Issue #7 Spring 2006

AmQRP.ORG HOMEBREWER

JOURNAL OF THE AMERICAN QRP CLUB

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JUMA TX1 Transmitter

The "mate" to the JUMA RX1

Feature Projects:

JUMA Transmitter, PNW15 Transceiver, Using Power Supplies, GPS & Morse Code, PipeVert Antenna, The Best Antenna, Measuring Crystals, 80m SSB Rx, A Better Crystal Set, Transformer Checker, OctaRing Antenna, Gorrilla Coil Design, MicroVert AntennaEL, HamCalc83, QuickieLab, Tilt-Over Antenna, Human Power, Squirt 80m Antenna, Warbler Deluxe

and ... SOLDERSMOKE!

Also included:

QRP Operating, Tuning Up, QRP Contesting, Test Topics & More, Handyman Guide

For electronic builders, experimenters, radio operators, and low power enthusiasts everywhere.

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to make it easier to interpret. Finally **Stimulus and Response** gives some clarification and enhancement for adjustment of the NJQRP FSM, the Sniffer.

QRP Operating: 2m FM Mountaintopping with a simple 3 element beam , *Richard Fisher, KI6SN*
Bring up QRP operating, and most often conversation turns to the high frequencies – 40- and 20-meter CW leading in the popularity polls. But there's a fabulous low-power world to explore at very high frequencies!

Tuning Up*, by Richard Arland, K7SZ*
Leave it to the Amateurs to pioneer every single mode and method of communications that we now enjoy world wide.

QRP Contesting *, by Ken Newman, N2CQ*
I'm guessing that the average HOMEBREWER subscriber is "melting solder" more often than into contesting. QRP however has many other fun outlets and what could be more fun than making your own rig or kit and using it in a contest to see how it well does? Plus, three month forecast of contesting events.

Atlanticon QRP Forums
Each springtime we host the Atlanticon QRP Forums in Timonium, Maryland. Make plans to attend a full Saturday of QRP talks presented by experts in our field, and have fun at the festivities surrounding these presentations on Friday and Saturday evenings. Then take a bit of time on Sunday to attend the most popular hamfest on the eastern US seaboard: the Greater Baltimore Hamboree and Computerfest, which is within walking distance of the Atlanticon hotel!

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How Hard Can It Be?

It's just a quarterly newsletter, how hard could it be to put it together?

This is what I thought when N2APB asked if I could help take over the editing of the Homebrewer Magazine. As with many of us, life's path often takes twists and turns, and George's has recently turned him toward a simultaneous path of a new challenging job and a graduate education. The Homebrewer was George's baby and one of the finest ones in QRP as well as in Amateur Radio in general. We all look forward to each issue and it is because of George Heron and the brilliant contributors that Homebrewer is of such merit and value to us all.

At the same time I was considering jumping in fully I was assigned the lead on a new project at Giant Aerospace Company Incorporated where I am a senior design engineer. When I asked George just how hard is to edit and publish Homebrewer on a quarterly basis, he sent me the list of the tasks that are needed to put an issue to press. There are all the articles to sift through, laying out the pages, editing the drawings and diagrams, adding editorial comment, clarifying submissions and a host of other tasks. I knew with my new responsibilities I couldn't give Homebrewer the time and effort it deserved. I did offer to assist as much as I could any other helpers whom George could find. Well, George did find Al Miner, WA1CZG who was able to do a great job handling the logistics of handling author contributions and the mechanics of getting it all into the right format and converted to PDF files. Of course we already had Nancy Feeny, NJ8B on the editorial staff, who along with Jim Miller AB3CV and me, was then able to handle the editing part of material preparation. Together with George's coaching, we have put together some semblance of an issue. Al and Nancy provided ninety eight percent of the effort as my availability has been even less than I thought. Had any of us known just how much work is involved in publishing the Homebrewer we would have filtered George's emails better!

"Why do we do it when it seems so difficult?"

So what is it that drives us to tackle the tough jobs? Well for me it was a matter of paying back George and the other excellent contributors and designers who make up the AmQRP club, including the NJQRP folks and the NorCal folks. In all other things East Coast and West Coast there is competition – yet in QRP there is collaboration. The brilliant radio and accessory designs and projects that make QRPers so special have made my hobby much more fun and interesting. Homebrewer Magazine provides a forum for the designers of the transceivers, tuners, widgets and gadgets that we eagerly wait for each quarter. By letting Homebrewer die we would have killed a great resource and that forum would be lost for everyone.

QRP is the one major area left in amateur radio where you can still brag that you built it yourself. We all know that in the overall scheme of things it is a small matter but I would have missed Homebrewer, and certainly the many contributors would have missed it also. I am in awe of those who put their own effort and spare time into designing a project then unselfishly take the time to document it and share it with the rest of us. So I say to all of you who are reading Homebrewer issue 7 that you should thank Al and George and that we will work harder each issue to hopefully make it as good as George did. Thanks for your patience and enjoy issue 7.

72, Carl Hyde, W2CSH

THE FINAL WORD … *de N2APB*

W2CSH wrote his editorial segment (above) before we made the decision that we could not continue publishing the magazine. As I had previously mentioned, the river of life takes us each through many twists and turns over time. Sometimes the ride is straight and the waters are calm – other times we encounter branches sticking up through the surface, or even rapids and waterfalls that must be carefully navigated. My life is currently experiencing some of those twisting waterways with the new job and post-grad school, and I regret being unable to continue editing and publishing Homebrewer Magazine.

Having made the decision to close down the mag, I'm not saying that we will never do it again. Or perhaps more appropriately stated, we've learned lots along the way and I believe that there is even further ground to be broken in the area of presenting technical information and related media. We "discovered" electronic publishing with all its attendant benefits of virtually unlimited content, full color and full resolution material, hyperlinked access for multidimensional access to the huge collection of information being presented, and demonstrated its ability to host a vast range of supporting media that could never be presented in the old-school B&W printed magazine: audio interviews, video training, human-interactive navigation, podcasts, and software applications, utilities and data files.

Some in the QRP community will foolishly consider Homebrewer as a "failed experiment". However they are also the ones who strive to maintain the status quo; those who do not embrace change. They will never acknowledge or ever see the benefits that Homebrewer Mag brought to the QRP and homebrewing community just because of the diversity we offered.

But you readers certainly know otherwise. We have been the ones with vision to see the benefits of a new publishing medium and all the wonderful richness that can be delivered to our hobbyist community within its electronic pages. Perhaps you more than any others will understand that this will not likely be the last "experiment" tried by the AmQRP. Technology brings advancements in radios, computers and everyday life, so there is every reason to believe that similar kinds of advancements will also come for disseminating ideas and details about homebrewing electronic projects. Perhaps smartchips (computing and memory chips embedded in smartcards) or USB tokens will become cheap enough for one-time use, thus enabling the publishing of a magazine that literally computes to create and tailor content according to individual reader preferences. Who knows what the future will bring! But rest assured that the AmQRP and descendants of Homebrewer Magazine will be there to try it out.

I thank you readers for the support over the years, and especially for your confidence as we transitioned to the CD medium. The times were rough then, but I was steadfast in my vision of being able to create a very powerful technical journal in this format, and this has now been amply demonstrated.

I also profusely thank the contributing authors and (especially) the regular columnists who, like the editing staff, saw the vision and freely contributed their wisdom, experience, time and talent in helping to make Homebrewer an incredibly useful resource each time.

So for this last time, please sit back in your computer chair and enjoy digging through this current issue of Homebrewer. Print out selected articles for use in the “reading room” or put the files on your PDA for remote study. We believe Homebrewer CD Magazine provided a unique and valuable contribution to our hobby, and all of us writers and editors are very proud to produce it for you. We hope you enjoy this and each of our prior issues along the way

And remember … we do homebrewing here, and we love it. Keep the fever!

72, George N2APB n2apb@amqrp.org

AmQRP.ORG HOMEBREWER

Wayne McFee, NB6M

The PNW15

A 15 Meter, QRP CW Transceiver that makes use of very efficient construction techniques. This is an amazing project……..

PNW15 Front Panel

Shown above is the front panel of the PNW15, during the rig's first build. The controls on the left are the RF Gain, above, and the AF Gain, below. The two push-buttons below the LCD display are used to program the Digital Dial. On the right are the RIT pot, above, and the Tuning knob, below.

The finished transceiver has a stable VFO that provides coverage of more than 250 KHz of the band. The transmitter output is 3 Watts. The receiver is a simple superhet design with acceptable selectivity and better than acceptable sensitivity.

Although activity on 15 Meters isn't as heavy as it will be when the sunspot cycle comes back up, there is enough to warrant building the rig. The first QSO with it was between Washington State and New York.

The Thought Behind The PNW15

After completing a move from California to Washington State, the author joined a group of like-minded QRPers that meet, irregularly, for P&C (Pie and Coffee) at a restaurant in Bothell, a suburb of Seattle. These amateurs live in areas spread all over the state, and have used the P&Cs as a way to get together and discuss PNW QRP (Pacific NorthWest QRP), as well as a way to maintain amateur radio and social interest between the members of the group.

At one of the P&Cs, the question was raised about designing a receiver to complement a stand-alone transmitter, and making this a project that either all, or most of the group, would build. That is how this project got started. However, over time, it almost naturally evolved into a design for a complete transceiver.

15 Meters seemed to be the first choice for the majority of the group, because of the fact that very few kits had been marketed for that band. 10 Meters was second choice, and there was some interest in 20 as well.

10 Meters was ruled out for the time being, because of the lack of enough band openings to provide activity.

This design was developed with several goals in mind. Commonly available, discrete parts would be used, so as to foster better understanding of the circuitry as well as make any future repairs easy to accomplish. The project would be used to introduce the Ugly Style building method to the group, as well as to make the group more comfortable with building from scratch. Very fittingly, the rig would be called the PNW15.

As this is being written, seven members of the PNW QRP group are involved in the group build, and parts are being procured.

The Birth Of A Transceiver

Because of the success of the Nuts and Bolts 40 and Nuts and Bolts 20, previously designed and built by the author, and the desire to build this rig mostly with discrete parts, its receiver is based on the S7C receiver, from EMRFD[1]. A different Audio Output Amplifier would be used, in order to boost the audio output available, and, as in the Nuts and Bolts 20[2], an RF Preamplifier would be added to the basic receiver circuit.

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[1] Hayward, Campbell, and Larkin, ARRL 2003, Page 12.16
[2] Wayne McFee, "The Nuts and Bolts 20 Meter Transceiver", American QRP Club "Homebrewer" # 5, 2005, Page 52

Although most of the PNW QRPers wanted a rig for 15 Meters, there had been interest in building for 20 Meters, and 10 Meters as well. In order to provide a design that could be built, as is, for 15 Meters, but could easily be adapted for 20 Meters or 10 Meters, several mixing schemes were considered.

The result is a transceiver that uses a 10.000 MHz IF, and a VFO chain that produces an 11.000 to 11.250 MHz injection signal.

A Permeability Tuned VFO would be used, and in order to maximize its stability, it would be designed to operate at 4 MHz. Its output would be mixed with the output of a crystal-controlled Pre-Mix Oscillator operating at 7 MHz.

Although this results in the use of many more parts and more circuit complexity than would be the case if an 11.0 MHz VFO was used, there are two valuable benefits. First it is generally easier to achieve stability in a VFO if it operates at a relatively low frequency. Second the mixing scheme promotes flexibility in the design, because the 4 MHz VFO signal can be used directly with the 10 MHz IF and Transmitter Oscillator to put the rig on 20 Meters, and the Pre-Mix oscillator's signal can be doubled in order to put the rig on 10 Meters.

A Pre-Mix Oscillator crystal frequency of 7.122 MHz was used here, both because of its ready availability and the fact that its use would move any harmonics completely out of the 15 Meter Band.

The PTO VFO tunes from 3.878 to 4.128 MHz. The frequency range is easy to adjust, should the builder wish to put the rig on either 20 or 10 Meters.

Following the theme of band flexibility, the transmitter's RF Amplifier Chain is a broadband design that uses all bipolar transistors. Putting the transmitter on a band other than 15 Meters involves simply changing component values in the Transmitter Bandpass Filter, Output Filter, and the T/R circuit.

Transmitter output is 3 Watts. However, it should be easy to increase this to close to 5 Watts by doing a little tweaking of the design.

A PIC chip and a backlit LCD display provide the frequency readout. This is a version of IK3OIL's Digital Dial, with the addition of a JFET Buffer Amplifier in Source Follower configuration.

Introduction to "Ugly Style"

One of the goals of this project is to introduce the Ugly Style of building to the group, and to whoever else wishes to build this project, in order to promote the whole idea and practice of building from scratch.

Getting into the Ugly Style of building electronic circuitry has been, for me, one of the most rewarding and beneficial aspects of the home-brewing art.

Once you make that first step, and get away from dependence on having a printed circuit board in order to build something, you begin to realize that you can actually build any type of circuitry you desire, faster, easier, and with a whole lot less fuss and bother than you ever could before.

You won't have to wait for someone else to come out with a new kit before you can build something. And if you want to build something for a different band, or with a different type of circuitry than might be available in a kit, you can just go right ahead and do so.

When I think of all the hours I've spent laying out PC boards, or all the hours spent cutting little PC board pads, figuring out a layout for them, and gluing them down in Manhattan style, I just shake my head.

Because, by just simply going ahead and building whatever it is, Ugly Style, the layout develops on its own, governed more by the size and shape of the parts themselves, and the builder's imagination, than anything else. The layout happens almost automatically, without a lot of time or thought having to be spent on it.

Many times, the completed circuitry takes up much less board space than it would if laid out on a PC board, because you are actually building in three dimensions, instead of two.

There is another positive thing about building Ugly Style. It has been said, and it has proven out in my experience, that RF circuitry built over the solid ground plane provided by the continuous surface of a PC board material substrate works better than it does on a printed circuit board.

I have literally spent days of time drawing and re-drawing printed circuit boards, trying layout after layout, just to get a project to work somewhere close to how it works in Ugly Style.

So, when I start building something Ugly style, I know that as long as I get my connections right, it is going to work, and work well, right from the beginning.

Just what is Ugly Style building?

Ugly Style is simply the process of soldering those part leads that go to ground directly to the copper surface of a continuous sheet of PC board material, with parts such as resistors and bypass capacitors standing upright, so that the ungrounded connections can be made and maintained up and away from ground.

The circuitry is physically supported by the grounded parts, and is usually very strong, mechanically. If it turns out that a particular section isn't quite as rigid as we want, we can always put in a very high value resistor, or another bypass capacitor, between the shaky lead and ground in order to stabilize the circuitry.

Parts such as toroid transformers or inductors can be stabilized by the application of either epoxy cement, or a small amount of RTVcaulking compound.

And, with Ugly Style, it is very easy to connect power or audio and RF connectors to the circuitry for testing purposes. Simply solder the grounded side of power leads or connectors to the copper substrate, and solder the "hot" leads to the appropriate part leads.

Developing A Construction Plan

Now that we know what Ugly Style is, we need a plan of attack. When we build Ugly Style, we can build the entire rig on one PC board substrate, or can build either the main sections or individual stages on separate pieces of PC board material. The choice is up to us, but can be determined as well by the complexity of the rig.

Because of the air-wound tuning coil used in the PTO VFO, we will want to provide total shielding for at least the VFO and RIT circuitry, and, because of the mixing scheme used in the VFO chain, we may want to shield the remainder of the frequency generation circuitry as well. In order to do that, we will need to make sure we have plenty of space to allow for both circuit parts and shielding for that section on our main PC board substrate.

It might be a good idea to build the entire VFO chain on a separate substrate than that used for the remainder of the rig.

In the author's build of the PNW15, each section of the VFO chain was built on its own, separate piece of PC board material, and cut-off part leads were used to attach those boards to the main substrate. By doing so, shielding was provided between each section of the frequency generation circuitry, as well as between those sections and the remainder of the rig.

No matter what section of the circuit you are working on, you will want to build it on a larger piece of PC board material than will actually be needed, once the section, or the entire circuit, is finished.

In order to give us plenty of room, we will use a 6" by 8" sheet of PC board material for the main board. If you feel you may need more room, use a larger sheet. It can always be cut down if all the space is not used.

Using PC board material as the base of the rig has another benefit. We can easily fashion our own "case" for the finished rig, by soldering PC board material front and rear panels, sides, and top to the main substrate. If we do that, we can make the case fit the project exactly, in whatever shape or size the construction takes.

<u>The Secret of Ugly Style Building</u>

Just what is the secret to success with Ugly Style building, anyway?

There really is no big secret. The main ingredient is simply being able to look at a circuit, see what connects to what, and starting in.

But wait, you say, start where?

OK, if there is any secret to Ugly Style building, it is in knowing where to start.   Here is how that is determined.

Any type of electronic circuitry is made up of individual stages, such as oscillators, amplifiers, mixers, product detectors and filters. No matter how complex the circuit is when you look at it in its entirety, it can always be broken down into individual stages. Each stage is built one at a time, beginning at one end of a string of stages.

But, which stage do we start with?

The project at hand is a transceiver. In a transceiver, circuitry is associated with one of three different main functions. Receiving, transmitting, and frequency generation.

We want to start building these three main sections in such a way that it allows us to test each stage as it is completed. So, we need to start either with the receiver section or the frequency generation section. We can't really start with the transmitter section, if we want to be able to test each section as we go, because the transmitter section needs RF input from the frequency generation section in order to work.

If we start by building the frequency generation section, we need to start at the beginning, with the VFO itself, and work forward from there, because each subsequent stage uses the output from the previous stage. We will do the same thing with the transmitter, start at its first stage and work forward from there, for the same reason.

However, if we start with the receiver, we need to start at the end, with the audio output amplifier, because we can provide signals for testing purposes quite easily for each stage as we progress, and be able to hear the results.

In this case, if we are going to build all, or most, of the entire rig on one large PC board substrate, it makes sense to start with the receiver, because that will almost automatically determine the physical layout of the rig.

Now that we have determined that we are going to start with the audio output amplifier of the receiver, in terms of the circuitry, how do we get started with the actual construction?

Of course, before we can actually start, we have to have the parts on hand. In this case, a complete parts list for the PNW15 will be provided, and most likely a "group buy" of parts will be made. But, for the future, all you need to do is make a list of what you need, check your junk box to see what you have on hand, and order the rest.

One of the easiest ways to order electronic parts is to phone up either Mouser or Digikey on their 800 number, and talk to one of the sales reps. If you tell them, for instance, that you need .1 uF bypass capacitors, with a temperature coefficient of X7R, they will know which parts from which manufacturer are cheapest and available in stock at that moment.

Of course, you can dig through their catalogs, either printed ones, or on line, and make a list of part numbers yourself. But, especially at first, it will probably be far less stressful just to phone them up.

For toroids, there are several choices. I have had good luck with Amidon Associates. They will usually get an order out to you within a day or two, and their info is on line.

So, with all the parts on hand, we start by identifying and gathering the parts needed for that first stage, the audio output amplifier.

We do this by checking the circuit diagram for that individual stage, making a list, and separating out what we need from the main supply of parts for the rig.

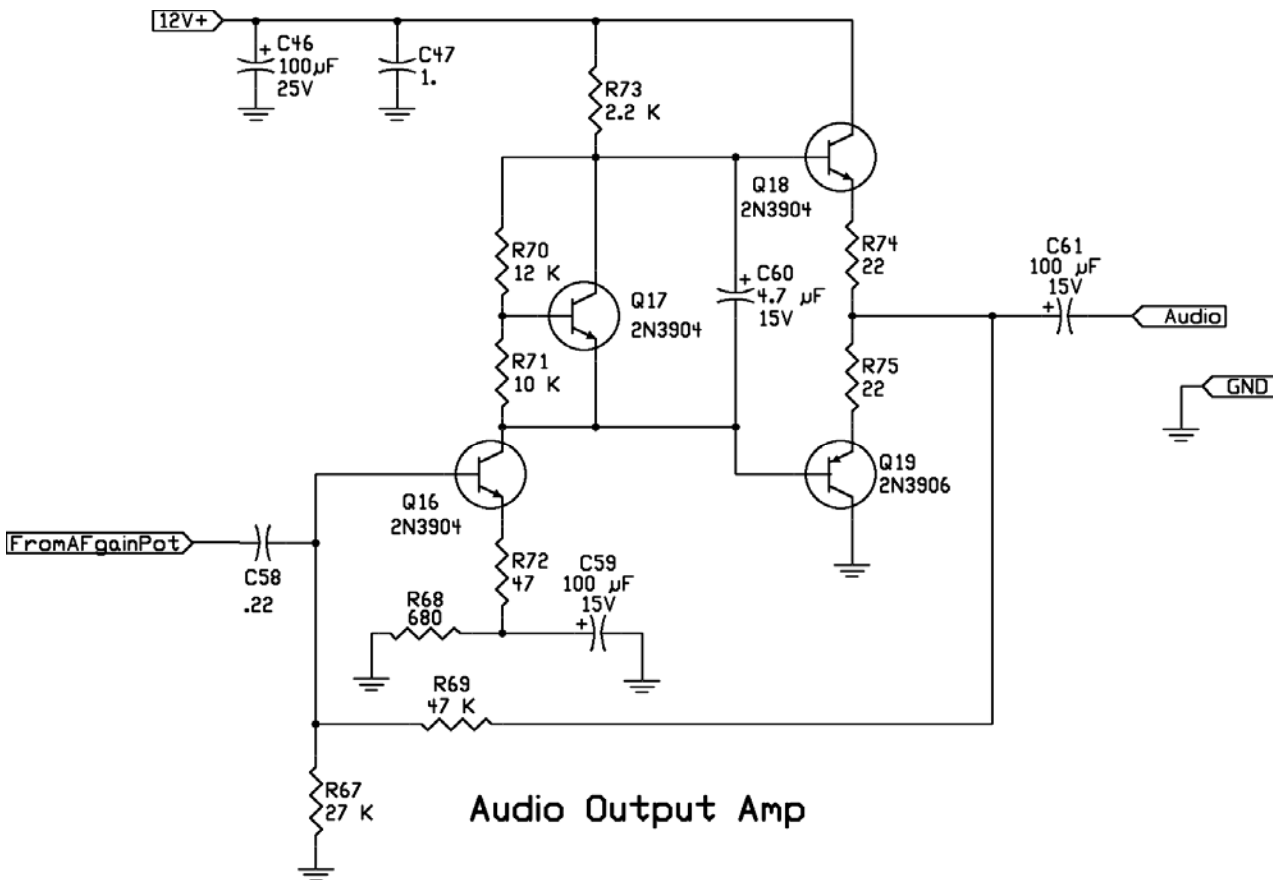
OK, we are finally really ready to start and can heat up our soldering irons.

I like to have two soldering irons plugged in and ready all the time during construction. I use a 15 Watt iron for almost all of the connections that do not go to ground, and a 25-30 Watt iron for all the ground connections.

By having two irons of appropriate wattage ready at all times, rather than using an iron with variable heat, I don't have to wait for an iron to heat or cool, and can get on with my building. Both for the physical strength of the solder joint, and to prevent lead contamination, I highly recommend the use of silver content solder.

With that said, let's take a look at the circuit for that audio output stage, and determine which part we are going to start with.

Here is the circuit.



The Ugly Style building method involves soldering part leads that go to ground directly to the copper surface of the PC board substrate. In this amplifier circuit, we have six parts that connect to ground. These are C46, C47, R67, R68, C59, and the collector of Q19. Which one do we start with?

Since we are going to start with the audio output amp and work backwards through the receiver, we want to lay out the receiver along one side of our PC board substrate and work from one rear corner towards the front.

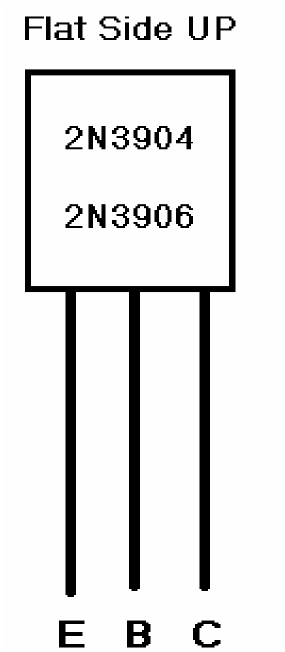
We know that we need to leave a little space at the rear of the main board so as to be able to install connectors between the circuitry and the rear panel of the case. We also need to leave a little smaller space along the side of the circuitry, between the parts and the edge of the board, in case we decide to fabricate our “case” from soldered-on pieces of PC board material.

In order to give you a chance to see exactly how Ugly Style is done, and hopefully give you the confidence to do it yourself, the entire build of the Audio Output Amplifier is going to be explained, and shown in pictures in detail here, step by step.

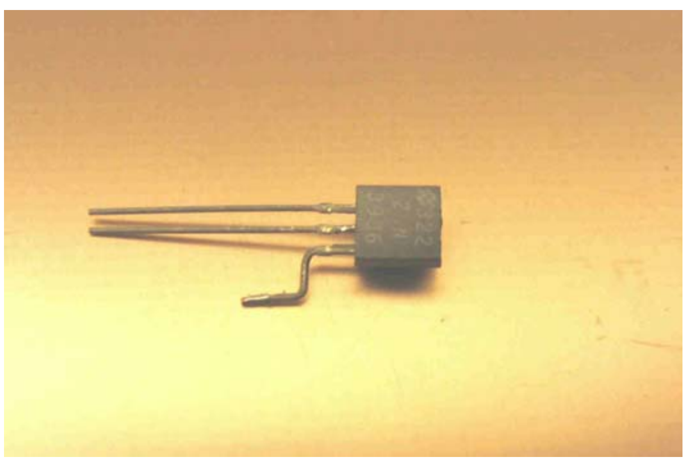
The audio section is typically the most complicated single stage in a transceiver, whether it is designed with all discrete parts, as this one is, or is an integrated circuit design. If you can successfully build this one stage, none of the rest of the stages should give you any trouble at all.

So as to fix the start of the physical layout, as well as build in logical order, we will start with the grounded part that will be nearest the earphone jack. Taking a look at the circuit, this will be Q19, which is a 2N3906. The lead that needs to go to ground is the Collector.

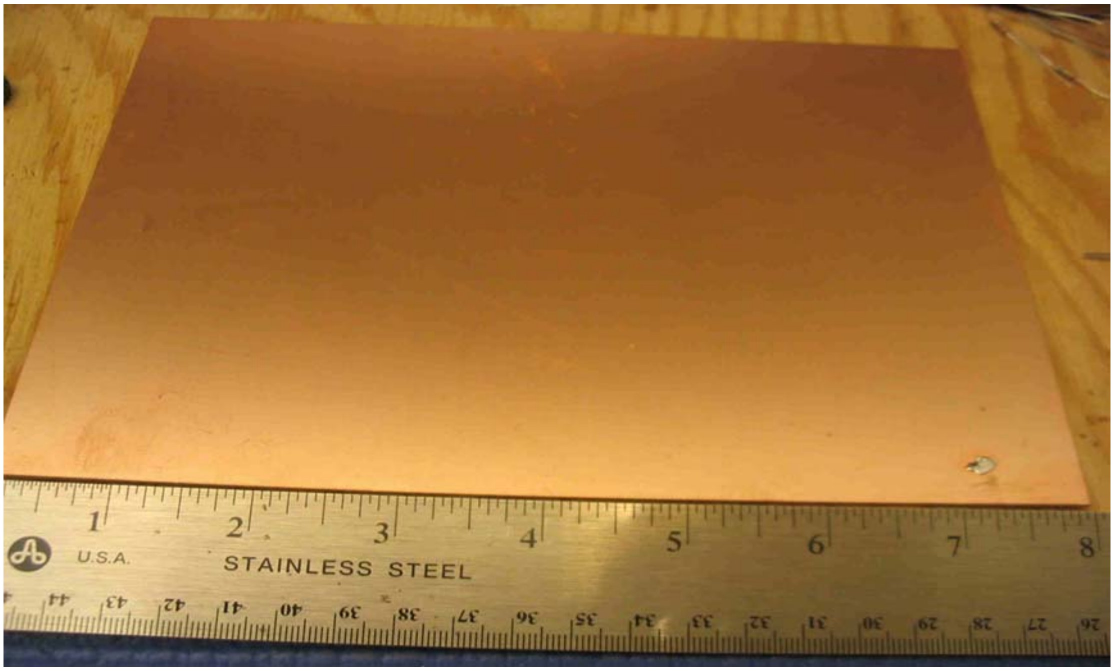
Here is the pin-out of either a 2N3904 or 2N3906.



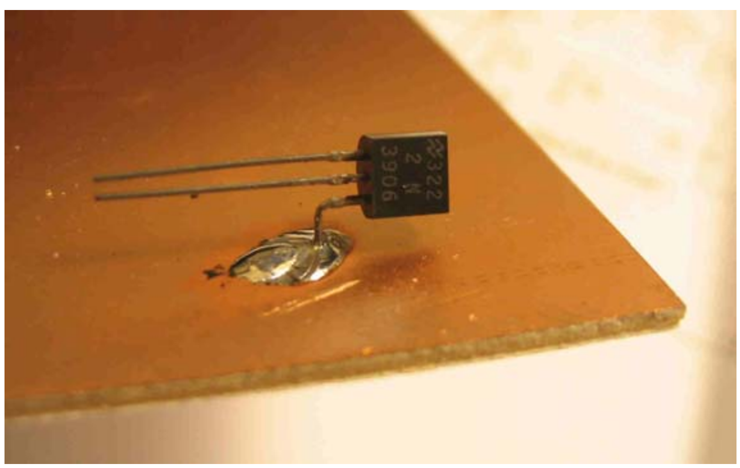
Since we know that we want to solder the collector to ground, we will bend the leads in order to facilitate the installation, as shown below.



Now we are actually going to take that first step in Ugly Style building. We are going to solder the collector of Q19 to ground, in a physical location about ¾ of an inch away from the rear edge of the PC board, and about half an inch away from what will be the right edge of the main board. To make it easier to solder the collector to ground, we will first make a solder spot in that location on the board.



That little solder spot is the first step in the actual construction of this rig, Ugly Style. Now let's get Q19 soldered on.

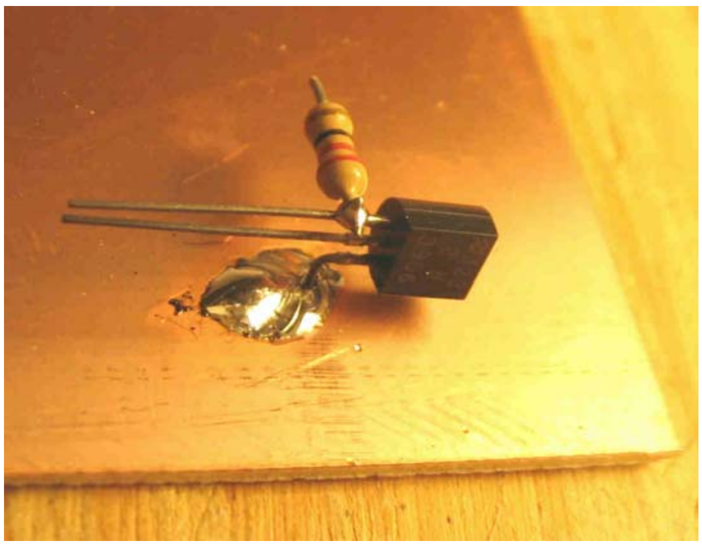


And there it is, Ugly Style construction begun. Congratulations. You've made that all-important first step. Now, what's next?

Remember, we said that part leads that connect to ground are soldered directly to the copper substrate, and ungrounded connections are simply soldered to each other. We also said that the circuitry is physically supported by those parts that go to ground.

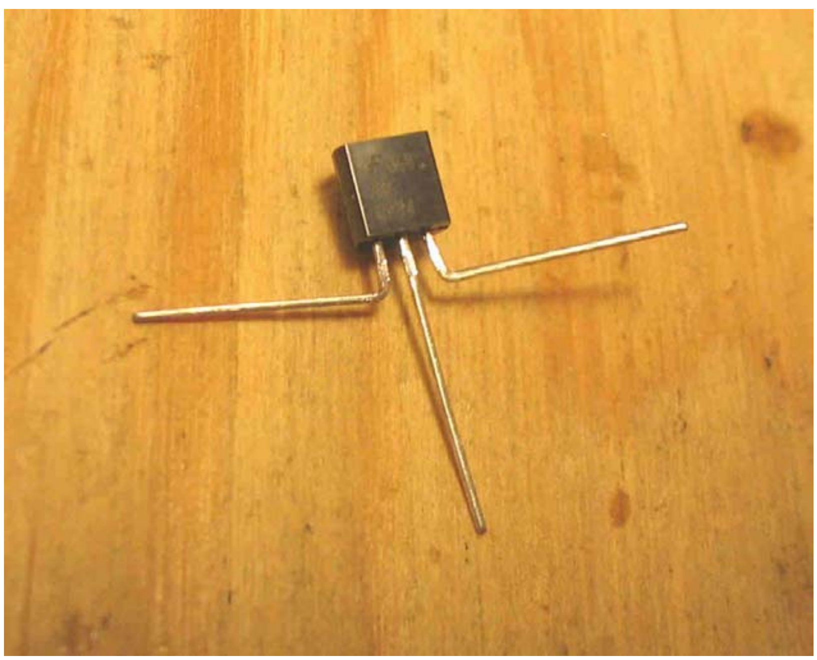
Looking at the audio output amplifier circuit again, we see that Q19 connects, through R75 and R74 to the emitter of Q18, and that the collector of Q18 connects to C46 and C47, both of which go to ground. These associated parts will be physically supported by the grounded collector of Q19 and the grounded leads of C46 and C47. We already have the Collector of Q19 soldered to ground. So let's start building over towards C46 and C47.

The next part in line is R75. We can see from the circuit that it connects to the emitter of Q19. Select a 22 Ohm resistor, cut one lead off fairly short, about 1/8" from the resistor body. Tin the short lead with just a small bead of solder, and use the long remaining lead as a handle to hold the short lead against the emitter lead of Q19 while you apply your soldering iron and complete the connection. Then cut the free lead of R75 as you did the first one. See the R75 installation photo below for further explanation.

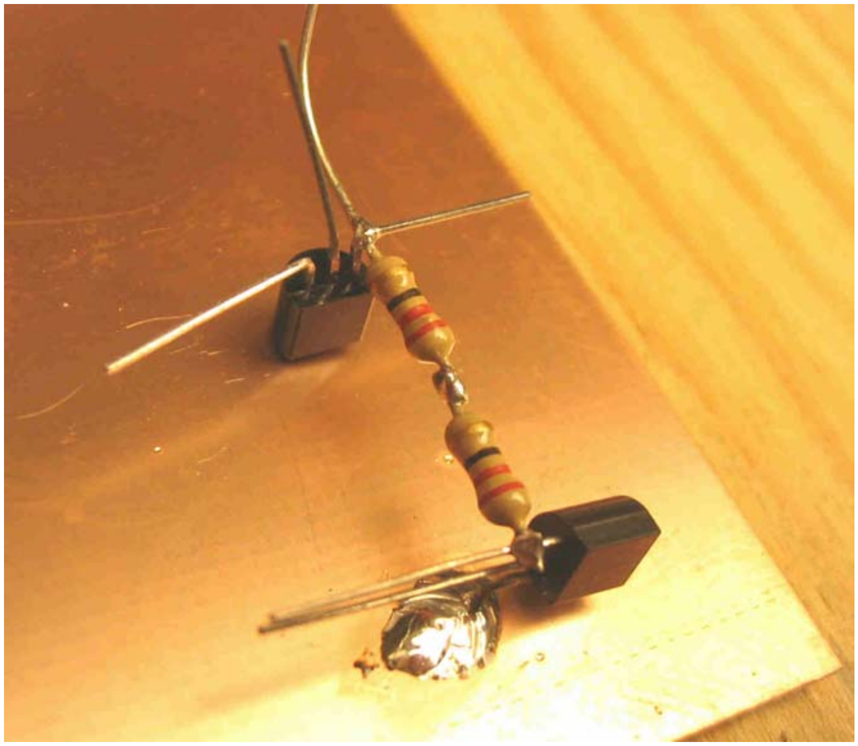


The next component in line is R74, another 22 Ohm resistor. Cut one lead short, tin it, and then solder it to R75, as shown below.

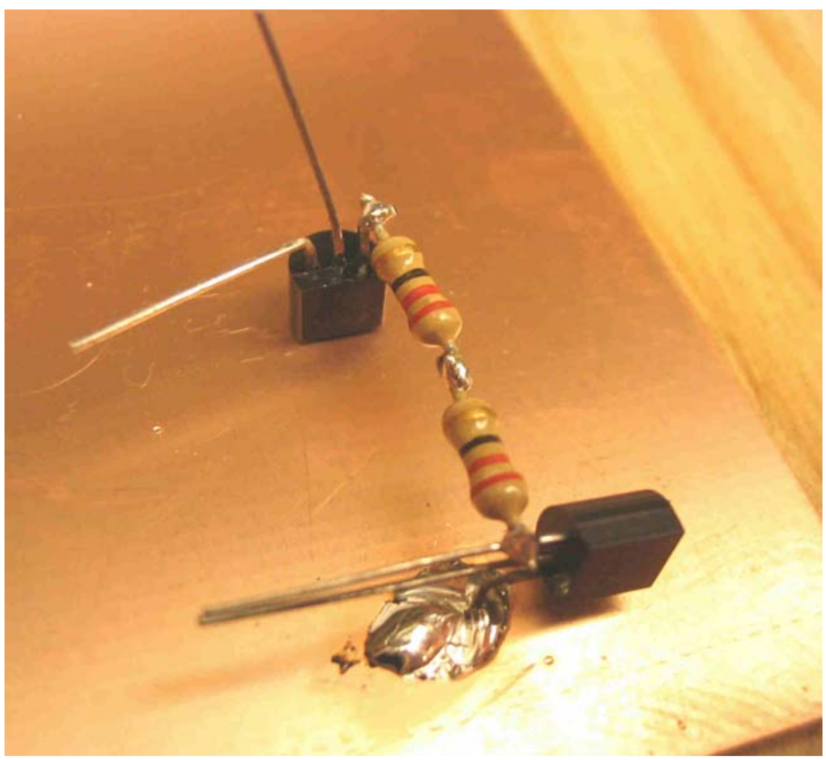
Next in that line of components is Q18, a 2N3904. Prepare it for installation as seen below.



And then solder its emitter to R74, as shown below.

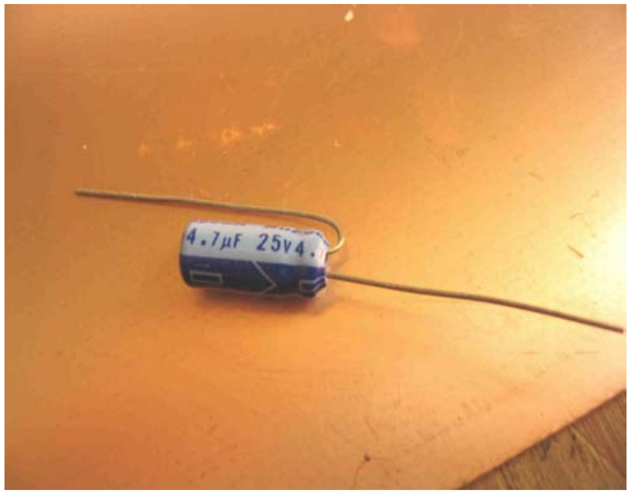


Clip the R74 and Q18 emitter leads as shown here.



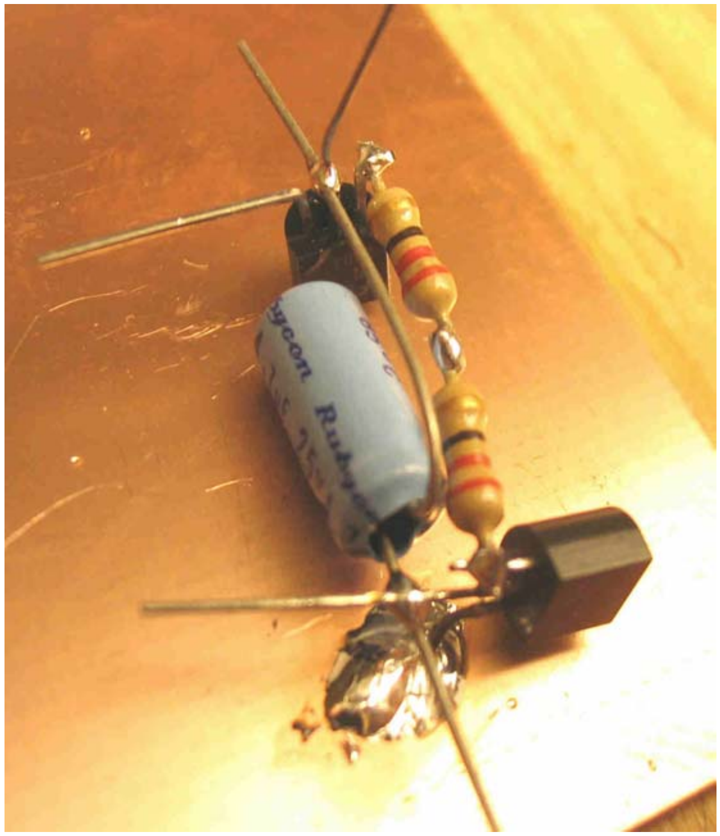
Even though no leads of Q18 will be grounded, by placing it vertically with the leads up, the plastic case provides both insulation and support for this “bridge” of parts.

Taking a look at the schematic again, we see that C60, a 4.7 uF electrolytic capacitor, connects between the base leads of Q18 and Q19, negative to Q19 base, and positive to Q18 base. Let’s prepare it for installation as shown here.

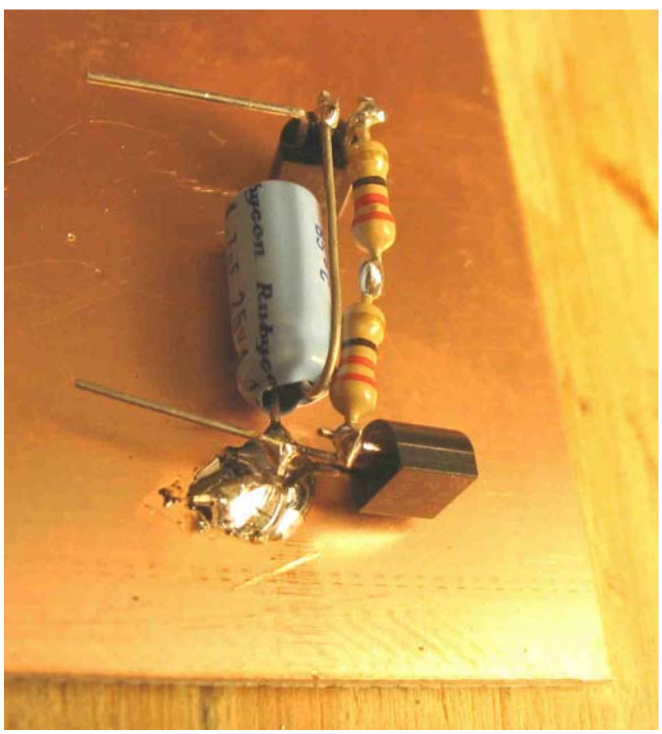


Note that the negative lead is left straight, and the positive lead is bent back over the body of the capacitor.

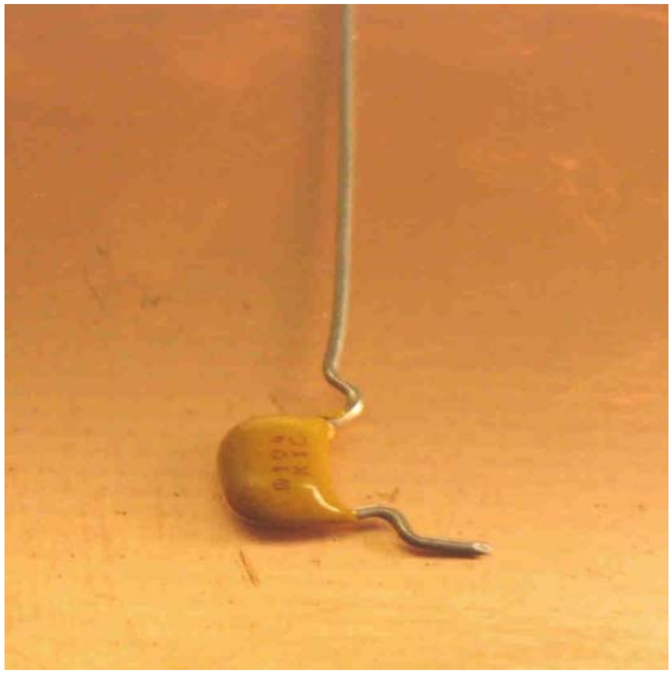
Now, let’s install it, as seen here.



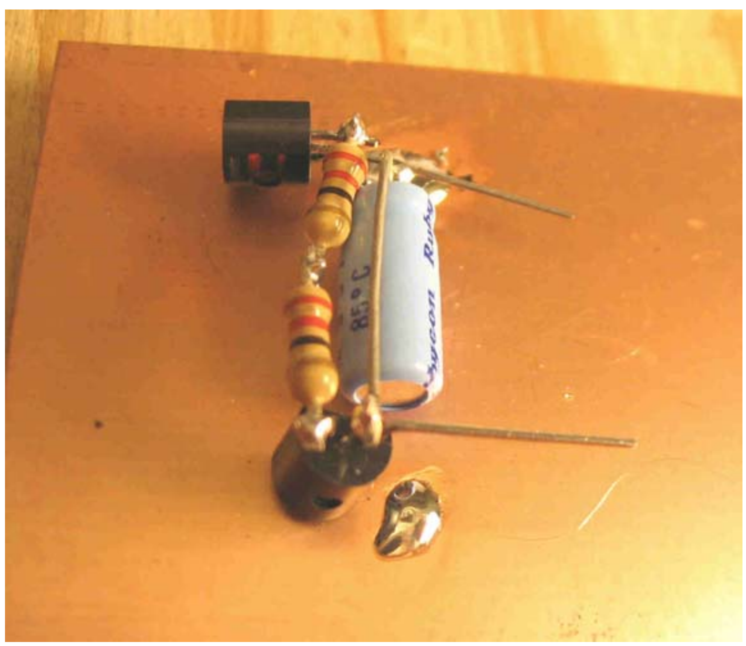
Clip the leads as shown below. Check to be sure that there is no short circuit between the base and emitter of Q18, or the base and collector of Q19.



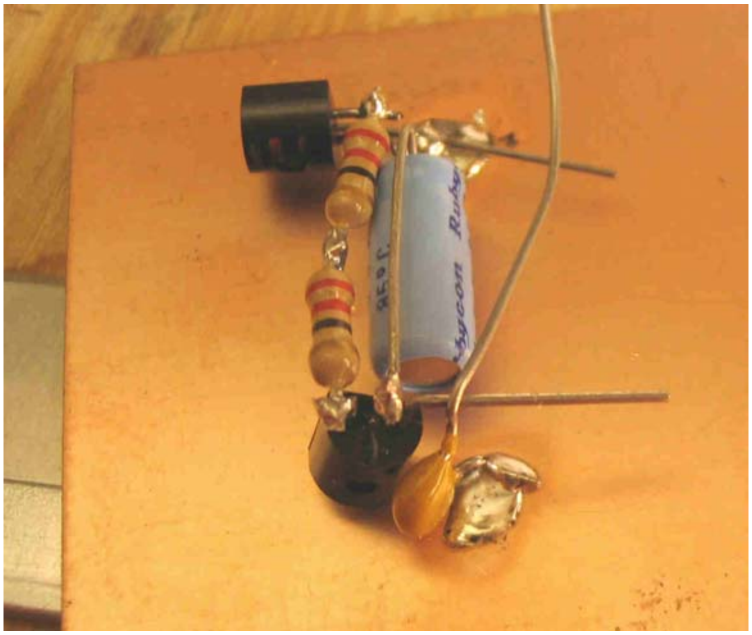
Now, in order to mechanically stabilize our "bridge" of parts, we will install C47, since it connects between the collector of Q18 and ground. Prepare a .1 uF capacitor as shown below.



And, form a solder spot in the location where C47 goes to ground, as shown below.



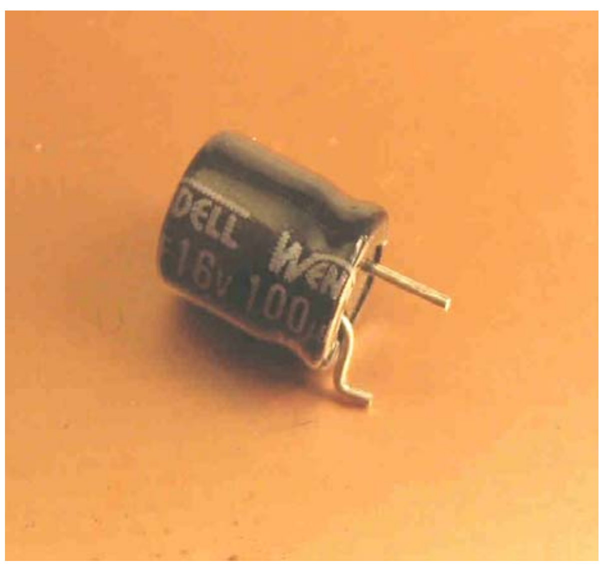
Now, solder the short lead of C47 to ground, as shown below.



Then, solder the .1 cap's long lead to the collector of Q18, and clip it short.

To add more mechanical support, and complete that leg of the circuit, we will install C46, a 100 uF electrolytic capacitor, next.

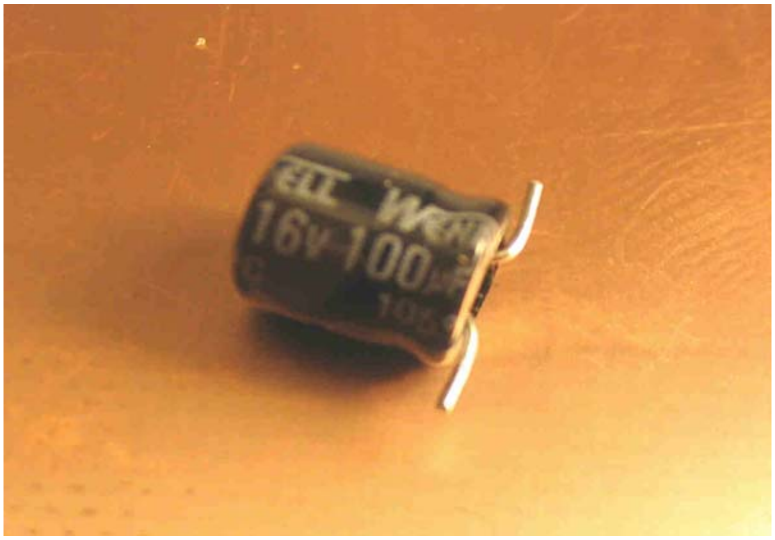
Prepare it as shown here.



Now solder the negative lead of C46 to ground, right next to the grounded lead of C47, as shown below.

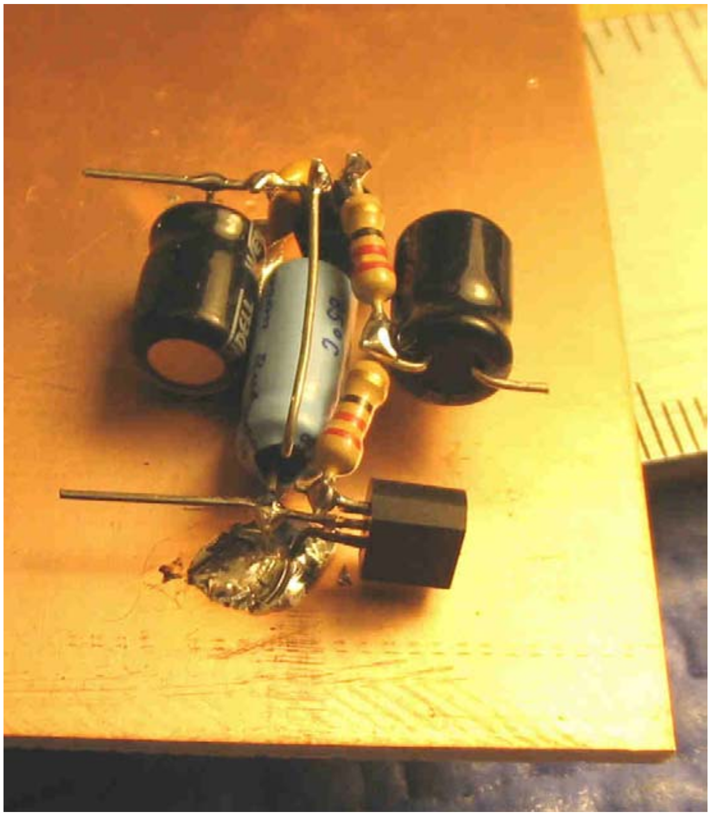
Next, solder the positive lead of the 100 uF cap to the collector of Q18 as shown below.

Now that we have our parts bridge firmly stabilized, let's complete the output end of the amplifier. First, we will prepare a 100 uF electrolytic capacitor as shown below.



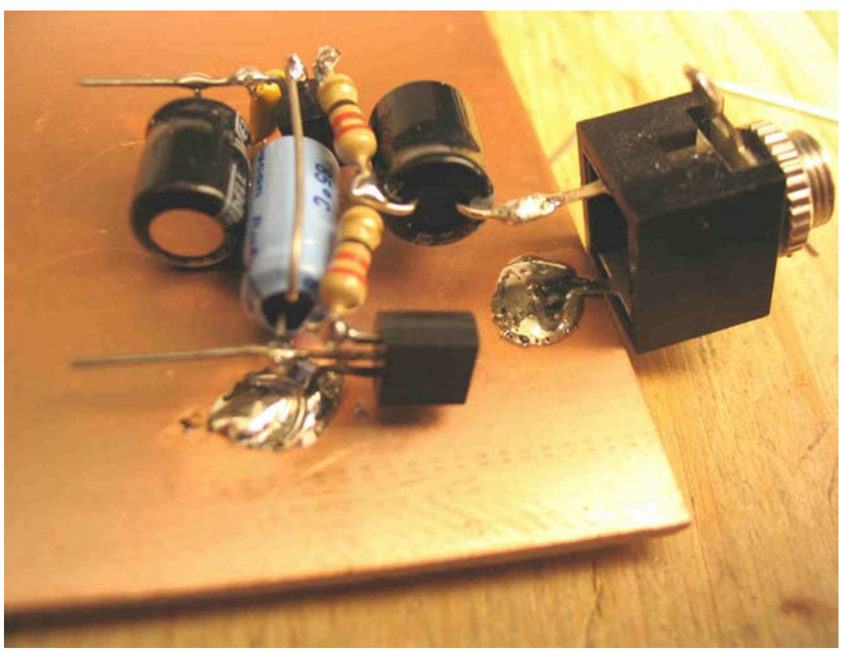
This capacitor will become C61, connecting the output of the complimentary symmetry output amplifier, the junction of R74 and R75, to the earphone jack.

Now solder the positive lead of the 100 uF cap to the junction of R74 and R75 as shown below.



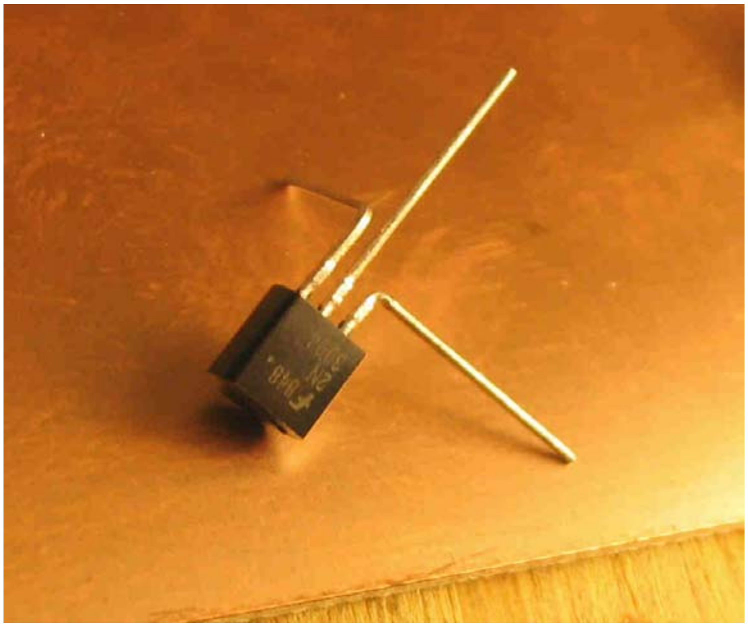
And now form a solder spot between the edge of the board and C61 for the ground connection of the earphone jack, as shown here.

Solder one lug of the earphone jack to ground, as shown here. Position the ground lug of the earphone jack up. That will effectively place the individual earpieces in series, electrically.

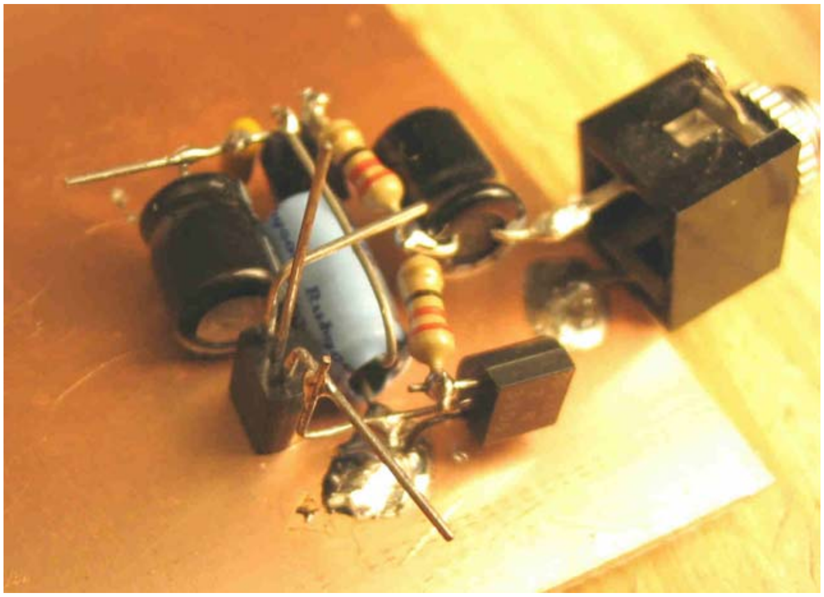


With the output portion of the amplifier circuit now complete, we can go back to finishing the input section.

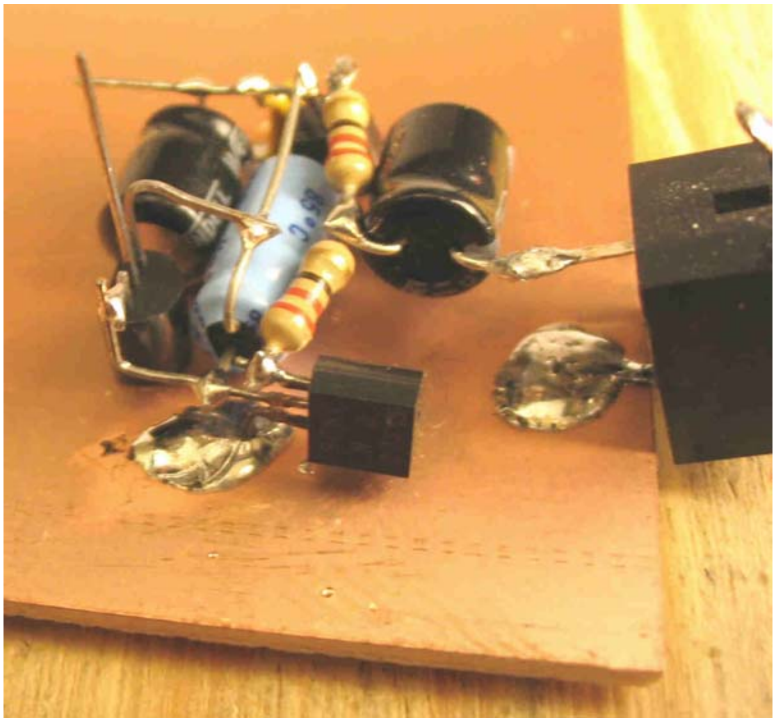
A quick look at the circuit shows us that Q17 should be next, with its emitter connected to the base of Q19, and its collector connected to the base of Q18. Prepare a 2N3904 transistor as shown below.



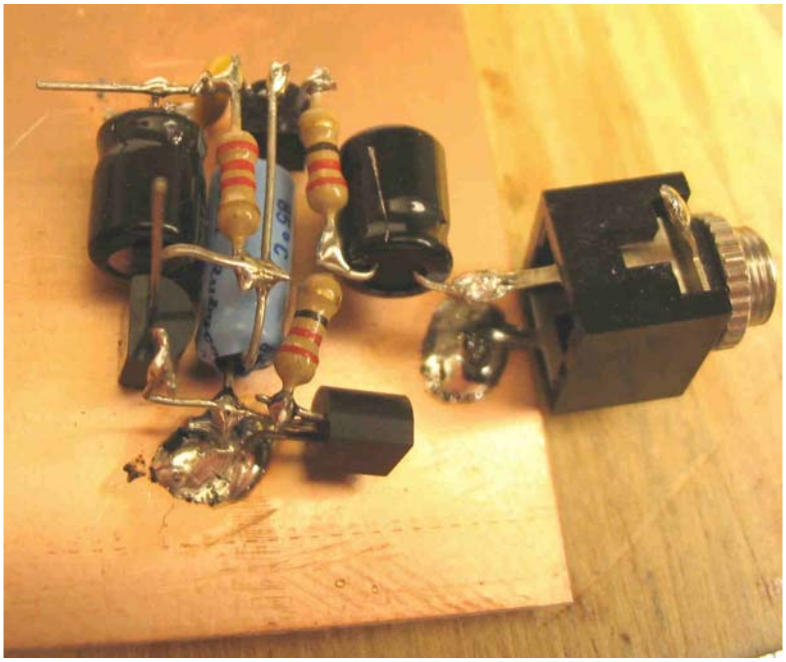
Position this 2N3904 with its collector against the base of Q18, and bend the base of Q19 up to rest against the emitter. Solder the emitter of this transistor to the base of Q19, as shown here.



Trim the emitter lead, solder and clip the collector lead, as shown below.

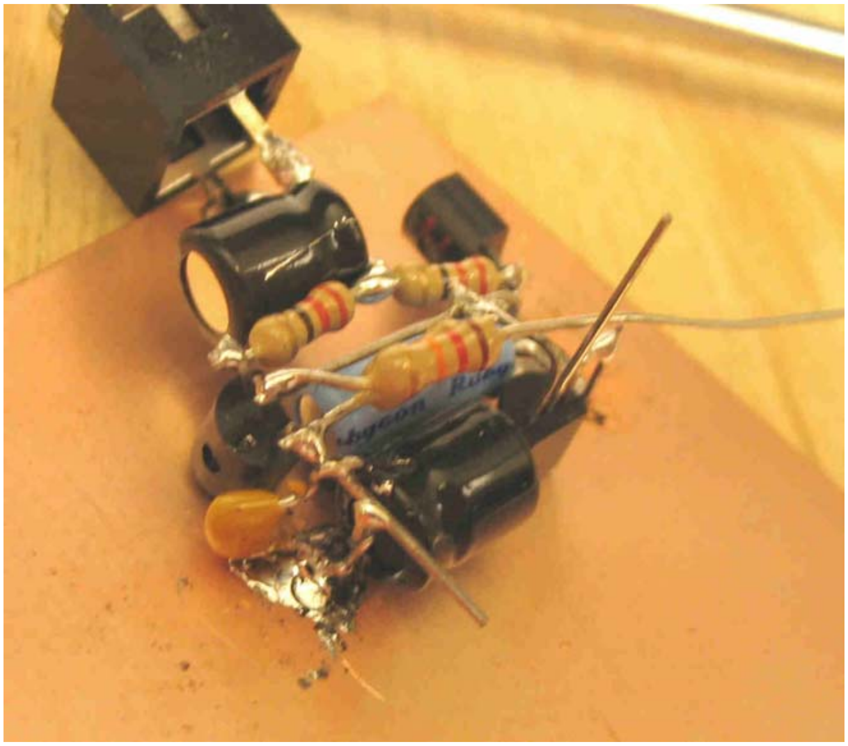


Checking the schematic once again shows us that R73 should be installed next, between the collector of Q18 and the collector of Q17. Lay a 2.2 K Ohm resistor between the collector of Q18 and the collector of Q17 (which is connect to the base of Q18) solder both connections, and trim the leads as shown here.



Next to be installed is R70, a 12 K Ohm resistor. Prepare it as shown below.

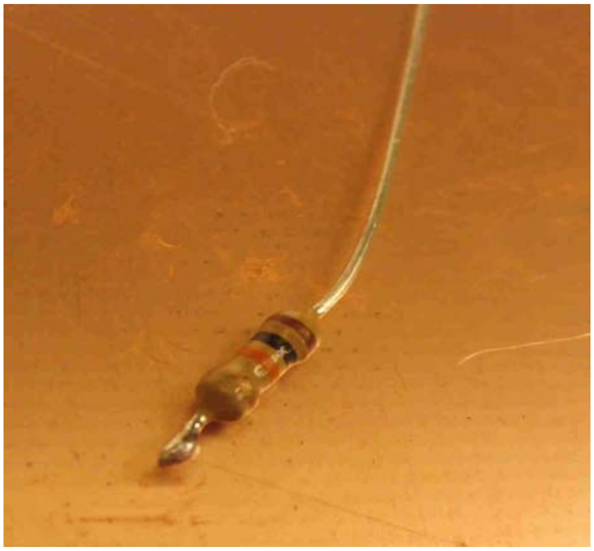
Solder the prepared end of the 12 K resistor to the base of Q18, as shown below.



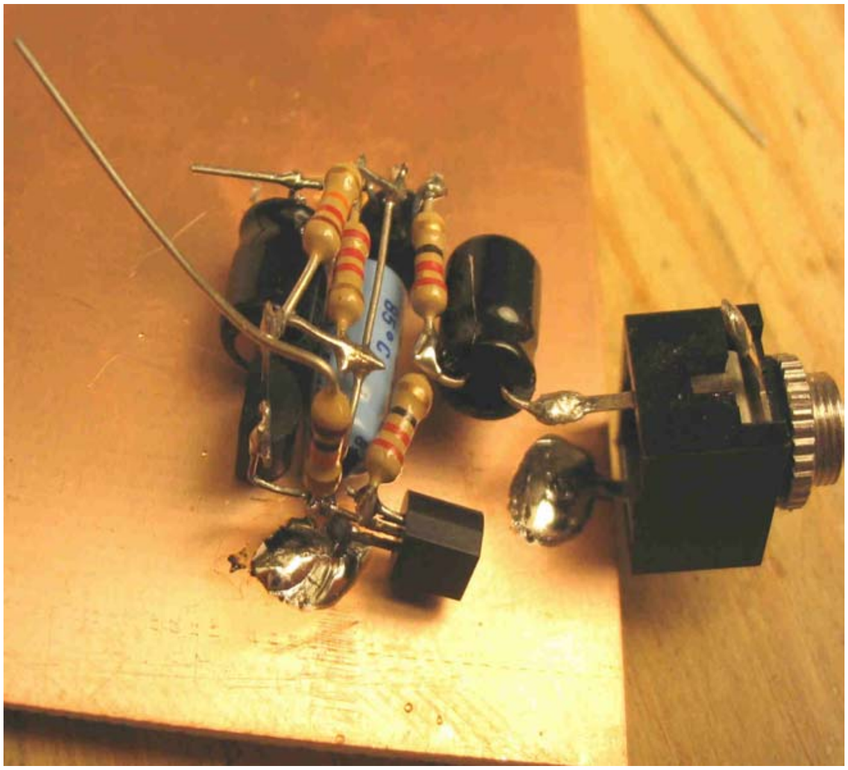
Although not clear in this photo, the 12 K resistor does not make contact with the 2.2 K resistor below it.

Next, solder the long lead of the 12 K resistor to the collector lead of Q17, and trim the resistor lead.

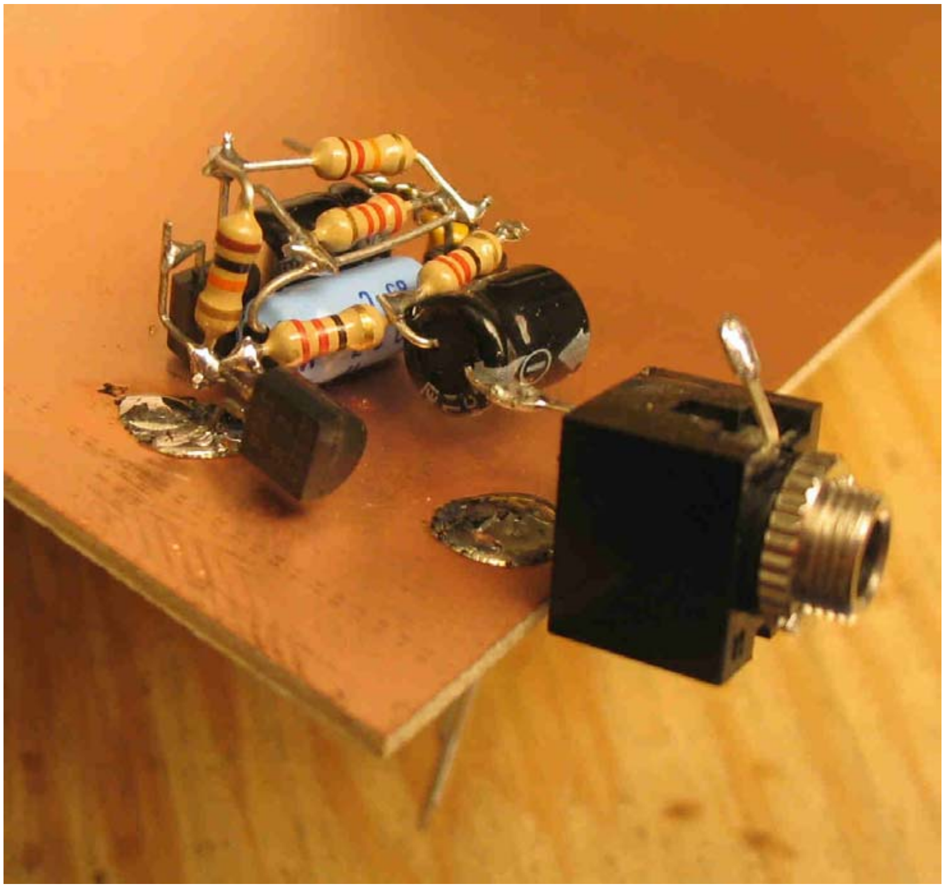
R71 will be next, a 10 K Ohm resistor, prepared as shown below.



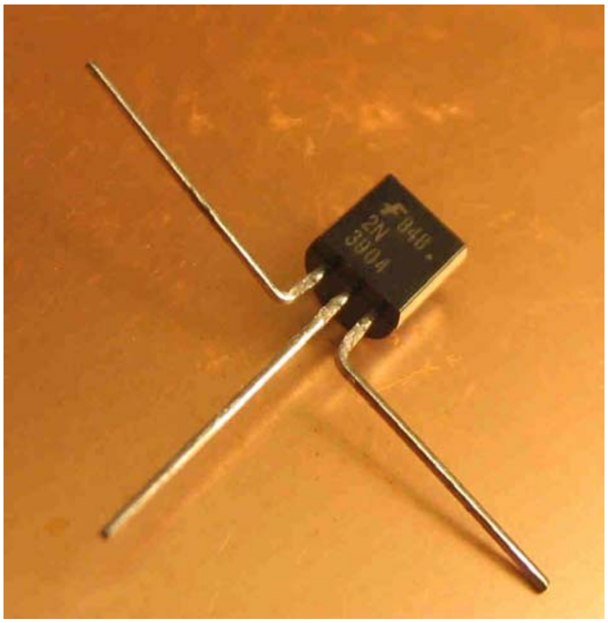
Holding the 10 K Ohm resistor vertically, solder the short, prepared end to the base of Q19. Then bend the long lead over to touch the base of Q17, as shown here.



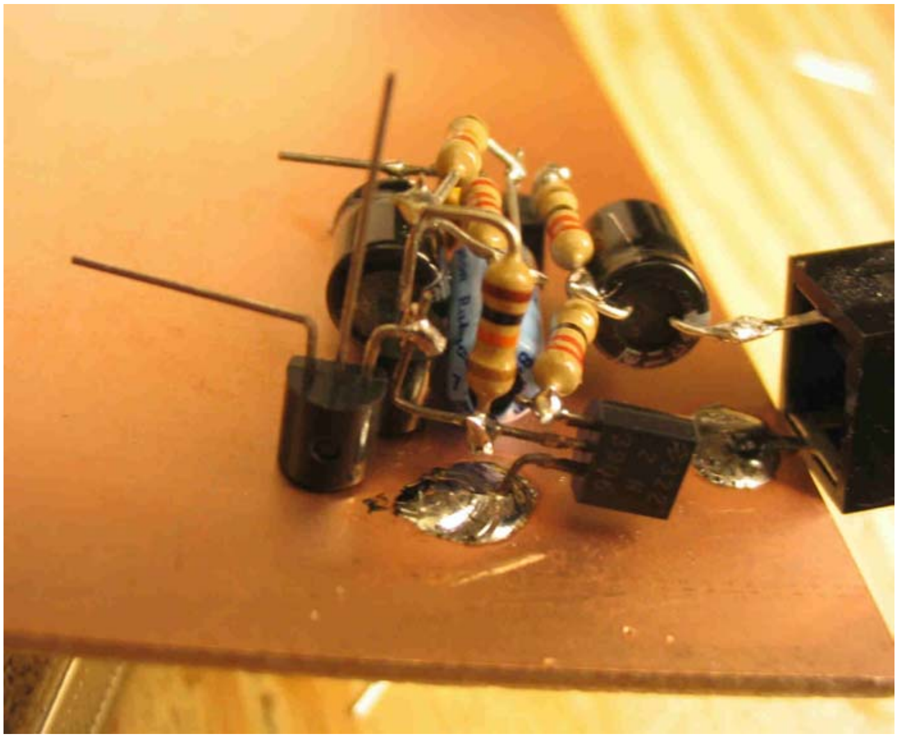
The picture below shows the top lead of the 10 K resistor, R71, soldered to the base of Q17 and lead of R70, and clipped short.



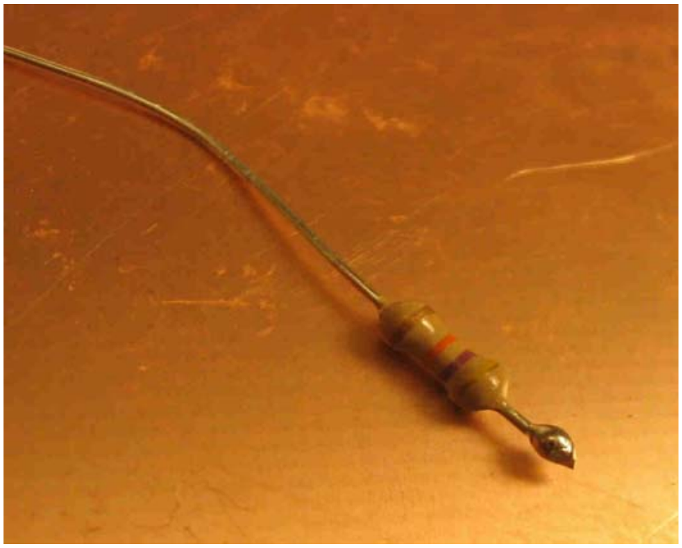
Q16 is next, another 2N3904, prepared as shown below.



Place the transistor vertically, with the collector lead against the base lead of Q19, solder the connection, and clip the lead, as shown below.

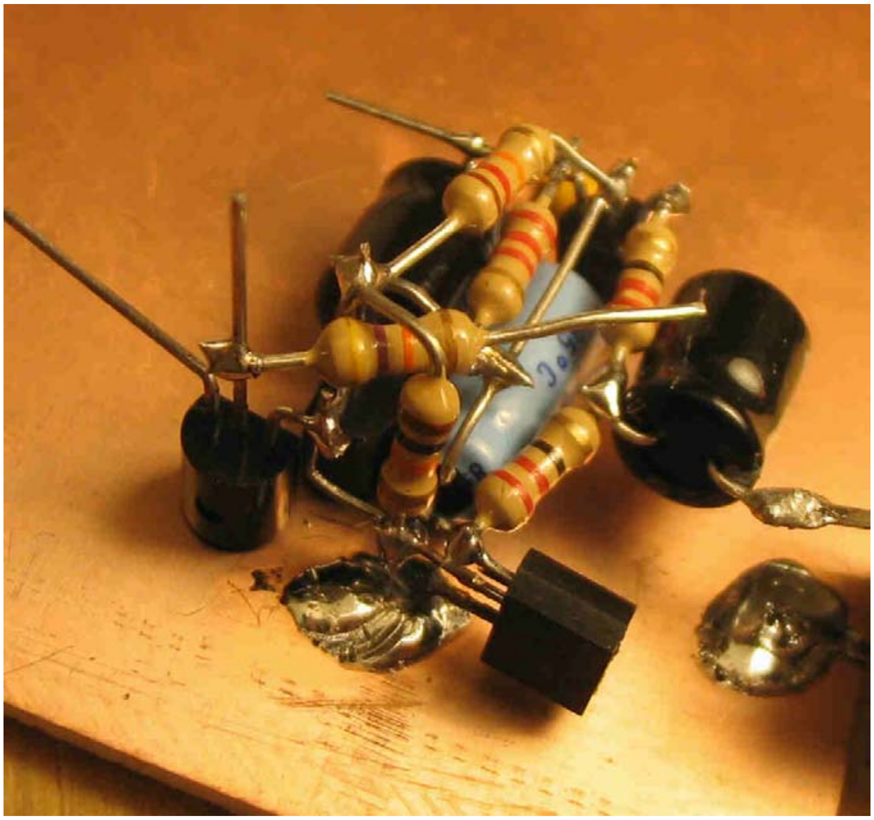


Now we are going to have a little fun. R69, along with R67, form a feedback network that help set the overall gain of the output amplifier. R69 is a 47 K Ohm resistor, prepared as shown below.



The 47 K resistor is inserted underneath the bent, upper leg of R71, held in contact with the base of Q16, and soldered there. Check to see that there is a little space between the body of the 47K resistor and all other parts. Bend as necessary. The long leg of the 47K resistor

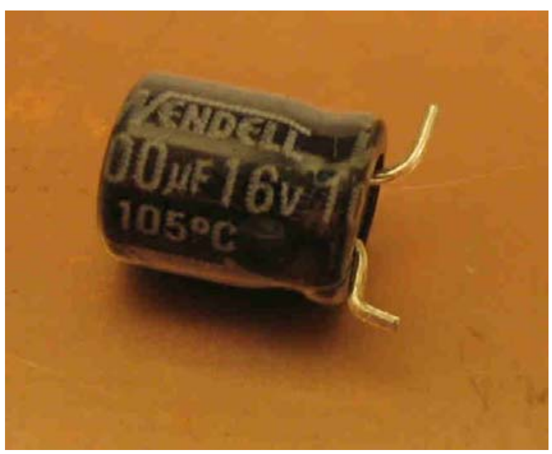
will be bent down to make contact with the junction of the two 22 Ohm resistors, so judge the correct length and clip the lead as shown.



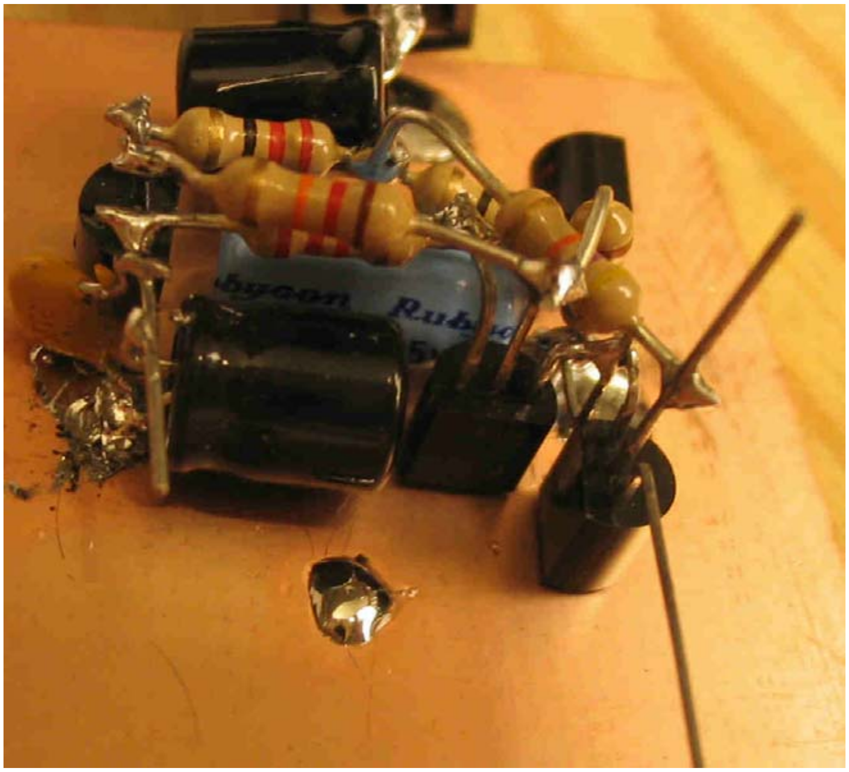
The next step is to bend the lead down and solder it to the junction of R74 and R75, as shown below.

Obviously, R69, the 47K resistor, can be placed out around the outside of the other parts, if one feels there is too little room in between.

Next on the list is C59, a 100 uF electrolytic capacitor, prepared as shown here, with the negative lead bent in “elbow” fashion, and the positive lead bent straight away from the negative lead.

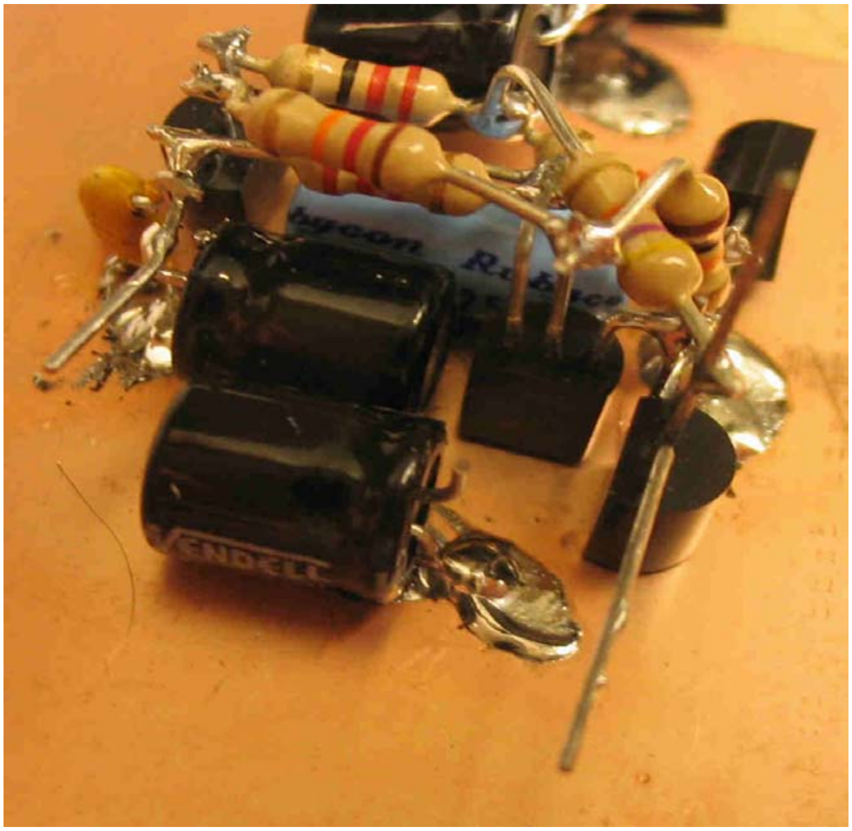


We will prepare a solder spot for its ground lead, as shown below.



The ground spot shown here proved to be too far to the left, as you will see in the next photo, of the installed C59.

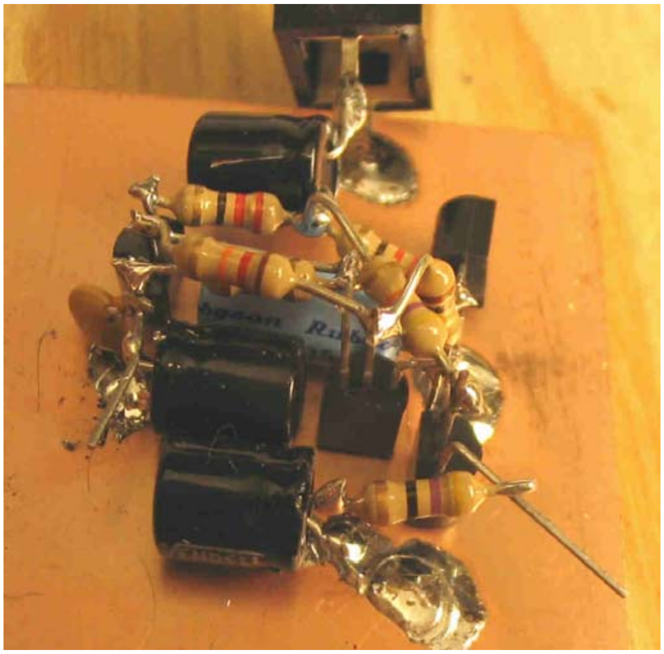
C59 Installed, with the ground lead soldered further to the right, to make clearance for the Collector lead of Q18.



C59 was deliberately placed a sufficient distance away from the emitter lead of Q16 so that a 47 Ohm resistor, R72, could be installed between the two.

A 47 Ohm resistor is prepared as shown below.

And is soldered to C59’s positive lead, as shown below.



Note that the emitter lead of Q16 was bent to allow contact with the free lead of the 47 Ohm resistor. Solder the free lead of the 47 Ohm resistor to the emitter lead of Q16, and clip the emitter lead.

Next, prepare a 680 Ohm resistor to become R68, as shown below.

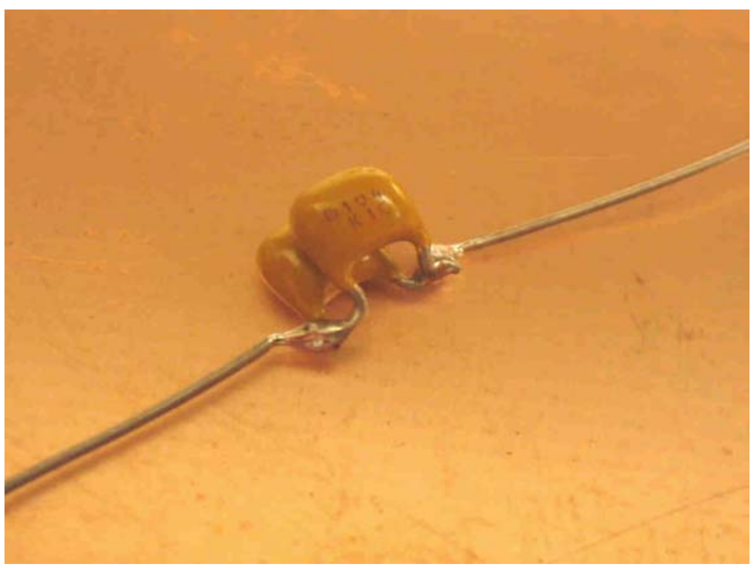
Solder the 680 Ohm resistor between the positive lead of C59 and ground, as shown below.

Next is R67, a 27 K Ohm resistor. Prepare it as shown here.

The 27 K resistor is soldered between the base of Q16 and ground, and the upper lead trimmed, as shown below.

R67

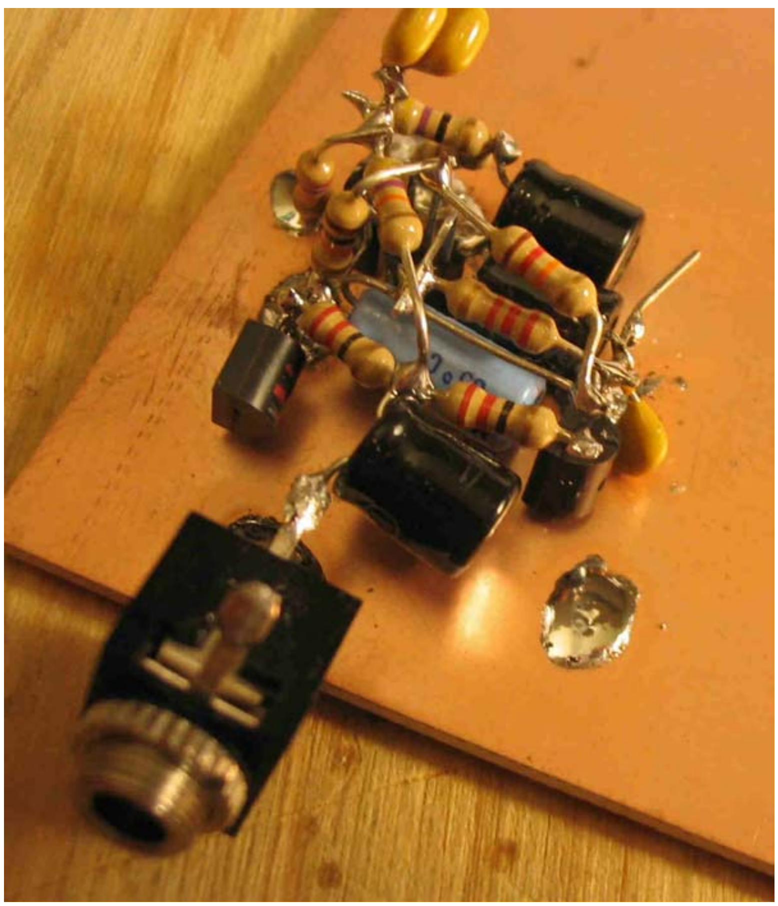
Now, we are ready to place the last discrete component in the audio output amplifier, C58. While the circuit calls for a .22 uF capacitor, we can make do with a pair of paralleled .1 uF caps, as shown below.



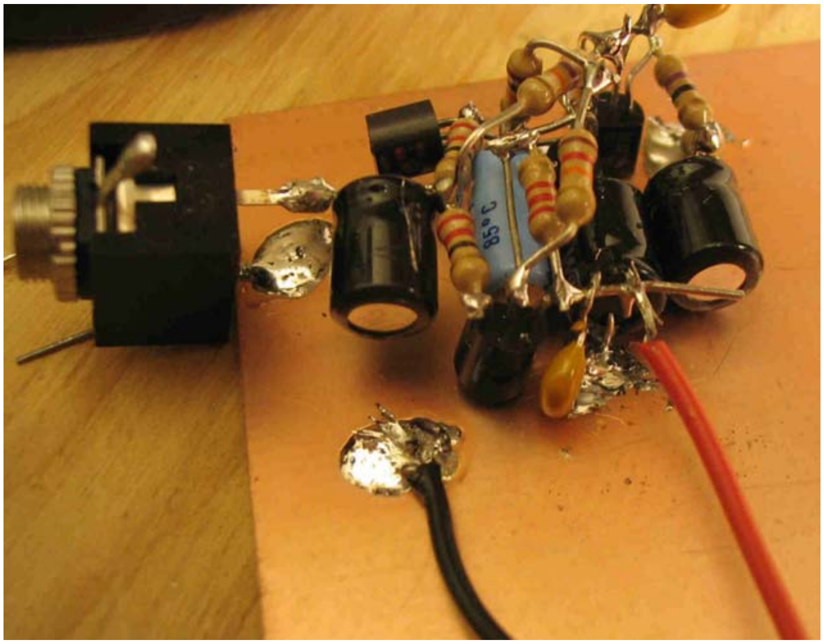
After clipping one lead short, C58's short lead is soldered to the base of Q16, as shown below.

Congratulations! You have just finished building an audio output amplifier, Ugly Style. All that is needed now is to supply power, in the form of 9 to 12 Volts DC to this circuit, and test it.

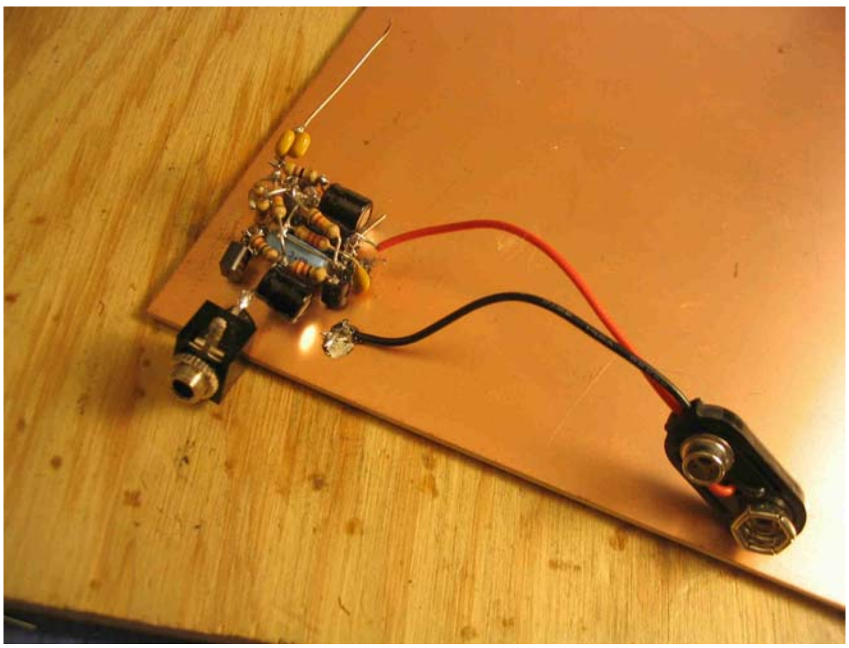
To that end, we will form a solder spot on the copper substrate, near the collector lead of Q18, as shown below, to facilitate connection of a battery clip.



Now, we will solder the leads of a battery clip to ground and the collector lead of Q18, as shown here.



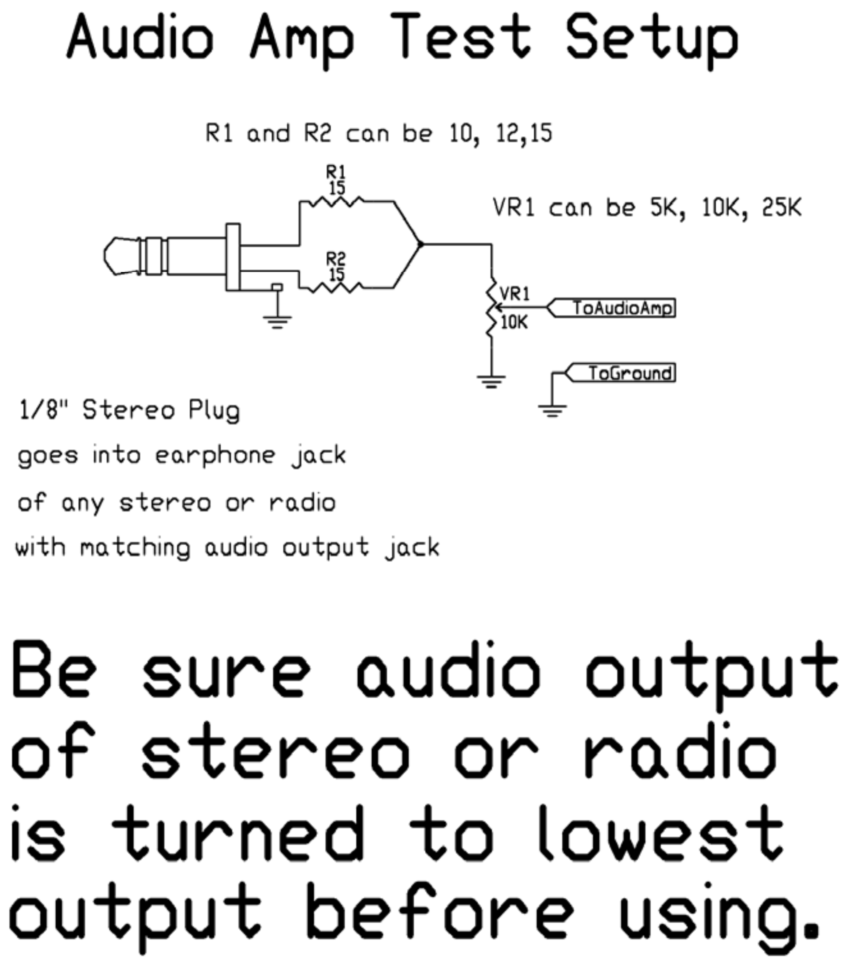
And, finally, the complete audio amp is ready to test.



One simple test of this circuit is to connect earphones, listen as you connect the battery, and then touch the free lead of the dual .1 caps with your finger.

You should hear a small "pop" as the battery is connected, and when you touch your finger to the dual .1 caps, you should hear a little 60 cycle hum.

One can also use the simple test setup described below, or an audio oscillator, to inject audio into the amplifier for test purposes.



As indicated above, before we connect the stereo plug of the test setup to the audio output of any convenient audio device with a matching audio jack, we will be sure to turn the audio gain control of the test setup to its lowest position. It is a good idea to leave the headset lying on the bench until you have made sure the audio level is low enough to prevent injury to your ears.

Concluding Thoughts About Ugly Style

Ugly Style building gives you the freedom to build, or design and build, virtually any type of electronic circuit, at will. When you see a circuit that you particularly like, and want to try it out, all it takes is the parts. No more do you have to wait for someone to lay out and sell a printed circuit board or kit in order to build something. If care is taken to use RTV caulk or 5-Minute epoxy to stabilize those few items that aren't as mechanically stable as one might like, such as toroid inductors, this type of construction is quite strong and very durable.

One Ugly Style build of the Nuts and Bolts 20 transceiver survived two trips to Kentucky and back, from California, at the hands of the U. S. Postal Service, and continues to work perfectly.

One of the advantages of the Ugly Style is that no two builds have to look the same, or have to use exactly the same brand or size parts. Another is that if something doesn't work or perform up to expectations, it is very easy to unsolder parts, remove stages or whole sections as necessary, and replace them with others.

I particularly like using PC board material both for the main substrate and for fabrication of a "case". The material is very easy to work with, can be easily soldered together, and allows one the freedom to build a case that actually fits the project just finished, no matter what size or shape it is.

Again, as is true in most rigs, the audio circuitry in the PNW15 is more complex by far than the RF stages. Having just built the most complicated part of this rig, you certainly should be able to go on and finish it.

Review of the Ugly Style Building Method

Up to this point, the process of building the Audio Output Amplifier for the PNW15, using the Ugly Style building method, was shown step by step.

To review, the method consists of using those parts that go to ground to physically support the remaining parts, and simply soldering parts together as the circuit directs. The layout almost determines itself, and is non-critical.

In building a receiver, we start, logically, with the Audio Output Amplifier, and continue on, backwards, through the receiver chain, so that we can test each section as we build them.

