can run it to any other 12 volt trace on the circuit board, or even to the power jack's center connector, if you like.

Solder a short piece of insulated hookup wire between the rear pad of C15 and the junction of the cathode of the 9.1 volt Zener, .1 uf capacitor, and 220 Ohm resistor at the near leg of VR2. This supplies 9 Volts regulated to the transmitter's tuning pot.

That completes the mod. Check your connections, again, especially checking between pins 8 and 7 of U3 for any solder bridges.

In my modified 40 Meter SMK-1, it was necessary to solder a short piece of cut off resistor lead across R14 in the PA circuit, so as to increase the output slightly, as the lower voltage output of the oscillator in this configuration meant that the output from the PA was below the threshold of drive necessary for the IRF510 in the 5 Watt Mod I had added. Bypassing R14 increased the available drive from 3.3 Volts RMS to 4.5 Volts RMS on the gate of the Mosfet, which was sufficient to produce 5 Watts of output.

You may need to bypass R14 as well, if you do this VXO Mod, so that your power output level will be what it was with the higher drive of the original oscillator configuration. I would suggest starting with a 2.2 Ohm or slightly higher value resistor in place of R14, so as to help ensure that there are no overheating problems with Q3.

Although this mod sounds a little complicated when it is described on paper, it took far less time to actually do the mod that it did to write it up. I completed the mod from start to finish in about an hour and a half, even with having to remove the 5 Watt Mod parts to get to the board itself, and then replace them after the mod was done. The results are well worth the effort.

In addition, this oscillator configuration can be used in any of the Tuna Tin II type transmitter circuits, with similar results.

I would welcome any input as to improvements on this "Mod" or any of the others I have developed, as I am sure everyone else who enjoys either the SMK-1 or any Tuna Tin II based transmitter would as well. Please share your results and/or suggestions on QRP-L and to myself via email.

Enjoy. Wayne NB6M

A Short Guide to Harmonic Filters for QRP Transmitter Output.

A Complete Do-It-Yourself Kit .... with just a few simple calculations

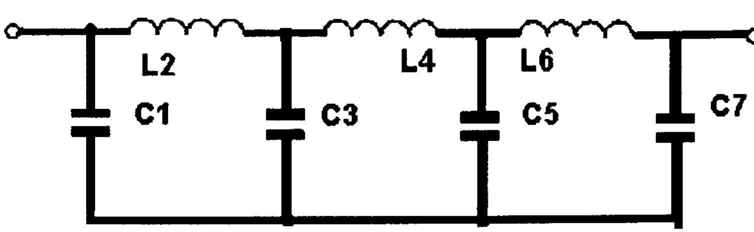
Rev. George Dobbs G3RJV

Although by their very nature, QRP transmitters radiate less power, the output from such a transmitter does require adequate filtering. Usually to keep the circuit compact, these transmitters have a final stage run in Class C and being driven hard with RF power. Of itself, this is a recipe for high harmonic output and a well designed low pass filter is essential. For many years I have used low pass filters calculated from a series of figures produced by Ed Wetherhold, W3NQN, (*a G QRP Club member*) and published in two articles in the UK Short Wave Magazine in December 1983 and January 1984.

Ed Wetherhold has been the ARRL adviser on passive filters for several years and published many fine articles on audio and radio frequency passive filtering. I believe that the two articles in Short Wave Magazine still represent the best source of information for the design of good low pass filters for RF amplifiers.

The articles are comprehensive but here I just want to share enough of the information to enable readers to build useful filters to add to their home made transmitters. There is very little mathematics - about 4 pushes of a calculator is the most required to produce information for a buildable filter. I will also give a chart for "off the shelf" low pass filters, which can handle up to 10 watts or RF power, suitable for every HF amateur band.

The W3NQN designs are based upon a seven elements: four capacitors and three inductors. They are designed for 50 ohms input and output impedance and use standard capacitor values. This is very useful because many calculations and computer programs for filter design give very odd values of capacitance which have to be made up from series and parallel values. Figure 1 shows a Seven Element Low Pass Filter. Now lets look at some numbers.



Recommended Values

Table 1 is a very short extract from a large list of filter parameters in the original W3NQN articles. I have taken the practical values for the nine HF amateur bands which have given me the best results over the years. Alongside each band are values for the seven elements in the filters with values on pF for capacitors and uH for inductors. The characteristics of each filter are described in terms of the ripple cut-off frequency (F-co) and the frequencies of the 3dB (F - 3dB) and 30dB (F - 30dB) attenuation levels. The capacitors are all easy values. I generally use polystyrene capacitors for my filter building.

W3NQN 7 ELEMENT STANDARD VALUE CAPACITOR LOW PASS FILTERS

TABLE 1 : Recommended Values

Band	F-co	F - 3dB	F-30dB	C1,7	C3,5	L2,6	L4
MHz	MHz	MHz	MHz	pF	pF	uH	uH
1.8	2.16	2.76	4.0	820	2200	4.442	5.608
3.5	4.125	5.11	7.3	470	1200	2.434	3.012
7.0	7.36	9.04	12.9	270	680	1.380	1.698
10.1	10.37	11.62	15.8	270	560	1.090	1.257
14.0	14.40	16.41	22.5	180	390	.773	.904
18.068	18.93	22.89	32.3	110	270	.548	.668
21.0	21.55	27.62	39.9	82	220	.444	.561
24.98	25.24	28.94	39.8	100	220	.438	.515
28 - 30	31.66	40.52	58.5	56	150	.303	.382

The Inductors

The inductors are all wound on toroidal cores in the popular Micrometals range. Translating the inductance value to practical inductors is very simple. The formula is given to calculate the number of turns. It does require knowledge of the inductance at 10 turns for the required core. These values are given in Table 2. Again I have reduced the W3NQN information to the 2 mix and 6 mix toroids, the ones that are of most use for this application. The formula is easily executed with a pocket calculator and the resultant figure is rounded to the nearest complete number of turns. The wire gauge is not critical. Simply use the gauge that will fit well on the core. The target is to wind an even coil on the core to occupy about three-quarters of the available space. If the opposite ends of the winding are too close this will introduce extra capacitance.