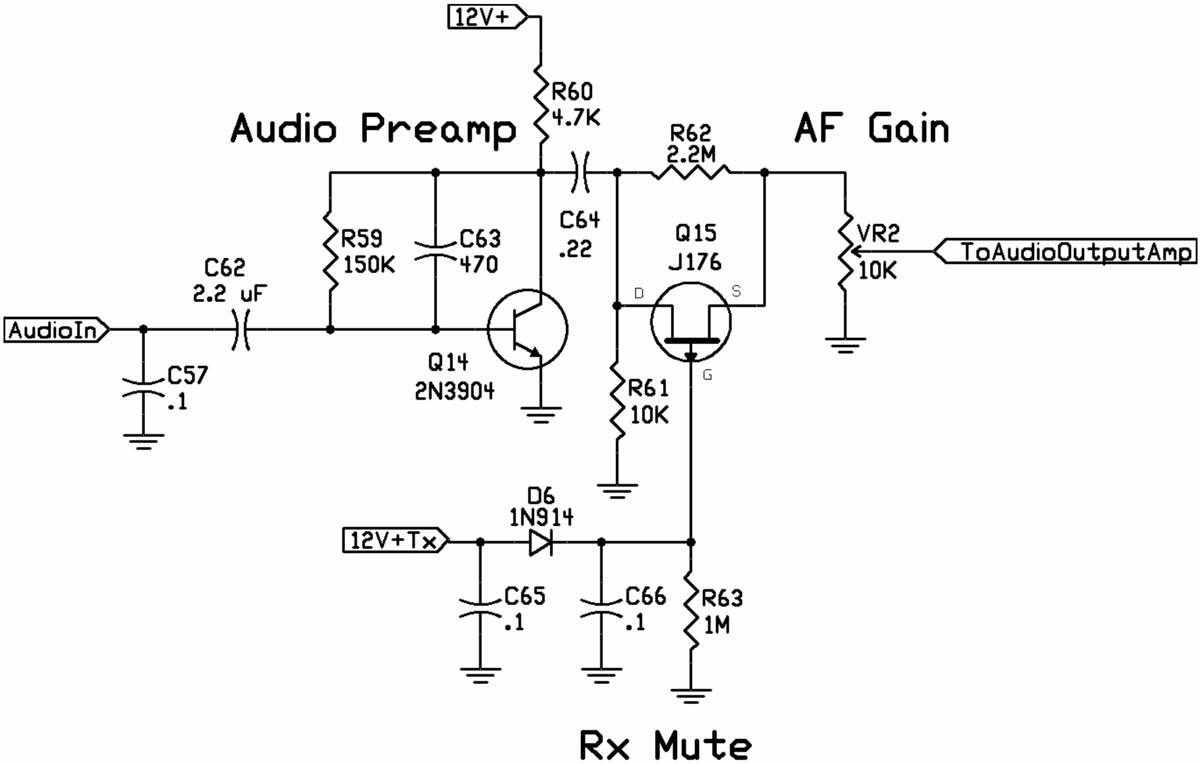
We started building on the right, rear corner of the PC board substrate, with Q19, the audio output amp transistor closest to the output that has a leg going to ground, and continued on from there, part by part.

The audio output amplifier is the most complicated single stage in this rig, and building it was described and shown in detail so that anyone who wishes to can learn the Ugly Style of building and become more comfortable with it.

The descriptions of the build from here on will be less detailed. However, by reading the circuitry presented with each stage or section, reading the text descriptions, and looking carefully at the accompanying photographs, building the remainder of the rig should follow with little difficulty.

Adding The Audio Preamp and Mute

Here is the schematic of the Audio Preamp and Mute circuitry.



Since we are building backwards through the receiver circuitry, the next part that needs to be added is VR2, the audio gain pot. Actually, this pot will be installed in the front panel of the rig, when we get to that point in the construction. For now, though, we will install it on the edge of the PC board substrate so that we can use it in testing the receiver as we go on with the building process.

This photo shows the completed build of the audio preamp and mute circuitry, with the pot installed on the edge of the board.

Audio Preamp and Mute Circuitry Completed

The yellow capacitor in lower left is C57, which shunts RF to ground from the output of the Product Detector. The light purple electrolytic is C62, which carries audio from the Product Detector to the base of the audio preamp transistor, which can be seen immediately behind C62, with its emitter soldered to ground.

A 4.7K resistor, R60, (yellow, purple, red) connects from the collector of Q14, the audio preamp transistor, to the 12V+ power line at C46, the 100uF electrolytic that bypasses audio to ground from the 12V+ input to the audio output amp.

The paralleled, yellow .1 uF caps in the left center of the photo are C64, taking the audio on to the drain of the mute transistor, Q15. The 2.2 Meg resistor (red, red, green) bridges the mute transistor, allowing a small amount of audio to pass on to the audio output amps so that we can hear the TX signal and thus have sidetone. If needed, we could adjust the sidetone level by changing the value of resistor R62.

The top of the audio gain pot connects to the Source of Q15, the mute transistor. The wiper of that pot connects to C58, the input of the Audio Output Amplifier section previously built.

A line from collector of the keying transistor, Q22, carrying 12V+Tx, will be connected to the anode of the 1N914 diode seen in lower right, so that when the transmitter is keyed, the mute transistor will be shut off, muting the audio output amplifiers while the transmitter is in operation.

Here are pictures showing more detail of the audio preamp and mute circuitry.

Audio Preamp and Mute from 12V+ side

Audio Preamp and Mute from Audio Input side

This part of the construction was begun by soldering the emitter of Q14, the audio preamp transistor, to ground. Next, the 2.2uF electrolytic, C62, was added, then C57.
To make the installation of C63 and R59 between the base and collector of Q14 easier, the leads of C63 were wrapped around the leads of R59, close to R59's body, trimmed, and soldered there. Then that paralleled combination was installed.

The 4.7K resistor from the 12V+ line to the collector was installed next, and then the mute circuitry was added.

When you are adding another stage, such as adding the mute transistor and its circuitry to the audio preamp circuitry, take a look at what parts go to ground and think, in this case of the .22uF cap that carries audio between the preamp and the mute transistor. Solder one lead of R61, 10K, to ground at a distance from Q14 that will allow for the installation of C64.

Solder C64 between the collector of Q14 and the top of R61 and trim the leads.

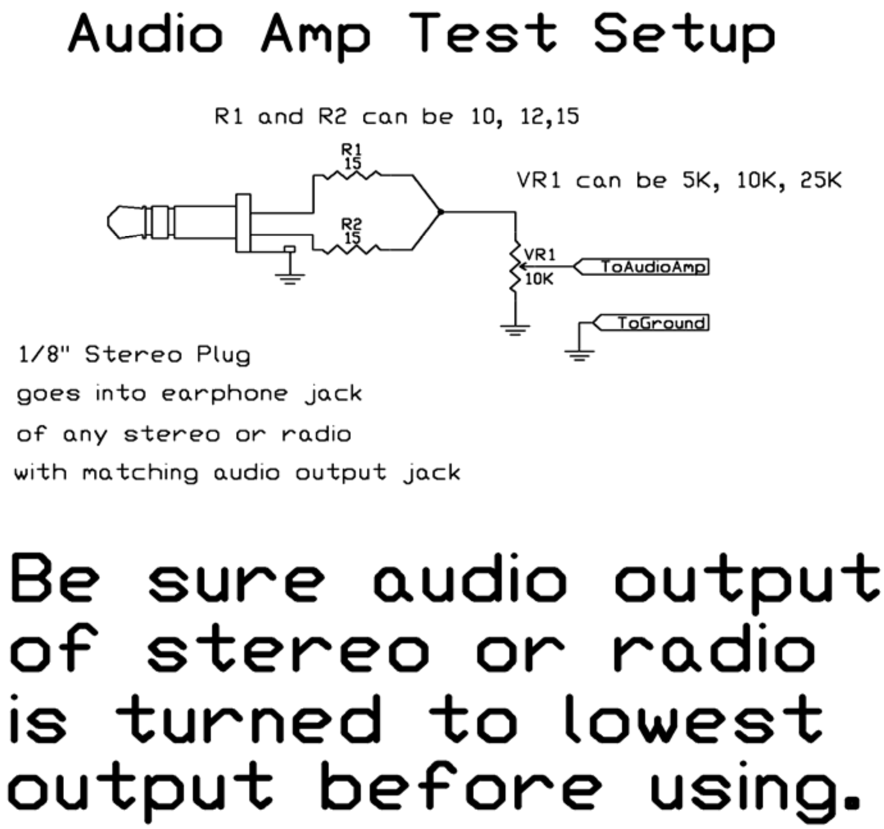
Then, identify the drain, gate, and source leads of Q15. Q15 will be installed with its body vertical, and if you look at it from its flat side, with leads up, the source, on the left, is bent towards you, the gate, in the middle, is bent away from you, and the drain, on the right, is bent to the right (see the above photo).

Solder the drain of Q15 to the junction of R61 and C64. After that lead is trimmed, solder one leg of R63, 1M, to ground close under the gate of Q15, then solder the gate of Q15 to the top of R63.

Next, solder R62, 2.2M, between the drain and source of Q15. Then, for the time being, use a cut off part lead to connect between the source of Q15 and the top of VR2.

Now add C66, D6, and C65, and you will have completed building the Audio Preamp and Mute section of the receiver.

Testing the Audio Amplifier Chain



Here, again, is the schematic of a simple test setup, which can be used to test any audio amplifier.

In this case, now that the audio preamplifier and mute circuitry has been added, we can test the muting effect also.

Since we have left a battery clip and its leads attached to the DC input of the Audio Output Amplifier, it will be easy to supply power to the audio chain.

Again, before we connect the stereo plug of the test setup to the audio output of any convenient audio device with a matching audio jack, we will be sure to turn both the audio gain control of the device and the test setup to their lowest positions.

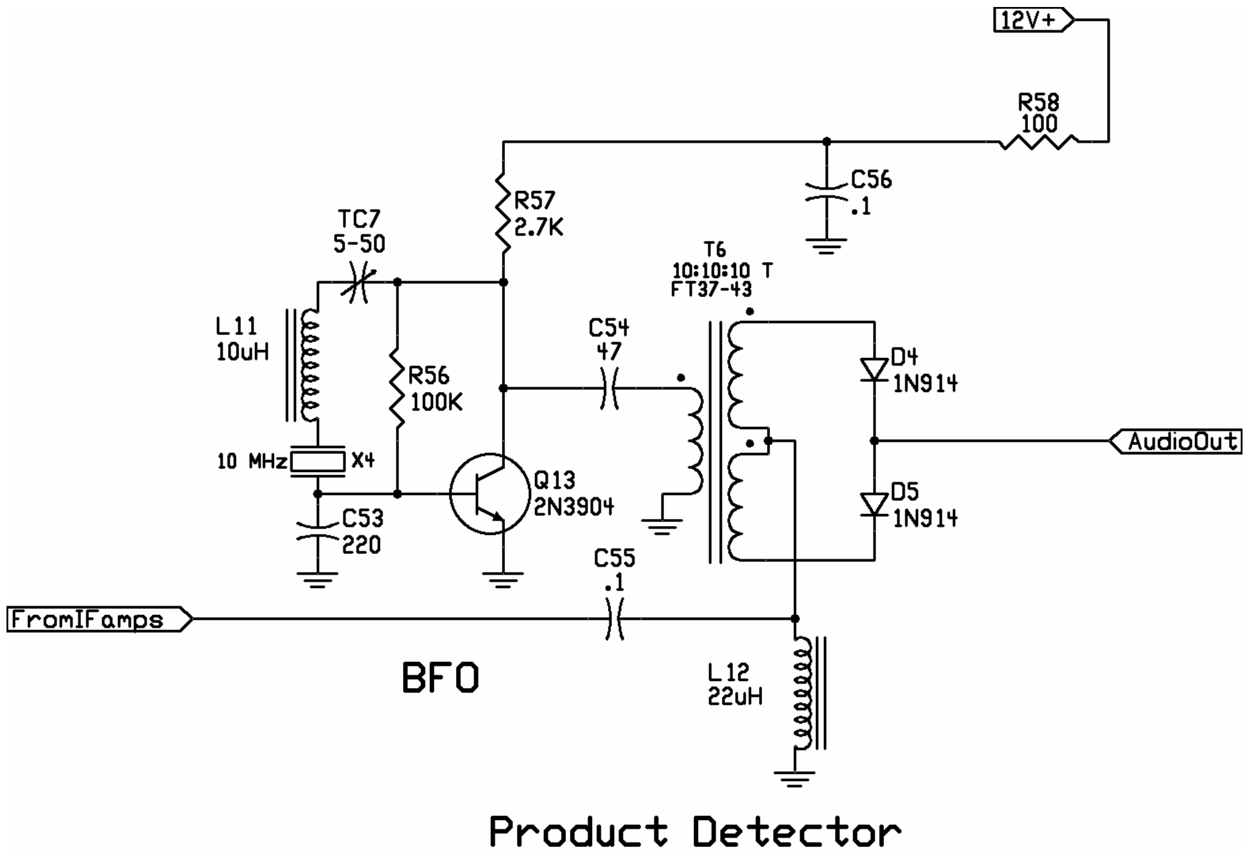
There is lots of gain in this audio amplifier chain, and it pays to be careful with the amount of input we supply it. In fact, it is a good idea not to put earphones on your head when first doing the testing. Just plug them into the audio amp chain's output jack and leave them lying on your desk.

The muting effect can be tested, once the test setup is connected and in use, with audio input and output levels adjusted, by using a jumper wire to connect between the positive DC power supply line and the junction of C65 and D6.

There should be a very definite and instantaneous reduction of audio when DC power is applied to the mute circuit's input.

Building The Product Detector And BFO

Here is the circuit diagram of the Product Detector and BFO.



You will notice one difference between this schematic and the ones posted previously on pQRP.

A 10 uH, inductor, L11, was added between TC7 and the 10 MHz crystal, X4. This was done so as to provide a little more tuning range when adjusting TC7, which is used to adjust the BFO so that an RF signal passing through the passband of the IF Filter will produce the desired audio tone in the headsets.
By now, you should be getting a little more comfortable with Ugly Style building. Once you really get used to it, you will wonder why you ever built anything any other way.

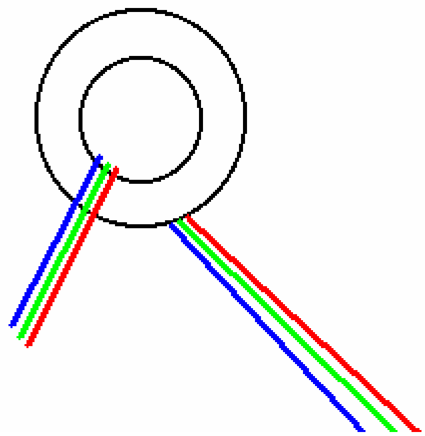
The only thing remotely complicated about the product detector is the Tri-Filar RF Transformer.

This is wound on an FT37-43 Ferrite core, and uses three windings of 10 turns each.

When winding either a Tri-Filar or Bi-Filar (two identical windings) transformer, it helps to use magnet wire with different colored insulation on each wire used as a winding.

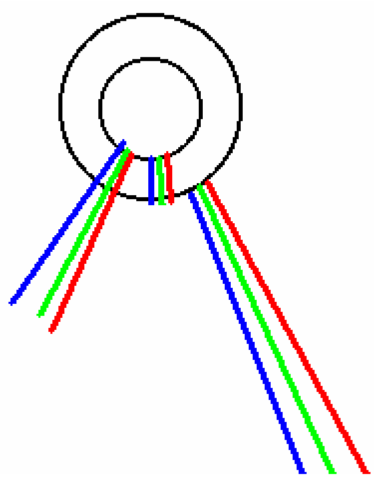
Or, if you don't have three different colors of the same wire size, two different colors will work out fine. All three of the same color will work out perfectly well, too, if the following procedure is followed.

Cut the wires to be used as windings into equal lengths, about ten inches long. Then, start the winding by passing the ends of the paralleled wires up through the hole in the toroid core and folding them over so as to form tails of about an inch in length, like shown below. That forms Turn ONE.



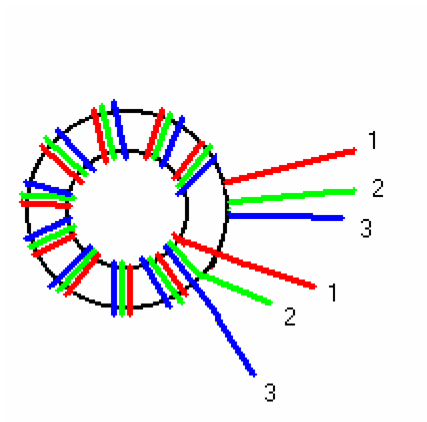
Turn Number One, Flat Wound

Then bring the long ends of the wires around the outside of the toroid and down through the hole once again, to form turn number TWO, as shown below.



Turn Number Two, Flat wound

Continue making turns with the paralleled wires, checking to make sure you have no twists and that each turn lays flat, until you have ten turns on the toroid, as shown below.

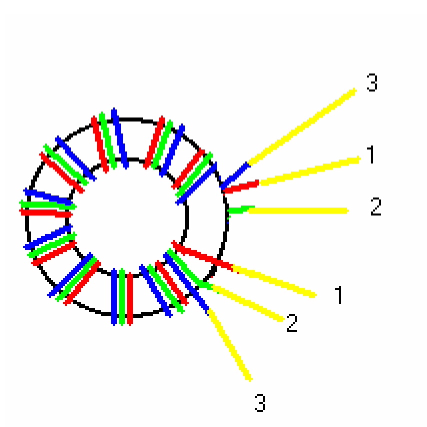


Ten Turns Tri-Filar, Flat Wound

Notice that if each turn of the paralleled wires is laid flat, with no twists, and the ends trimmed as shown, the three colors, or windings, are in the same relative positions to each other on each end of the winding.

Should you not have different colored wires, you can still easily wind a tri-filar transformer, and keep track of the winding ends, if you are careful to wind each turn flat and with no twists.

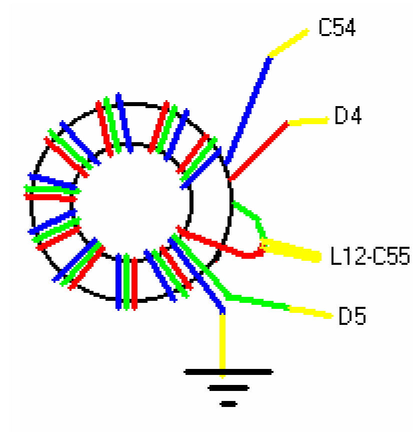
Now, in order to prepare the transformer for its connections, we first scrape the insulation off the ends of the wires, and then take the upper end of wire number 3 and take it around the upper ends of wires number 1 and 2, so that it looks like this.



T6 Preparations

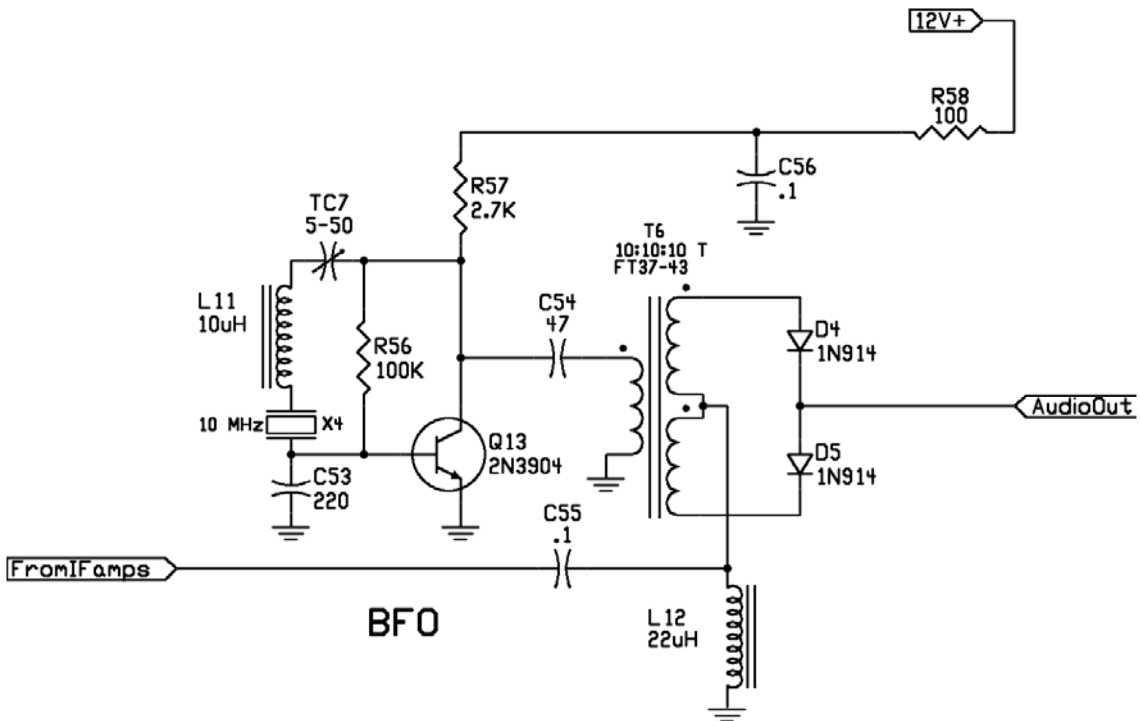
Now notice that the upper end of wire number 2, green in this drawing, is next to the lower end of wire number 1, red in this drawing. These physical positions greatly simplify the connections to be made. All we do is connect the upper end of wire 2 with the lower end of wire 1 and we have formed the secondary of the transformer with the correct phasing of the windings. Wire number 3 has thus become the primary of the transformer.

This is shown below, as well as the connection points for each winding leg of the transformer.



T6 Connections

Take the time to compare the drawing above, of the completed Tri-Filar Transformer, T6, and the connections indicated, with the Product Detector Schematic, shown again here for clarity.



Product Detector

Note that the bottom end of wire 3, and one end of L12 go to ground. The leads of D4 and D5 that are opposite their respective T6 connections are tied together and connect to the junction of C57 and C62 at the input of the Audio Preamplifier. These three connections physically support T6.

The installation of T6 is begun by soldering one end of wire #3, blue in the above drawing, to ground. Next, the 22 uH inductor is installed, soldering one of its leads to the junction of wire 1 and wire 2, and the other lead of the inductor to ground. The two diodes are installed next, between the upper end of wire one and the C57, C62 junction, and between the lower end of wire 2 and the C57, C62 junction. Be sure to note polarity.

Two connections remain to be made, the 47 pf capacitor bringing BFO energy to the primary of T6, and the .1 uF capacitor that brings RF energy to the junction of L12 and the center of the T6 secondary winding.

Below is a detail photo of the Product Detector.

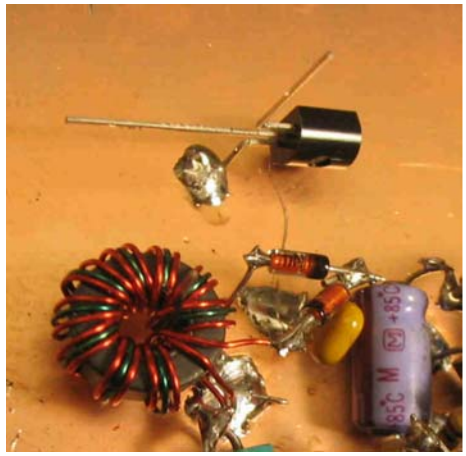
Product Detector Detail

An example of a Tri-Filar RF Transformer using two wire colors is shown here. Two red wires were used as the Bi-Filar secondary winding, and a green wire was used as the primary. The windings and connections were done exactly as described above with different colored windings.

Note the connection of D4 and D5 to the Audio Preamp input. The large, green part in lower center is a surplus 22 uH inductor from the author's junkbox. The yellow, .1 uF capacitor to the left of the inductor is C55, bringing RF from the second IF Amp.

Adding The BFO

Since the emitter of Q13, the BFO transistor, is grounded, soldering the emitter of Q13 to ground will be the first step of building the BFO. See the picture below.

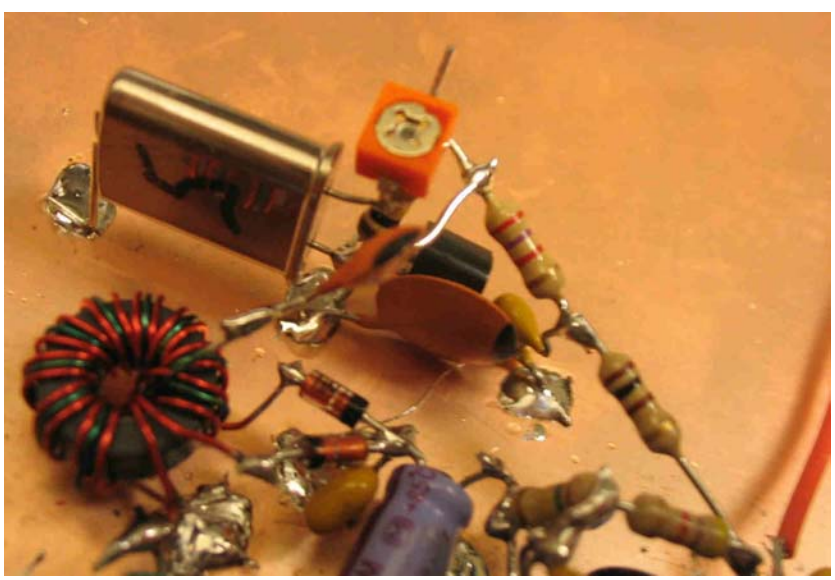


Next will come C53, from the base of Q13 to ground, R56, 100K, from base to collector of Q13, and then the crystal, 10uH inductor, and trimmer capacitor between base and collector.

For a better fit, both a surface mount inductor and a miniature trimmer capacitor were used here. First, one lead of the crystal was soldered to Q13 base. Next, one end of the inductor was soldered to the remaining crystal lead. Then the trimmer capacitor was soldered between the remaining end of the inductor and the collector of Q13.

A 47pf NP0 capacitor was then soldered between the collector of Q13 and the free, ungrounded end of wire number 3, the primary winding of T6.

Next, R57, 2.7K, C56, .1 uF, and R58, 100 Ohms, were added, completing the BFO installation. Here is a photo showing detail. Note that a cut off part lead was used to solder the end of the crystal case to ground, helping to stabilize the BFO installation physically.



The BFO and its Connections

Note that L11, the 10 uH inductor, is not shown in this photo. It was added later, after the receiver was finished and it was determined that more BFO tuning range was needed.

Testing the BFO

One can listen on 10 MHz for the BFO signal with a general coverage receiver, look at its output with an oscilloscope, or measure the amount of RF on its output. Since the Product Detector makes use of 1N914/1N4148 silicon diodes, one should see more than 1.4 Volts, Peak to Peak, on the connections between C54 and the single, primary winding of T6.

Testing the Product Detector

In order to test the Product Detector at this point, one needs a 10 MHz signal to inject. This can come from a simple, crystal oscillator, built up for the purpose, or could come from a signal generator.

However, since the circuitry built so far actually forms a direct conversion receiver for 10 MHz, one may well be able to use WWV as a signal source, if an outside antenna is connected to the input of the Product Detector at C55.

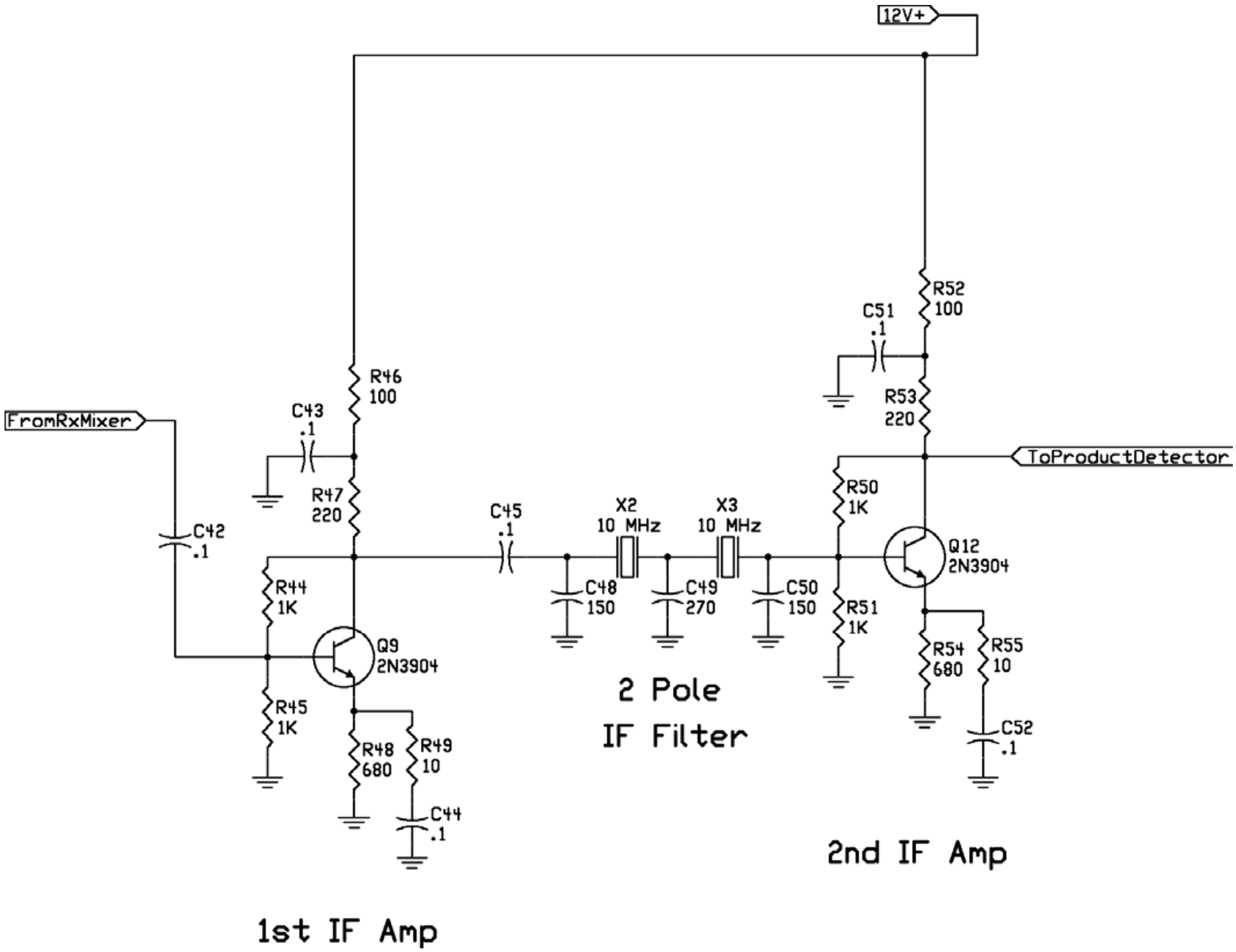
As an alternative, if one does not have a crystal oscillator already built to plug a 10 MHz crystal into, the PNW15's Transmitter Oscillator could be built at this point and used as a signal source.

Powering up a 10 MHz crystal oscillator that is just sitting on the bench nearby should provide enough of a signal to be heard quite easily, without physically connecting it to the product detector's RF input.

On to the IF Section

A minor change was implemented in the IF Section, in that the 6 db pads on the collectors of the two IF Amps were eliminated, and 220 Ohm collector loading resistors were used instead. This change was made in order to slightly increase the gain through the IF Amplifier chain.

Here is the current circuit diagram.



In the picture below, you will see that the resistive pad on the collector of the second IF Amp has not yet been changed. To implement the change, the 390 ohm and 100 ohm resistors going to the .1 RF coupling cap at the input to the Product Detector were eliminated, and the collector loading resistor, R53 in this case, was changed to 220 Ohms. The IF Amp layout remains the same.

As always with Ugly Style, construction of this stage was begun with those parts that go to ground, R54, C52, and R55, and then progressed to Q12, R51, R50, R53, C51, and R52. Next, the IF Filter and First IF Amplifier were added, as shown in the photo below.

PNW15 IF Strip

The cases of each crystal are connected to ground by a cut off lead part. This enhances physical stability and helps reduce feed-through of unwanted RF outside the filter's passband.

As noted above, the collector circuit of the first IF Amp has not yet been changed in this photo. Refer to IF Strip circuit diagram for details. Also, an extra .1 uF cap was used to physically support the 12V+ end of R46 (100 ohms) and a short length of stranded, insulated wire was used to connect R46 to the 12V+ DC power line.

Testing the IF Strip

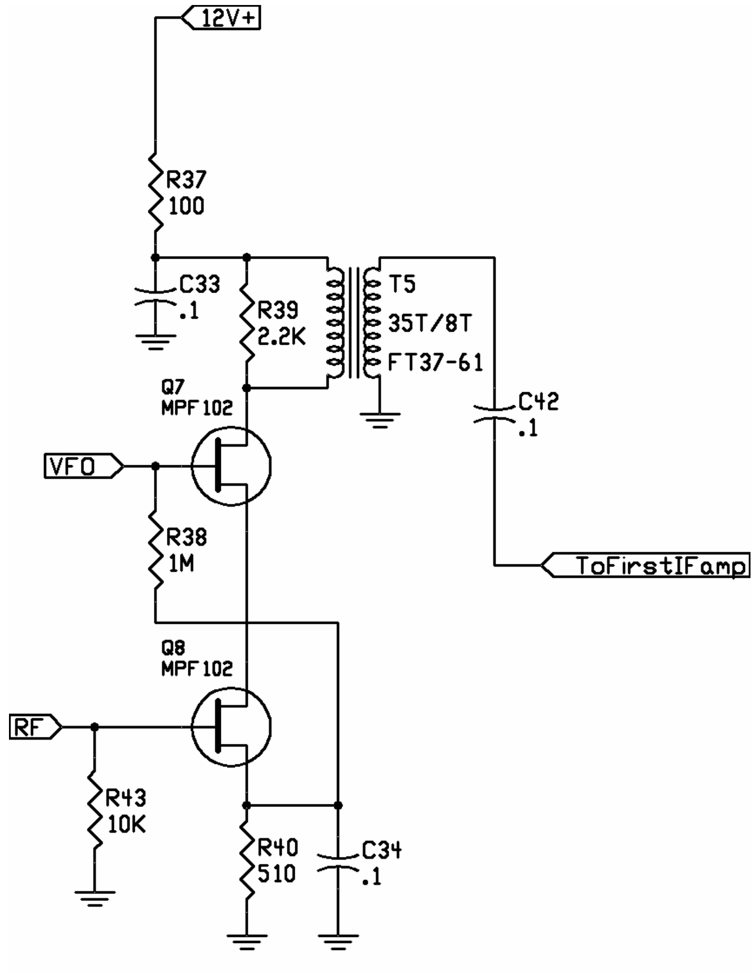
If a .1 uF capacitor is added to the input of the First IF Amp, at its base lead, connecting an outside antenna to that capacitor should provide enough of a signal from WWV to be heard easily. Or, a signal generator or nearby 10 MHz crystal oscillator can be used to inject a signal into the IF chain.

Building The Receiver Mixer

The Cascode Mixer used in the PNW15 receiver is pretty straightforward, in that it performs like a dual-gate mosfet mixer. The two FETs are series connected, with the gate of the lower FET acting as Gate 1 of a dual-gate mosfet, and the gate of the upper FET acting as Gate 2. A peak-to-peak VFO signal of 5 Volts is injected on Gate 2, and the received RF signal is injected on Gate 1.

R39, the 2.2K resistor across the primary of the output transformer is there to help prevent VHF oscillation in the stage.

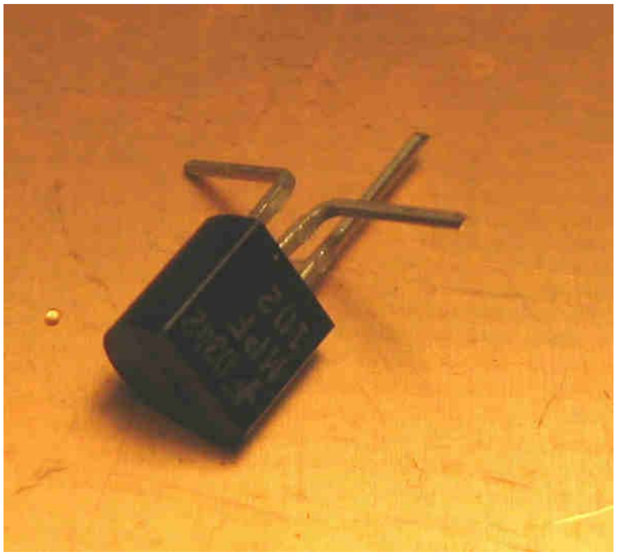
Here is the circuit diagram.



Cascode Mixer

Following the methodology of Ugly Style, we start by installing R40 and C34, and work through the stage from there.

Q8 is prepared for installation as shown below.



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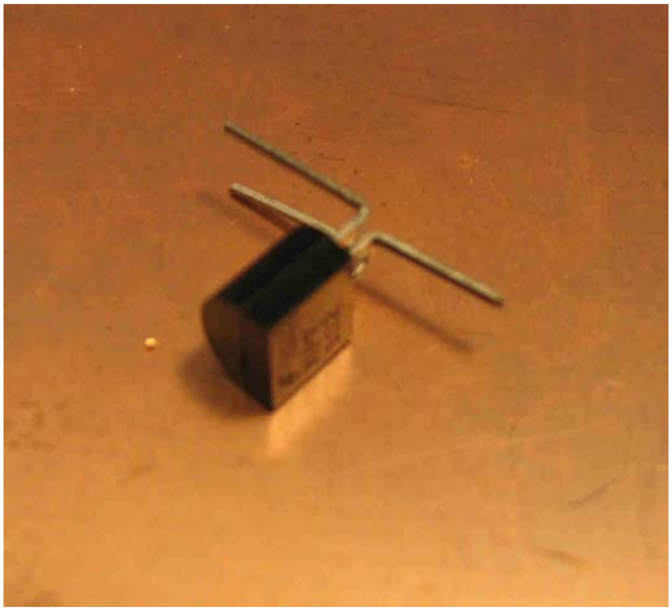
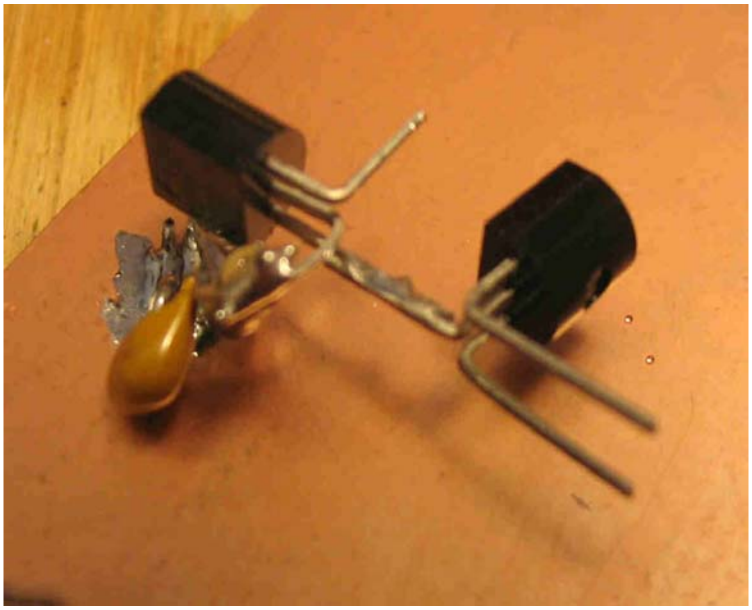
Q8 ready to install

Next, Q7 is prepared, as shown below.



Q7 prepared for installation

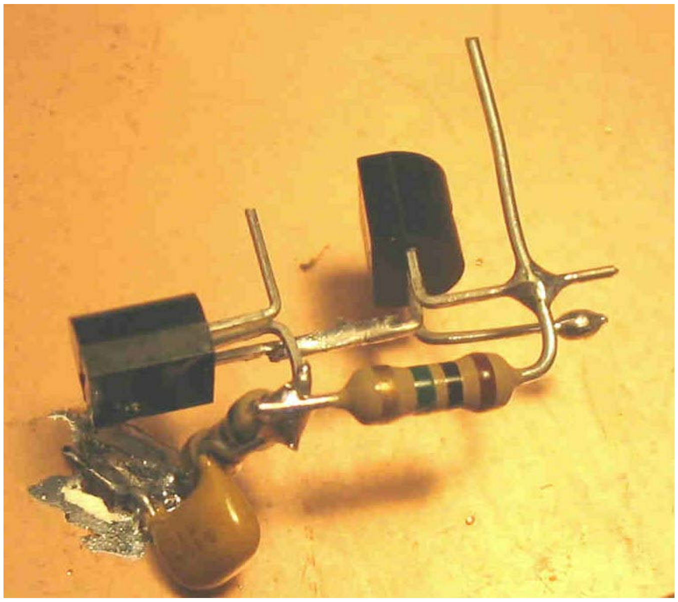
Next, the Source of Q8 is soldered to the junction of R40 and C34, and the Source of Q7 is soldered to the Drain of Q8, as shown here.



Q8, on the left, and Q7, installed

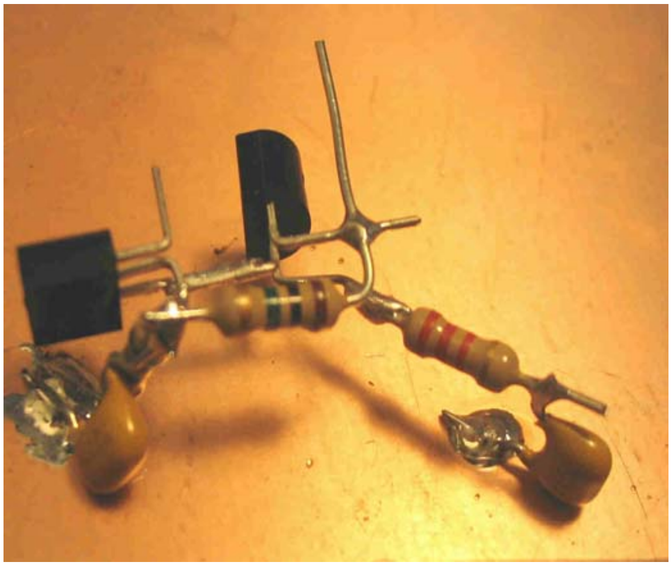
It is not clear in this photo, but there is NO connection between the source and drain of Q8.

Next, R38, 1M, is added. This is shown below.



R38 Added

Note that a drop of solder has been applied to the Drain of Q7, to facilitate the installation of R39 and the primary connection of T5. In the photo below, R39 and C33 have been installed.



R39 and C33 Installed

T5 is wound on an FT37-61 ferrite core. #28, red, wire was used for the 33 turn primary in this case, and #26, green, was used for 8 turn secondary.

The primary is connected across R39. One end of the secondary goes to ground, and the other end is connected to C42, a .1 uF cap that couples the mixer output to the first IF Amplifier.

These details are shown here.

T5 Details

Here are the details of the Receiver Mixer installation, from the perspective of the input side of the cascode mixer. R43, a 10K resistor, has been installed from the Q8 Gate to ground. A 5 Volt, peak-to-peak VFO signal will be applied to the R38, Q7 Gate junction, at the free lead on the left center. The receiver RF signal will be applied to the junction of R43, the 10K resistor, and Q8 Gate, just to lower right of center in this photo.

Receiver Mixer Details

This completes the receiver chain up to the RF Preamp.

Testing the Receiver Mixer

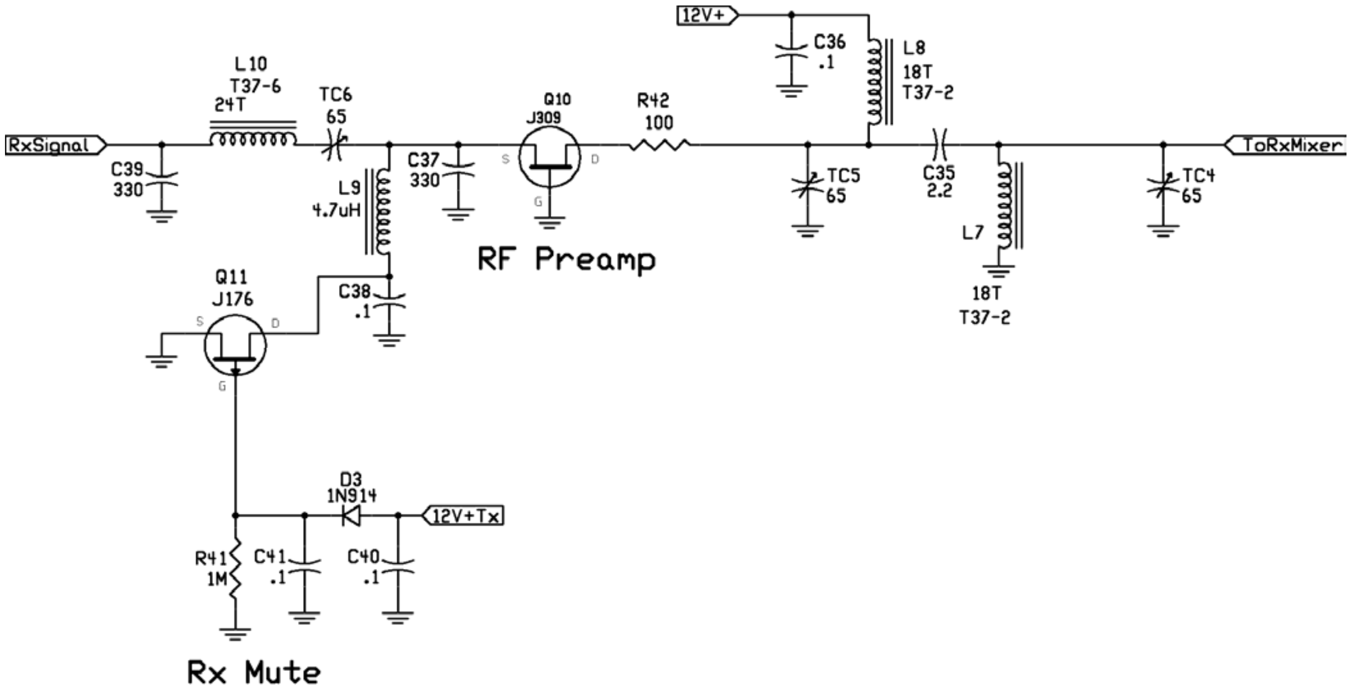
In order to test the Receiver Mixer, two injection signals are needed. The mixer requires about 5.5 Volts, Peak to Peak, of VFO energy applied to the gate of Q7.

Given that, an antenna would be connected to the gate of Q8, through a .1 uF capacitor that would be temporarily tacked onto Q8's gate.

However, if you have already used either a signal source or WWV to test the entire receiver chain up through the 1^{ST} IF Amp, then you may elect to wait until the VFO chain is built to test the Receiver Mixer.

Building the Receiver RF Preamp

Here is the circuit diagram.



This RF Preamp utilizes a J309 JFET in common-gate configuration, and incorporates both a tuned input circuit and a double-tuned output circuit. It has an input impedance of 50 Ohms, and a high-impedance output impedance that works well with the 10K Ohm input resistance on gate one of the cascode receiver mixer.

A P-Channel FET Switch, a J176, is used as the muting transistor. This choice of transistor for both audio and RF muting in the receiver greatly simplifies the T/R circuitry in this rig. One simply needs to route 12V+TX from the collector of the keying transistor to the muting transistor inputs. No other control circuitry is needed.

The trimmer capacitors used in this preamp are 65 pF units that have two ground lugs and one “hot” lead. The two used for TC4 and TC5 were prepared for installation as shown below.

Trimmer Capacitor Preparation

As seen above, the two ground lugs are bent out, close to their ends, and the layered, "hot" lug is bent out close to the body of the trimmer cap, so that when the ground lugs are soldered to the PC board substrate, the "hot" lug will not contact the surface and short the signal out.

Here is a photo of the completed RF Preamp.

PNW15 RX RF Preamp

The input is on the left, and the output to the right. Because the author had no leaded J309s on hand, a surface mount MMBFJ309 was used. It is hidden underneath the green inductor, just below the left-hand trimmer capacitor in the photo. The only difficulty presented by the use of the surface mount part was having to solder the tiny gate lead to the PC board substrate. However, a fine-pointed, low heat soldering iron did the trick nicely.

The left-hand trimmer capacitor is TC6, which does not have either lead grounded. One of its ground lugs was cut off, close to the capacitor body, and both the remaining ground lug and the "hot" lug were bent out at 90 degree angles, close to the capacitor body. The ground lug was then soldered to the junction of C37 and L9. Because C37's other lead goes to ground, the left-hand trimmer, TC6, is fairly stable, physically. Stability is also enhanced by the fact that L10, which connects to the other contact of TC6, is connected to C39, which has its other lead grounded as well.

In some cases it has been necessary to place a shield between the input and output of similar RF Preamps. However, in this case, perhaps due to the overall gain of the stage, which is relatively low, and the straight-line layout that has been used, no shield was necessary.

Shielded, miniature 50-Ohm coax is used between the T/R circuit and RF Gain Pot, between the RF Gain Pot and the RF Preamp input. In the author's build of the rig, this type of shielded wire was also used between the RF Preamp's output and the RX Mixer's RF input.

Tuning of the three trimmers in this preamp is very straightforward. Once the receiver is completed, and a resonant antenna is connected, one first peaks all three trimmers for loudest background noise, and then peaks them again on a fairly weak signal in the middle of the area of interest on the band. Usually, no further adjustment is necessary.

For receiver testing purposes, the RF Gain pot can have its ground lug soldered to the PC board substrate, as we did with the Audio Gain pot, and connections made from an antenna connector to the top of the RF Gain pot, and from the wiper of the RF Gain pot to the RF Preamp input.

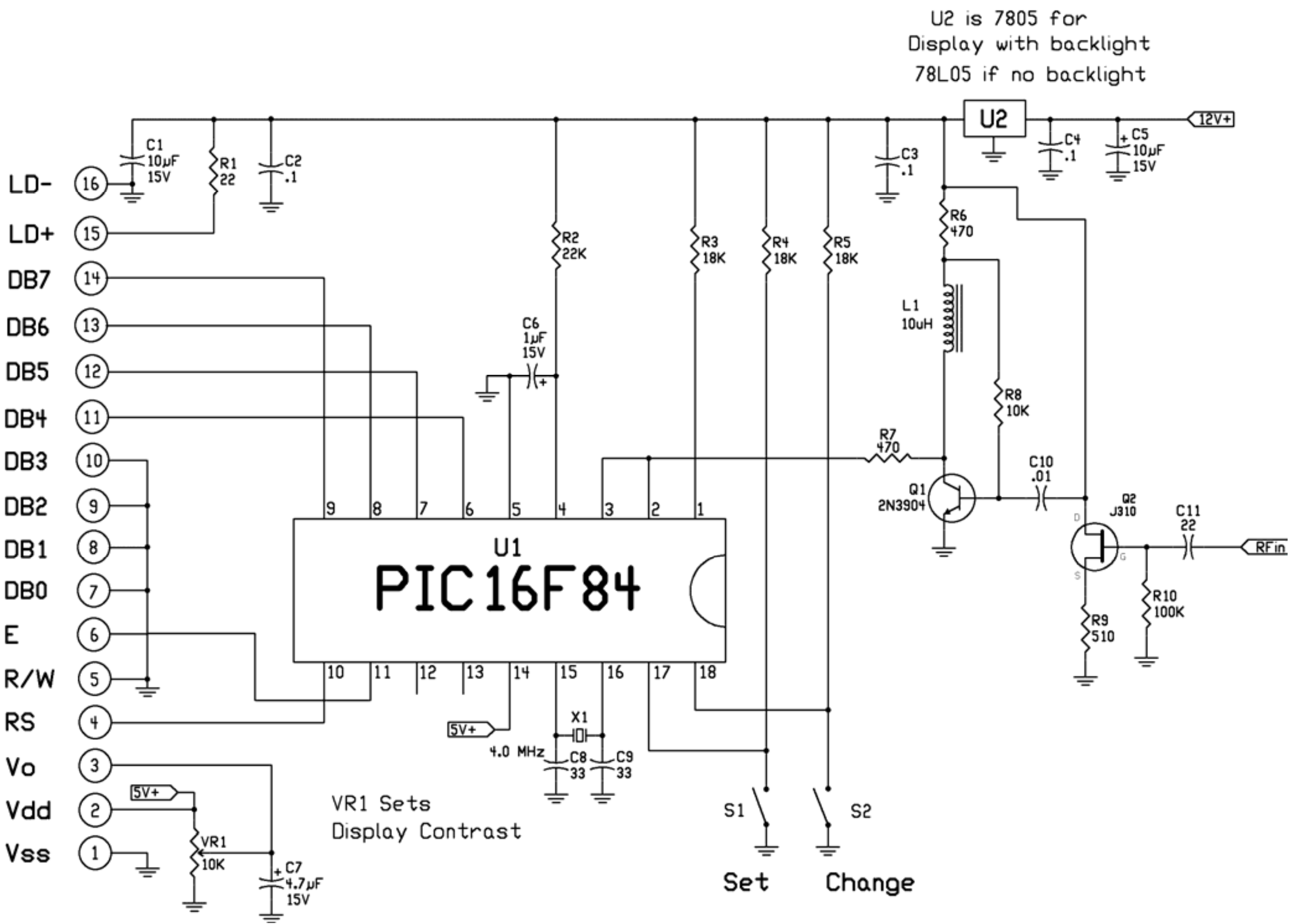
Then, with the injection of a VFO signal to Gate 2 of the RX Mixer, we can experience the excitement of hearing signals coming through our receiver for the first time.

Building The Digital Dial

Now that we have the complete receiver chain built, we will turn our attention to building the Digital Dial, so that it can be used to check signal frequencies when we build the VFO Chain.

The frequency display used in the PNW15 is a version of IK3OIL's Digital Dial, with the addition of a JFET buffer amplifier on its input.

Here is the circuit.



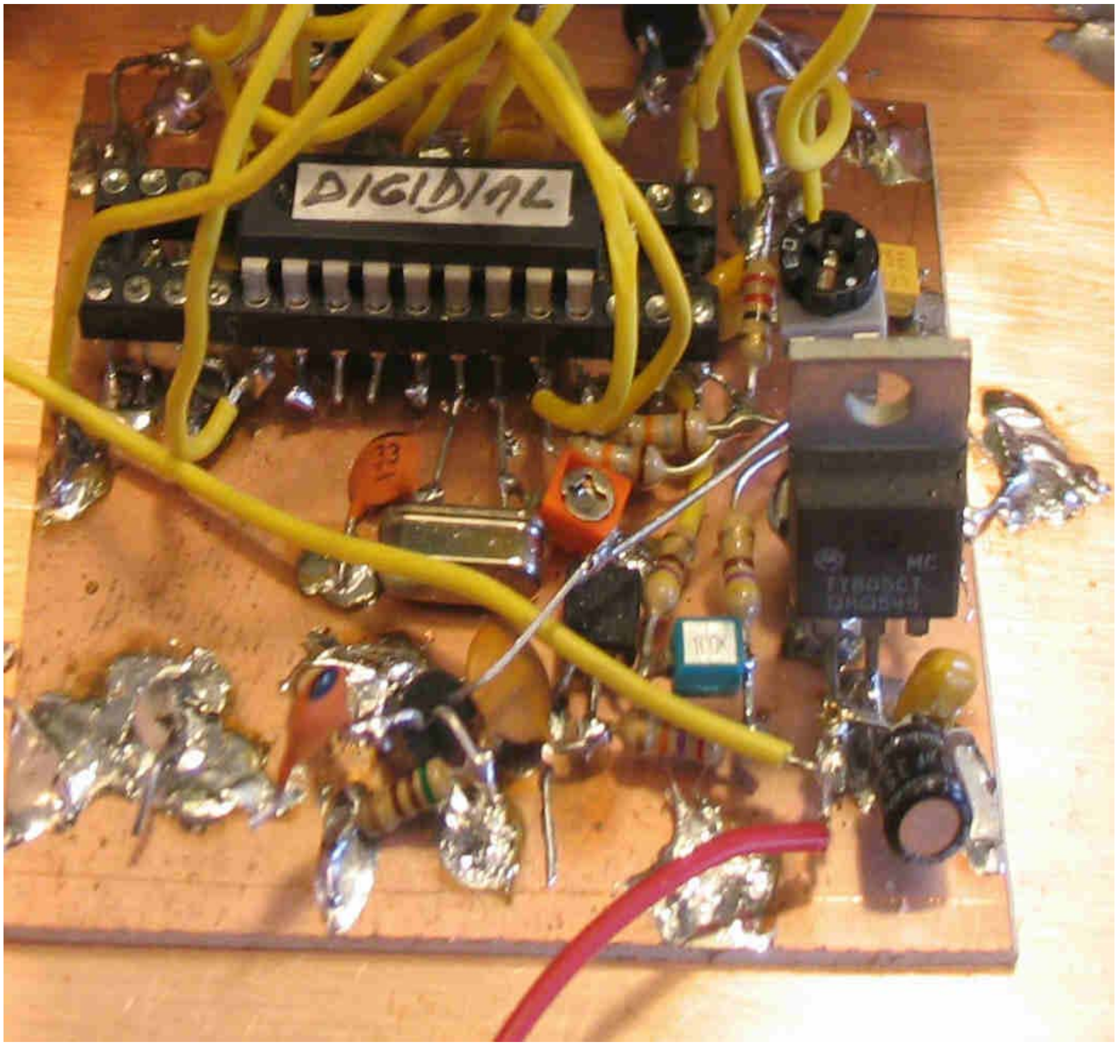
PNW15 Digital Dial

NOTE that pin 6 of the LCD display DOES NOT go to ground. Pin 6 of the display connects ONLY to pin 11 of the PIC chip. Pins 1, 5, 7, 8, 9, 10, and 16 of the display DO go to ground.

This circuit is an accurate frequency counter that is capable of down to 10 Hz resolution. It is programmable for IF Offset, and one can select just how many digits one wants displayed, if one is only interested in KHz and tenths of KHz, instead of going all the way down to tens of Hz.

A programmed 16F84 PIC reads the incoming frequency and displays it on a backlit, one by sixteen LCD display.

In building this frequency counter Ugly Style, one can either simply turn the PIC chip upside down, in true, dead bug style, or can do as was done in this case, where two 16-pin DIP sockets were used.



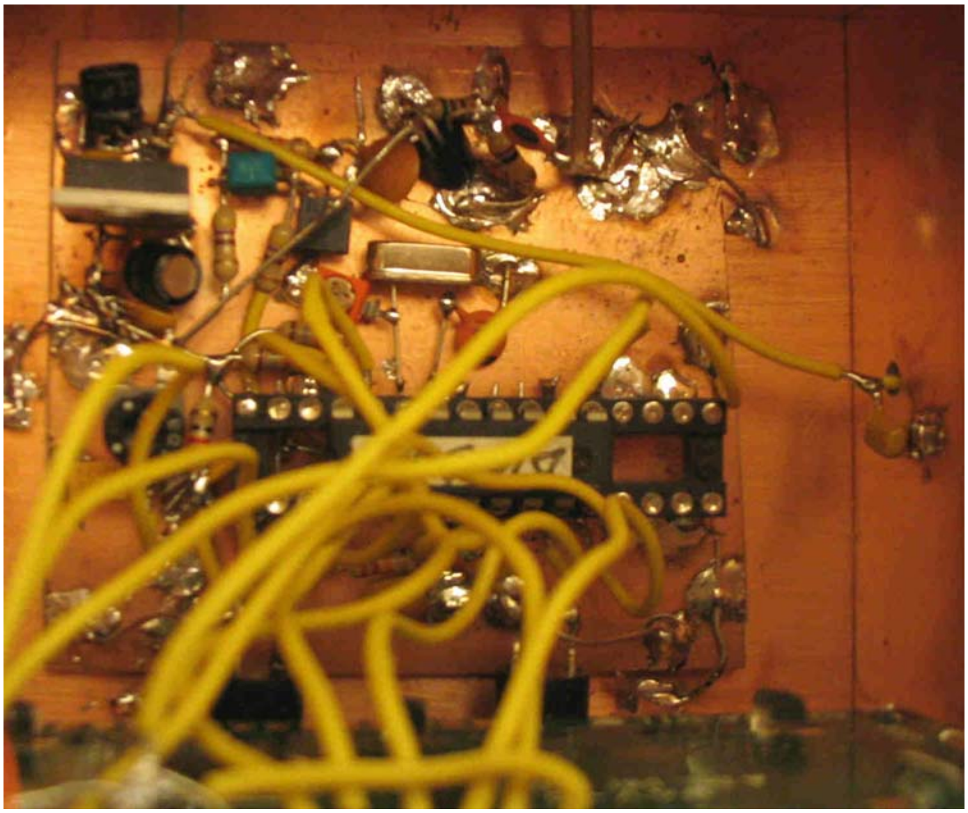
As you may be able to see in the above photo, the extra, unused pins of the two DIP sockets were either soldered directly to ground or, as is the case on the right end of the photo, were used as connections for the 5 Volts, regulated, supply line.

Those pins used by the PIC chip that needed a ground contact were also soldered directly to ground. All the remaining pins were bent out at a 90 degree angle so that the proper connections could be made to them and those connections would be physically kept up, away from the copper substrate surface.

The photo is slightly out of focus on its lower end, where the board was closest to the camera. However, the orange capacitor, with the black dot, towards the lower left, is the RF input connection, and the transistor directly to its right is the J310 buffer amplifier.

The red wire coming in from below is the 12 Volt Positive line, and the yellow wire connected to it and running off to the left takes 12 Volts Positive to the VFO.

The orange trimmer capacitor just to the right of the crystal is not used in the PNW15, a 33 pf NP0 capacitor is used in its place. The trimmer is not needed because we can program out any error in the frequency counter when we program in the IF offset.
As always, with Ugly Style, those parts that have one or more leads grounded physically support those which do not go to ground. Since this circuit has few parts, it is an easy one to build in this fashion, and is very useful either as a digital dial in a rig, or as an accurate, stand-alone frequency counter for the bench.
Here is an overhead shot of the Digital Dial board.



The 12 Volts Positive DC power comes in at upper left. The wire going out through the shield wall to the right takes DC power to the VFO board. A .1 uF cap was acts somewhat as a feed-through capacitor by being installed between the DC power line and ground, right at the hole where the line passes through the shield wall.

The large, TO220 part in upper left is the 7805 regulator. To its right can be seen the RF amplifier stage and buffer amplifier stage to the right of that.

A length of shielded, coaxial wire brings the VFO signal in at the top of this photo, and connects to C11, the 22 pF capacitor on the gate of the buffer amp.

If there is any trick to building a circuit like this Ugly Style it is simply being able to read the circuit diagram and make the necessary connections.

Start building on a larger PC board surface than will eventually be needed. If you plan to use two DIP sockets for the PIC chip, as was done here, so that unused pins can be directly soldered to ground and in that manner physically support the PIC and allow for ungrounded pins to be bent out and connections made to them, then determine which socket pins go to ground, leave them straight, and bend the others out at a 90 degree angle so that connections can be made to them.

In the case shown above, two 16 pin DIP sockets were used, and the PIC chip was inserted in such a way that four pairs of unused socket pins were at the pin 9 and 10 end of the PIC, and three pairs of unused socket pins were at the pin 1 and 18 end of the chip. In order to identify the grounded pins, the chip was inserted in that location in the pair of sockets, pins identified, and the appropriate ones bent up.

Install the sockets first, by soldering the grounded pins to the PC board substrate. In the case shown above, all the excess, unused socket pins at the pin 9 and 10 end of the PIC were soldered to ground. At the pin 1 and 18 end, the two socket pins closest to the PIC chip were left straight and soldered to ground, and the other two pairs were bent up so that they could be used to support components in the 5 Volt supply line.

Initially, in order to ensure that the sockets stay properly aligned, the PIC chip is left plugged in until the outer ground pins are soldered to the substrate.

As can be seen in the photos, once the two DIP sockets were soldered to the board the unused pin holes in the tops of the two sockets were filled with solder, so that the chip could only be inserted in the correct holes.

After installing the pair of sockets, the next few components to be installed should be the crystal, between pins 15 and 16 of the PIC, and the two 33 pf capacitors that go from the crystal leads to ground.

The 7805 regulator is mounted simply by bending a short length of its ground lead at a 90 degree angle and soldering it to the copper substrate. The “in” and “out” leads are bent closer to the body of the regulator, so that they do not make contact with the PC board surface, and the bypass capacitors on both those leads are soldered between the leads and ground. No heat sink is needed on this part.

Do not be concerned if your build of this circuit takes up a little more surface area than this one did. As long as you make the correct connections, it will work just as properly as this one does. That is why one should start out with a larger piece of PC board material than will be needed, so that after the circuit is built, the excess can be cut away and this “circuit board” can be attached to the larger piece of PC board material that forms the main substrate for the entire rig.

The hole in the front panel for the LCD display was formed in the following manner. First the outline of the display head was carefully marked in the desired location on the front panel.

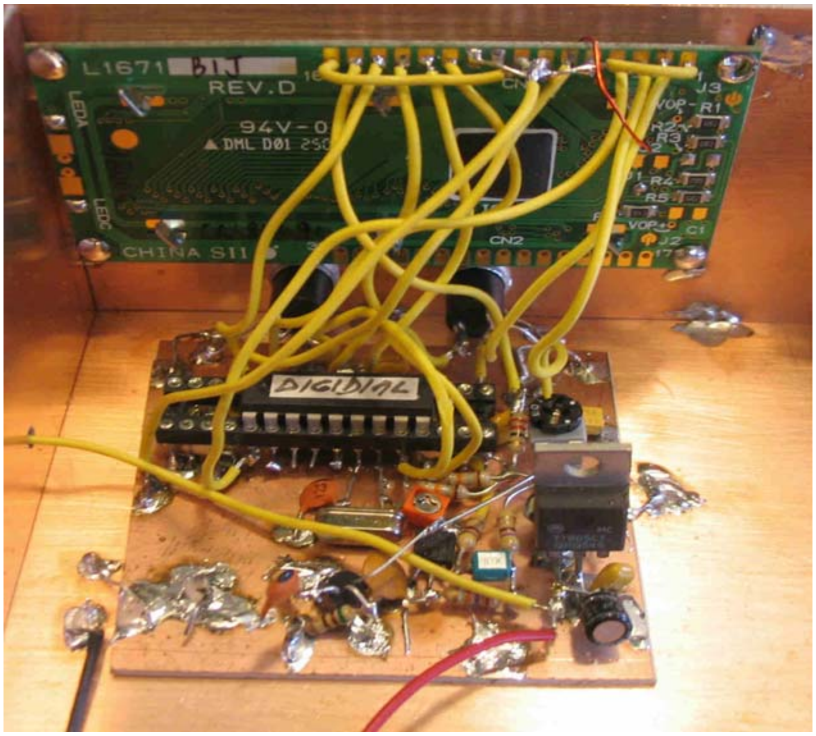
Then a hole was drilled inside the outline that was large enough to accommodate a “nibbler” tool. These tools are available at Radio Shack, as well as other sources.

Most of the unwanted material was then “nibbled” away in a very short time. Next, a file was used to remove the last small amounts of material so that the display head would just fit inside the hole. The display head itself was used as the “gauge” to determine the final hole size, by repeatedly attempting to insert the display, and working a little at a time, first on the horizontal dimension, and then when that was fixed, on the vertical dimension.

In actual practice, it takes almost as much time to describe this process as it did to form the hole. Here is a picture of the resulting installation.

The red and black push-button switches are used to program the digital dial for IF Offset and readout resolution. These could be mounted in a small panel inside the rig, as they are not used once the dial is programmed, and one of these front panel spaces could be used to install the push-button control switch for an electronic keyer.

Here is a photo of the entire installation with the LCD display installed in the front panel of the PNW15.



Mounting the LCD display in the hole cut in the front panel was simplicity itself. Cut-off part leads were inserted through the mounting holes in the display, and then soldered both to ground and into the mounting holes.

If you mount your display with this method be sure not to twist or torque the display's PC board. Doing so can cause malfunctions of the display.

The short, red piece of magnet wire seen in upper right of the display in this photo is a repair that was done because of a torn trace at the edge of one of the display connections. The display had been used in another project, and when it was removed, the trace was inadvertently broken.

In the author's build of the PNW15, the digital dial's PC board and display are enclosed by shielding panels of double-sided PC board material. For this rig, since the IF is not a harmonic of the 4 MHz clock frequency for the digital dial, this is probably overkill and unnecessary.

<u>Programming The IF Offset and Readout Resolution</u>

Pressing the "Set" button once and releasing it displays the IF Offset value. You may wish to leave this as is initially, so that the digital dial can be used to adjust the low end of the VFO's tuning range, since by leaving the IF offset at zero, the actual frequency generated will be displayed.

The “Change” button is then used to change each individual character of the offset, by pushing the change button until the desired number is displayed for that character and then briefly pressing the “Set” button to advance to the next character in line.

When the last digit on the right has been changed to the desired figure, another press of the ”Set” button starts the Mode Set function. The “Change” button is used to select between the three operating modes, “VFO + IF”, “VFO – IF”, and “IF – VFO”.

Pressing the “Set” button again enters the “Prescaler” mode where the “Change” button selects the counting ratio, thereby setting the display resolution.

Pressing the “Set” button a last time fixes the selected parameters in the PIC EEPROM, and re-activates the frequency readout function.

Once the PNW15 VFO chain is completed and is connected to the receiver chain, the easiest way to accurately program the IF offset is to listen to a station on another rig, tune the PNW15 so that the same station is heard at the same reception audio tone, and program the IF offset so that the readout on the PNW15 is exactly the same as it is on the other rig.

Both the exact frequency of the VFO Pre-Mix oscillator and the exact frequency of the receiver BFO directly affect the amount of IF offset actually needed in order to have an accurate digital dial readout.

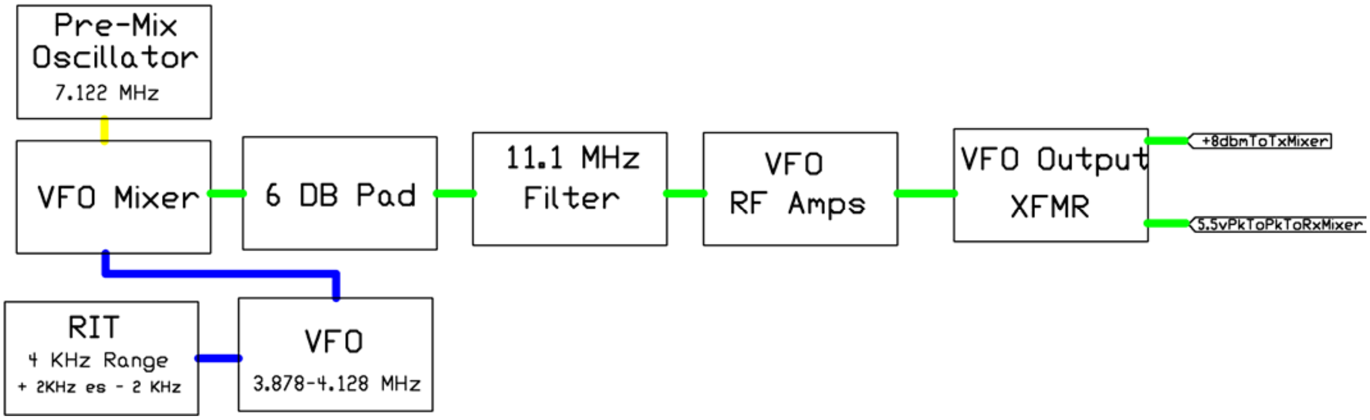
And now, with the Digital Dial complete, we can begin work on the VFO Chain.

Overview Of The VFO Signal Generation Scheme

In the PNW15, the output of an analog, permeability tuned VFO is mixed with the output of a crystal controlled oscillator, filtered, and then amplified to provide the proper amounts of VFO signal injection levels for the receiver and transmitter mixers.

The VFO covers the range of 3.878 to 4.128 MHz. Its output is mixed with the output of a 7.122 MHz crystal oscillator in order to provide a mixer injection signal of 11.0 to 11.250 MHz. This signal, when mixed with the 10.0 MHz IF and the 10.0 MHz transmitter oscillator, gives coverage of the lower 250 KHz of the 15 Meter band.

Here is a block diagram of the VFO chain.



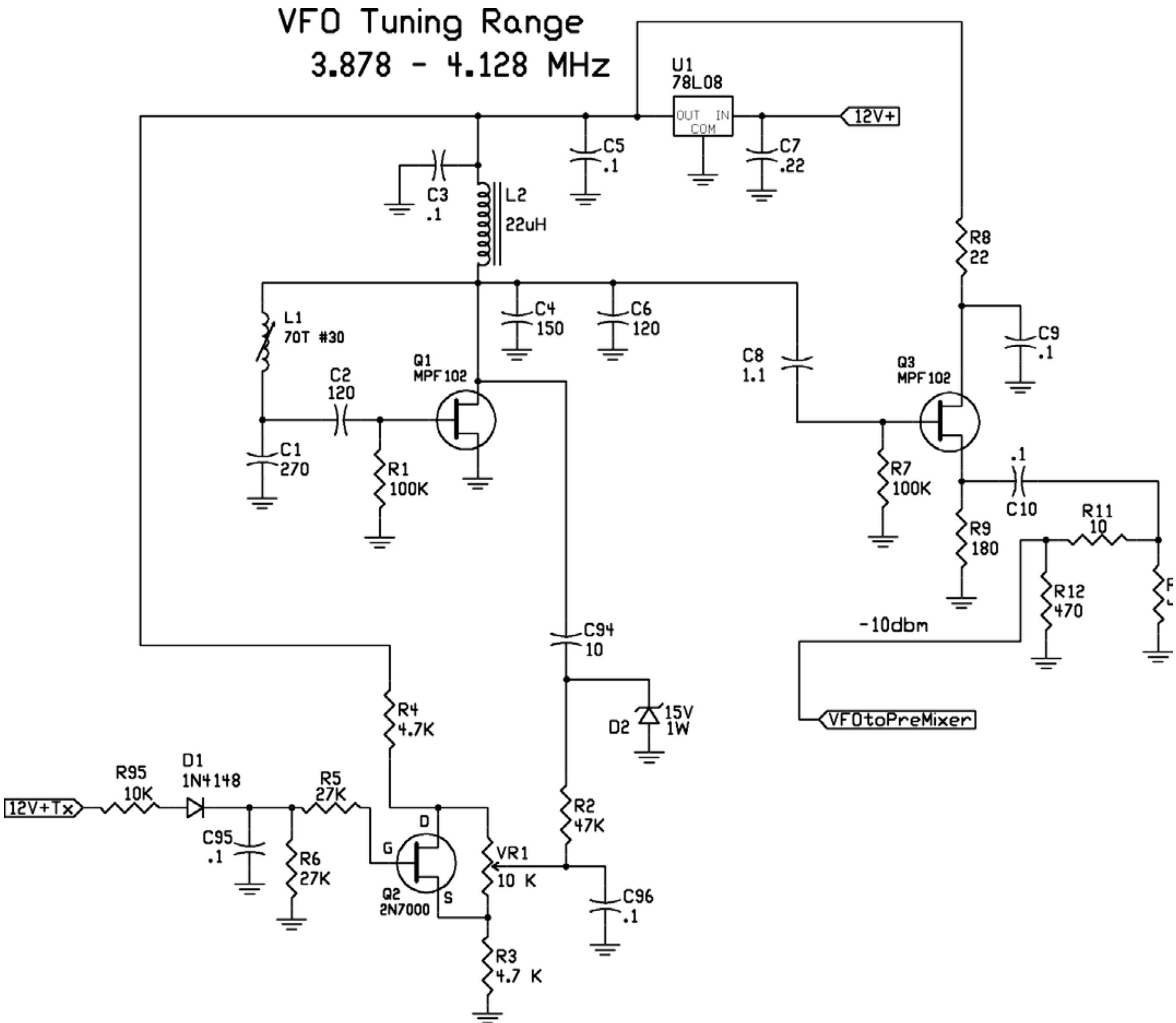
As can be seen in the block diagram, the VFO signal is mixed with the signal from a crystal controlled oscillator, fed through a 6 db, 50 Ohm resistive pad and a double-tuned bandpass filter, and then is amplified and sent through an RF transformer in order to provide two separate outputs of the levels required by the Transmitter Mixer and Receiver Mixer.

A VFO injection signal of +7 dbm will be sent to the Transmitter Mixer, and a 5 Volt, Peak to Peak VFO signal will be sent to the Receiver Mixer.

Building the VFO

As stated above, the VFO is an analog, permeability-tuned, variable frequency oscillator. The main tuning element in this case is a tuning coil wound on a plastic drinking straw with a 5/16" diameter. The inductance of the tuning coil is varied by means of a brass screw, which is turned either further into, or out of, the tuning coil itself.

Here is the circuit for the PNW15 VFO, RIT, and VFO Buffer Amplifier.

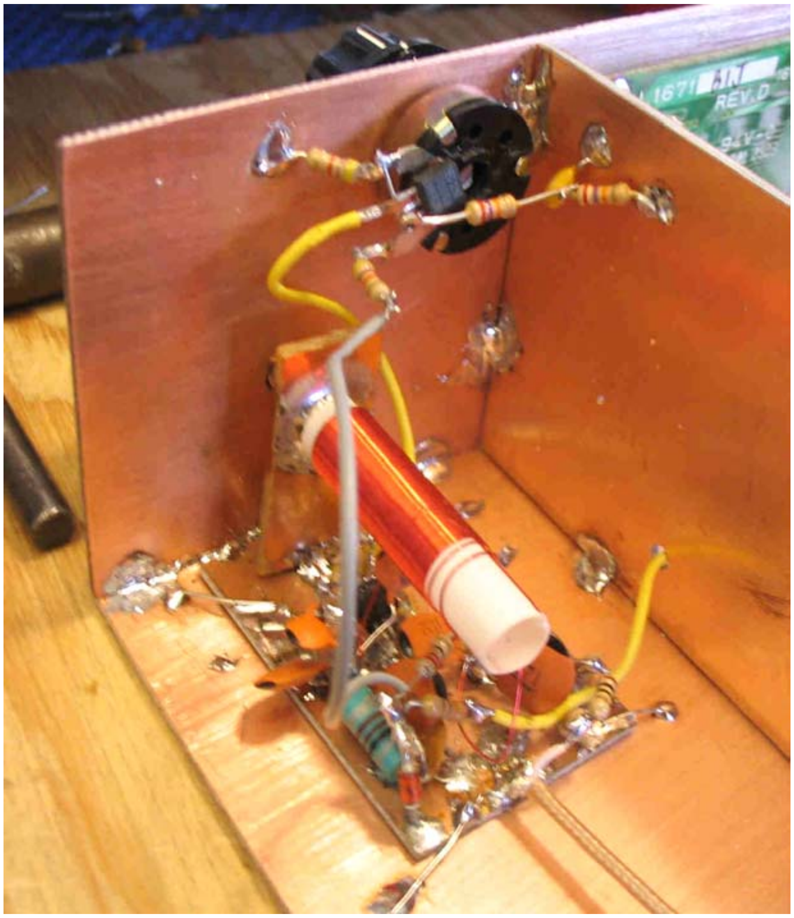


In building this section of the rig, all of the components of the VFO and Buffer, except for the Tuning Coil, are built onto the main PC board substrate. This includes C94, and D2, the active components of the RIT circuit. The value of C94 sets the RIT tuning range.

All of the remaining RIT circuit components are built on and around the RIT Pot, except for R95 and D1, which are installed in the 12V+TX line between the keying transistor and C95.

The complete VFO, Buffer, and RIT circuitry is totally enclosed in soldered-together PC board material panels, so as to provide needed shielding of this part of the rig. C95 will act somewhat as a feed-through capacitor, by being physically located right next to the hole in the shield wall where the 12V+Tx line passes.

Here is a picture of the VFO, Buffer, and RIT circuitry, before the shielding panels were installed.



As can be seen above, almost all of the RIT parts are built on and around the RIT Pot. The yellow wire coming in from the right is the 12V+ DC Power line. There is a .1 cap just outside the hole it passes through, going to ground, and shunting any RF that might be carried out of the VFO enclosure to ground. The gray wire takes 8 Volts regulated up through a 4.7K resistor to the RIT Pot. The yellow wire coming down from the wiper of the RIT pot brings controlling voltage to the C94, D2 junction.

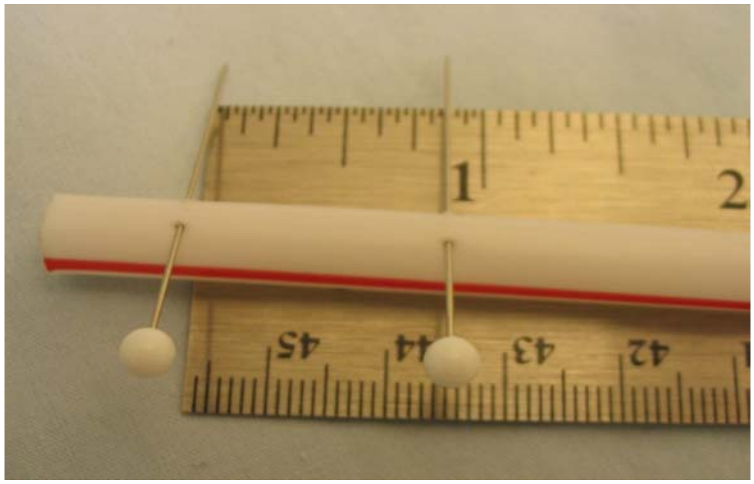
The diode in lower left is a Zener that acts as the voltage regulator for the VFO. This VFO board was left over from a previous project, and since it was already built, the three-terminal regulator shown in the circuit diagram was not used. The large green part in lower left is a junk-box 22 uH inductor.

The yellow capacitor on the shield wall in upper right is C95. After this picture was taken, a hole was made in the shield wall next to C95 and the 12V+Tx line was passed through and soldered to C95.

The tuning coil, wound on a section of plastic drinking straw, slips onto a rounded-off brass nut that is soldered to the double-sided PC board material tuning coil mount.

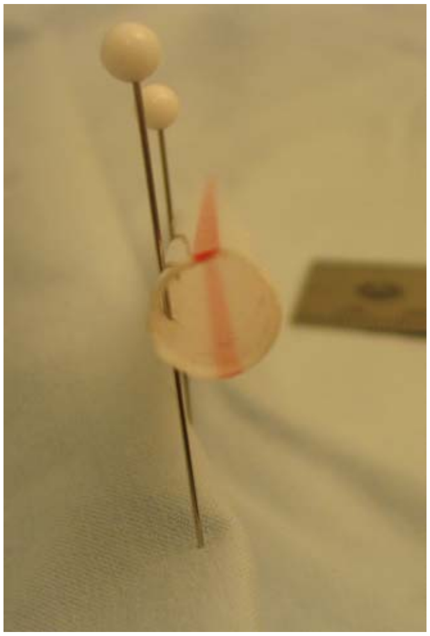
Tuning Coil Construction

The magnet wire wound onto the drinking straw to form the tuning coil is held in place by inserting the ends of the wire through holes poked in the edge of the plastic drinking straw, as shown below.

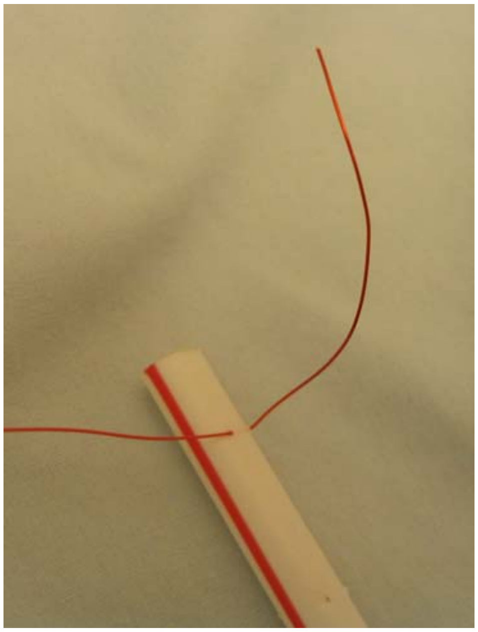


One of the holes should be about 3/8" from the end of the straw. The picture above shows the second hole about 7/8" away from the first one. However, in this case, for 70 turns, it would be a good idea either to place the second hole at least 1 and 1/8" away from the first hole, or wait until the 70 turns are wound on before making the second hole.

As shown in the picture below, the pinholes are made right out at the edge of the drinking straw's diameter. This is done to help insure that the brass screw, which is the tuning element, does not rub on the wire. It is worth noting that the tuning coil is at 12 VDC potential, and if it became shorted to ground, L2, at minimum, would be ruined and the VFO would cease to work.



Here is a picture showing the start of the coil winding. The end of the #30 wire is passed through the hole closest to the end of the straw, until a “tail” of about 2” or a little more of length is formed. This tail is then bent over, so as to anchor the wire while the turns are formed.



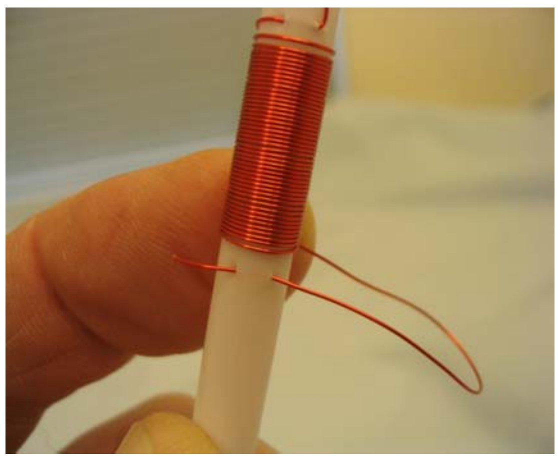
With a coil diameter of .320”, it will take some 6 feet of wire to make 70 turns. One should start out with at least 7 feet of wire, wind the turns, and then trim the long end of the wire.

If the magnet wire is being fed from a spool, what is done at this point is to hold the spool of wire in one hand and hold the straw in the other. A small amount of tension is kept on the wire by applying friction to the wire spool with the hand holding it. The straw is turned with the other hand in order to form the turns, rather than trying to wind the wire around the straw. This makes it easy to wind the turns on evenly, and turns are counted each time the "tail" comes around.

If the wire is not being fed from a spool, then a length of seven feet or more of wire should be straightened and laid out in a line away from your work area along the floor so that it will feed onto the coil without kinking. The wire is fed through one hand as the other hand turns the straw, and a small amount of friction is applied to the wire to keep the turns in place.

When 70 turns have been formed, the last turn is held in place with a finger of the hand holding the straw, the wire end is cut off about three inches away from the straw, leaving a three inch tail, and the second hole is then poked into the straw, if it has not already been formed.

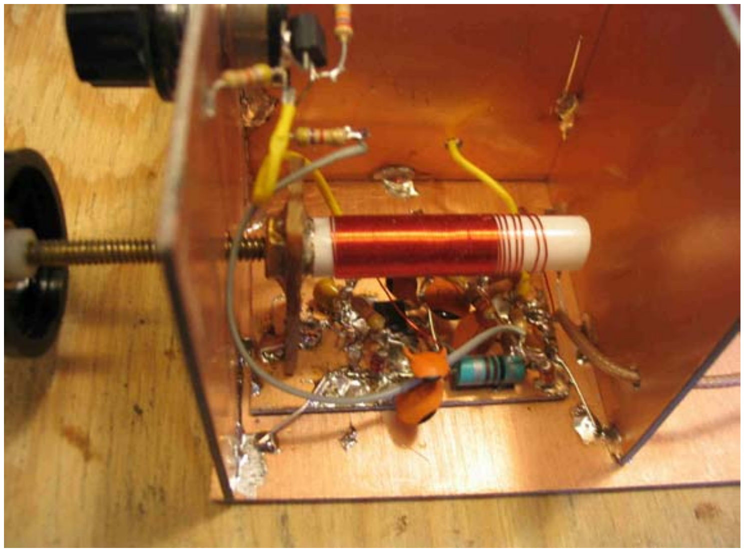
Next, the free end of the wire is fed through that second hole. This sequence is shown in the picture below.



Note that the second hole is a little distance away from the last turn, and that, in this photo the turns have not yet been pushed up close to the anchoring hole at the beginning end of the coil.

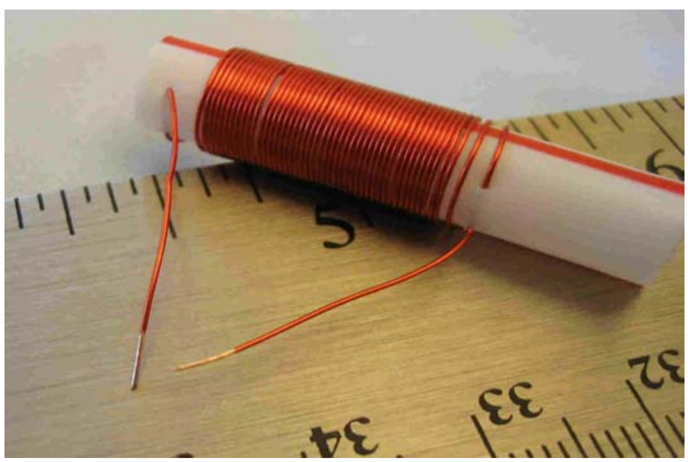
The idea here is to have a quarter inch or a little more of space between the last turn and the second anchoring hole, so that the last few turns can be stretched out away from the bulk of the turns. This allows one to adjust the lowest frequency of the VFO before the coil is covered with 5 Minute Epoxy to fix the turns in place.

This can be seen in the photo below of the tuning coil in the PNW15 VFO, where the last couple of turns are pulled out away from the main body of the coil, and, in this case, the lowest frequency the VFO tunes is 3.868 MHz, which translates to the VFO being able to tune down to about 10 KHz below the bottom of the band.



If one was not going to build and use some sort of frequency readout or annunciation capability with the rig, then this method could be used to fix the lowest VFO frequency so that the rig could not possibly tune below the bottom of the band.

The last turn is snugged up, and the straw is then cut off, close to the second anchoring hole and last turn of the coil. Both tails of the coil should be cut to about 2” length, and their ends carefully scraped free of insulation, as shown in the picture below.



A finished tuning Coil. Note that this one does not have enough turns for the PNW15 VFO

<u>Building The Coil Mount</u>

The coil mount is made from a piece of double-sided PC board material that is about a half inch wide and an inch and a half long.

A hole, large enough to provide clearance for the 6-32 brass screw used as the tuning element, is drilled about a quarter of an inch away from one end of the coil mount. Then a 6-

32 brass nut is rounded, either with a file or with a bench grinder, so that the longer end of the plastic drinking straw will just slip over it.

The easiest way to hang onto the nut while rounding it is to thread it all the way onto a brass screw, right up to the head of the screw, and either file or grind in the direction that tightens the nut against the screw head.

Once the nut has been rounded and reduced in size enough that the plastic straw will just slip over it, the rounded nut is soldered to one side of the coil mount. The best way to do this is to lay the coil mount flat, supported in such a way that the screw can protrude down through the hole. Leave the nut threaded part way onto the screw, and set the free end of the screw down through the hole so that the nut is positioned properly and the screw won't bind against the edge of the hole.

Here is a picture of a finished coil mount, which has a rounded 6-32 brass nut soldered to one side (on the left in the photo) and another 6-32 brass nut soldered to the other side. The longer plastic end of the tuning coil will slip-fit over the rounded nut.

The second nut, shown on the right in the above picture, is threaded onto the screw, up against the face of the coil mount, and soldered in place. This second nut can be adjusted for tightness so as to help set the amount of force needed to turn the tuning knob, as well as providing more stability to the tuning screw.

Another brass nut is soldered to the outer face of the front panel, helping to further stabilize the tuning screw. This can be seen in the picture below.

The tuning element itself is a 6-32 brass screw that is about 2 inches long. In order to fit a knob that is intended to go on a ¼" shaft onto this screw, we will use a 6-32 tap to thread the inside of a 1/4" diameter, half inch long nylon spacer, so that we can thread it onto the screw, turning it right up against the screw head.

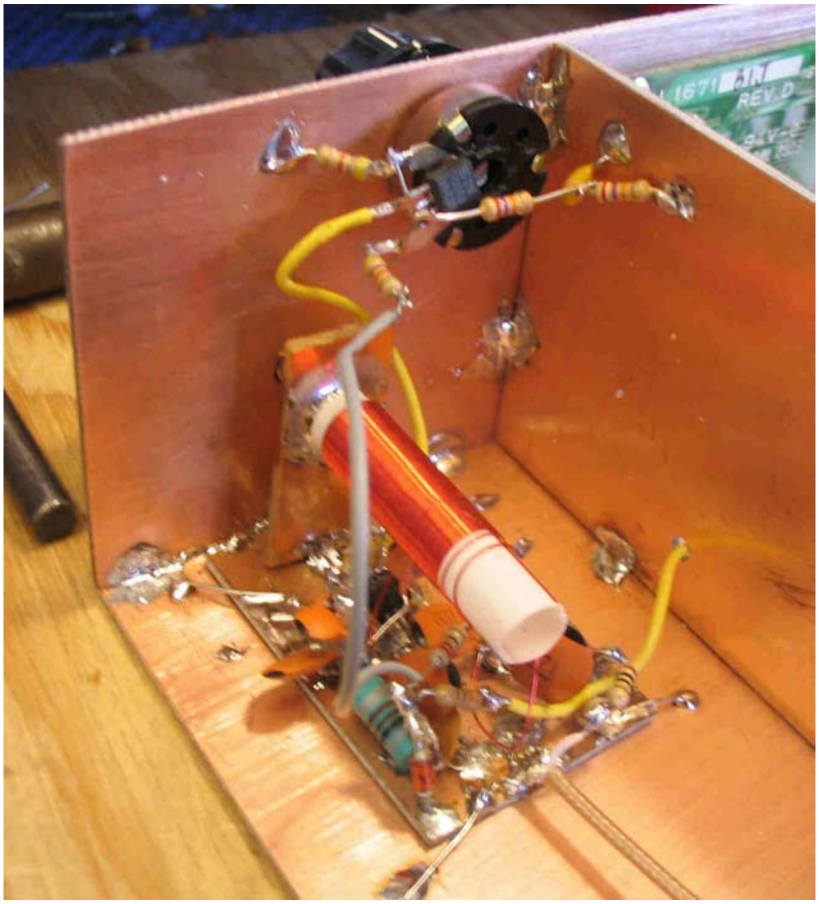
These spacers are intended to fit over a #4 screw, and thus can be easily tapped to screw onto 6-32 threads.

Next, we will either grind or file the screw head down until it has a diameter just under ¼", so that the knob will fit over it. This is shown below.

Once the spacer is threaded on, and the screw head diameter is reduced, the tuning knob can be installed on the screw, as shown below.

Now that we have had a look at the details of building the tuning coil and its mount, and preparing the tuning screw, let's take another look at the VFO installation.

Here again is the photo of the VFO installation, before the shield enclosure is added. The shielded, coaxial wire leading away from the VFO board, and out of the picture at the bottom, is the RF cable taking VFO energy through a small hole in the rear VFO shield panel to the VFO Mixer.



One can choose to build the VFO onto the main substrate, or can do as I show here, build the VFO onto a small piece of PC board material, and use cut-off part leads to attach the small board to the main substrate.

In order to locate the position of the tuning screw hole in the front panel, the tuning coil was slipped off its rounded nut mount, a screw was threaded through the mount from the rear, and was used to scratch the surface of the front panel to mark the screw hole location. This was done before the VFO board was fixed to the main substrate.

Then, the hole was drilled in the front panel, large enough to provide clearance for the tuning screw. A 6-32 brass nut was threaded onto a spare, brass screw, and was left about an inch away from the screw head.

Next, the screw was run through the hole in the front panel and threaded into the nut on the tuning coil mount. The VFO board was then positioned so that the tuning screw would be at a 90 degree angle to the face of the front panel, and the VFO board was attached to the main substrate by means of the soldered-on part leads. This fixed the location of the VFO board, relative to the tuning screw hole in the front panel.

The outside nut was then run up against the face of the front panel, and, making sure the plastic drinking straw coil form was not touching the coil mount or the screw threaded through the coil mount, heat was applied to the nut on the outside of the front panel and the copper surface underneath it, and the nut was soldered on.

Obviously, a relatively high wattage soldering iron will be needed to do this job. Alternatively, a gas cylinder and torch could be used to apply heat to the head area of the screw that is threaded through both the outside nut and the coil mount, in order to solder the nut on.

If this is done, the screw will most likely be destroyed, as the application of sufficient heat to the screw to bring the nut and the copper surface underneath it to soldering temperature will soften the screw enough that it will bend at the point of heat application.

Final Adjustments To The VFO

Once the screw, the coil mount, and the front panel have cooled, the screw is removed, and, if damaged, will be discarded.

Before threading the real tuning screw into the VFO assembly, the rear-most turns of the tuning coil are adjusted either closer together or farther apart from each other so as to set the lowest frequency of the VFO at approximately 3.868 MHz.

The finished Digital Dial, or another frequency counter, is used to read the frequency of the VFO in order to set its lower tuning limit.

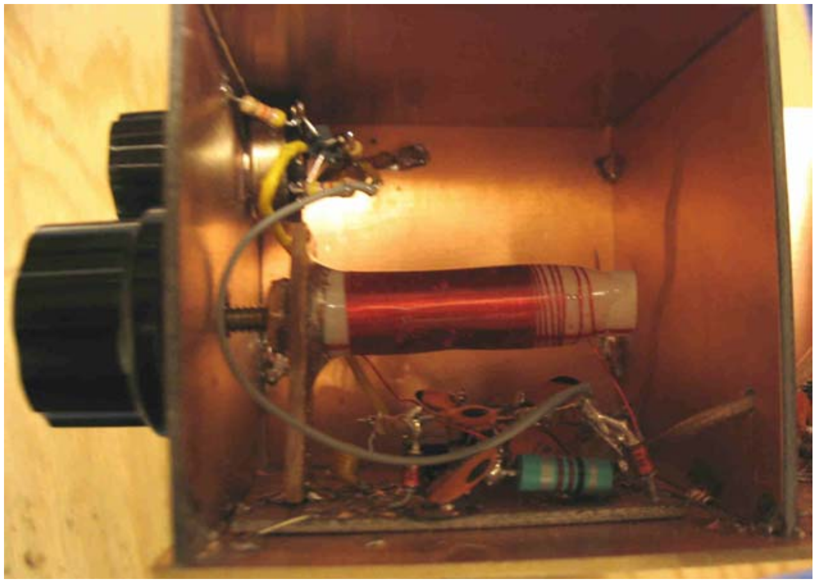
Once this is done, 5 Minute Epoxy is applied to the entire outer surface of the tuning coil in order to permanently fix the turns in place, both fixing the lower tuning limit and helping to ensure that the VFO frequency will be acceptably stable. Epoxy is also applied around the end of the plastic coil form that is slipped over the rounded nut and onto the surrounding surface of the coil mount, in order to fix the coil in place.

Before applying the epoxy, thread the tuning screw all the way into the VFO assembly, and position the outer end of the coil so that the screw is centered in the coil form. This will help ensure that the screw does not rub against, and short out, the coil wire where it passes through the plastic form.

In this case, the two-part epoxy was mixed together on a piece of heavy-duty aluminum foil, and then was carefully applied to the outer surface of the tuning coil. In order to do this without disturbing the coil turns, a toothpick was repeatedly dipped into the epoxy mixture and used to drip epoxy onto the coil, and to apply epoxy around the end of the coil form that is slipped over the rounded nut.

The whole project was turned and tilted in whatever manner was necessary to keep the epoxy on the coil and in a relatively even layer around the coil turns. This was continued until the epoxy set up.

Below is a picture of the tuning coil with its layer of epoxy.



Epoxied PNW15 Tuning Coil

Now that the VFO is built, adjusted, and the tuning coil firmly epoxied in place, the next section of the VFO chain can be built.