Table 2: INDUCTANCE AT 10 TURNS FOR MICROMETALS TOROIDS

Core Color		**Inductance (uH) at 10 Turns**					
Mix				Core Size & Prefix			
		T37	T44	T50	T68	T80	Range MHz
- 2	Red	.40	.52	.49	.57	.55	1 - 7
-6	Yellow	.30	.42	.40	.47	.45	7 +

Power Levels

Table 3 shows the smallest core that may be used for particular RF power levels. It is interesting because for transmitters of 10 watts or less, T37 cores are suitable, making

Table 3: SMALLEST USABLE TOROIDAL CORE FOR OUTPUT POWERS

		Power Level Range (Watts RMS)				
Core	Color	<10	10-25	25-50	50-100	100-200
- 2	Red	T37	T44	T68	T68	T80
-6	Yellow	T37	T37	T37	T44	T50

the filters very compact. Also notice that larger cores are required for the lower frequency bands. This again is an extract from the W3NQN data which used a very conservative maximum AC flux density to determine the minimum core size. So use this table to choose a core suitable for the required power handling of the filter.

Practical Examples

Table 4 gives practical designs for a series of low pass filters over the 9 HF amateur bands for transmitters of 10 watts power output and less. The constructor simply has to read off the values and make up the filters. All of these are filters that I have used to good effect in the past. Should you require filters for use with higher powers, take the information from the tables to choose a suitable core and

TABLE 4 : Practical Examples for Transmitters Under 10 watts RF Output

Band	C1,7	C3,5	L2,6	L4	Core	Wire
MHz	pF	pF	turns	turns	type	Gauge
1.8	820	2200	30	34	T50-2	30
3.5	470	1200	25	27	T37-2	28
7.0	270	680	19	21	T37-6	26
10.1	270	560	19	20	T37-6	26
14.0	180	390	16	17	T37-6	24
18.068	110	270	13	15	T37-6	24
21.0	82	220	12	14	T37-6	24
24.98	100	220	12	13	T37-6	22
28 - 30	56	150	10	11	T37-6	22

work out the appropriate number of turns for that core. A complete Do-It-Yourself filter design kit !

I keep a range of low pass filters in the shack, each one mounted in a small tin, for testing purposes. So when playing with transmitter circuits, I have a low pass filter I can put into use for testing the output. The more frugal constructor could use such a set of filters for several transmitters and not build filters into each of them.

Homebrew a 4 - 1 Balun

by Mike Martell, N1HXN

Many modern HF transceivers come fully equipped with built in tuners. While these tuners are great for changing bands, the manufacturers left out a very important accessory; the 4 to 1 balun. With out a balun the transceiver can only feed an antenna which uses coaxial cable. While this may be satisfactory for some operators, this is a real problem for those of us who prefer the super low loss ladder line. The only other alternative is to buy an external tuner with a built-in balun which is really absurd after spending the additional money to have one built into the radio. Fortunately, a 4 to 1 balun can be easily home brewed as illustrated in Figures 1 and 2.

Figure 1 shows a bifilar winding on a toroid. The toroid should be type 2 (red) material and can be any of the following sizes but the number of bifilar turns should be adjusted accordingly:

TOROID	NUMBER OF TURNS	POWER RATING
T80-2	25	60 Watts
T106-2	16	100 Watts
T130-2	18	150 Watts
T157-2	16	250 Watts
T200-2	17	400 Watts
T200A-2	13	400 Watts
T400-2	14	1000 Watts

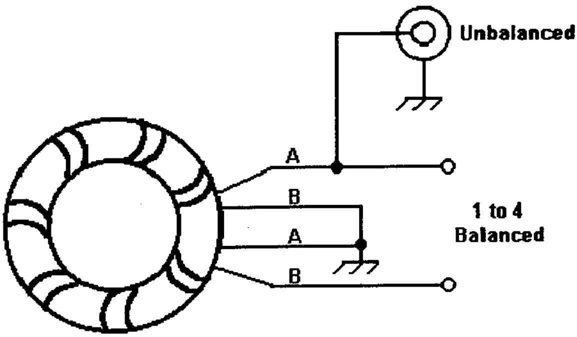


Figure 1

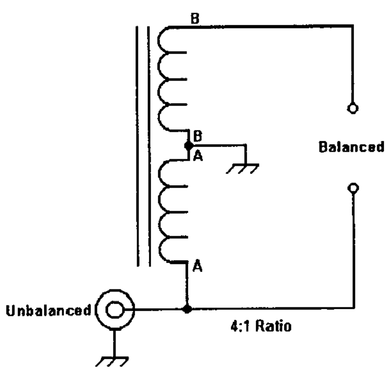


Figure 2

The exact number of turns is not critical but the numbers listed in the preceding table should yield optimum results. It is possible to exceed the power ratings listed above but the performance of the balun may be degraded during high SWR causing heating of the core.

Toroids of this type are available from Palomar Engineers, P.O. Box 462222, Escondido, CA 92046 (1-800-883-7020).

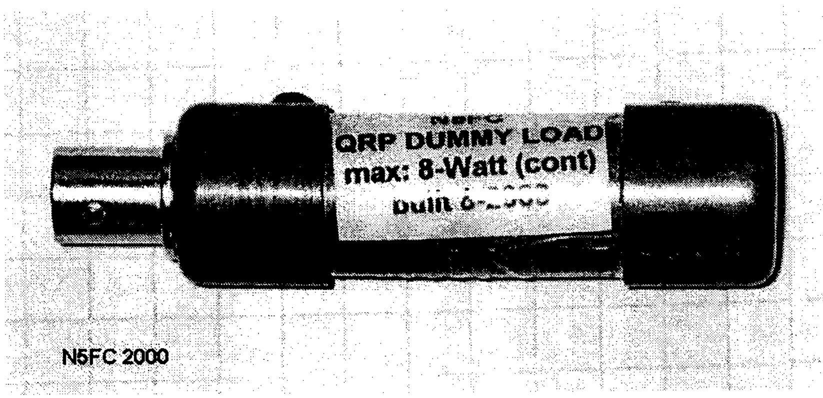
The balun should be housed in a suitable metal enclosure such as those available at Radio Shack. Use a SO239 or BNC connector for the unbalanced input. Nylon binding posts such as RS 274-662 work just fine for the balanced output.

DE N1HFX

Five Watt Dummy Load

by Monty Northrup, N5FC

This is another variation on the "parallel resistor" dummy load. This is one I built during my infatuation with copper pipe. It's perfect for QRP HF operation of 5-watts or less average power, and should be adequate for continuous operation at



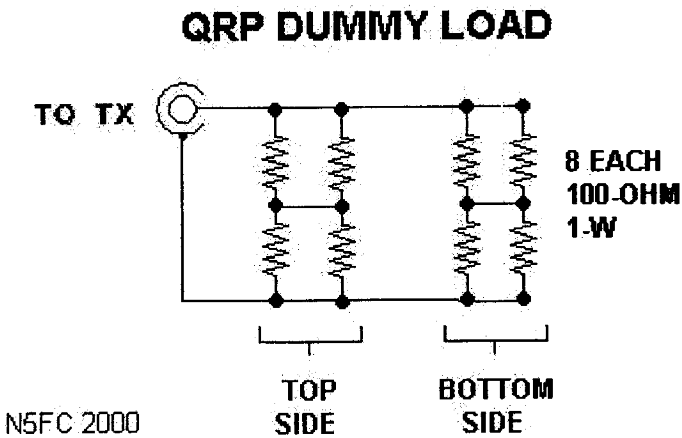
that level. It's light and compact, about 2-1/2" in length overall.

WARNING!

Dummy loads dissipate energy by generating heat. Heat generated in a small space translates to temperature rise, and temperatures can be hot enough (under the right circumstances) to burn people and ignite adjacent materials. Because of the thermal mass of the dummy load and its enclosure, that heat can stay around for a long time. Always locate your dummy load in a safe place, where there is no chance that it will burn people or catch something on fire.

The 1/2" copper pipe provides a convenient, compact form factor, is an excellent shield, and helps to dissipate heat to the outside world. Copper end-caps, available at most any hardware or plumbing supplier, provide a means of mounting the UG-1094 BNC jack and closing the unit.

This version uses 8 each 100-ohm 1-watt 5% metal-

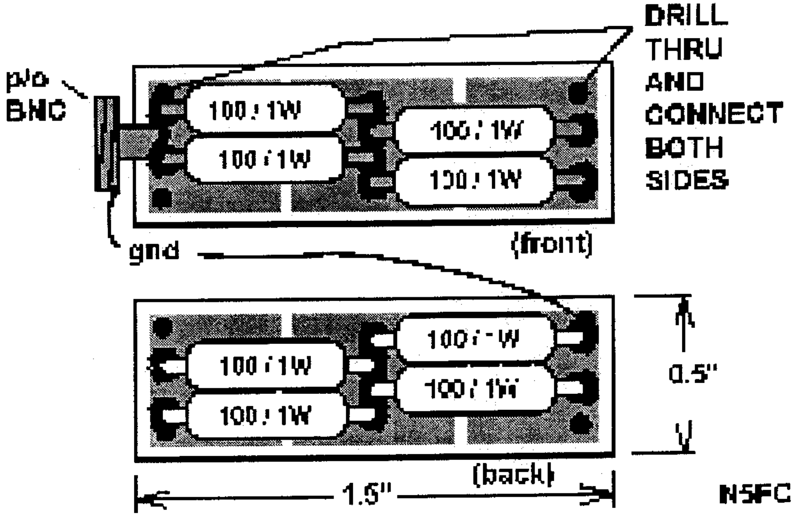


oxide resistors. Available from Radio Shack for a mere 25-cents each (RS 271-152), you'll invest all of $2 for the parts. The resistors are good through the HF range, but don't do particularly well at VHF. Here's a schematic:

We'll fabricate a printed-circuit board from scrap double-sided copper board, cut to 1/2 x 1-1/2-inches, and grooved to form 3 pads on each side. On the top side, we'll mount 4 of the 8 resistors, and on the bottom side we mount the remainder. Simply tack-solder the resistors to the board. At the pads on the ends, we drill a small hole through the board, and solder a wire in place top-to-bottom. On the top side, we end up with a 100-ohm, 4-watt equivalent resistor (a pair of parallel 100 ohm resistors makes 50 ohms, and two pairs in series make 100-ohms). When we join the top and bottom in parallel, our equivalent resistance is 50-ohms (two 100-ohm quads in parallel).

Here's a sketch of the pc-board layout:

Mount the UG-1094 BNC Jack in one of the copper end-caps. Then, connect the pc board assembly directly to the center post of the BNC connector, soldering same. Connect the far end of the board to the BNC ground post, via a short



piece of bare wire. Wrap the entire pc board assembly liberally with plumber's teflon tape (available for a buck in the plumbing section of any hardware store). Then run the bare wire outside the teflon tape. DO NOT use other types of tape (they *will* melt!). Next, we slide a short piece of 1/2-inch copper tubing over the assembly, slipping it into the BNC/end-cap. At this point, an ohmmeter should verify 50-ohms. Finally, mount the other end-cap to close and shield the unit. Drill and tap a screw into both end caps to connect the shield both electrically and mechanically.

When supplied RF power for an extended time, this dummy load can get quite warm, even with just 5 watts. Be aware, and plan for it. (Read the "WARNING!" above). My version has an SWR of 1:1 throughout the HF range (DC to

30 MHz). Another variation of this, that includes an rf detector for measuring power is in the following article
73, Monty N5FC

QRP Dummy Load With Built-in RF Detector

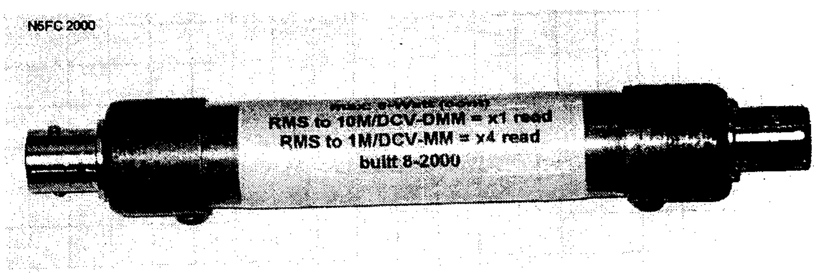
By Monty Northrup, N5FC

This is yet another variation on the "parallel resistor" dummy load. This is another one I built during my infatuation with copper pipe. It's suitable for QRP HF operation of 5-watts or less average power, and should be adequate for continuous operation at that level. It's light and compact, about 5-inches in length overall. This one is unique in that it has a built-in RF detector, with scaling, that may be used with your DC Voltmeter to measure power.

WARNING!!!!