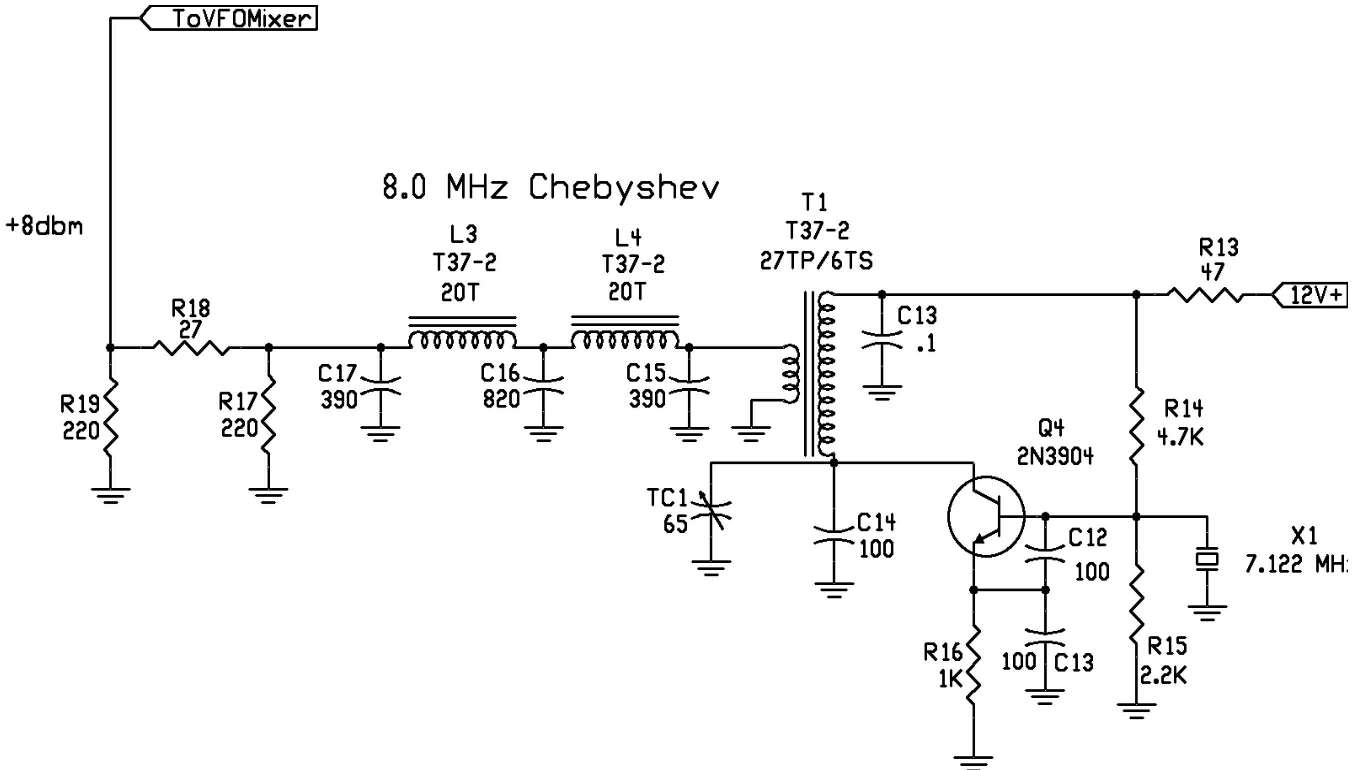
The Pre-Mix Oscillator, Mixer, And Bandpass Filter

As seen previously in the block diagram of the VFO signal chain, the output of the VFO is mixed with the output of a crystal-controlled 7.122 MHz oscillator in order to produce the needed injection frequency of 11 MHz to mix with the 10MHz IF and Transmitter Oscillator and put us on the 15 Meter band.

A 50 ohm, resistive pad on the output of the VFO Buffer sets the injection level from that source at –10 dbm. The output of the crystal oscillator is fed first through a five element Chebyshev filter with an 8.0 MHz cutoff frequency and then through a 50 ohm resistive pad that sets that signal level to +8 dbm. These two signals are fed into a Minicircuits ADE-1 doubly-balanced mixer. The mixer is terminated in a 50 ohm resistive pad and the signal is then fed through a double-tuned bandpass filter that centers on 11.1 MHz.

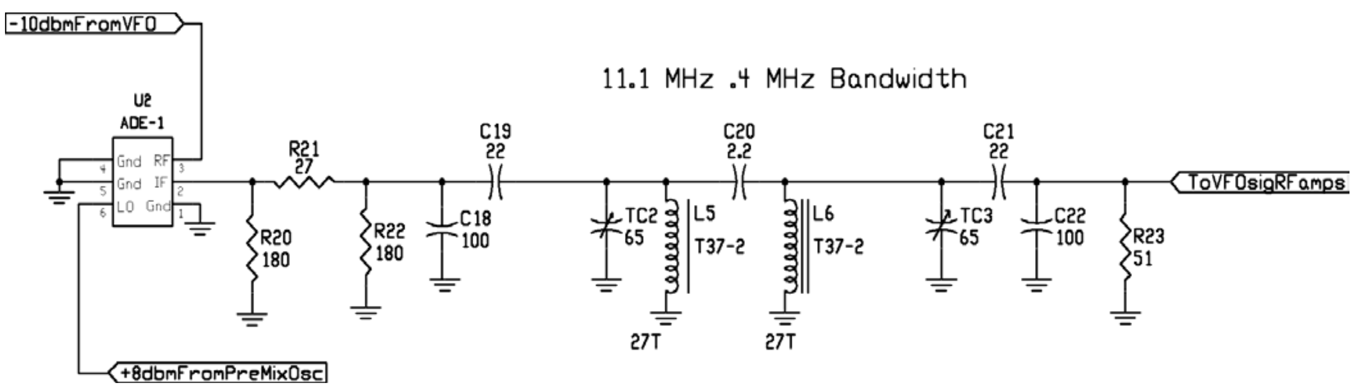
Note that the five element, Chebyshev filter on the Pre-Mix Oscillator's output was added to help ensure the spectral purity of the oscillator, so that the signal coming out of the VFO Mixer is cleaner and easier to filter with the 11 MHz bandpass filter before the signal is amplified and sent on to the receiver and transmitter mixers.

Here is the Pre-Mix Oscillator circuit.



The Pre-Mix Oscillator

And here is the circuit diagram of the VFO Mixer and Bandpass Filter.



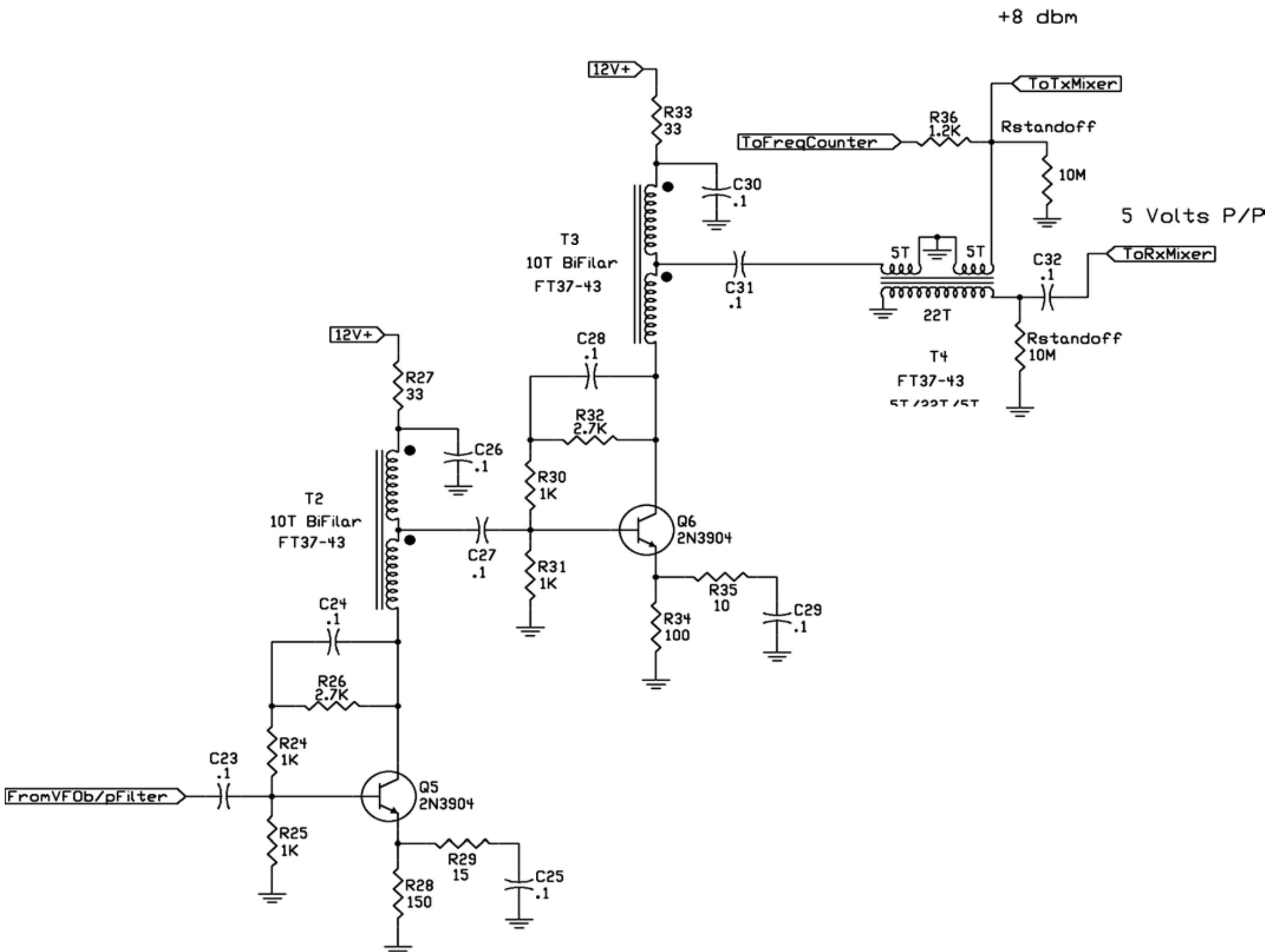
The VFO Mixer and Bandpass Filter

In the author's build of the rig, each of these sections, and the VFO Signal RF Amplifier section, were built on individual, small pieces of PC Board material, which were then attached to the main substrate by soldered-down, cut-off part leads. And, shield walls of PC board material were added between each section.

Again, this is probably overkill. What does need to happen is to have the VFO and RIT section completely shielded. This will help prevent any unwanted, radiated RF, such as from nearby AM radio stations, getting into the air-wound tuning coil, and creating spurious output from the VFO. Additionally, if it is determined to be necessary, the entire remainder of the VFO Chain can be shielded from the rest of the rig.

When the individual, small PC board sections are attached to the main substrate by soldered-on part leads, their surfaces effectively become a continuation of the ground plane of the main substrate.

Here is the circuit diagram of the VFO RF Amplifier section.



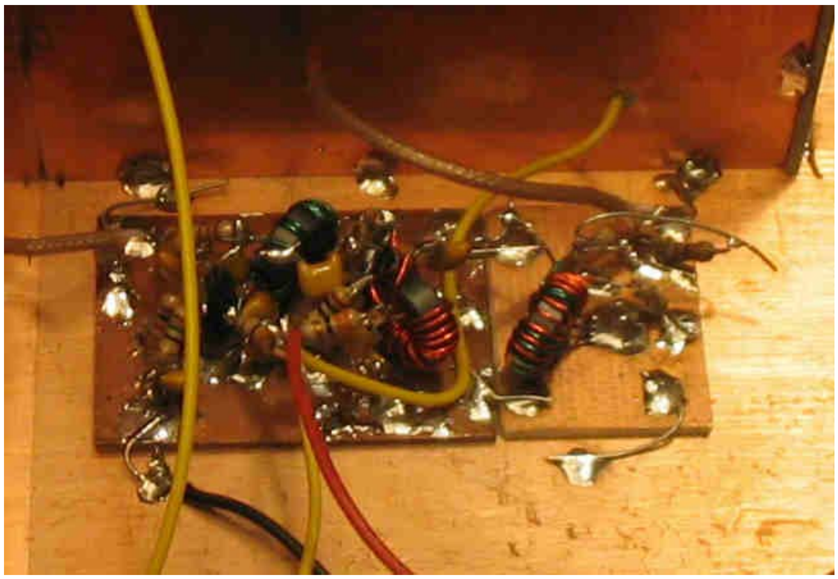
PNW15 VFO RF Amplifiers and VFO Signal Output Transformer

As is usual with most all circuitry, there are plenty of components going to ground in this section of the VFO chain to give good physical support to the ungrounded parts. However, 10 Meg Ohm resistors were used as standoff insulators on the two outputs of the impedance matching transformer that sends the VFO signal to the Transmitter Mixer and Receiver Mixer.

Shielded, coaxial wire is used to take the VFO signal on to those locations, as well as to the input of the Digital Dial. Below is a photo of the Pre-Mix Oscillator and the VFO Mixer and Bandpass Filter sections in the author's PNW15

Shielded, coaxial wire brings both the VFO and Pre-Mix oscillator signals to the VFO Mixer, and from the Bandpass Filter out to the VFO Signal RF Amps.

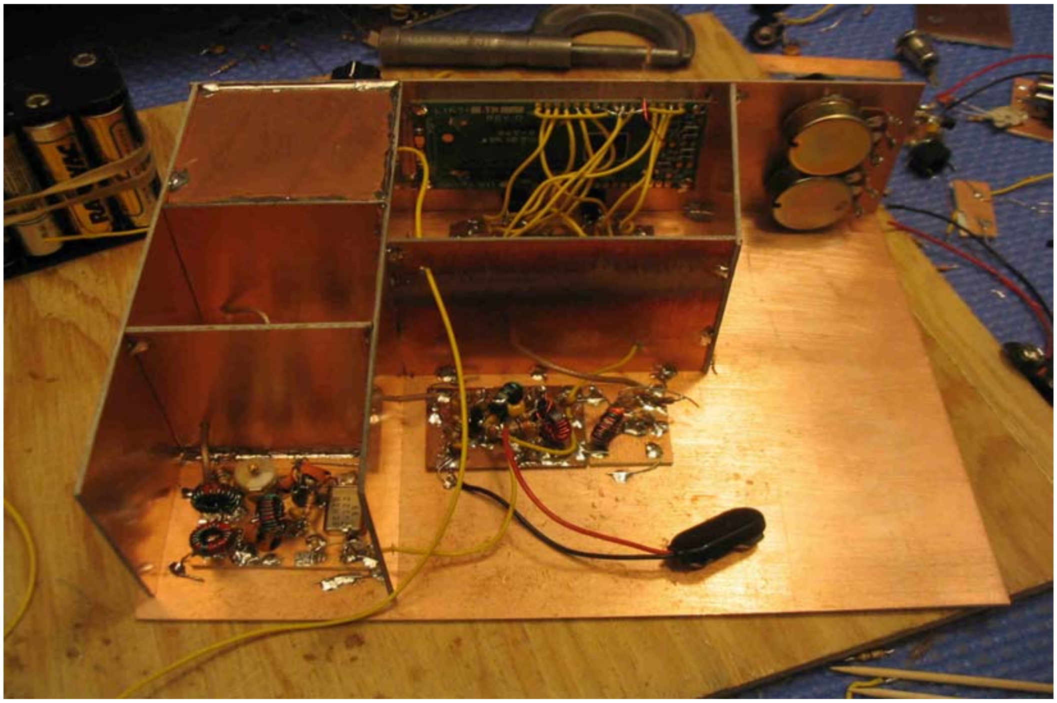
Here is a picture of the VFO Signal RF Amps and Output Transformer installed and being tested. The red wire brings in 12V+, the shielded wire on the left brings the VFO signal from the 11 MHz bandpass filter, and the shielded wire in upper center takes the VFO signal, through a 1.2K resistor, to the digital frequency counter.



VFO Signal RF Amps and Output Transformer

Although the output transformer is on a second, smaller piece of PC board here, this is only because the RF amp section was left over from a previous project, and its substrate is too small to add the transformer.

The yellow wires in the photo take 12V+ to the Digital Dial, VFO, and Pre-Mix oscillator boards. Here is a photo of the PNW15 construction to this point.



The central location of the VFO RF Amplifier section simplifies signal distribution to the three places the VFO output needs to go. The Digital Dial, Transmitter Mixer, and Receiver Mixer all use the VFO signal.

In this case, the Digital Dial is right in front of the VFO RF Amplifier section, and the receiver section of the build will go to its right. The Transmitter Mixer and Transmitter Bandpass Filter will go above the VFO RF Amplifier board, and the transmitter chain will be built along the rear of the main substrate.

Re-Programming The Digital Dial

With the entire VFO signal chain now built, the Digital Dial is re-programmed so as to reflect the 10 MHz IF offset. For now, use exactly 10.000 MHz as the offset. This will be adjusted slightly when the rig is complete, so as to account for the receiver and transmitter frequency offsets built into the BFO and Transmitter Oscillator.

What's Next?

Now that we have two major sections of the rig built, in addition to the Digital Dial, we can turn our attention to installing the receiver section into the rig, and building and installing the transmitter chain, which will be covered next.

Review Of The Build To This Point

At this stage of the construction, we have worked our way backwards through the receiver chain, built and tested the Digital Dial, built and adjusted the VFO, and have built the entire VFO Signal chain, including the Pre-Mix Oscillator, VFO Mixer and Bandpass Filter, and the VFO signal RF Amplifiers.

Before we continue on with the next sections of the build, we need to peak the Pre-Mix Oscillator signal by adjusting TC1, and we need to align the VFO Bandpass Filter, in order to peak the VFO signal in the desired area of the band.

Testing And Adjusting the VFO Chain

While having either an oscilloscope or a voltmeter and RF probe on hand will make the task easier, the initial alignment of the Pre-Mix Oscillator and the VFO Bandpass Filter can be accomplished by listening to the signals on a general coverage receiver as well.

In preparation for alignment and testing of the VFO Chain, the low-impedance output winding of T4 needs to be properly terminated so that the correct impedance is felt on the transformer output. This is done by temporarily soldering a 51 Ohm resistor between the junction of R36 and the 10M standoff resistor and ground.

Also, at this point, the input line of the Digital Dial should be disconnected from the output of the VFO RF Amplifier section and is connected to the output of the Pre-Mix oscillator, at the top of R17, by means of a clip-lead.

If either an oscilloscope or a voltmeter with RF Probe is available, connect its probe between the top of R17, at the output of the Pre-Mix Oscillator, and ground. Alternatively, tune a receiver to the area of 7.122 MHz, and locate the Pre-Mix Oscillator's signal.

In the author's PNW15, the Pre-Mix oscillator's signal was found at 7.123 MHz. This is not problematic. This signal does not have to be on an exact frequency, it just needs to be stable and TC1 needs to tune the oscillator output to the correct harmonic, which in this case is the fundamental of the crystal frequency.

Adjust TC1 for both the highest amount of RF output and the loudest received signal on or near 7.122 MHz. The Digital Dial should confirm that the oscillator's output is indeed on the fundamental frequency. An oscilloscope reading taken there should show approximately 2 Volts, Peak-to-Peak, or about .7 Volt, RMS.

Once the Pre-Mix Oscillator's signal has been peaked, temporarily connect the clip-lead going to the Digital Dial's input to the output of the VFO, where it goes into the VFO Mixer.

Add the VFO frequency to the output frequency of the Pre-Mix Oscillator, 7.122 MHz +/-, so as to determine the frequency to listen to or look for with the digital dial, and then re-connect the input line of the Digital Dial to the frequency counter output of the VFO RF Amplifiers, through 1200 Ohm resistor, R36.

Move the scope or voltmeter RF Probe to the top of the 51 Ohm resistor temporarily soldered between the junction of R36 and the 10M standoff resistor.
Alternatively, tune a receiver to the area of the frequency determined by the addition of the Pre-Mix oscillator frequency with that of the VFO, and try to locate to 11 MHz + signal.

Adjust TC2 and TC3 for the highest 11 MHz output. Then, tune the VFO so as to provide a VFO Chain output frequency of 11.060 MHz, and re-peak TC2 and TC3. An oscilloscope reading across the 51 Ohm resistor temporarily soldered between the R36 and 10M standoff resistor junction and ground should be about 1.5 Volts, peak to peak.

If you are aligning the filter by the method of listening for the signal in a receiver, I would suggest starting out by turning TC2 and TC3 to the mid points of their travel, and connecting a clip-lead to the top of the 51 ohm resistor going between R36 and ground so that the signal will be radiated better. Then tune the receiver up and down across the determined frequency while adjusting one of the trimmers for max signal heard. Once the signal is located, leave the receiver on that frequency and adjust the other trimmer. Then re-peak each trimmer.

Re-Programming The Digital Dial

It is at this point, with the VFO chain aligned and adjusted, that the Digital Dial is re-programmed so as to reflect the 10 MHz IF offset. For now, use exactly 10.000 MHz as the offset. This will be adjusted slightly when the rig is complete, in order to account for the receiver and transmitter frequency offsets built into the BFO and Transmitter Oscillator.

Installing The Receiver Sections

With the VFO chain complete, and aligned and tested, it is time to add the receiver sections previously built to the rig.

First, remove the 51 ohm resistor that was temporarily soldered from R36 to ground. A piece of shielded, coaxial wire is connected between the junction of the 22 turn secondary winding of T4 and its 10M standoff resistor and ground, and will be used to carry VFO energy to the Receiver Mixer.

A second length of shielded, coaxial wire is connected to the low impedance secondary winding, from the junction of R36 and its 10M standoff resistor to ground, which will take VFO energy to the Transmitter Mixer.

It is important to remember that the exact layout of one person's build of a rig may differ greatly from another build. The important things are the connections between individual components of a particular section of the circuitry, and the interconnections between the various sections.

And, in this transceiver, while it may well be beneficial to shield the entire VFO signal chain, shielding the VFO and RIT section alone may be sufficient.

The actual layout of the author's build was determined mostly by the size and shape of the various sections, coupled with the desire to position the sections of the rig in a way that would provide for logical signal flow throughout.

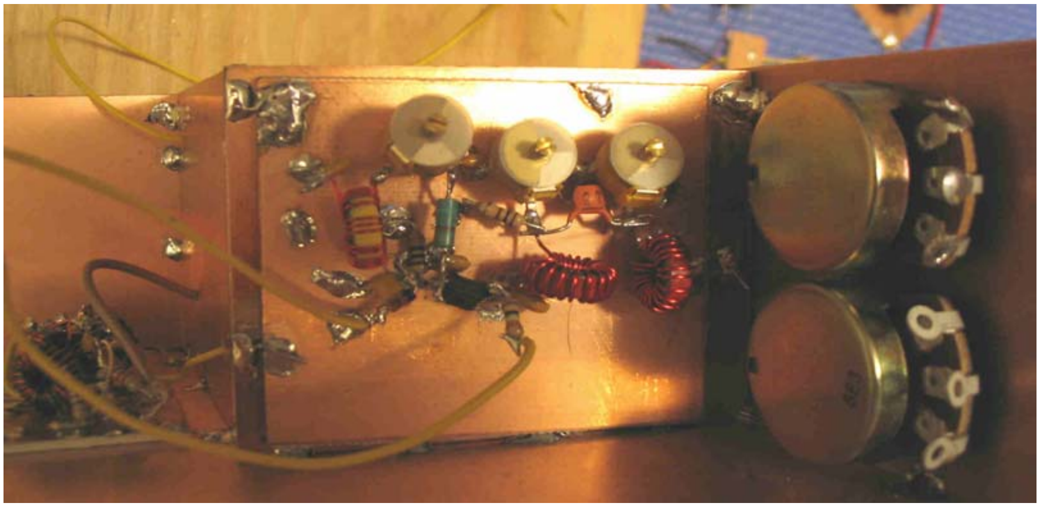
Lengths of shielded, coaxial wire were used in all cases to carry either RF or audio signals from place to place in the rig. Where DC power lines and control lines such as the line carrying 12 Volts + TX to the TX Oscillator and RIT circuit go through holes in shield walls, the line was broken and a .1 uF capacitor installed between the line and ground at that point to act somewhat as a feed-thru capacitor.

The considerations that must be taken into account when positioning the sections, in addition to their size and shape, are such connections as the VFO signal, which must go to three places, the Digital Dial, TX Mixer, and RX Mixer, and the position of the TX Output filter and T/R board, relative to the Transmitter Power Amplifier, so that the there is a short run for the RF line between the PA transistor and the output filter.

Such connections as the DC Power lines, the 12 Volts + TX lines that go from the keying transistor to the RIT circuit, TX Oscillator, Receiver Muting transistors, and to the TX Driver stages, and such lines as the connection between the T/R circuit in the PA Output network to the receiver's RF input allow more flexibility, since these are accomplished either with runs of single wires that can be bypassed by .1 or .01 capacitors at key points, or by shielded, coaxial wire, which is used to carry all the RF or Audio signals between the various boards and to controls such as the RF and Audio Gain pots.

In this case, it was decided to build the receiver sections into the open space next to the Digital Dial enclosure, near the front panel of the rig. This would leave the remaining space along the rear of the rig for all of the transmitter circuitry.

In order to accomplish this, the receiver was separated into three sections. The first section, the Receiver RF Preamp, was already built onto its own separate piece of PC board material. This was installed on the outside of the Digital Dial enclosure, as can be seen below.



As can be seen in the above photo, the three trimmer capacitors are tilted at an angle, so that when the remaining receiver circuitry is installed, the trimmers can be easily adjusted.

The yellow wire coming from the lower center of the circuitry is the DC power line. The other yellow wire, above and to the left of the DC power line, is the line that will bring 12 Volts + TX to the muting transistor on the RF Preamp board.

In the above photo, shielded, coaxial wires have yet to be connected between the RF Preamp's input, at the left end of the board, and the RF Gain Pot, or between the RF Preamp's output, at the right end of the board, and the input of the RX Mixer.

The remaining circuitry for the receiver, which had been built on one piece of PC board material, was split into two parts, by cutting the PC board in two parts, separating the circuitry between the IF Filter and the second IF amplifier.

These two sections were sandwiched together, back-to-back, in such a way that a very short length of hookup wire, run around the end of the sandwiched boards, could connect the output of the IF Filter to the input of the Second IF Amplifier. The two boards were connected together by soldering cut-off part leads around the edges of both boards. Here are photos of the two sections.

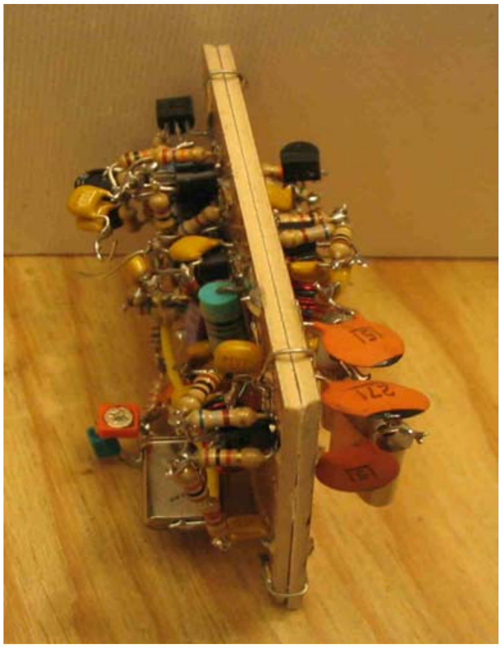
Receiver Mixer Thru IF Filter

In these photos, the DC power lines, the shielded RF Input line to the RX Mixer, and the line bringing 12 Volts + TX to the Audio Mute transistor have not been installed.

Second IF Amp, BFO and Audio Amplifier Chain

Note that the BFO trimmer capacitor, TC7, was removed and re-installed so that it would face upwards when the receiver sections were installed, in order to facilitate adjusting it.

The picture below shows the sandwiched receiver sections prior to installation.



Receiver Sandwich

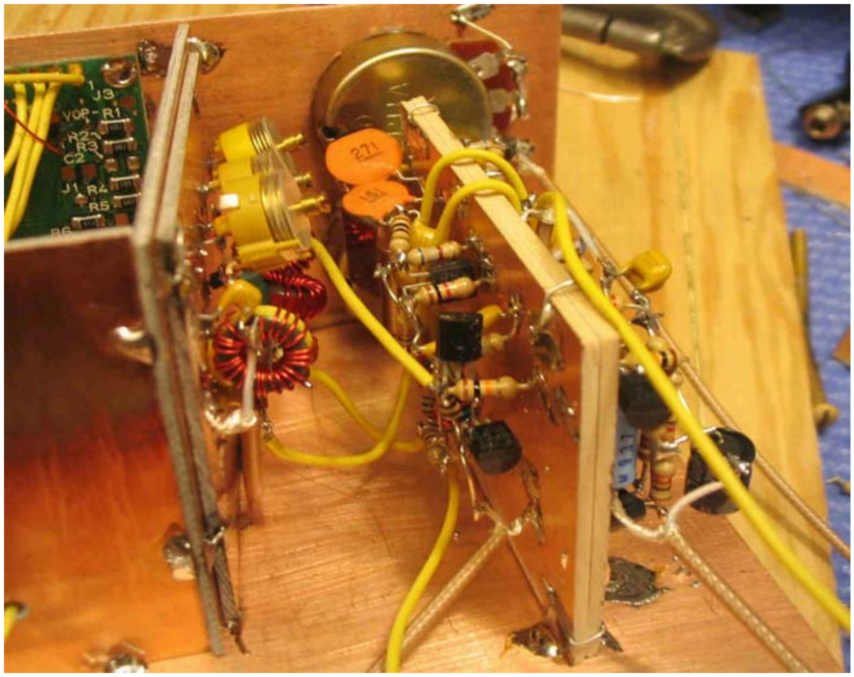
A short piece of hookup wire will connect between the junction of the 270 pF cap and the 150 pF cap on the right-hand board to the top of the 1K resistor on this end of the left-hand board, taking RF from the IF Filter to the input of the Second IF Amplifier.

Here is a photo of the installed, sandwiched sections, showing the side containing the 2nd IF Amp, the BFO, and the Audio Amplifier Chain. The sandwiched sections were attached to the main substrate by soldered-on cut-off part leads.

In this photo, shielded, coaxial wire has been used to connect the Audio Gain Pot to its proper connections between the Audio Preamp and Audio Output Amp.

Shielded coaxial wires have also been connected to the RF Gain Pot, in order to bring RF from the T/R circuit, and take RF from the pot to the RF Preamp's input. DC Power and Mute control lines have also been connected.

Here is a shot of the RF input side of the receiver sandwich.



A shielded, coaxial line has been installed bringing VFO energy to the Receiver Mixer, seen in lower center of this photo, and the shielded line bringing received RF from the RF Gain pot to the input of the RF Preamp can be seen in left center. The yellow wire coming in from lower center is the 12 Volts DC Power line.

A short piece of yellow wire can be seen continuing from where it connects on the Receiver Mixer board over to the RF Preamp board. The upper yellow wire coming from the RF Preamp board brings RF from the preamp to the Receiver Mixer.

The lower yellow wire coming from the Preamp board is the Mute line, connecting to the Audio Mute point on the Audio Amp board. The long, yellow wire coming out to lower right in the photo comes from that point, and will be connected to the 12 Volts + TX line coming from the Keying transistor, so that both the RF Preamp and Audio Amp will be muted on transmit.

What’s Next?

Now that the major sections of the receiver are installed, and appropriate connecting wires have been soldered to these sections, where do we go from here?

Perhaps the first thing, before continuing on, would be to connect an antenna to the receiver’s input line going to the RF Gain Pot, peak the trimmers in the RF Preamp at about 21.060 MHz, using either a signal generator or signals off the air, and listen to the receiver for a while just to make sure it is in good working order before proceeding.
Once we are satisfied that the receiver is working properly, we can think about what is left to build and install in order to complete the rig.

The following sections remain:

Transmitter Oscillator and Mixer

Transmitter Bandpass Filter

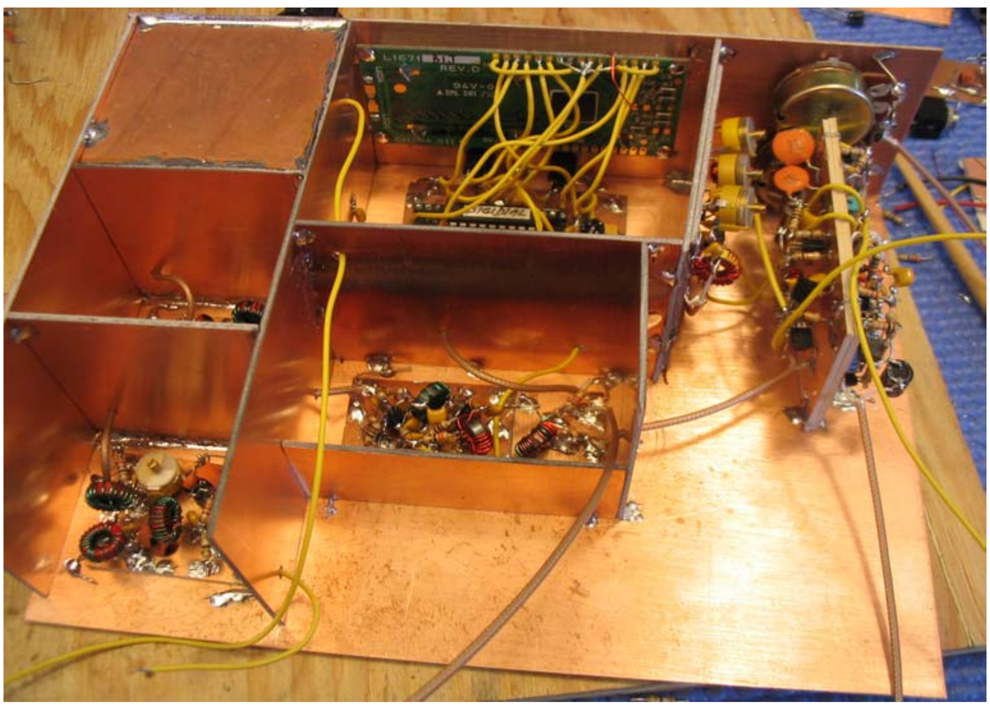
Keying Circuit

Transmitter Driver Amplifier Chain

Transmitter Power Amplifier

Output Filter and T/R Circuit

With those sections in mind, lets take a look at the physical layout so far. Here it is, below.



The small board in lower center is the VFO RF Amp chain. After taking a look at the remaining space, and thinking of the remaining sections to be built and installed, it was decided to enclose the VFO RF Amp chain in shielding, so that the Transmitter Oscillator, Mixer, and Bandpass Filter could be built on the lid of the VFO RF Amp Chain enclosure.

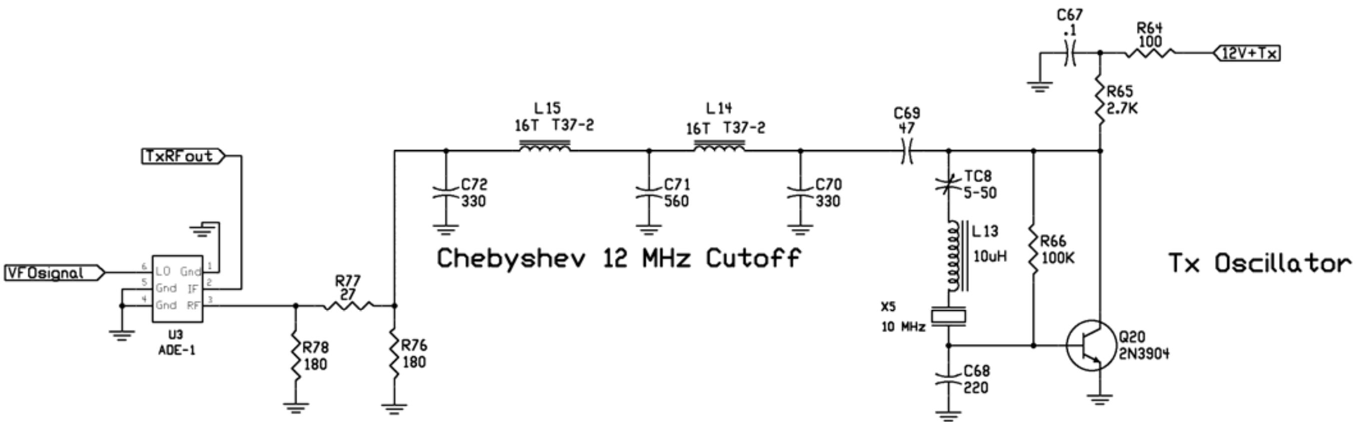
Another shield wall would be installed between the right-hand wall of the VFO RF Amp enclosure and the outer wall of the rig, effectively enclosing the receiver section.

The keying circuit would be built on the outside, rear-facing surface of the VFO RF Amp enclosure.

The Transmitter Driver Amplifier chain and Power Amplifier would be installed on the main substrate.

The Output Filter and T/R Circuit would be installed on the inside of the outer wall of the rig, to the right of the TX amplifier chain.

Here is the circuit for the Transmitter Mixer and Oscillator.

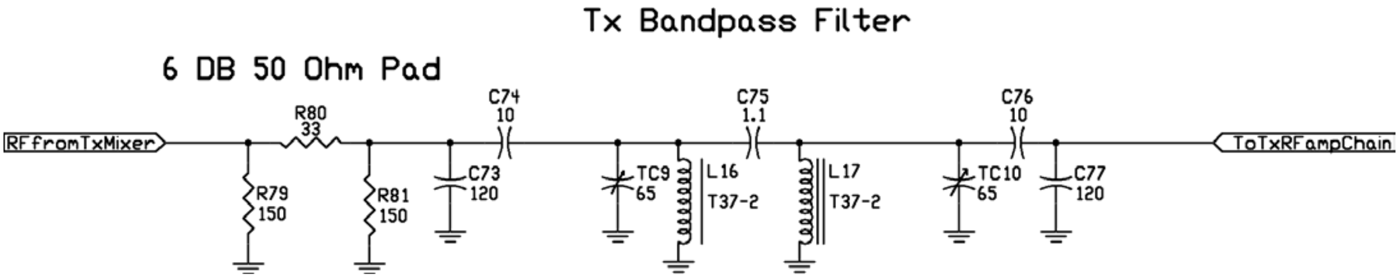


The photo below shows the Transmitter Oscillator and Mixer board, with space left over for the Bandpass Filter. Space will be left between the oscillator and mixer and the bandpass filter, so that another shield was can be installed.

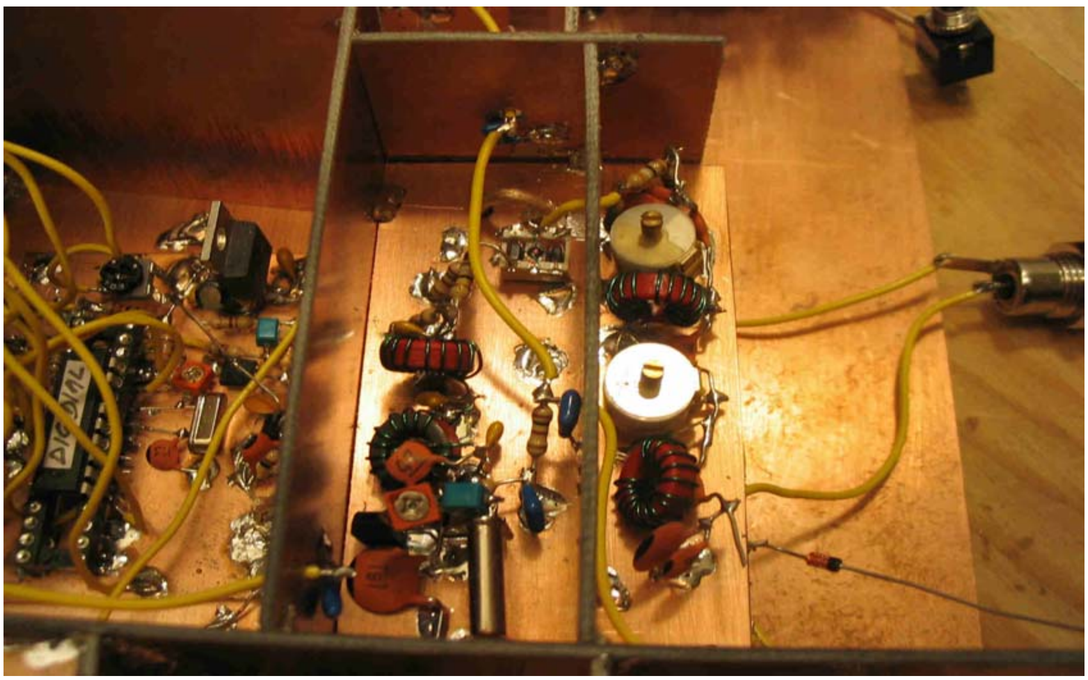
The hole in upper right is where the shielded, coaxial line from the VFO RF Amplifier will bring VFO energy to the Transmitter Mixer.

The bare space in front of the circuitry shown here is where the Transmitter Bandpass Filter will be built.

Here is the circuit for the Transmitter Bandpass Filter.

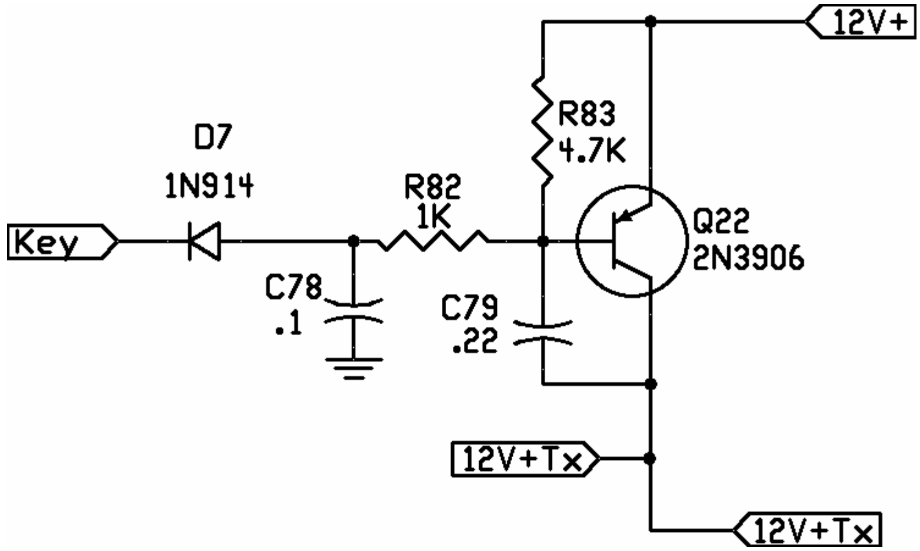


Below is a picture of the completed and installed Transmitter Oscillator, Mixer, and Bandpass Filter, with a shield panel installed between the bandpass filter and the remaining circuitry.



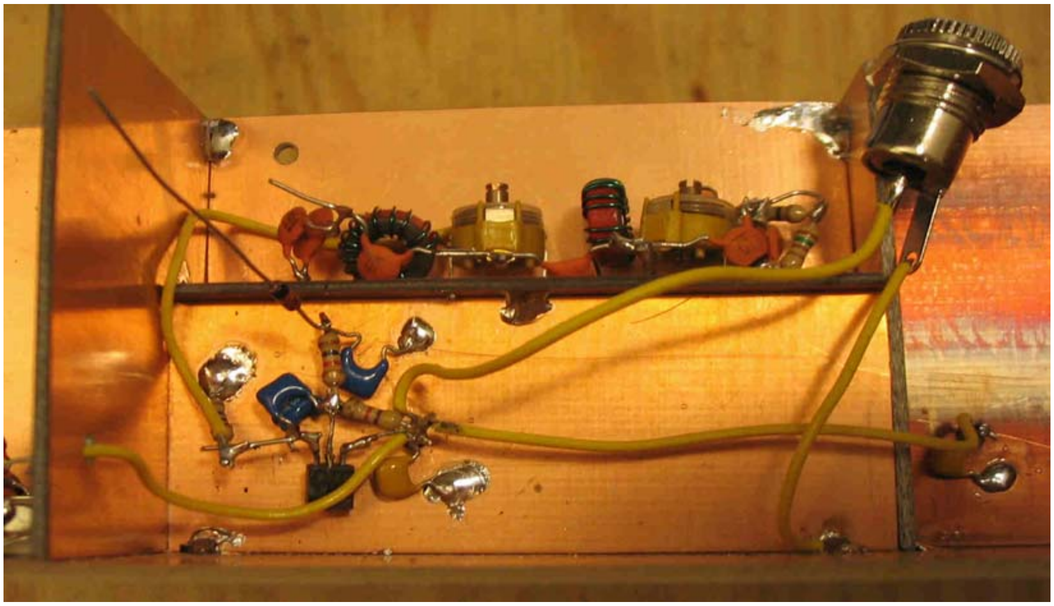
The yellow wire going out at upper center is the 12 Volts + TX line going to the Receiver Mute circuitry. This line comes in from lower center, coming from the Keying Circuit. The bandpass filter output is at the lower end of the filter in this photo. The diode to the right of that is not connected to the filter, it will connect the input of the Keying Circuit with the Key Jack.

Next to be installed is the Keying Circuit. Here is its circuit diagram.



PNW15 Keying Circuit

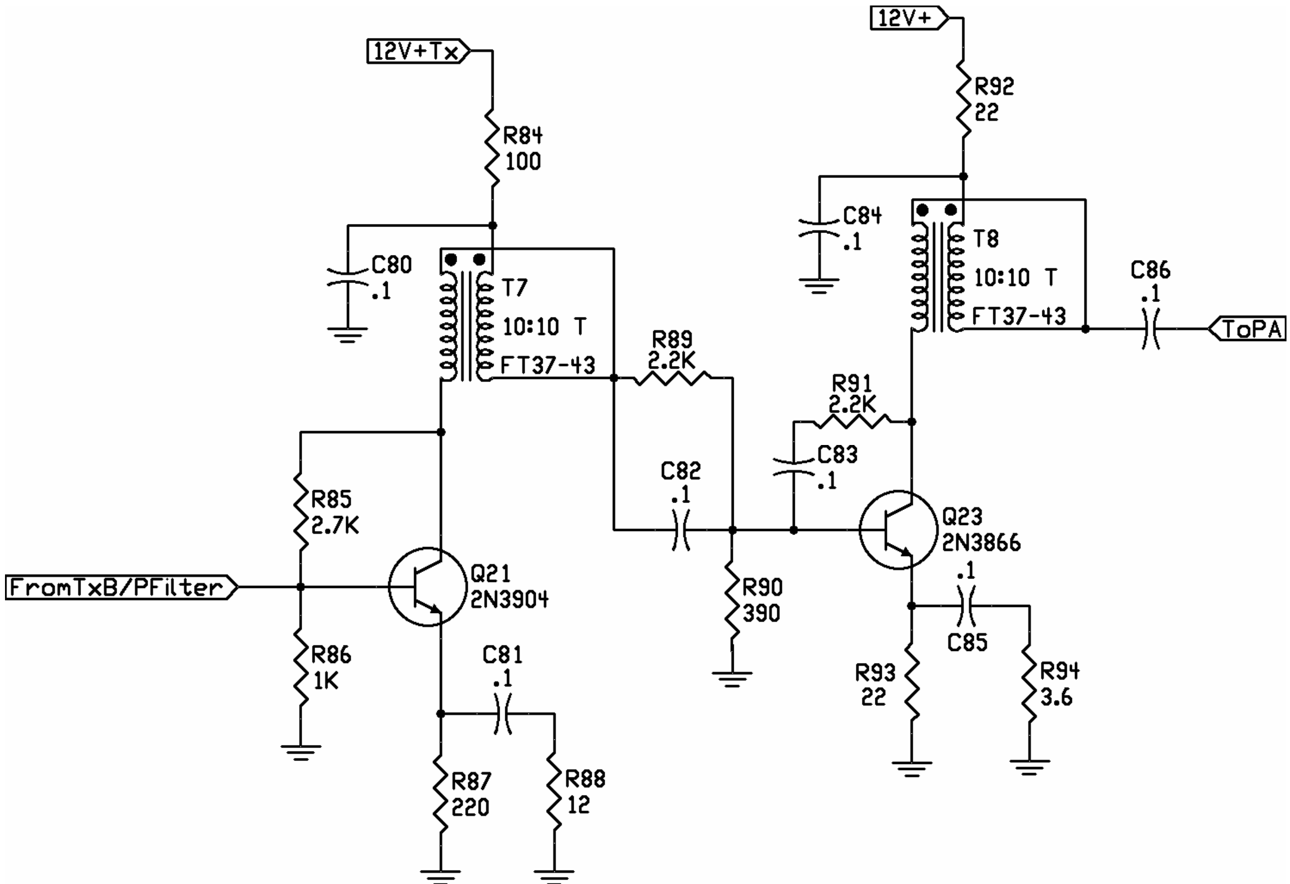
Below is a shot of the Keying Circuit, installed on the outside, rear face of the VFO RF Amp enclosure.



TX Bandpass Filter Above, Keying Circuit Below

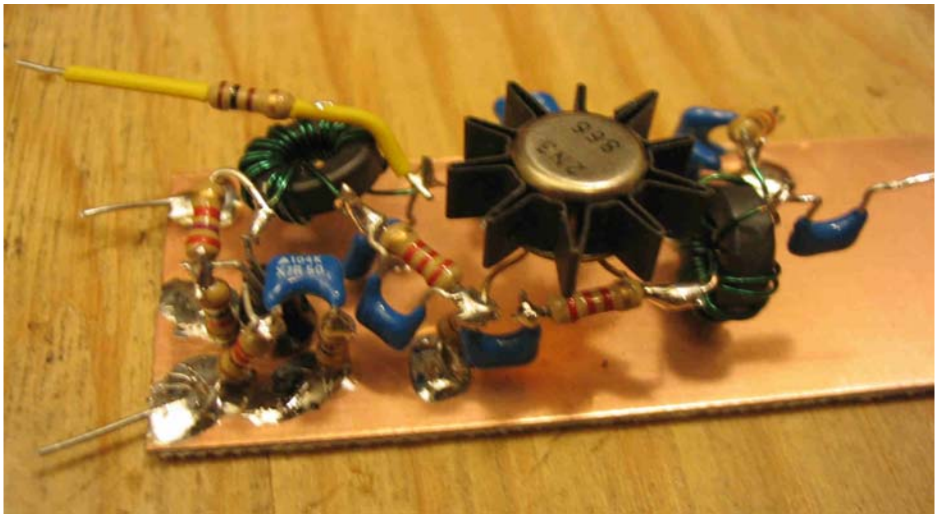
With the use of an oscilloscope or a sensitive voltmeter with RF Probe, the Transmitter Bandpass Filter can be aligned at this point. However, the output of the filter will only be somewhere between 50 and 75 milliVolts, Peak to Peak.

In order to properly terminate the filter and make that measurement, a 51 Ohm resistor would be installed, temporarily, between the filter's output and ground, and any measurement would be taken across the resistor. However, given the simplicity of the filter circuit, it may be just as well to wait until the Transmitter RF Amp and Driver are built. Here is the circuit for the Transmitter RF Amp and Driver.

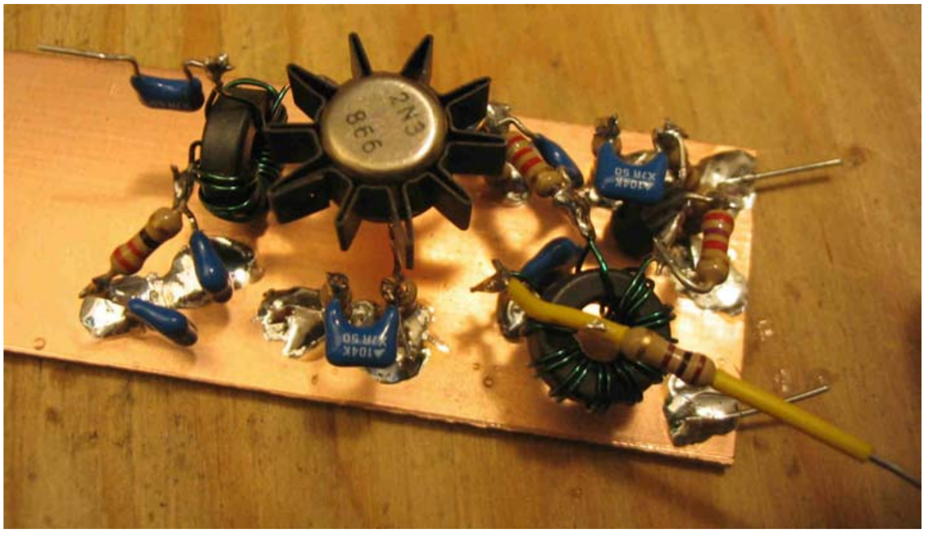


PNW15 Transmitter RF Amp and Driver

Here is a photo of the completed Transmitter RF Amplifier and Driver. Note the heat sink on the 2N3866 Driver transistor.



Below is the opposite view.

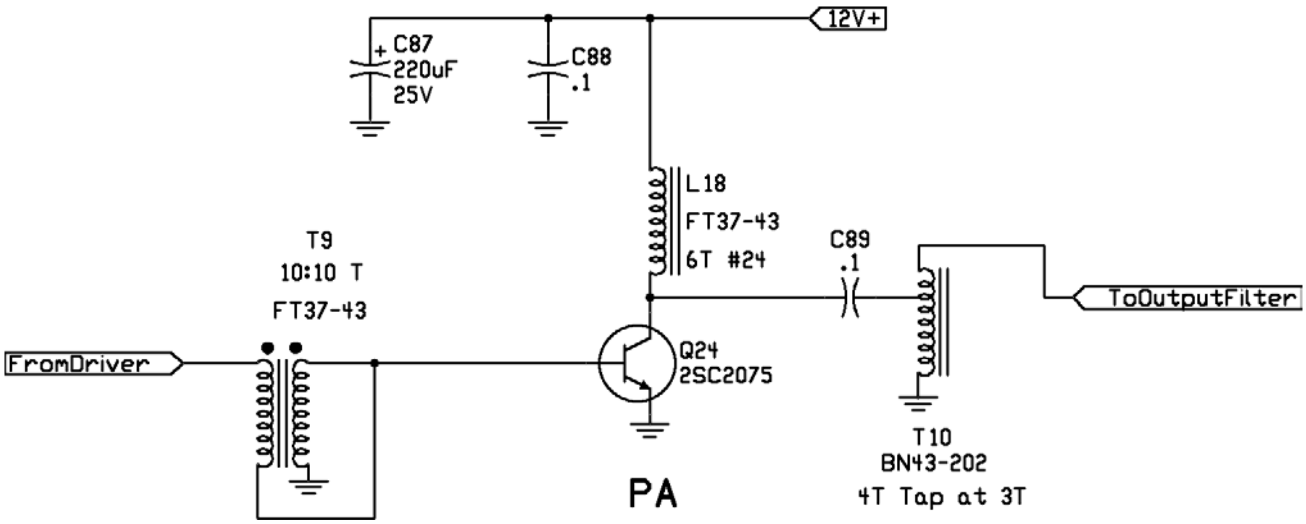


The resistor with the yellow insulation slid over its lead brings 12 Volts + TX to the RF Amp and the Driver's biasing circuit. 12 Volts + is applied to the Driver's collector circuit through the 22 Ohm resister at left center.

Once completed, the Transmitter RF Amp and Driver Amplifier board was installed in the rig. A 51 Ohm resistor was installed between the .1 uF cap seen here on the left end of the circuitry, and ground, in order to properly terminate the driver. The transmitter circuitry through the driver output was then tested, and the TX Bandpass Filter aligned.

There should be about 3.0 to 3.25 Volts, Peak-To-Peak, or between 1.0 and 1.15 Volts, RMS, of output from the Driver, going into the PA's input transformer.

After testing the TX RF Amp and Driver and aligning the TX Bandpass Filter, the TX RF Amp and Driver board was removed, the 51 Ohm resistor used to terminate the driver was removed, and the PA circuit components were added.
Here is the circuit for power amplifier.

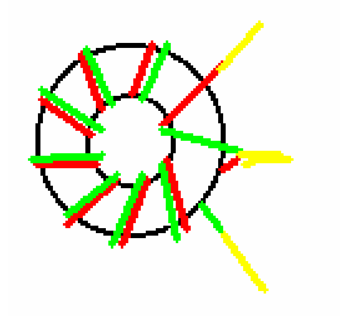


Although there are few parts in the Power Amplifier circuit, there are three toroids to wind. L18 is very simple, just six turns of #24 or #22 wire on an FT37-43 Ferrite core. This is the RF choke for the collector lead of the 2SC2075.

The input transformer, T9, is a bi-filar winding on another FT37-43.

The trick to winding bi-filar or tri-filar transformers is to keep the multiple windings parallel, allowing no twists, and laying each turn flat around the toroid core. If this is done, identifying the individual windings and making the appropriate connections is easy, even with a tri-filar winding.

A bi-filar winding, such as this one, is even easier. If two colors of wire are used, it is a no-brainer. Even if only one color is used, it is still simple and easy. Take a look at the drawing below.



Notice that if the windings are kept strictly parallel with each other, and no twisting of the wires is allowed, then when the four wire ends are brought out, still parallel, the two ends that are closest together will be the beginning of winding number 2 (green in this case) and the end of winding number 1 (red in this case.

All one has to do is maintain that relationship between the wire ends, carefully strip them free of insulation, twist the beginning of winding 2 together with the end of winding number 1, as shown above, and solder the two together.

Making the connections from there is just as easy. When we look at the schematic above, we see that the junction where the two windings are joined should go to the emitter of the power transistor. One of the single wire, free ends goes to ground, and the other free end is connected to the .1 uF capacitor that brings RF from the Driver stage.

Because we have correctly established the phasing relationship between the two windings, by paying attention to keeping the windings parallel and untwisted, and then joining the beginning of one of the windings with the end of the other, it doesn't make any difference which free end goes to ground, and which free end goes to the .1 cap. Either way, the phasing relationship remains the same.

The output transformer is wound on a binary core, a BN43-202. This is an oval shaped core with two, parallel holes in it.

One turn on a binary core is simply a U shaped piece of wire that passes in through one hole, makes a turn, and comes back out through the other. Taking the wire again through the first hole and back out through the second one forms turn two. Doing this again forms turn three.

Stop at that point, cut the long end of the wire about 5/8" away from the core, strip the insulation from 3/8" of the end of the wire, and do the same with the wire you cut off.

Join the two, stripped ends together by twisting them together, and solder them. This becomes the tap at turn three.

Now take the end of the wire you just soldered on, and pass it in through the first hole, and back out the second hole. You now have four turns, tapped at turn three.

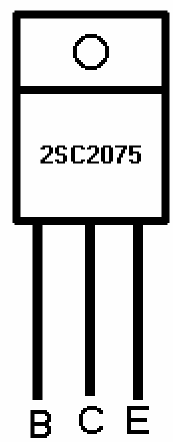
All you need to remember is which wire end is the one with three turns, and which wire end is the one with one turn. This should be easy, since you haven't yet cut off the long end of wire.

While that one is still long, strip the insulation off the end of the wire with three turns, tin it with solder, and make a kink in it so you can identify it. This is going to be the wire end that is to be soldered to ground.

Then cut off the long wire, and strip the insulation from its end. This will be the wire that connects to the T/R Circuit and Output Filter.

The twisted-together tap at turn three will be connected to the .l uF capacitor coming off the collector of the power amplifier transistor.

Of course, we need to know which lead is what on the 2SC2075. If we lay it flat with the metal tab down, and the lettering on the transistor body facing up, then the emitter is on the right, the collector is in the middle, and the base is on the left, as shown below.



The Emitter will be soldered directly to the copper substrate, so we will bend it at a 90 degree angle, towards us, about ¼" or a little more away from the body of the transistor.

The Collector will need to be bent at a 90 degree angle away from us, closer to the body of the transistor, so that it does not come into contact with ground.

The Base will need to be bend at a 90 degree angle towards us, again up close to the body of the transistor, so that it does not come into contact with ground.

The construction of the Power Amplifier stage starts with the bi-filar input transformer, connected as described above, and is followed by the power transistor, soldering the Emitter directly to the PC board surface, with the Base facing the input transformer and close enough to it to easily make its connection to the junction of the two, joined, windings.

Next, the negative lead of the 220 uF capacitor and one leg of the .1 uF bypass capacitor are soldered to ground, at a distance away from the Collector lead of the power transistor that will allow the RF choke to be soldered between the Collector of the transistor and the two bypass capacitors.

Once the RF choke is installed, the output transformer is next, with the end of its three turn winding going to ground, the joined ends forming the tap going to the Collector lead, and the end of the single turn winding left free to connect with the T/R circuit and Output Filter.

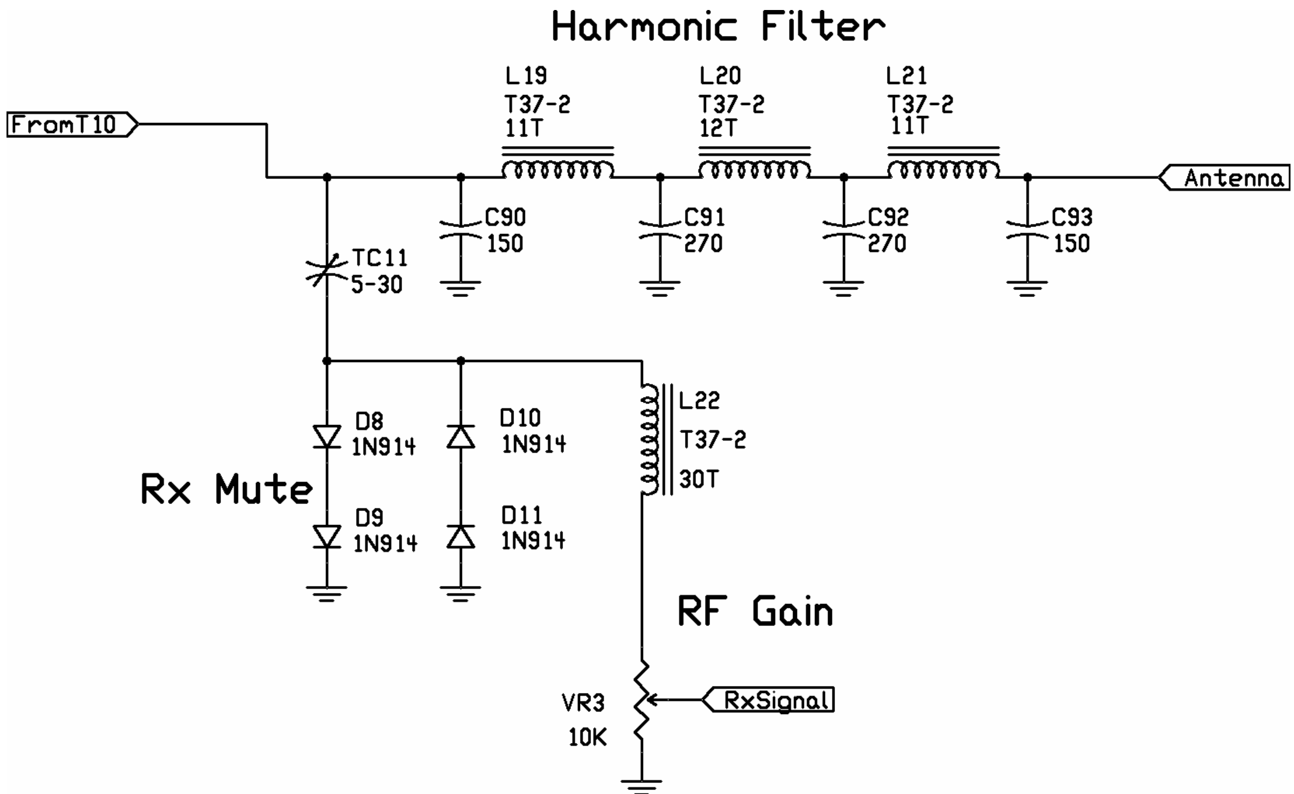
A 12 Volts + DC Power line is connected to the junction of the RF Choke and the bypass capacitors.

Here is a picture of the Power Amplifier installation.

Note that in the picture above, as is the case with any of the toroid core inductors or transformers that are in close proximity, adjoining toroids are turned at a 90 degree angle from their neighbors, so as to reduce what is called the "one turn effect" that comes into play when toroid inductors in close proximity have their cross-sections in the same plane.

The last section of the rig to be built and installed is the T/R Circuit and Output Filter.

Here is the circuit.



All of the components shown here except the RF Gain pot are built onto a small section of PC board material. The RF Gain Pot, as shown in previous photos, is on the front panel of the rig, and will be connected to the T/R Board with shielded, coaxial wire, as it already is to the RF Preamp in the receiver.

Here, below, is a photo of the finished T/R and Output Filter board.

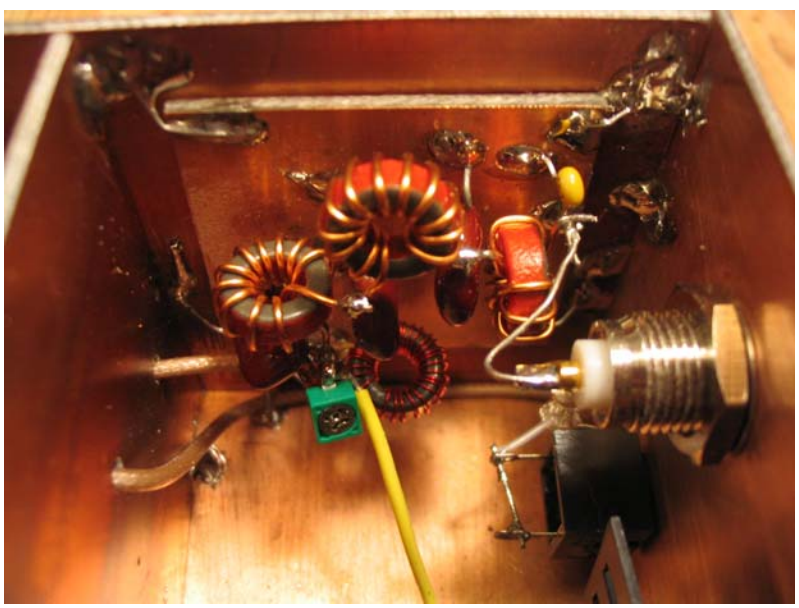
Note that a 10 Meg Ohm resistor was used as a standoff to support the end of L22, in the T/R circuit, to which the shielded, coaxial wire going to the RF Gain pot will be attached. L22 is the toroid coil at the top of this photo.

Also, in the photo above, a fixed, 22 pF capacitor had been installed in the T/R circuit, but was replaced by TC11, as it was found that the trimmer was needed in order to series resonate with L22 and peak the receiver signal.

The need for this trimmer was determined when it was found that the receiver was less sensitive with the signal coming through the output filter and T/R circuit than it was, previously, with the antenna connected directly to the RF Gain pot. A quick check with a clip lead, attached to the center of the shielded, coaxial wire going to the RF Gain pot and touched in sequence to the output of the T/R circuit, the input of the harmonic filter, and the output of the harmonic filter, determined that there was no detectable loss in the filter, the problem was that L22 and the fixed, 22 pF capacitor, were not resonant.

When the fixed capacitor was replaced with TC11, and that trimmer adjusted so as to peak the receiver's response, the original sensitivity level returned.

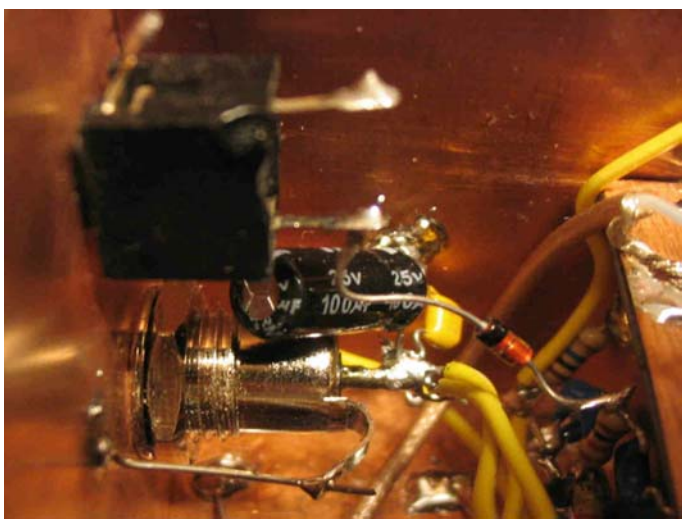
Here is a shot of the T/R and Output Filter board installed in the rig, with TC11, the trimmer capacitor in the T/R Circuit, installed.



Below is a photo of the complete PA and Output Filter installation.

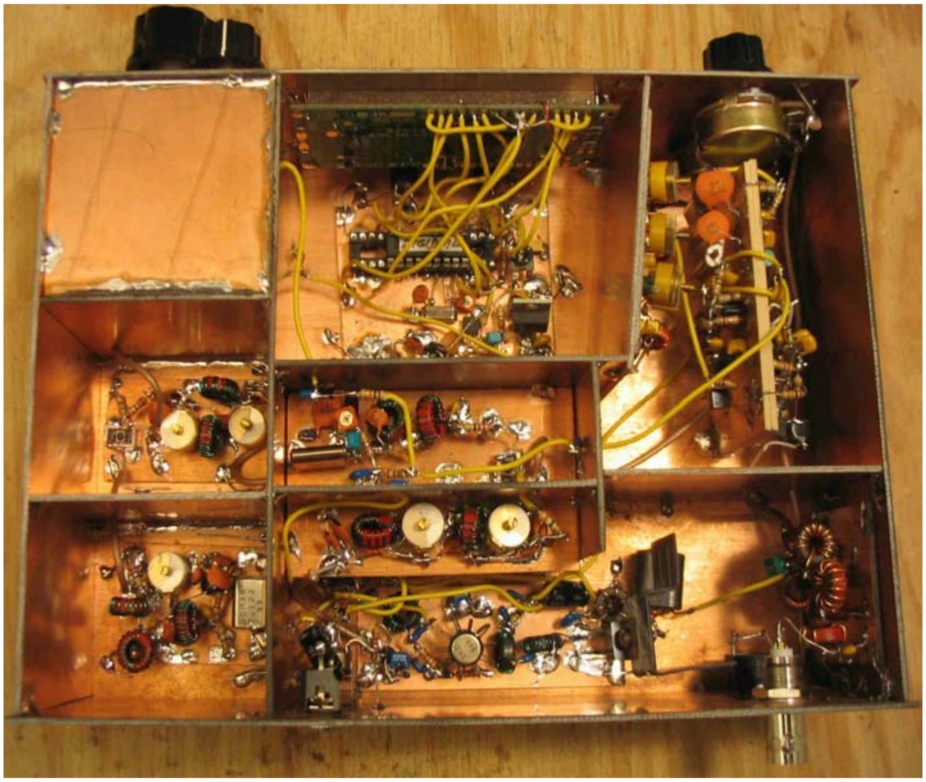
Because the power amplifier transistor is supported solely by its emitter being soldered to ground, and somewhat stabilized by its collector and base connections, it would be a good idea to use a nylon screw and three nuts to physically connect the heat sink with the rear panel of the rig. A metal screw cannot be used, because the heat sink is at 12 Volts + DC potential.

Here is a photo of the DC Power Jack and Key Jack, along with their connections.



The DC Power Jack has both a 100 uF electrolytic and a .1 uF bypass capacitor connected right from the center connector to ground. The diode going from the Key Jack leads to the Keying Circuit. The shielded, coaxial wire coming in from the right carries TX RF from the TX Bandpass Filter to the TX RF Amplifier chain.

And, here is an overhead shot of the completed rig.



Testing and Adjusting the Finished Rig

There are several key performance standards that any rig must meet, before a project like this can be deemed to be completed.

Since this rig uses an analog VFO, we cast a critical eye on its frequency stability. In a demonstration of this rig, from turn-on to a point a half hour later, the frequency of the VFO chain had not moved as much as 10 Hz. The permeability tuned VFO built into this rig has been a proven performer, stability wise, in several previous projects, and is an outstanding performer in this rig.

Receiver sensitivity is another key issue. In this case, Minimum Detected Signal tests performed by Lyle, KK7P, indicate that the receiver has at least a –135 dbm MDS capability.

Lyle also performed Spectrum Analyzer tests of the transmitter output, and all spurs were found to be 45 db or more below the carrier (-45 dbc).

The transmitter power output is 3 Watts, as the rig sits at the moment. While the rig meets current requirements for spectral purity of the transmitter output, and the power level is certainly acceptable at 3 Watts, more work can be done to improve the rig on both those points.

Another item that is critically observed is the stability and cleanliness of the transmitted signal during CW keying. In this case, the keying is crisp and clean, with no instability or other problems noted.

A few final adjustments must be made in order to properly operate the rig as a transceiver. The first is to go back and peak the trimmers in the receiver RF chain a final time, including the trimmer in the T/R circuit as well as the three trimmers in the RF Preamp. Use either a calibrated signal generator or signals off the air to align and peak the trimmer capacitors at about 21.060 MHz.

The next item will be to adjust the trimmers in the Transmitter Bandpass Filter for maximum output at that same frequency. With the transmitter output peaked, the receiver's BFO is adjusted for the proper offset frequency. Once that is done, the last item is to adjust the frequency of the Transmitter Oscillator so that the transmitted signal frequency matches the frequency of a received signal that is centered in the IF passband.

There should be enough tuning range in both the BFO and the TX Oscillator so that one can tune for either upper or lower sideband operation.   The choice is up to the user.

The idea is to tune the BFO to the desired side of the center of the IF Passband, so that a tone of the desired frequency is peaked in the receiver response, and so that there is good opposite sideband suppression.

This can be done by ear, or can be done by using the digital dial or other frequency counter to set the BFO frequency.

If you elect to use the Digital dial, you will need to disconnect its input from the BFO chain output, and use a cliplead to connect the input of the digital dial with the BFO output. Then, set the BFO frequency whatever distance away from 10.000 MHz correlates with the audio tone you want peaked in the IF passband.

In the days when we had a knob on the front panel of our radio to tune the BFO, we learned that the background noise goes through a high, to low, to high frequency sound as the BFO Tuning knob was turned. You can listen to the PNW15 receiver, with no signal present, and tune the BFO trimmer through this high-to-low-to-high sequence. The low frequency sound in the middle correlates to the BFO being tuned close to, or on, the center of the IF passband.

So, if you want to set the BFO frequency by ear, tune the BFO away from this center frequency a little, to either side. Then, tune in a signal, and as you tune through it, listen for a peak in the audio tone. If the audio tone is too low, or you get too much of the opposite sideband coming through, then tune the BFO further away from that center frequency.

When you are satisfied with that adjustment, you are ready to adjust the Transmitter Oscillator so that the transmitted signal frequency matches the frequency of the received signal.

Again, you can do this with test equipment such as a calibrated signal generator and a frequency counter, or you can do it by ear.

If you elect to do it by ear, the process is accomplished through the use of another receiver, so that you can listen to signals off the air on both the PNW15 and the other rig, as well as listen to the transmitter output of the PNW15 so that its frequency can be adjusted to match the frequency of the received signal.

You will also need to be able to switch the active antenna between the PNW15 and the other rig.

Here's how it is done. First, tune in a signal on the PNW15's receiver, adjusting the tuning so that the audio tone heard is peaked at the frequency previously determined when the BFO was adjusted.

Next, switch the antenna to the other rig, and tune that rig to the signal heard in the PNW15, tuning its receiver so that the same audio tone is heard.

Now, connect a dummy load to the PNW15's antenna jack, key the transmitter in the PNW15 and adjust the TX Oscillator trimmer so that the same exact audio tone frequency is heard in the other rig's receiver.

Then, connect the antenna back up to the PNW15, verify the audio tone frequency heard from the signal on the air, switch the antenna back to the other rig, check to be sure it is tuned so that you hear the same tone as you do in the PNW15.

Hook the dummy load back up to the PNW15, key its transmitter, and check that the tone heard from its signal is the same tone heard when the signal off the air is heard. In addition, your sidetone frequency should now match the tone of the received signal, and should match the tone heard in the other receiver.

The alternative is to use a calibrated signal generator, tune it so that its signal is peaked in the PNW15 receiver, then use a frequency counter, a dummy load, and appropriate attenuators to the counter input to check and adjust the transmitter frequency so that it matches the frequency of the signal generator. Again, another receiver can be used to verify that the adjustment has been done correctly, by following the procedure outlined above.

The last thing to do is adjust the IF Offset in the Digital Dial so that it accurately reflects the frequency of operation. This may take some trial and error, but when we are finished the PNW15's frequency readout should read the same as the readout on the other rig.

With these checks and alignments made, the rig is ready for operation on the air.

Concluding Thoughts

This transceiver makes use of a version of a simple superhet receiver with a two-pole IF Filter. Certainly, better selectivity than is provided here would be desirable, especially in crowded band conditions.

However, this simple receiver gives good results and has enough gain and selectivity to provide many hours of enjoyable QSOs.

The first contact with the author's rig was with a station in New York City, made from Birch Bay Village in northwestern Washington State. This was a solid contact with good copy on both ends. Although 15 Meters is not filled with activity right now, as it will be when the sunspot cycle changes for the better, there is enough activity to provide some excitement.

The VFO signal chain in this rig is considerably more complicated than it would be if the VFO itself were designed for the needed 11.0 MHz injection frequency. However, this scheme helps ensure that the VFO signal will be more than acceptably stable. The use of a mixing scheme, in this case using a 4 MHz VFO mixed with a 7 MHz crystal oscillator in order to arrive at 11.0 MHz, necessitates using a bandpass filter in addition to the RF amplifiers needed to boost the VFO signal. A separate buffer amplifier is also needed, between the VFO and the VFO Mixer.

But, parts are cheap and the result is a clean, stable VFO injection signal that gives coverage of approximately the bottom 250 KHz of the band.

In addition, this rig can easily be put on 20 Meters by foregoing the VFO Mixing scheme and using the 4 MHz VFO signal directly with the 10.0 MHz IF and TX Oscillator signal. The other changes needed would be to design the receiver's RF Preamp, the Transmitter Bandpass Filter, and the Transmitter Output Filter and T/R circuitry for 20 Meters.

The rig could also be put on 10 Meters by using a frequency doubler on the output of the Pre-Mix Oscillator and making the needed changes in the VFO Signal Bandpass Filter. This would provide an 18 MHz injection signal to use with the 10.0 MHz If and TX Oscillator signal. In addition, part values in the receiver's RF Preamp, Transmitter Bandpass Filter and Transmitter Output Filter and T/R circuit would need to be adjusted.

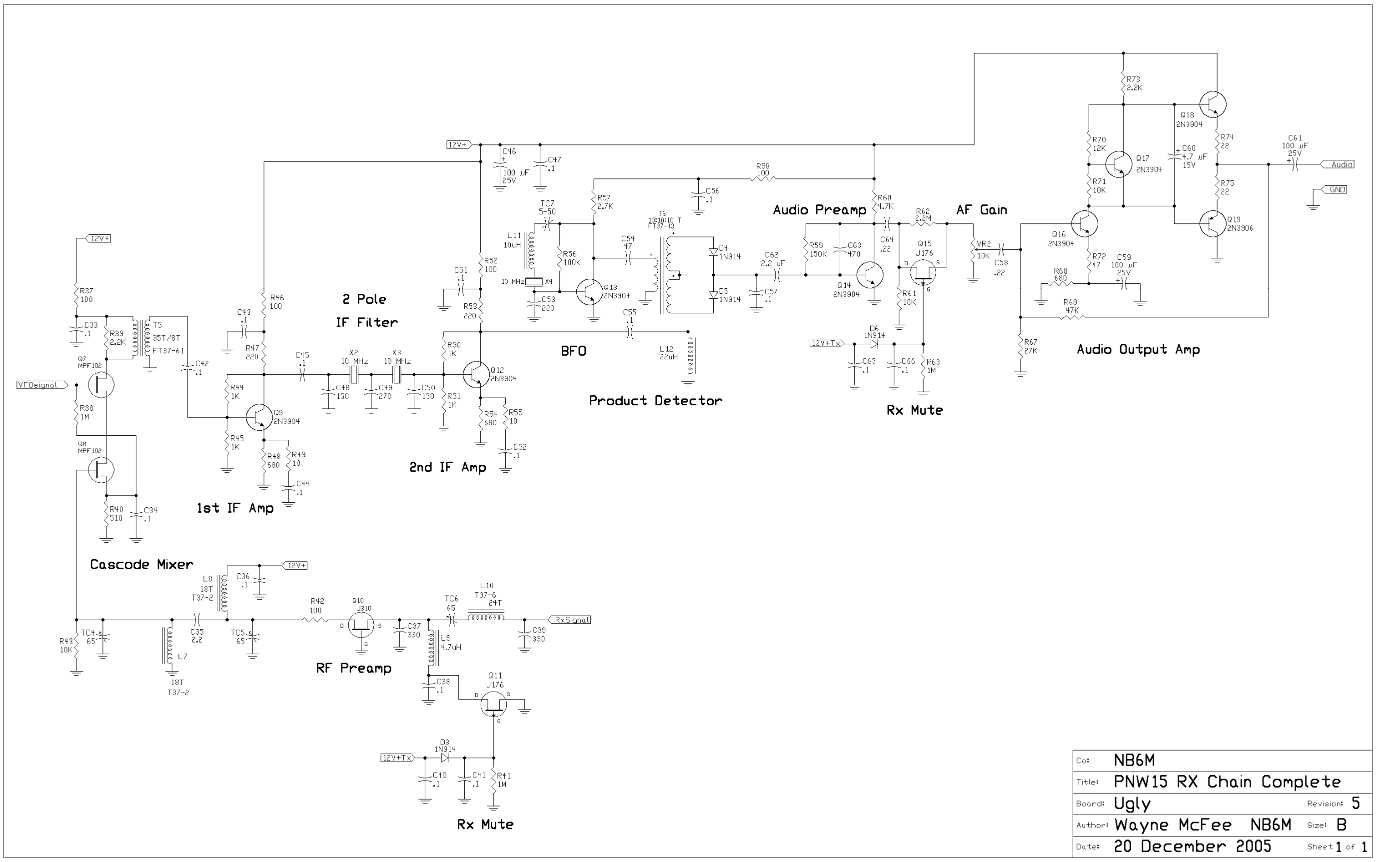
Alternatively, the Pre-Mix oscillator frequency could be changed to 14.060 MHz and the VFO Bandpass Filter changed accordingly. However, if this is done, there will be a birdie at 28.240 MHz. This may or may not be perceived as a problem.

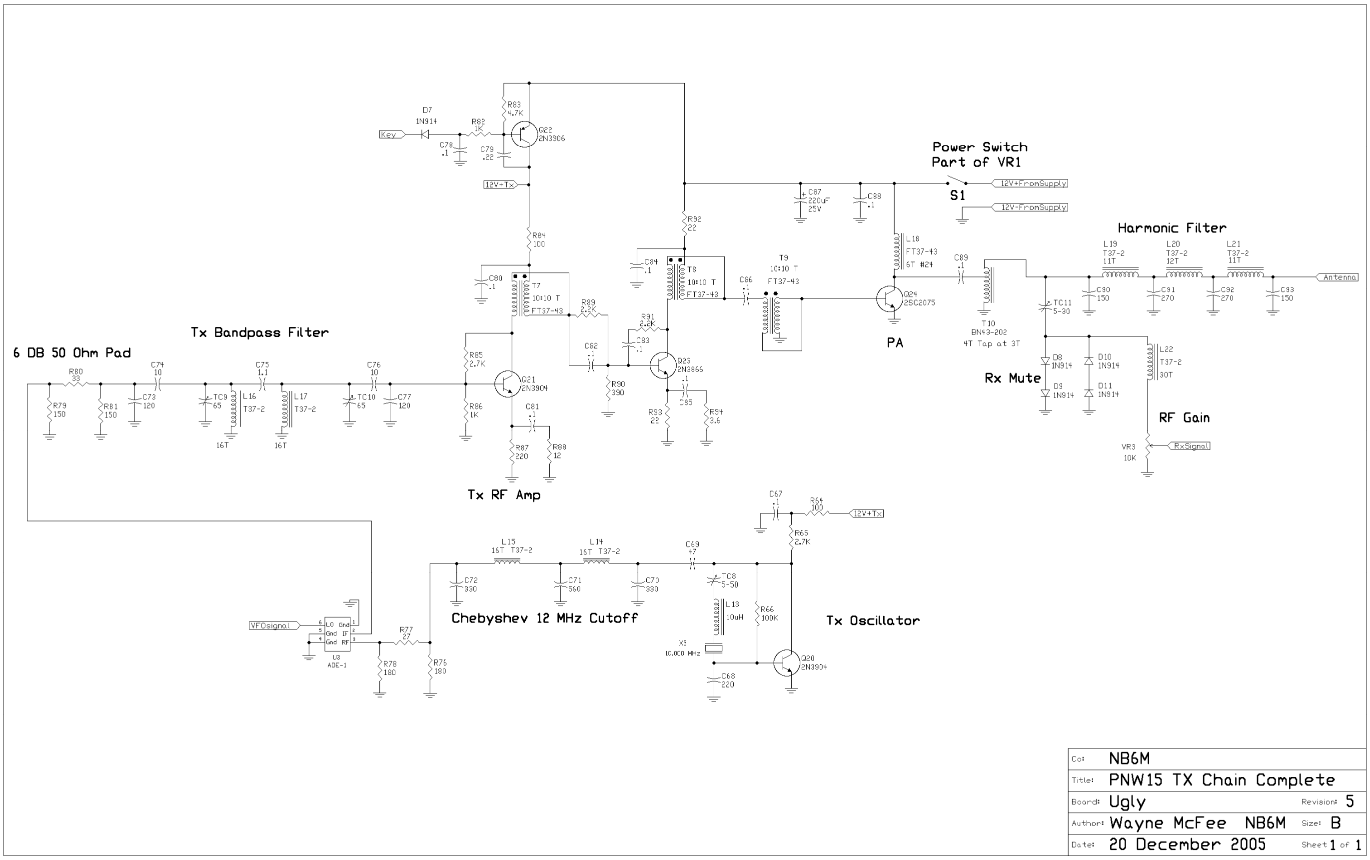
All in all, the finished PNW15 is a pleasing transceiver. It has enough transmitter output to ensure many contacts, along with a stable VFO and good, clean keying. The receiver is a simple, superhet design that has acceptable selectivity and better than acceptable sensitivity. The accurate, Digital Dial incorporated in the design makes tuning very simple.

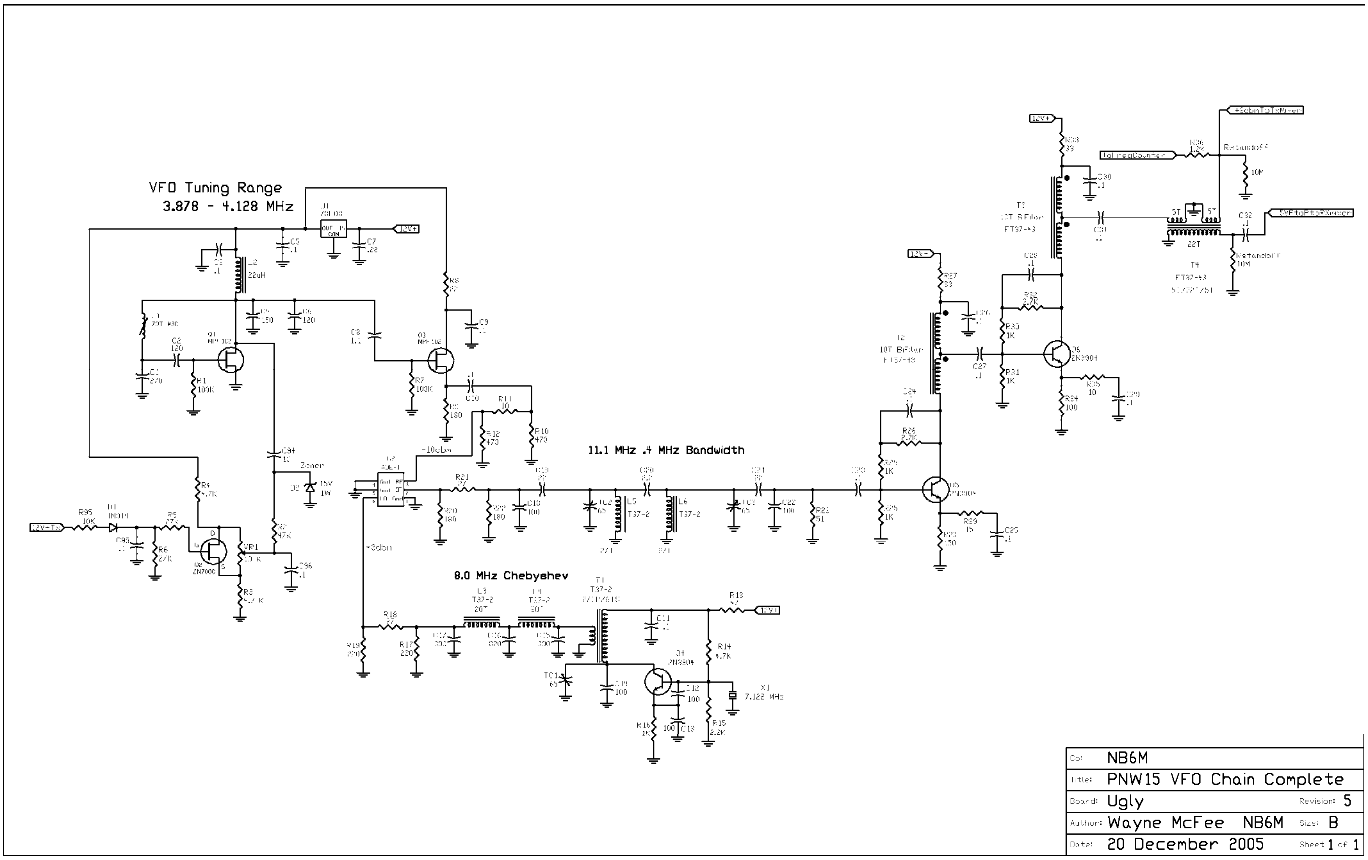
And, there is the added advantage that the entire rig, outside of the Digital Dial, is built with discrete, easy to replace parts, which makes any future needed repair a snap.

Enjoy,

Wayne NB6M
NB6M@aol.com




Power Switch
Part of VR1
S1
Harmonic Filter
Tx Bandpass Filter
6 DB 50 Ohm Pad
Tx RF Amp
PA
Rx Mute
RF Gain
Chebyshev 12 MHz Cutoff
Tx Oscillator
Co: NB6M
Title: PNW15 TX Chain Complete
Board: Ugly
Revision: 5
Author: Wayne McFee NB6M
Size: B
Date: 20 December 2005
Sheet 1 of 1


VFO Tuning Range
3.878 - 4.128 MHz
11.1 MHz .4 MHz Bandwidth
8.0 MHz Chebyshev
Co: NB6M
Title: PNW15 VFO Chain Complete
Board: Ugly
Revision: 5
Author: Wayne McFee NB6M
Size: B
Date: 20 December 2005
Sheet 1 of 1

AmQRP.ORG HOMEBREWER

Tony Catalano, WW2W

The Gorilla Coil

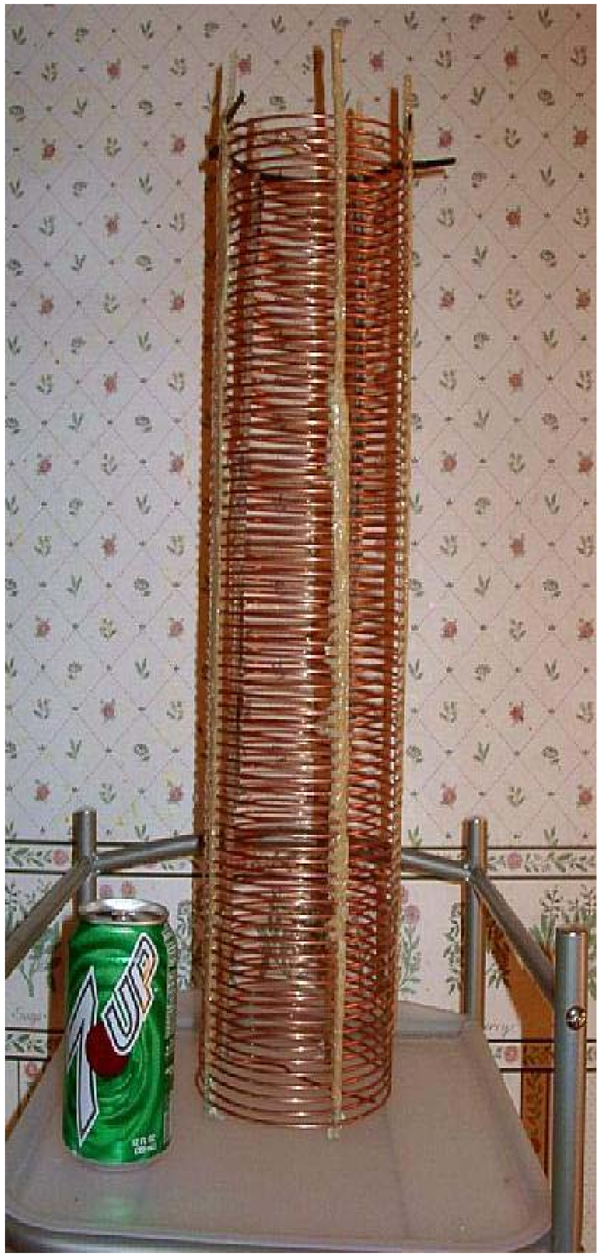
Tony builds a coil to load the Empire State building and in the process learns a new use for cardboard.

Here is a really BIG coil I built with the nylon slats that were being sold at Atlanticon a few years in a row. I figured I may as well do something constructive while watching the boob-tube!

Here we have the start of the beast. It uses a 100ft of soft-drawn copper wire wound on a 5 inch by 20 inch coil form using 10 nylon forms used in a 5 over 5 with a 2 inch overlap.

A major coil-constructing tip I had forgotten was always to *wind the coil onto a solid form that is covered with corrugated cardboard*. Water-soaking the coil after it was set collapsed the corrugated structure and allows the coil to slip off the form.

I, instead, used sheets of newspaper and after 2 hours of picking at soggy paper under the form rods I knew why corrugated cardboard had been invented.



. The gorilla glue expands a great deal when setting to its foamy hardness. This results in a coil that is large, useful and some may say pretty.

Tony Catalano WW2W
acatalan@pipeline.com

Bill Meara, N2CQR

Something New in Ham Radio:

SOLDERSMOKE

The First EchoLink Podcast

"Welcome to SolderSmoke - a continuing discussion between a couple of ham radio operators about all things electronic and geeky. We have been meeting on Echolink for some time now to discuss what was on our Workbenches and to kick design ideas around for new electronic projects."

You've seen them out there. All those little white ear-bud earphones. They are connected to iPods or other kinds of MP3 players. Most are playing music, but more and more of them are playing digital recordings of radio programs. And out there, amidst all the rock-and-roll and NPR, there is at least one program devoted to QRP, homebrewing and ham radio.

Last year, broadcasters started converting their programs into small audio files, usually in the mp3 format, and making them available on the web. Listeners can play them on their computers or download them into their MP3 players. This is called "podcasting."

About six months ago I was alerted to the potential of this new technology by an article in the British magazine "The New Scientist." The article described how people around the world were, in effect, creating their own radio programs on their home computers. It occurred to me that my home PC was close to being ready for the production of these kinds of shows.

For a few years Mike Caughran, KL7R and I have been having regular QSOs via the EchoLink Internet system. We usually discuss our homebrew radio projects. I mentioned the podcast idea to Mike and the next thing I knew he had recorded one of our QSOs and converted the recording into an MP3 file. We were suddenly podcasters!

We're now up to edition #24 of SolderSmoke. We usually get several hundred downloads for each show. Our only pay-off is the fan mail we get; we consider ourselves well compensated.

For those interested in the technical aspects of our operation, it is very simple. Mike records our QSOs using the record feature of the EchoLink program. He then uses the (free)

“Audacity” audio program to edit our jabbering and add the musical background theme. The file is then made available for free download via the very generous “Ourmedia” web site.

Listeners can subscribe to the show via a bit of free software called iPodder – in this way any new shows will be automatically downloaded to their MP3 player. Or they can just visit our “Ourmedia” site, click on the desired program and listen through their PC.

We have been having a lot of fun with this. Mike is in Alaska, and I am in London. It is usually 6 am for me and 9 pm for Mike when we talk. The next day, or the next month, a fellow ham may be listening to our show while jogging through Tulsa, or while going to work on a train in Tokyo…

Just as EchoLink opened up a new way to link ham radio to the web, there are clearly a lot of possibilities for our hobby in the new world of podcasting. If you participate in an interesting technical roundtable QSO, why not share it with a larger audience? What about a podcast of that weekly QRP roundtable on EchoLink? How about some of those great AM QSOs on 75 and 160? Right now they are all disappearing into the ether, but with this technology they could be essentially immortalized and made available on demand to hams around the world. How about a series of podcasts on that new rig you just built? And remember, many of those little MP3 players also have microphones in them. So you could do some time-shifted transmitting. For example we'd like to work some listener participation into our show. So maybe if you are listening to us someplace interesting (e.g., going through the channel tunnel or perhaps at 35,000 feet over the Pacific) how about recording us a little message – we could then put it into the show and send it out to the world.

Please check out our show. George is including on this CD all of our programs to date. You can subscribe to SolderSmoke by plugging this URL into your iPodder software: http://www.ourmedia.org/mediarss/user/36170 or you can find all of our shows on our Ourmedia homepage: http://www.ourmedia.org/user/36170 and they have also been included on this CD.

Like I said, feedback keeps us going so please let us know what you think. Send feedback to soldersmoke@yahoo.com

“So that's all for today from the Anglo-Alaskan SolderSmoke production team. Tune in next week for another inspiring edition of SolderSmoke!”

(Be sure to see the contents and links for the first 24 issues of SolderSmoke on the next page!)

SOLDERSMOKE ISSUES CONTAINED ON THIS CD-ROM in MP3 FORMAT

SolderSmoke 1
Tech talk of two radio amateurs. Bill in London and Mike in Juneau meet on the ECHOLINK VoIP system and discuss their homebrew radio projects.

SolderSmoke 2
Discussions between two amateur radio experimenters about what is currently on our benches.

SolderSmoke 3
This issue: "rubbering" ceramic resonators and the "DC to Daylight binaural receiver"

SolderSmoke 4
This issue : ladder filters, binaural receiver, test equipment

SolderSmoke 5
Binaural Receiver Crystal ladder filters. 17m DSB xcvr

SolderSmoke 6
Ham radio discussions of RF projects that are on our benches.

SolderSmoke 7
Discussions between two ham radio operators/experimentors about projects we have currently on our benches.

SolderSmoke 8
Discussions between two ham radio operators/experimentors about projects we have currently on our benches.

SolderSmoke 9
This week - Mars Rovers - nano wattmeter - xtal radios - QRP news

SolderSmoke 10
This week "Einstein's Heroes" - PCB prototyping - Atmel butterfly - respect for those who do with less.

SolderSmoke 11
Two amateur radio experimenters discussing workbench radio projects.

SolderSmoke 12
This week Dobsonian reflector telescopes. Class A amplifier design spice vs spreadsheet. Christmas.

SolderSmoke 13
This issue: Happy New Year 2006, Transisistor RF amp design using Spice and spreadsheets. Multistage amplifier feedback mechanisms. PopCorn QRP. Burning DVDs.

MP3 Players. Online and published technical magazines. The value vs price of technical publications. Experimental Methods. The 2006 Handbook. Solid State Design.

SolderSmoke 14
This week: curry toast and tea satellite tracking and worried neighbors. Stardust probe. Whale on the Thames river. HCJB Soundcard Modes

SolderSmoke 15
This Week: SuitSat. Jupiter's moons. Back yard telescopes. Trip to Pluto. TimeDomain Reflectometer. KX1 high power mod. DC-DC converters. Good Jobs. Movie Review: "The Dish". Book Review: "First Light".

SolderSmoke 16
Two ham radio operators discuss workbench radio projects. This week: Desitin as heatsink compound and bottom paint. Supermodulation. Mixers / ne602 spice models. Soldersmoke in space. Website review: revver.

SolderSmoke 17
Two amateur radio experimenters discussing workbench radio projects. This week K1 receiver/receivers in general. The "feel" of programming languages/rigs. NE602 Spice model. Blue sun. Green flash. Receivers made from tooth filling detectors. Ejection seat HF radios. Saturn. Book review: "Technical Topics". Websites of the week: www.theregister.co.uk, www.spaceweather.com. Cracking Enigma. SETI at home.

SolderSmoke 18
Two amateur radio experimenters discuss workbench radio projects. This week: New Bench and Shack wiring. Using a hot screwdriver as a soldering iron. VW solar panels. Class AB Amps. Saturn's watery moon. Mars Recon Rover. The next SolarMax. Heliosismology. Aurora in NY. DX during a solarmax on the Azores.

SolderSmoke 19
Two amateur radio experimenters discuss workbench radio projects. This week: Easter edition. Experimenter vs Tinkerer. NTP3055v FET amp. Apr 2006 Bacon Bits. Ham radio software. Soundcard software. IQ receivers with soundcard software. MMANA 4nec2. Michigan Mitey Mite Transmitter.

SolderSmoke 20
Two amateur radio experimenters discuss workbench radio projects. This week: 80 meter qrp ssb and dsb transciever circuits.

SolderSmoke 21
This week: First Light for QRP rigs, Final amplifier voodoo/ quantum mechanical necromancy, ne612 carrier balance, Transmitter lowpass filters, The sweet sound of DC receivers, Slinky verticals, LC tuners, TiddlyWiki,VMWare and AFUKnoppix.

SolderSmoke 22
Two amateur radio experimenters discuss workbench radio projects. This week: How to get more than a watt out of a 12volt/50ohm amplifier. Wb7aei lowpass filters. Passive and active mixers. The binaural receiver. UK vs US hamfests.

SolderSmoke 23
Two amateur radio experimentors discuss workbench radio projects. This week: Taming HF amp self-oscillation. Output broadband transformers. DSB transmit on both usb and lsb at the same time. Adjusting LSB ladder filters. The "SSB advantage" vs the "CW advantage". Satellite Oscar 52. Using jet wings as topband and magic band passive reflectors.

SolderSmoke 24
This week: Two-Tone Test mp3 file. Review online book "crystal sets to sideband". Doubly rockbound SSB TX. HF Packer SlimGem amps. Push Pull IRF510 Mosfet amps. W1FB 40 db wide band general purpose amp. HF amplifier degeneration. Hf+6 diplexer.

BIOs:

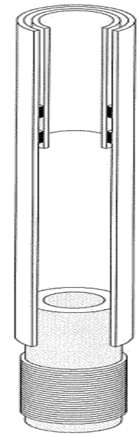
Mike Caughran, aka KL7R, got his ham ticket around 1977. His elmer passed along a love of building radios and working CW. He was born and raised in Alaska and is a patriot of that state. He education is in electronics but has been working with computers since 1982.
See http://kl7r.ham-radio.ch

Bill Meara, aka N2CQR, M0HBR, and CU2JL, got interested in ham radio by listening to programs of Jean Shepherd on WOR radio in New York during the 1970s. Bill does not work in electronics professionally, but his job does, in effect, put him on a permanent DX-pedition.
See http://www.gadgeteer.us
Ourmedia member since 08/2005

Murph, VE3ERP

The MicroVert Antenna

A small stealthy antenna for antenna restricted homes or emergency communications…



The DL7PE MicroVert Antenna

This remarkable antenna was brought to my attention by Arnie Coro, CO2KK, who has built and experimented with several of them. Arnie asked if I would write a design program for the MicroVert for inclusion in my free HamCalc software. I jumped at the chance. At Arnie's suggestion, I researched the antenna by referring to a comprehensive article about it in an Antennex Magazine CD entitled "Double Pack Volume 3". (Editors Note: See Arnie's excellent web site for more ham ideas at http://www.radiohc.org/Distributions/arnie.html)

Technical Stuff

The MicroVert is an extremely short monopole that can be mounted at any angle from vertical to horizontal. It has a high radiation resistance (about 30 ohms) and is thus very efficient. Its feed point impedance at resonance is close to 50 ohms. No special counterpoise is required apart from the braid of the coaxial feeder cable. Unlike mobile/maritime whips that use the metallic content of the vehicle for a counterpoise there is no need for a high Q, large diameter, heavy conductor loading coil. Therefore a wide bandwidth compact coil, close wound with small enamelled wire, can be used. The efficiency of a 14 MHz MicroVert is comparable to a 5 ft. diameter small circular loop antenna. Gain is -6 to-12 dBd (below full size dipole).

What is a MicroVert in plain English?

To non-techies like me, the MicroVert is (A) a single band monopole, (B) a dipole is two horizontal pieces of wire fed in the middle, and (C) a monopole is a tipped up dipole with a vertical radiator being one leg and the other leg being a counterpoise of some description. A well known monopole is the vertical ground plane antenna, with a vertical radiator (monopole) above 4 horizontal radiators (counterpoise). The Microvert uses a short length of aluminum tubing as the radiator, and the braid of the coaxial feedline as the counterpoise.

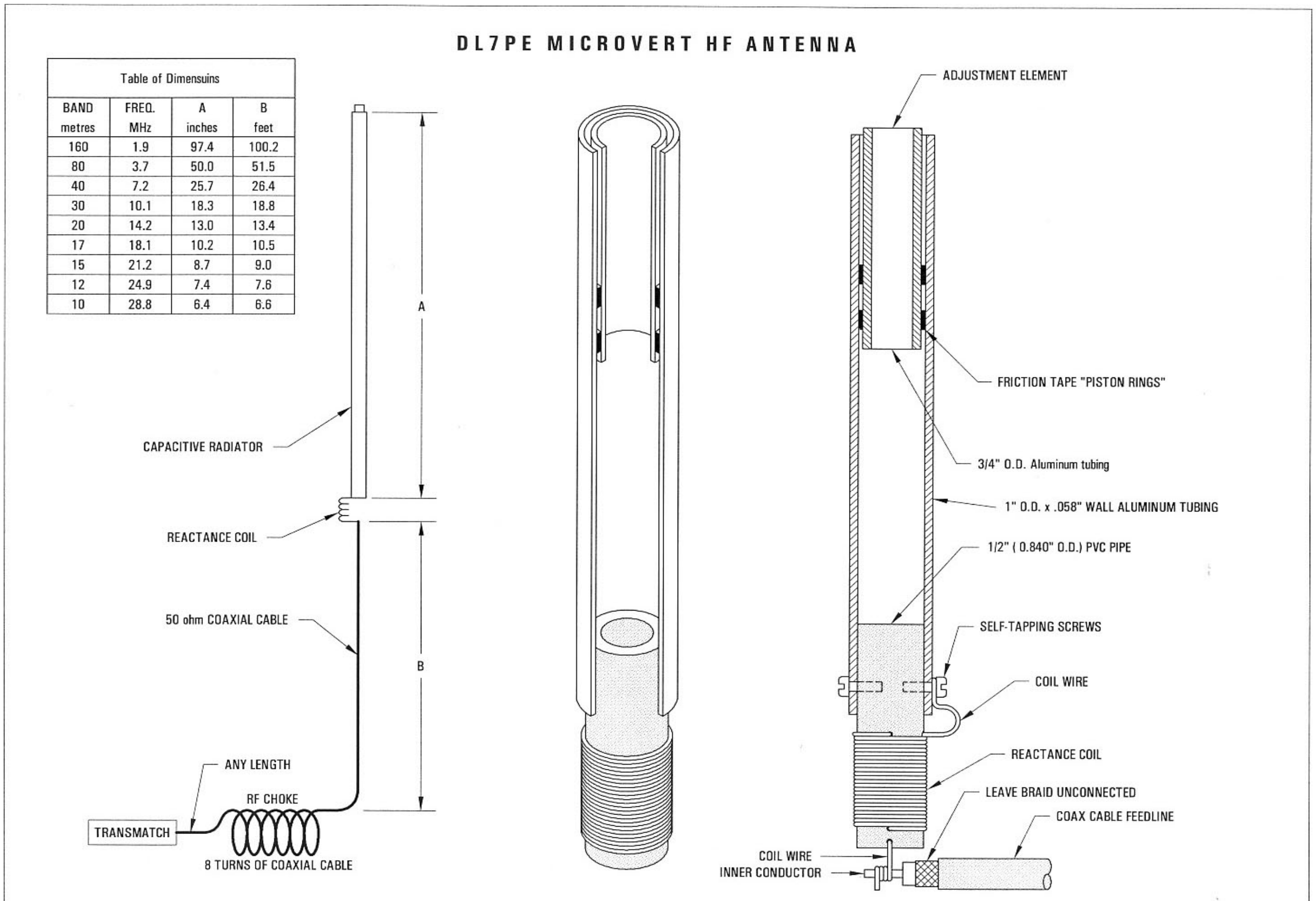


Table of Dimensuins

BAND metres	FREQ. MHz	A inches	B feet
160	1.9	97.4	100.2
80	3.7	50.0	51.5
40	7.2	25.7	26.4
30	10.1	18.3	18.8
20	14.2	13.0	13.4
17	18.1	10.2	10.5
15	21.2	8.7	9.0
12	24.9	7.4	7.6
10	28.8	6.4	6.6

Fig. 1 - Schematic   Fig. 2 - Cutaway View   Fig. 3 - Sectional View

Construction Notes

Refer to the drawing for general arrangement and details.

1. Use only PVC (polyvinyl chloride) pipe for the coil form. Plastic Pipe and tubing of other materials may contain substances that could inhibit performance of magnetic fields associated with the coil.

2. Secure the modified SO-239 connector (Fig.2) in the Plastic pipe cap (Fig. 4) with epoxy adhesive. Lock the cap in place with stainless steel self-tapping screws.

3. Start with an adjustment element with a length of about 1/4 that of the radiator.

4. Apply just enough turns of friction tape “piston rings” (Fig. 4)on the adjustment element to provide a snug friction fit inside the radiator.

5. Adjust the depth of insertion of the adjustment element into the radiator to provide minimum SWR at the design frequency.

6. Secure the adjustment element in place with a stainless steel self-tapping screw where shown in Fig. 4.

7. Cut off the projecting top of the adjustment element flush with the top of the radiator.

8. Caulk the gap between the adjustment element and the radiator, add a plastic cap, and enclose the whole top area in heat shrink tubing.

9. To allow escape of condensation, drill a few small weep holes through the pipe cap and coil close to the bottom of the assembly (Fig.4).

10. Enclose the bottom of the radiator, including the coil, in heat shrink tubing, being careful not to block the weep holes.

11. New 50 ohm RG-58 coaxial cable from a reputable manufacturer is recommended. Avoid used, surplus, or no-name “bargain” 50 ohm coaxial cable, especial those with combed loose wire shielding.

The (ugh!) Math

If you have HamCalc (preferably version 79 or later http://www.cq-amateur-radio.com/HamCalcem.html) software just run the MicroVert program - it does all the math for you. But if you are into self-destruction, here are the equations:

F = Frequency (MHz)
Dm = Radiator outside diameter in metres
Ls = 4700/F Radiator length in millimeters
Lsm= Ls/1000 Radiator length in metres
C = 19.1 x Lsm x 1/{log[.575 x (Lsm/Dm)]} in pF
L = (159/F)2/C in uH
LR = 58/F Counterpoise length in metres.

Had enough?

Me, too - math gives me a headache!

Murph VE3ERP
VE3ERP@encode.com

AmQRP.ORG HOMEBREWER

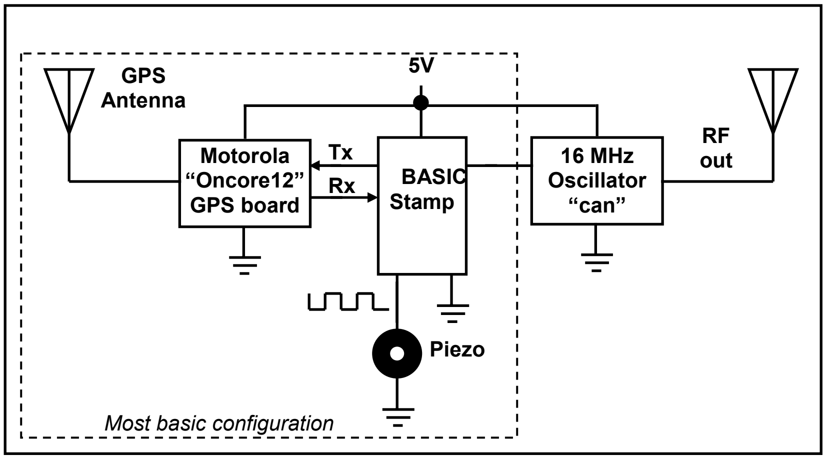
George Heron, N2APB

Use a BASIC Stamp to Send GPS Positioning in Morse Code

"Ever had a need to announce GPS information like latitude, longitude or a precise 1-second beep? Read on to discover how N2LO developed a unique approach by converting GPS data to Morse code and transmitting it to a SW receiver.

One of our club members came up to me at a recent NJQRP meeting and said “Tune your FT817 over to 16 MHz and tell me what you hear.” I was intrigued because I didn’t have a clue what service was assigned to that frequency. When we started copying the Morse transmissions (“40,21.3350,N 074,36.8327,W”) it became apparent what the data was ... lat/long positioning information from a GPS satellite. But how were we able to read it on this frequency?

Robert Evans, N2LO cleared up our confusion by explaining that he had placed a small box outside the building containing a micro-power transmitter sending the latitude-longitude data from a small GPS receiver controlled by a BASIC Stamp microcontroller. Neat! But I had to learn more, and what Robert shared with me illustrates what can be done with simple components and a BASIC Stamp controller.



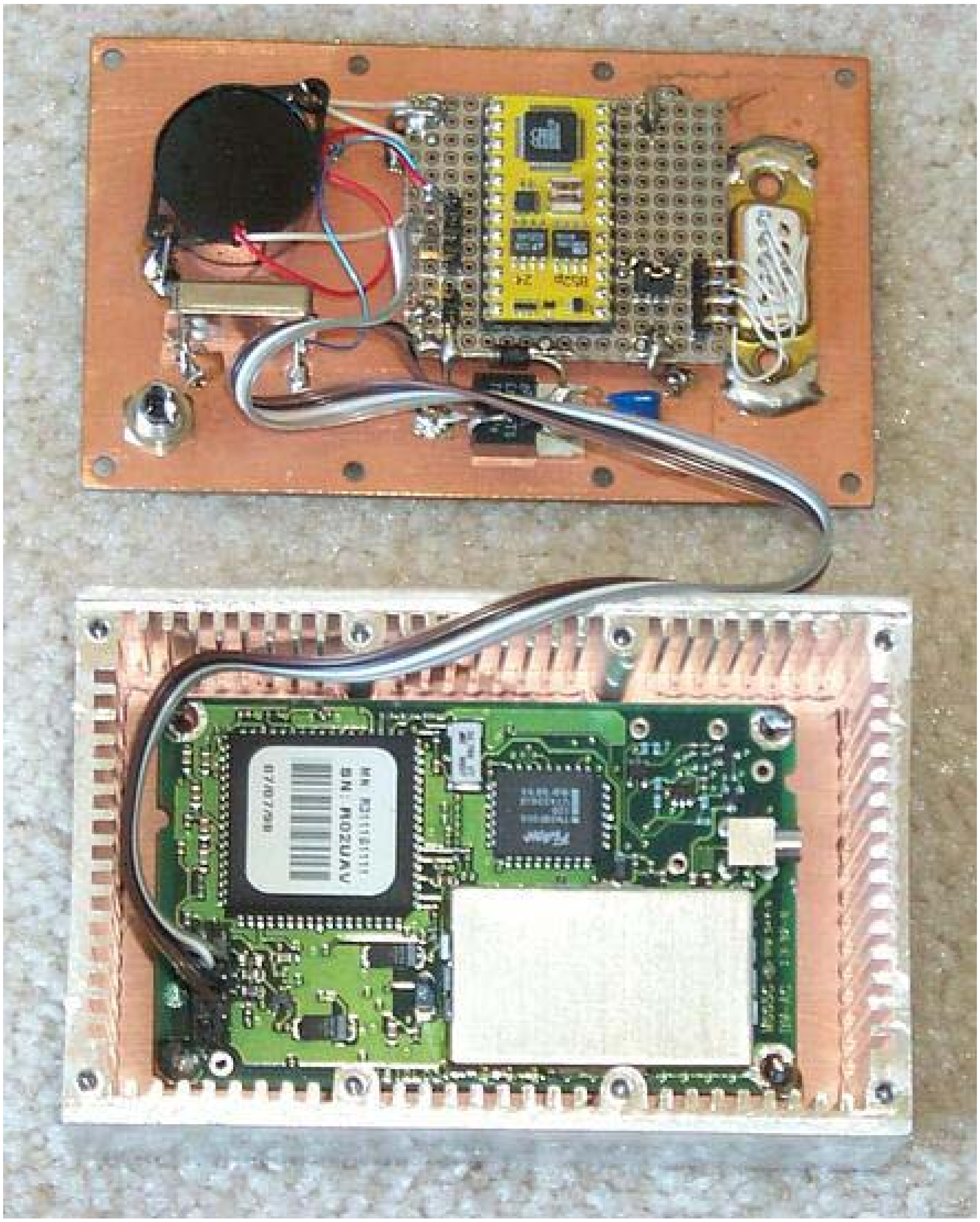
The heart of this system is a Motorola “Oncore12” GPS board. A surplus vendor (BG Micro) recently had a bunch of these little circuit boards on sale for $24 – quite a deal! TAPR also used this board in their GPS projects, and you could still likely find some around at a good price. Construct a 1.5 GHz GPS antenna for next-to-nothing cost (Oct 2002 QST), add a 5V power supply and you get a stream of NMEA-encoded ACSII data coming from the board at a 4800 bps serial rate. (Editors note: The Oncore 12 is very hard to find. Any NMEA 0183 compatible 3.3 to 12 volt GPS board can be used. I suggest the Trimble Lassen LP http://trl.trimble.com/docushare/dsweb/Get/Document-4753/ which is available for about 55.00 contact Mr. Micheal Leary at Trimble)

N2LO programmed a BASIC Stamp microcontroller with a simple program to read that NMEA data stream and convert the text characters to Morse code, as annunciated using a piezo sounding device mounted in the box. The BASIC Stamp comes from Parallax.com and can be programmed using their free editor and serial downloader. The Stamp costs $45 (ouch!), but you could also use the HC908 Daughtercard at about half the price from the NJQRP Club, or even a PIC microcontroller for an even cheaper solution. The software for the Stamp and the HC908 controllers is located on the NJQRP website for this project – it’s the homebrewer’s choice as to which way to go! (Visit www.njqrp.org/gps2morse for all the details, software listings, vendor contact info and references.)

The 16 MHz oscillator module was included in the box to provide a convenient way of getting the data when the GPS receiver is remote, as was demonstrated at our club meeting.

It’s often fun knowing exactly where you are when operating in the field. A device such as this (without the 16 MHz oscillator) could form the basis for a more elegant and useful piece of gear you could take on your next QRP outing in the mountains or along your favorite miles of beach. You could modify Robert’s software to accept more of the GPS data coming down from the “bird” and display latitude, longitude, elevation, speed, heading, time, and satellite status information as frequently as once per second on an LCD. This is a perfect project for the Digital QRP Breadboard (HC908 Daughtercard project), and you'll see the project details and software for this solution on the website too.

What applications can you come up with? Whatever they are, you can rest assured always knowing where you are!



The GPS receiver board is a mere 2"x 3" and sits in the bottom of the enclosure. The BASIC Stamp controller mounts under the cover. Not too complex!

George Heron, N2APB
n2apb@amsat.org

AmQRP.ORG HOMEBREWER

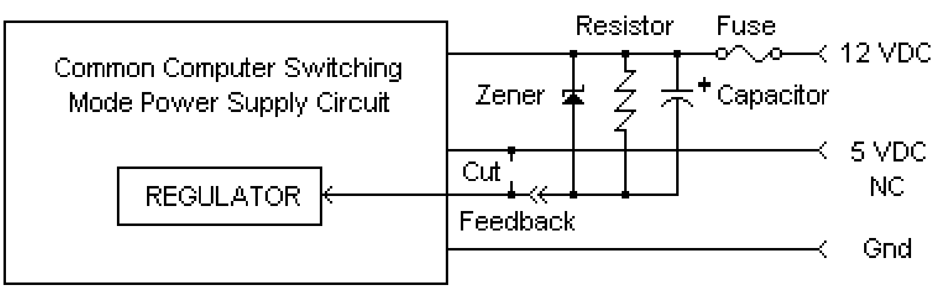
David S. Forsman, WA7JHZ

Modification of Computer Switching Mode Supply for 12 VDC Use

Here is what I have done to two old computer power supplies. I didn't want to haul them to the landfill.

The common switching-mode power supplies found in most computers can sometimes be modified for use at 12 VDC operation. Normally, feedback from the 5 VDC output source is fed to a discrete voltage regulator circuit or IC. The 5 VDC supply source is the first priority of the power supply regulation circuit, while the others (12 V, -12 V, -5 V, etc.) get only minimal regulation. In order to have good 12 VDC regulation, the regulator circuit must be connected to the 12 VDC source, instead.

The purpose of this modification is to “drop” the voltage of the 12 VDC source to a 5 VDC sample level; reroute it to the regulator circuit; and thus give primary regulation control to the 12 VDC output. Using an 8 VDC zener should result in about 13 VDC output.

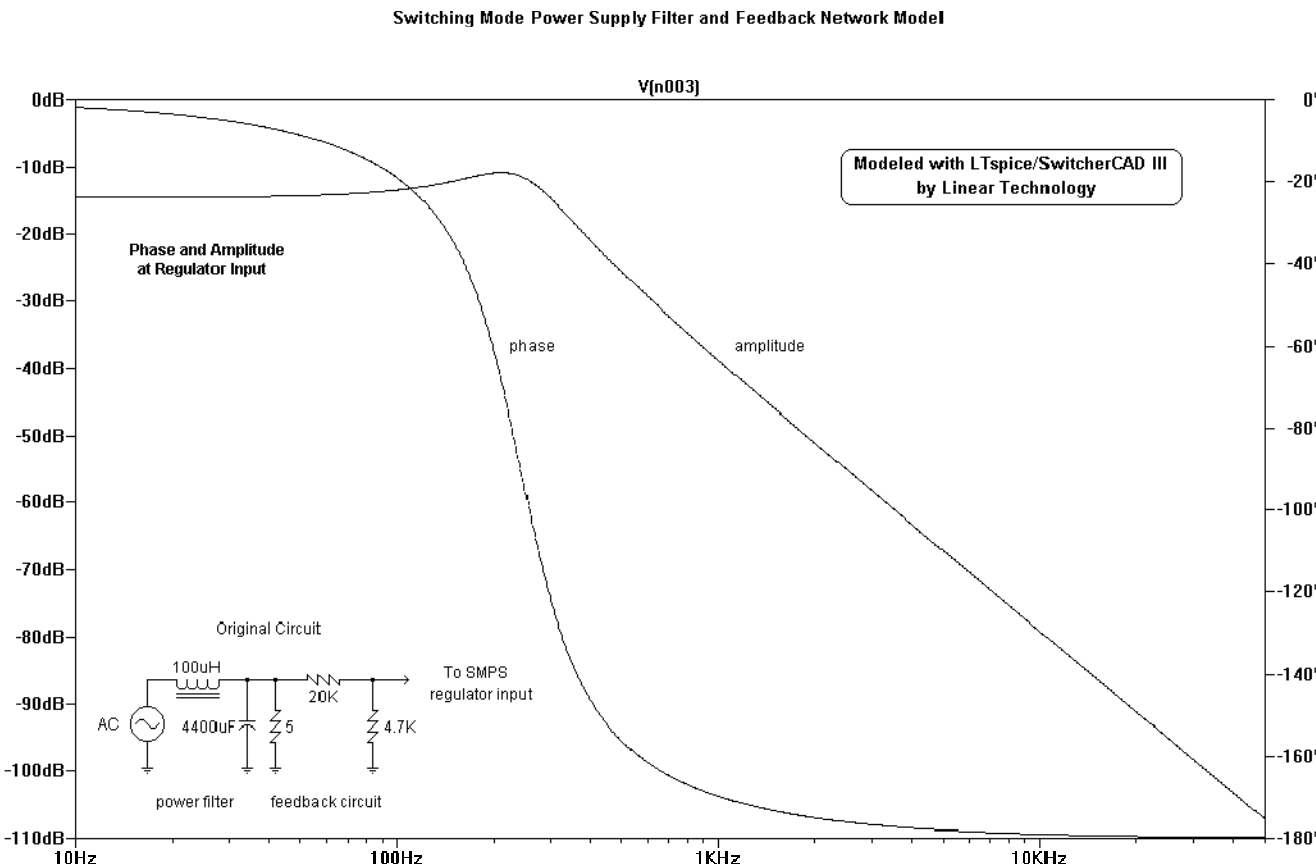


Begin by cutting the circuit trace between the 5 VDC source and the regulator circuit. Then connect the regulator-side circuit trace through a parallel network composed of a resistor, zener diode, and capacitor to the 12 VDC source. The resistor is not always necessary. The parallel capacitor may improve the regulation response speed and reduce output ripple on some units. Careful selection of these components is necessary to get the desired voltage output. Also, be careful not to exceed the rated output current of any particular voltage source. Always use a fuse of the same or lesser value.

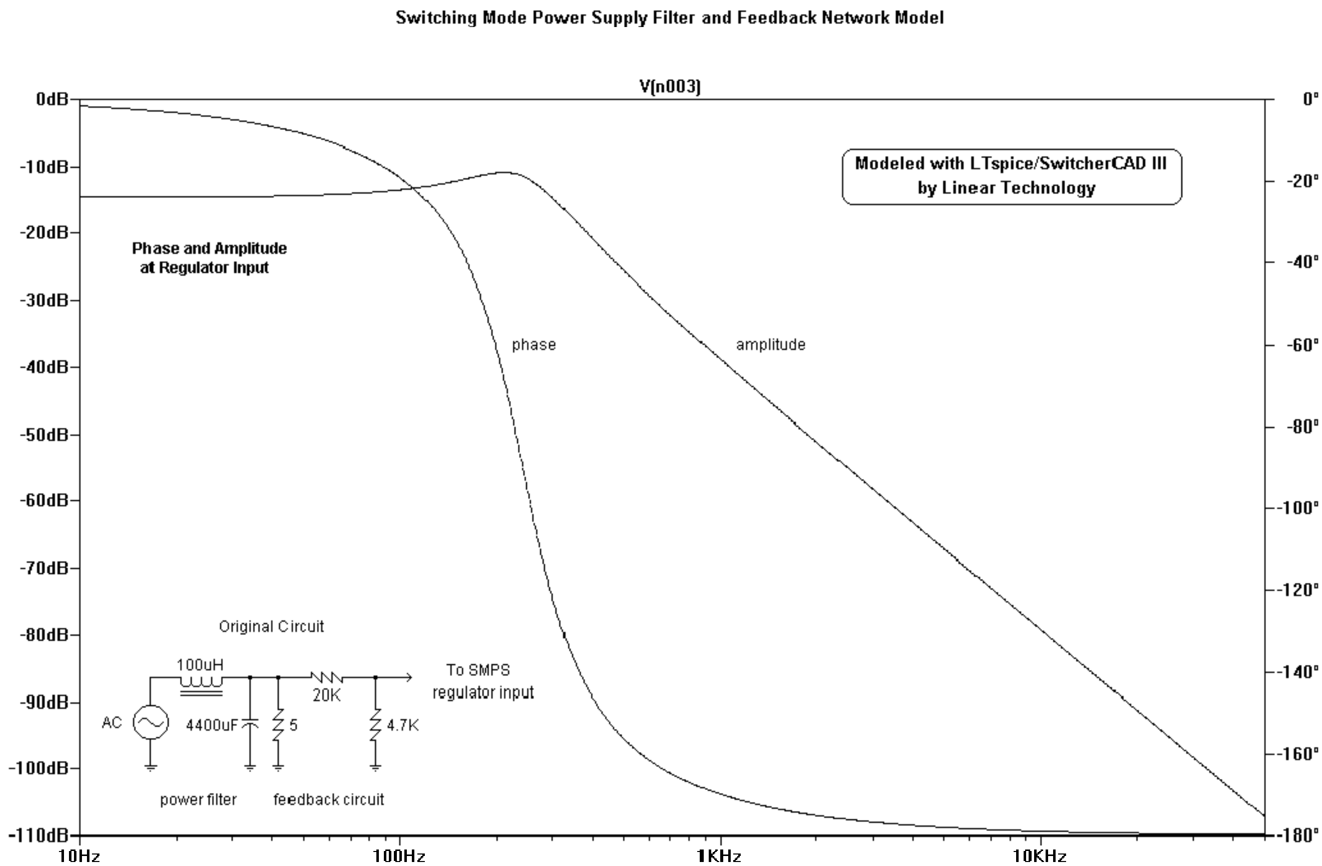
These devices operate with lethal internal voltages, so unplug the supply and let the capacitors discharge before opening their cases. As an added precaution, discharge the main electrolytics with a piece of wire. The end result should be a reliable 12 VDC power supply for Amateur Radio experimental use. The author assumes no liability for either their use or misuse.

I continue to modify old computer power supplies for 12-volt-only operation, but I don't think that I told you that I had one that oscillated at about 600 Hz. I finally modeled it with the AADE Filter Design V4 software and decided to add a small capacitor. It now runs perfectly. Most supplies use the TL494 regulator chip or a pin-for-pin generic version (like the KA7500).

Later, with the suggestion of the AADE web site, I downloaded the Linear Technology free software for power supply and general circuit modeling. I have attached a GIF file of what I ended up with. You should download the same, and I can try to help you with what I have already learned.



The phase-lead capacitor, as I prefer to call it, keeps the overall circuit phase shift below 180 degrees in a critical area of its function. According to the Nyquist Stability Theorem, oscillation will occur, as you well know, when the phase shift of an inverting circuit's feedback loop reaches 180 degrees with a gain greater than 1 (A > 1). Nyquist's work was important during WWII when some ordnance electronic steering mechanisms went into gyrations. His loop stability work kept more people from getting injured, to put it mildly.



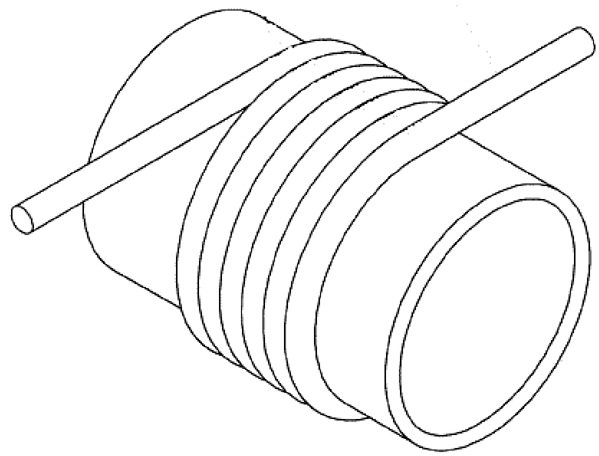
For those who can't afford a new 12 volt supply, the old computer supplies offer a good second choice. They do require some modification, but the end result is often as good as the real thing. Do you have a good 12 volt bench supply? If not, you might want to try one of these.

I have had one of the 5 volt dual rectifiers that I swapped with the 12 volt side short out due to its low PIV rating (a poor attempt at trying to increase its output current). Since then, I have put the original 12 volt dual rectifiers back in their places. Most of them are rated at 12 to 16 amps at 200 PIV, so they don't do too badly. The power switching transformer and power filter choke (100 uH) have about the same rating. So far, I've modified four supplies to 12 volt units.

David S. Forsman, WA7JHZ

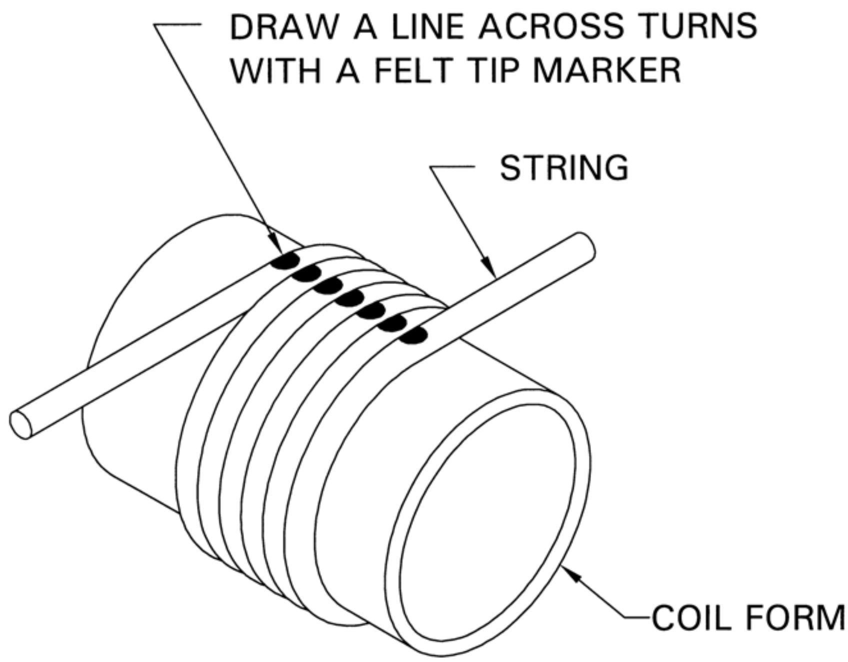
George Murphy, VE3ERP

Measuring a Coil Form



Ever wanted to measure a coil form accurately but lacked (or couldn't find…) your micrometer? The figure on the next page gives a helpful tip.

HOW TO MEASURE THE DIAMETER of a COIL FORM (or anything else) with MICROMETER ACCURACY WITHOUT A MICROMETER



UNWRAP THE STRING

MEASURE LENGTH BETWEEN FIRST AND LAST DOTS

COUNT NUMBER OF SPACES BETWEEN FIRST AND LAST DOTS

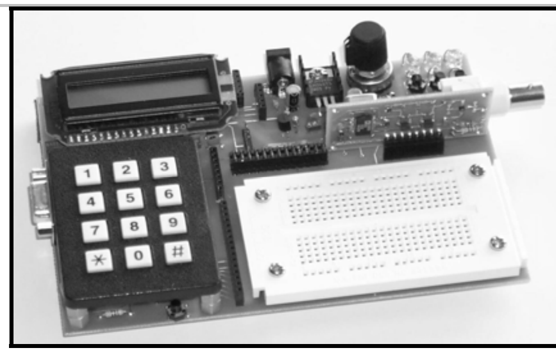
$$\text{DIAMETER} = \frac{\text{LENGTH}}{(\,3.14 \times \text{NUMBER OF SPACES}\,)}$$

AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

QuickieLab Test Bench

In the mood for a Quickie? Check this out…



The NJQRP QuickieLab (QL) is a great platform to build a ham measurement and test setup. The Inherent Basic Stamp 2 functions, Quickielab features, plus the Input Output eXtender (IOX) and optional Direct Digital Synthesizer (DDS) daughtercard are a powerful combination of tools to implement a wide variety of test equipment. We will see how the basic hardware plus some added interface circuitry can be used to make a powerful modular test system.

QuickieLab & Basic Stamp Features

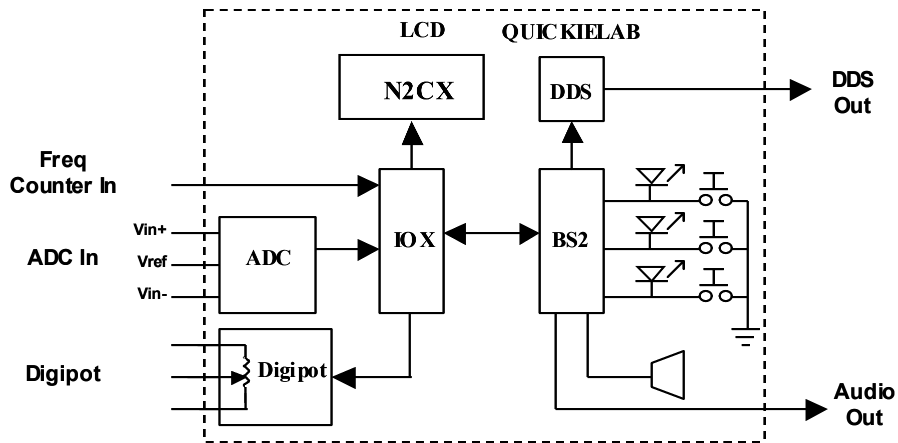
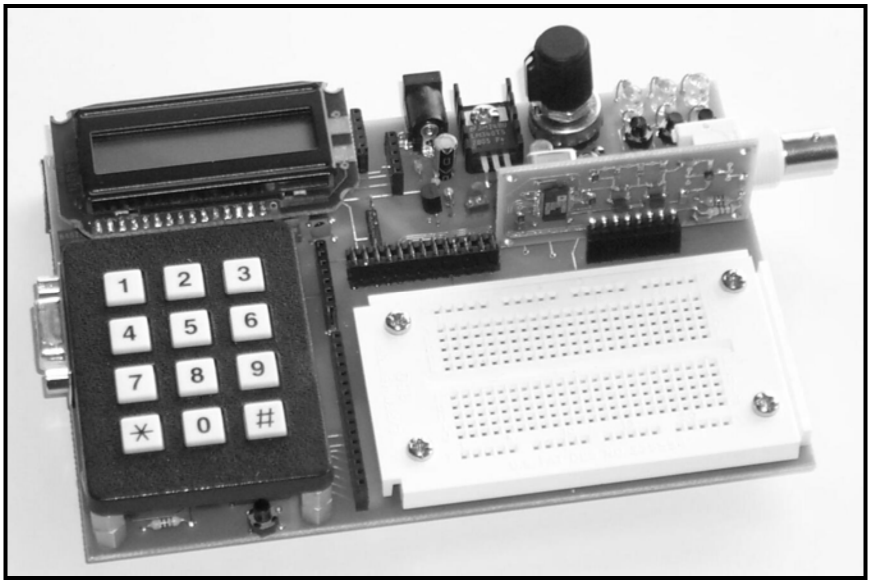


Figure 1 - Quickielab/IOX/DDS Block Diagram



The QuickieLab with DDS Daughtercard

First let's look at the features of the QuickieLab. The heart of the QuickieLab is a hybrid IC device from a company named Parallax. This chip, the Basic Stamp 2 (BS2) is a 40-pin device that uses a microcontroller and other associated components to achieve a powerful easy to use microcontroller that is programmed with a variant of the BASIC programming language named PBASIC. Much more info on the basic chip is available on the Parallax and NJQRP web sites - see the end of this article for links.

Salient features of the BS2 that are important to the QuickieLab Test Bench are:

- The BS2 chip is above all a digital controller that can coordinate internal functions and peripheral circuitry

- It uses a rich set of mathematical and logical commands that are useful in manipulating and formatting measured data.

- It incorporates inherent timing, tone generation and serial communications without the need for added hardware.

- It uses a simple (dare I say BASIC?) programming language and free software development and programming tools that run on any DOS or Windows computer with an RS232 port.

QuickieLab Features

At a higher level of abstraction the QuickieLab ("QL") offers the following:

- Complete access to all BS2 pins and features with connectors and pin headers for easy connection.
- Jumper-selectable connection to QL hardware.
- Three pushbuttons and LEDs for simple operator interaction.
- A built-in loudspeaker for audio output.
- An additional audio output for external connection.
- A solderless plugboard for on-board interface circuit assembly.
- A socket for expansion daughtercard such as NJQRP Direct Digital Synthesizer (DDS).
- Sockets for Input Output eXpansion chip (IOX) and interface components.

IOX Features

The IOX chip is a convenient "I/O Expander" developed by N2APB to enhance the ham-usability of various microcontrollers like the Stamp used in the QuickieLab. IOX is quite integral to the test bench, offering the following important functions:

- It interfaces with the BS2 controller via simple serial interface.
- Its own powerful command set integrates to QL programs
- A two-line 16 character Liquid Crystal Display (LCD)
- A 16-key keypad for data entry

- An 8-bit Analog to Digital Converter (ADC)

- A Digital potentiometer

- An audio and RF frequency counter with 1 Hz resolution

DDS Features

The DDS Daughtercard is another development from N2APB to give hams the ability to easily generate high quality precision waveforms up into the RF spectrum. This daughtercard another important module used to get maximum capability from the test bench. Briefly it offers:

- Generation of precise sine waves, from subaudio to RF, with an internal crystal controlled frequency reference.

- It is controlled by simple three-wire serial interface to the QL.

- Its output is a filtered sine wave providing 0 dBm (0.224V rms) into 50 ohms

Evolution of the Modular QuickieLab Test Bench

As will be presented below the idea of the test bench is to provide an evolutionary set of projects that use built-in functions of the extended QL combined with purpose-developed software and added interface circuitry to make a wide variety test equipment. The basic power of the QuickieLab makes it practical to have an integrated test workbench with personalized software and interface circuitry rather than having a whole ham shack full of individual independent pieces of test equipment.

Due to the variety and power of measurement functions present in the extended QL added interface circuitry required is generally rather simple. There are several ways of building these circuits. The solderless plugboard already part of the QL can be used for very simple or temporary DC and audio test circuits. Several examples of applications that use the plugboard can be seen on the NJQRP web site (www.njqrp.org).

Future more complex circuitry, RF circuits and frequently test interface circuits are probably best implemented in a more permanent form. While printed circuit boards are likely the best implementation, they are unnecessarily difficult to build for one-off applications. A practical alternative is the use of so-called ugly or Manhattan construction.

Building on the idea that the test bench can be built in modular fashion, the remainder of this paper will present some simple test circuits that have already been designed. Following these an enumeration of more complex test functions will be presented that incorporate these basic blocks and to build up increasingly sophisticated projects.

Basic DC Voltmeter Block – the Morse Voltmeter

The original QuickieLab test function was a DC voltmeter. Two implementations were described in recent QRP Quarterly articles and on the NJQRP web site.

The first voltmeter used the BS2 in conjunction with an ADC. Called the Morse Voltmeter, it connects directly to the ADC Vin+ input and uses the QL 5-volt regulated power for its voltage reference. It was originally designed before the IOX LCD function was available so it could not use a traditional numeric display output.

However since the QL did have tone outputs that could be sounded through the on-board loudspeaker, an audible Morse code “display” was used instead.

The ADC converted its DC input to an 8-bit digital value proportional to the input voltage. So an input of 0V would produce a value of 0000 0000 binary (00 hexadecimal). And a full-scale voltage of 5V would produce a value of 1111 1111 binary (FF hex).

This value was then scaled to produce a decimal number in the range of 0 to 499 corresponding to 0.00 to 4.99 V. Next this decimal number was converted to an audible Morse code output via the QL loudspeaker.

Enhanced DC Voltmeter – the Audio/Visual Voltmeter

While the Morse Voltmeter demonstrated that a DC voltmeter could be made using the QL/IOX combination, it had limited usefulness. The next DC voltmeter implementation would be more sophisticated. The result was a DC voltmeter with the usual numeric LCD output, an input voltage range that could be scaled via an input operational amplifier to other than the basic 0-5V range and the input amplifier would further provide the 10 megohm input impedance common in digital multimeters. Accurate calibration of the improved voltmeter would be achieved by using the QL 5V power supply as a reference but it would be adjusted at the ADC Vref input via a calibration potentiometer.

The Audio/Visual Voltmeter name comes about since the new project retained the audible Morse output as well as the new visual LCD output. A new audible feature was also included – a selectable tone output whose pitch is proportional to the input voltage. This added feature gives the AVV an analog type output useful for uses where the voltage must be monitored for a maximum or minimum value. As built, the AVV offers a 0-2V input voltage range with a resolution of 10 mv. The input voltage range can be tailored to almost any value, however by appropriate choice of buffer amplifier resistors.

The simple input amplifier and reference potentiometer were built up using the solderless breadboard for this example. However for more long-term use a separate purpose-built amplifier might be more practical.

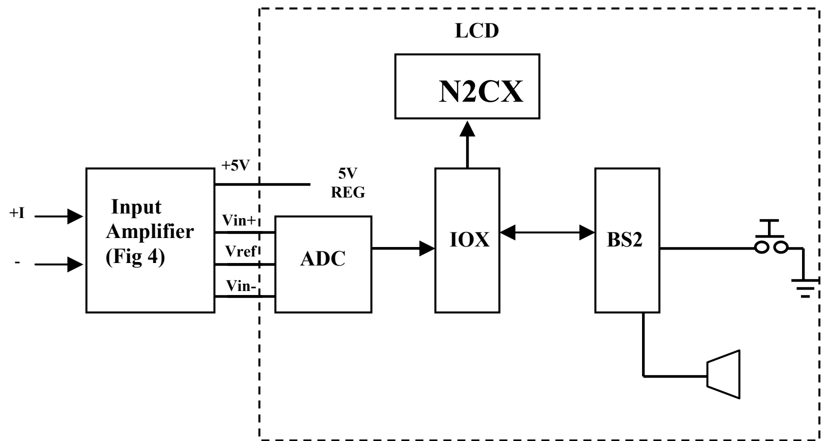


Figure 3 - Audio/Visual Voltmeter Block Diagram

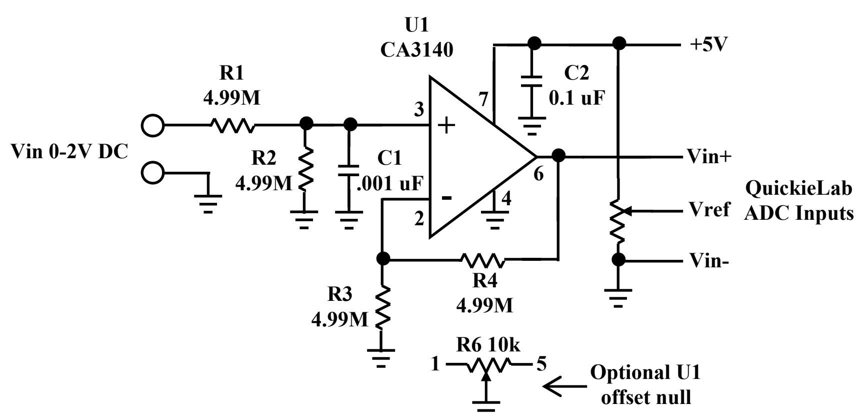


Figure 4 - AVV Input Amplifier

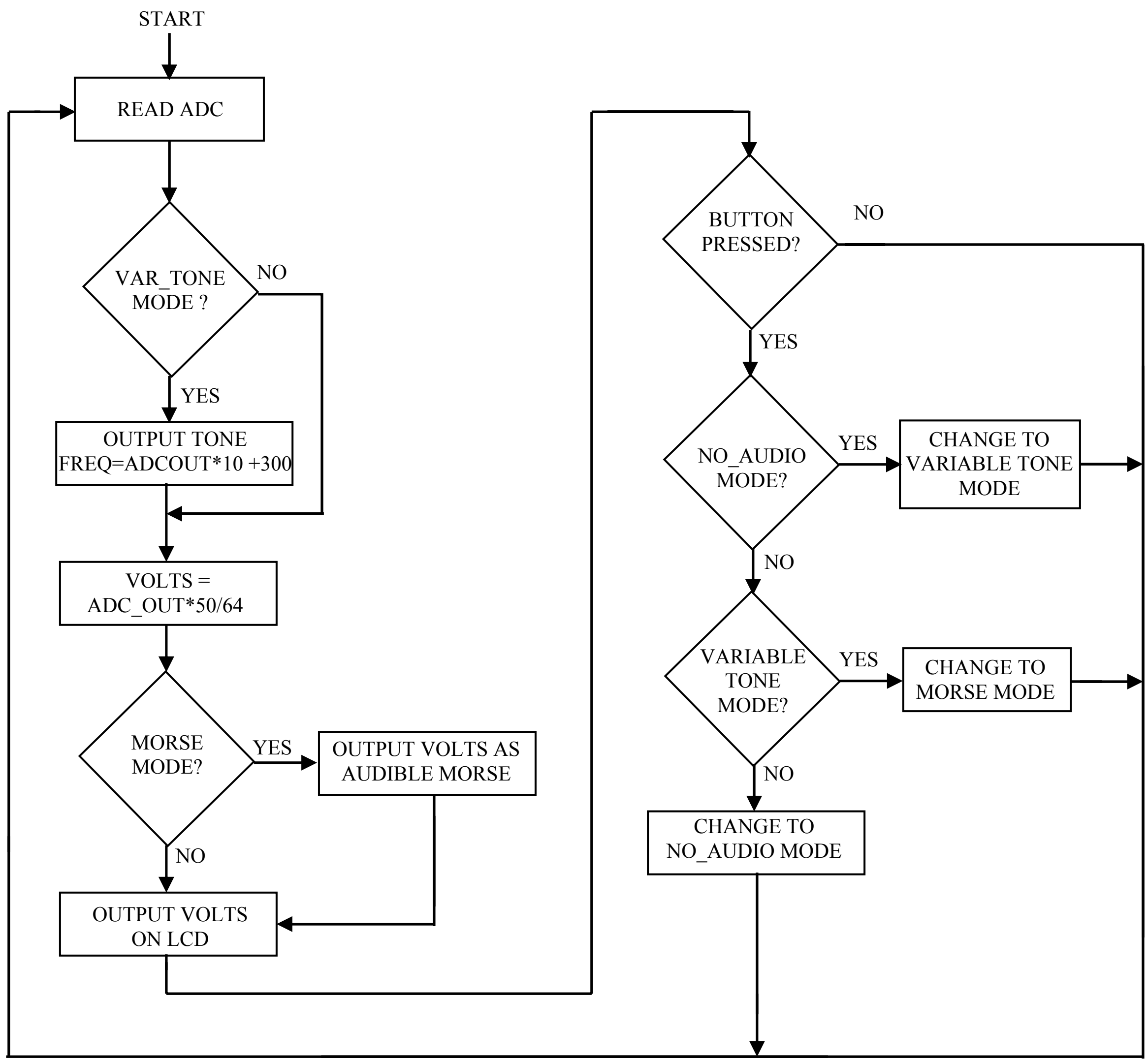


Figure 5 - AVV program block diagram

Integrated Frequency Counter and DC Voltmeter – the VXO-Mate

The first integrated test function is the VXO-Mate. It was inspired by the 2002 QRPacificon building contest. The subject of that contest was a voltage-controlled Variable Crystal Oscillator (VXO). The goal of the contest was to design such a device that provided the maximum tuning range with a common set of components and a tuning voltage range of 0-8VDC.

Since the QL/IOX combination could easily be used to make both a frequency counter and a DC voltmeter, the VXO-Mate was designed to monitor and display both the DC tuning voltage range and frequency output so that it could be used to evaluate the VXO.

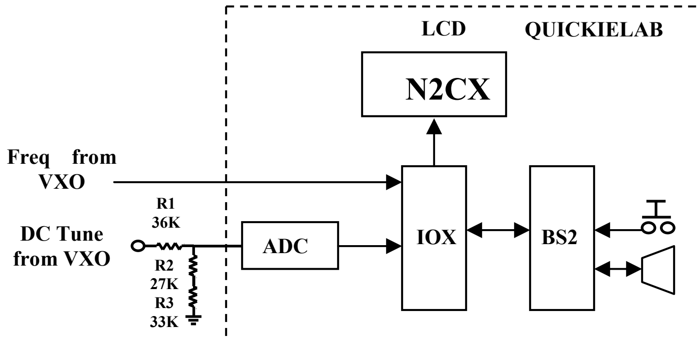


Figure 6 - VXOMate using QuickieLab

Figure 6 shows a block diagram of the almost trivially simple implementation connected to a VXO. The VXO tuning voltage is measured on the variable arm of the tuning potentiometer. The 0-8 volt range is divided down to 0-5V by a voltage divider consisting of R1 and R2. Not shown is the internal 5V connection made to the ADC Vref pin. The VXO output is fed directly to the IOX frequency counter input.

Signal Generator Building Block – the QuickieGen

The Spring 2003 QRP Quarterly describes the first example of a simple frequency generator using the DDS Daughtercard. It appears as a Joe's Quickie in the WA8MCQ Information Exchange column.

Since the QuickieGen needs only the QL and the IOX, no additional hardware is needed. The initial project uses a simple "canned program" that sends a 40-bit command word to the DDS card to tune it to the 40-meter QRP frequency. A different command word can be put into the program to tune to any audio or HF frequency.

Program QL_DDS_TST is available on the NJQRP web site. It is intended as an introduction to use of the QL and DDS card for precise frequency generation. A more sophisticated program will appear on the NJQRP web site when the article is published. This program QL_DDS adds command lines so that you can manually step the DDS through each of the common HF QRP frequencies. In addition it displays the chosen frequency on the IOX LCD and sounds the chosen band via Morse code on the QL loudspeaker.

The next evolutionary step is to expand the program to allow operator input to enter a frequency of his choice on the keypad to make an effective precision frequency source. This program will be the subject of a future article

Expansion of the Basic Functions

The basic QL functions by themselves are of limited use for test equipment. They can, however, be made much more useful by addition of some simple circuitry. Note that since operation is now in the RF part of the frequency spectrum it is advisable to construct these circuits with techniques such as ugly or Manhattan style which are more appropriate than the QL's solderless plugboard.

AC or RF Voltmeter

Adding a rudimentary diode detector allows the DC voltmeter to measure AC or RF signals. The simple diode detector converts AC or RF signals into DC to feed the DC voltmeter. Figure 7 shows this diode detector.

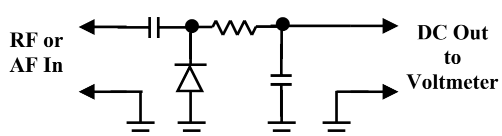


Figure 7 - Basic Diode Detector

While quite useful it has limited accuracy at low signal levels due to the inherent diode forward drop, approximately 0.2 volts for Germanium diodes such as the 1N34 and 0.6 volts for Silicon 1N4148 diodes.

Additional low-frequency (audio) AC measurement accuracy can be obtained by using a so-called precision rectifier. Shown in Figure 8, it uses an op-amp/diode combination. The limited bandwidth of most op-amps restricts the usable upper frequency end of the precision rectifier to the audio range.

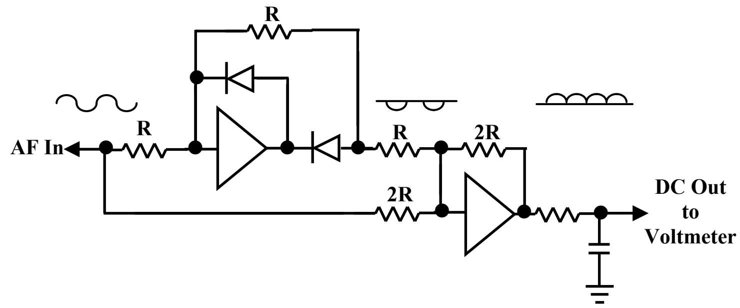


Figure 8 - Precision Detector

However a compensated diode detector (ref W7EL and Grebenkemper) provides accurate detection of RF signals down to –10 dBm or less. This circuit is used in the popular Oak Hills Research WM-series QRP wattmeters and is described in Ref 3. Figure 9 is a notional schematic diagram of this compensated RF detector.

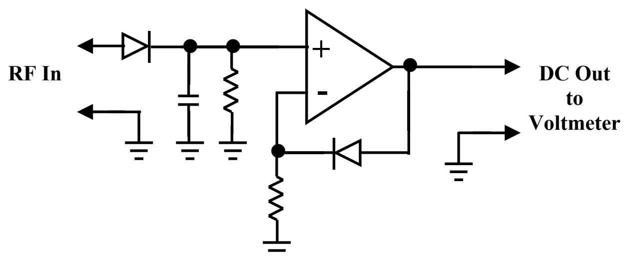


Figure 9 - Compensated Diode Detector

For even lower RF levels a sophisticated log detector, the Analog Devices AD8307 extends sensitivity down to the millivolt RF level. It has a much different characteristic than simple diode detectors. It outputs a DC voltage proportional to the logarithm of the RF input. This helps give it a much wider operating signal range and easy measurement of RF power levels as opposed to RF voltages. Figure 10 shows the AD8307 detector and transfer characteristic curve. For more information on this detector see the Analog Devices site (Ref 4) and a W7ZOI article (Ref 5).

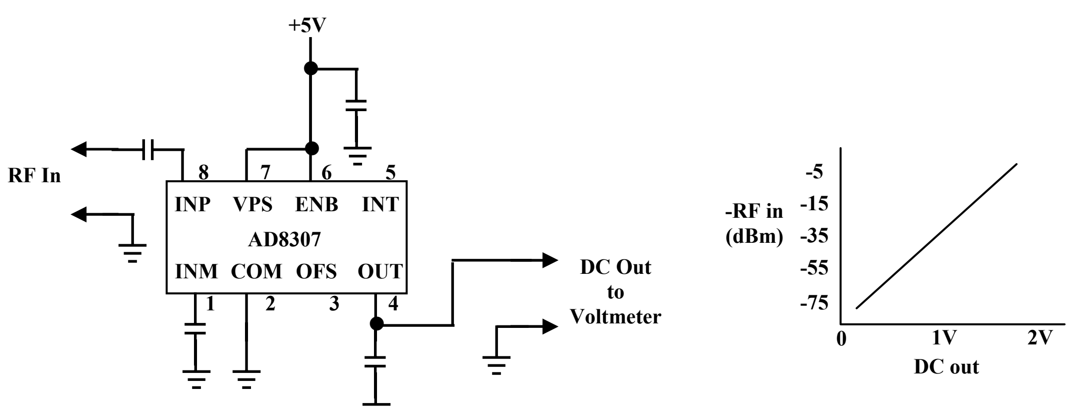


Figure 10 - AD8307 Precision Log Detector

RF Test Equipment

Armed with a usable RF detector, a wide variety of test equipment can be made.

Coupled with an accurate 50-ohm power dummy load, the QL forms a handy RF power meter. Some relatively simple mathematical additions to the QL software can be used to calculate and display RF power instead of RF voltage. Figure 11 is a conceptual RF Power meter schematic diagram

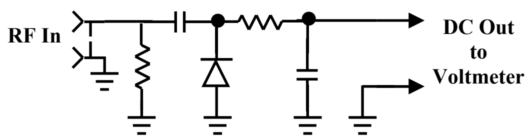


Figure 11 - Basic RF Wattmeter

With two detectors and a directional coupler, a directional wattmeter can be built. The GQRP Stockton Wattmeter (Ref or GA QRP NOGAwatt provide the directional coupler and detector functions. They were originally designed to feed analog meters. However if their DC output is fed to a QL set up as a DC voltmeter (and with suitable software changes) a digital forward and reverse RF power meter results. Figure 12 shows how this is done.

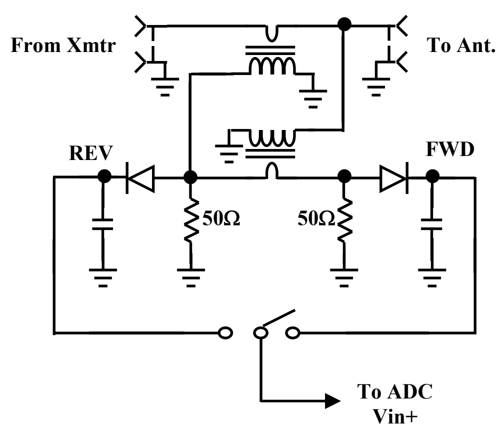


Figure 12 - Directional Wattmeter

Accuracy at low RF power levels is limited by the simple diode detector. Using a compensated detector such as the W7EL design mentioned earlier can provide accuracy at low RF power levels. In fact duplicating the W7EL wattmeter and using the QL for display results in a simple digital wattmeter.

Yet another piece of handy RF test gear is the digital SWR meter. The ADC built into the IOX can make automatic SWR measurement very easy. SWR is a measure of reflected and forward energy. It is calculated by the formula S = (1+P)/(1-P) where P is the ratio of the forward and reverse voltages of an SWR bridge.

This is relatively easy to do, but doing it in the usual way requires two ADC and the IOX has only one. But the whole matter can be simplified by using the ADC reference input pin. The ADC gives an 8-bit output that is relative to the reference input. This is, its full scale value of 255 results when the input pin is exactly the same as the reference voltage and its low end value of 0 results with a 0V input. Now if the SWR bridge forward sample is fed to the ADC reference input and the reverse sample goes to the normal input voltage pin, the digital output is the ratio of the two. Thus the need for a second ADC is bypassed and SWR calculation is simplified.

Figure 13 shows this SWR meter connection for the torroid directional coupler

An SWR bridge using more only resistors instead of torroids has some advantages. Naturally the components are simpler to obtain and there is not need to wind torroids! Also the rig connected to the SWR bridge is protected from high SWR. When an antenna tuner is used, some settings give a high SWR that can damage a rig's final if a torroidal directional coupler is used. The attenuation of the resistive SWR bridge limits the SWR that the rig sees to a maximum of 2:1. Of course it must be switched out once the tuner is adjusted or your signal will be reduced by 75%!

The resistive SWR bridge used in the NJQRP Rainbow Analyzer is shown in Figure 14. Not shown are the op-amp compensators that take care of low-signal diode detector inaccuracy.

A third detector is shown on the output connector of the resistive bridge. This can be used to calculate the RF impedance of the antenna or other load connected to the bridge. Resistor RX and the load impedance form a voltage divider so by comparing the detected bridge forward voltage to the detected output voltage, the QL can calculate an estimate of the output impedance. So in addition to SWR, the resistive bridge makes an RF impedance meter as well.

Remote-Reading Field Strength Meter

The Analog Devices AD8307 can be used with the QL for yet another neat device, a Field Strength Meter (FSM). Common FSMs use simple diode detectors and thus have limited sensitivity and accuracy. However the AD8307 detects RF inputs as low as –75 dBm and can be calibrated to provide exact as well as relative field strength readings. This has great utility for measuring antenna patterns and for comparing antenna performance.

Accurate antenna measurements need to have a separation of at least 4 wavelengths between the antenna being tested and the field strength meter. (Figure 15) Naturally this makes it necessary to remotely read the FSM. Testing at 20 meters means that the antenna and FSM need to be separated by at least about 250 feet. The QL can be employed to help overcome this limitation.

Briefly measurements at a distance are called telemetry. They involve converting the voltages or currents to be measured into a form that can be accurately transmitted over that distance. One way of using the QL to do this is by using the internal tone generator. As shown in Figure 16, the AD8307 log detector is connected to a test antenna that monitors the RF received from the remote antenna under test. Its DC output is fed to the QL ADC input. The QL converts the DC voltage into a digital number that is used, in turn to generate an audio tone using the DDS chip whose frequency is proportional to the input DC voltage. This tone is fed to the mic input of a Family Service Radio which sends a signal to the test antenna end of the test setup. The audio output from a Family Service Radio then feeds a second QL which measures the audio frequency and converts the tone to the corresponding field strength value. See Figure 17.

A more elegant way of doing telemetry is to use the ability of the BS2 to generate touchtone digits. Thus the operating program would perform the ADC measurement and directly generate touchtone digits corresponding to the measured filed strength value. These tones can be Motorola MC3362 touchtone detector chip feeds the second QL which displays the remote field strength on its LCD screen. Figure 18 illustrates this telemetry scheme.

The above has merely scratched the surface of test instrumentation that can be designed and built using the QL. The following is a list of other possibilities being considered. Watch the NJQRP site at (Ref 2) as well as the NJQRP QRP Homebrewer magazine and ARCI's QRP Quarterly magazine for upcoming articles describing them.

Other QuickieLab Test Bench Ideas

- Sweep generator/detector – This is a natural outgrowth of the DDS signal source. The idea is to sweep a signal from the DDS and present it to a filter or other frequency-sensitive circuit and monitor the output with a detector feeding its detected DC to the ADC. Appropriate software would display the peak frequency, 3, 6, 10 and 20 dB down frequencies as well as the bandwidth at each of those frequencies.

- Two-tone generator – The BS2 chip has built-in audio tone generation of one or two simultaneous frequencies. This can be used to generate two-tone outputs for SSB transmitter testing, DTMF (Touch-tone) generation or various two-tone signals.

• Digital thermometer – National Semiconductors, Maxim and others manufacture ICs that produce DC voltage outputs that are proportional to the temperature of the device. Feeding this DC signal to the QL ADC input provided temperature measurement that could be used for various monitoring purposes. This could be used to monitor a VFO, for example while monitoring its output frequency to determine the effectiveness of temperature compensation.

• Comparative headphone tester – The BS2 can be programmed to produce tone outputs simulating Morse code. Using the IOX digital potentiometer to produce a calibrated attenuator, headphone sensitivity can be compared.

• Battery life tester – Battery life under various load conditions can be determined by reading the output voltage of a battery over time. A voltage for end-of-life for the battery can be programmed to determine how many hours the battery can supply the load chosen until this set point is reached. In addition, the BS2 can be programmed to switch in different loads over time – for example different loads for transceiver transmit and receive current to measure battery life under simulated operating conditions.

• Automated quartz crystal parameter measurement test set – Using a crystal test circuit developed by W7ZOI in conjunction with the DDS, an RF detector and the IOX ADC, crystal parameters such as series resonant frequency, Q, series L and C can be measured and calculated to characterize crystals for cascaded filter use.

• Semiconductor parameter test set – Many semiconductor characteristics can be determined via DC stimulus and measurement. The following can be automatically measured in a manner similar to the Peak Atlas Semiconductor Analyzer. The operating principle is to apply controlled DC currents while monitoring the junction DC voltages and calculating the results.

Device pin identification

    Diode drop

    Zener breakdown voltage

    Transistor beta

    FET characteristics

        Transconductance

Pinch off voltage

Saturation drop

- Inductance and capacitance meter – Components to be tested are connected to a test oscillator. The QL\IOX measures the oscillator frequency then calculates and displays the component value.

- VFO – With appropriate software the DDS can be programmed by the IOX keypad on any frequency within its range and the tuning value displayed on the LCD screen.

- Marker generator – The DDS can be programmed to spot frequencies such as band edges, etc. Alternatively it can be set to a low frequency (10, 12.5, 50 or 100 kHz) and fed through a logic gate to generate HF harmonics for multi-frequency marker generation.

- Signal tracer – This is an audio or RF detector used in conjunction with the DDS sweep function mentioned above.

- Square wave generator – The BS2 can be programmed to generate audio frequency binary pulse streams with arbitrary patterns. Alternatively the DDS output can be "squared up" using a Schmitt trigger to produce a variable frequency square wave.

- Modulated RF signal generator – The DDS output can be amplitude modulated by feeding it and an audio tone from the QL into a double balanced mixer.

- Timer – The BS2 has timing commands built-in. For higher precision a crystal controlled input source (such as a 32.768 kHz clock crystal and a CD4060) can be used to provide programmable time delays.

- Q-meter – The DDS can be tuned across the resonant frequency of an LC tank. A detector feeding the ADC can monitor the LC circuit response to determine the center frequency and 3 dB bandwidth then determine the circuit Q.

- "Grid dip" meter – A test oscillator's operating frequency can be tuned via a voltage variable capacitor using the IOX digital potentiometer while voltages in the oscillator are monitored for a "dip" by a detector feeding the ADC. Simultaneously the IOX frequency counter measures the oscillator frequency at the dip.

• Programmable/automated RF attenuator – An audio attenuator can be made using the IOX digital potentiometer. For RF use, the BS2 digital outputs can be used to control relays switching external resistive attenuator sections. Either can be used in conjunction with the DDS signal source and AF or RF detectors described above.

References:

1. Parallax web site: http://www.parallax.com/

2. Quickielab URL: http://www.njqrp.org/quickielab/index.html

3. R. Lewallen, "A Simple and Accurate QRP Directional Wattmeter," QST,

Feb, 1990, pp 19-23.

Note: This reference is also included on the CD included with the excellent book

“Experimental Methods in RF Design” by Wes Hayward , W7ZOI, Rick Campbell, KK7B and

Bob Larkin ,W7PUA

4. Analog Devices Inc. AD8307 see www.analog.com and search for AD8307

5 W. Hayward and R. Larkin, "Simple RF-Power Measurement", QST, Jun,

2001, pp 38-43. – also on the EMRFD CD

6. David Stockton, “A Bi-directional Wattmeter,” SPRAT No. 61, Winter 1989/90, pp12-16

7. SPRAT CD from GQRP club. This reference is included on the G-QRP SPRAT CD

8. NOGAwatt Directional Wattmeter
http://www.qsl.net/nogaqrp/projects/NOGAwatt/kitinfo.html

Appendix – QuickieLab test lab limitations

The QuickieLab is a convenient platform to quickly and easily develop test and measurement applications. However it is a “hobby-grade” device, and should not be expected to perform as accurately or as well as much more expensive lab-grade equipment. Briefly some of the limitations are listed below:

- The BS2 has a small memory space in which to store programs. Operating programs msut be rather small in size. A plus, however is that the programs are easily stored on a DOS or Windows computer and new applications are quick and easy to load to change from one test application to another.

- The PBASIC language used by the BS2 chip is an interpretive language which does not operate as quickly as complied languages. Typically operating speed is limited to at most several thousand instructions per second.

- The BS2 is not capable of multitasking. That is it must complete acting on current instructions before running others. Thus it cannot, for example read inputs and output tones or serial data streams simultaneously. This limitation is somewhat lessened by use of the IOX chip which can operate almost independently of the BS2 processor.

- The ADC and digital potentiometer are limited to 8-bit accuracy limiting the ultimate resolution and accuracy of measurements. A 10-bit ADC can be interfaced directly to the BS2 chip for more accuracy. If this is done a high-accuracy reference voltage source should also be used.

- The BS2 has no floating point arithmetic instructions. It does, however include 16-bit integer arithmetic math instructions that can be used effectively for accurate calculations.

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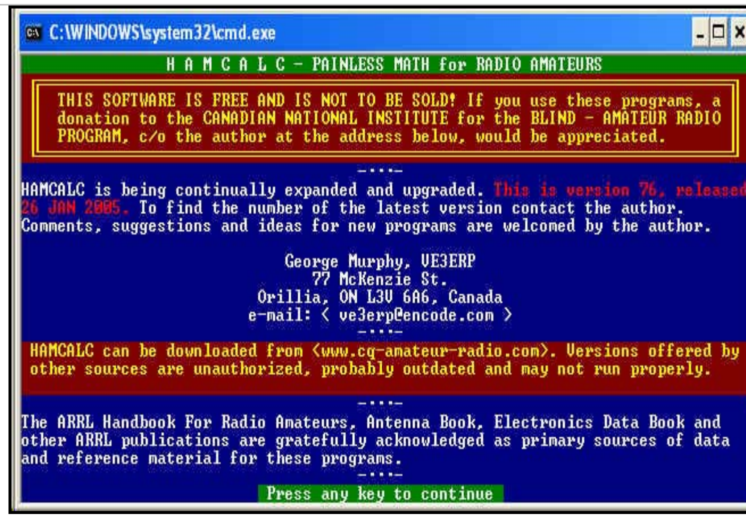
George Murphy, VE3ERP
narration by Nancy Feeny, NJ8B

HamCalc

Free software for WINDOWS or MS-DOS containing over 300 "Painless Math" computer programs for radio amateurs and professionals, used worldwide as a design, reference and learning tool since its introduction in 1993.



Most programs can be run in either Metric or Imperial/USA units of measure. Contains much information not readily found in current popular handbooks and literature. Easy to install, use and understand by non-technical hobbyists.

HamCalc does not support mouse operation. Menu selections are by keyboard entry (usually a single keystroke).

Call up individual programs from either the Program Menus or the INDEX option on the Main Menu. When you exit HamCalc you are automatically returned to WINDOWS Desktop.

HAMCALC can be downloaded from <http.www.cq-amateur-radio.com/HamCalcem.html>. Versions obtained elsewhere are unauthorized, probably outdated and may not run very well. To find out the latest HAMCALC version number at any time, contact the author at ve3erp@encode.com. The latest version, HAMCALC 81, was released November 2005 and is now available as a free download. Scroll down the opening page and click on the prompt that says CLICK HERE TO DOWNLOAD THE CURRENT VERSION OF HAMCALC at the bottom of the page.

-73- Murph VE3ERP

In this installment, we are going to use HamCalc to work with different value components for the 555 Timer IC, which is still the most popular IC timer. It can operate as either a one-shot timer or as an astable multivibrator. There are many different applications for the 555. Basically it consists of two comparators, a flip-flop, a discharge transistor, an output buffer, and a resistive voltage divider. Figure One shows its internal diagram.

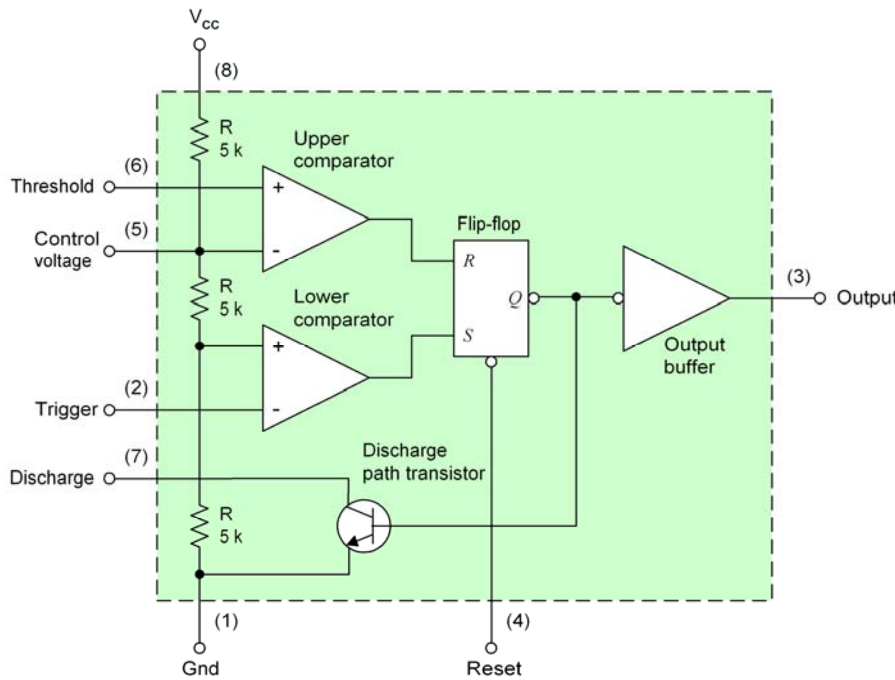


Figure One. Internal diagram of the 555 timer IC.

In this exercise, we will connect the 555 timer to operate in the astable mode to operate as a free-running non-sinusoidal oscillator. The Threshold input is connected to the Trigger input. The external components R1, R2 and C form the timing network that sets the frequency of oscillation. Figure Two shows a 555 timer connected as an astable multivibrator. The 0.01 μF capacitor connected to the Control input is strictly for decoupling and has no effect on operation; in many cases it can be left off.

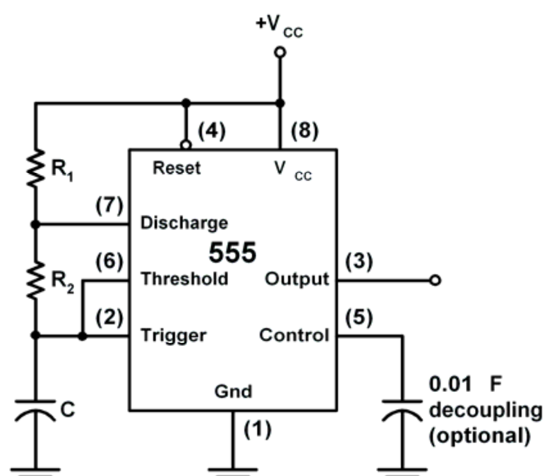
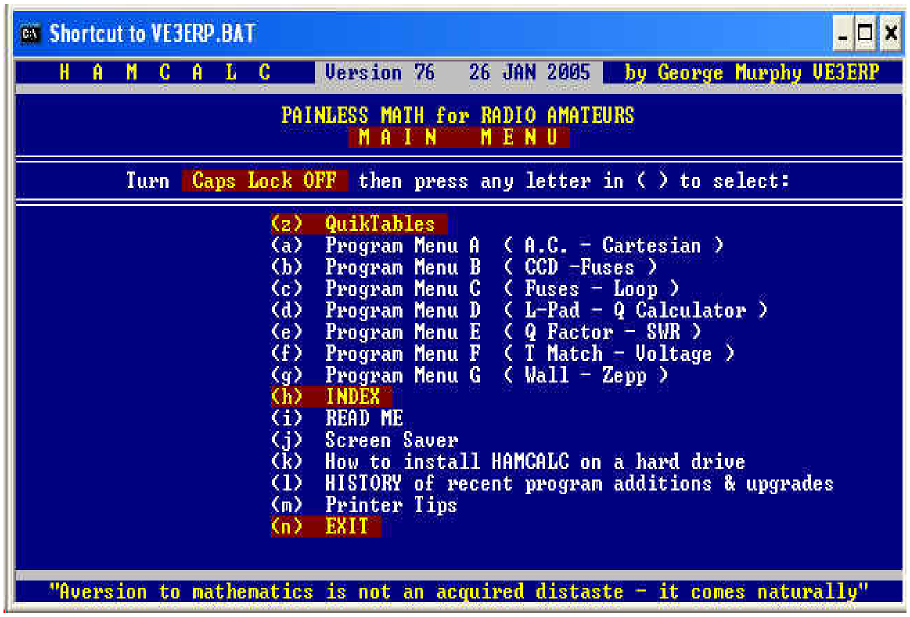
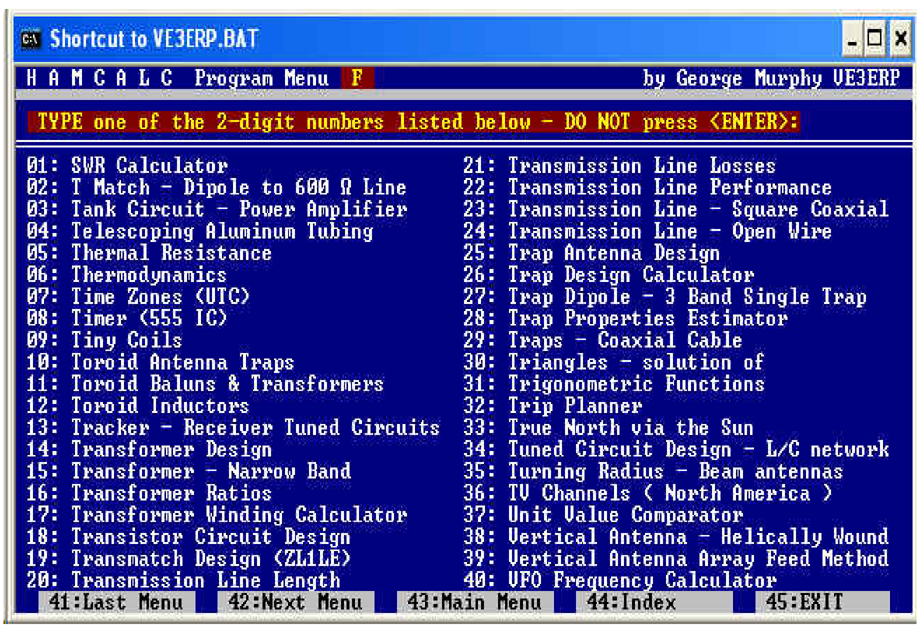


Figure Two. The 555 timer connected as an astable multivibrator.

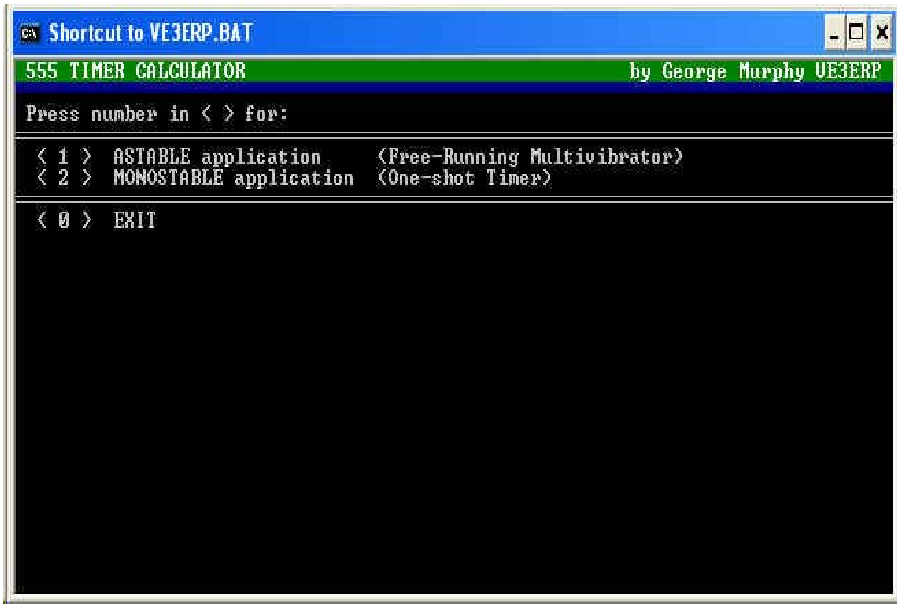
Going into HamCalc, we find ourselves on the Main Menu page:



Selecting Program Menu <f> (T Match - Voltage) brings up the following screen:



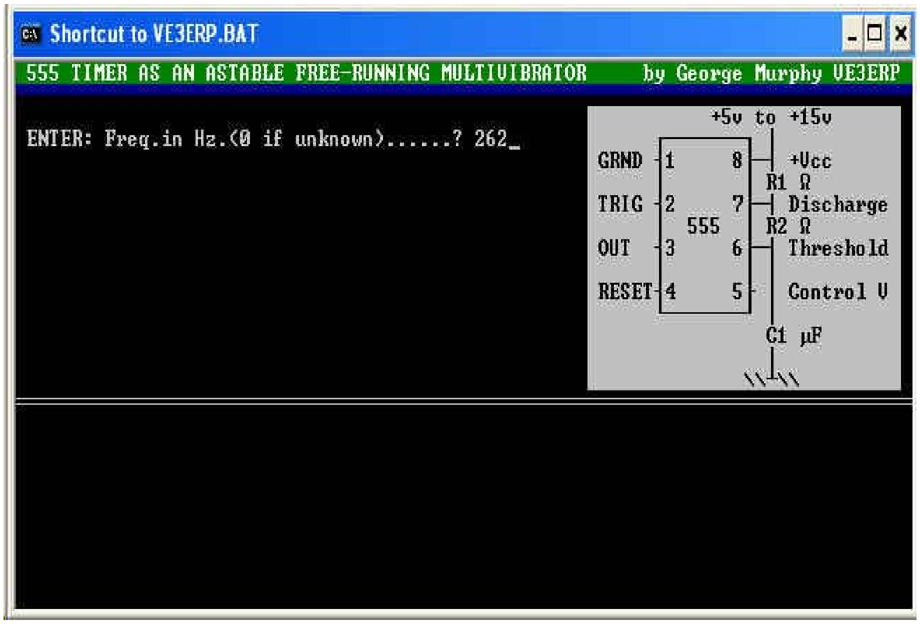
Selecting <08> (Timer <555 IC>) brings up the following:



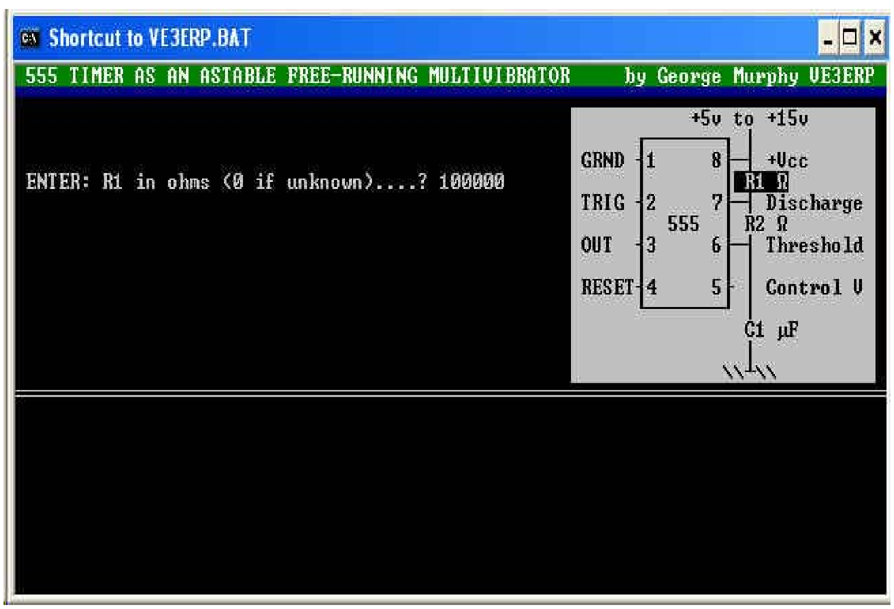
Deciding to match the frequency of oscillation to a musical note, we did an Internet search, where we found the frequencies for an even-tempered scale. On this scale, Middle C is C_4. The following table lists the notes and frequencies. This is only a partial list.

Note	Frequency (Hz)	Note	Frequency (Hz)
C_4	261.63	G_4	392.00
$C^{\#}_4/D^b_4$	277.18	$G^{\#}_4/A^b_4$	415.30
D_4	293.66	A_4	440.00
$D^{\#}_4/E^b_4$	311.13	$A^{\#}_4/B^b_4$	466.16
E_4	329.63	B_4	493.88
F_4	349.23	C_5	523.25
$F^{\#}_4/G^b_4$	369.99	$C^{\#}_5/D^b_5$	554.37

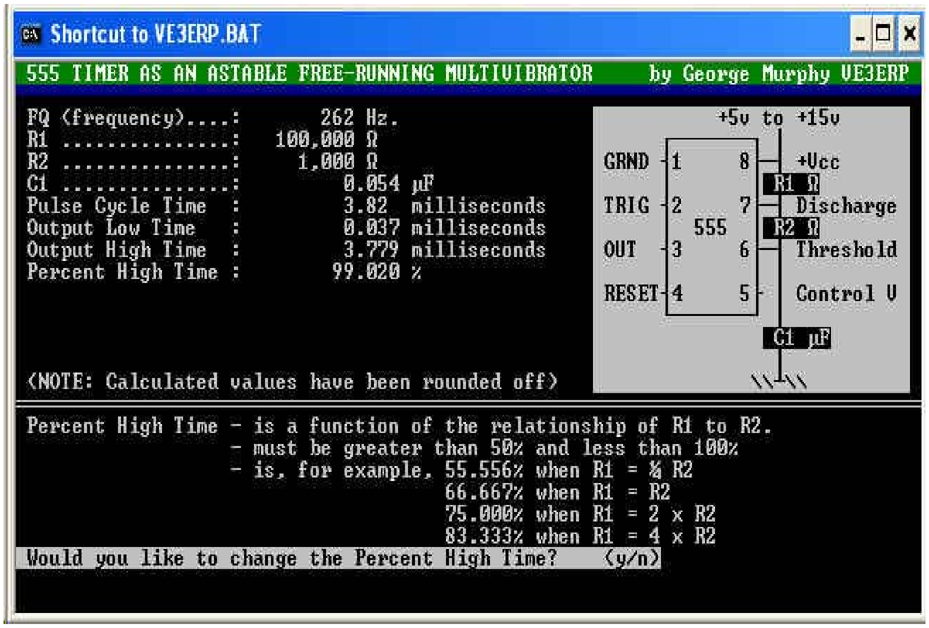
Selecting <1> (ASTABLE application) brings up the following screen. At the prompt “ENTER: Freq. In Hz. (0 if unknown)……?”, we entered a frequency of 262 Hz., which is Middle C (rounded off):



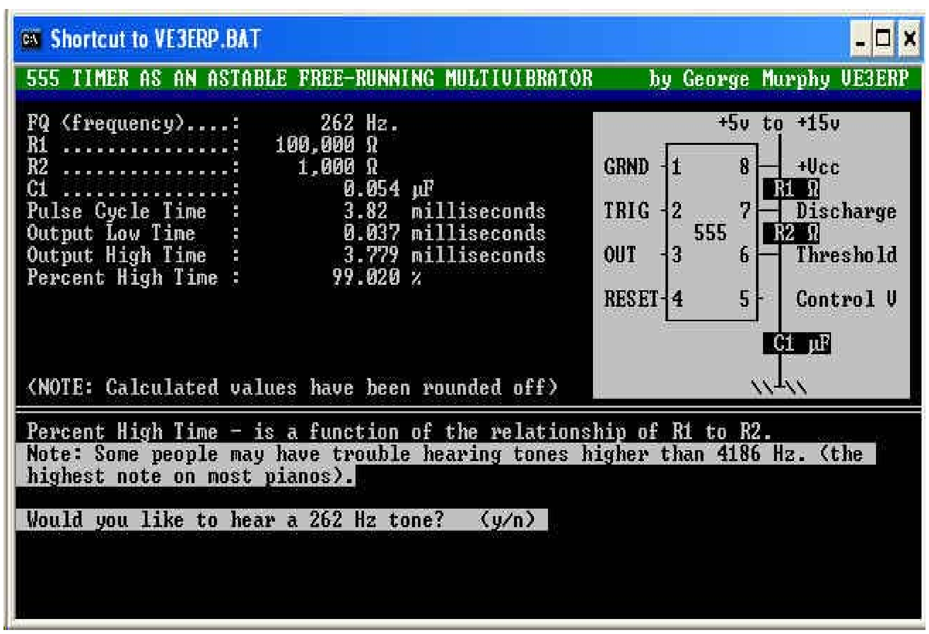
Next, the program came up with the prompt “ENTER: R1 in ohms (0 if unknown)….?”. Here, we entered a value of 100000 ohms (100 kΩ),



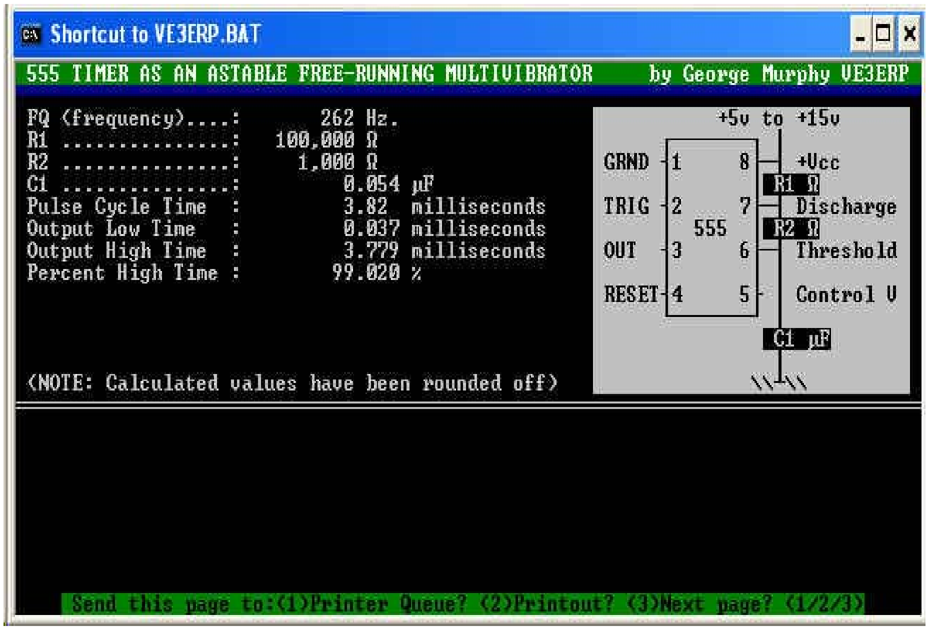
This brought up the following screen. Here, the calculated value for R2 is 1000 ohms (1 kΩ) and C1 is 0.054 µF.



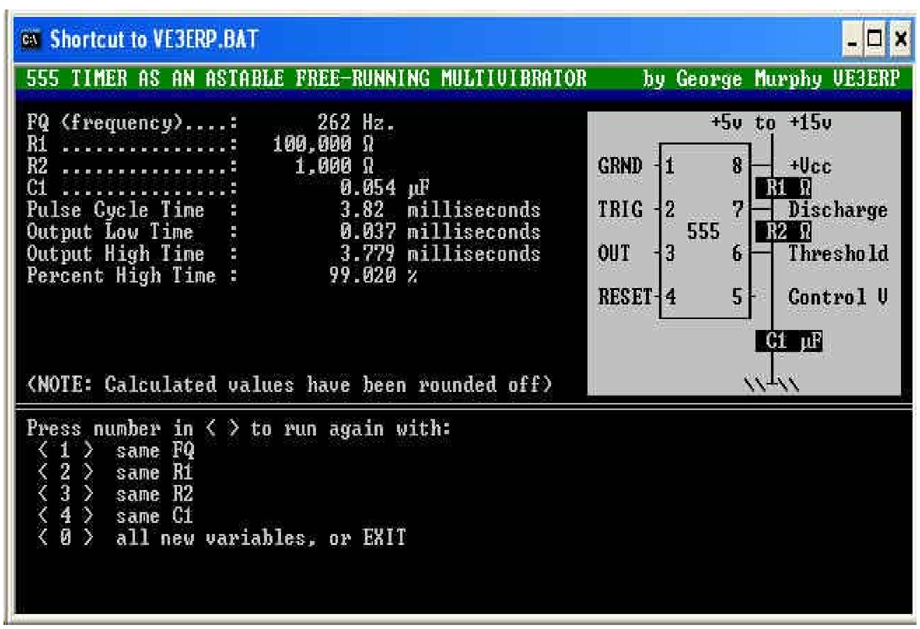
After entering "n" to the prompt "Would you like to change the Percent High Time?", the program came up with the following screen:



One really neat feature of this program is the ability to hear what the frequency sounds like (provided the frequency is in the audible range). Here, at the prompt "Would you like to hear a 262 Hz tone?", we entered "y". This allowed us to hear the tone and brought up the following screen:



At the prompt "Send this page to:(1)Printer Queue? (2)Printout? (3)Next page? (1/2/3)", we entered "3". This brought up the following screen:

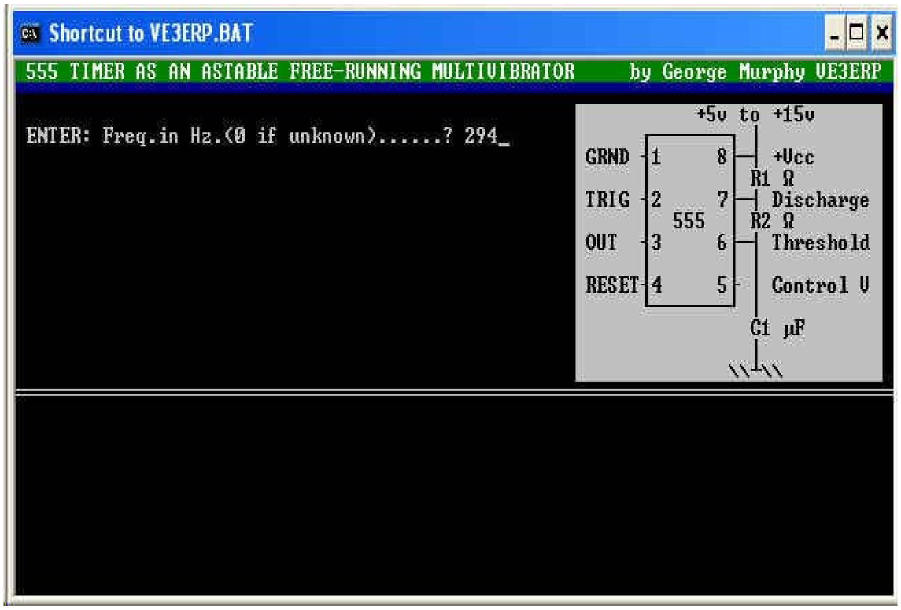


At the prompt

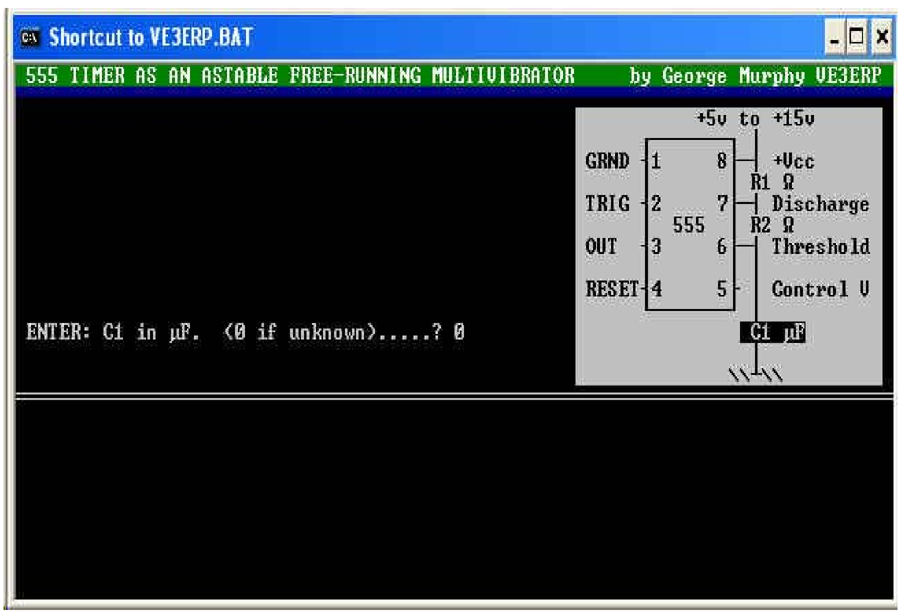
Press number in ( ) to run again with:

(1) same FQ
(2) same R1
(3) same R2
(4) same C1
(0) all new variables, or EXIT

we entered “2” (same R1). This brought up the following screen. This time we entered a frequency of 294 Hz.



At the prompt “ENTER: C1 in µF. (0 if unknown)…..?”, we entered “0”.



At this point, the operation is basically a repeat of the previous screens. Using a simple whole note scale, we came up with the following figures for the first eight notes starting with Middle C, as shown in the next table. Here, the frequencies and capacitance values are rounded off.

Note	Frequency (Hz)	Capacitance (μF)
C_4	262	0.054
D_4	294	0.048
E_4	330	0.043
F_4	349	0.041
G_4	392	0.036
A_4	440	0.032
B_4	494	0.029
C_5	523	0.027

Figure Three shows the circuit using the calculated capacitance values. This may be configured as a toy organ. If you build this circuit, I would suggest using trimmer capacitors so you can precisely adjust the capacitance. All switches are normally open types.

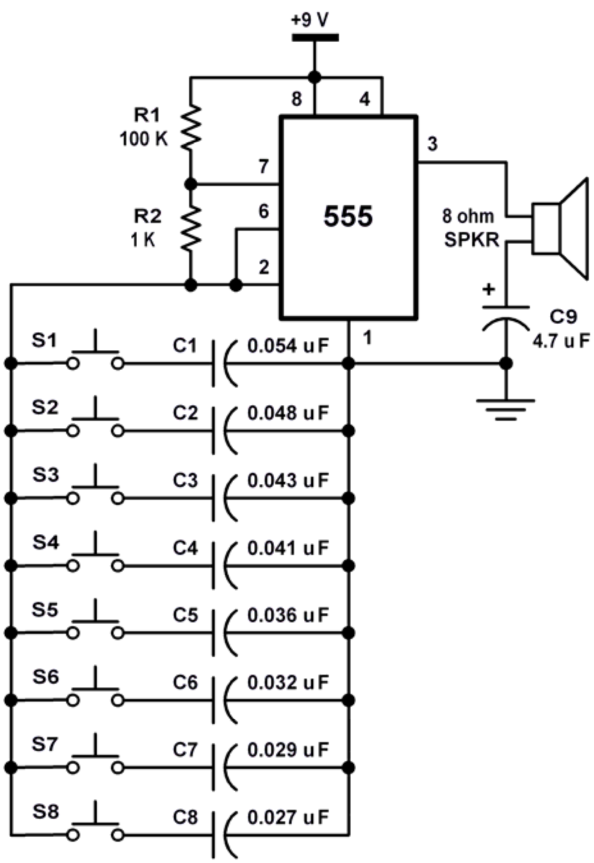


FIGURE THREE. Circuit showing calculated capacitance values for first eight notes.