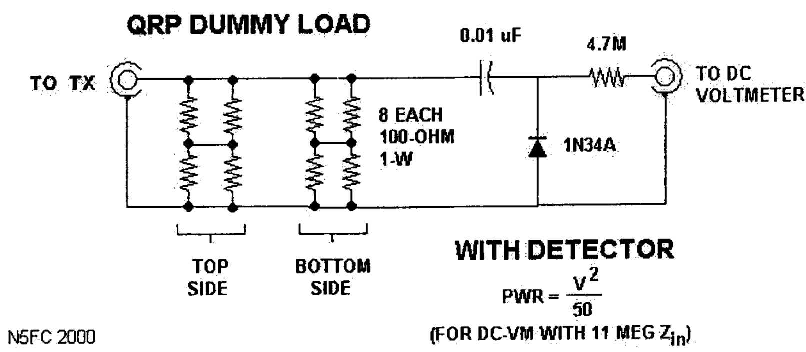
Dummy loads dissipate energy by generating heat. Heat generated in a small space translates to temperature rise, and temperatures can be hot enough (under the right circumstances) to burn people and ignite adjacent materials. Because of the thermal mass of the dummy load and its enclosure, that heat can stay around for a long time. Always locate your dummy load in a safe place, where there is no chance that it will burn people or catch something on fire.

The 1/2" copper pipe provides a convenient, compact

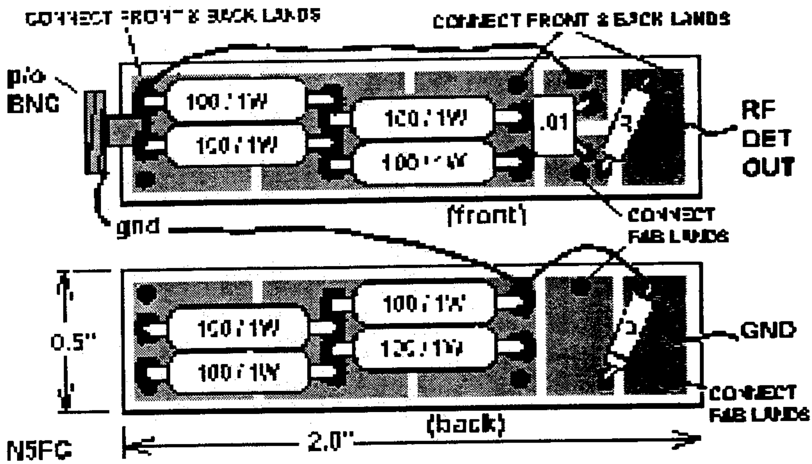


form factor, is an excellent shield, and helps to dissipate heat to the outside world. Copper end-caps, available at most any hardware or plumbing supplier, provide a means of mounting the two UG-1094 BNC jacks and closing the unit.

This version uses 8 each 100-ohm 1-watt 5% metal-oxide resistors, available from Radio Shack for a mere 25-cents each (RS 271-152). All the detector parts (yes, all three of them, a 0.01 capacitor, a 4.7-Meg resistor, and a 1N34A diode) are also available at Radio Shack. You would be hard-pressed to spend much more than $5-6 dollars on this project. The resistors are good through the HF range, but don't do particularly well at VHF. Here's a schematic:



We'll fabricate a printed-circuit board from scrap double-sided copper board, cut to 1/2 x 2-inches, and grooved to form pads on each side, as shown in the layout below. On the top side, we'll mount 4 of the 8 resistors, and on the bottom side we mount the remainder. Simply tack-solder the resistors to the board. Where required to connect the resistors, we drill a small hole through the board, and solder a wire in place top-to-bottom. On the top side, we end up with a 100-ohm, 4-watt equivalent resistor (a pair of parallel 100 ohm resistors makes 50 ohms, and two pairs in series make 100-ohms). When we join the top and bottom in parallel, our equivalent resistance is 50-ohms (two 100-ohm quads in parallel

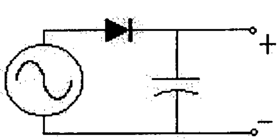


Mount a UG-1094 BNC Jack in each of the two copper end-caps. Then, connect the pc board assembly directly to the center post of the BNC connector, soldering same. Make all other interconnections with teflon-insulated wire. DON'T SUBSTITUTE OTHER INSULATIONS! Sorry, I know teflon wire is tough to find, but other insulation types will almost certainly fail when the resistors get hot. Wrap the entire pc-board assembly in teflon tape (often called plumber's tape, available at any hardware store. DO NOT use other types of tape (they *will* melt!). Next, we slide a short piece of 1/2-inch copper tubing over the assembly, slipping it into the BNC/end-cap. At this point, an ohmmeter should verify 50-ohms. Finally, solder the detector output wires to the second BNC, and mount the other end-cap to close and shield the unit. Drill and tap a screw into both end caps to connect the shield both electrically and mechanically.

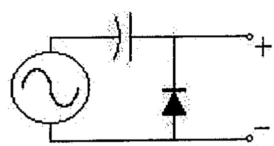
When supplied RF power for an extended time, this dummy load can get quite warm, even with just 5 watts. Be aware, and plan for it. (Read the "WARNING!" above). My version has an SWR of 1:1 throughout the HF range (DC to 30 MHz). Measuring power is easy, and accurate if the detector's resistor is sized to work with your DC Voltmeter's input impedance. Read the DC Voltage, square it, and divide by 50. Example: we read 10 Volts, which is 10 * 10 / 50 = 2 watts.

What's an RF probe, and how does it work?

You might think of an RF probe as a special test lead that converts your regular old' DC voltmeter to a RF reading voltmeter. Why not just read it using your trusty voltmeter, set on AC? Well, because most voltmeters wont read AC signals having a frequency above 10 or 100 kHz, and RF is way above that. [You can buy special RF-reading voltmeters, but they're very expensive... a homebrew RF probe is dirt-cheap]. Let's examine how an RF Probe works.