The above example uses just one of many programs found in HamCalc. Using this program, you can design a circuit using a 555 timer in either an astable (free-running multivibrator) or monostable (one-shot timer) application. Most of these programs ask you to input data. If you are asked to enter some data that you don't know, or that you want the computer to tell you, just press the <ENTER> key to by-pass the question.

A hard drive is required for the installation of HamCalc. Once installed it can be run in WINDOWS or MS-DOS. HamCalc is written in GWBASIC but does not require MS-DOS to run. GWBASIC.exe is a stand-alone file that runs in WINDOWS and MS-DOS operating systems.

Using one or several of HamCalc's over 300 computer programs, one could easily design or analyze a simple circuit that many QRPers have.

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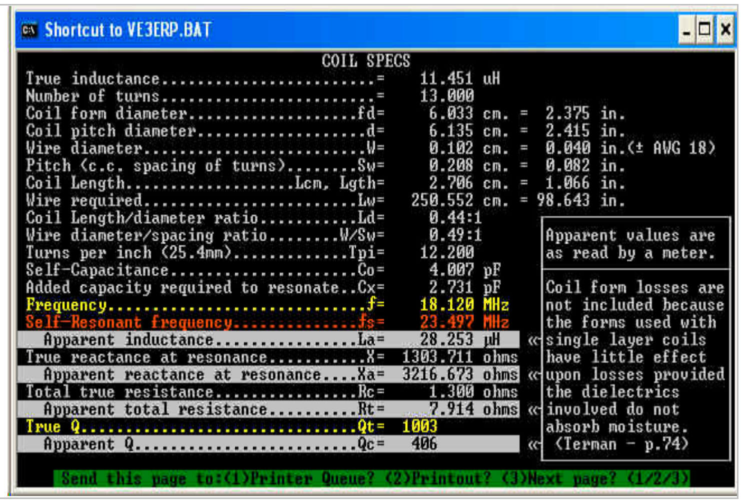
ELECTRICALLY SHORTENED QRP DIPOLES

(Your Tiny Back Yard May Be Bigger Than You Think!)



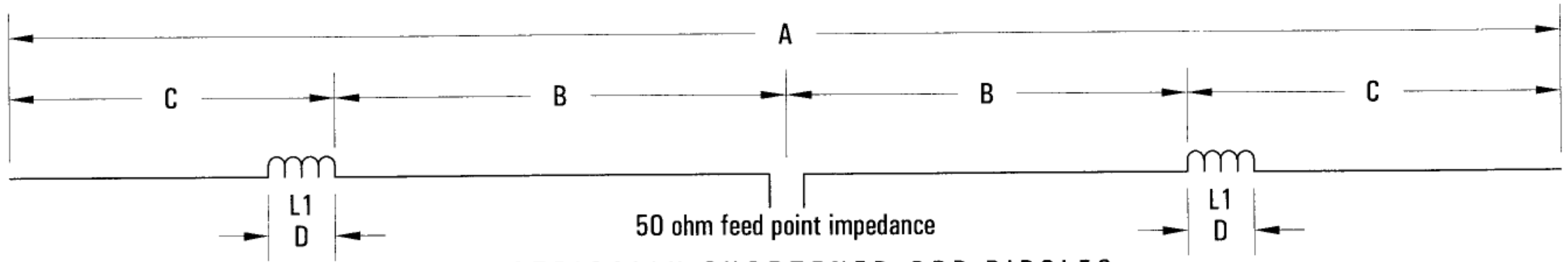
DESCRIPTION

For years the antennas of choice for many hams have been dipoles because they are uncomplicated, inexpensive, easy to install and relatively maintenance free. The Bad News is that for some of us their length exceeds the space available. The Good News is that dipoles can be designed to fit available space by adding loading coils in each leg to make them to behave electrically, albeit with somewhat less efficiency, like full size dipoles. Fig.1 shows the configuration and several typical examples for the HF bands. The dimensions are for QRP power levels. Higher power would require much heavier wire, and coil forms up to 6" to 8" in diameter.

THE DESIGN

The design is based on the concept of inductive loading, widely used in centre loaded mobile whip antennas. The antenna should be as long as possible, consistent with available space, and the use of high Q low loss loading coils is necessary for maximum efficiency. The coils should be as far from the centre feed point as possible, bearing in mind that as the distance from the feed point increases, coil size increases and the self-resonant frequency of the coils decreases until it reaches the operating frequency where coil Q decays to zero and the antenna becomes ineffective. Optimum Q occurs when the self-resonant frequency is about twice the operating frequency. In other words it takes a lot of juggling to find the right combination of several factors. Fortunately, most of the design problems can be solved by the single equation (hang on to your hat!) shown in Fig. 2.

Fig.1



ELECTRICALLY SHORTENED QRP DIPOLES

BAND	FREQUENCY	A	B = C (GOOD) #18 AWG B	#18 AWG C	LOADING COIL L1 INDUCTANCE	COIL FORM DIA. (PVC pipe)	No. of TURNS	#18 AWG D	B = 2 x C (BETTER) #18 AWG B	#18 AWG C	LOADING COIL L1 INDUCTANCE	COIL FORM DIA. (PVC pipe)	No. of TURNS	#18 AWG D
metres	MHz	feet	inches	inches	μH	inches		inches	inches	inches	μH	inches		inches
80	3.750	62' - 0"	186	186	43.1	3.500	21	1.61	256	128	68.6	4.000	26	2.19
40	7.150	32' - 0"	96	96	21.2	2.875	16	1.25	128	64	31.5	2.875	21	1.66
30	10.120	23' - 0"	69	69	13.7	2.375	15	1.31	92	46	20.2	2.875	16	1.38
20	14.150	16' - 0"	48	48	9.9	1.900	15	1.27	64	32	14.5	2.375	15	1.18
17	18.120	12' - 0"	36	36	7.8	1.900	12	0.86	48	24	11.5	2.375	13	1.06
15	21.220	11' - 0"	33	33	5.9	1.660	12	1.00	44	22	8.7	1.900	13	0.96
12	24.950	9' - 0"	27	27	5.2	1.660	11	0.92	36	18	7.5	1.900	11	0.92
10	28.850	8' - 0"	24	24	5.2	1.660	11	0.92	32	16	6.8	1.900	11	0.80

L SUB uH = ~ 10 SUP 6 OVER { 68 `  PI  SUP 2 ` f SUP 2 } ~ LEFT ({{LEFT (log SUB n ~ {24 ~ LEFT ({234 OVER f }-B RIGHT)}over D -1 RIGHT) ~ LEFT (LEFT (1 ~ - ~ {{f ` B}OVER 234 }RIGHT ) SUP 2 ~-1 RIGHT) } OVER  {{234 OVER f}-B } ~ - ~ {LEFT(log SUB n {24 ` LEFT ({A OVER 2 }-B RIGHT) }OVER D-1 RIGHT) ~ LEFT(LEFT({ { {f ` A }OVER 2 }-f ` B }OVER 234 RIGHT) SUP 2-1 RIGHT) } OVER { {A OVER 2 }-B }} RIGHT)

Fig.2

LOADING COIL EQUATION FOR ELECTRICALLY SHORTENED DIPOLES
ARRL Antenna Book, 18th edition, p. 6-26 (Eq10)

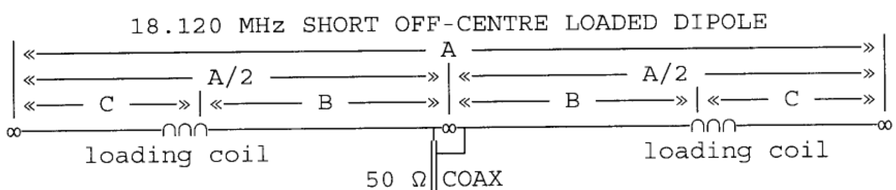
L_{uH}	=	inductance (μH) required for resonance
log_n	=	natural log
f	=	frequency (Mhz)
A	=	overall antenna length (feet)
B	=	distance (feet) from center to each loading coil
D	=	diameter (inches) of radiator

THE CALCULATIONS

Don't be intimidated by Fig.2! If you have HamCalc (version 83 or later) loaded in you computer it will design a short off-centre loaded dipole for you. Here are the step-by step instructions, using the 17m. (18.120 MHz) antenna in Fig.1 as an example.

- Load the "Short Off-Centre Loaded Dipole" program
- Press (1) to start program.
- Press (2) to select inches.
- When the green option bar appears, press (3).
- For frequency enter (18.12).
- For length enter (12).
- Press <c> for AWG and enter (18).
- A chart appears. Press (y) for other B & C dimensions
- For "B" dimension enter (4).
- Your choice <0> is added to the chart (Fig.3)
  (See note below)
- Press (n) to continue.

- When the green option bar appears, press (3).
- To select your choice, press (zero).
- A menu appears. Press 2 to run “Coil Designer” program.
- In the “Coil Designer” menu press (2).
- A new menu appears. Press (2) to select inches.
- For L/D ratio enter (0.5)
- For Coil form diameter enter (2.375).
- To round off turns press (y).
- At “Try Another” press (n).
- A detailed chart of coil specifications appears.
- When the green option bar appears, press (3).
- Press any key to finish.



A= 12.00 ft.(3.66 m.) using 0.040 in. (1.0 mm) wire

	B	C	L	COIL diameter	self-res.	Q
<1>	0.60 ft.(0.18 m.)	5.40 ft.(1.65 m.)	4.6 μH	1.66 in.	44.2 MHz	607
<2>	1.20 ft.(0.37 m.)	4.80 ft.(1.46 m.)	5.1 μH	1.72 in.	41.3 MHz	610
<3>	1.80 ft.(0.55 m.)	4.20 ft.(1.28 m.)	5.8 μH	1.79 in.	38.2 MHz	609
<4>	2.40 ft.(0.73 m.)	3.60 ft.(1.10 m.)	6.6 μH	1.87 in.	34.8 MHz	600
<5>	3.00 ft.(0.91 m.)	3.00 ft.(0.91 m.)	7.8 μH	1.98 in.	31.1 MHz	575
<6>	3.60 ft.(1.10 m.)	2.40 ft.(0.73 m.)	9.7 μH	2.12 in.	27.1 MHz	516
<7>	4.20 ft.(1.28 m.)	1.80 ft.(0.55 m.)	12.6 μH	2.32 in.	22.7 MHz	368
<8>	4.80 ft.(1.46 m.)	1.20 ft.(0.37 m.)	18.4 μH	2.63 in.	17.7 MHz	0
<9>	5.40 ft.(1.65 m.)	0.60 ft.(0.18 m.)	33.9 μH	3.22 in.	11.7 MHz	0
	The self-resonant frequency of the coil must be higher than 18.1 MHz					
<0>	4.00 ft.(1.22 m.)	2.00 ft.(0.61 m.)	11.5 μH	2.24 in.	24.2 MHz	433

For optimum efficiency self-resonance should be near 36.2 MHz

FIGURE 3


```
                                   COIL SPECS
True inductance.......................=    11.451 uH
Number of turns.......................=    13.000
Coil form diameter..................fd=     6.033 cm. =  2.375 in.
Coil pitch diameter..................d=     6.135 cm. =  2.415 in.
Wire diameter........................W=     0.102 cm. =  0.040 in.(± AWG 18)
Pitch (c.c. spacing of turns)........Sw=    0.208 cm. =  0.082 in.
Coil Length..................Lcm, Lgth=     2.706 cm. =  1.066 in.
Wire required.......................Lw=   250.552 cm. = 98.643 in.
Coil Length/diameter ratio..........Ld=     0.44:1
Wire diameter/spacing ratio.......W/Sw=     0.49:1      Apparent values are
Turns per inch (25.4mm).............Tpi=   12.200       as read by a meter.
Self-Capacitance....................Co=     4.007 pF
Added capacity required to resonate..Cx=    2.731 pF     Coil form losses are
Frequency............................f=    18.120 MHz    not included because
Self-Resonant frequency.............fs=    23.497 MHz    the forms used with
  Apparent inductance...............La=    28.253 µH  «- single layer coils
True reactance at resonance..........X=  1303.711 ohms   have little effect
  Apparent reactance at resonance....Xa=  3216.673 ohms «- upon losses provided
Total true resistance...............Rc=     1.300 ohms   the dielectrics
  Apparent total resistance.........Rt=     7.914 ohms «- involved do not
True Q..............................Qt=  1003            absorb moisture.
  Apparent Q........................Qc=   406          «-  (Terman - p.74)
```

That's it! Finished! Done! Now go build one!

Note: If you are running HamCalc version 83 or earlier there may be an error in Fig. 3. In the line referring to self-resonant frequency the minimum should be the design frequency (i.e. 18.120).

-30-

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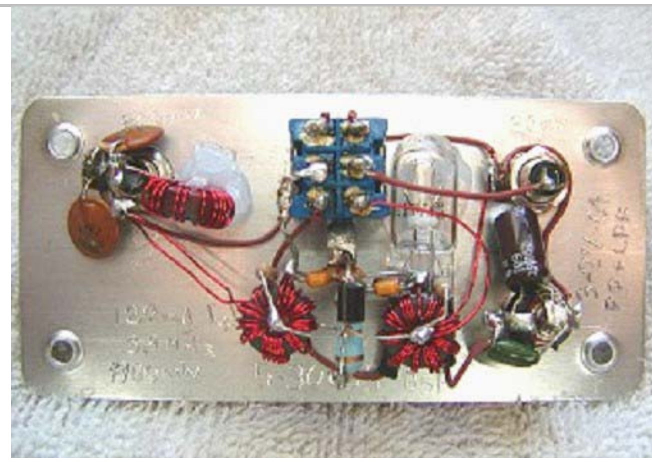
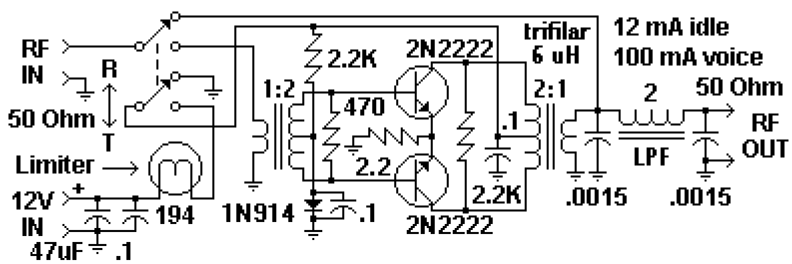
David Forsman, WA7JHZ

External 500 mw 75 Meter Amplifier

Here is an update to the 500 mw linear amplifier that makes it even more fun to operate.





Optional External 500 mW 75 m Amplifier/Filter

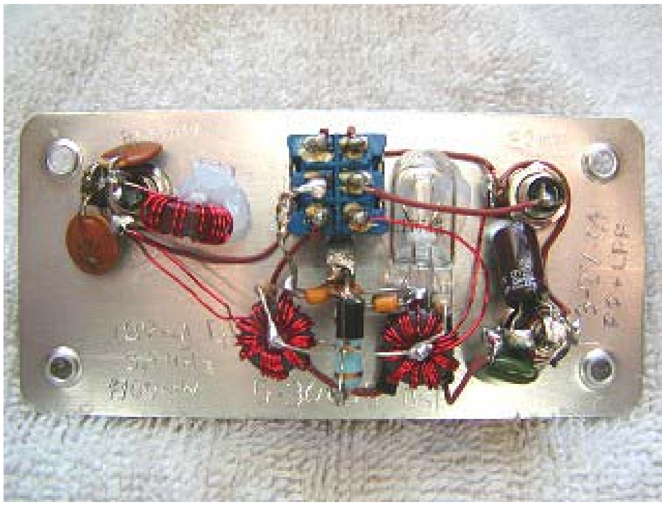
With added resistors (470 & 2.2K), current limiting bulb (194), receive-transmit switch, and modified low-pass filter (LPF).

3-27-04 by David S. Forsman, WA7JHZ

The external 500 mW amplifier for the QRP QRP 75 Meter SSB Transceiver has been updated. These changes include the addition of a 470 and 2.2K ohm resistor, a current limiting bulb, a transmit-receive switch, and changed values in the low-pass-filter (LPF).

, I have attached a photograph (640 bit width) and the complete 75 meter SSB rig with the new external amplifier. You may use them the way you wish.

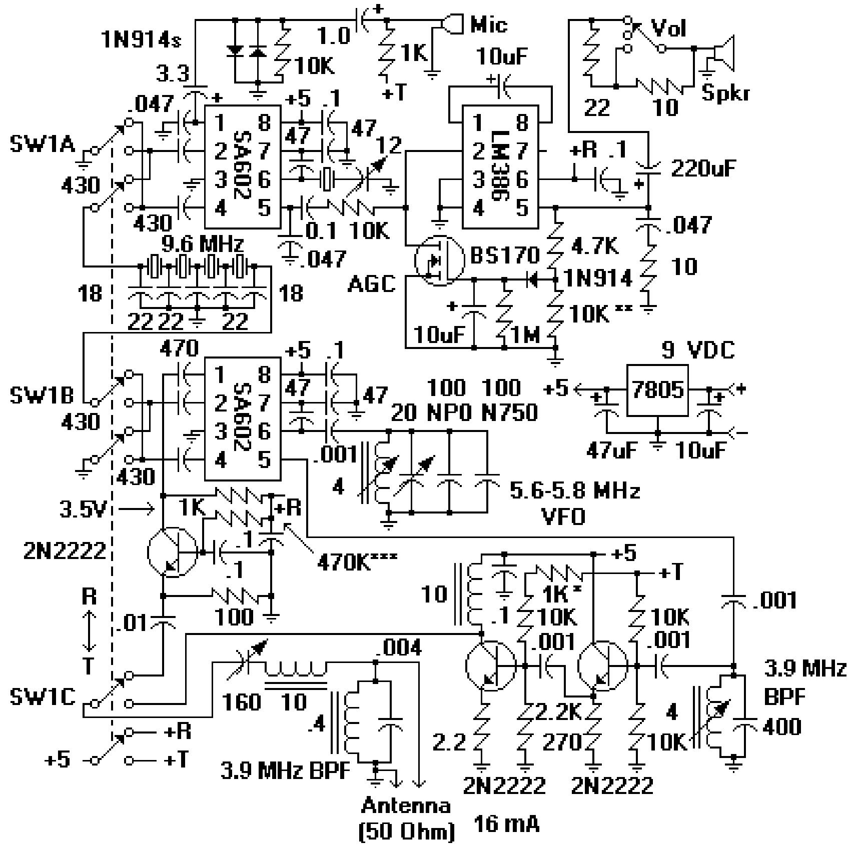
Sincerely yours,



The external amplifier seems to be more stable with loads other than 50 ohms, and the current limiting bulb acts as both a fuse and a protective device. Below the schematic for the complete 75 Meter transceiver has been included for your reference.

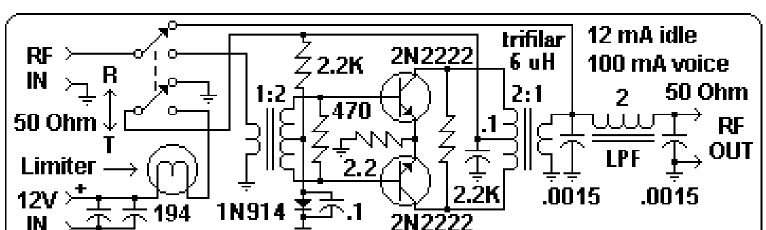
QRP 75 Meter SSB Transceiver for Amateur Radio

by David S. Forsman, WA7JHZ



* Bias Adj (16 mA) ** AGC Adj *** Preamp Bias Capacitance in pF; otherwise value is in uF with decimal values (.047 etc) or as noted. Inductor values in uH. Xtal filter design from Ladder4.	**Specifications** Receive Current: 17 mA Dynamic Range: 80 dB IF Bandwidth: 3 KHz* Transmit Current: 40 mA Transmit Power: 20 mW Harmonic Attn: 30 dB* * Calculated Values	SW1 is made up of three Radio Shack "ALPHA" DPDT slide switches. Remove the detent springs from two of them; weaken the third switch spring; and link all three together so they operate as one.

This is a 75 meter QRP SSB Xcvr for experimentation and educational uses, and should provide the radio amateur with several hours of quality entertainment. The author assumes no liability for either its use or misuse. Follow all safety and FCC rules when operating.



Optional External 500 mW 75 m Amplifier/Filter

75 Meter SSB Transceiver-- 4-9-03, 5-22-03, 3-27-04

Drawing Date
3-28-04

AmQRP.ORG HOMEBREWER

JUHA NIINIKOSKI OH2NLT
MATTI HOHTOLA OH7SV

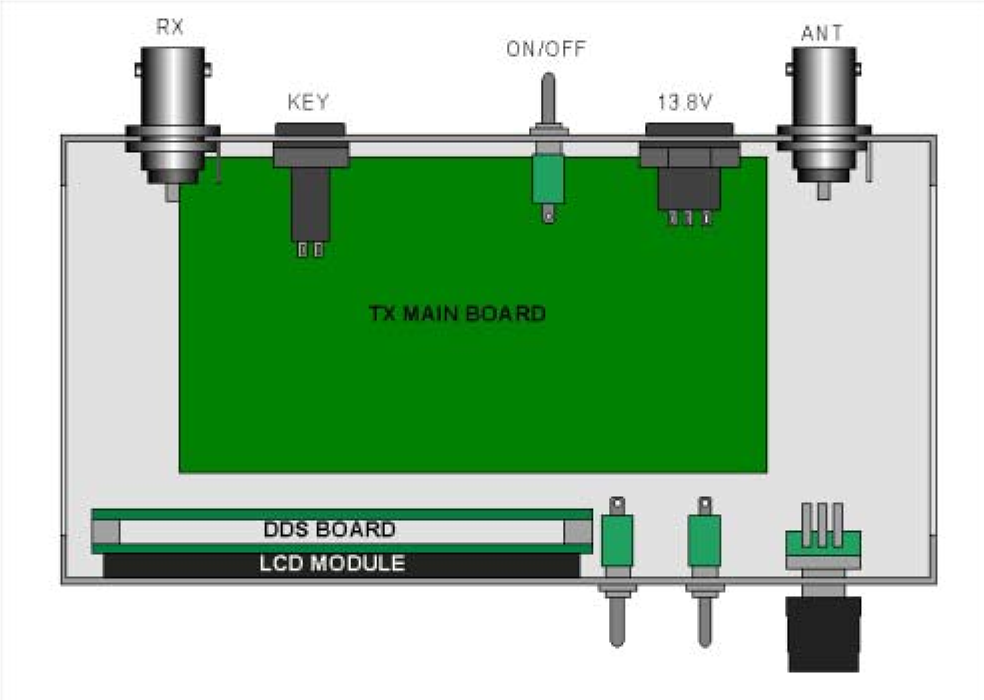
Juma-TX1

DDS Controlled CW transmitter for 80m and 40m amateur radio bands

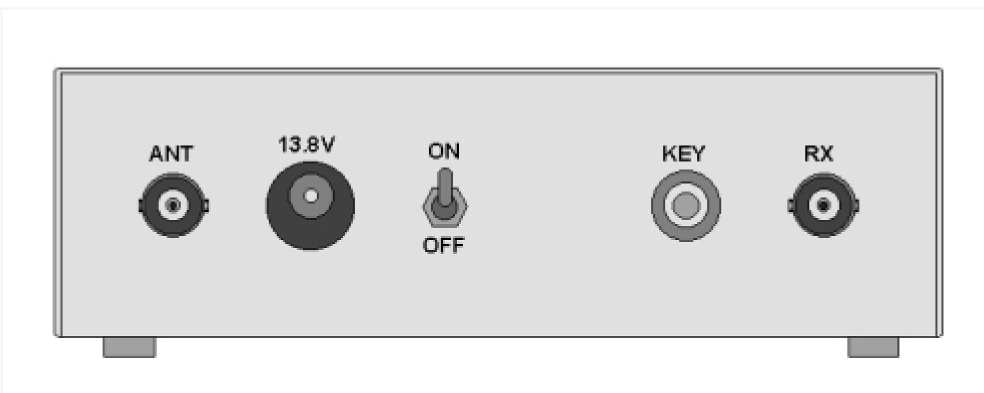
General description

JUMA-TX1 is a CW transmitter for 80 m and 40 m amateur radio bands. It is a follow-up project to the JUMA-RX1 HF receiver featured in Homebrewer #6. The VFO is using DDS and the output power is 5 watts. JUMA-TX1 is a compact stand-alone QRP transmitter with good CW keying primarily intended for use with the JUMA-RX1. Additionally it can be used with any HF receiver which covers the 80 m and 40 m amateur radio bands. The frequency stability is excellent and the frequency can be set in steps of 10 Hz, 100 Hz, 1 kHz and 100 kHz.

JUMA-TX1 transmitter is built using the same small size aluminum enclosure as the preceding JUMA-RX1.

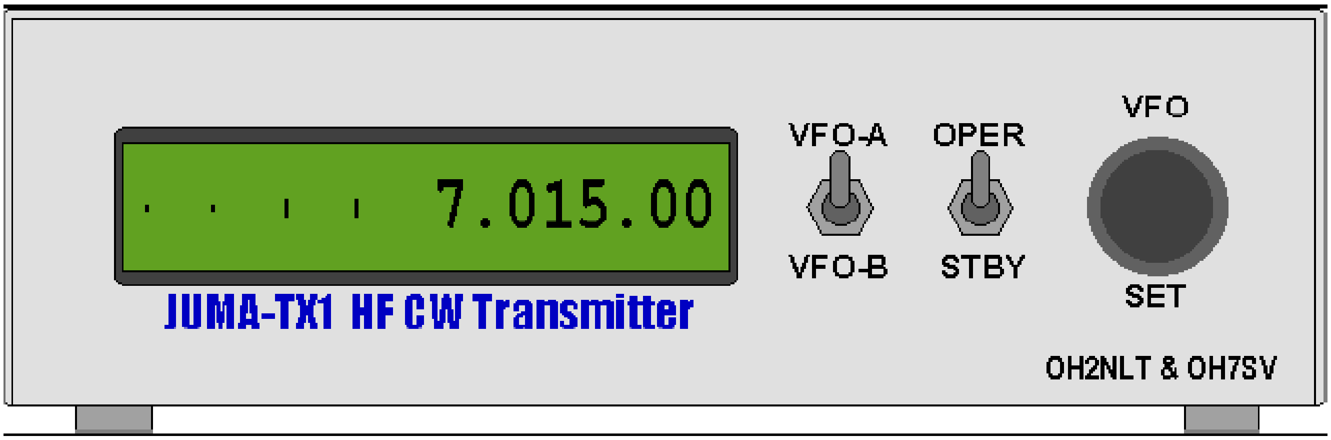


The TX1 consist of two circuit boards, the DDS board and the TX-main board. Additionally there is a LCD module for frequency, relative power and supply voltage display. No coil winding is needed when constructing this TX.



The antenna connector, power supply connector, power switch, key connector and the RX antenna connector are on the rear panel.

JUMA-TX1 Quick Guide



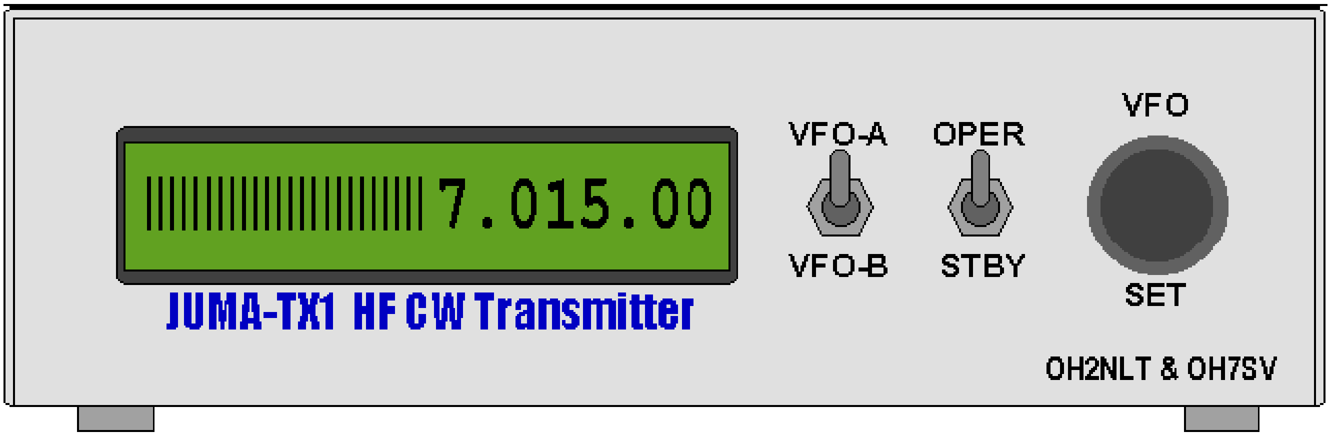
Frequency display
The right half of the LCD display shows the selected frequency. The frequency is shown with a resolution of 10 Hz.

VFO-A / VFO-B switch
This switch selects one of the two VFOs, A or B. Both of the VFOs can be tuned independently to any valid JUMA-TX1 operating frequency. The frequency display indicates the selected VFO by changing the number separator characters. Periods are shown when VFO A is selected and commas are shown when VFO B is selected.

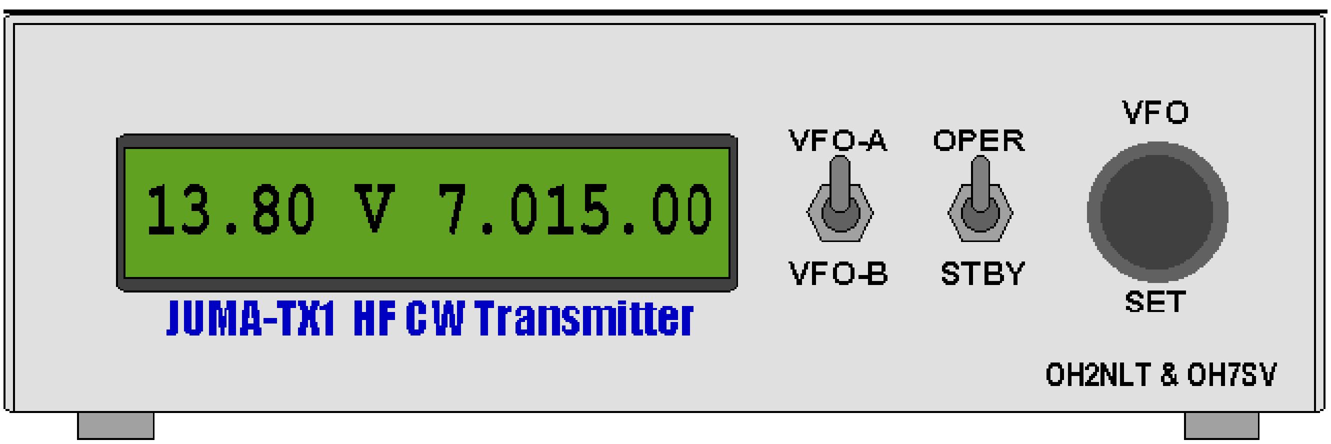
OPER / STBY switch
When this switch is in the OPER position the T/R switch is enabled and a key down signal will activate the transmission. In STBY position the T/R switch is disabled but you can key down and spot your frequency with a receiver.

VFO - SET encoder/switch
This multi-function control is a rotary encoder with a push button switch. By rotating this knob you can tune the frequency up and down. The tuning step can be selected by pushing and simultaneously rotating the encoder. The tuning step can be set to 10 Hz, 100 Hz, 1 kHz or 100 kHz. The tuning step is the same for both VFOs. Just pushing the encoder switch once without rotating it toggles between the relative power and the supply voltage displays. Holding the encoder switch depressed more than two seconds stores both VFO frequencies and the tuning step into the non-volatile memory.

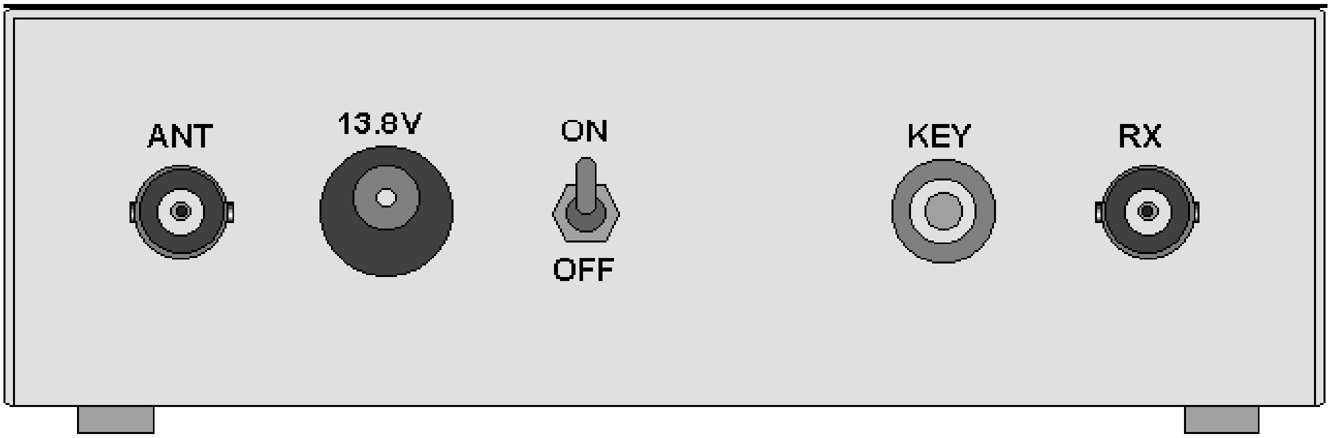
Acknowledgement tones
A small speaker inside the TX provides the acknowledgement tones. During power up JUMA-TX1 gives a hello message in audible CW. The tuning steps are indicated with different pitch tones. The saving of the frequency setup is acknowledged with an "R" in Morse Code.



Relative power display
During transmission the relative output power is shown with a bar graph on the left half of the display. Full-scale display corresponds to approx. 6 W of power to a 50 ohm load. The relative power detector is an RF voltage meter and thus the reading can show lower or higher values depending on the actual antenna impedance.



Power supply voltage display
Power supply voltage can be monitored on the left half of the display by pushing the encoder switch once. The resolution of the reading is 0.02 V. The supply voltage indicator is very useful when the TX is operated with a battery.



ANT connector
This is the BNC type antenna connector for a 50 ohm, 80 m or 40 m antenna. If the antenna impedance is far off from 50 ohms (SWR > 1:3) a tuner is recommended between JUMA-TX1 and the antenna.

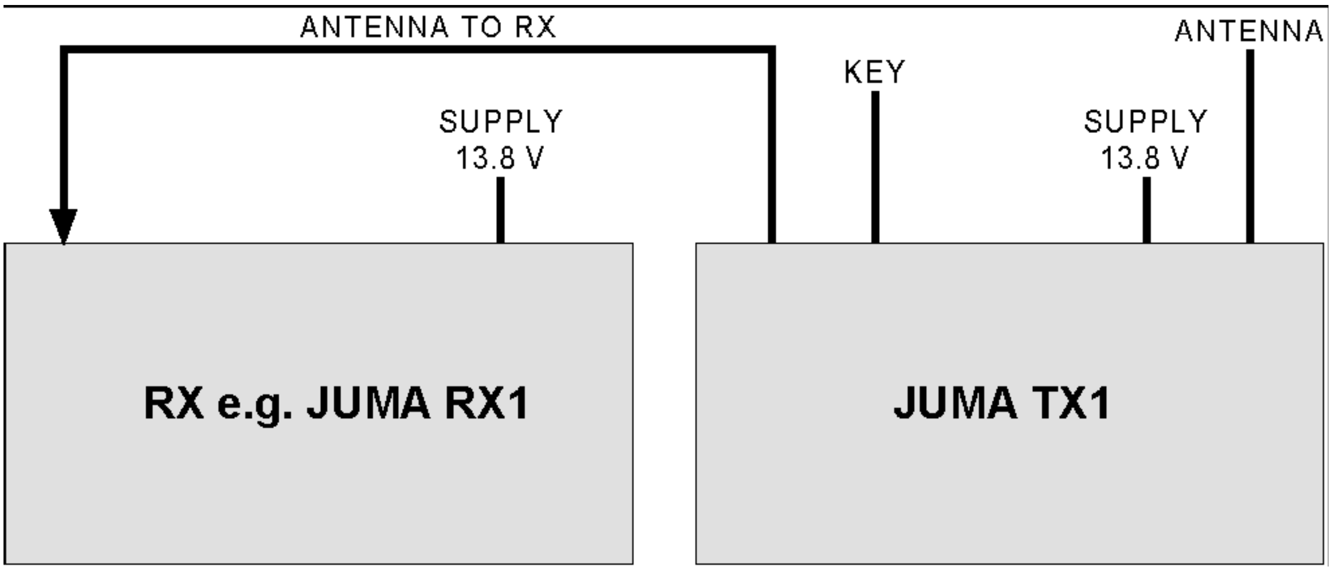
13.8V connector
This is the DC power supply connector. A 12-15 volt regulated power supply capable of delivering at least 1.5 A is required. The power supply input is protected against over current and against wrong polarity with a built-in 2 A fuse. JUMA-TX1 can also be operated with a 12 V battery capable of providing 1.5 A current.

ON / OFF switch
This power ON/OFF switch interrupts only the control power for the DDS and the TX board. Power supply voltage is always connected to the RF power amplifier MOSFETs but they do not draw any current when control power is OFF. When JUMA-TX1 is OFF the 80 m band low-pass filter is connected between the antenna and the RX connector.

KEY connector
A key or an automatic keyer (elbug) with a grounding switch can be connected to the JUMA-TX1 key input. The keying interface is a 5 kohm positive pull-up to +6 V. The required sink current is less than 2 mA, thus any NPN transistor or N-MOSFET in the keyer output is suitable for driving the keying input. When the OPER state is selected and the key is pressed, JUMA-TX1 will automatically change to the transmit state. Releasing the key will restore the ready state after a typical 300 ms release time.

RX connector
This is the BNC type RX antenna output which provides the antenna signal to a JUMA-RX1 or any other HF receiver. When JUMATX1 is not transmitting, it connects the antenna to the receiver connector through a low-pass filter. When just listening, the JUMATX1 should be tuned to same band to select the correct low pass filter. The cross-over frequency from 80 m to 40 m is 4 MHz.

Using the JUMA-TX1 with a receiver



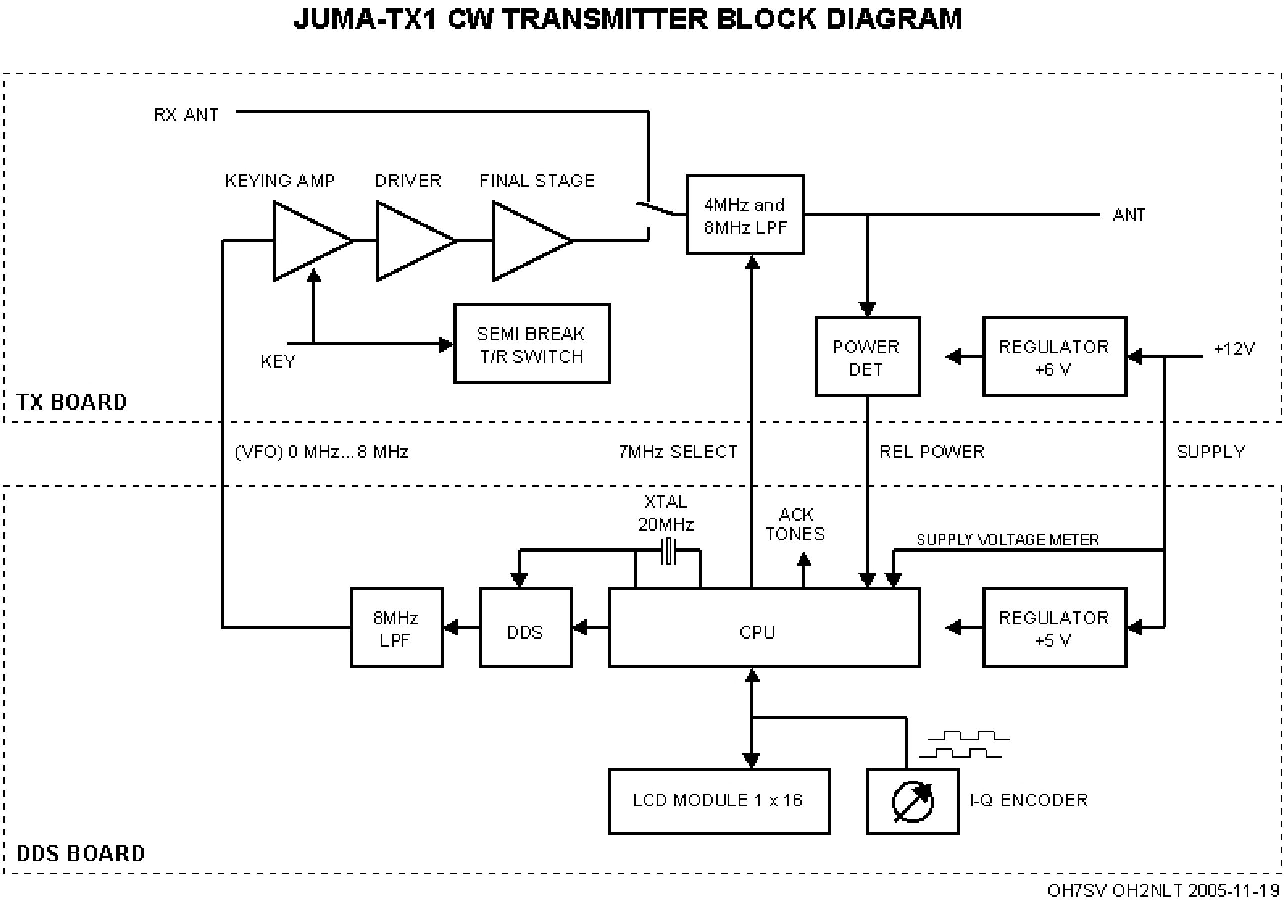
Connect an antenna to the JUMA-TX1
Connect the RX antenna cable via JUMA-TX1 RX connector
Power up both the RX and the TX
Connect a key or an elbug to the KEY input of the JUMA-TX1

CW working procedures
The best practice for listening CW is to tune the RX frequency so that the CW tone pitch is quite low. The reason for this is that the human ear has better selectivity in the lower frequency range. Thus tuning for a low pitch will make copying easier when QRM is present. Most experienced amateurs tune to a pitch of approx. 700 Hz. The best advice when working with a QRP transmitter is: “listen, listen, listen!”. Naturally you can call CQ but the best QSOs are achieved by first listening carefully.

RX/TX tuning procedures
Before trying to have a QSO with a station that you are listening to, you need to set your transmitter at the correct frequency. For this you need to know whether your receiver is tuned to a lower or to a higher frequency than the transmission you are listening to. If the pitch of the CW goes up as you tune up the frequency, your receiver is tuned at a higher frequency than the transmission. In this case you need to set your transmitter VFO at a frequency about 700 Hz lower than your receiver (if you are listening with a pitch of 700 Hz). Likewise, if the pitch of the reception goes down when you tune up the receiver frequency, set your transmitter at a correspondingly higher frequency. As you can hear your own CW via the RX in the STBY state for "spotting" and in the OPER state when transmitting, it is easy to verify that you are transmitting at the correct frequency. The pitch of the received and the transmitted CW should be approx. the same when the tuning is spot on.

Band limits

JUMA-TX1 DDS control does not limit the transmitter frequency to be within the amateur radio bands. Keep track that you are operating within the allocated bands and within your license limits. A valid amateur radio license is required to operate this transmitter.



TX1 Main Board Description 04.01.2006 (Revision D)

Board construction

The TX1 main board is a small (94 mm x 50 mm) double side PCB. All components are of SMD type and are assembled on the top layer. The bottom plane provides low impedance RF and DC path as well as good heat spreading. The TX board is installed on bottom of the aluminum enclosure. The JUMA-TX1 can be built without winding any coils or transformers!

Features

The board contains the RF path from DDS board to the antenna. There are three amplifier stages which provide the required gain. CW keying is handled by the first amplifier. Driver and the final stages are using low cost SMD MOSFETs intended for switching applications. The board includes a semi break T/R switch (VOX) and low-pass filters for the 80 m and 40 m bands. Although the TX is a CW transmitter the MOSFETs are biased for linear operation to achieve the required gain and to maintain an excellent keying performance. Nominal output power is 5W with a 13.8V supply voltage and typical current is less than 1.2 A.

CW keying amplifier
The RF input signal, 0.25Vp-p, coming from the DDS board is fed to the keying amplifier IC1. It is a tiny single gate CMOS inverting buffer which is biased for linear operation. The gain is adjustable by the trimmer R2. The keying is made by switching the supply voltage of this amplifier. Key-down signal is pulling down the input of the Schmitt trigger inverter IC2. This drives the "click" filter R17/C27 which provides good clickless and prompt keying. Filtered keying DC signal is buffered by transistor TR4 which provides the supply to the keying amplifier IC1.

Semi break T/R switch
The key down signal is charging the C28 which drives the Schmitt trigger input of IC3. The output of the IC3 controls the antenna relay and the bias voltages. The semi break (VOX) release time can be adjusted by changing the value of capacitor C28 and/or resistor R18. The STBY signal is used to switch the TX to the standby state.

Driver and final stages
D-pak type SMD MOSFETs are used in the RF amplifier. TR1 is the driver amplifier. Input impedance is damped down to 50 ohm with R3 to eliminate the effect of the input and reverse capacitance of the MOSFET. The driver MOSFET operates in class A with a 100 mA nominal bias current. The bias current is adjusted with the multi turn trimmer resistor R4. Source resistor R5 and the capacitor C6 are used to align a flat frequency response from 3 MHz to 8 MHz. A commercial SMD common mode signal filter is used as a wide band RF transformer (T1). The filter is made by TDK and has a turn ratio of 1:1. It has an excellent RF performance at the selected impedance level.

The secondary winding of the transformer T1 is differentially driving the two final stage SMD MOSFETs (TR2 and TR3) which are in a push-pull configuration. This stage is operating in class AB with a 50 mA bias in each MOSFET. The bias currents are adjusted with the multi-turn trimmers R6 and R9.

The output transformer T2 is also a commercial SMD common mode signal filter from TDK. This type has four windings. The drain-drain to antenna turns ratio is 1:1 which theoretically provides a maximum of 7 watts with a 13.8 volt supply. See the circuit diagram for connections of the windings. According to the measurements the TDK signal filter shows a very good performance as an output transformer and it can handle the 5 watt power level without over heating.

Low-pass filters
The low pass filters for the 80 m and 40 m amateur band are made of commercial SMD inductors of size 2220. They can handle the 5 watt level just fine. The changing of the filters is controlled automatically by the software in the DDS board. When the frequency is higher than 4 MHz the 40 m low-pass filter is selected. MOSFET TR7 is taking care of this filter change.

Relative output indication
Diode D4 and related components are used for relative power detection. The recovered DC signal is scaled to the DDS board analog input range of 0…0.234 V. The relative output is shown graphically as a bar in the LCD module.

Voltage regulator
The keying circuits, T/R switch and the bias supply voltage is +5.7 V, which is coming from the regulator REG1. The diode (D5) is used as a negative temperature compensation for the bias currents of the RF amplifier MOSFETs.

Failure protection
Over current protection is handled by the small size, on board, 2A fuse. In case of a wrong power supply polarity, the fuse will also blow with the aid of the reverse diodes in the MOSFETs TR1…TR3.

Special features

- During reception the antenna signal is connected to a RX via the relay contacts RL1. The antenna signal path is going through a low-pass filter to improve spurious response in a RX. This means that the TX frequency must be set to the same band as the RX. The 80m/40m crossover frequency is 4 MHz.
- JUMA-TX1 has no built in side tone generator, but the T/R switch is designed so that the transmitted CW signal can be monitored at a convenient level from RX. In STBY state you can key down and spot your frequency with a RX.
- During transmission the +5.7 volt DC is connected to the antenna output via resistors R10 and R11. This is the "JUMA protocol" which is used to activate an optional, external PA. This output signal will not harm anything, because it can supply only approx. 1 mA to the antenna output.
- The T/R switch can be disabled by turning the switch in the front panel to "STBY". You can then key down and spot your frequency with an RX or activate the DDS output for e.g. frequency measurement purposes.

TX1-main board adjustments

Required equipment for adjustments
V/A/Ohm meter, 13.8V/1.5 A DC supply and a 50 ohm/5W dummy load. A home made dummy load can be used. Example: Two 100 ohm/2W resistors in parallel (do not use wire wound types).

Caution 1. The TX board must be installed on the bottom of the enclosure or on a similar aluminium plate to assure proper cooling.
Caution 2. Connect a 50 ohm/5 watt dummy load to the antenna connector.
Caution 3. Do not connect the power supply without checking the voltage and the polarity.

Before connecting the power supply
Turn the three multi turn bias trimmers R4, R6 and R9 so that the resistance from gates to GND of the MOSFETs TR1, TR2 and TR3 indicates minimum resistance. This ensures that the bias currents of the MOSFETs are zero in the beginning. This is important because otherwise the current can be very high and the 2 A fuse may blow.

Power supply check
Check and adjust the DC power supply voltage to 13.8V (±0.2V). Current limit, if available, is recommended to be adjusted to 1.5 A.

Bias adjustments
Disconnect the RF-input (marked "RF IN" on the TX main board) by de-soldering the "hot" wire. Connect a current meter in series with the power supply + wire. Switch ON the power supply and JUMA-TX1 and turn the STBY switch to OPER position. Connect a CW key or a push button switch to the "key" connector and key down to activate the T/R switch. Now make a note of this stand-by current typically approx. 50 mA (15 mA more in 40 m band). Adjust the driver bias by turning the trimmer TR1 until the current increases 100 mA. Next adjust the final stage fias by turning the trimmers TR2 and TR3 until each trimmer increases the current by 50 mA. The final current should be the stand-by current + 200 mA. Finally, reconnect the RF input coming from the DDS board.

Power output adjustment
Note1: A DC current meter in the power supply wire can be improper during RF power tests because the meter has internal resistance and causes a voltage drop with 1A current. Replace the meter with direct connection.

Note2: Do not use antenna as a load during adjustment because the impedance is unknown. Use only a 50 ohm dummy load.

Key down and turn the RF gain trimmer R2 until the LCD relative output shows one bar below full scale in the LCD. Then you have 5 W output. Check this output power on both of the bands, 3.5 MHz and 7 MHz. If there is a large output power difference between the two bands, the gain can be compensated by changing the value of capacitor C31. In the LCD relative power display, 3 bars difference between the bands is ok, that equals approx. 1 dB. Observe the 7 MHz low pass filter control functionality during these band tests (audible click from the relay when passing 4 MHz). The output power can be verified with an oscilloscope if available. It should show 45 Vp-p for 5 watts output. Typical power supply DC current is approx. 0.8 A at 3.5 MHz and approx. 1.2 A at 7.0 MHz.

Note3: When the TX is connected to an antenna, the relative RF output display can show higher or lower readings. This is normal because the relative output detector is a voltage detector and thus the antenna impedance affects the relative output reading.

Description of the signals (markings on the board, refer also to the circuit diagram)

RF IN (J1, J2)
RF input to the TX board. Nominal signal level 0.25 Vp-p. Input impedance approx. 1 kohms with a parallel capacitance of approx. 20pF.

KEY (J3, J4)
Active low CW key input. Can be driven by a conventional key, relay, open collector or open drain circuit. Open circuit voltage +5.7 V and active low sink current < 2 mA.

TX (J5)
TX transmit state output. High (+5.7 V) during transmit state. Note: TX signal will go high also in stand-by state when the "VOX" is activated by a key input.

STBY (J6, J7)
Stand-by select input. When this signal is grounded, the transmitter is in stand-by state and the T/R switch will not activate with a key signal but the DDS and RF driver will be activated whereupon you can spot the frequency.

7M (J8)
Band selection input. When high (3 V...15 V) selects the 40 m band low-pass filter. When low (< 1V) selects the 80 m band low-pass filter.

REL (J9)
Relative RF output DC signal. Output of 0.22 VDC corresponds to 5 W RF output with a nominal 50 ohm RF load. Output impedance 5 kohm.

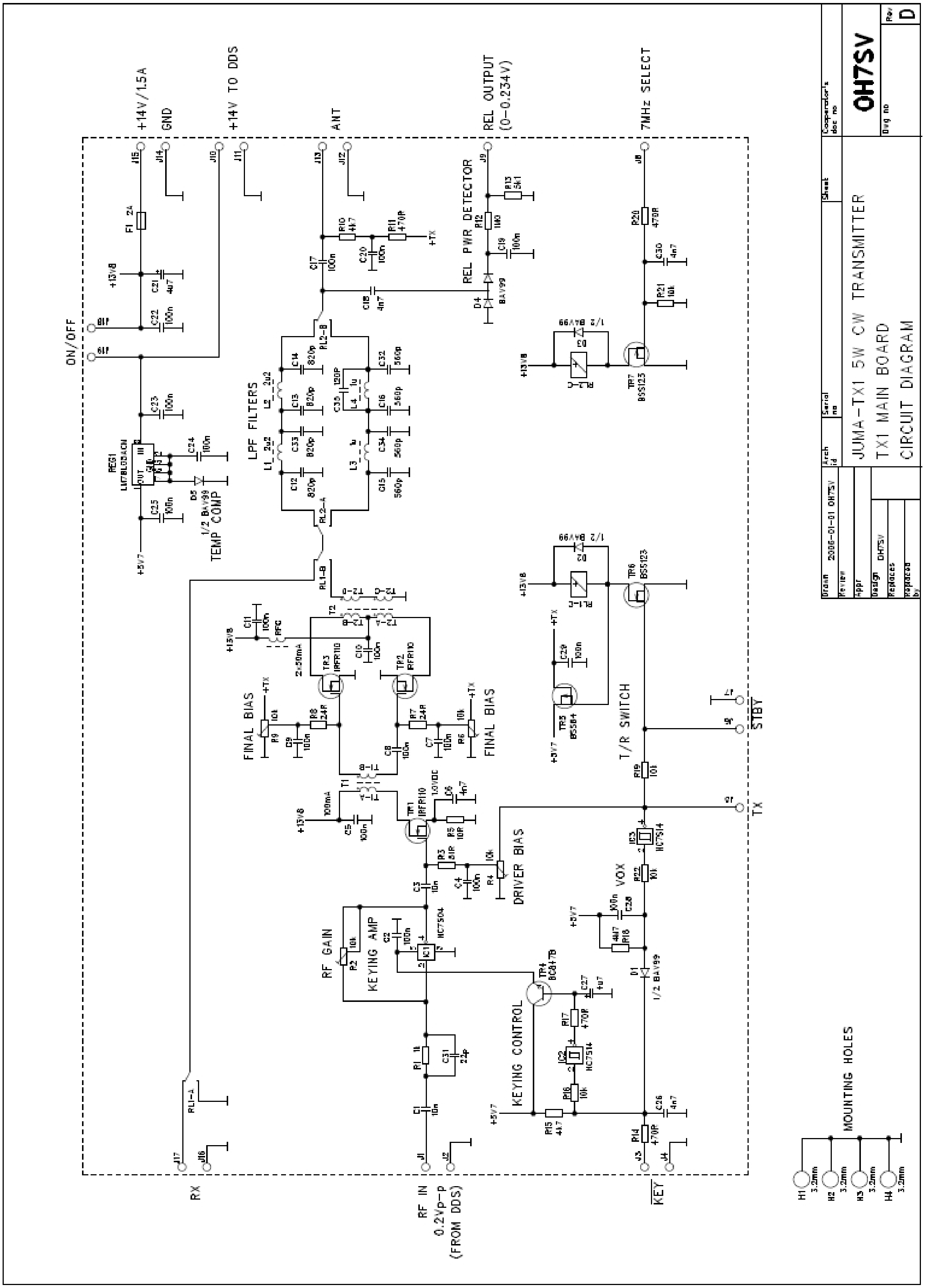
+ (J10, J11)
Switched +13.8 VDC supply output for the DDS board

ANT (J13, J12)
Antenna connection, nominal 50 ohms.

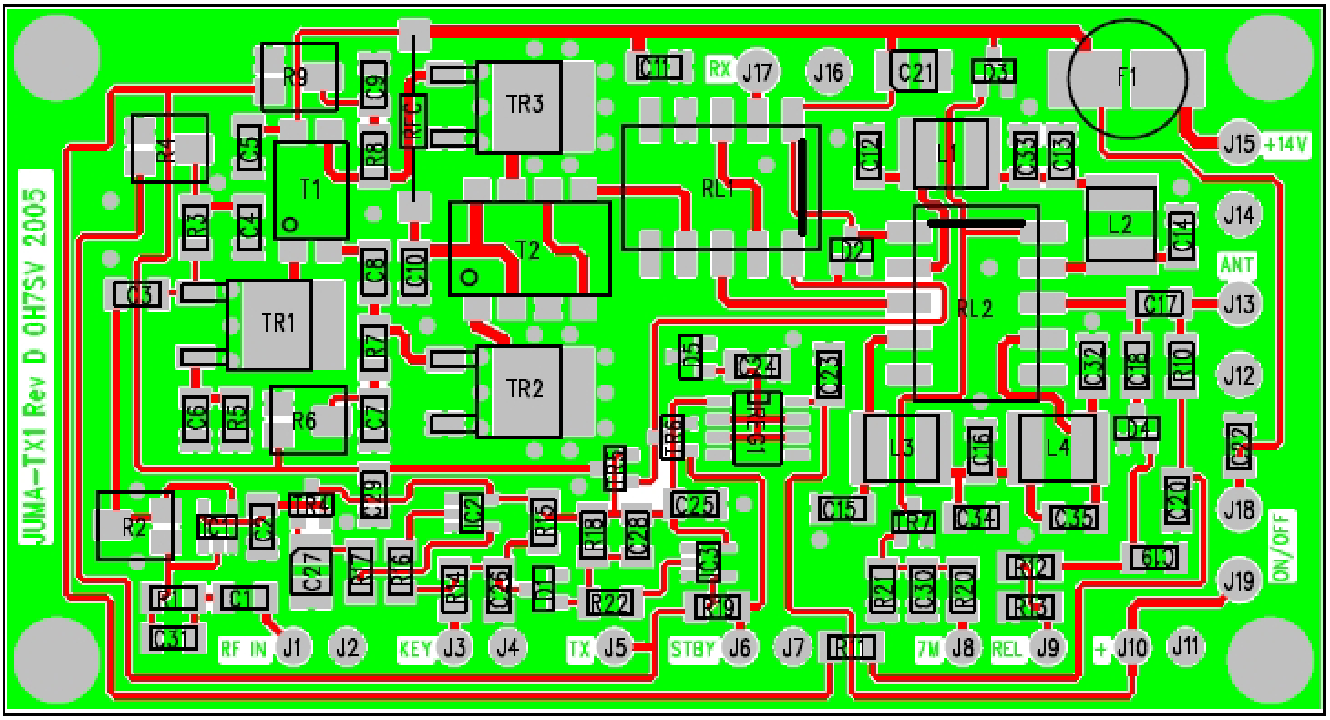
+14 (J15, J14)
Power supply input. Voltage range +12 VDC...+15 VDC. Protected by a 2A fuse on the TX board.

RX (J17, J16)
Antenna output for RX. Please observe that the receive path goes via the PA low-pass filters.

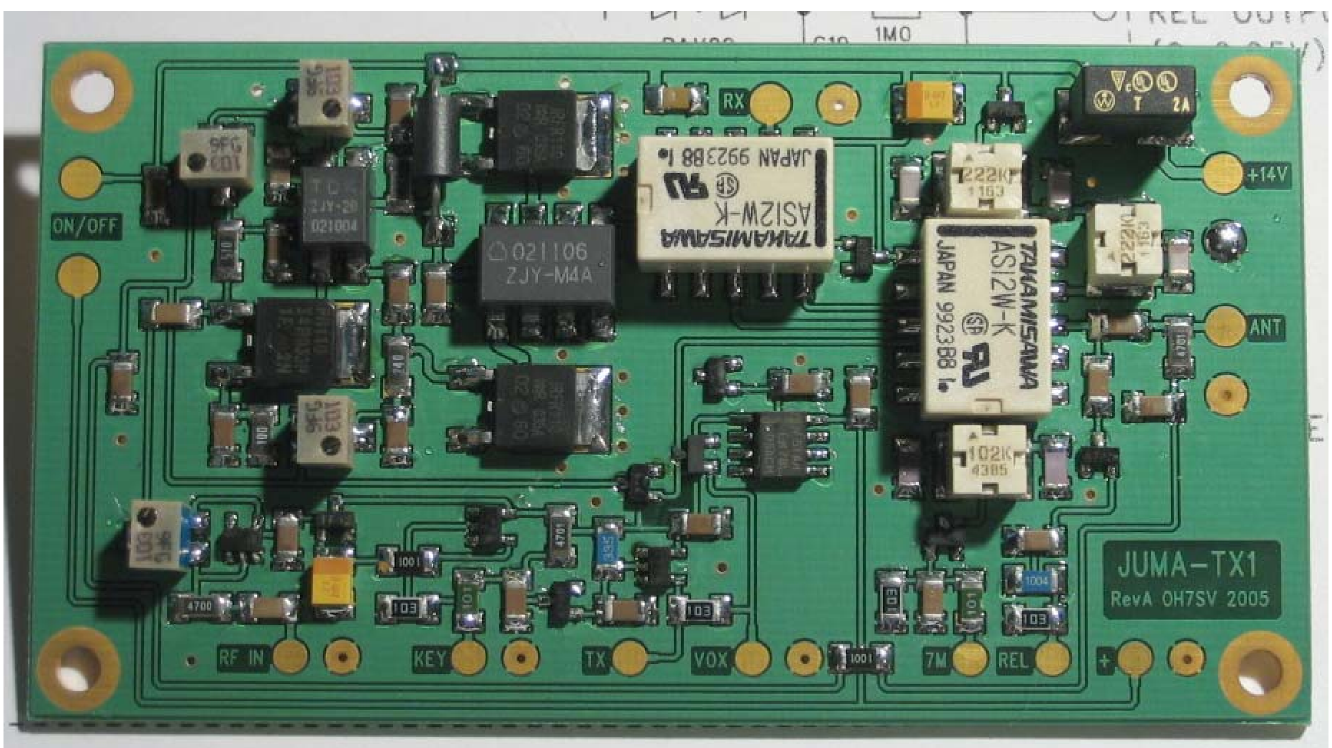
ON/OFF (J18, J19)
Pads for power ON/OFF switch. Please observe that the power supply is directly connected to the driver and final stage MOSFETs.



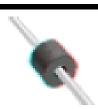
JUMA-TX1 5W CW TRANSMITTER
TX1 MAIN BOARD
CIRCUIT DIAGRAM
OH7SV
D
+14V/1.5A
GND
+14V TO DDS
ANT
REL OUTPUT
(0-0.234V)
7MHz SELECT
ON/OFF
LPF FILTERS
REL PWR DETECTOR
TEMP COMP
FINAL BIAS
T/R SWITCH
STBY
TX
DRIVER BIAS
VOX
RF GAIN
KEYING AMP
KEYING CONTROL
MOUNTING HOLES
RX
RF IN
0.2Vp-p
(FROM DDS)
KEY



Transmit Board Component Layout



JUMA-TX1 main board components Rev. D 07.02.2006

Part number	Description	Value / type	pcs	Note
R5	Resistor SMD size 1206	10R	1	
R7, R8		24R	2	
R3		51R	1	
R11, R14, R17, R20		470R	4	
R1		1k	1	
R10, R15		4k7	2	
R13		5k1	1	
R16, R19, R21, R22		10k	4	
R12		1M	1	
R18		4M7	1	Semi break release time
R2	SMD trimmer resistor, single turn	10k	1	E.g. Bourns 3314J
R4, R6, R9	Multi turn SMD trimmer Bourns 3214 or 3224W series or Vishay TSM4YJ or TSM4YL series	10k	3	Or similar 5 turn or 10 turn SMD trimmer. Values of 5k, 10k, 20k or 50k can be used
C31	Cer capacitor SMD size 1206 NP0 / 25 V or more	22p	1	3.5MHz / 7MHz gain, see description
C35	NP0 / 50 V or more	120p	1	
C15, C16, C32, C34	NP0 / 50 V or more	560p	4	
C12, C13, C14, C33	NP0 / 50 V or more	820p	4	
C6, C18, C26, C30	25 V or more	4n7	4	
C1, C3	25 V or more	10n	2	
C2, C4, C5, C7, C8, C9, C10, C11, C17, C19, C20 C22, C23, C24, C25 C28, C29	25 V or more	100n	17	
C21, C27	Tantalum Capacitor SMD	4u7/16V Case style B	2	Value range 4u7-10u. Can be replaced with a radial Tantalum.
L1, L2	Inductor SMD Case size 2220	2u2H	2	Manufacturer e.g. Epcos SIMID 2220 series. High current type SIMID 2220H series can also be used
L3, L4	Inductor SMD Case size 2220	1uH	2	Manufacturer e.g. Epcos SIMID 2220 series. High current type SIMID 2220H series can also be used
RFC 	RF choke, inductance range 0.5uH…10uH (wire through a ferrite bead)	Small ferrite bead e.g. Amidon FB-43-101 outer diameter 3.5 mm, inner diameter 1.3 mm, length 3.5 mm	1	Not critical, a wire diameter of 0.4mm-1mm through any small ferrite bead is ok
T1	RF transformer	TDK signal filter ZJYS51R5-2PB or ZJYS51R5-2PB-01	1	Farnell code 423-0413 or Farnell code 962-1270
T2		TDK signal filter TDK ZJYS51R5-M4PA or TDK ZJYS51R5-M4PA-01	1	Farnell code 423-0474 or Farnell code 962-1334
D1, D2, D3, D4, D5	Diode dual SMD SOT-23	BAV99	5	or similar SOT-23 Si-diode
TR1,TR2, TR3	MOSFET N-type D-PAK	IRFR110	3	IRFU110 (I-PAK) can be used by shortening and bending the legs
TR4	NPN transistor	BC848B SOT-23	1	or BC846B, BC847B
TR5	MOSFET P-type SOT-23	BSS84	1	or similar, Rds < 10 ohm e.g NDS332P
TR6, TR7	MOSFET N-type SOT-23	BSS123	2	or similar, Rds < 10 ohm e.g. 2N7002
IC1	CMOS inverter SOT-23-5	NC7S04	1	Fairchild
IC2, IC3	CMOS Schmitt trigger inverter SOT-23-5	NC7S14	2	Fairchild
REG1	Voltage regulator SO-8	78L05	1	
RL1, RL2	SMD Relay	NEC EB2-12V	2	Or Omron G6H-2F-12V or Nais TQ2SA-12V or Takamisawa AS12W-K
F1	Mini Fuse: Round D=8.5 mm, or rectangle 4 mm x 8.5 mm, lead spacing 5.08 mm	T2A	1	Fuse soldered to the pads. IC type socket header can be used
PCB	PCB	JUMA-TX1-main PCB	1	

TX1-DDS board description (Refer to the circuit diagram)

General

The VFO of the JUMA-TX1 has been implemented using the DDS (Direct Digital Synthesis) principle. Analog Devices AD9833 DDS IC is controlled by a Microchip PIC microcontroller. The controller is also responsible for other functions of the TX. The physical interface of the DDS board consists of a 1x16-character LCD display and an interface for a rotary encoder that also includes a push button switch. JUMA-TX1 DDS board is a slightly enhanced version of the JUMA-RX1 DDS board. JUMA-TX1 DDS board is software compatible with the RX1 board and can be used for RX applications if needed. JUMA-TX1 software will also run on JUMA-RX1 DDS board but without the Filter Select output signal.

Mechanical construction

The mechanical size of the DDS-and-control board is 80 mm x 40 mm. The PCB is designed to be installed with the same screws fixing the LCD display to the front panel of the box. All components are located on the bottom side of the PCB.

The functions of the DDS board

- Generation of the frequency, implemented with a DDS IC
- Setting of frequency with the rotary encoder
- Indication of frequency on the LCD display
- Selection of the frequency step (fine/coarse tuning) with the encoder
- Indication of settings on the LCD display
- Saving defaults in the non-volatile memory
- Graphic display of the relative TX power output on the LCD display
- Supply voltage display on the LCD display
- TX state indication on the LCD display
- Generation of ACK tones of the user interface
- Calibration of the crystal oscillator frequency with a trimmer
- Filter select signal for the TX board RF LPF filter select

Microcontroller

The chosen microcontroller is a PIC16F88 made by Microchip. It was decided to use an IC in a DIP case because it is easier for programming. A conventional spring loaded IC socket for the microcontroller is installed like a SMD component on the PCB.

XTAL oscillator

The oscillator was implemented using a standard (low cost) 20 MHz crystal for the microcontroller and for generating the reference frequency of the DDS IC. Oscillator was implemented using the osc circuit of the microcontroller and using the output as the clock signal for the DDS IC as well. Oscillator frequency fine-tuning is accomplished by a trimmer capacitor connected in parallel with the loading capacitor of the oscillator.

DDS and low-pass filter
The VFO signal is generated using the DDS (Direct Digital Synthesis) principle from the 20 MHz reference frequency. The DDS principle can be used to generate frequencies with very fine resolution. In this implementation (20 MHz reference clock), the minimum frequency step is 0.0745 Hz, which is way more than enough. The selected smallest step is 10 Hz. The maximum usable frequency with the DDS principle is determined by Nyqvist theory. This means that in theory the max. frequency would be 10 MHz. In practice, the highest good quality signal is 40 % of the reference frequency. The DDS principle also generates a series of harmonic frequencies depending on the fundamental frequency. These are filtered with a 8 MHz low pass filter. Frequency rage of the DDS board is 0...8 MHz and RF output level is ca. 250 mVp-p with an 200 ohm output impedance.

Voltage regulator
The operating voltage of the DDS board is +5 V and the current consumption is ca. 20 mA. The required +5 V is derived from the 9 V...15 V supply voltage and it is stabilized with a 78L05 regulator. The 5 V operating voltage also serves as the reference voltage for the A/D converter of the PIC16F88.

VFO select
Microcontroller's MCLR (Reset) pin can also be programmed as a general purpose input pin. In JUMA-TX1 DDS board this signal is wired to connector pad J9 and is used as the frequency memory of VFO select signal. When the signal is high, VFO A is used and when the signal is low (grounded), VFO B is used. Both frequency memories can hold any valid JUMA-TX1 frequency. It is the user's choice, how to use these two frequencies.

Band select
74HC74 flip flop data inputs are connected to the LCD display bus signals D2 and D3. Flip-flop is clocked with DDS data load signal. HC74 Q-outputs are connected to connector pads J6 and J7. J7 is used for TX board RF LPF filter select signal. When this signal is low 3,5 MHz filter is selected. High state selects 7MHz filter. In the software the flip-flop handling is embedded in the AD9833 DDS chip driver.

TX control signal
The TX board generates the TX state signal. In the DDS board this signal is connected to the connector pad J1-1. The TX signal is used to control the DDS output. During RX (TX signal low) the DDS output is suspended. This is necessary to avoid RX interference caused by the TX DDS output frequency. When the TX signal is high (or J1-1 not connected), DDS generates the set frequency. If the DDS board is started in test mode, the TX signal is ignored and DDS generates continuous output.

ACK tones
The microcontroller generates the JUMA-TX1 audible hello message at startup and marker tones for different frequency tuning steps when the step is changed. A tone signal is available at connector pad J5. The signal must be DC isolated with an external capacitor. The signal

can be used to drive a miniature speaker. A series resistor may be added if speaker volume needs to be reduced.

LCD display
The LCD display is a commercial 1x16 character alphanumeric low cost display module. For driving the display eight data bits and a couple of control signals are needed. The data bus is driven by the I/O port B of the 16F88 controller. A portion of this bus is also used for driving the DDS IC and for reading the status of the rotary encoder. The display module is able to display letters, numbers, and a selection of other characters. It is also possible to construct some of your own characters in the RAM of the module. This feature has been utilized in implementing the graphics needed for the relative power level-meter. The contrast of the display has been set by resistor R2 on the DDS PC board.

Encoder
The frequency is set by the rotary push button encoder. A low cost model producing 30 pulses per revolution and equipped with a push button switch was selected. The encoder is constructed as a rotary switch with two contacts. These contacts are phased in order to produce two signals with 90-degree phase shift. This IQ signal can be interpreted to indicate encoder movement and direction of rotation. The signals from the encoder and its pushbutton are connected through separating resistors to the data bus of the LCD display where their states are read by the software.

Adjustments
The DDS section doesn't necessarily require adjustment. However, the frequency depends on the frequency of the reference oscillator. For adjusting the reference oscillator, a special adjustment mode is included in the software. If the pushbutton switch of the encoder is kept depressed during start-up, it will enter the adjustment mode. To indicate this mode, the display will show 1 MHz. In this mode, the setting of the DDS is an exactly calculated number corresponding to 1 MHz output frequency. While in this mode, the frequency generated by the DDS can be measured with a precision frequency counter and can be adjusted with the trimmer capacitor C20. Alternatively the frequency can be adjusted by using the interference method which can be done by listening the TX1 output and another accurate reference signal with a receiver and then adjusting the audible interference ("wow-wow-wow") as slow as possible. In the adjustment mode DDS generate an output signal regardless of the state of TX signal.

Due to the resistor tolerances and to the precision of the +5 V regulator, the displayed value of the supply voltage probably isn't quite accurate. The supply voltage display can be adjusted by adding a suitable resistor in parallel with R23 (910R). A suitable value can be found by temporarily soldering e.g. a 100 k trimmer in parallel with R23. When the voltage display is accurate, the trimmer can be measured and then replaced with the nearest standard value resistor.

LCD display contrast is set by voltage in pin #3 of the display module connector. Resistor R2 (1k8 nominal) is used to set the contrast voltage. The voltage producing ”suitable” contrast depends on the display module and on the temperature of operation. If you use a different type of display than the one in the parts list, or if the contrast is not satisfactory, it can be adjusted by changing the value of R2. Lowering the value will make the display darker and increasing it will make the display lighter. The adjustment range is between zero and a few kilo-ohms. A suitable value can be found by soldering a temporary trimmer (e.g. 5k) on the pads of R2.

DDS board signal description

J1-1 TX signal
When high (5-6V) the DDS generates the set frequency. When low (0V), the DDS is stopped and no TX LO frequency is generated. Signal state is indicated in LCD display when voltage display is selected. The TX board VOX circuit generates this signal.

J1-2 Encoder switch input
Encoder shaft or separate push button switch to ground. Most of the user interface controls are done with this switch.

J1-3 and J1-4
Rotary encoder A and B signal inputs. Rotary encoder switches these signals to ground. Signals are 90 degrees out of phase. Pulse count is used for tuning and phase information for up/down direction select.

J1-5 DDS VCC output
DDS board +5V VCC. This is power feed for an encoder with active logic. Not used in the current design.

J1-6 Ground
Ground connector for the encoder and the push button switch.

J2-1 LO output
DDS signal output. About 200mV p-p RF voltage at set frequency.

J2-2 LO ground
Ground connector for LO signal

J3 Bar graph display input
A/D converter input for bar graph display. Range is from 0 to 240mV. Input is 5V tolerant. All values above 240mV give full bar display.

J4-1 Power feed input
Power feed to the DDS board. Voltage can vary between 6,5 and 15V DC. Nominal current is 20mA which varies according to the encoder and switch states.

J4-2 Power ground
Power feed ground wire connector

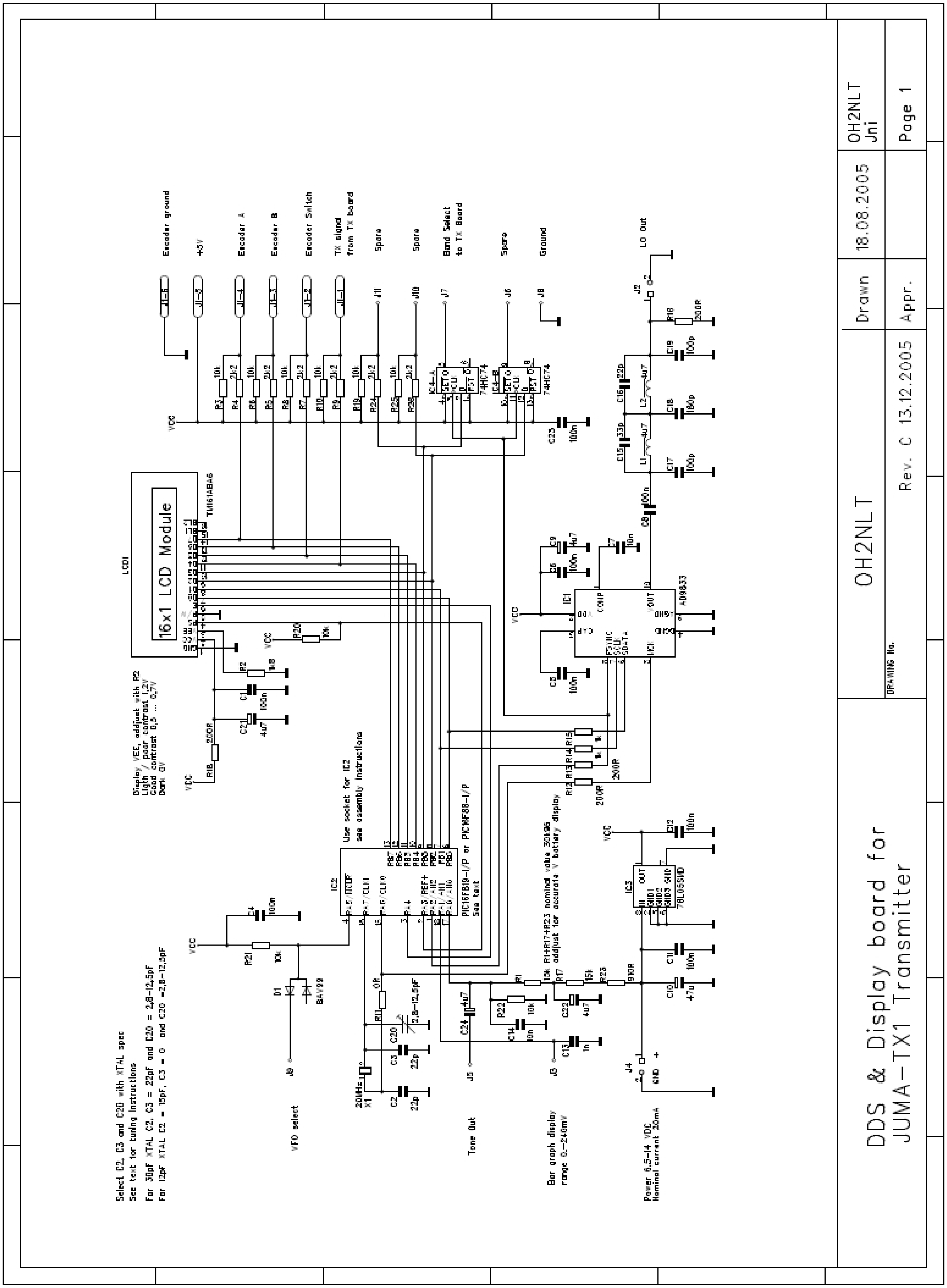
J5 Tone output
User interface indicator tone output. This signal is also used for DDS board internal voltage measurement and must be DC isolated with a capacitor. A miniature speaker can be connected between ground and this terminal with a series capacitor. A series resistor can be added to reduce volume if needed.

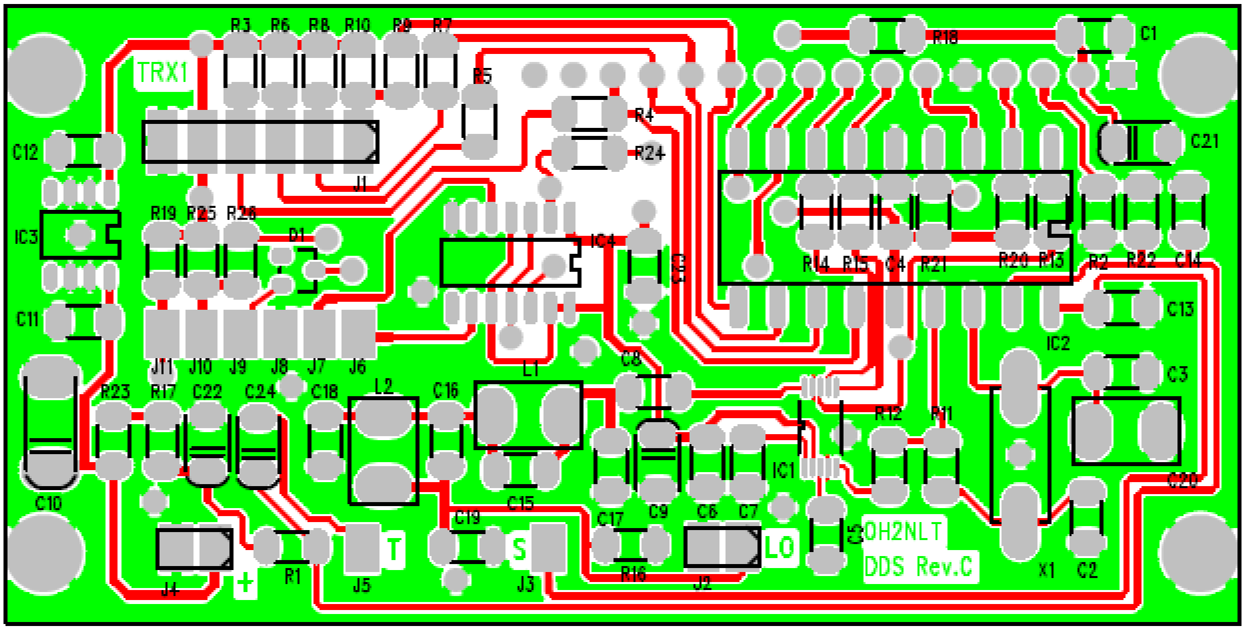
J6 Spare
Spare output signal

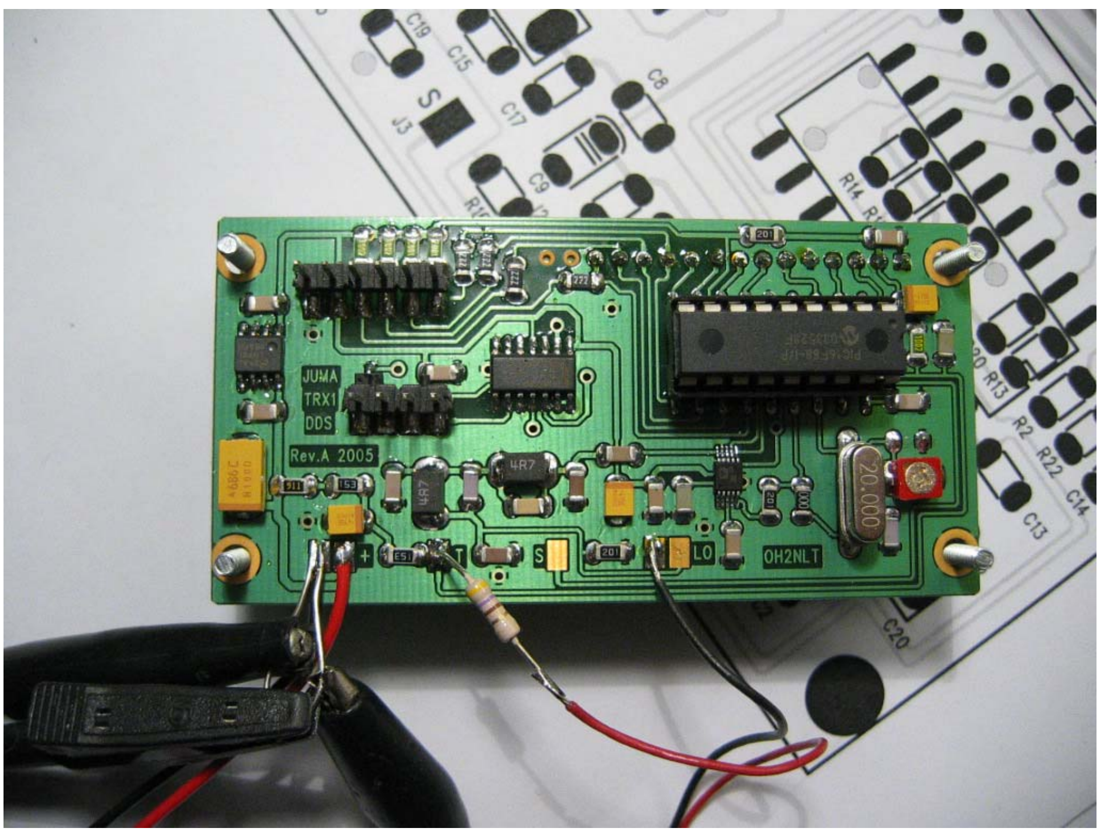
J7 Band select output
Band filter select signal to the TX board. 3,5MHz filter is selected when this signal is 0V. A 7MHz filter is selected when this signal is 5V. DDS software controls the filter select action. Switch-over from 3,5 to 7MHz filter is done at 4.000.250Hz.

J8 Ground
Ground connector for the VFO select switch

J9 VFO select input
Switch between J9 and ground, select the VFO (frequency memory). When open VFO-A is selected. When grounded VFO-B is selected.

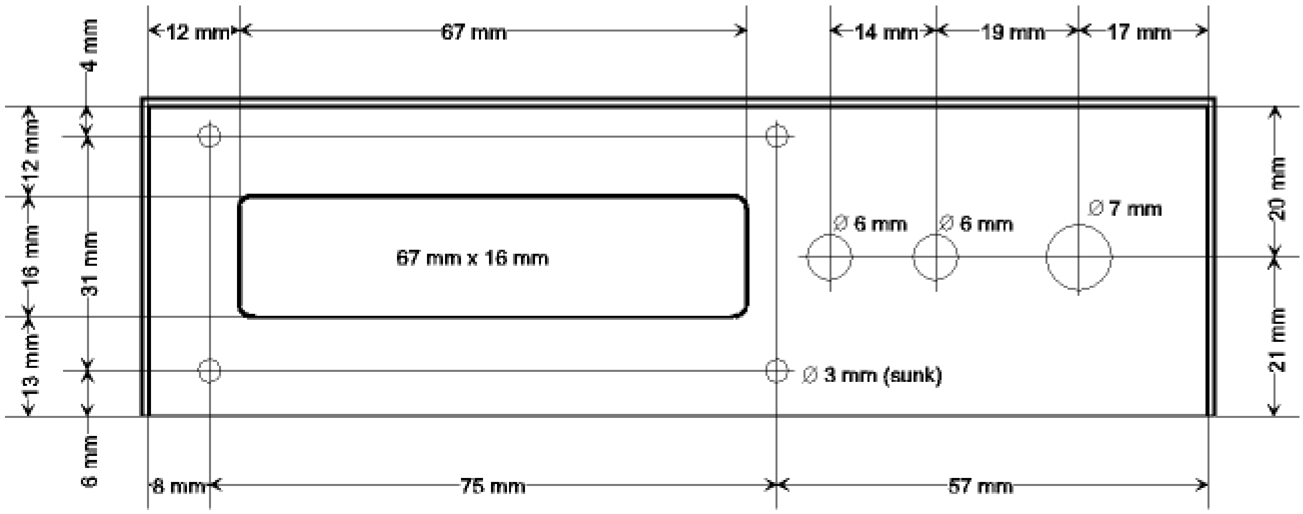

DDS & Display board for
JUMA-TX1 Transmitter
OH2NLT
Drawn
Appr.
18.08.2005
Rev. C 13.12.2005
OH2NLT
Jni
Page 1
DRAWING No.
16x1 LCD Module
AD9833
74HC74
78L05SMD
PIC16F819-I/P or PIC16F88-I/P
See text
Use socket for IC2
see assembly instructions
Select C2, C3 and C20 with XTAL spec
See text for tuning instructions
VFO select
Tone Out
Bar graph display
range 0-240mV
Power 6,5-14 VDC
LO Out
Encoder ground
+5V
Encoder A
Encoder B
Encoder Switch
TX signal
from TX board
Spare
Band Select
to TX Board
Ground

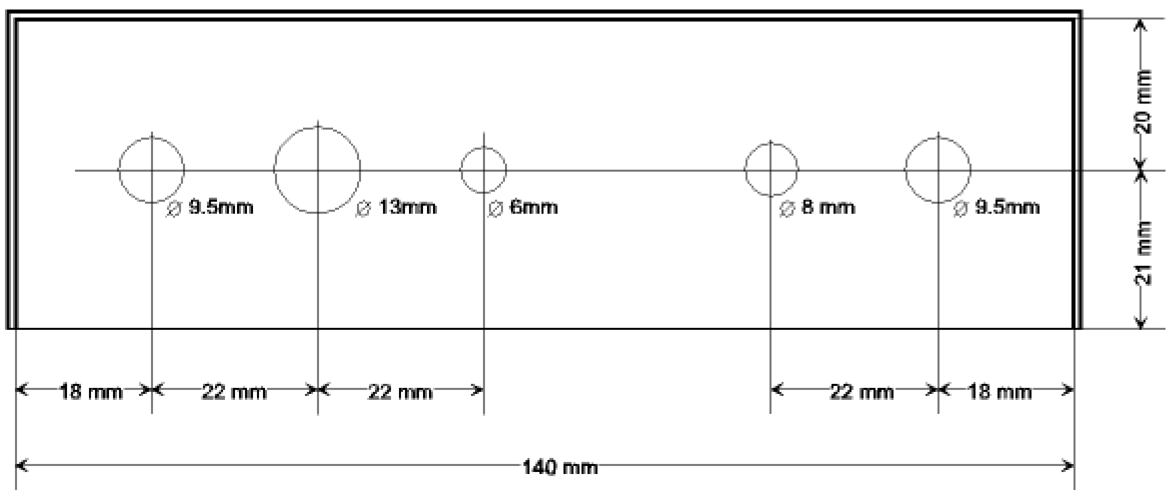

TRX1
R3 R6 R8 R10 R9 R7
R5
R4
R24
R18
C1
C21
C12
J1
R19 R25 R26
D1
IC3
IC4
C11
J11 J10 J9 J8 J7 J6
C13
IC2
C3
R14 R15 C4 R21 R20 R13 R2 R22 C14
L1
C8
L2
R23 R17 C22 C24 C18 C16
R12 R11
C10
IC1
C20
C15
C19
C17 C9 C6 C7
C5
OH2NLT
DDS Rev.C
LO
T
S
+
J4 R1 J5 J3 R16 J2
X1 C2


JUMA
TRX1
DDS
Rev.A 2005
OH2NLT
20.000
LO
S

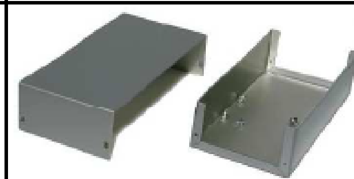
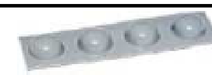
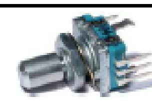
JUMA-TX1 DDS board components Rev. C 16.12.2005

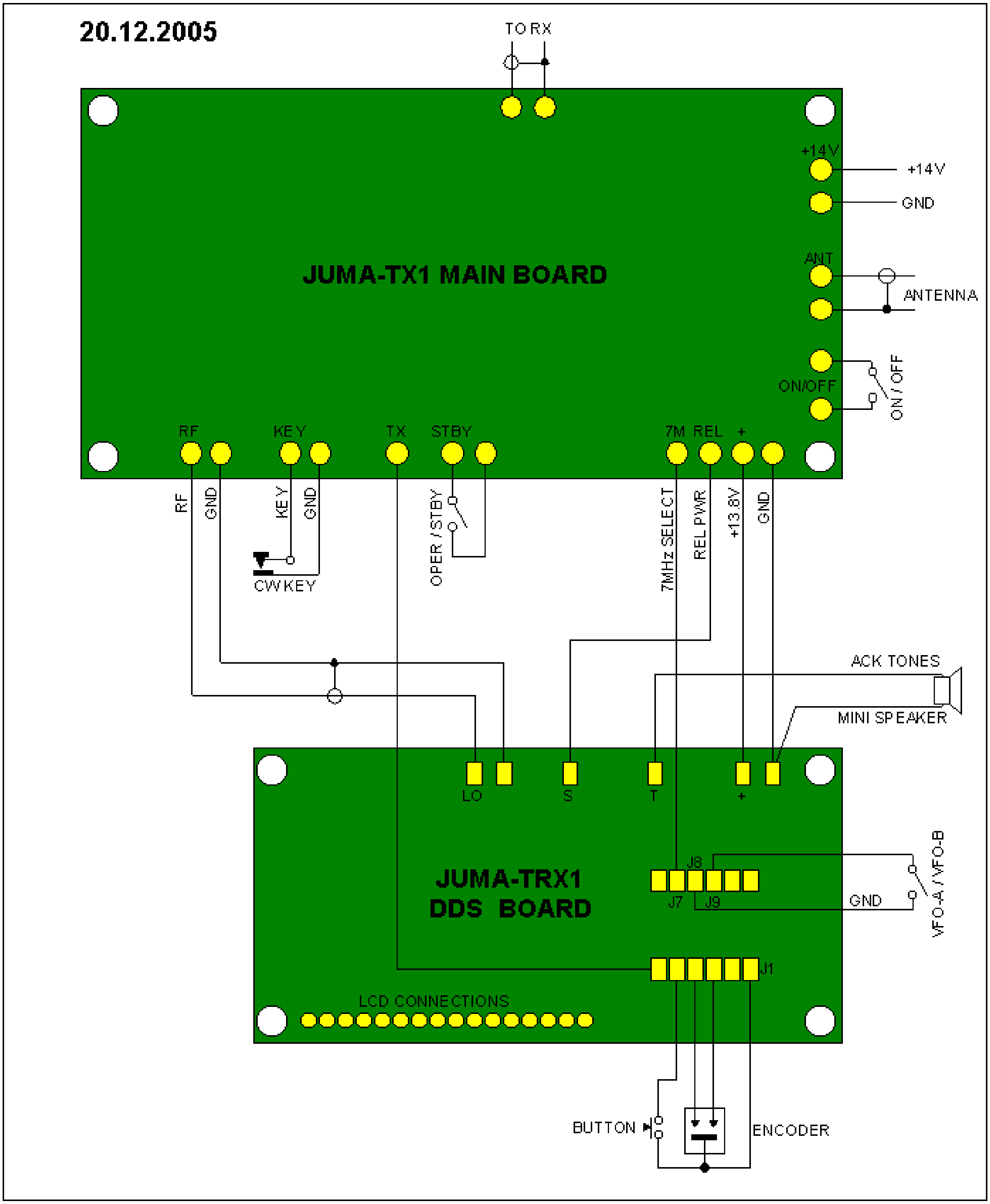
Part number	Description	Value / type	pcs	Note
R11	Resistor SMD size 1206	0R	1	Or jumper wire
R12, R13, R16, R18		200R	4	
R23		910R	1	
R14, R15		1k	2	R21 10k for Dual VFO mod
R2		1k8	1	LCD contrast adjust
R4, R5, R7, R9, R24, R26		2k2	6	
R3, R6, R8, R10, R19, R20, R21, R22, R25		10k	9	
R1, R17		15k	2	
C2, C3, C16	Cer capacitor SMD size 1206	22p	3	C2, C3 see schematics for XTAL frequency tuning instructions
C15		33p	1	
C17, C19		100p	2	
C18		180p	1	
C13		1n	1	
C7, C14		10n	2	
C1, C4, C5, C6, C8, C11, C12, C23		100n	8	
C9, C21, C22, C24	Tantalum Capacitor SMD	4u7/16V Case style B	4	Value range 4u7-10u. Can be replaced with a radial Tantalum.
C10		47u/16V Case style D	1	or elko 47u or 100u
C20	Trimmer Capacitor SMD	20 pF e.g. Murata TZC3P200A110B00	1	Can be replaced with a small radial trimmer
L1, L2	Inductor SMD Case size 1210 or 1812	4u7H	2	
X1	XTAL HC49	20MHz	1	or SMD case HC49/4HSMX
D1	Diode dual SMD SOT-23	BAV99	1	or similar SOT-23 Si-diode
IC1	DDS	AD9833BRM or AD9833BRMZ	1	Case marking DJB or D68
IC2	Microcontroller 18 pin DIP	PIC16F88-I/P	1	
IC3	Voltage regualator SMD	LM78L05ACM SO-8	1	
IC4	D-type Flip-Flop CMOS	74HC74 SO-14	1	
LCD1	LCD Display 1*16 character	TM161ABA6	1	or similar 8+8 char, one row
	IC socket	18-pin DIL 0,3" spring type	1	Bend and shorten the legs
-	PCB	JUMA-TRX1-dds PCB	1	


12 mm
67 mm
14 mm
19 mm
17 mm
4 mm
12 mm
16 mm
31 mm
13 mm
6 mm
67 mm x 16 mm
Ø 6 mm
Ø 6 mm
Ø 7 mm
Ø 3 mm (sunk)
20 mm
21 mm
8 mm
75 mm
57 mm


Ø 9.5mm
Ø 13mm
Ø 6mm
Ø 8 mm
Ø 9.5mm
20 mm
21 mm
18 mm
22 mm
22 mm
22 mm
18 mm
140 mm

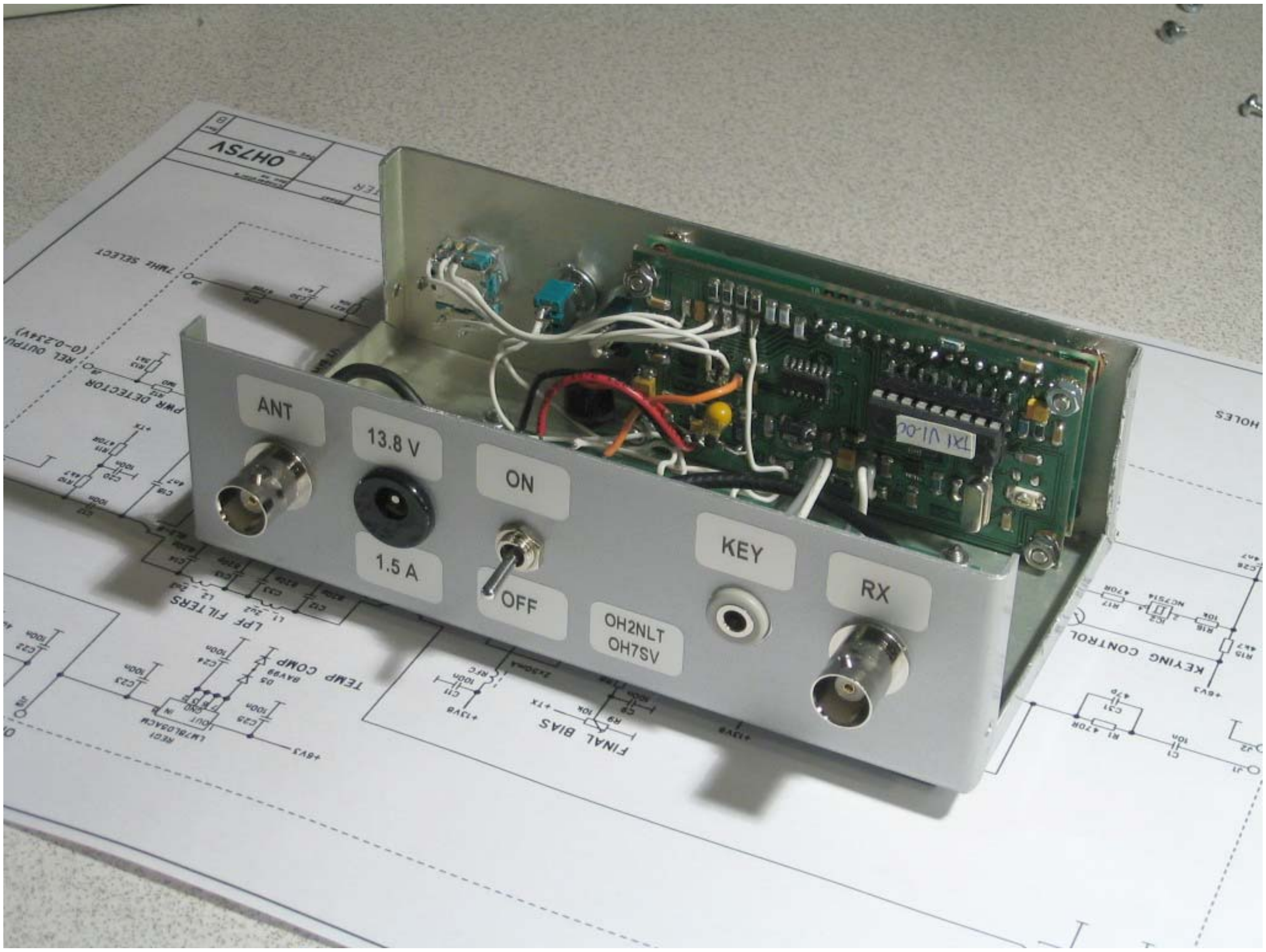
JUMA-TX1 Electromecahanics Rev C 20.12.2005

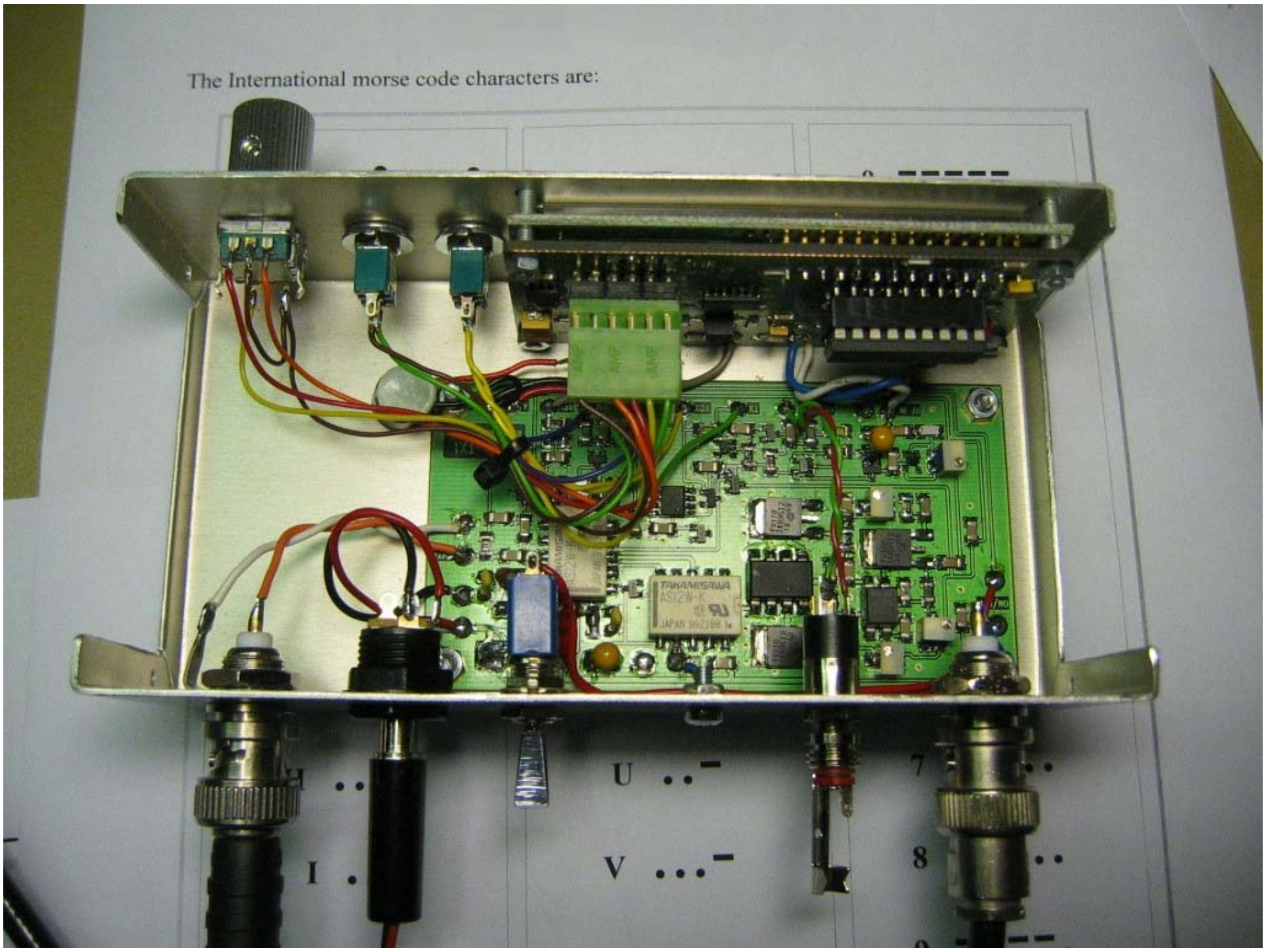
Description	Value / type		pcs	Note
Machine Screw. Phillips flat countersunk head	M2.5, length 18 mm	For DDS and LCD assembly	4	
Nut	M2.5	(16 pcs for LCD/DDS-spacing)	20	
Machine Screw. Phillips	M3, length 6 mm	For TX board assembly	4	
Nut	M3	For TX board assembly	4	
Auminium enclosure 44x72x140	Teko 4/B	www.teko.it	1	
Plastic equipment base	Self sticking		4	
Mini speaker	10...100 ohm, d approx 10 mm		1	
Rotary encoder	Piher CI-11CT-V1Y22-LFACF or equivalent	Farnell code 445-2446	1	
Knob	Plastic, for 6mm axle		1	
BNC socket bulkhead	BNC JR	Nut type with solder lug	2	
Jack socket	3.5 mm stereo	For CW key connection	1	
Switch	Mounting hole 6 mm		3	
DC socket	Chassis DC PWR 2.1MM PK10, pin 2.1 mm, nut fixing cut-out 12.5 mm	Mfg Schurter	1	

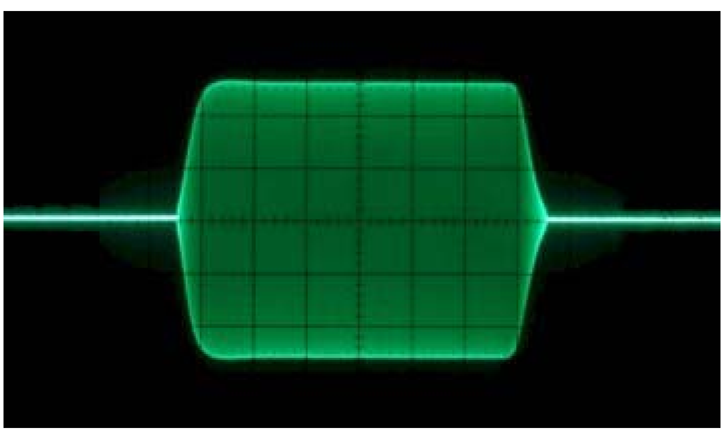


20.12.2005
TO RX
JUMA-TX1 MAIN BOARD
+14V
+14V
GND
ANT
ANTENNA
ON/OFF
ON / OFF
RF
KEY
TX
STBY
7M
REL
+
RF
GND
KEY
GND
CW KEY
OPER / STBY
7MHz SELECT
REL PWR
+13.8V
GND
ACK TONES
MINI SPEAKER
LO
S
T
+
JUMA-TRX1
DDS BOARD
J8
J7
J9
GND
VFO-A / VFO-B
J1
LCD CONNECTIONS
BUTTON
ENCODER


VFO-A
OPER
VFO
VFO-B
STBY
JUMA-TX1


ANT
13.8 V
1.5 A
ON
OFF
OH2NLT
OH7SV
KEY
RX
TX1 V1.0C
OH7SV
LPF FILTERS
TEMP COMP
FINAL BIAS
KEYING CONTROL
PWR DETECTOR





Juma Keying

CW sample

This CW sample is transmitted by OH7SV with JUMA-TX1 and the recording is made by OH2GWE with JUMA-RX1. http://www.nikkemedia.fi/juma-tx1/juma-tx1-cw.wav

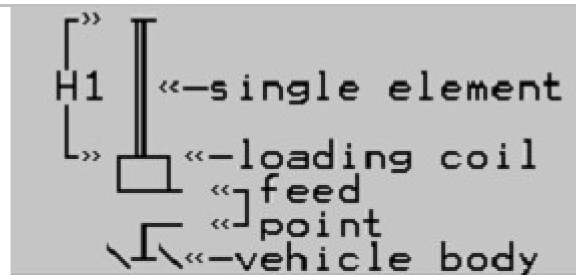
More JUMA-TX1 information can be found at http://www.nikkemedia.fi/juma-tx1/index.html.