Classic Peak Rectifier



Simplified RF Probe

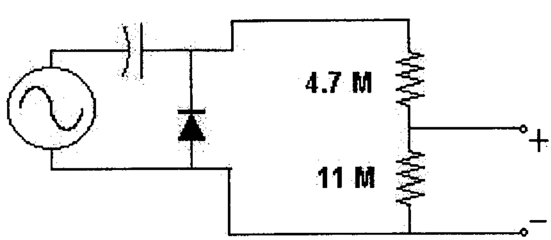
Above left, we see the schematic of a classic half-wave peak rectifier, commonly seen in power supplies. It's purpose is to take an AC signal at the input (usually from a transformer or the AC line), rectify it, and charge a capacitor. If you don't take a lot of power from the circuit (i.e., if your load doesn't draw a lot of current), the capacitor charges up to the peak voltage of the AC signal, and stays pretty much constant. Notice the simplicity of the circuit: not counting the load, we see it is an AC Source, a diode, and a capacitor in series.

Above right, we see a simplified schematic of the RF Probe. At first glance, it looks quite different from the circuit at the left. But notice: just like the first, it consists of an AC Source, a diode, and a capacitor in series. It's purpose is to take an AC signal at the input (usually from a circuit under test), rectify it, and charge a capacitor. And just like the first circuit, If you don't take a lot of power from the circuit (i.e., if your load doesn't draw a lot of current), the capacitor charges up to the peak voltage of the AC signal, and stays pretty much constant.

What's the difference between these two circuits, then? One small little thing, really. In the first circuit (the half-wave peak rectifier), any *positive* DC component gets added to the voltage at the output. In the second circuit (the RF Probe), the circuit is insensitive to *positive* DC components. This is good for an RF probe, because we're going to be testing circuits with DC biases applied, and we don't want those biases to affect our readings (we're interested in the AC only, i.e., the RF)

In both these circuits, if we place a DC (not AC) voltmeter at the place where it says "+" and "-" we'll read a DC voltage that is approximately equal to the *peak* of the applied AC voltage. If we knew our applied AC was a sinusoidal signal (or sine wave), then we could divide our reading by 1.414 to obtain the RMS value, which is the way we usually measure AC voltages. Even if it's not a sinusoid, at least we know what the peak voltage is, and that's something we didn't know before we started.

We'll do one more little trick to make the RF Probe more useful, and it will only cost us the addition of a 2-cent resistor. So that we don't have to manually divide our readings by 1.414, we'll use a resistor to create a voltage divider that will do it for us. Here's a classic voltage divider, added to our RF Probe circuit:



As we know from elemental electronic theory, the voltage across the second resistor (where it says "+" and "-") is equal to the applied voltage multiplied times the ratio of the second resistance divided by the total resistance in series. In our case, for a sinusoidal input, we know the applied DC voltage is equal to the PEAK of the AC voltage. We would like the resistor divider to divide by 1.414, which means that the total resistance in series (including the second resistor) needs to be equal to 1.414 times the second resistance. In our example circuit, shown above, the second resistor is 11 Megohms, and the total series resistance is 11 Megohms PLUS 4.7 megohms, or 15.7 Megohms. Is this ratio 1.414? Pretty close, about 1.427, closer than the typical resistor tolerances.

But wait! I said we would add one resistor, not two! What's up with that? Well, the 11 Megohms is the typical input resistance of a high-impedance voltmeter, like an electronic VTVM or a digital voltmeter. As long as it's 10-11 Megohms, it'll give results close enough for government work (HI). Obviously, it's important to know what your voltmeter's input resistance is, and you can find this out in your voltmeter's specifications, or measure it (I wont get into that). And really, accuracy is often not that important, especially when you're signal-tracing.

73, Monty N5FC

QRP Operating

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Your QRP Accent, And What to Do About It

A few weeks after receiving my Novice license in 1965, an envelope arrived in the mailbox containing a small, quarter-folded pamphlet headlined: ***Your Novice Accent, And What to Do About It.***

Written by Keith S. Williams, W6DTY, it was a reprint of an article that first appeared in the November 1956 edition of QST magazine. I suspect that at the time, all newly licensed Novices around New England were sent a copy.

'DTY expressed concern about "a new accent, a new dialect" that was beginning to be heard in the Novice portion of 80- and 40-meter CW. After all, we tenderfoot CW ops were confined to a fairly narrow frequency window, crystal controlled with, for the most part, only each other to talk to. It's only natural, Williams surmised, that "people speak a language with the same accent as those with whom they live and work. New hams pick up habits and operating procedures of the gang they chew the fat with."

"Your Novice Accent" was an antidote to poor CW operating practices 'DTY was hearing. A primer on avoiding the pitfalls and bad habits befalling all too many Novices at the time.

While that original quarter-folded pamphlet was lost in the shuffle of life in the shack of WN1DWL back in '60s, I managed to run across another printed copy of the article some years later and occasionally re-read it. It's a refresher of the back-to-basics practices and procedures that can make a good CW operator even better.

If you'd like to see 'DTY's original article for yourself, visit this Internet address: http://www.qsl.net/ae9k/novaccnt.html

With the passion I have for low power operation, I've been regularly hanging around the CW QRP frequencies for nearly 40 years. And for many of those years I've been thinking about the concerns expressed by 'DTY in "Your Novice Accent." Do you suppose we low power enthusiasts run the same risk? "Your QRP Accent?"

There seem to be some operating procedures that are - for better or worse - somewhat habitual in the common CW QRP neighborhoods.

The Great 'CQ' Debate

To "CQ" or not to "CQ" - that's the question. Heaven knows where the notion might have germinated, but many years ago someone atop the mount sent forth the dictum that if you're running 5-watts or less, it's fruitless to call "CQ." Not just fruitless, but wrong.

Perhaps the theory was that the other guy looking for a CW contact shops around for the strongest signal on the band. So anything less than 599 is out of the running.

How silly. I've got a pile of logbooks full of contacts stemming from "CQ de KI6SN."

Put yourself in the place of "the other guy." There's an S-9 "CQ" pounding into your receiver but you can hardly copy a callsign. His fist is so poor you've got to figure out if he's sending an "E" and an "M" or that his dit and dah spacing is so bad, he's really just sending the letter "W." A few kilohertz down the band is an S-7 station sending "CQ" and his callsign in perfectly formed CW. Which fellow are you more likely to choose to chat with?

Making the QSO experience as pleasant as possible for the receiving station is absolutely key. Easy-to-read CW at any signal strength is certainly a big plus.

"CQ?" By all means. It's a great way to make QRP contacts. You'll know pretty quickly whether band conditions favor your strategy or not. But don't listen to those who say for QRPers, sending "CQ" under any circumstance is a mistake. Take it from a near 40 year QRP veteran: They're full of baloney.