AmQRP.ORG HOMEBREWER

George Murphy, VE3ERP

PIPEVERT

A QRP Vertical Antenna That Occupies Very Little Airspace Over Almost No Real Estate



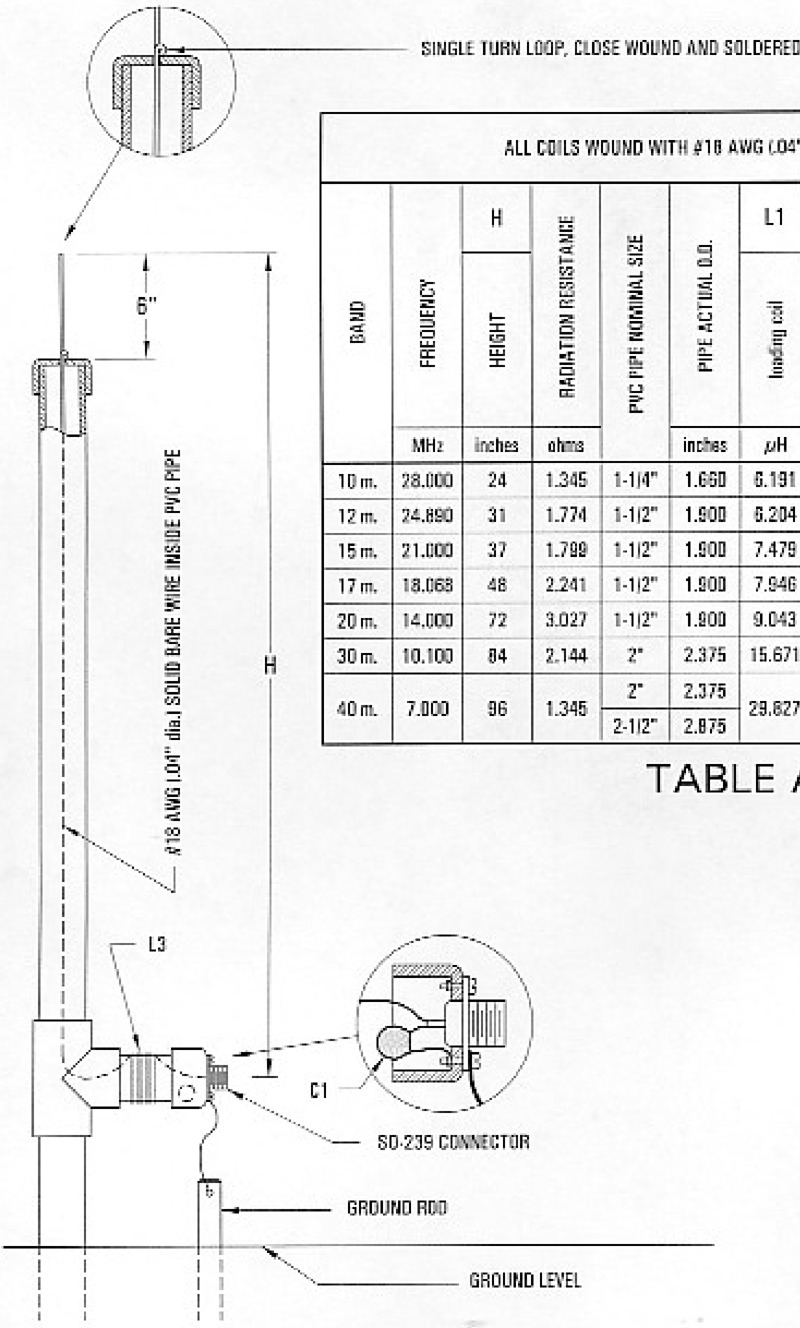
History

At one period in my chequered ham radio career I had no alternative other than to experiment with apartment house balcony antennas, and the frustrations of home brewing mobile whips and getting them to work have been gnawing at my innards ever since. Recently I was sitting in my house (which doesn't have a balcony) contemplating my misspent youth messing with large loading coils and floppy whips when an idea came to me - Why not investigate a solution to these problems and try to come up with a QRP version that, instead of a wispy whip sprouting from the top of a coil the size of a gallon paint can, uses the same size wire for both? At QRP power levels it is possible to have a high Q loading coil with small diameter wire wound on a piece of PVC pipe, and if you are going to buy a piece of pipe anyway, why not use some of it as a rigid container for a "whip" of the same skinny wire used for the loading coil? (0.04" diameter AWG 18 wire will safely carry effective radiated power outputs of up to 10 watts).

Concept

The result of my investigation is the Pipevert antenna (Fig. 1), suitable for installation alongside your house (performance will be improved if you can bury a few 1/4 wavelength radials radiating from the ground rod). But the Pipevert was primarily conceived as a balcony vertical without a ground rod, which is bit of a problem on a 17th floor apartment balcony. But not to worry - just lean out of a window near one end of the balcony and toss one end of a long wire to a friend on your balcony, who attaches it to one of the SO-239 connector mounting screws. Attach a weight to your end of the wire and let it drop out the window (you may have to explain what you are doing to the occupants who live at the level of the bottom of the wire)! Or, if your balcony railing is of welded steel construction, just use it as a ground.

PIPEVERT ANTENNA



ALL COILS WOUND WITH #18 AWG (.04" dia.) SOLID BARE WIRE

BAND	FREQUENCY (MHz)	H HEIGHT (inches)	RADIATION RESISTANCE (ohms)	PVC PIPE NOMINAL SIZE	PIPE ACTUAL O.D. (inches)	L1 loading coil (µH)	L2 impedance matching (µH)	L3 L1 + L2 (µH)	L3 length (mm)	L3 no. of turns	C1 impedance matching (pF)
10 m.	28.000	24	1.345	1-1/4"	1.660	6.191	0.046	6.239	22.9	12	680
12 m.	24.890	31	1.774	1-1/2"	1.900	6.204	0.053	6.257	24.1	11	680
15 m.	21.000	37	1.799	1-1/2"	1.900	7.479	0.071	7.550	23.5	12	750
17 m.	18.068	48	2.241	1-1/2"	1.900	7.946	0.091	8.037	26.1	13	820
20 m.	14.000	72	3.027	1-1/2"	1.900	9.043	0.136	9.179	28.9	14	910
30 m.	10.100	84	2.144	2"	2.375	15.671	0.160	15.831	31.8	16	1500
40 m.	7.000	96	1.345	2"	2.375	29.827	0.184	30.001	46.0	21	2700
				2-1/2"	2.875				50.0	25	

TABLE A

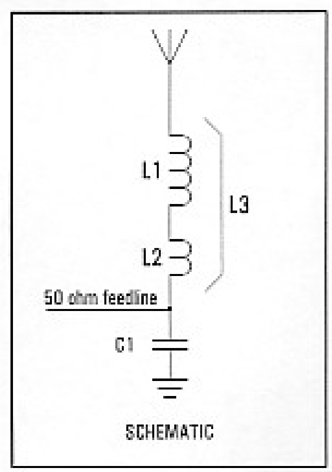


FIG. 1

Design Notes

The design uses equations that have appeared for years in several publications (e.g., The ARRL Antenna Book, 18th edition, pp.16-5 to 16-11 and p.16-18). I used the equations for a single element base loaded whip. The results of the ARRL equations for several typical Pipevert antennas are shown in Table A (there are two 40m. designs because the preferred 2-1/2" PVC pipe is not always available in small quantities). One major design option is the selection of a suitable whip length / loading coil / wire size combination. I found that for a Pipevert, a whip length of about 25 electrical degrees usually results in a PVC pipe size suitable for both the coil form and the rigid enclosure for a small diameter wire whip. For maximum coil Q (which base loaded whips need) the coil should have a length of about half its diameter, with spacing between turns equal to the wire diameter. All this sounds like some serious math is required, but you don't necessarily have to do it. HamCalc "Painless Math for Radio Amateurs" (version 83 or later) software can do it for you.

The HamCalc Approach

In this example we will design the 30m antenna shown in Table A. Run the "Mobile/Maritime Whip" program. When asked for your choice of measurement units select <i> for inches. Then when asked whether you want to design a (s)ingle or (d)ouble element whip, press <s>. When asked for frequency in MHz and wire size in inches enter (10.1) and then (.04). As soon as you make these entries a table of whip characteristics (Fig.2) immediately appears. Press <3> and enter (84). This brings up a brief summary of the design so far (Fig.3). Make a note of the radiation resistance (2.144) - you will need this value to design the matching circuit L2 and C1). Press <3> to continue, <n> to refuse the option to change length and <y> to launch the "Coil Designer" program.

Coil Design

There is only one coil, consisting of the loading coil L1 and the impedance matching coil L2 consecutively wound as a single coil L3. Designing L3 requires 4 steps:

Step 1. Determine value of L1.
Step 2. Determine value of L2.
Step 3. Determine value of L3.
Step 4. Proceed with the design of L3.

Step 1

In "Coil Designer" press <1> to start the program, then press <2> to select dimensions in inches. When asked for desired L/D ratio enter (0.5) and a menu appears asking for wire size. Press <c> and enter (18). A coil specification chart appears, showing the optimum coil form size and asking you to enter an available form size as near as possible to the optimum.

Choose a PVC pipe size (2.375) from the displayed list and enter it. A new coil specification chart for the form size you specified appears. When asked if you want to round off the number of turns, press <y>. The display changes to show the revised specification, and asks if you want to design another coil with the same inductance. Press <n>. This completes the coil design and a green option bar appears at the bottom of the screen. The loading coil inductance (15.671uH) is the value of L1 (make a note of L1 for use in step 3). You can then press <2> for a hard copy printout (Fig.4)or <3> to continue. When you press <3> the “Mobile Antenna Matching” program is launched.

Step 2
In “Mobile Antenna Matching” press <1> to start the program, and enter radiation resistance (2.144 from Fig. 3) at the feed point L1 (2.144 ohms) and the feedline impedance (50 ohms). The program calculates (Fig. 5) the matching network capacitance (1489pF) and inductance (0.160µH). These are the values of Pipevert’s C1 and L2 respectively (make a note the inductance for use in step 3). To finish press <3> in the green options bar at the bottom of the screen. Press <0> to finish, then <0> to close the program.

Step 3
L3 = L1 + L2 (15.671 + .016 = 15.831uH). Make a note of L3 for use in Step 4.

Step 4
This is similar to step 1, except the values entered are different. Run HamCalc’s “Coil Designer” program again. Press <1> to start the program, then press <2> to select dimensions in inches. For frequency enter (10.1) and for desired L/D ratio enter (0.5). For inductance enter L3 from step 3 (15.831). A menu appears asking for wire size. Press <c> and enter (18). A coil specification appears showing the optimum coil size and asking you to enter your choice of coil size. Enter the coil form size already selected in Step 1, Fig.4 (2.375). A new specification chart appears. Press <y) to round off number of turns, and <n> to exit. When the green option bar appears at the bottom of the screen press (3) to finish. A detailed description (Fig.6) appears telling you everything you need to know about Pipevert’s only coil.

As you can see, HamCalc can be used to design a Pipevert for any HF frequency in a few minutes.

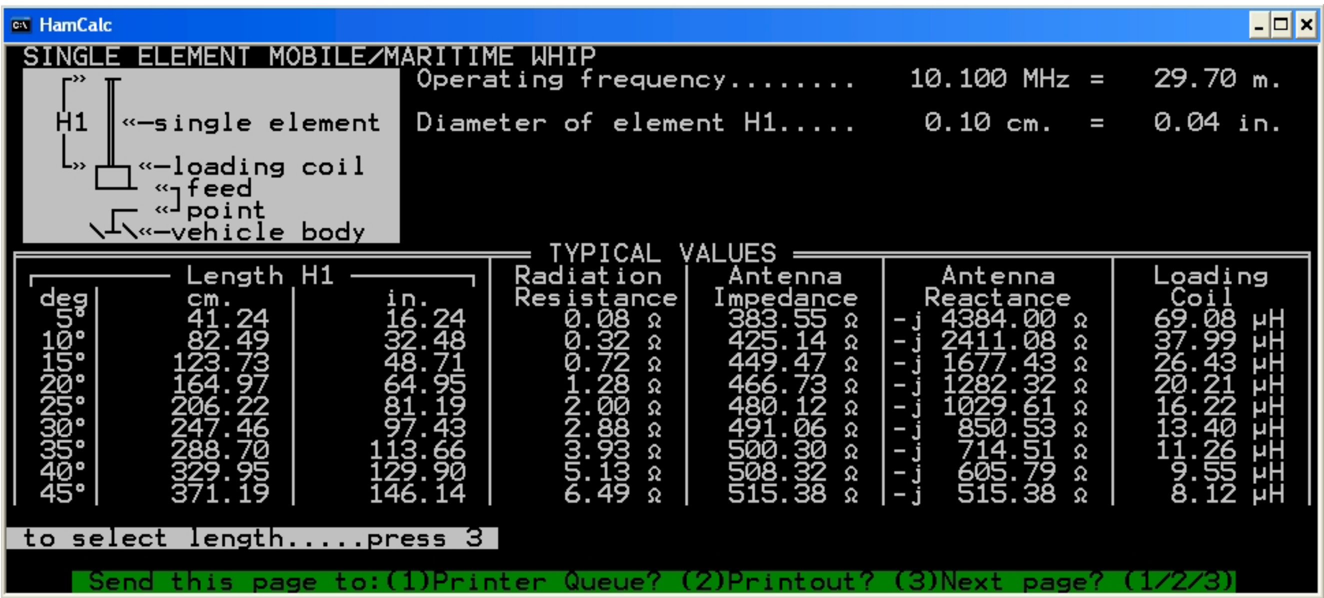
<u>Construction Notes</u>
The only fiddly part of the antenna is L3. Drill two 1/16" holes, spaced the length of L3 apart, in a short length of pipe (the coil form) as shown in Fig.1. Space the turns evenly (the space between turns is close to the diameter of the wire) leaving the ends projecting out both ends of the pipe. Secure the turns by coating them with shellac, enclosing them in heat shrink tubing, or preferably both. This is important because even a slight change in turn spacing, while not affecting the inductance, can appreciably lower the Q of the coil.

Mount a SO-239 connector either inside or outside (depending on the pipe size) a PVC pipe cap. Solder the coil outer end wire and one lead of C1 to the connector as shown in Fig.1, and secure the other lead of C1 under one of the mounting screws. Attach a #12 solid copper ground wire under exterior head of the same screw. You can then attach to cap to the coil form with PVC adhesive.

Assemble all the other pipe elements with PVC adhesive, drill a 1-16" hole in the top pipe cap and you are ready for final assembly. Make a close wound single turn loop in the top end of the radiator wire and solder it closed. Insert the bottom end of the wire through the hole in the top cap, and let it drop down to where you can fish it out the centre outlet of the PVC "T" fitting. Trim length as required and twist-join and solder it to the coil form inner end wire. Insert the coil form into the "T" carefully, taking care to keep the wiring from each and of the coil well separated. Secure the cap with PVC adhesive, caulk around the SO-239 fitting and the hole in the top cap with silicone adhesive and you are done!

Testing and Adjusting

The element length is purposely designed for minimum SWR at slightly lower than the design frequency, so you should be able to obtain resonance at the desired frequency by carefully pruning the wire projecting from the top cap. But DO NOT cut off the little loop or the wire will drop into a sealed PVC tunnel!



deg	Length H1 cm.	Length H1 in.	Radiation Resistance	Antenna Impedance	Antenna Reactance	Loading Coil
5°	41.24	16.24	0.08 Ω	383.55 Ω	-j 4384.00 Ω	69.08 µH
10°	82.49	32.48	0.32 Ω	425.14 Ω	-j 2411.08 Ω	37.99 µH
15°	123.73	48.71	0.72 Ω	449.47 Ω	-j 1677.43 Ω	26.43 µH
20°	164.97	64.95	1.28 Ω	466.73 Ω	-j 1282.32 Ω	20.21 µH
25°	206.22	81.19	2.00 Ω	480.12 Ω	-j 1029.61 Ω	16.22 µH
30°	247.46	97.43	2.88 Ω	491.06 Ω	-j 850.53 Ω	13.40 µH
35°	288.70	113.66	3.93 Ω	500.30 Ω	-j 714.51 Ω	11.26 µH
40°	329.95	129.90	5.13 Ω	508.32 Ω	-j 605.79 Ω	9.55 µH
45°	371.19	146.14	6.49 Ω	515.38 Ω	-j 515.38 Ω	8.12 µH

Figure 2

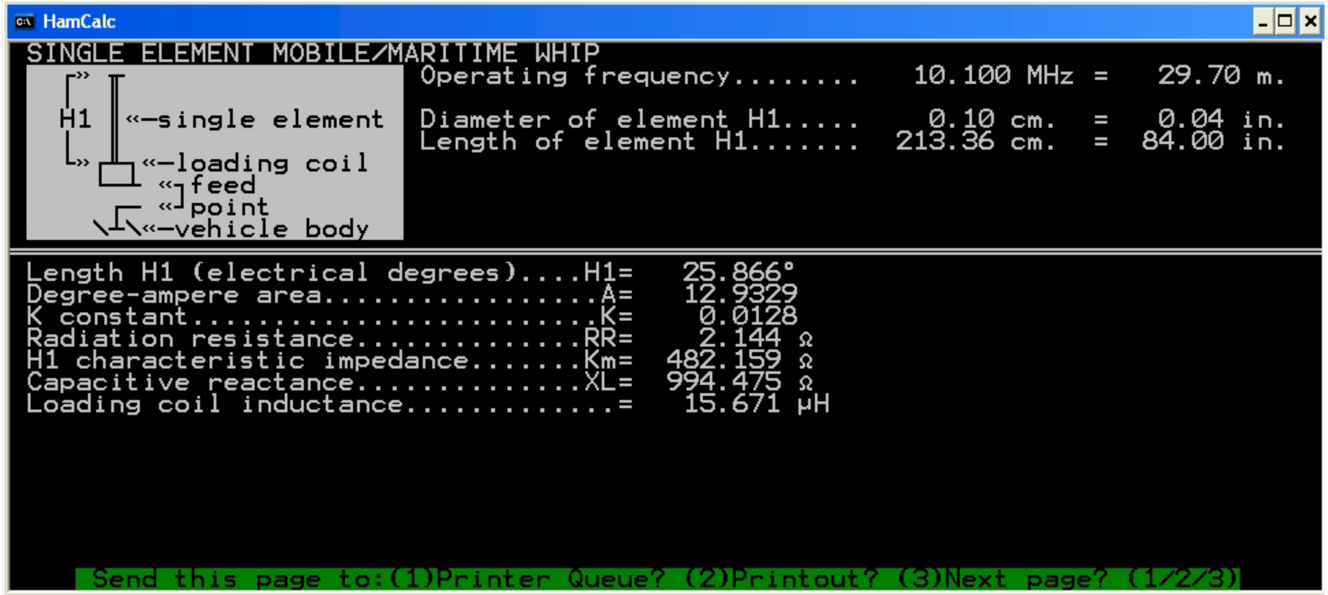


Figure 3

Figure 4

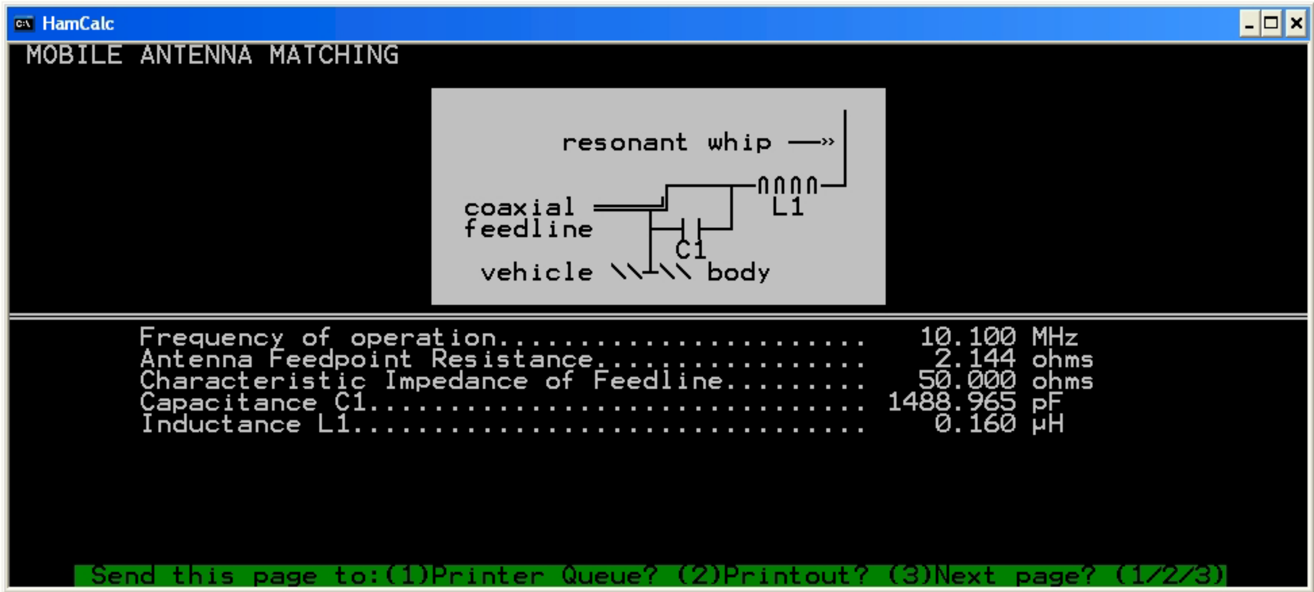


Figure 5

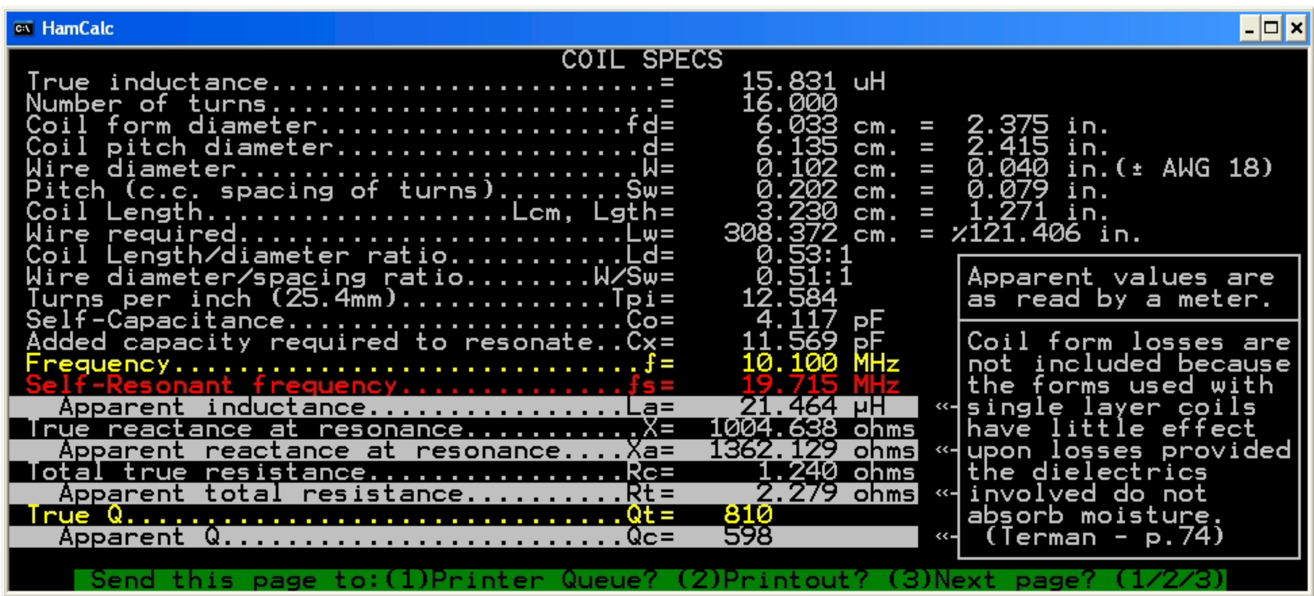


Figure 6

-30-
17 FEB 06

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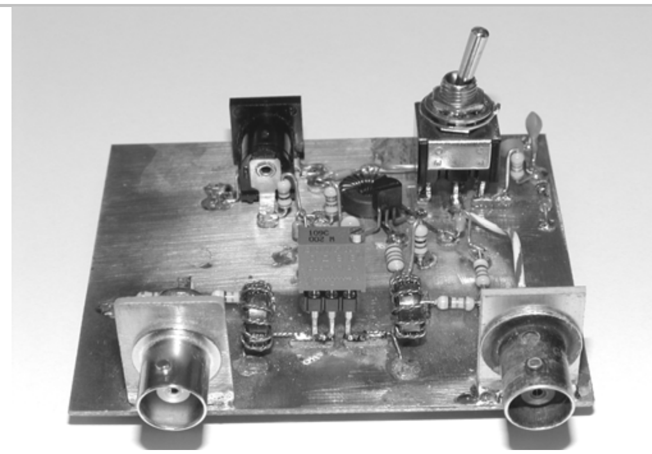
Orillia, ON L3V 6A6, Canada
e-mail ve3erp@rac.ca

Jim Kortge, K8IQY

Simplified Tools and Methods for Measuring Crystals

How to be "Crystal Clear" on your homebrew filter's performance…..



This paper describes an approach for measuring crystal parameters using relatively simple test apparatus and test setups. Some of the required test instruments are easily built, using Manhattan-style construction methods. Others can be obtained on the surplus market at low cost. With careful use, the resulting crystal parameter values are comparable in accuracy to those measured with instruments costing thousands of dollars. The same instruments and setup can also be used for measuring crystals for use in multi-pole filters.

Background

One of the common elements in all modern super heterodyne receivers is at least one crystal filter. A contest grade receiver may employ more than one filter for improved performance. One can obtain a crystal filter essentially two ways; either purchase a commercial unit on the required IF frequency or build the filter from easily obtained components.

Purchasing the filter requires little effort, but the cost is high, on the order of $150.00, and may be much more than this amount for a high performance filter. On the other hand, the components to build a filter will probably cost one-tenth of the commercial unit, but effort is required to build the filter. Most of that effort is embodied in determining the characteristics of the crystals that will be used. The remainder is in assembling and testing the constructed filter.

What are the benefits of building a filter? First, one can tailor the filter's characteristics to exactly those desired. For example, the filter could be built for CW use with a pass band of 350 Hz. Obtaining a commercial filter with that bandwidth is prohibitively expensive, since it is not a standard. Another reason for building our own filter is the ability to choose the number of elements needed to achieve the performance desired. If a 4-pole filter is needed, that's what is built. On the other hand, if a 7-pole filter is desired for enhanced performance, it too can be built with little additional effort. We can even build a filter with an adjustable pass band; try to find one of those commercially. Finally, by building our own filters, we have many more options available in deciding the RF mixing schemes used. With commercial filters, most of those decisions are dictated by the offerings of the various manufacturers, which are limited unless a custom filters is ordered.

Crystal Parameters

Before we can build a crystal filter, we have to know the properties of the crystals that will go into it. If the filter is built without that knowledge, two important deficiencies will occur. First, the filter will probably be far from optimum in performance. There will most likely be artifacts in the pass band amplitude and phase characteristics, and the insertion loss will not be minimized. Second, our ability to reproduce the filter, regardless of its performance, or lack of, will be compromised. A second unit built from the same kind of parts will most likely be markedly different in performance. Notice that I used the term "most likely" since by chance, one may end up with a good filter, with reproducible characteristics, without knowing anything about the crystal elements used. However, the probability of that actually happening is very, very small. The remainder of this paper will concentrate on the equipment and test setups required to ascertain this vital information

Crystals are characterized by the following parameters:

Fs = this is the series resonant frequency of the crystal, and represents the point where the series inductive and capacitive reactance terms cancel.

Rs = this term is the equivalent series resistance of the crystal at resonance (Fs), and represents the energy loss in the quartz element.

Lm = this term is the motional inductance of the crystal, and represents the vibrating mass of the quartz element.

Cm = this term is the motional capacitance of the crystal, and represents the elasticity of the quartz element

Co = this term is the holder capacitance of the crystal, and is the capacitance of the plated contact areas on the quartz element, the connecting lead wires, and the parasitic capacitance to the surrounding case.

Q = this term represents the overall energy loss in the crystal when it is being driven by an external source. It is equivalent to the Q of a capacitor or inductor.

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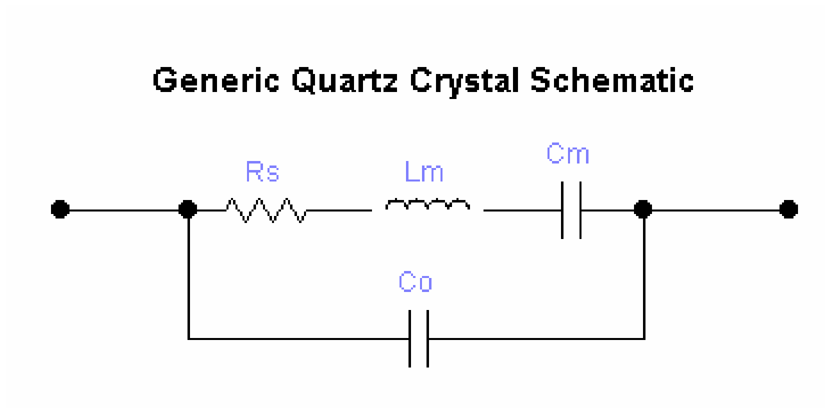
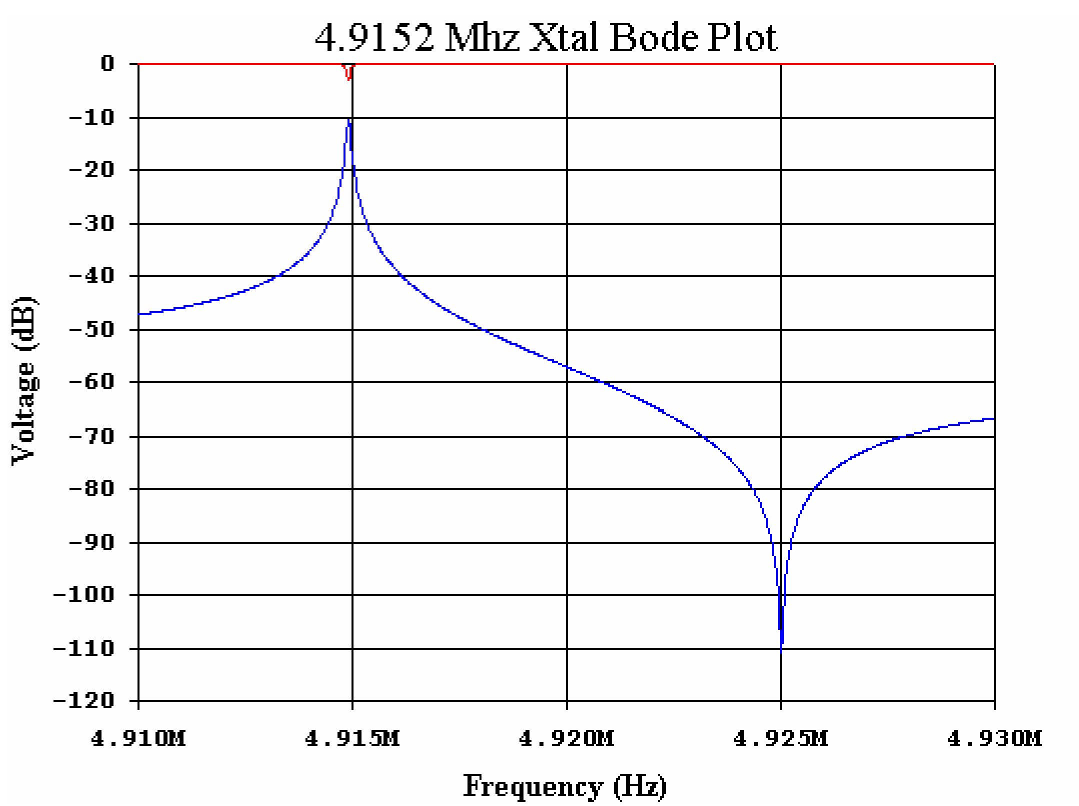


A typical electrical schematic for a crystal, with the various parameters identified

As can be seen, the basic structure is a series RLC circuit comprised of Rs, Lm, and Cm, with Co in parallel with the RLC elements. This might suggest that the crystal will behave differently depending on the frequency exciting it, and that's exactly what happens.



This is a frequency response, or Bode plot for a 4.9152 MHz crystal, typical of the crystal element used in the 2N2/40+ IF filter, or the IF filter in a K1 or K2.

As suggested, we see a very sharp response peak from the series RLC part of the circuit at nominally the frequency marked on the case. However, there is also a very deep null about 10 KHz higher in frequency, at the parallel resonance point. This is where the “series” motional capacitance is absorbed into the motional inductance, and the “parallel” holder capacitance term, Co now prevails. Notice that the difference in amplitude between the series resonant peak and the parallel resonant null is about 100 dB. This very large dynamic range makes it difficult to see or measure the parallel resonance of a crystal unless one has access to an instrument with a corresponding very wide dynamic range. A spectrum analyzer, or similar instrument is typically required to make this measurement.

Here are the parameters for this crystal:

Fs = 4.9152 MHz

Rs = 13.0 Ohms

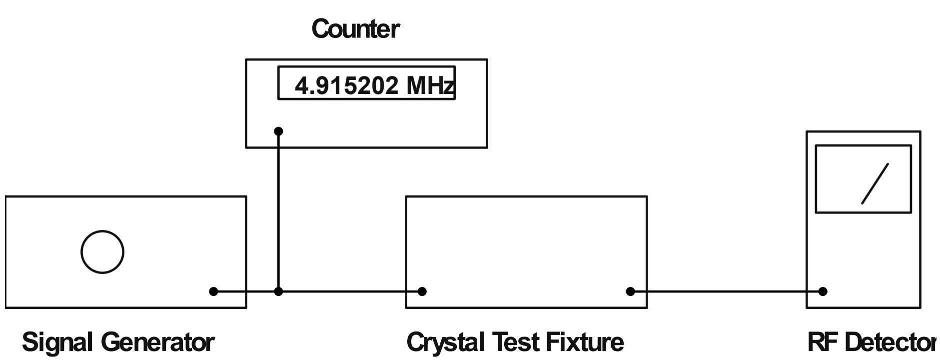
Lm = 0.070 Henry

Cm = 1.50E-14 Farad

Co = 3.64E-12 Farad

Q = 167,500

Crystal Parameter Measurements - Overview



A block diagram of the basic setup used to measure the crystal parameters.

This arrangement employs a signal generator with good short-term stability and precision, a counter to measure the signal generator frequency if the generator does not have its own readout, a fixture to hold the crystal under test, and a suitable RF detector.

Some details on each of the blocks in this diagram are appropriate. The signal generator can vary widely in terms of its capability. It can be a highly accurate, digitally synthesized, low phase noise, mega-dollar unit from Agilent or Rhode & Schwartz. It could be a lower cost, older unit from Racal, Fluke, or HP, such as an 8640B. Or it could be a very low cost, rather simple but highly stable, VXO based generator, built Manhattan-style that utilizes one of the crystals that will eventually be incorporated into a filter. We'll see details of this generator type later on.

The counter may or may not be needed, depending on the design of the generator. Whichever way it is implemented, it must be capable of resolving 1 Hz at the crystal's resonant frequency, and have good short term and long term stability. Almost any crystal base counter will suffice if the resolution requirement is met. The Arizona QRP Club's "Stinger Singer" would be suitable as a low cost choice. (Editors Note: The web site for the Arizona SCQRPions QRP Club is no longer available. Try http://www.azqrp.org/azqrp/)

A special crystal test fixture is required as part of this system. It must mechanically hold the crystal, and more importantly, provide appropriately conditioned signals to the crystal under test, and to the downstream detector. This element is also rather simple in design, and can be constructed Manhattan-style, using readily available parts. We'll see details of this test fixture later on too.

The final element in the system is some kind of RF detector. This could be something as simple as an RF probe, used with a digital voltmeter, or analog VOM. It could also take the form of a low bandwidth oscilloscope, with or without the RF probe used as a demodulator. My favorite is a HP 400EL AC voltmeter. These are available on the used equipment market, typically for under $50, and provide detection and an analog display in dB up to 10 MHz. A suitable alternative is a used HP 3400A. It has the same basic capabilities as the 400EL, but its primary scale is linear.

Of those crystal parameters shown earlier, only Fs, Rs, and Co are directly measured. The remaining are obtained by way of additional measurements, and a set of equations to compute them. Here are those equations:

Lm = (25+Rs/(2*PI*DeltaF) where DeltaF is the frequency difference between the –3 dB points on the response curve

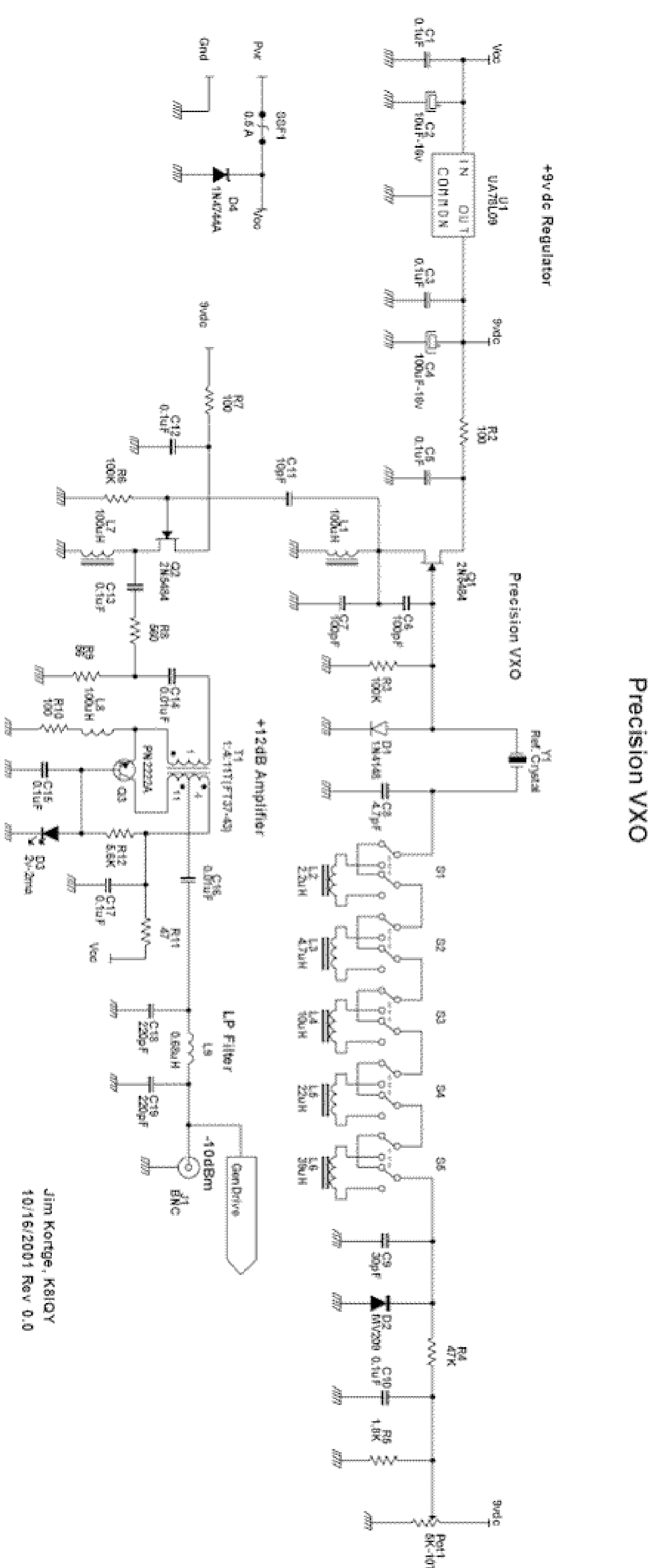
$Cm = 1/(4*PI^2*Fs^2*Lm)$

$Q = (2*PI*Fs*Lm)/Rs$

The actual crystal characterization is done a piece at a time, with the next parameter being derived from previous information in most cases. After we look at the details of the signal generator and crystal test fixture, we'll come back to these equations and see in detail how they are used.

Signal Generator Details – A Precision VXO

As was suggested earlier, one of the options for generating a stable signal for crystal testing is to use a VXO. The one that I am presenting fills the need for a precision, stable source, capable of providing measurement results comparable to those obtained with a high end, commercial signal generator. Over the past several years, I have suggested this approach to several experimenters, but am not aware that any actually tried it. I wasn't sure the idea was sound until a prototype was built, and several sets of crystals had been tested. The results using this generator were comparable to those obtained using my Racal-Dana 9087.


Precision VXO
+9vdc Regulator
Precision VXO
+12dB Amplifier
LP Filter
-10dBm
Gen Drive
Jim Kortge, K8IQY
10/16/2001 Rev 0.0

The schematic for this Precision VXO design

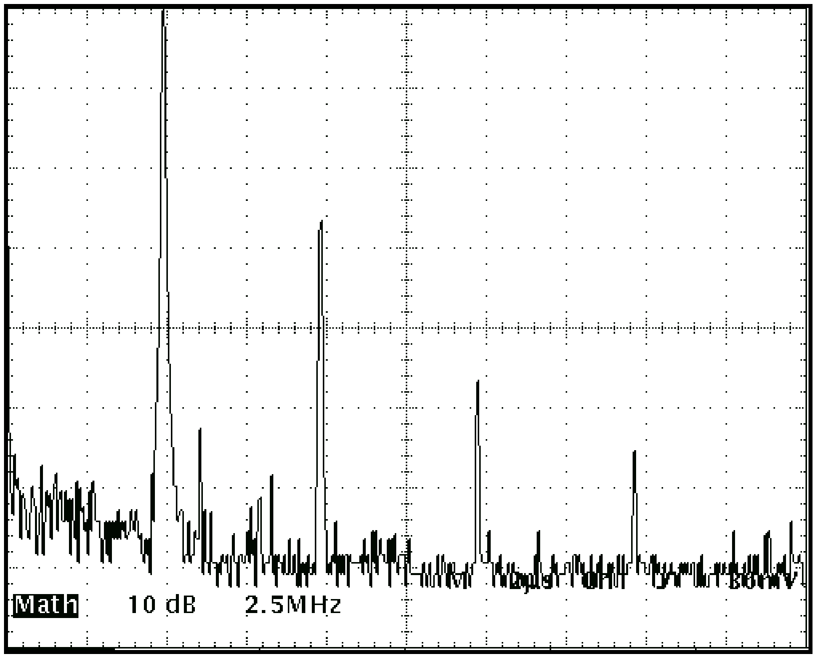
This generator consists of a Colpitts oscillator, Q1 using a 2N5484 junction FET. The crystal employed is one from the set, which will be used for building a filter or for LO service. Controlling the frequency of oscillation is accomplished with a varicap diode, a MV209, and a set of 5 molded inductors configured as a binary weighted set. Inductance needed to force the crystal to oscillate at its marked case frequency is experimentally determined by selecting the desired total inductance using switches S1 through S5. When no inductors are selected, the minimum inductance is that of the leads going to S1 and S5 in the actual prototype. Maximum inductance is obtained when all of the inductors are selected and are connected in series. The minimum inductance change is 2.2 uH, provided by S1.

With most crystals, the tuning range of the varicap diode can provide the overlap needed to make the digitally controlled inductance work smoothly. It can also provide sufficient frequency span so that the resonant frequency of a crystal under test can be determined.

Frequency precision is obtained by using a 10-turn potentiometer, and stability is achieved through the use of a regulated supply, and by minimizing the RF levels in the oscillator circuit.

A second 2N5484, Q2, is used as a source follower to further isolate the oscillator from any changes reflected back from the output load. The stage is also set up, by way of a voltage divider (R8 and R9), to provide an output impedance of 50 ohms. This impedance properly drives the fixed input impedance of the Norton amplifier used in the output stage. Both Q1 and Q2 are supplied with 9 volts from a regulator. Using a regulated supply helps maintain frequency and amplitude stability.

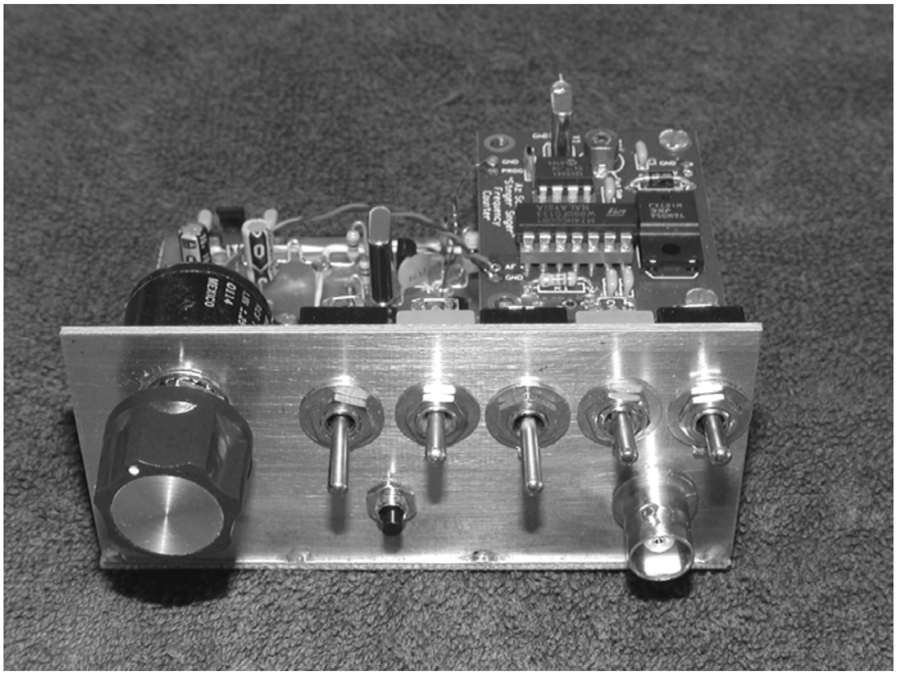
The output stage, a PN2222 (Q3) provides a gain of +12 dB and amplifies the generated signal to a level of approximately –10 dBm, suitable for driving a crystal in the crystal test fixture. This stage is a noiseless Norton amplifier design. Downstream of this amplifier is a low pass filter, to reduce harmonic content above 20 MHz.



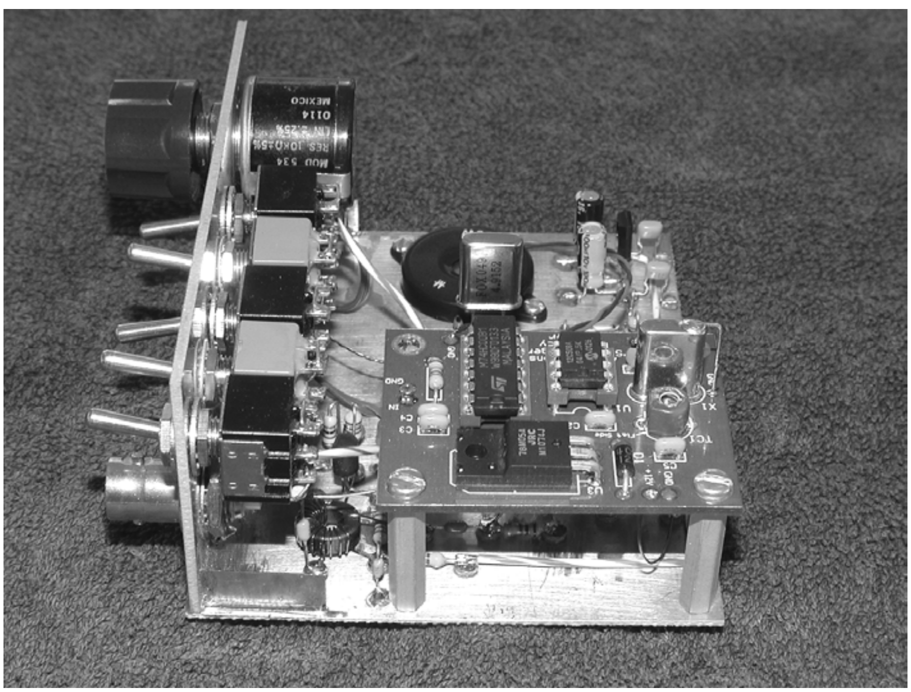
A spectrum plot of the output

Overall, this Precision VXO generator is designed to work with commonly available HC49, and HC49U style computer crystals used in IF filter service. It will operate with crystals in the frequency range of 3.5 through 13.5 MHz, but is optimized for crystals at 9 MHz and below.

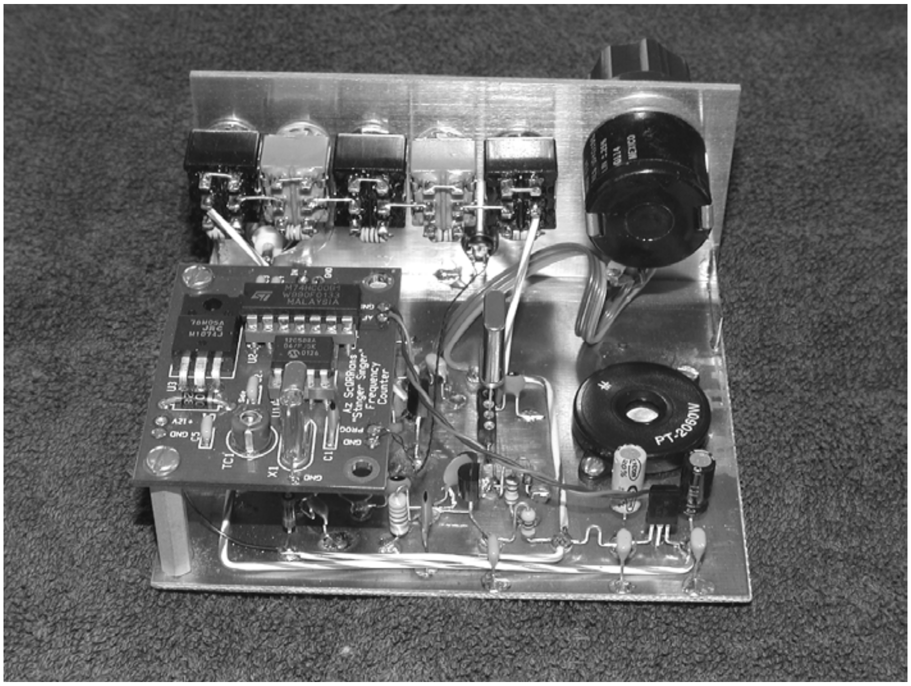
A prototype was built using Manhattan-style construction for the basic frequency generator portion. After finding out how well the generator worked, an Arizona ScQRPion Stinger Singer frequency readout was added.



Construction Detail - Front



Construction Detail - Side



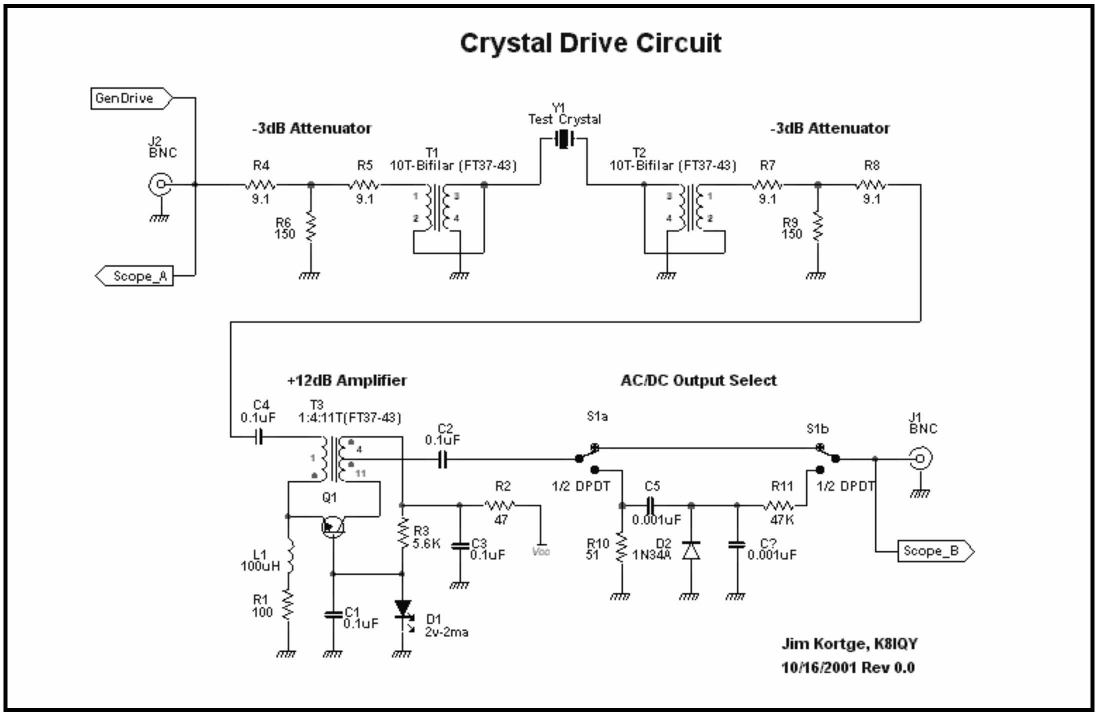
Construction Detail - Back

Besides having a clean output spectrum, this low cost generator also has excellent frequency stability. Its warm-up drift is a few Hz, and the stability over a 24-hour period is within 20 Hz. Short-term stability is not measurable with the equipment in my laboratory.

The tuning range with a 4.9152 MHz crystal is approximately plus and minus 250 Hz, more than adequate for covering the series resonant frequency of crystals being characterized, or matched. More importantly, with the wide range of inductance available, the oscillating frequency of the VXO crystal can be moved over a considerably wider range, assuring that one can find the series resonant frequency of a crystal under test.

Its overall size will allow it to fit nicely into a Ten Tec TP-17 case. That case is 1.75 X 4.25 X 3.5 inches in size.

<u>Crystal Test Fixture – A Crystal Drive Circuit</u>



The schematic for a Crystal Test Fixture.

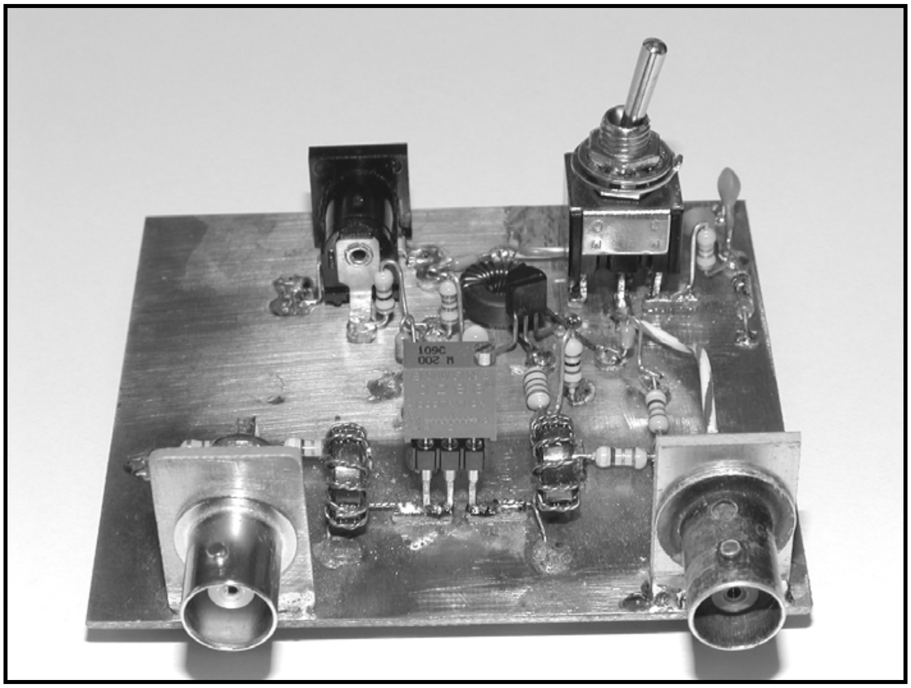
The driving signal from the generator is first attenuated by 3 dB before being applied to the crystal. Some attenuation is desirable to reduce the load variations the generator sees as the crystal is driven at various frequencies. As the attenuation is increased, the variations decrease. As in all designs, there are tradeoffs. If more attenuation is used, more generator power must be provided to achieve a drive level sufficiently large that we can accurately measure the crystal. The 3 dB value is a reasonable choice, but 6 dB would also work, and provide a bit more isolation.

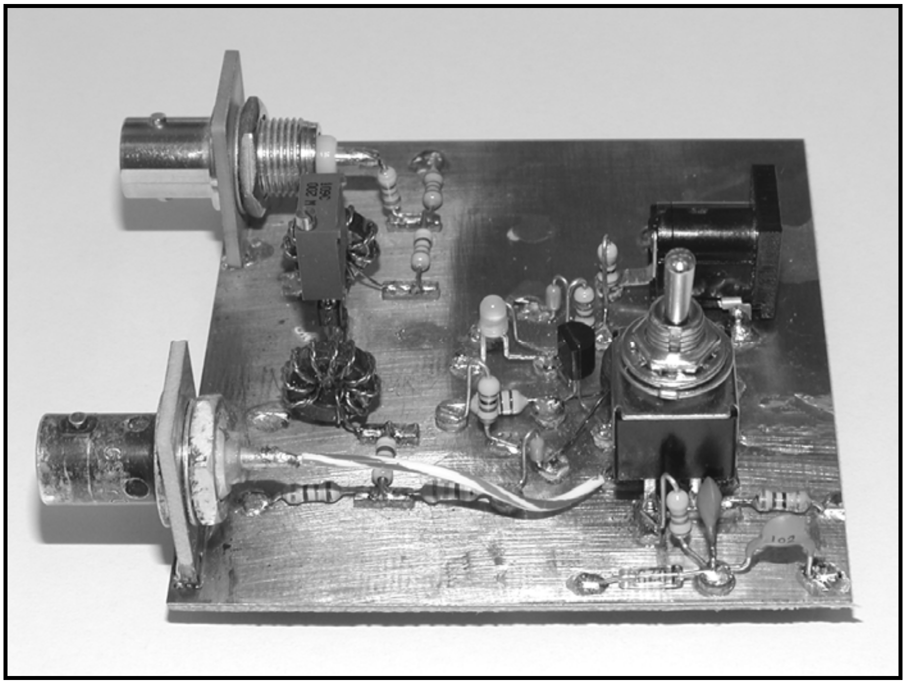
After the first attenuator, the drive is applied to a 4:1 step down transformer, T1. This transformer uses bifilar construction, and is wound with 10 turns. While wire size isn't critical, #28 or #30 are the preferred sizes for ease in winding. The output impedance of T1 is 12.5 ohms, which is a reasonable approximation to the Rs values for the crystals being tested.

The drive signal next passes through the crystal being tested, and on to another transformer, T2. This transformer is identical to T1, and is connected to provide an impedance step up back to 50 ohms. Another 3 dB attenuator follows T2, again, to help keep the 50-ohm impedance constant into the output amplifier, as the crystal impedance varies during testing.

The output amplifier, Q1, is a Norton configuration, identical to the output amplifier used in the Precision VXO. It uses a PN2222 transistor, provides 12 dB of gain, and has an output impedance of 50 ohms. The output signal is then routed to the output connector either directly, or through a built-in RF detector. With either output configuration, a 50-ohm load is provided to the output amplifier.

When the test crystal is replaced with a short circuit, the net gain of the test fixture itself is 6 dB. The test fixture, as designed, should be driven with a signal generator having an output impedance of 50 ohms. In like manner, the output should be connected to a detector with an input impedance of 50 ohms. When using the RF detector setting, an internal 50-ohm load is provided to the output amplifier.





The above figures show how this fixture was constructed.

Measuring Crystal Parameter - Details

Now that we have seen the details of the measuring system, let's go back and walk through the measurement of a crystal, and see how each of the parameters is obtained.

Once that is done, we'll also take a look at using the system for measuring a group of crystals for use in a crystal filter.

We start with perhaps the most important aspect of the process, getting the equipment ready to do the measuring. First, connect everything together, and make sure it follows the setup diagram. Next, and this is the important part, turn everything on, and let it warm up for at least 4 hours, longer if at all possible, and overnight if you can plan your measurement session that far ahead. The reason is that we are going to be making measurements down to one Hz out of several million, and temperature drift is our worst enemy.

Next, decide how many crystals will be tested, and get them out on the bench so they can warm up to ambient temperature also. You'll quickly find out how sensitive crystals are to temperature changes when you start doing these measurements. You can see the temperature drift induced by picking up a crystal and plugging it into the test fixture. Once plugged in, you can see it change again due to heating caused by the drive signal. And finally, you'll discover that crystals measured in one session will not be the same if measured again several hours later, the next day, or the next week. This caveat is especially important if you are only finding the resonant frequency of each unit for matching purposes. Do them all in one batch, or you will end up with confusing, inaccurate, and inconclusive results. I'd also suggest that at least 5 crystals be measured and that an average of each parameter be used as the characteristics for the batch.

OK, let's measure a crystal. We'll assume that all of the equipment is warmed up and stable.

Step 1
Put a crystal into the Precision VXO socket, if you are using that kind of signal generator. If not, skip this step. Adjust the Precision VXO tuning pot to the center of its range, that is, at 5 turns from one end. Remove all of the inductance by setting S1 through S5 to the bypass position. Measure the frequency of the VXO crystal. If it is above its case marked frequency, start adding inductance. Keep adding inductance until the measured frequency is below that marked on the case. Reconfigure the inductance switches a final time to make sure you are as close as you can get to the frequency marked on the crystal case. Above or below is acceptable, but below is preferred.

Step 2
Insert a crystal into the Crystal Test Fixture. Let it stabilize for at least a minute, maybe two. Start increasing the frequency of the generator being used, looking for a change in the detector signal level. If none is noted, increase the detector sensitivity until an increase or decrease is noted. If the signal is increasing with increasing frequency, keep going in that direction until a peak is found. If the signal is decreasing with increasing frequency, reverse the frequency direction, and find a peak. Vary the frequency back and forth through the peak several times until you are sure you've found the best peak you can get. Measure the frequency of the generator and write it down. Also, write down the reading shown on the detector, as we'll need this value later. The frequency we noted where the peak occurred is our first parameter, Fs, the resonant frequency of the crystal.

Step 3
Remove the crystal, and replace it with a 25-ohm, cermet, or other non-inductive trim potentiometer, and don't change the generator frequency setting. Adjust the trim potentiometer to the same reading that was recorded when the crystal was in the test fixture. Remove the trim potentiometer, and replace it with the crystal being characterized. Measure the trim potentiometer with a DMM, set on its lowest ohm scale. Be sure to compensate the reading for lead length errors if a non-zero reading occurs when the test leads are shorted together. Record this resistance value. This is our second parameter, Rs, the equivalent series resistance of the crystal.

Step 4
Readjust the signal generator to assure it is still set on the resonance peak of the crystal under test. Record the detector setting. Adjust the signal generator higher in frequency until

the detector setting decreases by 3 dB, or 0.707 times its peak reading. Record the generator frequency of this point. In a like manner, retune the signal generator lower in frequency until the resonance peak is passed, and the detector is again lower by 3 dB, or 0.707 times the peak reading. Record this generator frequency. Subtract the lower reading from the higher, and record the difference. This is the DeltaF term in the Lm equation. For those who are curious about the Lm equation, the “25” constant in the numerator is the sum of the impedances driving the crystal, in our example test fixture, 2 times 12.5 ohms, or 25 ohms total. Plug the Rs and DeltaF values into the Lm equation and do the math. The numerical result is our third parameter, Lm, the motional inductance of the crystal.

Step 5
We’re done with the measurements on this first crystal, so replace it with another crystal in the test fixture, and return the signal generator frequency control to the 5-turn position.

This will allow the next crystal to stabilize while we complete the remaining calculations. Continuing on, plug in the Fs and just computed Lm values into the Cm equation, and turn the crank. The resulting value is our fourth parameter, Cm, the motional capacitance of the crystal.

Step 6
After removing the crystal from the test fixture, plug it in to whatever apparatus you have for measuring low capacitance values. My preferred instrument is an AADE L/C Meter. However, companies such as B & K Instruments also make an L/C meter. There are other choices too, including using an MFJ 274B Antenna Analyzer or the RF-1 antenna analyzer made by Autek Research. If an instrument is not available, use a value of 3.5 pF as the estimated Co for HC-49 style crystals in the 3.5 to 9 MHz range. This measurement or estimate yields the fifth parameter, Co, the holder capacitance.

Step 7
Almost done, plug in the Fs, Rs, and Lm values into the equation for Q, and do the math. The result is our sixth, and last parameter, Q, the Q of the crystal. The higher the Q value, the better the crystal will be for use as a filter. The higher the Q, the lower the insertion loss. Values above 150,000 are really good, those above 100,000 are more than adequate, and those above 50,000 are useable, but the filters will be about as lossy as can be tolerated.

Step 8
Measure at least another 4 more crystals using the previous steps. Compute the average value for each of the parameters and record these in your logbook along with other relevant information, such as manufacturer, measurement date, etc. As you accumulate crystals, and measurement information, these records become very important in deciding who makes good crystals for filters, and who does not. There is much variation among manufacturers.

Matching Crystals for Filter Elements

Now that we know the characteristics of a batch of crystals from the previous steps, using the test setup for matching crystals for filter use is a natural extension. It's really quite simple. The basic process is this: Insert a crystal in the test fixture. Let it "soak" for a fixed time period. A minute is suggested as the minimum. Adjust the signal generator for a peak reading on the output detector. Write the last 4 digits of the frequency readout on the crystal with an indelible marker. Put another crystal in the test fixture, and repeat the process until all of them are done. As you are measuring your batch, look for crystals that show excessive drift, or which result in very low readings on the output detector. Mark these with an "X", and don't use them in your filter. Those that tend to drift will result in a less than optimal filter, and those producing low detector outputs have abnormally high equivalent series resistance values. Using those in a filter will raise its insertion loss, sometimes by a significant amount. All of these rejects will work fine as Local Oscillator crystals, so don't throw them away, just don't use them in a filter.

Once all of the crystals are measured, select the set that has the tightest frequency grouping for use in your filter. With a group of 20 or more crystals, sets of 4 or more are often within a range of 20-25 Hz. The "rule of thumb" is to have the crystals matched within 10% of the filters bandwidth. So for a 500 Hz filter, the crystals should all be within a span of 50 Hz, quite easy to do with crystals from a known source.

Final Comments

I hope you have found the information within to be enlightening and more importantly, useful. Measuring crystal parameters can be done accurately, with relatively simple equipment if you don't mind building some of it. Matching crystals is also easy to accomplish when using the equipment and methods shown. Your efforts can result in home-built filters that are remarkably good and very inexpensive compared to commercial units.

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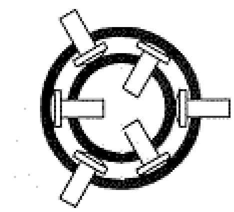
AmQRP.ORG HOMEBREWER

George Murphy, VE3ERP

TROMBONE CAPACITORS



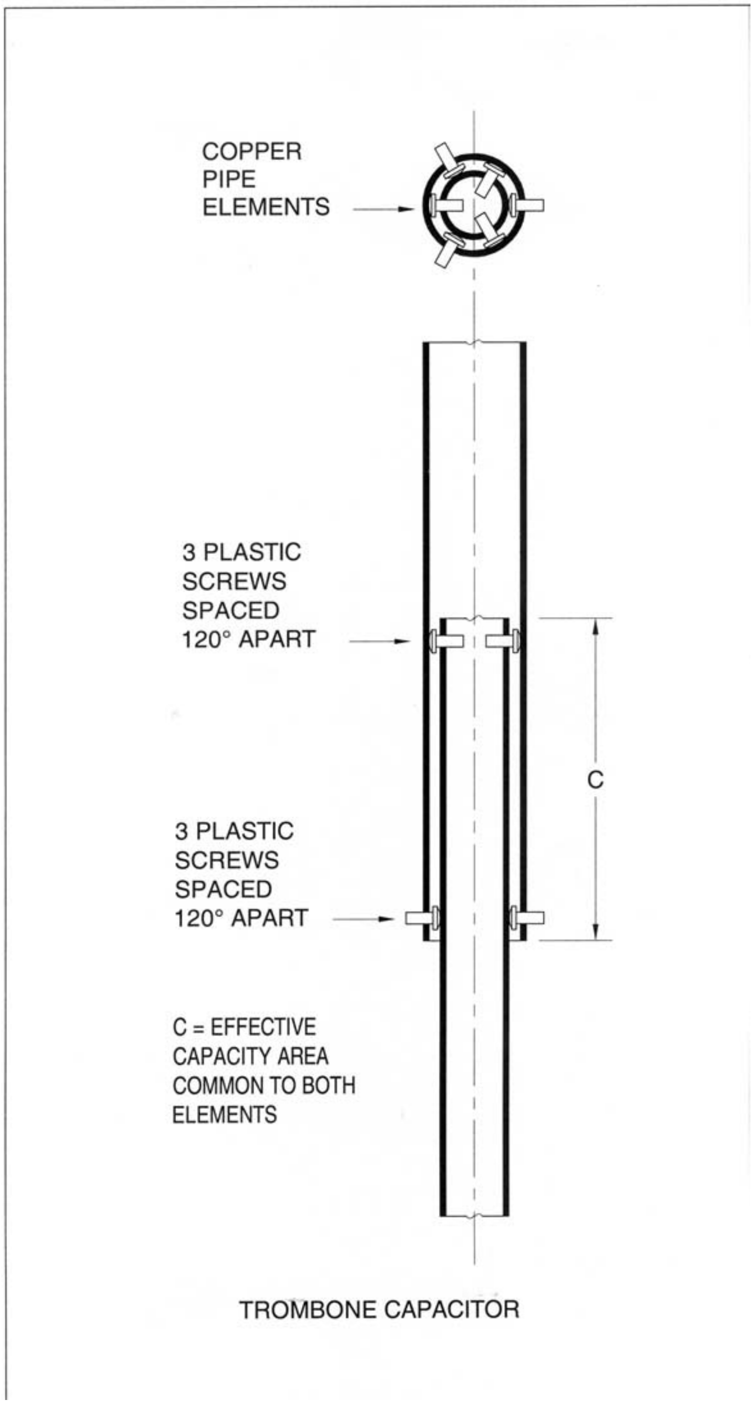
Whenever there has been a need for an expensive (and hard to find) oddball capacity, high voltage, variable capacitor, radio amateurs for many years have home brewed trombone capacitors. The principle is simple - one metal tube sliding inside, but not touching, another. While the principal is simple, there are mechanical problems, one of which is maintaining alignment of the tubes and preserving a constant space between them. Whatever material is used to fill this space is the capacitor's dielectric and the best dielectric is air. Anything else (e.g. layers of tape or plastic wrap, etc.) Can degrade the capacitor. The design shown on the accompanying drawing solves these problems.

Construction Details

Common type L copper pipe is a good choice for the elements, and Nylon or Teflon machine screws for the spacers. Drill and tap the elements as required for the machine screws. Use screws with a head thickness to suit the airspace. If necessary you can file down the screw heads to obtain a proper fit (in QRP versions the head may end up a mere thin flange). You don't have to worry about the screws working themselves loose, because they are trapped and it is impossible for them to fall out! But as insurance against slight misalignment it is a good idea to apply some epoxy glue to the projecting threads. Mounting, electrical connections and actuation of the movable element are left to the builder's ingenuity.

Design

For complete design data run HamCalc's "Capacitors, Telescoping Variable" program. As an example, suppose you want a 200pF, 300 volt variable capacitor. Run the program and press i to calculate dimensions in inches. When asked for voltage, enter 300. Make a note that the air gap must be at least 0.14 inches the press any key to continue. From the menu that comes up press 3 to select type L hard copper pipe sizes. In the table that appears you will see that option (d) has air gap and voltage ratings that fit your needs so press d. In the display that appears press 1 and enter the capacity 200. The design specs are displayed, indicating a 5/8" pipe (.750" O.D) inner element and a 3/4" pipe (.785" O.D.) outer element, with a capacity of 200 pF when they overlap about 6-1/2", and a breakdown voltage of 368 volts.



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Part 2

The Handyman's Guide to – HOMEBREW CONSTRUCTION PRACTICES
Surface Mount — Manhattan Style

*In **Homebrewer #6**, Part 1 looked at techniques for "building from scratch," based largely on thru-hole components and building circuits "ugly" to Manhattan style of construction.*

*Part 2 focuses primarily on techniques for homebrewing with **surface mount components** (SMC), for which the least amount of documentation exists. Unlike thru-hole components, SMC is not well suited for ugly-style of construction. A variation of Manhattan style is shown that makes building from scratch using SMC a viable approach. Even if you build an SMC circuit from a kit, you might find some of the following information useful.*

1. A Quick Review . . .

MANHATTAN STYLE . . . What is it?

Simply put, ***Manhattan Style*** of construction uses small pieces of copper clad (the "pads") glued to a main copper clad circuit board (the "substrate") that serve as component mounting platforms. The electronic components are then mounted and soldered onto these pads. The main "substrate" board serves as the ground plane. Not only is this technique an easy and neat way to build a circuit, it also produces a very quiet circuit due to the solid ground plane.

Making the "pads." One popular and easy method for making the pads is using a ***nibbling tool*** to *nibble* out small pieces of copper clad from a larger piece, as shown in **Fig. 1**. Others use round pads from a punch or cut the pads out of the main board with a Dremel tool and a small cutting disc.

Building the circuit. The pads are then glued onto the main board for mounting the components. Super glue is usually used for affixing the pads to the main board. The pads are positioned more-or-less in circuit order, similar to laying out a printed circuit board (PCB). A little forethought of layout goes a long ways. After the layout is decided, it is best to "build as you go along" ... that is, glue down a few pads, solder the components, then move to the next few pads, to keep from working yourself into a corner or running out of room.

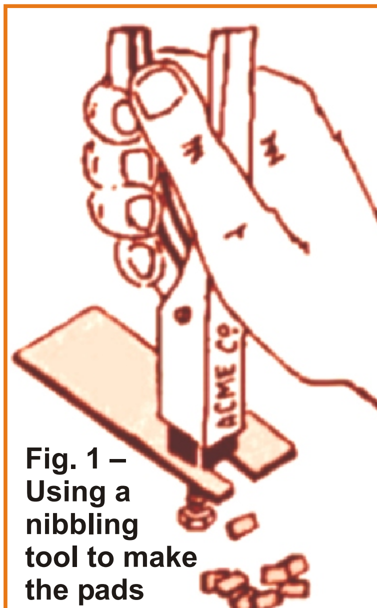


Fig. 1 – Using a nibbling tool to make the pads

FIG. 2 – The famous "Iowa 10," a 10M QRP rig designed and built by Mike Fitzgibbon, NØMF. It is an excellent example of building a rig from scratch using thru-hole components and Manhattan Style of construction. Note the use of "vertical" boards - one contains the VFO and receiver, the 2nd board the transmitter circuitry.

2. Techniques for Surface Mount Components (SMC)

With thru-hole components, there is great flexibility in how one builds a circuit. With surface mount, there are few options. Using printed circuit boards intended for prototyping SMC circuits are expensive. Trying to build "ugly" or "dead bug" is nearly impractical. It turns out, Manhattan style can be a nice way to prototype or build circuits using SMCs.

For SMC MANHATTAN CONSTRUCTION, I recommend using the thinner .031" thick copper clad for the pads. The main board "substrate" can be either .031" or .062" as desired.

With thru-hole parts, you have long leads to fit components between the pads. With SMC, you don't have this luxury. The small SMC parts must be mounted between two very closely spaced pads, requiring a host of jumpers or hookup wires to connect to the other component pads in the circuit. This additional interconnecting wiring gets very tedious (and ugly).

Therefore, in addition to using the .031" copper clad for the ***pads***, ***I recommend using the .031" for forming circuit strips*** as shown in **Fig. 3**. The strips can be cut on a PCB shear, paper cutter, or with scissors. They should be cut to about the width of a nibbled pad (0.065"), or other widths as desired. When cutting the strips with scissors, they will have a tendency to "curl." However, they are easily straightened.

The strips are used for interconnecting the circuits by cutting to length, and positioning as if forming traces on a PCB. **Fig 4**. shows the strip technique for mounting several MiniCircuit SMC devices, including an ADE-35MH, identical to the ADE-1 mixer, and an ERA amplifier, both used in many QRP circuits. The SMC caps and resistors are size 0805.

I have developed this technique from building numerous surface mount "Manhattan" circuits, both at home (QRP) and at work over the past couple of years. The combination of using .031" copper clad and the strips works quite well ... *up to around 1GHz* ... a technique I'll refer to as ***Manhattan-031***.

TOOLS TO USE

Fig. 5 shows the tools you should have for surface mount construction. **Tweezers** are used for positioning the smaller components (such as 1206 or 0805 sized resistors) into place. **Hemostats** are often easier to manipulate than small pliers for positioning and holding odd shaped components (such as SOT-23 packages or round components). A small **screw driver** can be used as a hold-down device, particularly for gluing the pads, islands or strips into place. **Q-tip** shafts can also be used as a hold-down device – and the cotton swab end for cleaning. Q-tips with the soft paper or plastic shafts do not work as well as those with the wooden shafts.

Fig. 3 – The basics for *Manhattan-031*. Strips of .031 copper clad are cut into narrow strips with a PCB shear or regular scissors; pads were made with a nibbling tool; super glue is used to affix the pads and strips to the main copper clad board.

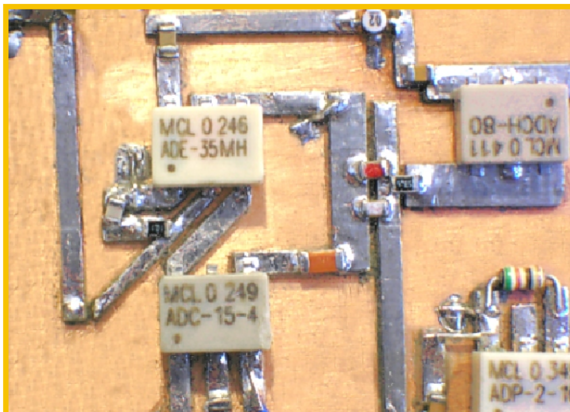


Fig. 4 –The strips form "traces" similar to a PCB for orderly mounting of the SM components. Often, diagonal runs will be more convenient, as shown here.

Fig. 5 – Tools of the trade: hemostats, tweezers, small screw driver and Q-tips.

SOLDERING ("PICK AND PLACE" METHOD)

Soldering surface mount components to the pads is relatively easy. The various exotic schemes of building hold-down devices and jigs is not necessary and actually quite time consuming to use.

Fig. 6 illustrates the simple steps of soldering a surface mount component, such as a 1206/0805 resistor or capacitor. Lightly solder *one* of the pads. Position the component into place with tweezers and hold in place. Heat the pre-soldered pad until the *solder flows onto the component*. It does not have to be a good solder joint at this point – just enough to hold the component in place. Remove the tweezers or hold-down device and solder the remaining pad. This should be a good, proper solder joint, though be frugal with the solder (no big blobs or excessive heat). Return to the first pad and apply a bit more solder if required. It is helpful to perform this assembly and soldering with plenty of light and under some sort of magnifying lens (particularly if you are older than say, 50!).

Do not make contact with the component when soldering – heat only the pad and solder, letting it "flow" to the component.

Do not pre-solder both pads. This will cause the component to mount at an angle, or noticeable tilt. When soldering the second pad, there is a tendency to push down on the component with the hold-down device or soldering iron to make it lay flat between the two pads. With the first pad already soldered and cold, applying pressure to make the part lay flat can crack or break the component.

With a little practice, this "pick and place" method becomes quite easy and quick. It's how the professionals do it.

THE SOLDERING IRON and SOLDERING TEMPERATURE

The soldering iron should have a fairly sharp tip (See **Fig. 6–2**). Keep it clean and well tinned. SM components should not be exposed to excessive heat, both in terms of temperature (>800°F) or duration (>5 seconds) of direct heating. *Temperatures in the **500°–600°F (260°C–320°C)** range are recommended*. Below 500°F, it takes longer to melt the solder, heating the SMC part longer than 5 seconds. Above 800°F can damage the part, plus, all the flux is boiled off, leaving a dull solder finish. Note that these temperatures are those recommended by the manufacturers of the standard 60/40 solder, as shown in **Fig. 7**.

"But, I don't know what temperature my soldering iron is at!" If your soldering iron takes several seconds to melt the solder and it dries in a lumpy, dull finish, it is not hot enough (<500°F). If it quickly melts the solder, but dries in a dull finish, it is running too hot (>700°F). If the solder quickly melts, flows rather smoothly, and cools with a "shine," the temperature is correct.

Fig. 6 – How to solder surface mount parts.

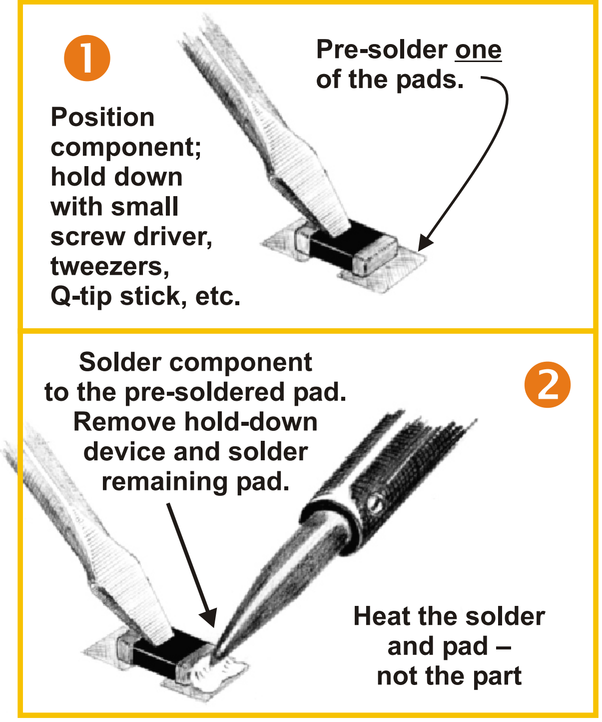


Fig. 7 – A Quick Primer on 60/40 Solder

60/40 is the standard rosin-core solder used by most amateurs and QRPers.

60/40 melts at 370°F (188°C). This is the ***plastic state*** and makes a poor connection, dull in appearance. Also called a "cold" joint.

60/40 liquifies at 500°F (260°C). This is the ideal soldering state, allowing the solder to easily "flow" to the component. Leaves a smooth, shiny connection.

60/40 rosin (flux) **vaporizes** around 700°F (370°C), leaving a dull, uneven connection.

Use as little solder and heat as possible for SMC. Excessive heat can alter the value of the component, cause the metal solder tab to separate from the component, or cause the body to crack. Remember, a large solder blob will fuel heat into the component long after you remove the soldering iron.

THOSE EXOTIC SMC SOLDERS

There are various solders developed for SMC, such as special low melt solder, organic rosins, 2-10% silver, and no lead (Pb) varieties. These are becoming more popular in industry due to environmental and health concerns. However, they are also expensive. The standard 60/40 resin-core solder still works great for most all soldering needs, including SMC, following the temperature guidelines in **Fig 7**. To reduce health hazards and eye-irritation, solder in a well ventilated area. Of course, the choice to use organic rosins or no-lead solders for hobby use is a personal one.

AMATEUR vs. PROFESSIONAL METHODS

Believe it or not, there is not much difference in how SMC circuits are built by the homebrewer vs. the professionals. For large scale operations, such as building hundreds or thousands of cell phone boards, machines are used for placing and re-flow soldering the components. For building dozens of the same board, hand assembly is still more cost effective. At the Very Large Array (VLA) radio telescope (where I work), we are completely replacing the original 1970s electronics in the antennas with newly designed electronics. Most all circuits are now surface mount, which are built "in-house" by several professional assemblers, such as Connie Angel shown in **Fig 8**. She is shown building an SMC board by hand – using good old tweezers and a soldering iron. The only advantage she has is the assembly station microscope, especially useful for mounting those 0603 or 0402 parts!

CLEAN–UP

After soldering several components, whether Manhattan-031 or a PCB, clean the solder, components and pads with a Q-tip or hobby brush moistened with rubbing alcohol as shown in **Fig. 9**. This will remove the excess rosin (the brown stuff) before it has time to solidify for a clean, shiny solder job. Removing the flux, even organic, can prevent corrosion problems months or years later. At the observatory, (as at other facilities) final cleaning is done in an ultrasonic sink using 91% alcohol as the solvent. Critical boards are then checked for loose components on a "shaker table." Dropping your project on the floor a time or two serves the same purpose!

I have cleaned my Manhattan-031 projects in the ultrasonic cleaner with no problems with the pads vibrating loose. This is only a luxury if you have access to an ultrasonic sink.

ASSEMBLY JIG

One building problem is a small board has a tendency to "walk around" on the work bench as you attempt to solder and built it. On a printed circuit board, this can scratch and nick the circuit (bottom) side of the board. **Fig. 10** shows an assembly jig I made for building prototype boards. I have used this both at work and at home. It is a simple aluminum base with 4-40 (or 6-32) threaded stand-offs for mounting the board being built. The standoffs are mounted to the base along slots for adjusting to different board sizes. Small rubber feet assist in keeping it from sliding around on the work bench.

Fig. 8 – Connie Angel, one of the professional assemblers at the VLA observatory, solders surface mount components onto a board with tweezers and a soldering iron. The board is part of a new radio telescope (called ALMA) being built in Chile.

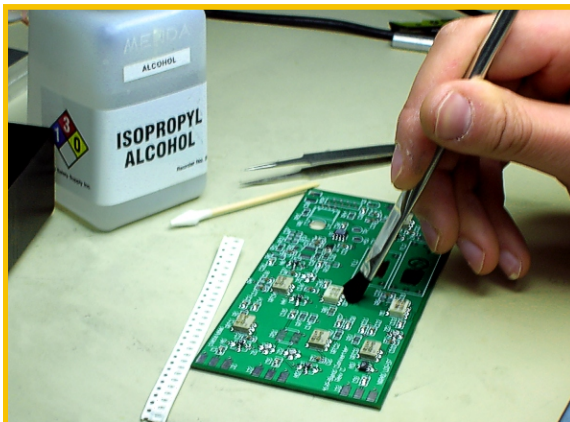


Fig. 9 – Clean solder connections with a hobby brush and alcohol. This keeps the board clean and free of corrosive rosin, whether building Manhattan or a PCB.

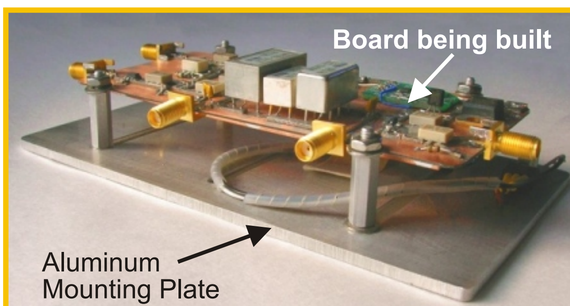


Fig. 10 – An assembly jig for holding the board being built can be made from an aluminum plate or piece of wood. It gives the board some weight and stability during construction and testing.

A wood base can also be used for the assembly jig as well. It is simply to give it some weight, and to keep the board from sliding around. The jig is also helpful when oscilloscope, power and signal generator leads are connected to the circuit during testing.

3. Manhattan-031 — Let's Build Something SMC

AN ERA-1 SMC RF AMPLIFIER

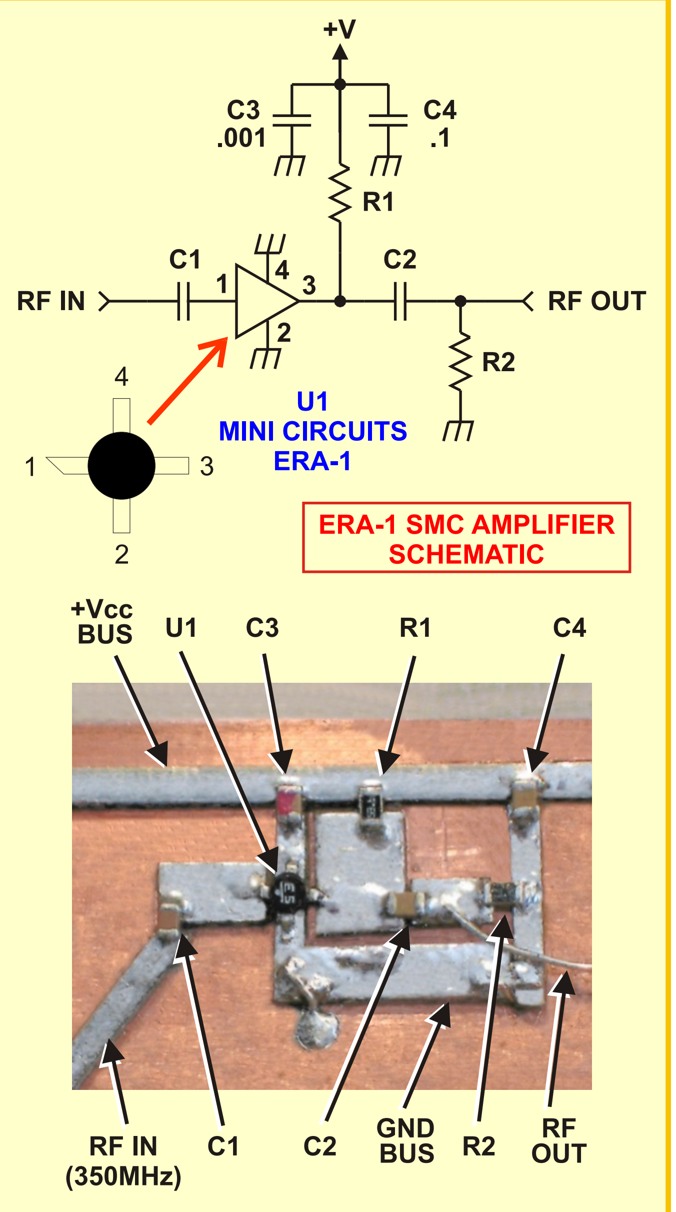
The schematic diagram of a very basic wideband amplifier, using the MiniCircuits ERA series of amplifiers, is shown in **Fig. 11**. The circuit was built entirely of SMC components, using 0805 resistors and capacitors Manhattan-031 style. The ERA is a series of surface mount amplifiers commonly called a MMIC device, short for "Monolithic Millimeter-wave Integrated Circuit," often pronounced "mimmic."