Signing " / QRP"

Justified or not, some QRO operators look upon another station's pronouncement that it is at low power as an indictment of any power above 5-watts: "If you're being heard at QRP levels, I must be a terrible person for running my TS-140 at 100 watts."

If you think about it, nothing could be further from the truth. Any bloke can put a 2-watt CW signal into the ether. It's the superlative skill of the RECEIVING operator who makes the QRP contact happen. A terrible person? Certainly not.

But remember that flashing your QRP moniker gratuitously can send an unspoken message you may not want to be dispatching.

That said, however, I've found that by politely asking if the other guy, for the fun of it, would like to reduce his 100 watts to, say, 10 watts, he's more than eager to try.

He's often amazed to hear that his 10-watt signal is just as readable as his 100. Then I suggest going to 5 watts, then 2 watts, 1 watt, and then into the milliwatt level. "How can you be hearing me?" they sometimes ask in disbelief. "I'm not even moving my output meter here." Talk about fun. And educational.

But back to the fundamental issue: Is it necessary for "KI6SN / QRP" to be part of my "QRP accent?" In the vast majority of cases, I'd say it's not.

For casual operation, the guy on the other end is merely looking for someone to have a nice conversation with. Your power level isn't really an issue. The quality of your signal and CW is, though.

DX chasing is another matter, however. Seasoned veterans have suggested over the years that in pile-ups, it's sometimes to the low power operator's advantage to sign " / QRP." This gives the DX station a heads-up that a QRPer is in the pack.

It's then the DX station's option either to act upon that bit of additional information, or ignore it. The QRPer will learn pretty quickly if the foreign station is willing to ask other stations to standby so a low power signal can briefly be given the floor.

In all cases, I'd recommend that " / QRP" be used with great forethought and prudence. It's not the kind of postscript you want to wag around haphazardly. Do that and you run the risk of sending that wrong, unspoken message to everyone listening on the band.

Department of Redundancy Department

There's frequently a tendency on the QRP operator's part to assume that the receiving station is struggling to hear his signal. Craning an ear toward the speaker, he strains to pull the low power station's CW from the din.

Experience tells us, though, that for rank-and-file QRPers this is far more the exception than the rule. Most contacts are made with each station comfortably copying the other.

So, what possesses some QRPers to act upon the urge to routinely repeat information?

"AGE HR IS 52 52 52 52." Jeepers, I'd given him a 579 RST. That's pretty darned readable in my book. And I got his age just fine the first time. It's highly unlikely he's 52,525,252 years old, so why's he wasting my time and his energy by sending it four times?

With a 579 or even a 549, it's OK to have confidence in your signal and in the ability of the operator at the other end to copy. Believe me, if your signal is failing or the other operator's skills are lacking, you'll most likely hear about.

It's not fair for the QRPer to merely assume the other station is struggling. The net effect of unnecessarily repeating things is often frustrating the receiving operator and sending an unspoken message to him: You're not very confident that he's up to the task of handling a QRP signal.

That can be interpreted in lots of different ways - including arrogance. Is that the impression you want to leave with your fellow radio amateur? Let's hope not.

Bottom line: Unless the other station makes it clear that he's having problems copying you, assume he's not. And, in your best CW, converse as though he's hearing you fine, sitting right across the room.

"Let's talk about me. . ."

We all know the thrill of making contacts across thousands of miles with a lot less power than it takes to light the bulb in your refrigerator. That's one of the thrills of QRP. Every contact is an adventure. But what's thrilling to us needn't always be the center of attention in a CW QSO.

Indeed, some of the radio amateurs on the other end are genuinely fascinated by your QRP signal. They may have lots of questions about your station and your antenna. How you got started and your best DX.

Don't, however, assume that that fascination is universal. Face it, there are thousands of QRPers around the world. They are avid CW operators and really "get around."

The chances are fairly good that the guy you're QSOing has already talked with other QRPers. You're not the first, nor will be the last. So this business about getting out with 5 watts isn't such a startling revelation or a big deal.

If questioned about your low power exploits, by all means describe them. But if that's not happening, it's OK to be curious about the other operator, In other words, "Let's talk about you. . ."

Some of my most enjoyable, interesting and memorable contacts have made only passing reference to QRP. In fact, there are dozens of instances where the output power of my station was never even mentioned.

Yes, QRP operation can be a great conversation piece. But it's not the only one. It's OK to be curious about the other guy's station layout and antenna. His occupation. His family. His QTH. His other interests. There are some darned interesting people on the air who don't have the slightest interest in QRP. And that's OK. How boring our airwaves would be if we were focused on just one topic.

Tuning around

It may be a throwback to the days when most of us were "rock bound" with crystal controlled transmitters. But in my Novice days it was common practice after calling "CQ" to tune around the CW band for stations that might be answering you, but didn't have a crystal cut to your transmitting frequency.

With so many crystal-controlled transmitters in the QRP game even today, "tuning around" isn't a bad habit to acquire. Think about how many of the classic crystal-controlled Tuna-Tin 2 transmitters are regularly in use.

The TT-2 operator may hear you sending "CQ" a couple of kilohertz up the band and give you a call. Unless you've taken the time and exercised the courtesy of listening to either side of your transmitting frequency, chances are good you'll never make contact. That's a shame.

Even listening across the skirt range of the receiver incremental tuning - the RIT found on most of today's transceivers - is a good thing.

If you're the guy with the VFO, it's perfectly OK - even preferable - to zero beat the crystal-controlled station's frequency.

By doing so, you're taking up less of the band for your QSO by being on the same frequency as your QSO partner. At the same time, except for short pauses as you turn the conversation over to the other station, you're signaling constantly to oncoming stations that your frequency is in use.

For heaven's sake, take a breath

Especially in times of erratic sunspot activity, band conditions can change in a matter of seconds. That S-9 signal you're comfortably copying suddenly drops off the end of the table, and you're fighting to pull him out of the noise.

That's one of the main arguments for keeping your transmissions relatively short. Rambling conversations run the risk of getting "timed out" by changing propagation.

There are few things more embarrassing to me as an operator than to have waxed elegantly, albeit longwindedly, about something I think I'm very smart about, only to turn the conversation back to a guy who lost me in the noise five minutes earlier.