The value of R1 is determined from the data sheets, which establishes the bias and operating current for a given +Vcc. For the +8v used in this circuit, the value of R1 is 53.7 ., a 1% precision resistor value. A 5% 51 standard value could also be used.

Two circuits were built Manhattan style. The first (not shown) used .062" pads cut from a nibbling tool, #22 hookup wire for the +8v, and #26 wire for interconnecting the pads. Analysis of this circuit on a scalar network analyzer (HP 8657) revealed reduced gain in the 10-500 MHz range due to oscillations in the 4-6 GHz region. An 18dB gain "suck-out" around 200MHz was also present. The circuit was rebuilt as shown to the right, using .031" copper clad for the pads, islands and strips to replace the hookup wiring and the +8Vcc bus. The larger "islands" on the input and output terminals of the ERA (ERA-5 "E5" used in the version in the photograph) added sufficient inductance to prevent interactive feedback. The circuit was used for amplifying a 60–400MHz signal. The gain sweep of this circuit was much flatter, due to removing the inductance and resonances caused by the stranded hookup wire at the higher frequencies. This method proved to be a stable circuit at both HF and VHF (no oscillations or major gain suck-outs).

These ERA MMIC amplifiers are wideband, from DC-4GHz. Even if the circuit is used for a mere 10 MHz, the wideband nature can cause oscillations at VHF and degrade HF circuit performance. The Manhattan-031 style of using islands and strips should still be employed at the lower frequencies (<30MHz). If the gain of the amplifier circuit is several dB below what the device is rated for, chances are, you have an oscillation at a very high frequency.

Fig. 11 – A surface mount RF amplifier using a MiniCircuits ERA-1 MMIC amplifier.



The pads, islands and strips were cut from .031" copper clad. The main board, in this case, was also .031, although either .031" or .062" could be used. The pads and strips were affixed with super glue.

0805 resistors and caps were used. It is always advisable to check your soldering through a magnifying glass to ensure you have a good solder bond to all SMC components.

The circuits that follow are part of a low frequency (74-350 MHz) upconverter I was assigned to design for the VLA. The prototype was built using Manhattan-031 to test the circuit and differences between components (such as the mixers and power splitters for phase stability). Once the prototype was finished and tested, it became the model for laying out the 4-layer PCB for the project. This upconverter is now in several VLA antennas doing science.

LO AMP AND MIXER

Fig. 12 is the circuit for a 1024MHz LO amplifier and mixer. This scheme could be used for any HF or VHF frequency.

The LO amplifier is a MiniCircuits GALI-51 in a SOT-23 package. It is shown here since the SOT-23 is also used for SMC transistors, such as the 2N3904, and would be mounted identical to U1 in **Fig. 13**.

The mixer is a MiniCircuits ADE-35MH – identical to the popular $1 ADE-1 mixer used in some QRP kits and homebrew circuits. It is easy to mount Manhattan-031 style as shown. Pins 1, 4 and 5 are grounded via .031 strips, rather than bending the small pins for soldering to the ground plane. This circuit is one way to drive an ADE-1 50 DBM mixer with the required +7dBm (or +13dBm) LO power.

The Z1 2dB pad is the same package used by the ERA series of amplifiers. In this case, the ground pins are soldered to the main board as they are for the ERA-1.

This circuit up-converts the outputs from 74, 196 and 327 MHz receivers to 1.1–1.5GHz L-band IF with a 1024 MHz LO. Therefore, it should work on 20M!

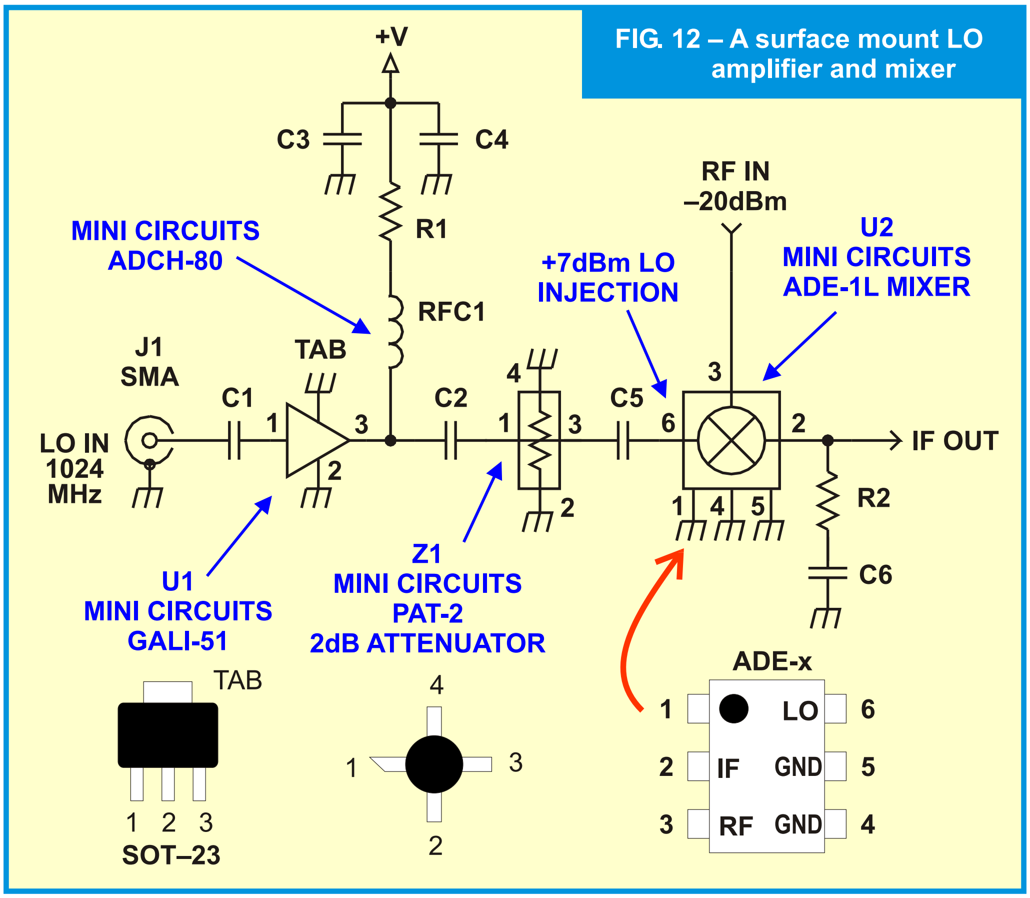
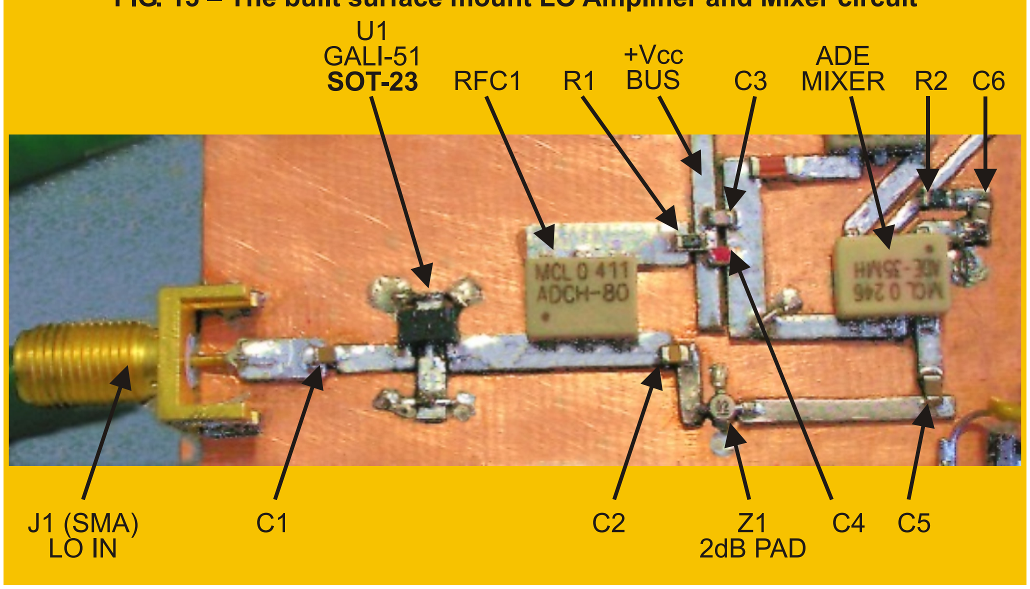


FIG. 12 – A surface mount LO amplifier and mixer

FIG. 13 – The built surface mount LO Amplifier and Mixer circuit



A SURFACE MOUNT POWER DETECTOR

This is another circuit built at work to test out the new (at the time) Analog Devices power detector IC, the AD8361. This would make an excellent QRP project as either a bench power meter (–30 to 0dBm), or with an external attenuator, a power/SWR meter. Except for one thing. The AD8361 is an 8-pin IC in the Micro-SOIC package, or about ten times larger than a grain of salt. It's difficult enough soldering it to a PCB, but I about died trying to build it ugly/Manhattan style, as shown in **Fig. 15**.

While the purpose of this article is construction techniques, a little description of the circuit may be appreciated by some.

The AD8361 produces about a 0-2v output voltage related to the input power. U2 AD8031 op amp amplifies this voltage by about 2.5 to drive a 0–5v analog to digital converter. The gain of the non-inverting op amp is determined by the ratio of RV1+R2 to R1. RV1 is thus included to precisely set an output voltage to correspond to a certain input power (in this case, +4v=–20dBm).

I built the prototype of the circuit as shown in **Fig. 15**. First, I covered the copper clad with a dielectric tape (the reddish stuff). Most of the "pads" around the AD8361 are actually strips of copper tape, requiring insulation from the main board ground. I did this because of the extremely small size of the AD8361, making pads that small impossible. Note the input wire labeled "RF IN." This is a piece of fairly small #30 solid wire wrap wire. Yet, it is about the same diameter as the pins on the Micro-SOIC AD8361. Anything larger could not be soldered to the pins. I had to solder the connections to U1 using our surface mount station at work under the microscope. The magnifying lens I normally use was not sufficient to see what I was doing while soldering.

Building the circuit with the Micro-SOIC chip was fun – *once*. I doubt I will try it again!

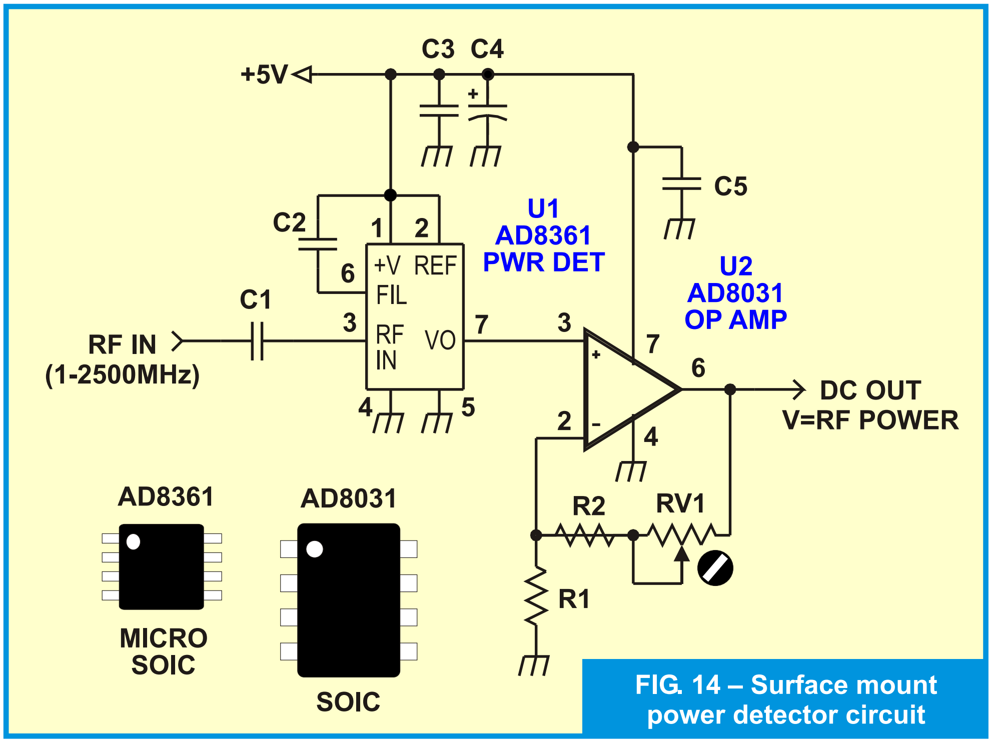


FIG. 14 – Surface mount power detector circuit

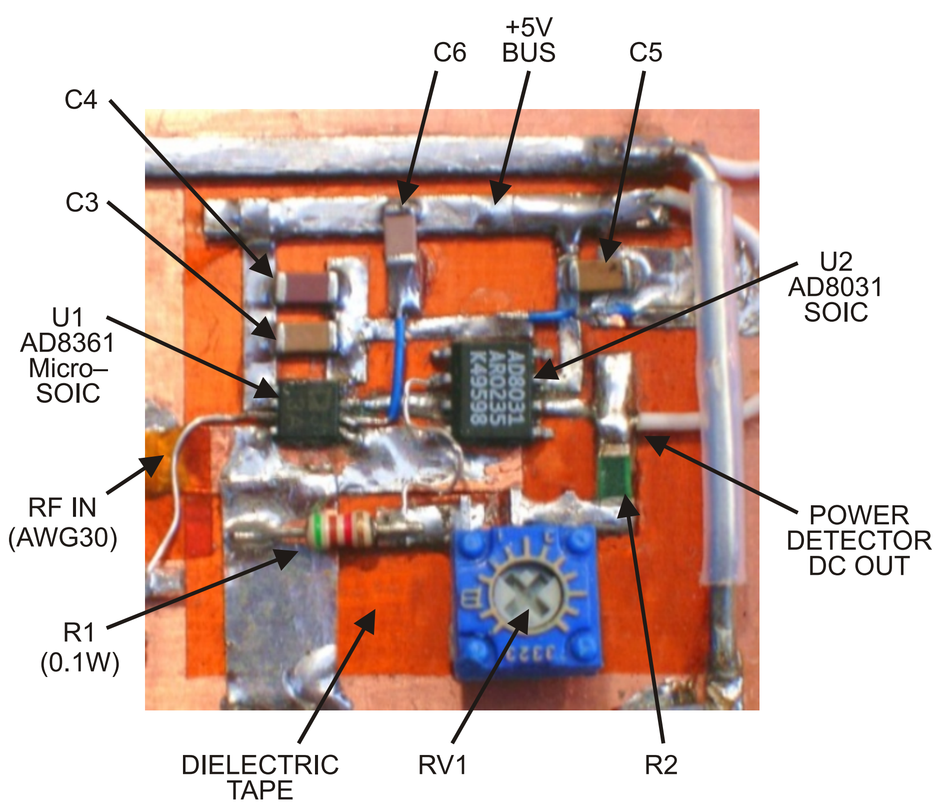


FIG. 15 – THE Prototype Build of the SMC AD8361 Power Detector

The Micro-SOIC package is just too small to properly build on a prototype level without a microscope. The other surface mount IC, the U2 AD8031, in the "normal" SOIC package, was relatively painless.

The rest of the circuit was built in a fairly straight-forward way – mounting the SMC components between .031" Manhattan pads.

4. Some More SMC Applications

A SMC "ADD ON CIRCUIT"

One advantage of the small surface mount components and building a circuit Manhattan style is if a small circuit is needed to modify an existing circuit or a PCB. This was the situation I found myself in with the upconverter project. After the PCB version was built, it was not working properly – there was hardly any image rejection. The problem turned out to be the commercial bandpass filters were incorrectly built by the filter manufacturer (the 3dB point somehow ended up being about 800 MHz instead of 1090 MHz as ordered). This was critical, since the LO was 1024 MHz. Therefore, 400 MHz of image was blowing through the filter below 1090 MHz.

The manufacturer agreed to replace the filters, but the turn-around time was estimated at 12 to 16 weeks. We couldn't afford to have several VLA antennas down for that long. I decided to try and build my own 1090 MHz high pass filters (HPF) and add them on to the PCB ahead of the bad filter on the board until the commercial filters arrived.

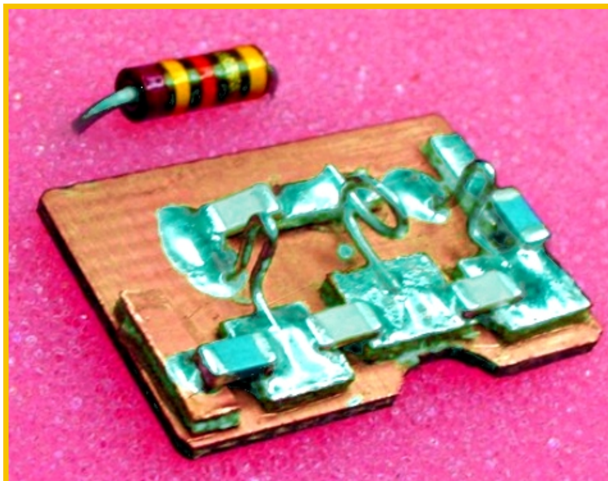


FIG. 16 – A 1090 MHz High Pass Filter made from SMC capacitors and "hand made" inductors Manhattan-031 style.

The final 1090 MHz HPF is shown in **Fig. 16**. The board is about 0.5 x 0.75 inches. This is pushing what one can do with "lumped elements," that is, with discrete components. The values to establish the –3dB frequency of 1090 MHz was C=1.7 and 2.2pF, and the inductors about 4nH (.004uH). If nothing else, this project verified that .031" Manhattan pads have about 1.0pF of capacitance to ground! This value had to be subtracted from the capacitance needed to select the capacitors. The coils were wound as shown in the photographs, and squeezed and twisted to tune the filter. **Figure 14** shows the board added to the bottom of the PCB. The filter did knock down the unwanted images about -25dB, or just barely enough for the upconverter to be used. 16-weeks later, the commercial filters arrived, providing –60dB of image rejection.

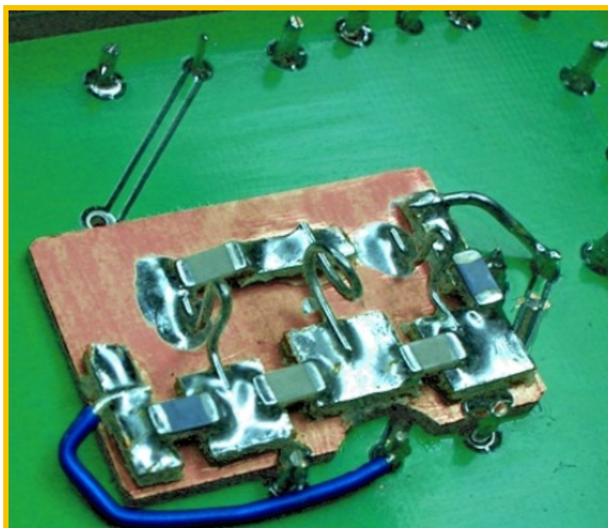


FIG. 17 – The temporary 1090 MHz High Pass Filter added to the PCB.

The point of this is how a small SMC Manhattan style board can be used to build a small "low profile" circuit board for modifying a PCB. Published mods to a QRP kit, or your own modification, can be easily implemented in this manner. Adding a CW filter, keyer, or an AGC are other examples of circuits that can be built with SMC and added to an existing rig or kit, requiring a minimum of space.

HYBRID CIRCUITS

For those contemplating building something with SMC Manhattan-031 style, it is unlikely one would build a QRP rig or project “from scratch” entirely surface mount the first time. Most of us build something from as many junk box items as possible. Therefore, it would likely be a combination of thru-hole and SMC. In industry terms, this is called a “hybrid circuit.” **Fig. 18** shows a hybrid circuit, a 40M QRP transceiver built with both technologies. I used both 0805 SMC and 1/8W thru-hole resistors, though the .031” pads are still high enough to mount standard 1/4W resistors. The surface mount ADEX-10L mixer is a low-power (LO= 0dBm) version of the ADE-1.

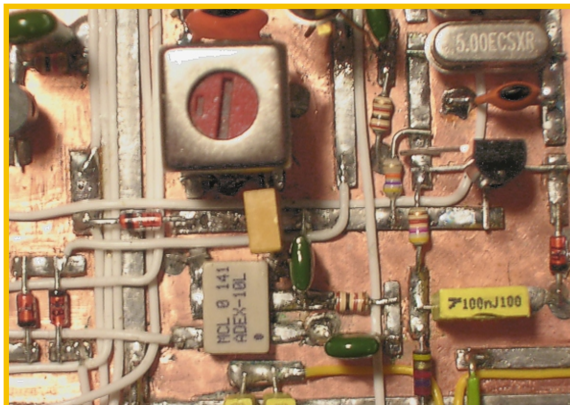


FIG. 18 – A “hybrid circuit” – a combination of thru-hole and SMC using Manhattan-031.

A hybrid circuit is an excellent way to get your “hands dirty” with SMC. On your next project, build it Manhattan style with traditional thru-hole components, but use some SM parts to “get the hang of it,” such as a few SOT-23 2N3904s, a MMIC mixer (such as the ADE-1) or amplifier (ERA or GALI series), or a handful of 0.1uF 1206 or 0805 caps for all the bypass caps.

QRP is a hobby, and many of us love to build things. There’s no law that says you can’t mix thru-hole and SMC. *Just build!!!*

FROM PROTOTYPE TO PCB

Another advantage of Manhattan-031 (thru-hole or SMC) are those situations where it is to serve as a prototype for PC board production. While most QRPers build a circuit on a one-time basis, there are situations where the circuit may be intended for a kit or product. The orderly arrangement of components of Manhattan construction serves as a close model for the PCB layout.

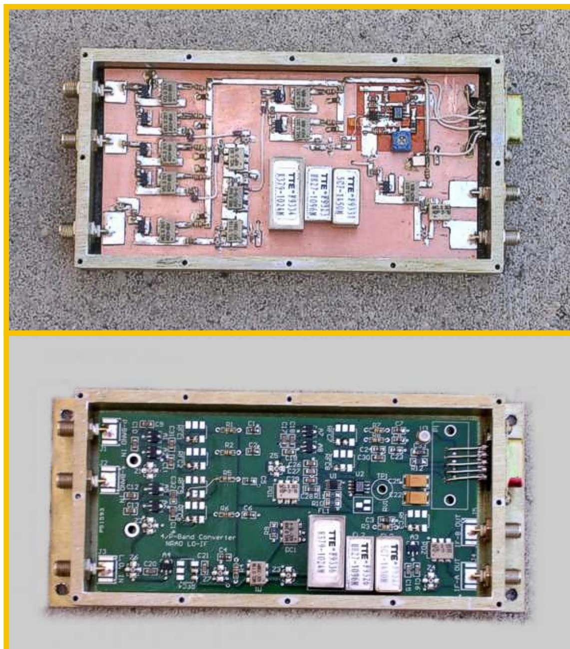


FIG. 19 – The Manhattan-031 prototype VHF upconverter (top) became the model for the PCB (bottom) with few differences, and mounted inside RFI enclosures.

FIG. 20 – The finished VHF upconverter ready for installation in an antenna. There are two converters in each module, one for left-hand and right-hand polarization.

As previously mentioned, some of the circuits shown were prototypes for a VHF upconverter module. **Fig. 18, 19** and **20** shows the evolution of a Manhattan-031 built prototype to the finished product. The PCB shown in **Fig. 19** followed the layout of the Manhattan-031 version almost exactly. The major difference is the PCB uses 50 controlled impedance traces, while there was little attempt to do this with the .031” strips. (Theoretically, .031” copper clad .05” wide would be about 50).

5. More Professional Techniques

Hopefully, this article has demonstrated that the way we homebrewer's build SMC circuits with a pair of tweezers and a soldering iron is not indifferent from the professionals. However, there are other methods being used in industry to make SMC construction easier and faster. A few are presented here for information purposes only – to show what a few of the "buzz words" you may have heard are all about – and not neccessarily an endorsement for the hobbyist to attempt.

Fig. 21 – Professional assembler Mary Ellen Chavez applies solder paste to a PCB preparatory to reflow soldering.

PASTING TECHNIQUES

There are several forms of "paste" that are used to mount surface mount components to the PCB before soldering. This allows all of the components to be mounted on the board as the first step, then soldering all of the components to the pads in a second step. This saves time over "pick and place" method of mounting and soldering components one-at-a-time.

Hand Soldering Paste. In this method, small drops of paste are placed where the components are to be mounted. The components are then positioned with tweezers on the drops of paste, which remain tacky, much like bees wax, holding the components in place. The components are then soldered in place manually with a soldering iron. Following soldering, the boards are cleaned in water or alcohol to dissolve and remove the paste from the board.

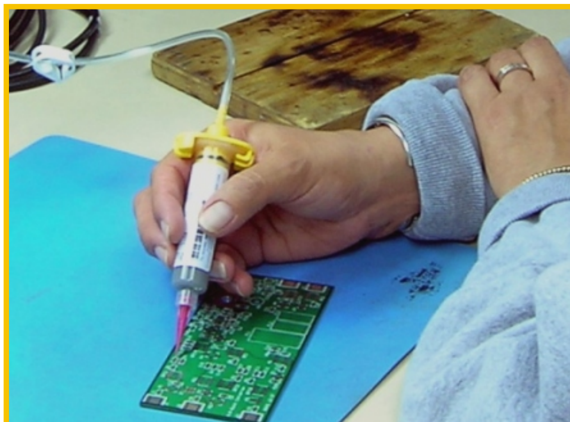


Fig. 22 – A closer view of the solder paste syringe. Air pressure deposits extremely small drops of paste of uniform size.

Some amateur's use a similar technique by using glue. *Super glue should not be used*, as when heated, it produces toxic, eye-watering fumes that should be avoided. Others claim success with model airplane glue to Elmer's glue, though I have not personally tried these. These are fast drying glues, such that the components must be mounted immediately, making one wonder, "what's the point?"

Reflow Solder Paste. **Fig. 21** and **Fig. 22** shows solder paste being applied to a PCB. The pasting machine is set for the desired size of the drops, deposited on the board with air pressure to produce drops of uniform size. This type of paste requires refrigeration when not being used. After the solder paste has been applied, the SMC parts are positioned on the board manually with tweezers as shown in **Fig. 23**.

Fig. 23 –After manually applying the paste, Mary Ellen Chavez places the SM components on the board with tweezers and microscope prior to reflow soldering.

Reflow soldering. Once all the parts have been positioned on the PCB, the board is placed in an oven, usually set for around 350°F, the melting point of the paste and the thin coat of low-melt solder already on the pads. The heat liquifies the paste, pulling the components tight against the pads. The liquified paste also flows onto the pads, acting as a flux, smoothly soldering the SMC pins to the pads. This process takes less heat and solder over manual soldering, plus all components are soldered at the same time. Since the solder was previously ***flowed*** onto the board, this is called ***re-flow*** soldering.

REFLOW SOLDERING AT HOME

There are various reflow soldering techniques used by the homebrewer. This includes applying the proper solder paste and heating the circuit boards in a convection oven, electric cooking ware, to pans heated on an electric or gas cooking stove. Small pencil-sized heat guns are also used.

These methods are not recommended for the general homebrewer, nor does the ***AmQRP Homebrewer*** endorse methods that includes heating boards over open flames or using pans and convection ovens used for food preparation.

Excessive heat can cause the PCB to warp, the solder masking and screening to literally ignite, setting the board on fire. It can take a fair amount of experimentation to get it right. Although, certainly a "hats off" to those who have mastered it.

If you are interested in this, there are several websites describing these methods for the homebrewer. It is my opinion that for building a one-of-a-kind SMC project, tweezers and a solder iron is by far the most efficient and safe.

STENCIL PASTING

While applying paste and reflow soldering does save time over manual soldering, it is still very time consuming if numerous identical boards need to be built. For high volume PCB work, the paste is applied by a stencil machine, as shown in **Fig 24**. The stencil is a thin piece of anodized aluminum with holes cut out for the exact size of the area to receive the paste. The stencils are generally made by an outside company and cost $100-200, depending upon the size and complexity.

Once the stencil is mounted in the machine, the PCB is placed underneath and properly aligned. The paste is heated and forced through the stencil onto the PCB ... in a very similar fashion to the screen printing process for making custom t-shirts.

The stencil mounted in the machine shown in **Fig. 24** is used for pasting the board shown in **Fig 25**

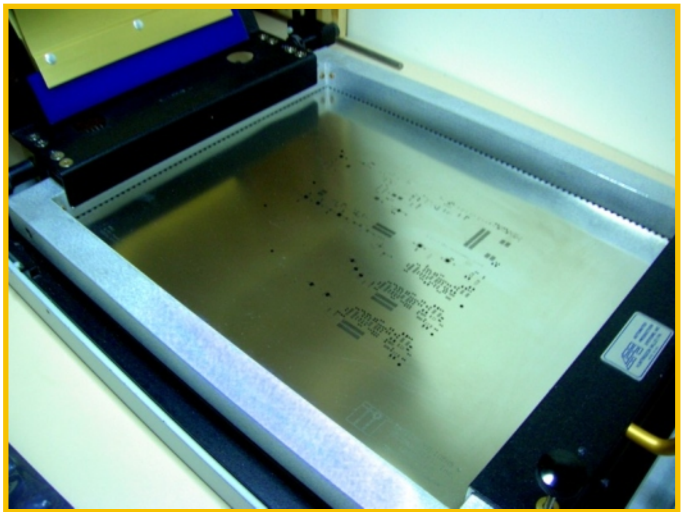


FIG. 24 – A stencil mounted, ready for pasting

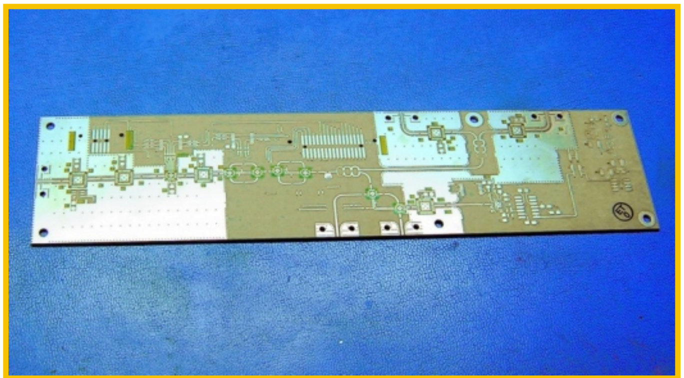


FIG. 25 – The PCB "pasted" with the above stencil. This board down-converts the VLA 8–12 GHz IF to 0–4 GHz baseband, then digitally sampled at 8 GHz.

CONCLUSION

There are numerous methods to build electronic equipment using both thru-hole and SMC. The Manhattan-031 technique presented here has been used by the author and others for building thru-hole, SMC and hybrid circuits with good results. Practice makes perfect. Therefore, try it – and build something. You'll be surprised how easy SMC can be. There is no shortage of thru-hole parts, inspite the claims of some, but SMC, and some of the newer ICs available only in SMC packages, have their advantage and worthy of experimentation by the QRPer.

72, Paul NA5N

.

Richard H. Arland, K7SZ

Real Radios have Motors !

MOST radios don't require motors, but the ***REALLY NEAT ONES*** do!

As I rounded the corner heading toward Mel Sims' shoe repair shop, I almost ran over Everett West, President of The Old National Bank, in my home town of Palouse (Washington).

"Whoa, there Young Mr. Arland, where's the fire?" inquired Everett.

"Hello Mr. West", I stammered, "Sorry I was in a hurry and didn't see you", I replied.

"So, Dick, what's the rush? You still haven't told me why you're in such a hurry." challenged the middle aged bank president.

"It came! I just got it from Mr. Draper at the Post Office! My ham license finally came from Gettysburg! Look, it's even signed by Ben F. Wapple of the FCC!" I gushed.

"Let me guess, you are on your way to inform the town cobbler of your newly acquired license, is that it?"

"You bet! Mel, err, Mr. Sims has a radio he is willing to lend me so I can get on the air and talk all over the world!" I eagerly volunteered.

"Well, mind how you go, Dick, I'd hate to see anyone get trampled in your exuberance to "get on the air". With that Everett strolled off toward the Post Office to have his morning chat with Kenny Draper the Postmaster. Shortly the two of them would wander over to the Oasis café and have a coffee and one of Paul Byers' excellent cinnamon rolls, all the while talking about the latest gossip around the small eastern Washington town of Palouse.

I ducked into Mel's shoe repair shop with a huge smile on my sixteen year old face. Mel looked up from his work of resoling a boot and commented, "So, your license finally arrived, aye?"

"It certainly did, Mr. Sims", I replied.

"Well, now I suppose that you are here to collect that receiver I promised you, right?"

"Right again, Mr. Sims", I said, the grin continuing to widen on my face. Man, a real receiver. One that tuned the ham bands! I could barely restrain myself.

Mel went into the back of his shop and I dutifully followed a few paces behind the old cobbler, who had become my "Elmer" over the years. Mel had been a ham for as long as anyone in the area could remember. His call, W7CIS, was indeed an old call sign. His modest home on the south hill of Palouse, overlooking the Palouse River, sported an odd assortment of wire antennas while his shack boasted an old National NC-57 receiver and a Heathkit DX-40 transmitter: Certainly not a contest quality station for the early 1960s but none the less a humble accomplishment in an area of dirt farmers.

Mel had been my merit badge counselor for my Boy Scouts radio merit badge. Through his kindness and hospitality, I was introduced to the world of Amateur Radio at the tender age of 14. During the intervening two years, Mel, along with George Comstock, W7CJ, mentored my efforts to obtain my Novice ticket. Without their help and encouragement I would not have made the grade, of that I am certain.

Mel's contribution to my quest, aside from answering a lot of dumb questions and quizzing me almost daily on radio theory and Morse Code, was to provide me with a "loaner" receiver once I got my Novice ticket. Mom and Dad were all for me getting into this technical hobby, but my level of participation was to be strictly governed by the amount of money I could earn to buy my own gear. Needless to say, during the summer of 1963, there were a whole lot of yards mowed and garden beds weeded by this young ham to support his radio hobby!

Mel took a medium size black box off the shelf, turned, and handed it to me saying, "There you are, Dick, your own HF receiver. Take care of it, because it's only on loan and I need it back."

I looked at the arm full of crinkle finished black box that I held gingerly, not knowing how to express my gratitude. "Wow, Mr. Sims, this is great! What do I need to know to make it work?" I asked.

"Well, it's pretty simple. Plug in the power supply and plug the radio into it, turn it on here (indicating a small toggle switch on the front panel of the receiver), attach the antenna wire here (indicating a push-type binding post on the upper edge of the front panel), plug your headphones into this jack, here (signifying a quarter inch phone jack beside the on/off switch), turn up the gain over here (pointing to the "chicken head" knob on the front of the receiver) and you should hear something. The main tuning crank is here (indicating a small sliver knob with a “spinner shaft” on the front) and that turns the main tuning dial centered on the front of the radio. Be careful, tune slowly, and you’ll start hearing signals from all over”, commented Mel. “Dial calibration is a bit off, but you’ll get the hang of things after an hour or so” concluded Mel.

I thanked Mel profusely several more times and he finally kicked me out of his shop so he could get back to work and make some money. Returning home, I set the receiver and power supply up on my make-shift operating bench, actually it was an old closet door Dad had cut down for me so it would fit along one wall of my twelve foot square bedroom.

I followed Mel’s instructions to the letter. I flipped on the power switch and was rewarded with a low volume whine from a black crinkle finished oblong tube on the back of the receiver. Hmmmm, Mel didn’t say anything about “whining”. I shut things down and went over his instructions again in my mind; nope, definitely nothing about a “whine” from the radio when it was powering up. I certainly hope I did nothing wrong when I transported it from Mel’s place to mine. Better call him!

Mel stopped laughing after about five minutes. “Dick, what you’re hearing is the dynamotor that powers the receiver turning over and spooling up to speed, Nothing to worry about, trust me”, chuckled Mel.

Whew! That was a load off my mind. I thanked Mel and returned to my “shack” (such as it was) and fired the receiver up again and started tuning around the bands. Life was good.

As many of you “Old Timers” will probably realize Mel had given me an old BC-455 ARC-5 Command Set from World War-II. After the end of the war, literally hundreds of thousands of these radio sets hit the surplus market and the radio amateurs of the day were quick to snap them up, make some minor modifications, and use them on the ham bands. These receivers and transmitters were powered by a dynamotor (the early version of a DC-to-DC converter) that was powered by 12, 24, or 28 volts from inside the aircraft, tank, troop carrier, etc. While the Command Sets were in abundance, you had to have several of them to cover the major bands due to their limited tuning range. In my case, Mel had provided me with the 6 to 9 MHz version that covered 40 meters, roughly 7 MHz. If I wanted to work 80 Meters, I’d have to get another ARC-5 (BC-454) that covered the 3.5 to 4 MHz part of the spectrum.

Many hams removed the dynamotors and built a small AC power supply onto the rear deck area where the dynamotor used to live. This was handy but it destroyed the originality of the set, which in this day and age is of primary importance.

As I gained experience with Mel’s loner receiver I longed for more frequency coverage, and I finally persuaded Mom and Dad to allow me to get a Heathkit HR-10 ham band receiver that covered all the major HF ham bands of the day. I still have that receiver and use it regularly, just so I never forget my roots! With a few simple and reversible mods, like zener diodes in the B+ lines on the local oscillator and BFO tubes, the HR-10 settles down and can be a semi-serious HF receiver.

Mom and Dad were only too happy to front me the money for my new receiver due to two totally unrelated events. Prior to obtaining Mel's ARC-5 receiver, I had attempted to build a receiver from the 1959 ARRL handbook. This ended in a minor disaster when, after applying power, the shack was showered with sparks and the air was filled with the pungent smell of melting insulation and boiling lacquer (from the transformer windings). Dad came flying into the room with a stunned look on his face and a small fire extinguisher in his hand. Thankfully I had not managed to set the entire house on fire, just a small portion of my work bench, namely that area that held the 1959 copy of the ARRL Handbook. There is an object lesson there; I just haven't figured it out yet. Hey, it's only been 40+ years!

The second incident centered upon the ARC-5 set itself. Dad and Mom were always a bit leery after that episode and when I brought Mel's receiver into the shack, they looked over the power supply, the receiver with its dynamotor, and decided that there just had to be a better way. Mom was really wary of the dynamotor as she was under the distinct impression that motors were not required to listen to a radio. Well, Mom was partially correct. ***MOST*** radios don't require motors, but the ***REALLY NEAT ONES*** do! Out came the Heathkit catalog and within in a few weeks I had my new HR-10 kit just after Christmas 1963. Life was getting better!

I returned the ARC-5 to Mel and thanked him profusely. Mel offered me loan of a surplus ARC-5 transmitter but I declined. My high school principal, an inactive ham, had provided Mom and Dad with his old Novice transmitter, a Johnson Viking Adventurer along with a hand full of 80 and 40 Meter crystals. Life was getting real good, now!

My initial foray into military communications (MilComm) equipment collecting/refurbishing and use was less than spectacular. The few short weeks I had the ARC-5 in my shack I became quite adept at tuning it and developed my skills of separating out Novice CW stations, letting my brain become my "active" CW filter. My main complaint was that the Trimm 2000 Ohm headphones became uncomfortable after a couple of hours! This initial MilComm experience was filed away as a "data point" (as my good friend and fellow QRPer, Joe Everhart, N2CX would say) in my cerebral cortex, for future reference.

That future reference came while in tech school at Kessler AFB, MS in 1967-68. One of the guys in the barracks had a BC-455 receiver and a small two tube crystal controlled transmitter on 40 Meters. Using an end-fed wire out the second floor window of the barracks, and a 33 foot counterpoise draped around on the floor, he and I would get on the air in our limited spare time and have some fun on 40 CW.

Over the years of my USAF career, I was exposed to all sorts of MilComm radio gear, owing to the fact that I spent my entire career in Air Force Comm Command. I developed a love/hate relationship with much of the "green radio gear" and never really had any overpowering desire to obtain anything beyond a couple of ARC-5 receivers and companion transmitters and a BC-221 frequency meter. In 1973 that all changed.

One of the neatest radio sets that I ever saw in my entire life occurred while stationed at the Third Mobile Comm Group (3rd Herd) at Tinker AFB, OK, and was packed into the back end of a military jeep (M-151 "Mutt"). The military nomenclature for this highly mobile bundle of RF communications was the MRC-107 (pronounced “Mark-One Oh Seven”). The jeep (either the M-151 or the earlier M-38 vehicle) was modified to hold an entire suite of RF equipment (HF through UHF) to allow communications with air and ground units at a forward location. You knew you were in a “forward” area when the jeep and radio gear started picking up extra ventilation holes from incoming small arms fire!!

I immediately fell in love with the MRC-107. We had two of them in the 3rd Herd and I always wanted to take one of them out on a Field Day just to see how they performed. The radio gear (much of it made by Collins) consisted of a GRC-106 (pronounced “Jerk-One Oh Six) for tactical and long-haul HF SSB/CW/AM operations, a PRC-71 (pronounced “Prick-Seventy One”) for UHF FM tactical air/ground communications, a PRC-47 man-pack HF SSB/CW radio (and you thought this HF Pack stuff was new!) for back up HF coverage, and either a PRC-25 or PRC-77 for low band (35-70 MHz) tactical FM voice for ground to ground operations. In order to cram all this stuff into the back of a jeep, the passenger’s seat along with the rear seat were removed and the passenger seat was turned around 180 degrees to face toward the rear of the jeep. The passenger then became the radio operator. This was a two person vehicle to be sure.

Antennas for the radio gear bristled from the rear deck of the jeep. Long antennas for HF, short stubby antennas for UHF A/G, slightly longer vertical whips for VHF tac. Man, this thing was a beauty to behold. I was sold! I gotta get me one of these!!!

Thirty years have passed and I still don’t have my own MRC-107, but I’m not through looking! However, I do have a small eclectic bunch of “green radios” (along with a couple of black ones) in my humble but growing collection. In 1996 I started becoming interested in obtaining some of the military comm gear that I knew I could use on the HF bands. My first purchase was a GRC-109 Special Forces/CIA spy set left over from the Cold War. Originally designed and produced in the mid-1940s right after the end of WWII, the GRC-109 consisted of three “black boxes” that comprised the radio set, a hand-cranked generator, and spare parts kit. The CIA trained human intelligence (HUMINT) operatives using these sets to send back information from various hot spots around the world during the late 40s on through the 60s.

Fair Radio Sales was offering the complete set, receiver, transmitter, and large PP-2685 power supply, for around $125, less shipping. I ordered two and gave one to a friend who was an old retired Marine Gunnery Sergeant, named Roger Rake, N3PBL. Over the last few years Gunny Rake and I attended all but one of the Military Radio Collector’s Association (MRCA) meets in northeastern Pennsylvania. It was at these meets that I encountered a tremendous group of like minded hams who took pleasure in obtaining, reconditioning, and using this MilCom gear on a regular basis. The wealth of information that these guys have at their fingertips is truly amazing. They are a friendly bunch and always ready and willing to help the “newbie” in the hobby with hard to find schematics, advice, modification tips and operating tips. These guys are truly amazing.

My GRC-109 has seen use on the 80, 40, and 20 Meter ham bands. The T-784 transmitter is a 10-15 watt output, crystal controlled, CW transmitter (weighing 11 pounds) whose matching R-1004A receiver covers 1.8 through 24 MHz in three bands and weighs in at 12 pounds. The entire radio set weighs about 50 pounds with the PP-2685/GRC-109 multi-voltage power supply and GN-58 hand-cranked generator included. Can you believe that Special Forces troops (Green Berets or, as we in the Air Force like to call 'em "Green Beanies") actually jumped with this gear into the jungles of Viet Nam, humped this mess through all sorts of inhospitable terrain, and used it to contact their rear area bases using a hand full of crystals, a J-45 telegraph key, a GRA-71 burst encoder and wire antennas? And they did all this while engaging the enemy who was bent upon their untimely destruction. Talk about earning your paycheck!

I think you can see where I am going with this. Collecting MilCom gear is more than just finding a "green radio" and putting it on a shelf. The experience is rewarding, as all the MilCom gear has a place in the history and formation of our country. By refurbishing and using these old "Boatanchor" radios you are not only saving and restoring a bit of history, you are using some extremely rugged radios that are well suited to life on the ham bands.

Rugged: You have absolutely ***NO*** idea! Most of this gear was state of the art for its time and cost the American tax payers a few thousand dollars each to procure for our troops. While the gear is highly ruggedized, much of it is extremely complicated in theory (don't believe me….check out the auto tuning system on a T-195 HF transmitter!). That fact is offset buy the various Technical Manuals or Tech Orders (TMs and TOs in military lingo) that cover these rigs. These maintenance documents are quite comprehensive in their coverage of the theory of operation, alignment, and use of each piece of gear.

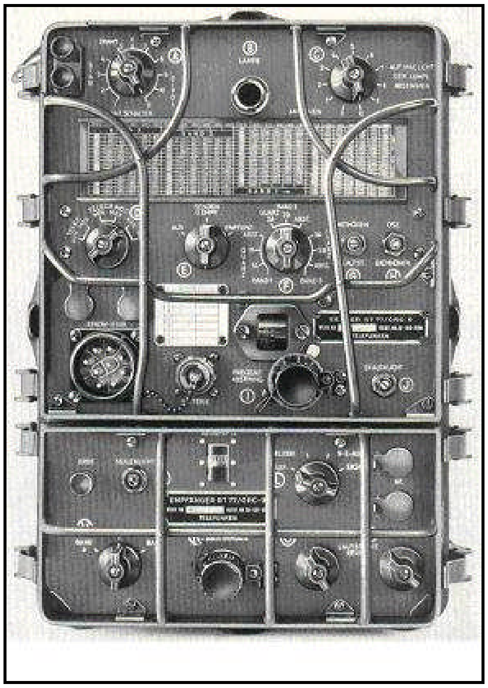
My GRC-109 has garnered its fair share of CW QRP contacts over the years. It is really fun to tell the other station about my rig. It is amazing that when you send: "RIG HR IS GRC 109 SPY SET" what reactions you get from the other operator. In one instance the distant end op came back to me saying that he not only knew what a GRC-109 was, his father, a retired US Army Green Beret colonel, had used them during the early days as an advisor in Viet Nam!

Dave Carey, N3PBV, my next door neighbor, came over about a year ago with a big green box. A present from him to me, much to the consternation of my wife, Patricia, KB3MCT. All I needed was another radio to sit in the basement!

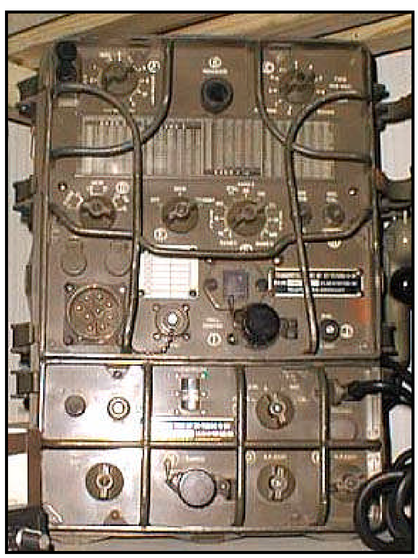
Dave's gift was an AN/GRC-9 (called an "Angry Nine") that was overhauled by the Tobyhanna Army Depot in the early 1980s. It still had all the tags from the Depot; the radio cover was brand new and fit tightly over the front of the radio offering some inclement weather protection. The front cover, once removed, yielded an almost mint condition GRC-9. The only "catch" was that there was no power supply available. It makes things a bit difficult to troubleshoot and use if you don't have the right power supply. Not only that, there was a lack of power cable, antenna insulator and a host of ancillary gear one needed to put this puppy on the air. Enter e-bay.

It took me about a month, but I found the proper power cord (with the correct cable ends on it) along with the T-17 microphone (you know, the old carbon mics from the army movies) and antenna base. The latter two coming all the way from Italy!

Al Klase, N3FRP, MilCom guru, and main player in the yearly MRCA meet provided a DY-88 dynamotor supply at this year’s meet, so I could fire up the rig. Between Al and me, we managed to get the receiver on the GRC-9 up and running but, alas, nothing was coming out of the transmitter; more troubleshooting, as soon as I find my own DY-88. Like I said, ***real radios have motors***!



This is a drawing of the venerable GRC-9. This radio was the replacement for the WWII HF radios.The rig puts out about 15 W on cW and 7 on AM phone. Its all "hollow state" technology with a 2E22 as the final amp. Weighing in at 30 pounds this is definately NOT a man-pac rig. Most of the time they were vehicular mounted or used as fixed comm assets in command posts and TOCs.



Here is a close up shot of a working GRC-9 mounted in a commo van.

Here, wearing the BIG simile is Lou Ribble, N3OD at the annual Military Radio Collector's Association (MCRA) meet at Gilbert, PA Fairgrounds in 2004. Lou is sitting in front of his GRC-9. Notice the T-17 microphone for AM use and the LS-7 speaker on the table. This old Warhorse (Ithe radio not Lou) is a lot of fun to use and a real nice piece of military history to display.

While serious MilCom collectors measure their “wealth” by the ***ton***, most of us merely count the number of radios we have in the shack (or, in my case, the basement). There are collectors/users out there that won’t let anything get away from them, insisting that all MilCom gear must be procured, saved, tagged, and restored or salvaged. This makes for a lot of gear. Much more than I have room or time for. Therefore, I consider myself a serious restorer and user as opposed to a collector. I think many of us fit this description.

Today my collection sits at eight radios: An AN/GRC-109 HF CW spy set, a Hallicrafters HA-2 AM Walkie-Talkie used in Viet Nam by the Special Forces units. This particular unit works on 29-45 MHz and has the VHF converter for air/ground comms on 108 to 136 MHz. One of my favorite HF rigs is the AN/GRC-9 (Angry Nine) since it is fully tunable from 2 through 12 MHz and you can run CW and AM phone for the 3885 kHz Military Net each Sunday morning.

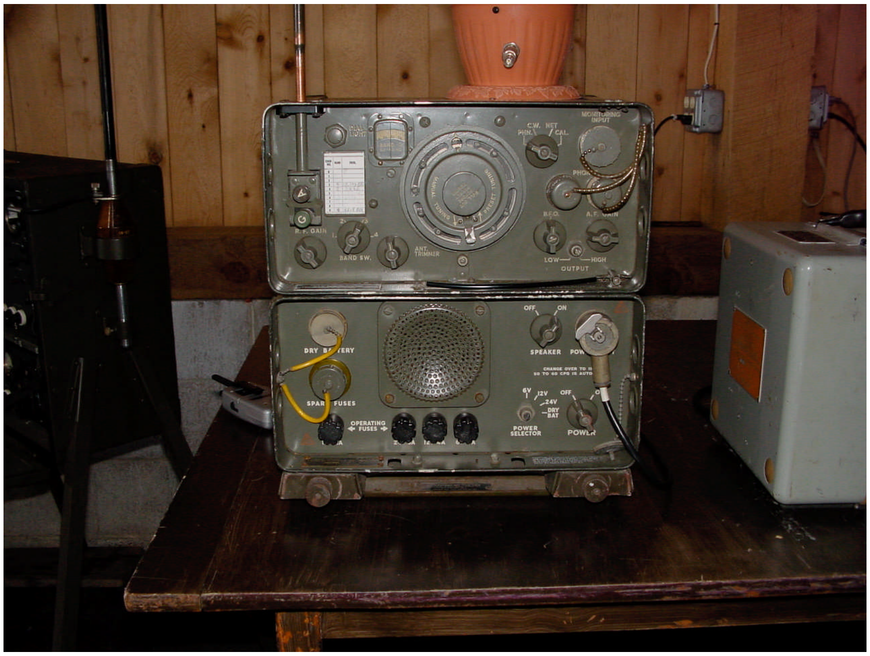
Once I read about one of these rigs I just had to have one: AN/TRC-77A (pronounced Track-Seventy Seven Alpha). This is about the last evolution of vacuum tube technology in a man-pack clandestine radio set. The 77A runs about 5-7 watts output on CW on six preset channels. It is crystal controlled and was used by the US Army Special Forces and Marine Force Recon to send back information when the unit was too far out of range for tactical FM voice to be effective. My 77A came from a fellow MilCom collector in Maryland. This is a great radio to use even though it is crystal controlled. I have rocked my 77A up with three 80

Meter frequencies (3560, 3562 and 3570 kHz), and four 40 Meter rocks (7038, 7040, 7042 & 7200 kHz). This will gives me enough room to play on/near the QRP calling freqs. My TRC-77A was in excellent electrical shape when I received it and I have done very little in the way of realignment or modifications. Cosmetically it could use a face lift consisting of new paint and re-lettering. It works well as a QRP CW rig and I plan on using it for Field Day in 2006.

No MilCom collection would be complete without at least one or two tactical FM radio sets. In late 2005 I located a set of AN/PRC-6 walkie-talkies, complete with technical manual and information on fabricating a battery for this ultra compact tube-type HT. One PRC-6 went to Gunny Rake and I kept the other. The defacto MilCom FM frequency for ham radio operators using these “squad radios” is 50.1 MHz. This radio tunes that frequency once the proper crystal is plugged into the radio. A set of crystals (12 in all) were procured from a Canadian ham via e-bay: total cost $23 including s/h. Applying the proper voltages and aligning the radio was a relatively simple matter. Now Gunny Rake and I have a set of Prick-Sixs on 6 Meters; output power: 300 mW! That is definitely QRP!

In addition to the walkie-talkies, we also found a set of PRC-10s complete with long and short antennas; handset and LBE pack assembly for $95 (extremely cheap by e-bay standards). These are man-pack low band VHF radios from the Korean War/Viet Nam era. They too, go on 51.0 but they are fully tunable over the range of 38-54 MHz range. Other members of this family include the PRC-8 (20-27.9 MHz) and the PRC-9 (27-38.9 MHz). These radio sets can also be vehicular mounted using the AN-598 power supply/AF amplifier to provide mobile or base station VHF comm. The trick here is to find an AN-598 in good condition at a reasonable price. Kinda like looking for the Holy Grail, if you get my drift. A PRC-9 would make a great little radio for 10M FM simplex. RF output from these man-pack units is around 1 Watt, well within the QRP guidelines.

My absolutely favorite “green radio” is a GRR-5 shortwave receiver that cost me $10 at a local ham fest. This HF receiver will cover 2 to 18 MHz, is very sensitive, and can be operated from 6, 12, or 24 VDC, an external dry battery pack and 115VAC. All thanks to an on board power supply. I regularly use this radio to listen to shortwave broadcasts on a nightly basis. It is soooooo cool to fire this baby up and listen to SW stations. Tuning takes a bit of getting use to, but in all the GRR-5 is a very rugged and weighty radio at 60 pounds! It receives AM, CW and SSB modes but SSB tuning requires some patience and a lot of practice. The receiver actually sounds pretty darned good for something that was designed in the late 1940s or early. Now I listen to the BBC with a smile on my face, knowing that this old warhorse will be around long after I’m gone!



Here is my baby! This is my very favorite "green radio": the GRR-5/R-174 HF receiver. This late 40s/early 50s bullet proof piece of comm gear weights in at 60 pounds and is built like a proverbal tank. Covering 1.5 to 18 mc,. this old Warhorse can get you on 160, 80, 40, 30 and 20 meters in fine style. Coupled up with a QRP toob transmitter like the old 6L6 circuit using one crystal, and you are set for some real fun.

Future additions to my “collection” include a BC-611 Motorola walkie-talkie from WW-II. This is an 80 Meter AM set with 300 mW of RF output. It was the US Army’s first successful attempt at a squad radio and quite literally helped the allies win the war in Europe and against Japan.

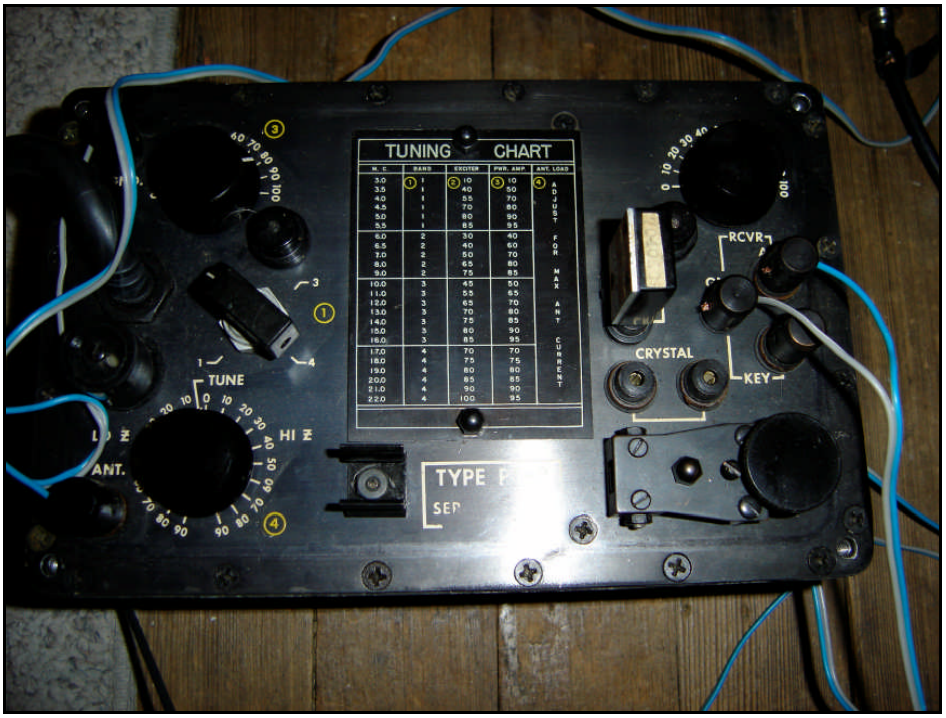
Well, I hope you have enjoyed this little trip down MilCom Lane. It is vitally important that more individuals become active in collecting, restoring, and using these older military radios. From an historical perspective by restoring this gear you are preserving a piece of American history. From a ham radio aspect, you are using some really rugged equipment that can survive better than most of us humans can in the bush. Primative? Yes, by some standards, but remember much of this gear is 40 to 50 years old and was cutting edge technology in its day. My goal is to procure a PRC-74 or PRC-1099 HF man-pack radio capable of SSB and/or CW operation and use it at Field Day and hiking trips on the Appalachian Trail in the near future. This HF Pack stuff is very addictive! Hope to C U on the bands using my MilCom gear. Until then: “Semper Fi!”

These photos show Ted Young, W3PWW operating his AN/GRC-19 HF radio set. This unit is made up of the T-195 HF transmitter (with a really wild electro-mechanical automatic antenna tuner built in!) and the R-392 receiver (which is a mobile version of the Collins R-390 fixed station receiver). This unit is capable of several hundred watts output and can transmit CW/AM and SSB. It's big, it's noisy, and ***it has motors!!!!!!***

If you really get involved with this MilCom hobby, you can go so far as to procure your very own WWII Enigma Cypher machine right from Germany! Really, there is one member of the MRCA group who goes to Germany every several years and picks up a few of these classic cypher machines and imports them to sell to military collectors in the States. Ready for some sticker shock? Got a spare $2500? If so, you too can own an Enigma!

Here is an old GRC-9 mounted in a flat fendered jeep from the post WWII era. The GRC-9 saw action in Korea, Viet Nam and around the world. It is still in some National Guard Units commo bunkers!

Here is the entire GRC-109 Special Forces/CIA spy radio station set up for operation. This station is a gas to use, despite the wide IF bandwidth on the R-1004 receiver. I have tried a passive AF filter on this radio with limited success. The transmitter has a nice little "chirp" that makes it stand out in a crowd.



This is a close up shot of the T-784 transmitter. The novel tune up procedure relies upon neon lights to indicate a peak in RF output. Watch out, though, it is VERY EASY to let your finger slip during tune up and contact the antenna output jack and receive a nasty little RF burn for your carelessness.

Shown here is a close up of the R-1004 receiver. There are no separate RF/AF gain controls on this receiver, only a single "gain" control. You have to use this carefully along with the BFO control above and to the left of the gain knob in order to receive good CW. Despite the very wide IF passband in the receiver, this is a relatively good device considering it was designed at the end of WWII and represented a "minimalist" concept in receiver design for that era. One nice or possibly not so nice thing to remember about this receiver is that it uses the very rare 1L6 tube for a mixer. This is the same tube that the older Zenith Transoceanics use, so if you have an old TO, you can always swap 1L6s in an emergency! Notice the made in China 2000 ohm headphones. Since this photo was taken I have acquired a set of Trimm 2k phones to make things technically correct for the era.

Richard H. Arland, K7SZ

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Dave Ottenberg, WA2DJN

The Transformer Checker

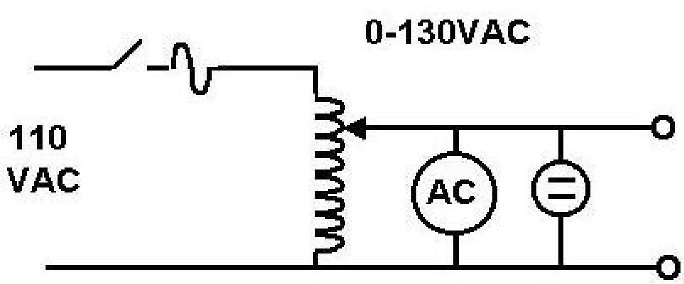
Make sure that transformer works before lugging it around Dayton all day….

Have you ever been to a hamfest and saw a neat transformer, ac muffin fan, AC meter or electronic gadget ... and wondered “Does it work?”... Of course you have!

Well, I’m going to tell you about a piece of test gear that I use almost every day. I built an AC transformer checker using a 5A variac (auto transformer), a 0-150VAC voltmeter, a fuse, an outlet box and binding posts. With this unit I am able to check unknown transformers, AC bulbs, or any piece of gear that works from 0-150VAC.

The variacs I’ve found most useful come in various sizes: 1.5A, 3.75A, 5A, 7A and 10A. I use the 5A size as it is the most convenient for me. The other parts can be found at hamfests, in junk boxes, at ham friends’ houses, and even at Radio Shack.

True, this is a very basic piece of test equipment, but it’s one I find extremely useful.



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George Heron, N2APB

Universal Tilt-Over Antenna Base

Protect your vertical from bad weather and picky neighbors

Stuck with neighbors who don't appreciate the beauty of a permanent skyhook? Or how about a homeowners association with restrictive antenna covenants? Well, here's a way you can have your antenna "up" when you need it, and "down" and hidden from sight when not in use. Additionally, you get a reusable "base" in the deal that facilitates great antenna experimentation.

I had some antenna challenges last year when moving into my new QTH here in a northern suburb of Baltimore. It's a new development, built on nice, flat, open farmland and homes have a good distance between them. But the covenants were such that antennas need special approval which is hard to come by. Complicating life is that there are virtually no trees to hide or support antennas. So my challenge begins.

I had previously used a GAP all-band vertical antenna mounted about 5 feet off the ground, and was very fond of the performance and convenience. (Low mounting, no ground radials, all band, no adjustments.) So naturally I wanted to use the same antenna here at the new place but even mounted close to the ground as before, it would readily stand out and be noticed.

So I made a simple tip-over mounting base and attached my GAP antenna to this pipe. When I operate (which tends to be mostly during darkness hours, I walk the antenna into the upright position up (which isn't too hard at all), pin it in place and I can then operate. When I'm done for the evening, I bring the antenna down such that it's laying horizontal about 2-feet off the ground, resting on a short supports along its length. I have small evergreen bushes planted strategically at the base and along the 30-foot length of the antenna, and one would hardly notice anything out of the ordinary when the antenna is down.

I occasionally operate during the daylight hours too, and as it turns out my neighbors don't comment too negatively about the sight. (Although I think it's a beauty!) As long as I bring it down when not in use, they tolerate me. And of course since I operate exclusively at QRP levels (actually 1W max), there are no problems whatsoever with TV/phone/etc so I'm even more the nice neighbor.

The Basic Base

As can be seen in the photo of Figure 1, and in the diagram of Figure 2, the antenna base consists of two steel pipes anchored into the ground, with a third pipe above ground and between them. There are two pins (actually long threaded stock) through all three pipes, separated by about 18". In operation, the lower pin is removed and the middle pipe pivots down on the upper pin, giving me convenient access to attach my antenna or to just lay it down when not in use.

Antenna Experimentation

I have a multitude of options with this arrangement. The tip-over base is located at the back of my property (about 150-feet from the house), so when I use a taller support tube (in place of the GAP vertical) I have a nice end-support for one leg of a dipole, an end support for an inverted L, an end support for an end-fed Zepp, a mid-support for an inverted vee, etc. And I can easily substitute other antennas onto this tip-over base and experiment with a range of designs. This is a perfect arrangement for trying out some of the W4RNL PVC antennas.

All of these antennas and supports tip over when not in use, making me the conscientious neighbor ... yet still allowing me to be the experimenting homebrewer. Hopefully this will give you some ideas for your own "antenna challenged properties".

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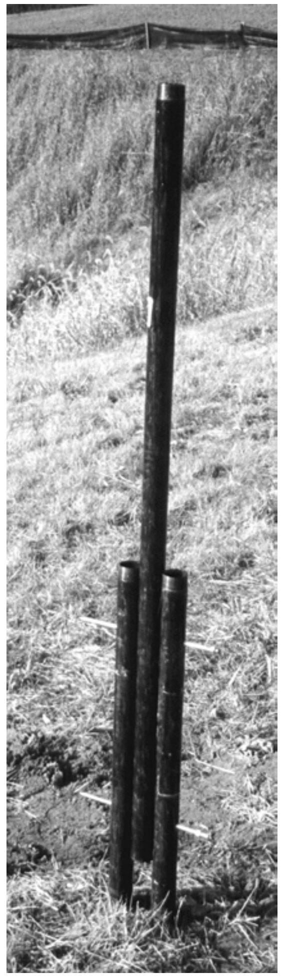


Figure 1: Two pipes anchored in ground

Figure 3: Walking the antenna up (or down) is a relatively simple 1-person job. Notice short supports to hold antenna horizontal.

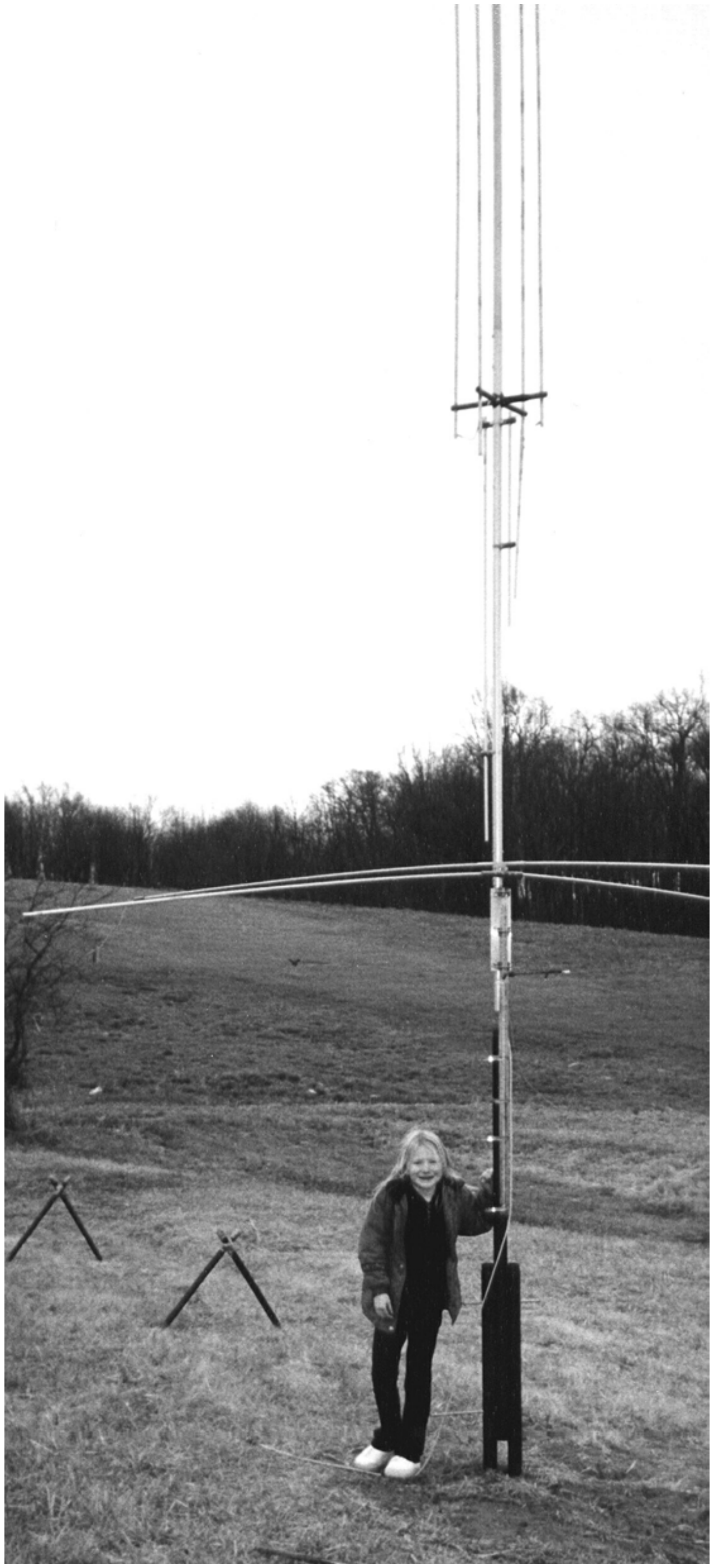
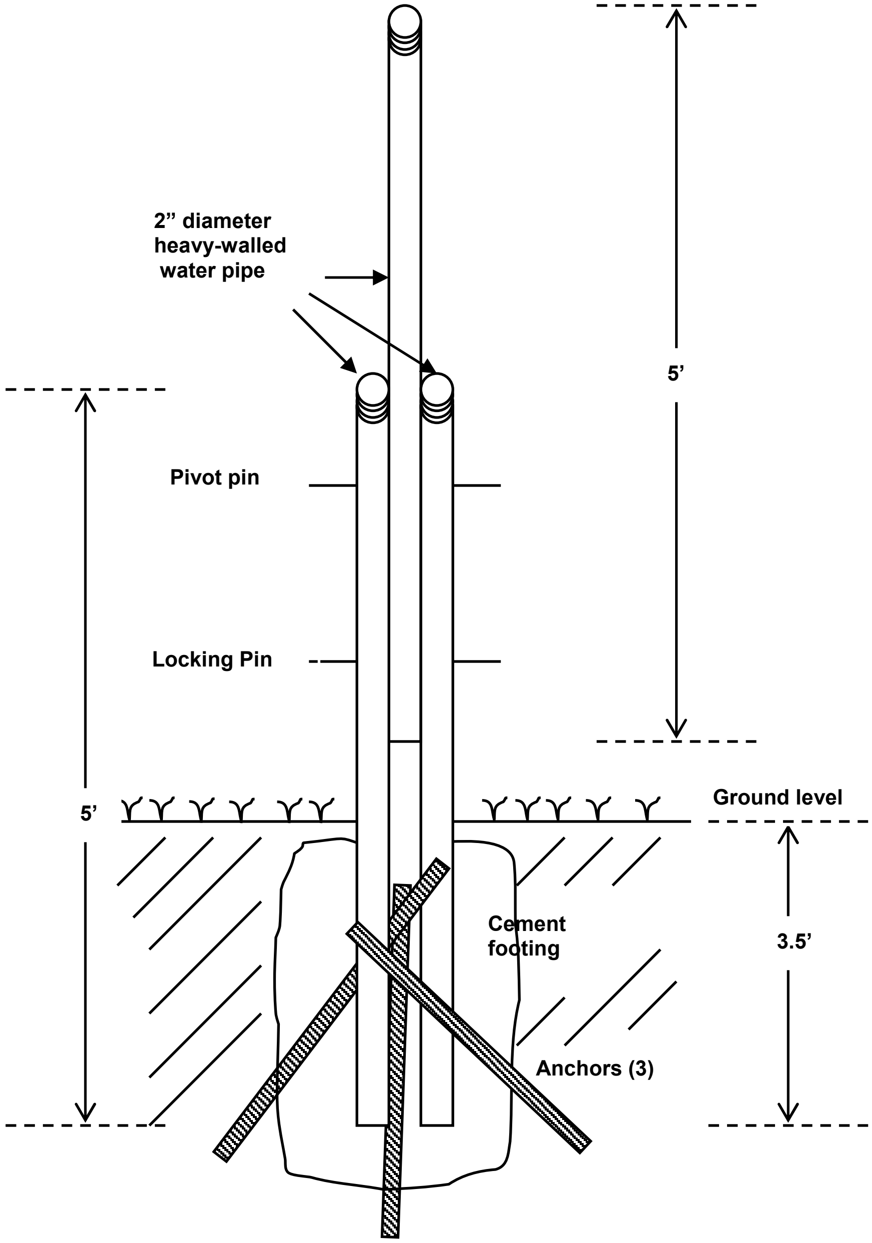


Figure 4: My daughter stands at the base of the GAP antenna once pinned in place.

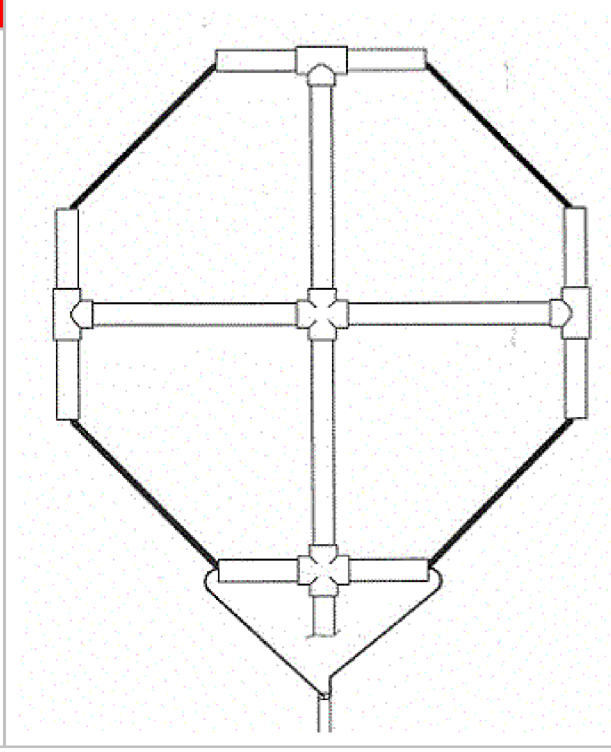

2” diameter
heavy-walled
water pipe
Pivot pin
Locking Pin
5’
5’
Ground level
Cement
footing
3.5’
Anchors (3)

AmQRP.ORG HOMEBREWER

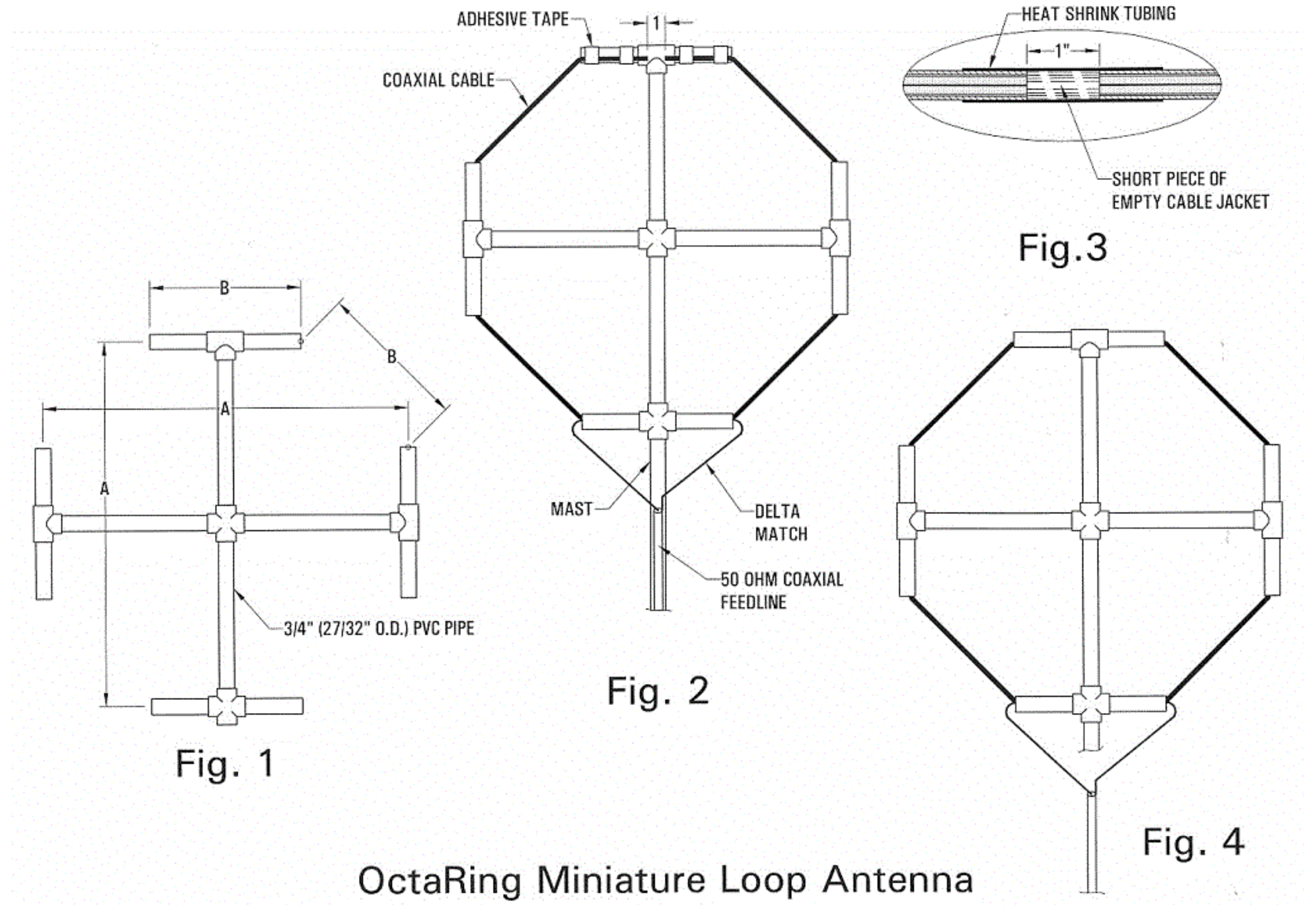
George Murphy, VE3ERP

The OctaRing Miniature Loop

Ever wonder how an Octaloop becomes an OctaRing ? Here's how…………



The OctaRing is a variation of Harold Kane's (W2AHW) Octaloop antenna (See American QRP Homebrewer, issue #6, page 86). Before getting too far into the OctaRing discussion, I recommend you review the Octaloop article, since it contains a lot of design information that also applies to the OctaRing.



OctaRing Miniature Loop Antenna

The Octaloop is basically a dipole with both legs bent upward in segmented steps until they form an octagonal loop with the ends not quite touching (They had better not because even with low powered transmitters there can be a dangerously high voltage potential across the ends). Tuning is similar to many other miniature loop antennas and is accomplished by a variable capacitor at the top connected across the ends. Because of the high voltages the capacitor tends to be very large and expensive, if indeed you can find one.

The Octaloop's variable capacitor is a coaxial cable tuning stub that connects the stub's inherent capacity across the loop's ends. The OctaRing has no trimmer at all, the length of the cable loop being calculated so the cable's inherent capacity and inductance achieve resonance at the design frequency. At the design frequency, the total length of radiator in the OctaRing is slightly greater than in an Octaloop making it somewhat more efficient. Fine tuning is accomplished by pruning the ends, which reduces the length of the loop when the ends are pulled together to about one inch between them. The PVC pipe frame is designed to provided a slightly sloppy fit for the cable to allow for some reduction of the overall length due to pruning.

Construction and Pruning:

1. Run HamCalc's "OctaRing Miniature Loop Antenna" program (HamCalc version 81 or later) to establish all dimensions. The dimension "A" between sides is between the PVC pipe center lines.

2. Assemble the frame (Fig. 1) using PVC pipe cement. DO NOT cement the two side tees to the horizontal centre pipe yet. Just press fit them in place.

3. Cut the perimeter cable about 5% longer than the design length to allow for pruning and thread it through the bottom and side tees but at the top just tape the ends spaced 1" apart to the top tee (Fig. 2).

4. At the two ends of the bottom tee strip an inch or two off the cable and tack solder the two delta match wires to the braid of the cable (Fig. 2). Use heat sinks on either side of the joint to minimize melting the dielectric.

5. Attach the delta match wires to the coaxial feedline, and you are ready for testing and pruning.

6. Your initial test should find lowest SWR at slightly lower than the design frequency. Trim the same amount off each cable end until the SWR is lowest at the design frequency. As you pull the ends together to re-tape to the tee, if necessary slip the side tees off the centre pipe, cut a bit off the ends of the horizontal pipe and replace the side tees. When pruning is complete, unsolder the delta match wire at the right end of the bottom tee. Ease out the side tees far enough to apply cement and cement them back in place.

7. Remove the tape holding the cable at the top tee, insert the left side cable end into the left end of the top tee and gently "walk" the cable around until the cable end comes out the right end of the tee.

8. Slip a piece of heat shrink tubing over one end of the cable, insert a spacer made from a short length of cable jacket then insert the other end of the cable into the tubing (Fig. 3). Centre the heat shrink tubing over the joint and shrink it with a hair dryer or other heat source.

9. "Walk" the cable back until the connection point for the removed delta match wire reappears at the right end of the bottom tee. Re-solder the delta match wire in place and you are done (Fig.4)!

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David S. Forsman, WA7JHZ

The Shannon-Hartley Theorem as Applied to Broadband-Over-Power-Line (BPL)

For those of us who love and enjoy high-frequency (HF) communications, we are indebted to Claude Elwood Shannon and Ralph Vinton Lyon Hartley. They are the fathers of modern *information theory* and the authors of the Shannon-Hartley theorem: a mathematical expression that defines the *channel capacity*, C, of any communications system in *bits-per-second* (bps) given only its *bandwidth* (BW) in Hertz (Hz) and its *signal-to-noise* (S/N) ratio in units of power (not dB)

$$C = BW \log_2(1 + S/N)$$

Using natural logarithms (Ln) and decibel (dB) values in place of S/N (dB=10log(S/N) and S/N = 10^(dB/10)), the fundamental equation can be expressed in the following three forms that are more-easily applied to electronics:

$$C = BW \frac{Ln(1 + 10^{\frac{dB}{10}})}{Ln(2)} \qquad BW = \frac{C \; Ln(2)}{Ln(1 + 10^{\frac{dB}{10}})} \qquad dB = \frac{10 \, Ln(2^{\frac{C}{BW}} - 1)}{Ln(10)}$$

First, for reference, we define a *bit* as the fundamental unit of binary (two-number) information; there is nothing smaller. The well-known “bits” from computer science are usually denoted as zeros (0) and ones (1). In fact, any logical relation can be assigned to the values of the two bits: red and green, hot and cold, up and down, X and Y, and so on. When applied to broadband-over-power-line (BPL) circuits running at specific bandwidths (BW) and signal-to-noise (S/N) ratios, their number, in bits-per-second (bps), represents the amount of fundamental information that the system can carry in a given amount of time. Many interesting relationships in BPL function can be calculated from these three basic equations (see SHANHAR2.EXE executable BASIC program).

For example, suppose that the 40-meter Amateur Radio band (7.0 to 7.3 MHz) is going to be used for a nearby BPL project. The BPL contractor needs to simultaneously serve 30 customers in a housing subdivision with the equivalent of 28.8 Kbps dial-up modem capacity for each of his customer nodes. We know that he intends to use a bandwidth (BW) of 300 KHz (7.0 MHz to 7.3 MHz) and that he also needs a total channel capacity of 864 Kbps (28.8 Kbps x 30 customers). Assuming that his BPL transceivers have 100% modulation data conversion efficiency (only in a perfect world), let us calculate the S/N value in dB that his system will need.

Using the dB solution equation, above, and calculating using 300 KHz bandwidth (BW) and 864 Kbps capacity (C), the contractor would need to inject his BPL signal at about 8 dB above the noise floor of the 40-meter band. If there were strong nearby SSB, shortwave broadcast, or CW signals, he would need to overcome those levels by the same 8 dB value. To maintain his desired channel capacity of 864 Kbps, the BPL contractor could continue to increase his injection signal level up to the FCC limit which is not currently set at this time. The end result would be strong BPL interference to both 40-meter Amateur Radio and shortwave station reception in both the subdivision and the adjacent neighborhoods. Only the strongest nearby Amateur Radio stations would now get through.

Obviously, this is not a good outcome for Amateur Radio operators and/or shortwave broadcast listeners. BPL has the potential to end practical communications on the high-frequency (HF) Amateur Radio and shortwave broadcast bands. You may think that a solution would be to increase your power level by 8 dB to overcome the BPL interference, but this would only increase your current 100 watts of output power to 631 watts. The BPL contractor could easily match your increase with an increased power line signal injection level, and the game would be over.

So, what is a solution to BPL interference? Unfortunately, there appears to be none. In spite of BPL's shortcomings, and that some nations have already banned or restricted its use, Congress, the FCC, and the President believe that it is necessary for America to have this new Internet technology. Faced with future unknown disasters and the need for emergency communications, Americans will have only their basic cell phone systems to, hopefully, carry them through--and I am very skeptical.

David S. Forsman, WA7JHZ

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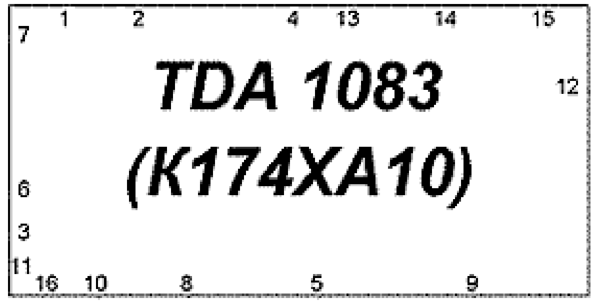
Serge Dyilda,US5QBR

Simple 80m SSB Receiver

A brilliantly-simple receiver using a one chip receiver for 80 Meters



Once came to me the idea of creating an one-chip SSB RX. I want to have the simple and relatively high-performance receiver, which can explore only one IC and can be assembled during one week-end. Having looked through about two tens of projects, I came to the conclusion: the most suitable IC for that purpose (price/functionality) will be TDA1083 (analog to K174XA10-Russia, A283-Germany).

(Editor's Note: See http://www.schema.academ.org/mic/tda/tda1083.pdf for the chip datasheet. Chip is made by Telefunken and others, use Google to find a vendor)

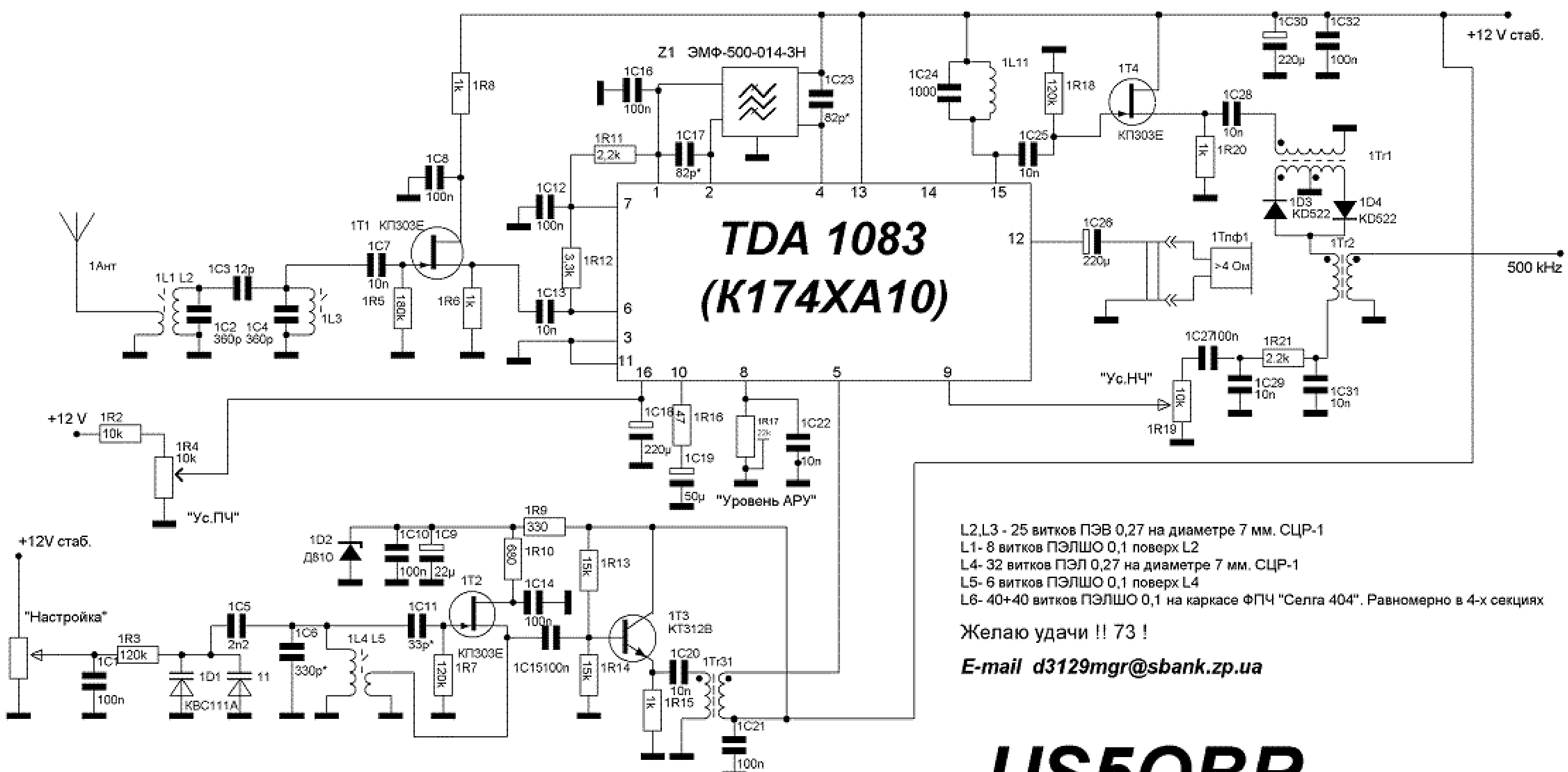
The simple schematics of my project appears below. This is, as you see, not a one-chip RX, but still it has not many components to add to.

As far as the main selective element is concerned, electro-mechanic-filter (EMF) with lower side-band is chosen, as the most common part with the new-comers.

Схема простого SSB приемника на 3.5 Мгц на ИМС TDA1083

Чувтсвительность около 1 мкВ

Динамический диапазон около 80 Дб



L2,L3 - 25 витков ПЭВ 0,27 на диаметре 7 мм. СЦР-1
L1- 8 витков ПЭЛШО 0,1 поверх L2
L4- 32 витков ПЭЛ 0,27 на диаметре 7 мм. СЦР-1
L5- 6 витков ПЭЛШО 0,1 поверх L4
L6- 40+40 витков ПЭЛШО 0,1 на каркасе ФПЧ "Селга 404". Равномерно в 4-х секциях

Желаю удачи !! 73 !

E-mail d3129mgr@sbank.zp.ua

US5QBR

The connection of TDA 1083 IC (herein referred to as the IC) to other components is mostly typical, but there are some notes:

1. There is a separate two-transistor VFO used instead of IC's VFO. The board resident VFO permits to fully decoupling the VFO from IC and reduces frequency deviation, which occurs under powerful incoming signals in the case of IC's resident VFO.

2. To produce a better signal-to-noise ratio I did not use the IC's AM-demodulator, which could be used as a mixer by putting a 500Kc BFO signal to pin 14 of IC through a small value cap. I decided to use a simple two-diode balanced mixer (1D3, 1D4). Even with unmatched diodes this mixer demodulates better and at minimum of noise than the IC resident demodulator.

The operation of the receiver (in brief).

The incoming signal from antenna passes to the band-pass-filter (BPF) consisting of 1L1, 1L2, 1L3, 1C2-1C4. The filtered signal is fed to the gate of 1T1 which functions as a source-follower. Many of hams ignore such a simple method of matching the BPF to the IC. By the way, 1T1 stage has the 100% negative voltage fold-back, this fact improves dynamics of receiver and helps to get the full voltage from BPF. The next signal maintenance is produced by the IC: it converts the incoming signal frequency to 500Kc IF and amplifies it. The tank circuit consisting of 1C24, 1L11 is the IC IF load. To have again the full voltage from the tank-circuit, the more source - follower is used (1T4). Then IF signal is put to balanced mixer (1D3, 1D4), where it is mixed to BFO voltage (500Kc). After simple LPF 1C31, 1C29, 1R21 the demodulated signal comes to the audio amplifier input (again to IC) through volume control pot 1R19. By changing the resistance of 1R16 You can choose the gain of this amp. The lack of this resistor can make the audio amp oscillate. You must choose "the golden middle point" – maximum gain at minimum noise.

There is an IF Gain control installed in the receiver. The simplest method to change the gain is to vary the supply voltage of the Chip's IF amplifier at pin 16. This method shows itself to be rather effective: at 0 V IC is fully closed, the maximum IF amp gain comes at Vcc/2 at pin 16. 1C18 must be not too large (max 220 μF), because it will cause the slow AGC: the larger 1C18, the slower AGC. 100…200 μF is enough.

The internal structure of TDA1083 is that the AGC is always functional, You can not switch it off. You can only slightly change the starting AGC point, which is set by 1R17 (22 kOhm) inserted between pin 8 of IC and the common ground. The author's variant of the receiver lacks it.

Headphones are taken from a CD player "TECSUN" (RL = 32 Ohm).

The VFO schematic is common, but here is the underlying method of getting absolute immunity of oscillator (1T2) to powerful incoming signals by using the buffer stage consisting of 1T3 (No chirp).

To tune the receiver along the band a varicap-matrix is used. The matrix KBC-111A consists of two varicap-diodes connected series-against one another. I've put two matrixes (four diodes) into the Receiver schematics to have the tuning range ability from 3,5 to 3,7 mc. Certainly, You can use the variable cap undertaking some corrections to VFO oscillator tank circuit.

The 500 Kc BFO schematic is simple, common but is not present here. BFO's output voltage must be not less then 1.5 V at the load of 500…1000 Ohms.

As BFO crystals were taken ones piezzo from China. They have wide tolerance marked as 500 kc. The frequency shift in BFO produced by series connected to crystal coil or cap can reach 10-15 kc.

Tuning.

The tuning of the receiver is simple and goes on usually without problems. If You mount all the components right and all of them are functional, the RX will function when power is applied. You have only to set the 80m band by using the VFO, - it has to oscillate in between 2,8-3,0 mc (with lower side band EMF). Connect a suitable 80m antenna to the Receiver's rf input. Using received weak signals in the 80m band, tune to maximum BPF in two points at edges of the 80m band, then tune the IF tank circuit to maximum output signal. Also tune the IF tank circuits to maximum of output signal at the EMF's terminals by trimming the values of 1C17 and 1C23. Choose weak signals for tuning so as not to spoil the result by the functioning of the AGC circuit. That's all.

This RX was mount on experimental board as a week-end project. Till now I could not destruct it, the quality of functioning is so high that one wants to sit at RX for hours. The dynamic range is about 80 dB that is enough for this kind of RX. "Soft" CW and "jussy" SSB signals strike me till now. I recommend to use the ear-phones "TECSUN" or equal produced according to "SUPER-BASS" technology. This kind of ear-phones produce super sound (not plain) according to their construction, resonating capsules are put into the ears.

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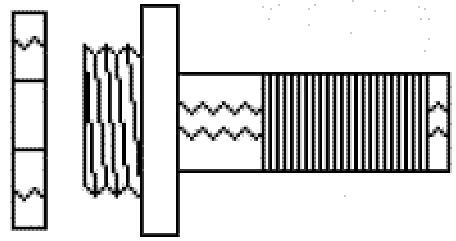
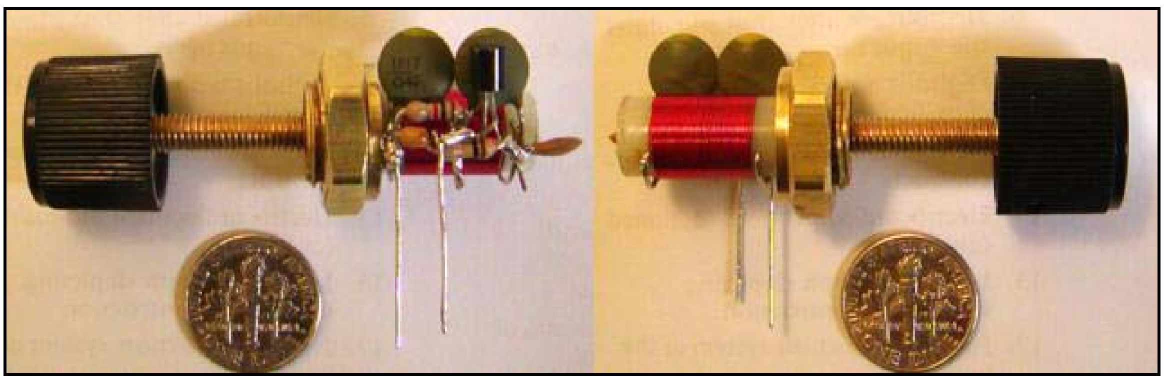
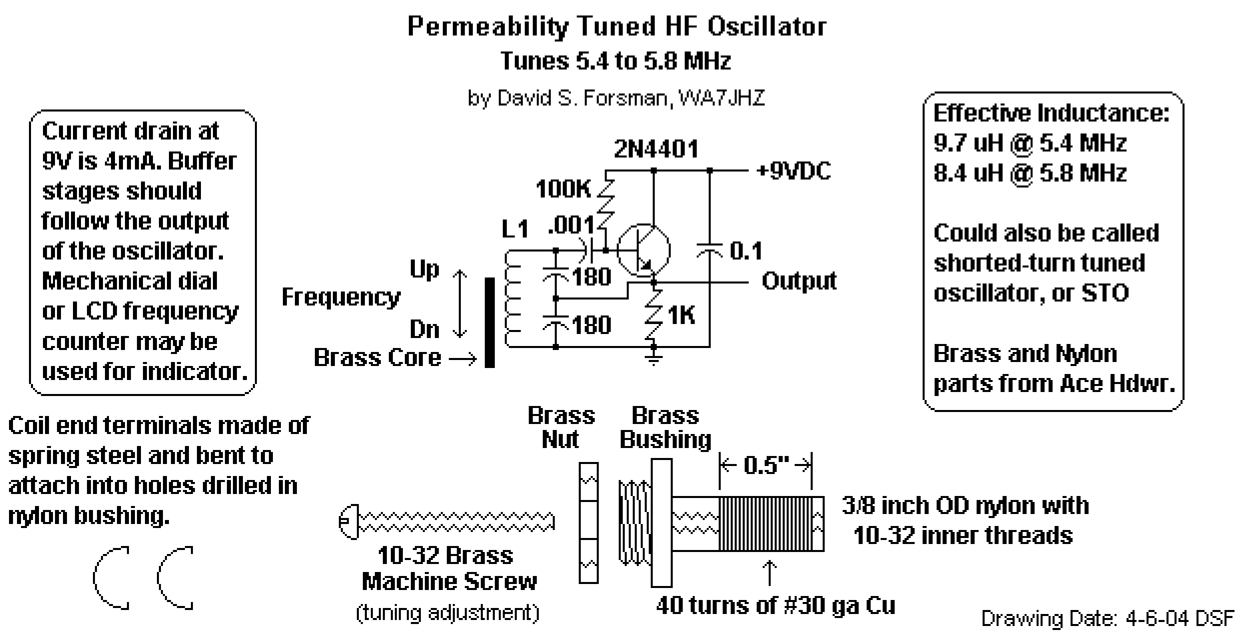
David S. Forsman, WA7JHZ

Colpitts PMT Oscillator



Following is a schematic and an image of a HF oscillator that I recently put together. I was inspired by the "Tin Ear" receiver, but I wanted to use a Colpitts design instead. This is a good alternative to finding variable capacitors or making varactor diode tuned oscillators.