Using frequent breaks is a fine CW operating procedure to counteract the effects of fast-changing conditions. For example, instead of asking three questions on three separate subjects and then turning it over to the other guy for response, ask just one question and "break" the conversation: "What feedline are you using? BK" The other station then answers in a similar staccato manner: "600 ohm open wire. BK." It's tantamount to taking a breath during day-to-day conversation.

This way if the band starts "going south," the other guy can let you know right away. Similarly, you can notify him that you're having problems.

If you're carrying on about something for four or five minutes, it may be too late for you to react. You're left with a busted QSO and a nagging curiosity: "I wonder how much of that he actually got?"

Lasting impressions

In the lexicon of American Indian wisdom there is a saying that "We will be known forever by the tracks we leave."

As a member of the QRP community, I often wonder what impression I've left with the last fellow I QSO'd. How was my CW fist? Was the quality of my signal something I'd be proud of? Was I a good listener? If the going got rough, was I skillful? Was I patient? Was I understanding? Was I at all times a gentleman?

If the other guy was viewing the entire QRP community through his QSO with me, have I shown our colors well?

As one low power enthusiast among many, I hope that my "QRP Accent" is one that admirably represents the QRP community and radio amateurs at large.

QRPp Subscriptions

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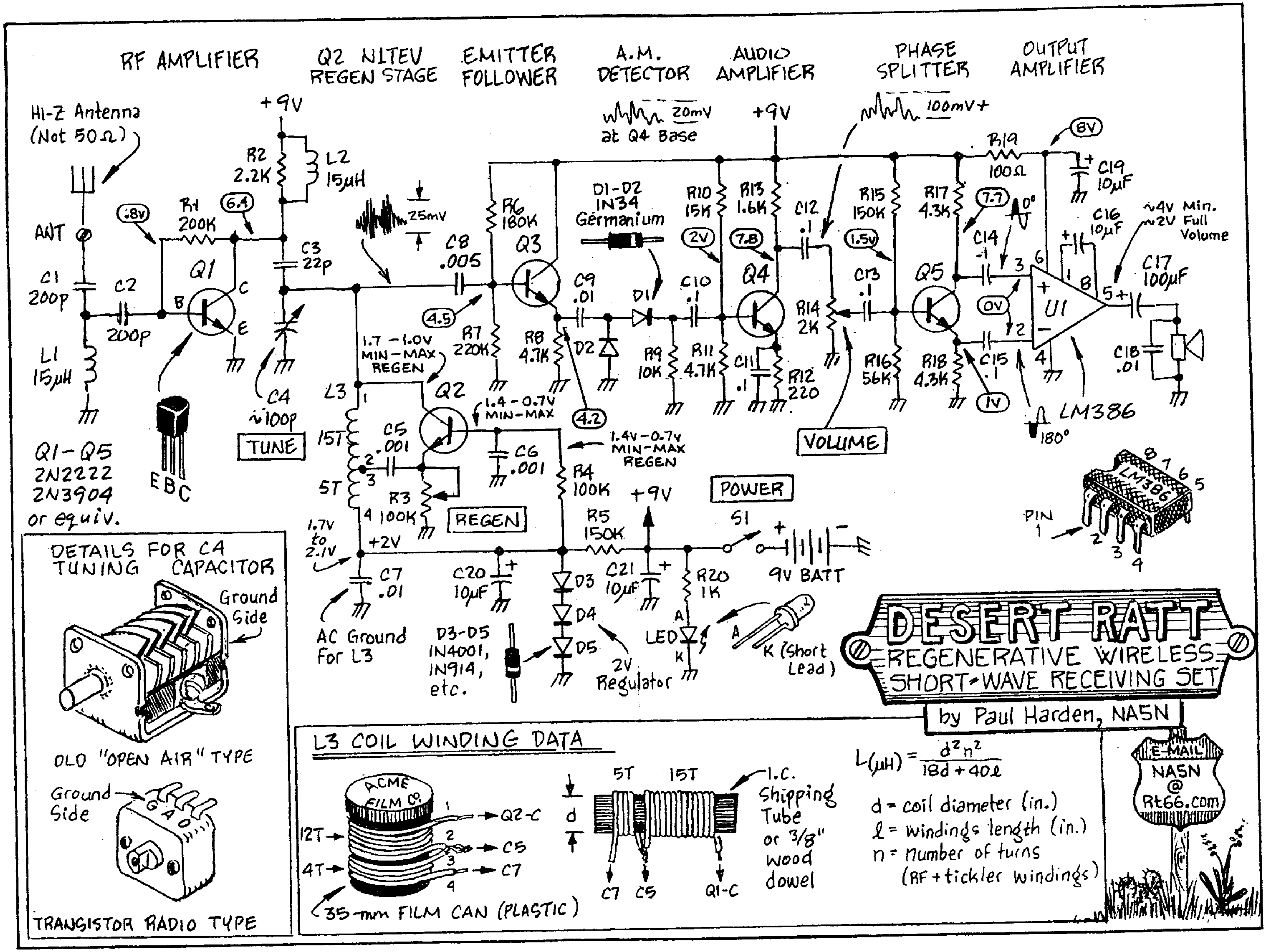
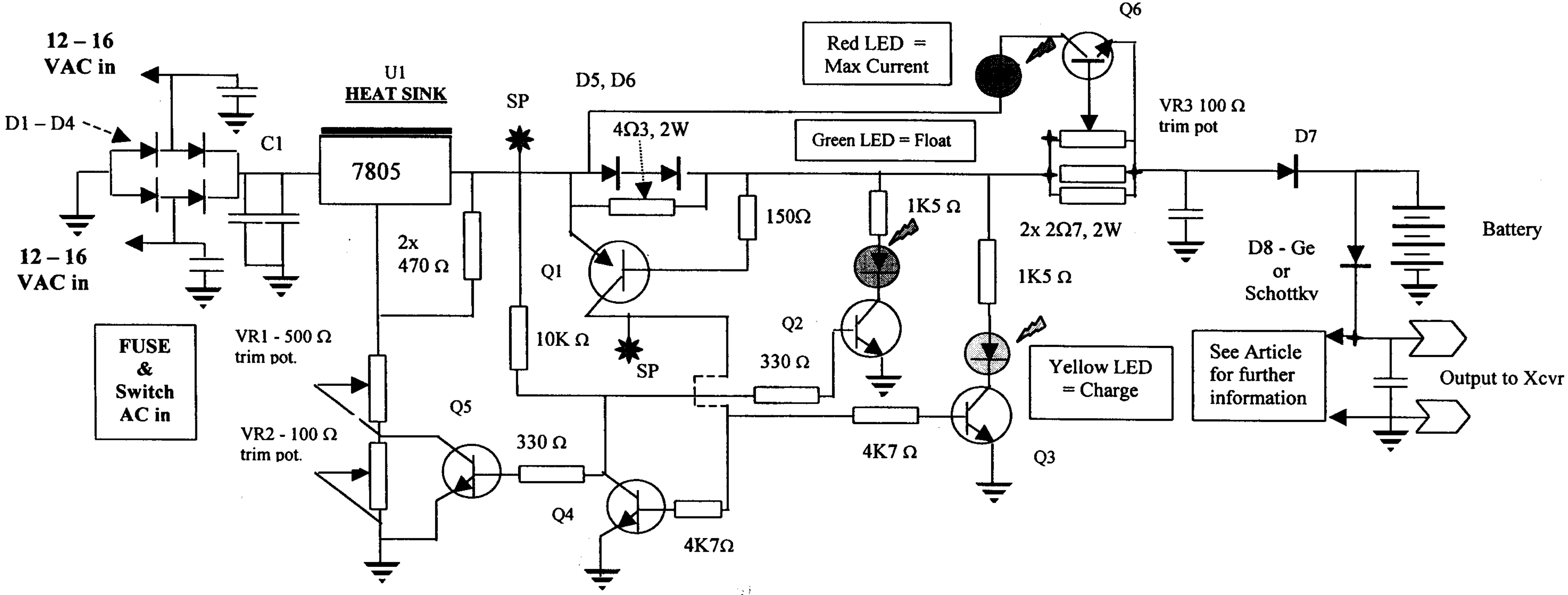


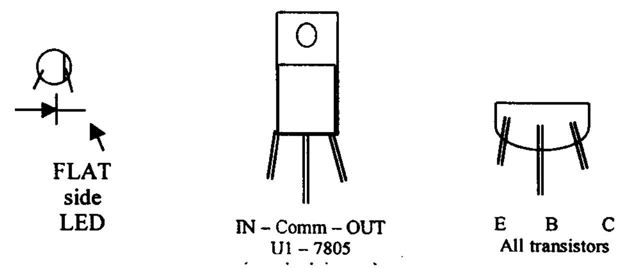
RF AMPLIFIER
Q2 NITEV REGEN STAGE
EMITTER FOLLOWER
A.M. DETECTOR
AUDIO AMPLIFIER
PHASE SPLITTER
OUTPUT AMPLIFIER
Hi-Z Antenna (Not 50Ω)
ANT
C1 200p
C2 200p
L1 15μH
R1 200K
R2 2.2K
L2 15μH
C3 22p
C4 ~100p
TUNE
Q1-Q5 2N2222 2N3904 or equiv.
EBC
25mV
C8 .005
R6 180K
R7 220K
R8 4.7K
C9 .01
D1-D2 1N34 Germanium
20mV at Q4 Base
R9 10K
C10 .1
R10 15K
R11 4.7K
C11 .1
R12 220
R13 1.6K
C12 .1
R14 2K
VOLUME
100mV+
R15 150K
C13 .1
R16 56K
R17 4.3K
R18 4.3K
C14 .1
C15 .1
R19 100Ω
C19 10μF
C16 10μF
~4V Min. ~2V Full Volume
C17 100μF
C18 .01
LM386
PIN 1
1.7 - 1.0V MIN-MAX REGEN
1.4 - 0.7V MIN-MAX
1.4V-0.7V MIN-MAX REGEN
L3
15T
5T
C5 .001
C6 .001
R3 100K
REGEN
R4 100K
R5 150K
+9V
POWER
S1
9V BATT
1.7V to 2.1V
+2V
C7 .01
AC Ground For L3
C20 10μF
D3-D5 1N4001, 1N914, etc.
C21 10μF
2V Regulator
R20 1K
LED
K (Short Lead)
DESERT RATT
REGENERATIVE WIRELESS SHORT-WAVE RECEIVING SET
by Paul Harden, NA5N
E-MAIL NA5N @ Rt66.com
DETAILS FOR C4 TUNING CAPACITOR
Ground Side
OLD "OPEN AIR" TYPE
TRANSISTOR RADIO TYPE
L3 COIL WINDING DATA
ACME FILM Co.
12T
4T
Q2-C
C5
C7
35-mm FILM CAN (PLASTIC)
I.C. Shipping Tube or 3/8" wood dowel
Q1-C
L(μH) = d²n² / (18d + 40ℓ)
d = coil diameter (in.)
ℓ = windings length (in.)
n = number of turns (RF + tickler windings)



Parts Identification

C1 = 1000 mfd electrolytic
Cx = all unidentified capacitors = .1 mfd
D1 – D7 = 1 amp Si (1N4001 etc)
D8 = 2 amp rated, Ge, Schottky barrier diode (if used)
LED 1= Green for On/Float Red for Max Current
LED 2= Yellow for active Charge above 100 mA
LED 3= Red for Max Current as set (500 mA)
Resistor values as shown. All ¼ watt except where noted
VR1 = 500 Ω Trimpot
VR2, VR3 = 100 Ω Trimpot
Q1 = PNP 2N3906 or equivalent
Q2 – Q6 = NPN 2N3904 or equiv.
U1 = LM7805 – Heat Sink U1 ~ Important!

<u>Simple Adjustments:</u> With <u>NO battery attached</u> to terminals,
Step 1) Apply 12 – 16 VAC power and, adjust VR2 for 13.6 Volts at battery terminals. The Green LED only should be lighted.
Step 2) Short the two SP terminals and adjust VR2 for 14.6 volts at battery terminals. When SP terminals are shorted, the Green "Float" LED goes off and the Yellow "Charge" LED turns on.
Step 3) Connect a DMM reading 1 ampere in series with a 27Ω 5W resistor (placing a 500 mA load on circuit), adjust VR 1 until red "Current Limiting" LED lights at the 500 mA output current level (or other mA rate based on 10% of your Gel Cell amperage rating.). Do Not exceed 700 mA charging rate with components listed. Remove test equipment, install battery and power.



K5BDZ Notes:

700 mA GelCell Charger with monitoring circuits.

By Bill Hickox, K5BDZ