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David S. Forsman, WA7JHZ

Human Power

David has found a way to keep fit and provide power for a radio. All you need is to be able to pedal and talk at the same time.

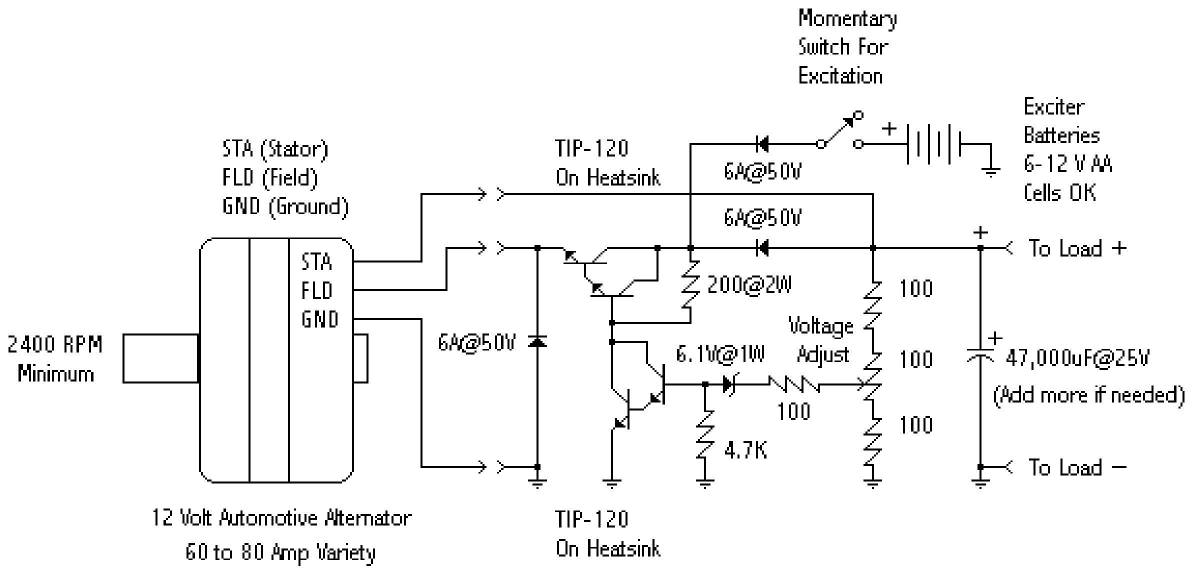
Here is a twelve-volt generation system for human power. I used it for energy presentations to freshmen physics students at the local Lewis-Clark State College, and to power a small television in my living room for exercise.

I run the generator from a modified stationary exercise bicycle. This should be a good project for amateur radio groups on field day--emergency power points. A person in good physical condition can get 500 watts electrical output (or more) for short durations of about 60 seconds. I have also powered an ICOM 707 with this device. I hope that you enjoy this project.

Human Powered Twelve Volt Electrical Generation System

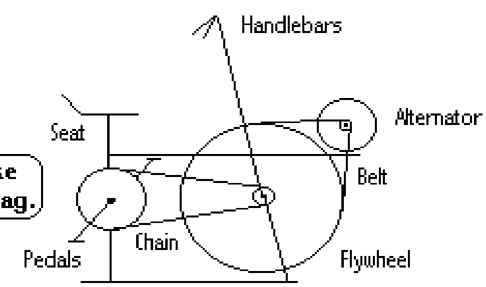
"From A Ham In Idaho"

April 1989



All resistors 1/2 Watt except as otherwise noted. TIP-120 transistors are both mounted on heatsinks. Excitation batteries last for many months, since they are only used for a few seconds each time the generator is operated. The output voltage of this system is suitable for the operation of shortwave amateur radio 100 Watt class SSB, CW, and AM stations. For foot pedal operation, induction gearing of at least 40:1 is necessary to bring alternator RPM to efficient range.

Stationary Bike Mechanical Diag.



Here is an electrical generation system that can be powered by an exercise bike, regular bicycle, wind, water, or anything that can spin the alternator. It has regulated voltage output with low ripple, and can be adjusted to any voltage from 10 to 15 volts. It can be used to power emergency lights, communication equipment, amateur radio field day equipment, educational energy presentations, or anything that operates from a twelve-volt power source. In its basic form, the author hired a local machine shop to cut a 3/8 inch belt groove in a stationary exercise bicycle flywheel. He then attached the alternator to the bike frame, added a smaller pulley to the alternator, and connected it with a fractional horsepower rubber belt. He has used it mainly to operate a small television (while exercising) and to give energy presentations to physics students. The main power limitation of this device is the power source. An average human being can supply a mechanical power output of about 100 watts. Due to the mechanical and electrical efficiencies, only a part of the mechanical input power is converted to electrical power. For short durations, humans can exceed 500 watts of electrical power output with this generator! For long-term continuous output, expect only ten to twenty watts of electrical power. Use safety guards on all mechanical parts like chains, flywheels, and belts--they are dangerous. The author assumes no liability for either its use or misuse.

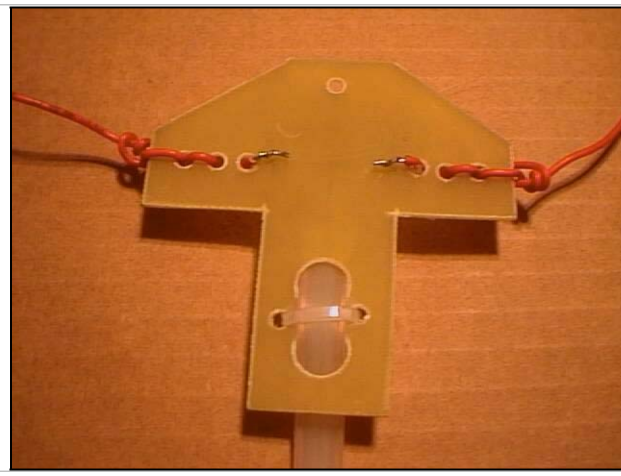
Drawing Date: 7-6-03

AmQRP.ORG HOMEBREWER

Joe Everhart, N2CX

80-Meter Alchemy with the SQUIRT Antenna

Golden-Oldie Low-Band Antenna Formulas



80 meters is a great band! It has lots of advantages for reliable 24-hour local communications at almost any time of the year. And the recent introduction of a PSK31 rig for that band called the PSK-80 adds a very effective new means of using the band. Unfortunately many hams don't take advantage of this band because they think that it takes a huge property to put up an effective 80-meter antenna. This article will briefly discuss some of the advantages of 80-meter operation and describe some tried and true antenna solutions to the limited space dilemma.

At 3.5 MHz, 80 is the lowest true HF band since 160 is, by definition, an MF band - check it out for yourself in the ARRL handbook! Being relatively low in the spectrum, 80 is the highest frequency ham band that supports true ground wave propagation. In this mode, vertically polarized signals hug the earth providing fairly stable round-the- clock coverage. During the day the ionosphere also supports high-angle ionospheric propagation (called NVIS or near vertical incidence skywave) that also favors close-in communication. Practically speaking these two modes cover out to perhaps a couple hundred miles. But the coverage is continuous within that radius! Try that with your two-meter repeater…

After sunset ionospheric absorption decreases and lower-angle refraction occurs which can result in trans- or inter- continental contacts when conditions are favorable. This is not for the faint of heart though when you are using QRP.

Summer activity on 80 suffers quite a bit due to atmospheric noise or QRN. Far-off lightning produces a most annoying cacophony of crashes that mask weak QRP signals. And the ever-present electrical noise and computer generated hash in densely populate areas tend to cause hams to shy away from 80.

Those of us (alas, QCWA-bait) who began hamming in the middle of the just-past century remember when 80 was much more popular as a superb local band. As a novice back in the 60's I found a number of my fellow rookies on 80 cw afternoons year-round. We would rush home from school to pound brass daily on impromptu nets. No one told us that 80 was no good during the day so we successfully pushed out 75-watt max signals all over the East Coast. From southern NJ it was routine to work other novices from Virginia up into New England and out as far as western Pennsylvania.

Recent QRP beacon experiments have focused on 40 meters with good results. However WA3NNA ran an 80-meter QRP beacon one March weekend several years ago and demonstrated that his qrp signal was eminently copyable over the same range. In fact he had a good solid signal that was pounding in to the W1AW ARRL HQ station during an NEQRP meeting.

And when 80 meter activity was more common, 80 has been the absolute best band for banging out contacts during the ARRL Field Day even when running only 5 watts or less.

In the last couple of years there have been several attempts to revive 80-meter operation by the QRP gang. For several years the New England QRP Club (or is it the QRP Club of New England) ran a 79'er Sprint which centered on crystal controlled operation at the color burst frequency. And the Knight Lites offered a surface mount technology 80-meter rig based on the Pixie. A number of kits were sold and there was lots of activity by its builder on 3686.4 kHz. And several QRP clubs offer nighttime nets near the QRP watering hole of 3560 kHz.

Now there is an exciting new reason to operate on 80 meters – PSK-31. This very narrowband digital mode has lots to offer, as a conversational medium in addition to offering robustness needed for QRP operation on 80 meters by virtue of its narrowband nature. Availability of this neat new rig is a good reason to try out 80 while pioneering a new facet of amateur radio.

Probably the biggest roadblock to getting on 80 is probably the perception that you can't put up an effective 80-meter antenna in a small yard. To this I say balderdash, hogwash, bull shoes and horse hockey! A number of very effective antennas have been used historically on 80 and several of them are as small as more common 40 meter antennas. While you can go out and buy some, this article will encourage you to build your own or at least buy an inexpensive kit (more about that later…)

Lots can be written about the relative merits of various 80-meter antennas and there will be a follow-up article doing just that. For now, however the merits are summarized in Table 1. This table summarizes tradeoffs between some likely candidates. As you can see, my choices are the half-size center-fed dipole and the ¼-wave Marconi set up as an inverted L. In fact for best space efficiency the center-fed dipole is best erected as an inverted Vee. Let's look at these in a little more detail.

Table 1 - Homebrew 80 Meter Antenna Comparisons					
Type	Size	Efficiency	DX/Local	Best use	Comments
1 wave loop	Very large	Good	Either if high	Large space	Poor urban utility Needs tuner
½ wave dipole	Large	Good	Either if high	Large space	Poor urban utility
G5RV	Moderate/ Large	Good	Either if High	Moderate Space Candidate	Slightly Smaller than Full Size Dipole
¼ wave dipole	Moderate	Moderate	Either if high	Limited Space Candidate	Space efficient Needs tuner
¼ wave vertical	Large	Varies	Ground wave or DX	Serious DX	Poor urban utility Needs good ground
Short vertical	Small to Moderate	Poor to Abysmal	Ground wave or DX?	Mobile or Dummy Load	Poorest efficiency
¼ wave Marconi (Inv L)	Moderate	Varies	Either	Limited-Space Candidate	Space efficient Needs good ground
Random wire	Varies	Varies	Varies	Portable Operation	Best if over ¼ wave Needs Tuner
W3EDP	Varies	Varies	Varies	Portable Operation	Needs Tuner
Magnetic Loop	Small	Can be Good	Either	Special Purpose	Needs Skill to Build $$ Capacitor
DCTL	Small	?	?	?	Cheap, Worth Checking Into

It's ironic that these two represent the earliest types of radio antennas. The half-wave dipole is a form of the Hertzian antenna used by Heinrich Hertz in his early radio experiments and the quarter-wave wire fed against ground descends from the antennas that Guglielmo Marconi used! Boy, talk about resurrecting the old stuff…

The ¼ wave dipole is a compromise between space savings and efficiency. At half the size of a full half-wave it is much easier to fit in a small back yard. Smaller would fit better but its losses increase substantially when shorter than ¼ wave. At this length the antenna itself suffers a decrease in radiation of no more than a dB or two. However a so-called "tuned feeder" is needed since the feedpoint impedance of the antenna is not a simple resistance.

A feedline length can be chose to present an impedance that can be handled with a very simple tuner – at least for single-band operation. The feeder operates at a rather high SWR between the antenna proper and the tuner. This means that you must use a relatively low-loss feeder to minimize added loss. The best solution is to use high impedance open wire or "window" line. If you can accept a fraction of an S-unit more loss, a good grade of 300-ohm twinlead is an inexpensive option.

Figure 1 shows a photo of just such a reduced-size 80-meter dipole using some hard-core do-it-yourself materials.

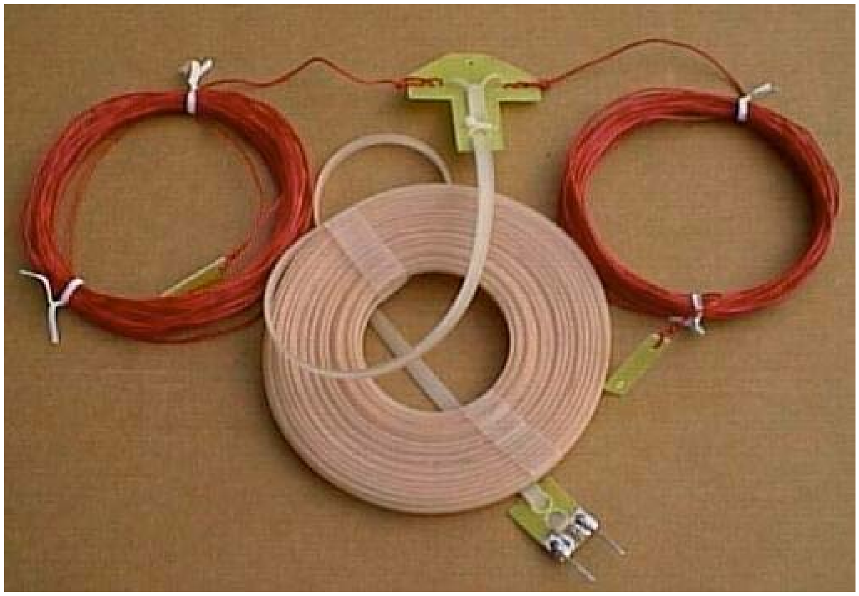


FIGURE 1. REDUCED-SIZE 80-METER DIPOLE.

It's a dipole antenna with two 34-foot legs composed of small-gauge hookup wire and fed with 300-ohm twinlead. As described above it's half the normal size for an 80-meter antenna and when set up as an inverted vee requires only about 50 feet of space.

Piece parts used in the antenna are detailed in the next couple of figures. A center insulator is fabricated from a scrap of glass-epoxy printed circuit board which has the copper removed. Holes are drilled in it to accept the dipole wire legs and to provide strain relief for 300-ohm twinlead.   Figure 2 is a blow-up of the center insulator. Two sets of holes are used for the dipole wires to give strain relief as the antenna sways in the wind. Similarly the twinlead snakes through two sets of larger holes and is held securely by a nylon cable tie.

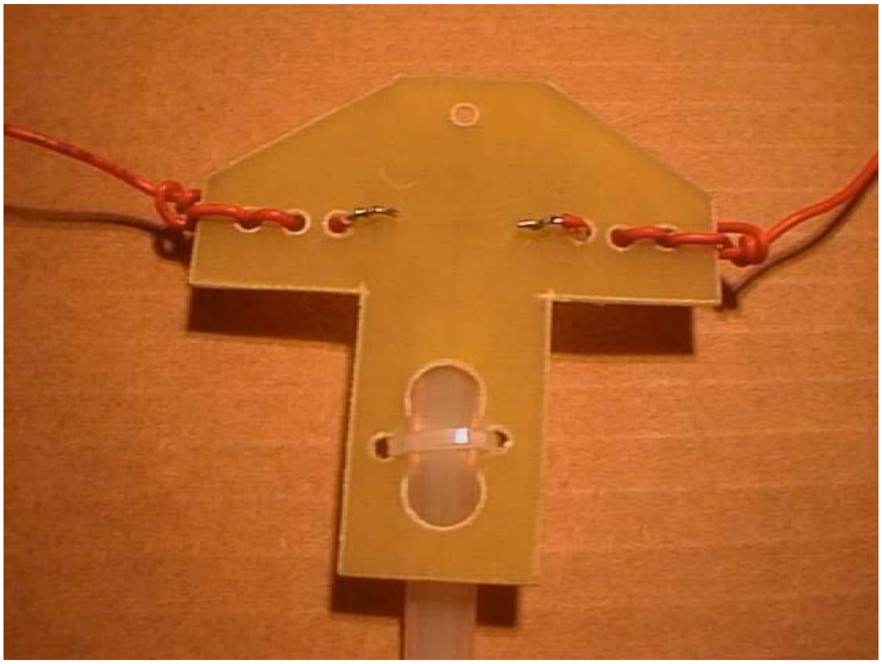


FIGURE 2. CENTER INSULATOR.

Dipole wire end insulators are also made from smaller pieces of the same pc board stock.

The “ground” end of the twinlead is terminated in a homebrew connector of sorts made of (you guessed it!) more pc board material. See Figure 3.

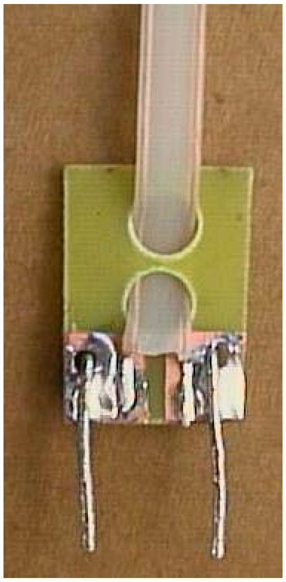


FIGURE 3. HOMEBREW CONNECTOR SHOWING TWINLEAD TERMINATION.

The ribbon passes thorough two holes to secure it and the two individual conductors are soldered onto two pads of left-behind copper, which terminate in large-gauge copper wire used as terminals. These 12 or 14 gauge wires pass through holes in the copper-clad area and are bend under for mechanical strength. The two leads are spaced ¾ inch apart so that they will mate with standard dual-banana jacks as found on many antenna tuners. Figure 4 is a photo of the connector mated with 5-way binding posts on the prototype tuner.

FIGURE 4. CONNECTOR MATED WITH 5-WAY BINDING POSTS.

Dimensions for the insulators are given in sketches in figure 5.

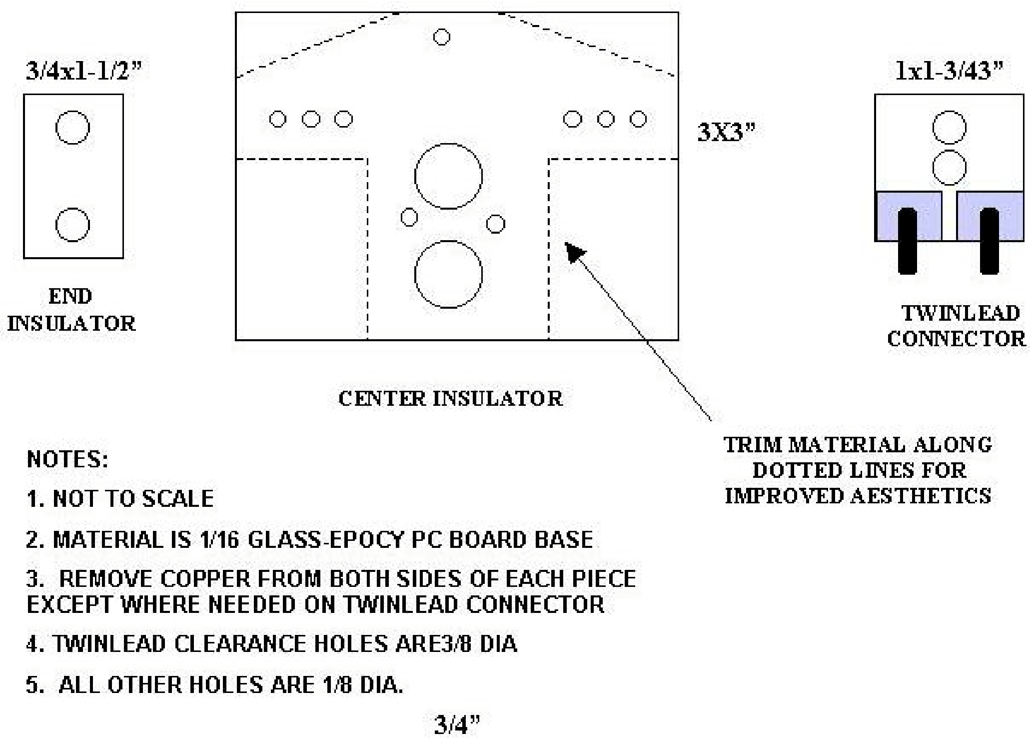


FIGURE 5 - SQUIRT INSULATORS AND CONNECTOR

The feeder must be of a length that it presents an impedance that your tuner will handle. Some pruning of this length might be necessary depending on which tuner you use. An empirically determined feeder length (cut and try…) of about 45 feet can be readily matched on 80 with the very low-parts-count tuner shown in Figure 6 and 7.

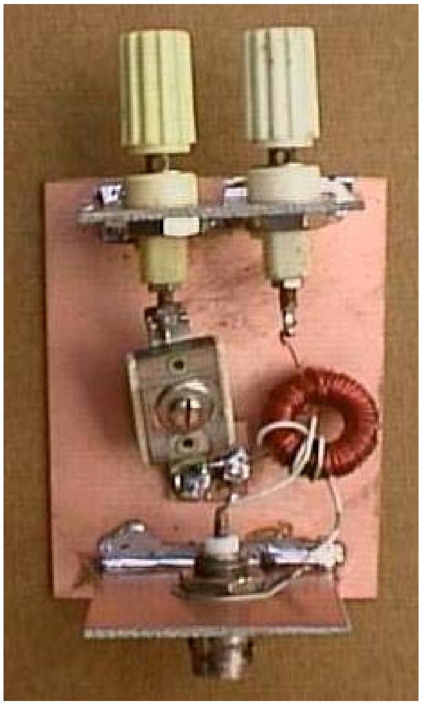


Figure 6 – Squirt-80 Tuner

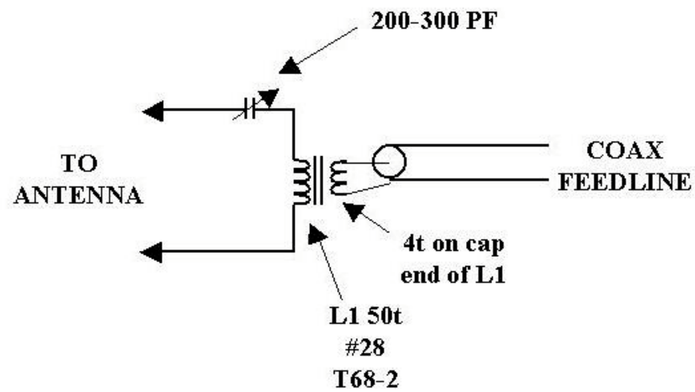


Figure 7 - Squirt-80 Tuner Schematic Diagram

The antenna impedance is low with this length so it can be matched with the series –resonant circuit shown. The variable capacitor allows adjustment to resonance over the low end of the 80-meter band. The link shown on the coil provides a good match to 50-ohm coax cable. The prototype used 50 turns of #28 ga. enameled wire with a 4 turn link. The tuning capacitor employed was a 300-pf mica compression trimmer. Any type of small variable capacitor of that value can be used but it must be floated above ground and thus may present some hand-capacitance problems.

The antenna and tuner are very high Q so tuning is rather sharp. With a little trial, SWR can be gotten as low as 1.5:1 at any single frequency between 3.5 and 3.6 MHz. However since it tunes sharply, you may have to readjust if you move more than 10-15 kHz from where you first tuned up. This is not at all a problem with PSK-31 since most operation is within a couple of kHz of 3580 kHz.

Since the antenna was intended for limited space situations and erected as an inverted vee, light-gauge hookup wire was used in the prototype. Dipoles put up this way have most of the weight borne by the center support so the legs don't have to be very strong at all. If the dipole is supported horizontally or if its supports sway appreciably in the wind, heavier gauge wire is called for. As with any horizontal antenna, generally you want it as high as possible. But for NVIS use extreme height is not what you want. Practically speaking a center height of 20 to 30 feet is fine and the ends should be at least 7 feet or so above the surroundings. It will work at lower heights but ground losses might degrade its radiating properties. See Figure 8.

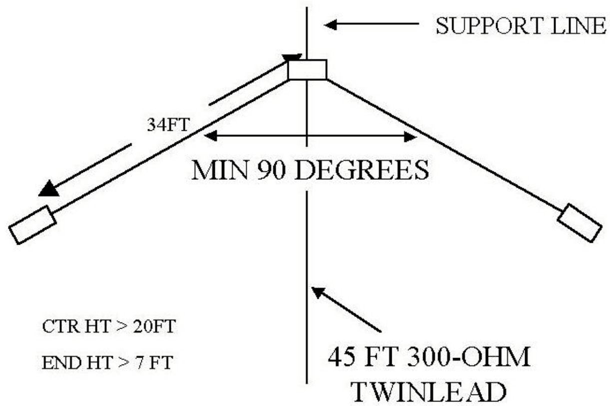


FIGURE 8- SQUIRT ANTENNA SKETCH

Though small in size this antenna works nearly as well as a full-size dipole antenna. A similar device has been in use at N2CX for the last year. The only significant difference between the two is that the N2CX home antenna uses 300-ohm “window” line instead of twinlead. It has garnered a whole slew of contacts on 80 thru 10 meters using a different tuner (the Emtech ZM-2). For the last month the old antenna was taken down and replaced by a Squirt. Almost no change in performance was seen! Even during August a number of 599 reports were received on local 80-meter contacts and PSK-31 operation on 80 has been very successful using the Squirt with the tuner described in this article.

An even simpler limited-space antenna is the Marconi. While not as efficient as the dipole, it can be pressed into service. Let’s look at just how. The Marconi quarter-wave end –fed monopole can be used in an inverted L configuration to end up with a smaller footprint a shown in Figure 9.

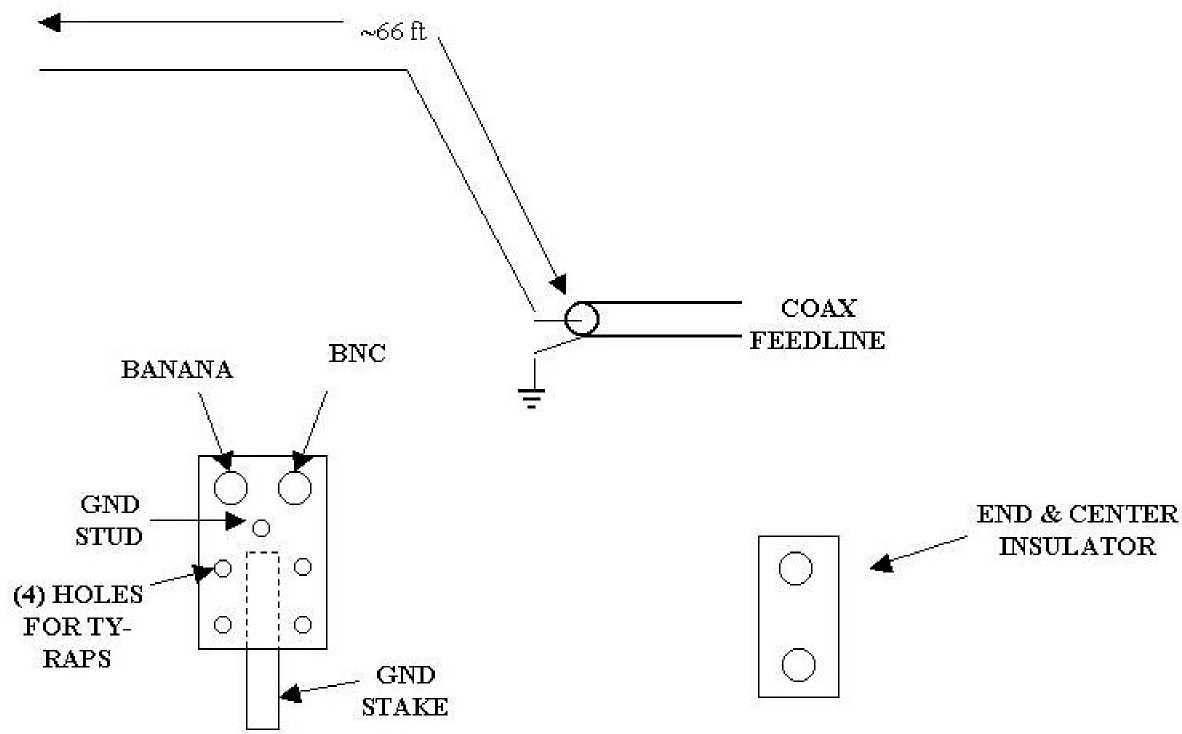


FIGURE 9 - INVERTED L ANTENNA

The vertical portion acts as a vertical radiator to give some ground-wave radiation while the horizontal length provides high-angle NVIS operation. Results will be poor unless the horizontal portion is at least 20 feet above ground. Marconi will be very inefficient unless a proper ground system is used. An absolute minimum of 4 radials is needed, and their length should be 30 feet or more. Keep in mind that this antenna's ground requirements are similar to the quarter wave vertical. Recommendations for them call for up to 120 radials each ¼ wave long 66 ft.

The inverted L can be made from light gauge wire just as the dipole was since it will not have to support much weight. Insulators can be made from pc board material just as the end insulators for the dipole. You can likely get away without a tuner since at resonance the Marconi will have an impedance that will be close to 50 ohms. In fact it will be lower with a good ground so a good match doesn't necessarily mean a high efficiency.

So there are two limited space antenna options for 80 meters. Either one can give good performance on 80 depending its erection. The dipole antenna is likely to be more effective if you have room to erect it and at least
One high support. If not the Marconi inverted L might work out well particularly if you can arrange a good ground system.

NJQRP is offering the above antenna, called the Squirt-80 as a companion to the PSK80 rig. The Squirt is a kit project. All materials needed to make the antenna and a breadboard-style tuner are included along with directions to guide you through the process. Construction can be completed in an afternoon.

The kit includes:

2 – 34 foot lengths of insulated hookup wire
1 – 45 foot length of 300-ohm twinlead
1 – T68-2 toroid core
1 – length of magnet wire for tuner inductor
1 – 300-pf mica compression trimmer
2 – binding posts
1 – BNC panel-mount connector
An assortment bunch of pc board pieces for you make the required insulators and a Manhattan-style tuner.

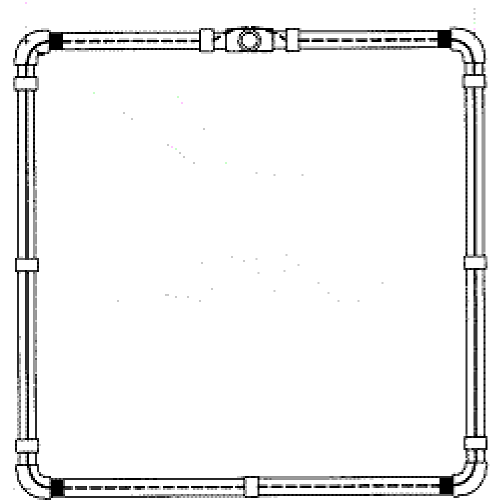
Joe Everhart, N2CX
n2cx@verizon.net

AmQRP.ORG HOMEBREWER

George Murphy, VE3ERP

QuasiQuad Antennas

A small antenna that's easy to build and modify



THE CONCEPT

Being a QRPerson, I think Low and Small - Low power, Small rigs; Low budget, Small bank account; Low cost and Small antennas. Here are a couple of cheap and easy "Design-It-Yourself" miniature QuasiQuads for those of us who like to experiment. You can design one in about 5 minutes using HamCalc software, version 81 or later (download it for free at www.cq-amateur-radio.com) and you can "breadboard" the director element around 4 nails in a piece of plywood to see if it works before building the supporting frame and the reflector element.

Here's how to design and build a QuasiQuad:

DETERMINE SIZE:

Yes, you CAN fit a quad into a small space by building a coil shortened quad as described by Kris Merschrod, KA2OIG in the ARRL Antenna Compendium, volume 2, pp. 90-94. I used Kris's design for a half size 40 metre quad to write a HamCalc program to design MiniQuad antennas for almost any frequency and any reduced size. The QuasiQuads shown in the drawings are a 32% full size for 10 metres and a 48% full size for 2 metres.

Once you have decided on a size HamCalc does all the design work - all you have to do is enter a few numbers. Computers are very precise and do not understand "close enough" entries, so please take time to THINK before you punch any keys!

There are a couple of things to keep in mind when designing the antenna. Make sure the wire size you select is large enough to handle the currents involved, and design it for the centre frequency of the band to allow for pruning, if necessary. Quads are very forgiving and you may not need any trimming, but it doesn't hurt to allow a little extra!

THE HAMCALC PROGRAMS

Just sit back and relax while your computer does all the work. It will ask you questions and all you have to do is press a key or two in reply. Run the HamCalc “Miniquad shortened Antenna” program. The computer asks simple questions you can answer with a couple of keystrokes and the progress of the program is displayed as you proceed.

Four programs are used, “Miniquad Shortened Antenna”, ”Coil Q Calculator”, “Coil Q - True vs. Apparent” and Coil Designer” but don’t let this throw you off - they are all linked and function as a single program. Start by running the HamCalc “MiniQuad Shortened Antenna” program. The design example that follows is for the 10 metre quad shown on the drawings. The questions start as soon as you open the program, so here goes:

Q. Continue or exit?
    A. Press 1
Q. Metric or USA?
    A. Press 2
Q. Width?
    A. Type 2.75, press <ENTER>
Q. Height?
    A. Type 2.75, press <ENTER>
Q. Conductor?
    A. Press c
Q. AWG?
    A. Type 22, press <ENTER>
Q. Frequency?
    A. Type 28.837, press <ENTER>, press any key
Q. Send page?
    A. Press 1 to send the screen display to your printer queue, then press 3.
Q. Options?
    You are now linked to “Coil Q Calculator”
    A. Press 1
Q. Dimensions?
    A. Press i
Q. Coil form diameter?
    A. Type 1.315, press <ENTER>, press 1

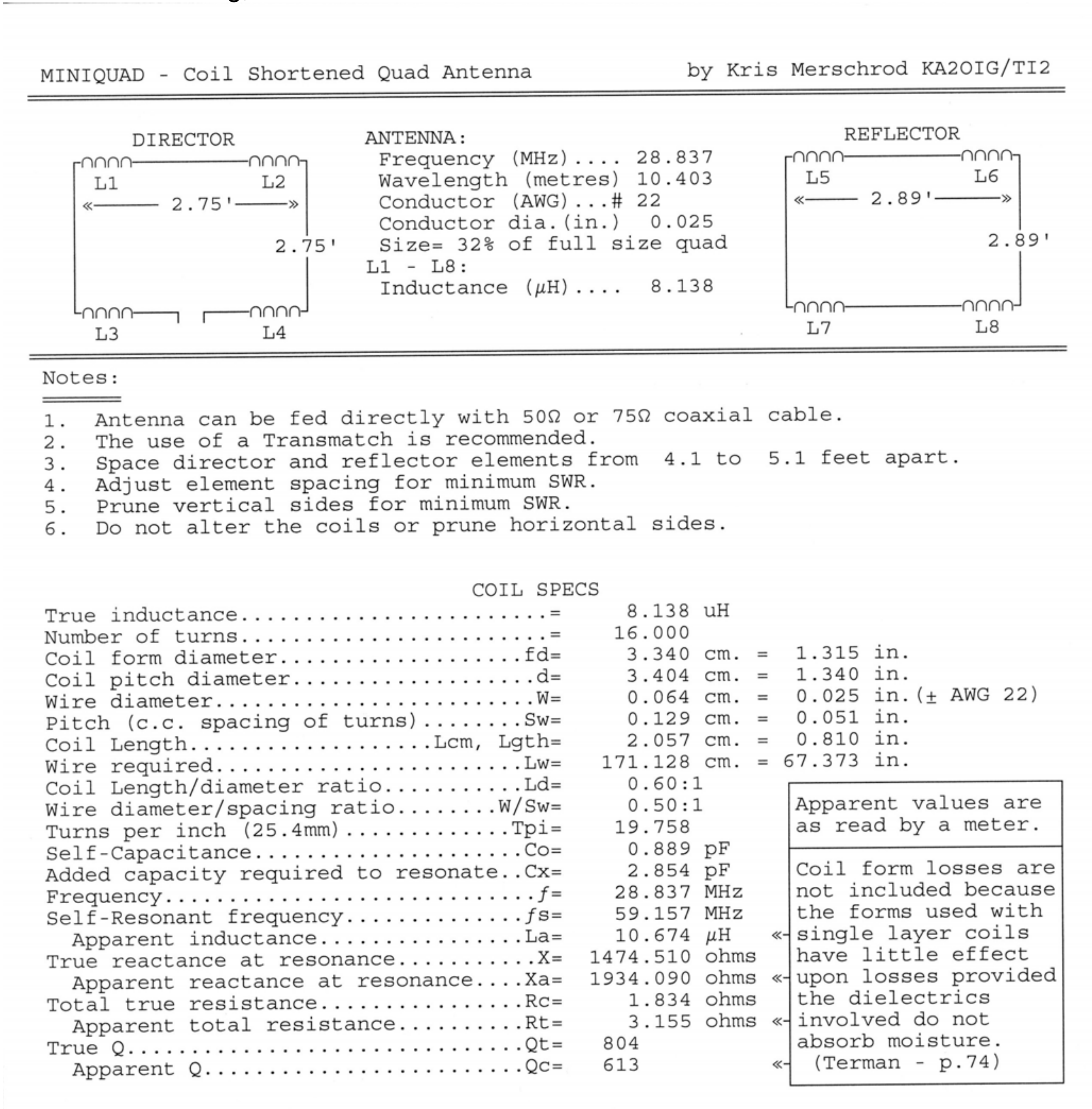
(In this step a brief image flits across the screen when you press <ENTER> - You have been linked to “Coil Q - True vs. Apparent” which immediately links to “Coil Designer” to allow you to round off turns and recalculate coil properties accordingly)

Q. Round off?
    A. press y
Q. Send page?
    You are now returned to “CoilQ- True vs. Apparent”
    A. press 3
Q. Send page?

A. press 2 to add the screen display to the printer queue and print Fig.1, then press 3.

EXIT Q Calculator

That didn't take long, did it?



MINIQUAD - Coil Shortened Quad Antenna   by Kris Merschrod KA2OIG/TI2

DIRECTOR
L1 L2
«— 2.75' —»
2.75'
L3 L4

ANTENNA:
Frequency (MHz).... 28.837
Wavelength (metres) 10.403
Conductor (AWG)...# 22
Conductor dia.(in.) 0.025
Size= 32% of full size quad
L1 - L8:
Inductance (μH).... 8.138

REFLECTOR
L5 L6
«— 2.89' —»
2.89'
L7 L8

Notes:

1. Antenna can be fed directly with 50Ω or 75Ω coaxial cable.
2. The use of a Transmatch is recommended.
3. Space director and reflector elements from 4.1 to 5.1 feet apart.
4. Adjust element spacing for minimum SWR.
5. Prune vertical sides for minimum SWR.
6. Do not alter the coils or prune horizontal sides.

COIL SPECS

True inductance........................=	8.138 uH	
Number of turns........................=	16.000	
Coil form diameter..................fd=	3.340 cm. =	1.315 in.
Coil pitch diameter..................d=	3.404 cm. =	1.340 in.
Wire diameter........................W=	0.064 cm. =	0.025 in.(± AWG 22)
Pitch (c.c. spacing of turns)........Sw=	0.129 cm. =	0.051 in.
Coil Length..................Lcm, Lgth=	2.057 cm. =	0.810 in.
Wire required.......................Lw=	171.128 cm. =	67.373 in.
Coil Length/diameter ratio..........Ld=	0.60:1	
Wire diameter/spacing ratio........W/Sw=	0.50:1	
Turns per inch (25.4mm)............Tpi=	19.758	
Self-Capacitance....................Co=	0.889 pF	
Added capacity required to resonate..Cx=	2.854 pF	
Frequency............................*f*=	28.837 MHz	
Self-Resonant frequency.............*f*s=	59.157 MHz	
Apparent inductance................La=	10.674 μH	«
True reactance at resonance..........X=	1474.510 ohms	
Apparent reactance at resonance....Xa=	1934.090 ohms	«
Total true resistance...............Rc=	1.834 ohms	
Apparent total resistance..........Rt=	3.155 ohms	«
True Q..............................Qt=	804	
Apparent Q.........................Qc=	613	«

Apparent values are as read by a meter.

Coil form losses are not included because the forms used with single layer coils have little effect upon losses provided the dielectrics involved do not absorb moisture. (Terman - p.74)

Figure 1

THE COILS

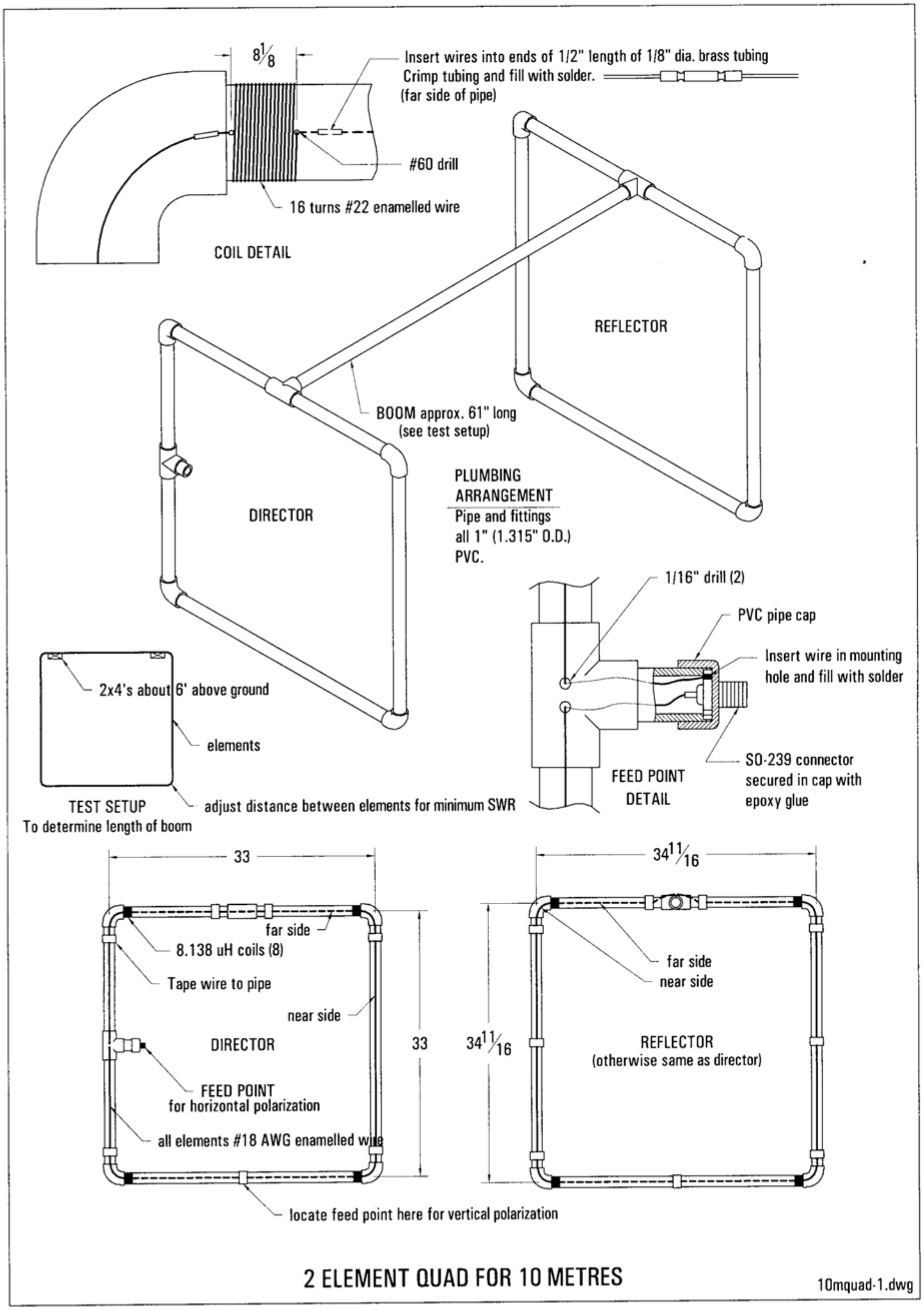
As with any coil shortened antenna, it is most important that the coils be well designed and precisely constructed. HamCalc takes care of the design, but the rest is up to the builder. Cut the pieces of PVC pipe that are to be the coil forms about 5% longer than the design length to allow for pruning. On a QuasiQuad if you prune the wire, you must also prune the pipe! Use a #60 drill to make the holes for the coil ends to pass right through the pipe, spacing the holes at the exact coil length shown on your coil specification sheet. Using enamelled wire, wind each coil as shown on the drawings with the ends projecting through the pipe and run along the pipe for a few inches. Space the turns evenly between the holes, using a scrap length of the wire as a spacer between turns. When finished, being careful not to shift any of the turns, gently slip a piece of heat shrink tubing over the coil and shrink it. Alternatively, you can run a few beads of hot melt glue across the turns, wrap the lot in heat shrink tape and shrink it. The whole idea of all this is to prevent the coil turns from shifting. DO NOT attempt to change the number of turns or adjust their spacing. Scrape the enamel off the wire ends and attach brass tubing “connectors” as shown on the drawings.

THE FRAMES

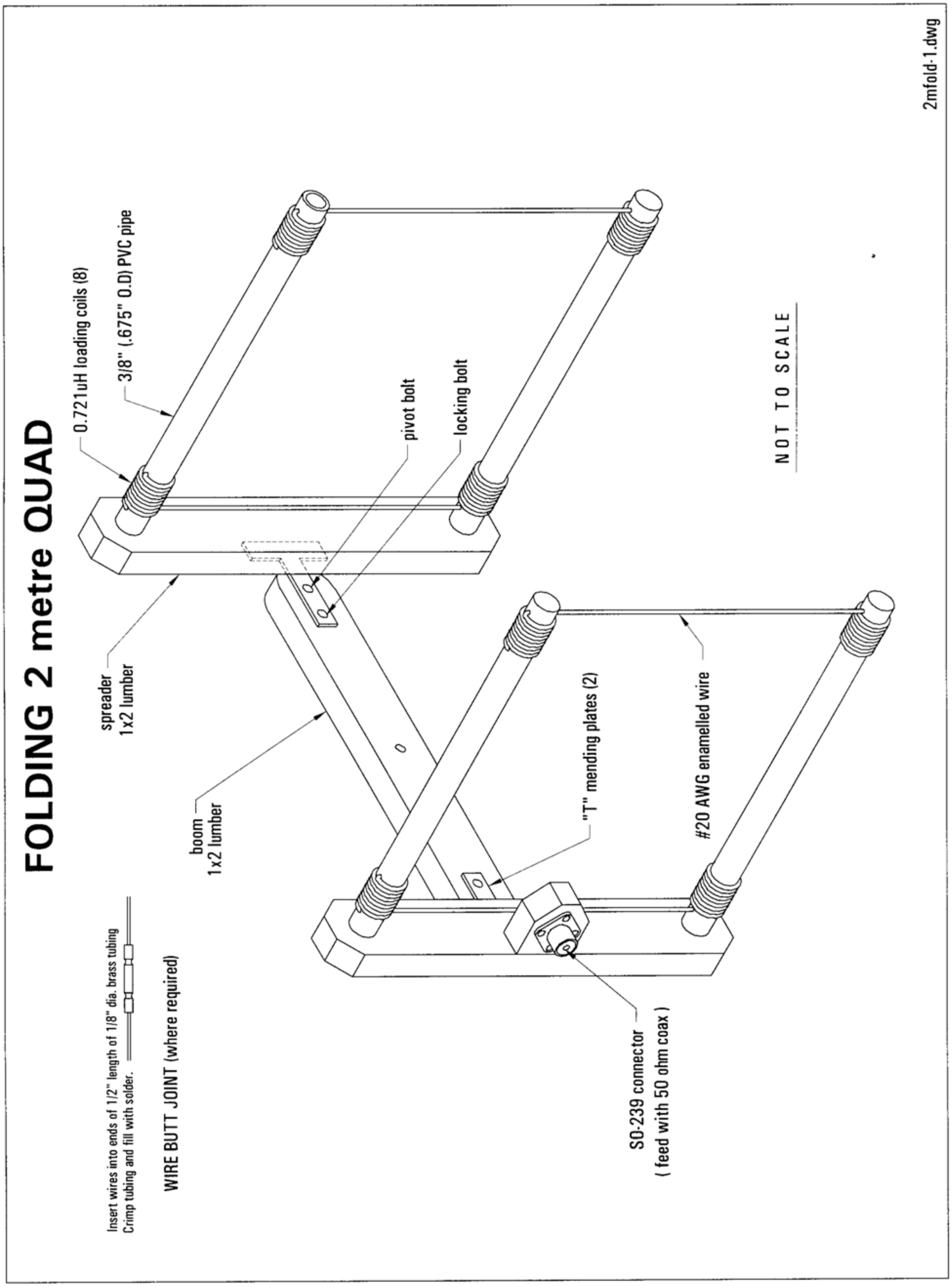
Assemble the frames as shown, fitting the parts together without any adhesives (you may need to do a little taking apart and putting back together during the testing and pruning operation). About the only dimension that should be determined experimentally by SWR readings is the length of the boom between the elements. It will probably be within the range shown in the top part of your coil specification sheet (Fig. 1). For the 2 metre antenna you can temporarily attach the element “T” plates at various distances along a piece of scrap lumber. For the 10 metre version all you need is a couple of friends with 2x4's on their shoulders (see Test Setup on the drawing). When all OK glue all the bits and pieces together (using PVC pipe solvent where applicable) and crimp and solder all the connectors.

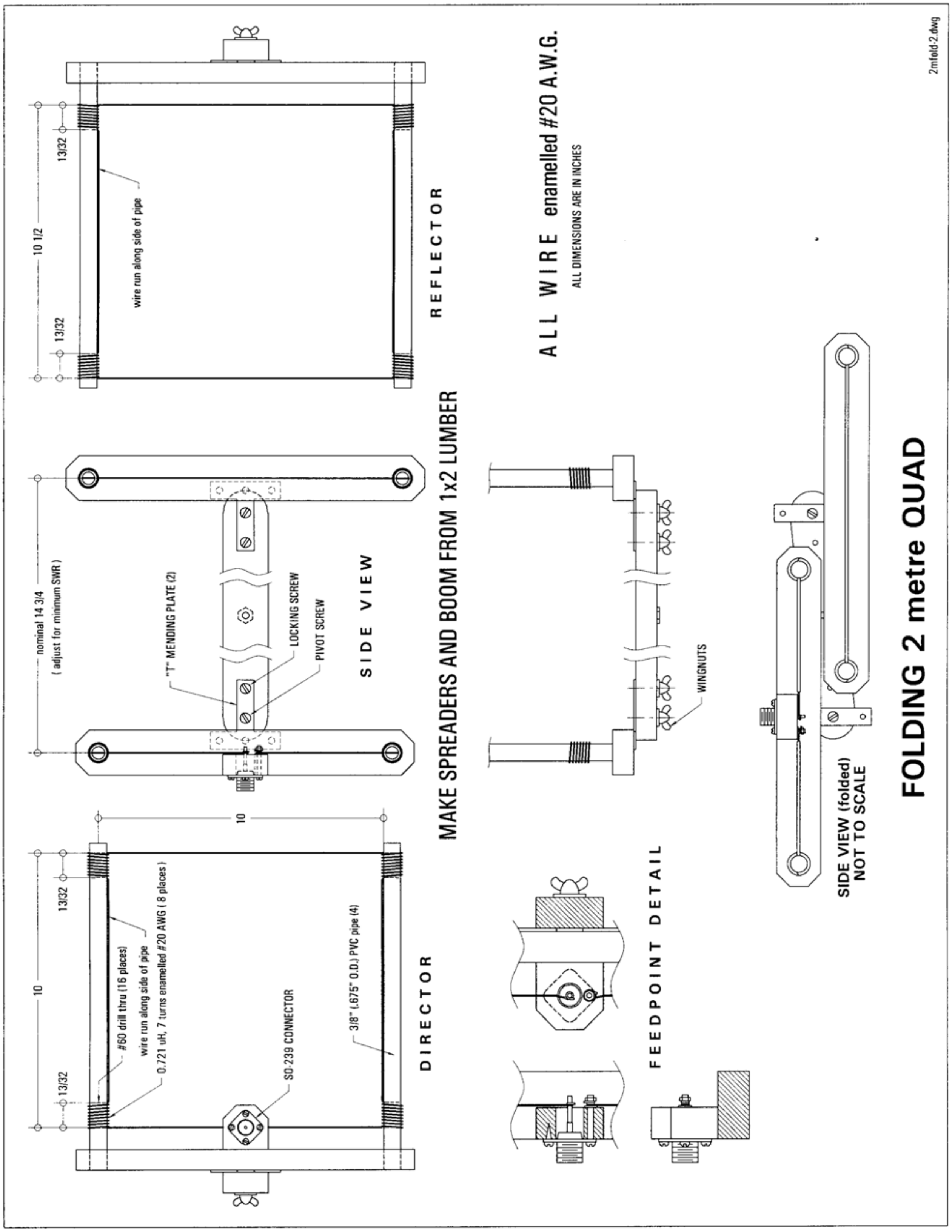
CONCLUSION

My next thousand words are replaced by the drawings. You are now on your own and on your way to a lot of fun with these strictly experimental QuasiQuads!



2 ELEMENT QUAD FOR 10 METRES


FOLDING 2 metre QUAD
0.721uH loading coils (8)
3/8" (.675" O.D) PVC pipe
pivot bolt
locking bolt
NOT TO SCALE
2mfold-1.dwg
spreader
1x2 lumber
boom
1x2 lumber
"T" mending plates (2)
#20 AWG enamelled wire
Insert wires into ends of 1/2" length of 1/8" dia. brass tubing
Crimp tubing and fill with solder.
WIRE BUTT JOINT (where required)
SO-239 connector
(feed with 50 ohm coax)


FOLDING 2 metre QUAD
MAKE SPREADERS AND BOOM FROM 1x2 LUMBER
ALL WIRE enamelled #20 A.W.G.
ALL DIMENSIONS ARE IN INCHES
REFLECTOR
SIDE VIEW
DIRECTOR
FEEDPOINT DETAIL
SIDE VIEW (folded)
NOT TO SCALE
10 1/2
13/32
13/32
wire run along side of pipe
nominal 14 3/4
(adjust for minimum SWR)
"T" MENDING PLATE (2)
LOCKING SCREW
PIVOT SCREW
WINGNUTS
10
10
13/32
13/32
#60 drill thru (16 places)
wire run along side of pipe
0.721 uH, 7 turns enamelled #20 AWG (8 places)
SO-239 CONNECTOR
3/8" (.675" O.D.) PVC pipe (4)
2mfold-2.dwg

-30-

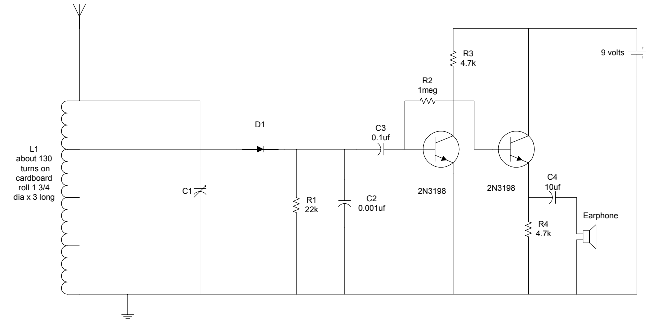
George Murphy, VE3ERP
77 McKenzie St.
Orillia, ON L3V 6A6, Canada
e-mail ve3erp@rac.ca

AmQRP.ORG HOMEBREWER

Phil de Caire, WB7AEI

Better Crystal Set

Phill takes on a journey that ends with a project that is fun to build, useful and shows how to remove the crystal from a crystal radio



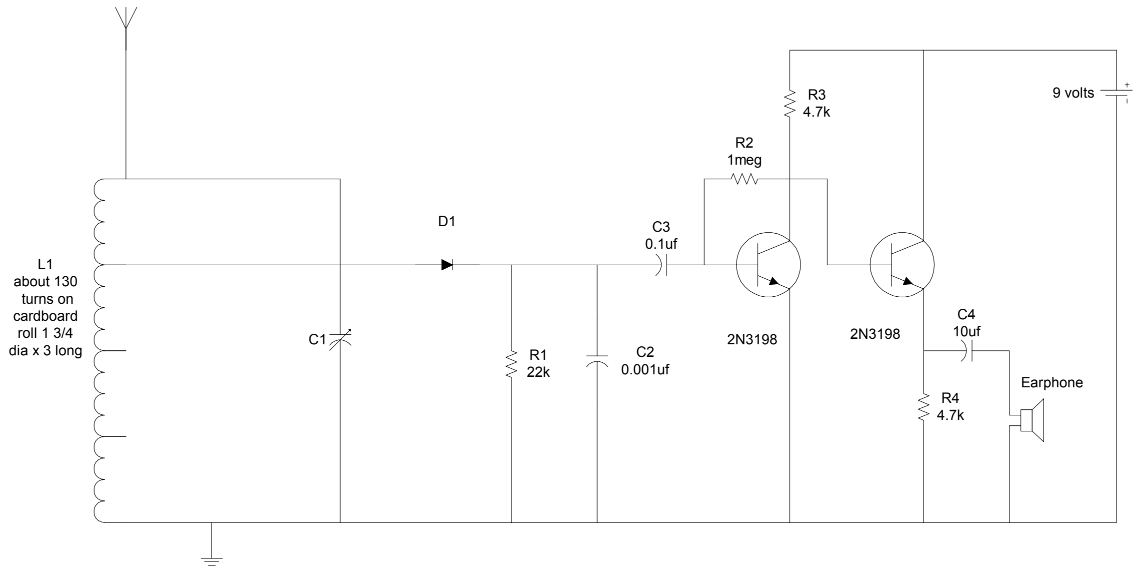
"Build your own radio"
(amplified crystal set, original configuration)

<u>The Crystal Set Revisited</u> (Experiments and musings on the nature of detection)

The words on the back of the box spoke of the ***magic and mystery of radio, spy gadgets, secret codes, international broadcasting, and extraterrestrial contact!*** This story starts when Dan, N7PWO, dropped an “Inventors Notebook” kit on my desk that he found at a local discount store. That kind of talk spoke to me over 45 years ago and hooked me on radio, electronics, and hamming, and got me started in my electronics career. The kit included a project - constructing your own amplified crystal set. The parts packet included a couple transistors, some resistors, a couple capacitors including the variable tuning capacitor, and a bunch of wire to wind the tuning coil. Who could resist? I didn't want to use up the kit and take the fun away from the boys in Dan's Royal Ranger troop though, so I went home and started breadboarding. Somebody had to check this out before the boys built it, right? This little project occupied my spare time for some weeks, and I got reacquainted with how crystal sets worked. I went beyond my previous bounds and learned a little and even surprised myself with the results.

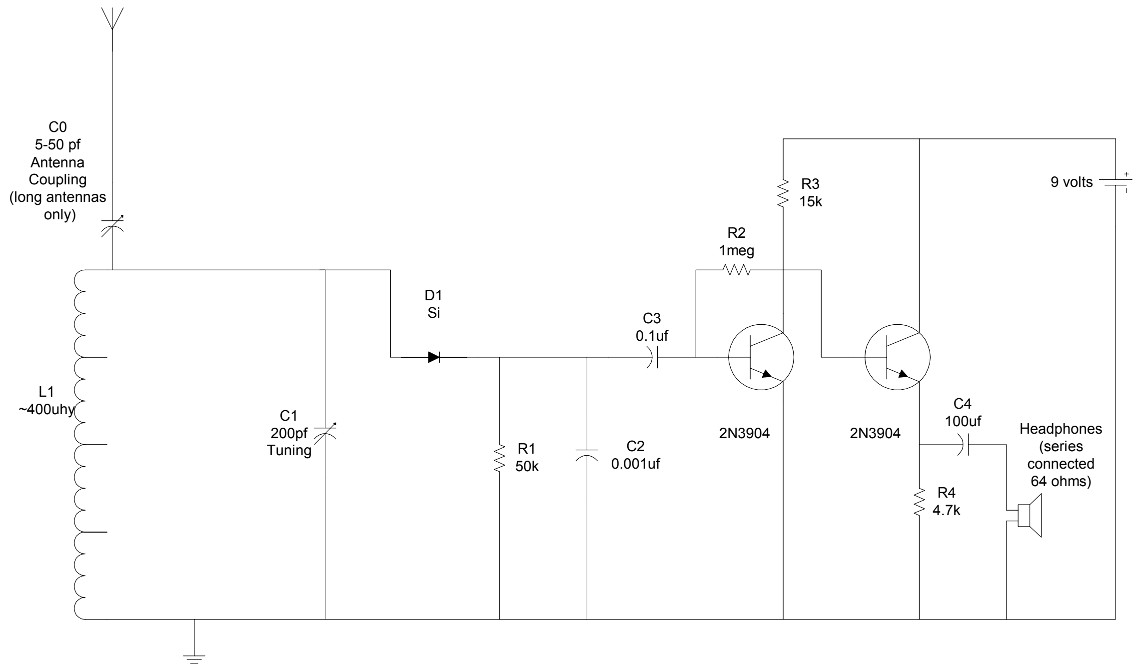
<u>An AM broadast band crystal set</u>

Starting with the “usual” parts - an air variable capacitor, a ferrite rod with about 80 turns of #30, and a variety of diodes (silicon, germanium), a working Broadcast Band crystal set was quickly built up on a plug-in breadboard.



"Build your own radio"
(amplified crystal set, original configuration)

The radio in the above mentioned kit included a two-transistor audio amplifier to drive a low impedance earphone, so I more or less copied that on the breadboard. The amplifier circuit is a simple common emitter amplifier stage driving an emitter follower, with a total power gain of somewhere around 50 dB. Now we had some volume!



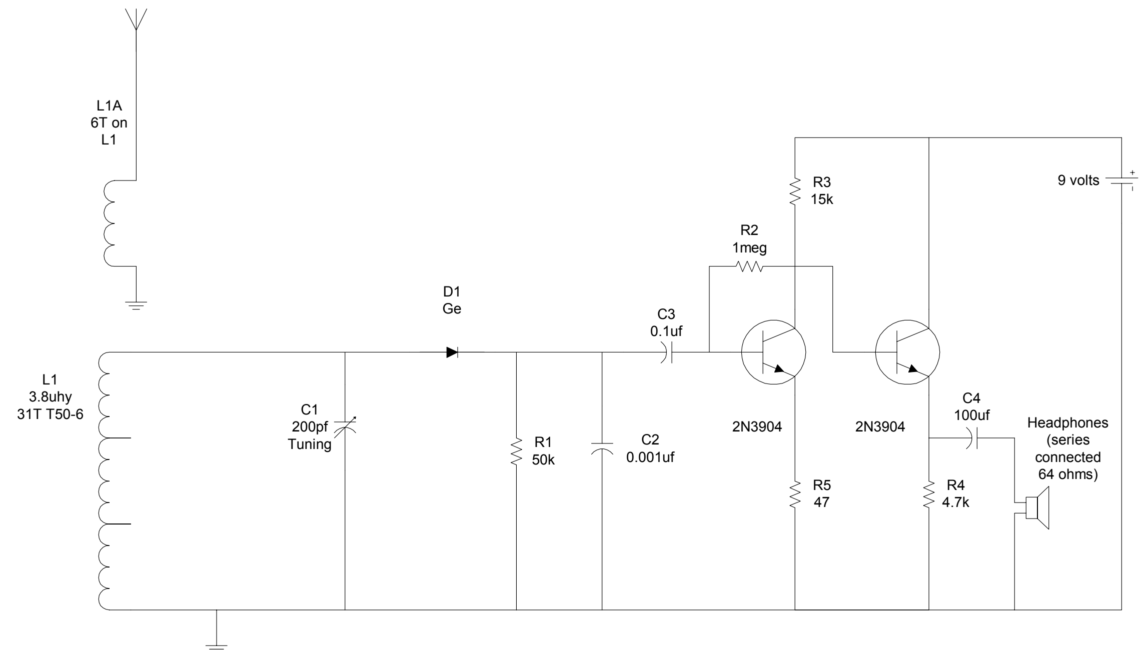
"Build your own radio"
(amplified crystal set, Phil's Broadcast Band configuration)

A few tweaks to resistor values optimized the amplifier which draws all of 1 1/2 mA from a 9 volt battery. As expected, high antenna coupling with a long antenna gave louder signals but restricted the tuning range and decreased the selectivity With light coupling (maybe 5 pf) the selectivity was very good, and signals could be separated, but volume was down.

I thought I had a germanium diode in the set, but on substituting other diodes found it was silicon. I was more than a little surprised to find that the silicon diode actually worked well. It did give much better selectivity than germanium, due to its lower loading on the tank. The germanium diode was perhaps a little louder, but all the stations came in together. Hmm … if someone had asked me whether a silicon diode would work ok, I would have said “no” before now. In fact, I was getting listenable volume from about half a dozen local stations with only 5 feet of clip leads for an antenna, clipped directly to the top of the tank circuit. I had to try biasing the silicon diode with about 10 uA thru a 1 megohm resistor. That increased the volume comparable to the germanium diode, and also the loading on the tuned circuit, for no net gain in performance.

A Shortwave crystal set

What next? I’d always wondered what a crystal set would do on shortwave frequencies but had never gotten around to actually trying it. Some web sites indicate that you can actually hear quite a bit on a shortwave crystal set. Plugging in a toroid coil got me up into the 5-10 Mhz range. I hooked up my 40M end fed half wave and in the evening I could tune in signals in the 49M band, but performance wasn't very good. Signals were not loud, and the selectivity was such that the set covered a whole band at once. With the lower shortwave signal levels I had to go to the germanium diode; the silicon diode gave no audible output. The breakthrough was when I coupled the antenna via a step-up (about 5:1) link coil rather than directly to the tank.

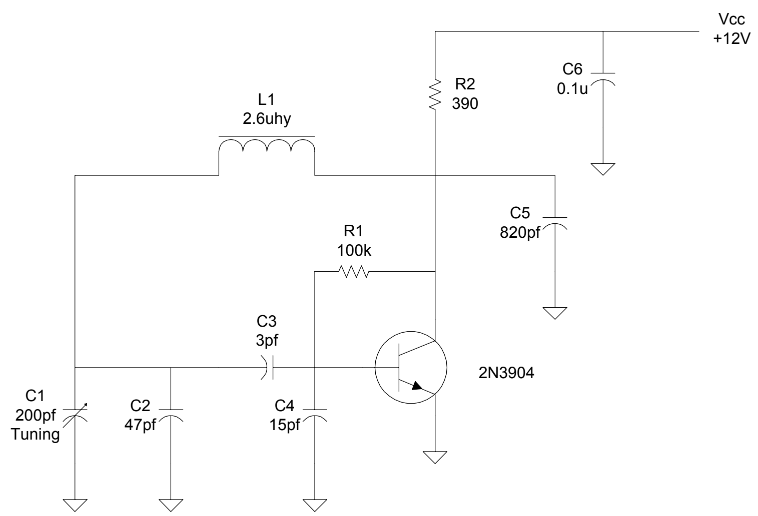


"Build your own radio"
(amplified crystal set, Phil's Shortwave configuration
tunes ~5.5 to 18 MHz)

All of a sudden I was hearing loud signals, with fair selectivity. A couple days of playing with it convinced me that yes, you can hear quite a bit on a shortwave crystal set (an amplified crystal set, that is). I've heard Radio Netherlands (transmitting from Bonaire, Netherlands Antilles) and Radio Australia on 49M, WWV on 10 and 15 MHz, and many other of the stronger SWBC signals up thru the 16M band. Yes, it really does work, well enough so that I built a permanent model in a little plastic box.

It is instructive to spend some time really listening to a shortwave crystal set like this to get a feel for its operating characteristics. Fading is a fact of life on shortwave frequencies. With a crystal set's square law detection, which gives a 20 dB output change for a 10 dB input change, fading is a major problem. A 20 dB fade on a superhet is a 40 dB fade on a crystal set. The signal doesn't just drop, but it literally disappears completely on the down side of fades. On the up side of the fade, the crystal set blares louder than other radios. And the "pops" and "crackles" tend to be much louder from the crystal set than the other radios, for the same reason - the stronger the signal, the more efficient the detection. It is interesting to operate several receivers using different technologies at the same time, tuned to the same signal. The differences can be very dramatic. I've noted the best fading performance seems to come from my regen receivers. As others have previously pointed out, regenerative radios seem to have their own built-in AGC function.

The most intriguing crystal set web site I found talked about adding a BFO to a crystal set for ham CW and SSB reception.
[http://cs.okanagan.bc.ca/ve7ouc/eng/kc6wdk-mirror/receiver.html] Of course, I had to try that. In theory this should work, since we're actually creating a very simple direct conversion receiver.



BFO (Vackar VFO)

So I tossed together a Vackar VFO that tuned about 6-12 Mhz on a separate breadboard and fired it up. I managed to get the BFO tuned to 7.03 Mhz, peaked the crystal set tuning, and voila - 40M CW in the headphones! It sounded and acted like a DC receiver, complete with the infamous DC receiver "tunable hum". The sensitivity and volume were very adequate. Of course, the less coupling between the BFO and antenna, the less hum.

I'd figured quite a bit of coupling would be needed to get good mixing efficiency, but that didn't appear to be the case. Not only didn't I have to couple the antenna lead to the BFO, but it worked better (less hum) with the BFO isolated from the set and sitting some inches away. This was with an air wound coil in the BFO. On reflection, that made sense, since the requirement is only that the BFO be much stronger than the received signal AND strong enough to cause detection in the diode. A measurement of the diode DC output showed about 50 to 60 millivolts when the BFO was powered on (and essentially zero with it powered off). Higher levels didn't seem to increase the sensitivity. Later experiments with a toroid coil in the BFO did require running the antenna lead through the middle of the BFO circuit to get sufficient coupling. The air wound coil obviously radiated much more signal than the toroid, another good lesson.

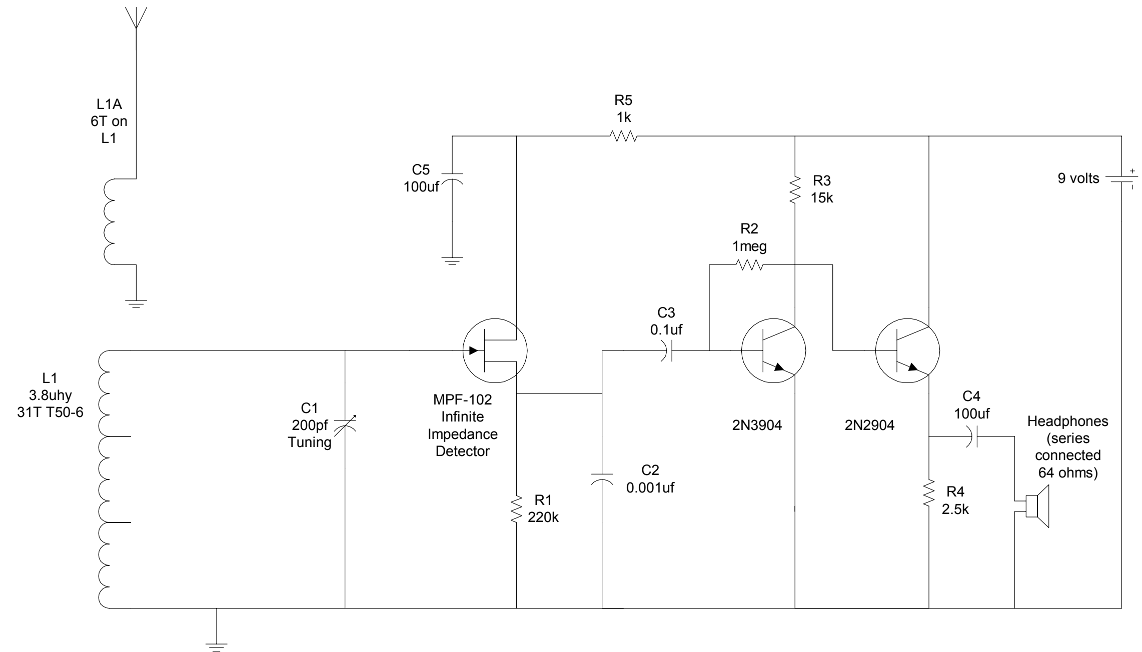
Detection

The increased detection sensitivity with the BFO was very obvious. Signals that were inaudible without the BFO were easily copyable with it on. There was a noticeable background noise with the BFO on, but the crystal set by itself had no background noise. This got me thinking about the basics of what we call "detection". The process of detection turns RF signals, which we can't hear, into audio signals which we can hear (when fed to a proper transducer). Per theory, a 2nd order (or square law) detection function gives you a detector output which decreases by 20 dB for every 10 dB that you drop the input signal level. This means detection doesn't work with really weak signals. At low enough signal levels, the diode current is essentially the same in either direction, and detection doesn't occur. So how do we fix that? We can either amplify the signal before detecting it, or we can make the detector more efficient. In this case, we feed a strong signal (BFO) into the detector together with the weak one, and the two get detected together. The strong signal makes the detector perform its detection function efficiently (that is, operate nonlinearly), and the detector output includes the detected weak signal as well as the detected strong signal. The detected strong signal is just a DC level, so we can easily separate that from the detected weak signal audio, which we amplify and feed to the headphones. **This is genuine radio magic!** We could also say we're mixing the two signals and amplifying the audio difference frequencies. The mixer loss is only on the order of 6 to 10 dB, much less than a square law detector. The mixer is linear with respect to input level; that is, it gives an output that decreases by only 10 dB for every 10 dB the input is decreased. So this gives much improved detection of very low level signals as compared to a square law detector.

It seems to me this same phenomenon of a relatively inefficient square law detector turning into a relatively efficient mixer occurs when a regenerative receiver crosses the threshold of oscillation. The same increase in background noise and increase in sensitivity occurs. In theory, the circuit gain is 1.0 at the oscillation frequency when the detector oscillates -- otherwise the oscillation amplitude would keep increasing until circuit nonlinearities caused the gain to be 1.0. That implies we've lost the high signal gain we get in the regeneration process. And yet there is no apparent decrease in sensitivity or volume. The loss in gain must be made up by the more efficient detection. That's my theory, at least. When we turn up the regeneration even higher, we know the sensitivity and volume drop. The detector saturates harder on its own oscillation, so that the weak signal can't modulate the output. Crank up the regeneration high enough, and you will hear nothing. This works like an AM radio with no AGC. The modulation is stripped off the stronger AM signals by amplifier clipping, so all you hear is the presence of the carrier but no audio. When the signal fades, you start to hear audio. Weak signals come thru just fine, until you get on the upside of a fade and start to clip. That's another interesting experiment to do, and it can be quite puzzling the first time you run into the phenomenon. We do this on purpose in FM receivers, of course, to eliminate AM noise. That explains the "quieting" you get with strong signals.

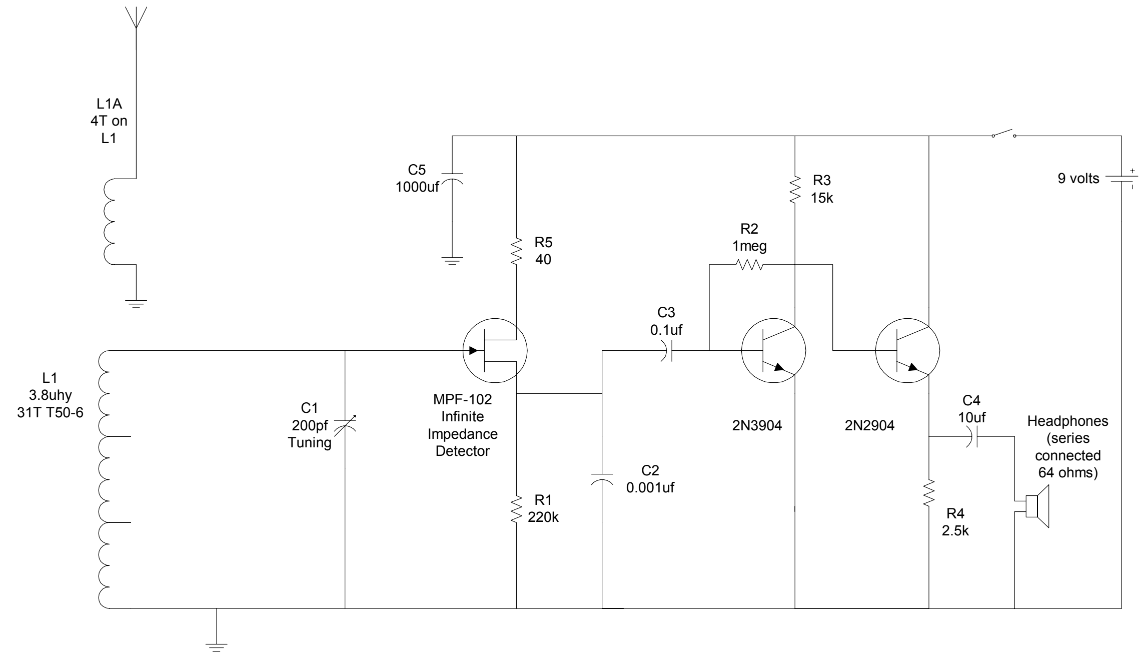
A "crystal set" with no crystal

What next? We're not done yet! Lets update to a fancier detector. I learned that this scheme works very well in regen receivers and decided to try it here.



"Build your own radio"
(amplified crystal set, Phil's Shortwave configuration
tunes ~5.5 to 18 MHz with JFET detector)

A JFET with the gate tied to the top of the tank (at DC ground), drain to Vcc, and the source grounded via a very high resistance (about 220k ohms) makes a great detector due to the JFET's 2^{nd} order transfer characteristic . This is the solid state version of the old tube "infinite impedance detector", and it has a lot of good points. There is no amplification in this circuit, so the detected output is about the same as that of the 1N34 diode. The output impedance is lower than the 1N34, so it drives the amplifier better, and the loading on the tank is lighter for better selectivity. We already have an amplifier and battery, so the added 15 microamps of current drain isn't a problem. It works better than a diiode and results in more volume. In fact, the headset volume control is necessary to keep it from blasting on 49 meters in the evening. At this point we probably can't call this a crystal set anymore, since it doesn't have a diode detector. The performance is quite good though, and its a lot of fun to tune around with it and see what you can hear.

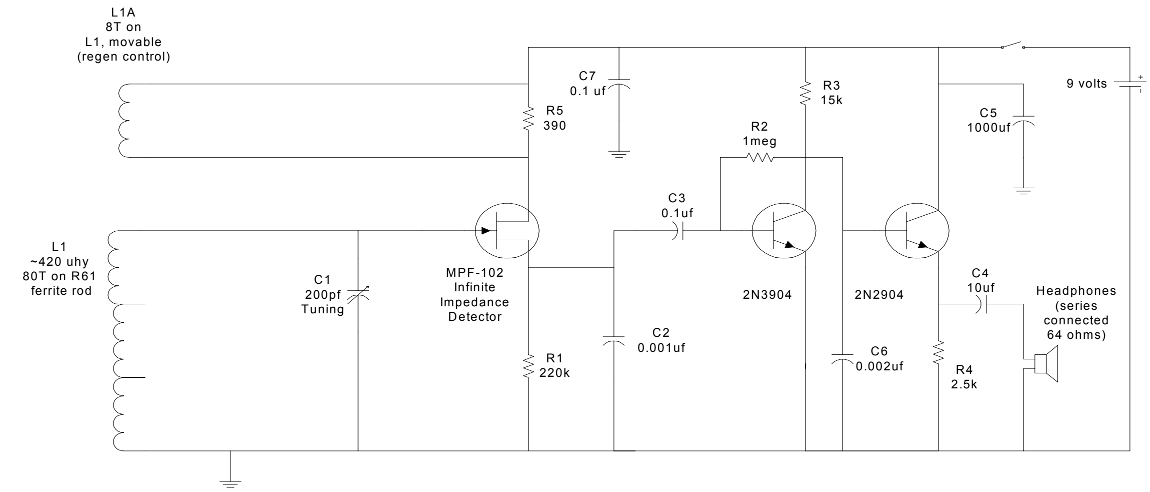


"Build your own radio"
(amplified crystal set, Phil's as-built Shortwave configuration
tunes ~5.5 to 18 MHz with JFET detector)

The final version has a few minor changes and is the version I built in the box. As a casual listening radio, it works quite a bit better than I had expected. The standing current could be increased in the audio output stage to drive a small 16 or 32 ohm loudspeaker.

A better technology

As a postscript to all this, some weeks after the initial work, I realized that with the addition of only a couple feet of wire a breadboard BCB version of my shorwave crystal set could become a regen.



"Build your own radio"
(AM broadcast band regenerative)

I wound a movable tickler coil of 8 or 10 turns and connected the leads across the 390 ohm decoupling resistor in the JFET detector drain. Sure enough, after swapping the leads to get the right polarity, it oscillated. The regeneration was easily controlled by moving the tickler coil with respect to the main tuning coil - the first time I've tried this method. I've played with it for some weeks, and I'm amazed at its sensitivity. It receives most of the locals inside the building where I work, and a coworker commented that his portable radio couldn't hear anything inside the building. I've regularly heard KGO San Francisco and KOH Reno in the evening at my Seattle QTH, with nothing for an antenna except the ferrite rod coil! Its easy to see why the regen eclipsed other designs for a period of time, giving vastly improved performance (both sensitivity and selectivity) with minimal added components. The added gain and/or detection efficiency made it possible to hear signals that were orders of magnitude weaker than could be heard on even the best crystal sets. It is harder to operate though, and requires frequent readjustment as the battery voltage slowly drifts down. The regen version gives solid copy to signals that are not audible at all on a crystal set. To demonstrate this, just back off on the regeneration so the radio reverts to a square law detector with no regenerative gain, and the signals drop away and disappear. Radio magic indeed!

Sidebar: The math of "detection"

What we call "detection" is really nothing more than a particular form of distortion that results in conversion of an RF signal into audio frequencies that we use for communication. A distortionless (linear) circuit produces a copy of the input waveform that looks exactly like the original. If all our circuits were linear, we couldn't have radio or a lot of other electronic things. A linear circuit is described by an equation like Vo = k * Vi , where k is the gain.

At its simplest, detection uses devices like diodes or JFETs which have a "square law" characteristic for small signals. In English, this means the output voltage is porportional to the square of the input voltage. This is different from the linear case above. The simplest device would have the equation Vo = Vi ^2, although any real device would have a much more complex description. Now, lets do the math of running a sine wave through this simple device:

Vo = Vi ^2 = (sin a) ^2

Of course, we're assuming the input amplitude of the sine wave is one volt. It could be any value, although in our circuits we're typically dealing with millivolts, but one is a convenient number to deal with while doing math. From any book with trig identities,

(sin a) ^2 = 1/2 -1/2 cos 2a and so

Vo = 1/2 -1/2 cos 2a

The 1/2 is a DC term and means we've converted some of the RF input to a DC voltage. In the circuit, it would be apparent as a shift in operating point (or bias) of the device. The presence of the RF signal causes the average (DC) voltage and current to change. Now if we vary the amplitude of the sine wave going in, the DC value of 1/2 is going to vary too. This represents our modulation and is the desired output of the detector. You can see this intuitively for the JFET detector as follows: When the input sine wave goes positive, the JFET source tends to also go more positive to follow the input. Since the JFET is already very near the cutoff point, when the input sine wave goes negative, the source cannot go negative by the same amount. The result is a net upward shift in JFET current and source voltage as a result of the sine wave input.

The second term, -1/2 cos 2a, represents a 2nd harmonic term that is double the frequency of the RF input. That term gets filtered out in our radio, since we're not interested in it. In some other application, we may use a similar circuit but choose to throw away the DC (detected) term and use the 2nd harmonic output, giving us a frequency doubler. Its interesting that in this theoretical case we get an output that does not include the original input signal; this would seldom be the case with real-world devices and circuits.

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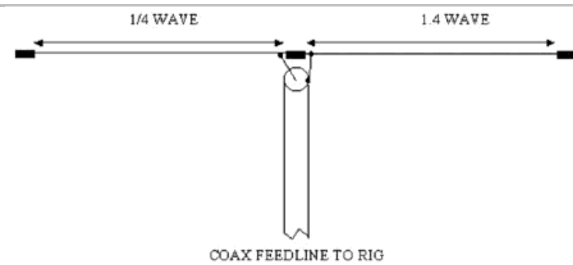
Joe Everhart, N2CX

What is the Best Antenna?

This is a question that is always asked and has many answers. Here is Joe's



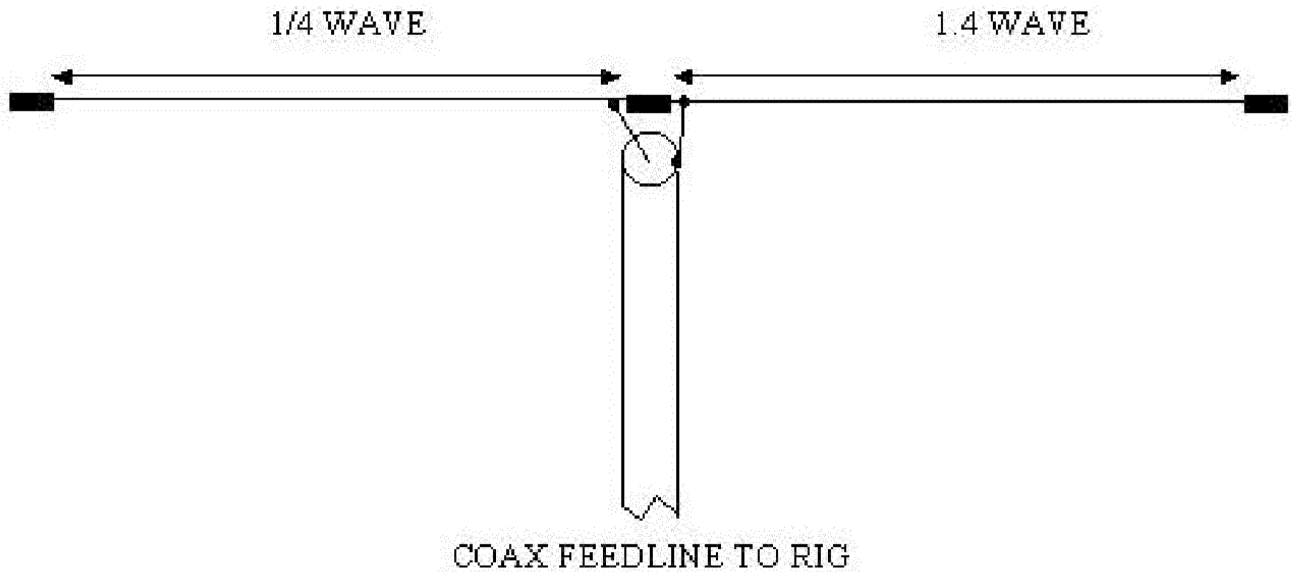
CENTER -FED DIPOLE 1/2 WAVE DIPOLE

Our prolific and talented Elmer comes to us again to describe just what antenna he finds to be the best all 'round performer. N2CX references figures at the end of this article which are much better reprints of the figures he used in his piece on Portable Antennas in QHB #1.

A popular discussion topic wherever hams gather is "What is the best antenna?" Obviously no antenna is best for all situations. Like most things in life choosing an antenna is a process of balancing exactly what performance you need against size, weight, the antenna environment and the always-present issue of cost.

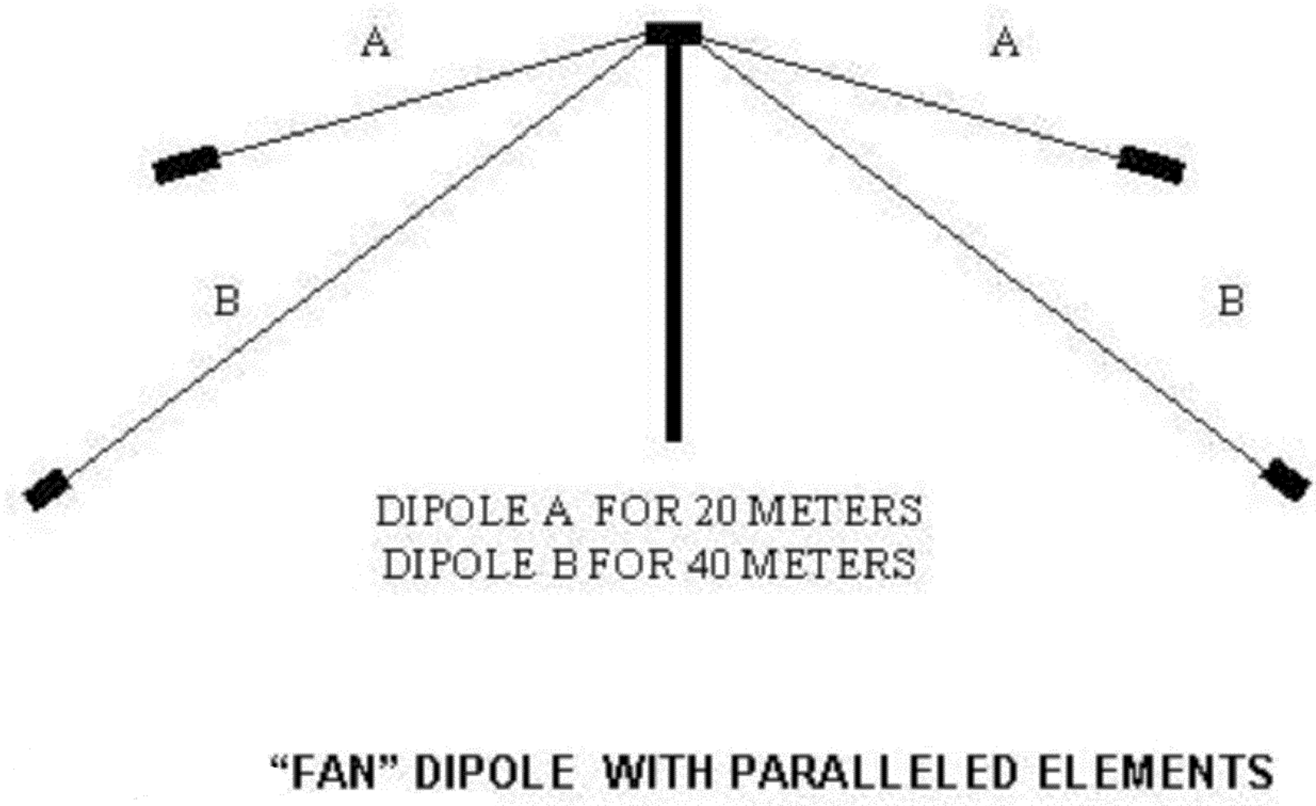
I want to make a short pitch for what I consider to be the best family of antennas for portable use. For me, dipoles are the overall optimum choice.

Dipoles are the most effective way to assure a dependable level of performance under almost any circumstances. And they can be configured in a variety of ways depending on individual applications and tastes. While other antennas such as random length wires and short verticals are often convenient to use, they take experience to employ effectively. They work well once you have made the effort to learn how to best use them, but dipoles are usually the closest thing to a "universal" choice that assures effective performance.

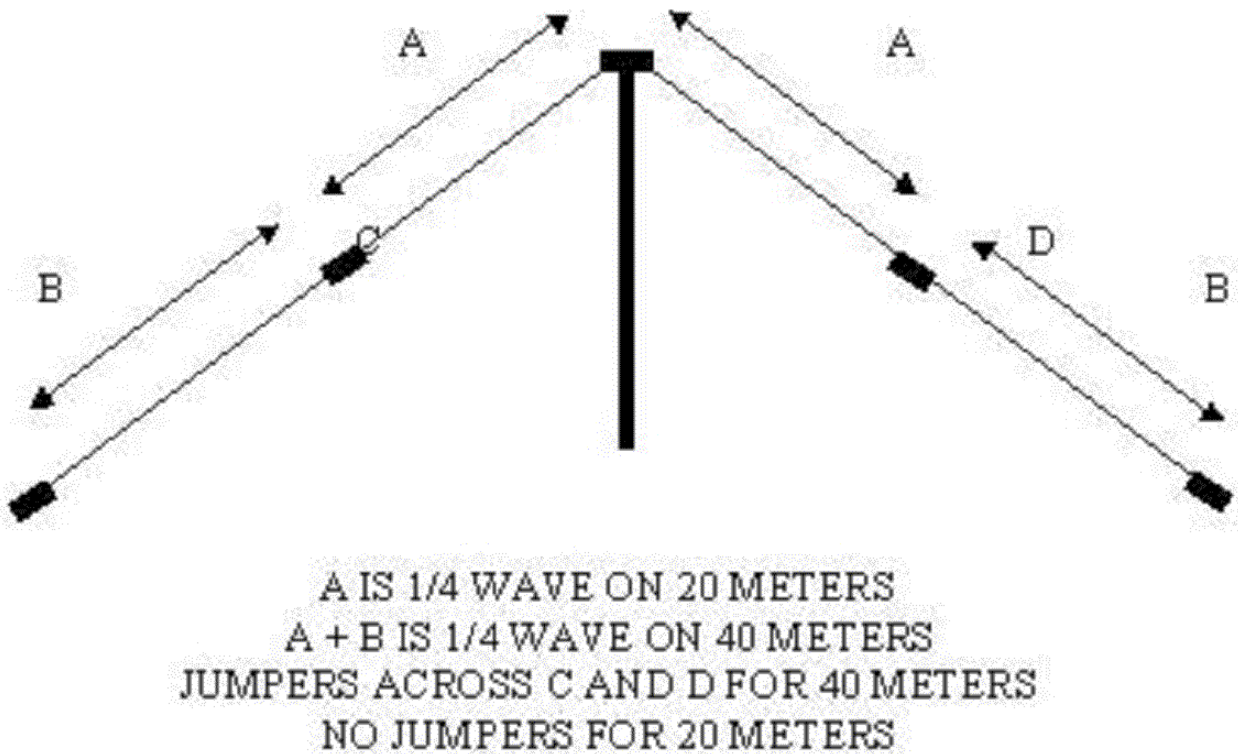


CENTER -FED DIPOLE 1/2 WAVE DIPOLE

A single-band dipole with coaxial feed is the basic choice. By dispensing with a balun (of course you can use one) you minimize weight and complexity. For my portable dipoles I use 20-22 ga stranded hookup wire and RG-174 to make an inverted vee antenna for any HF band from 40 thru 10 meters that weighs less than a pound and fits in a zippered food storage bag. No tuner is needed. I simply raise it in the air, hook up a rig and get on the air.

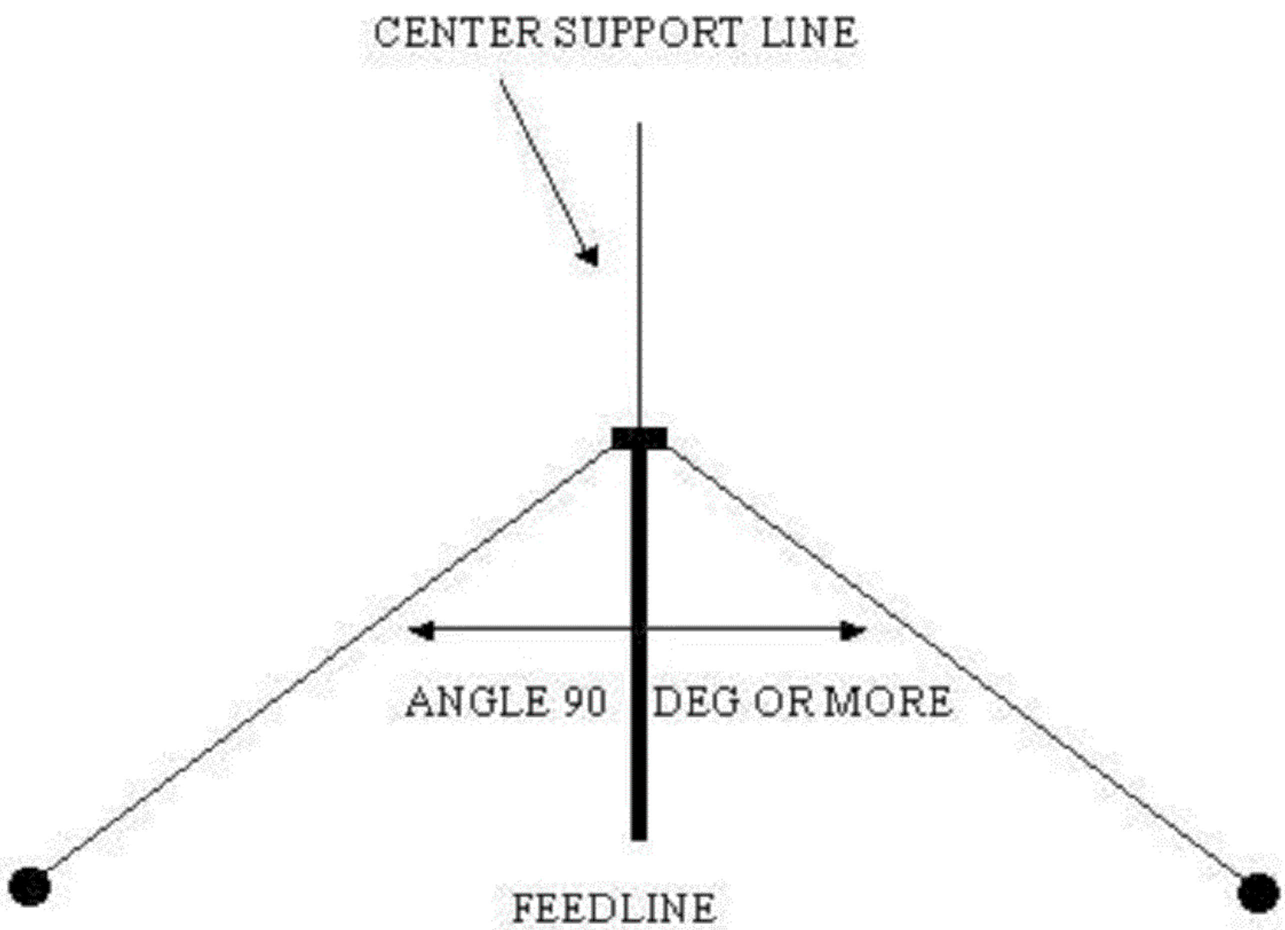


Want a multi-bander? That's simple! The "fan" dipole uses quarter-wave elements for several bands fed by a common feedline for "no-switch" operation on multiple bands. A dipole segmented for several bands with insulators is sometimes called a "Leap Frog" antenna. To change bands, the appropriate insulators are jumpered with short alligator clip leads.



"LEAPFROG" TWO-BAND SEGMENTED DIPOLE

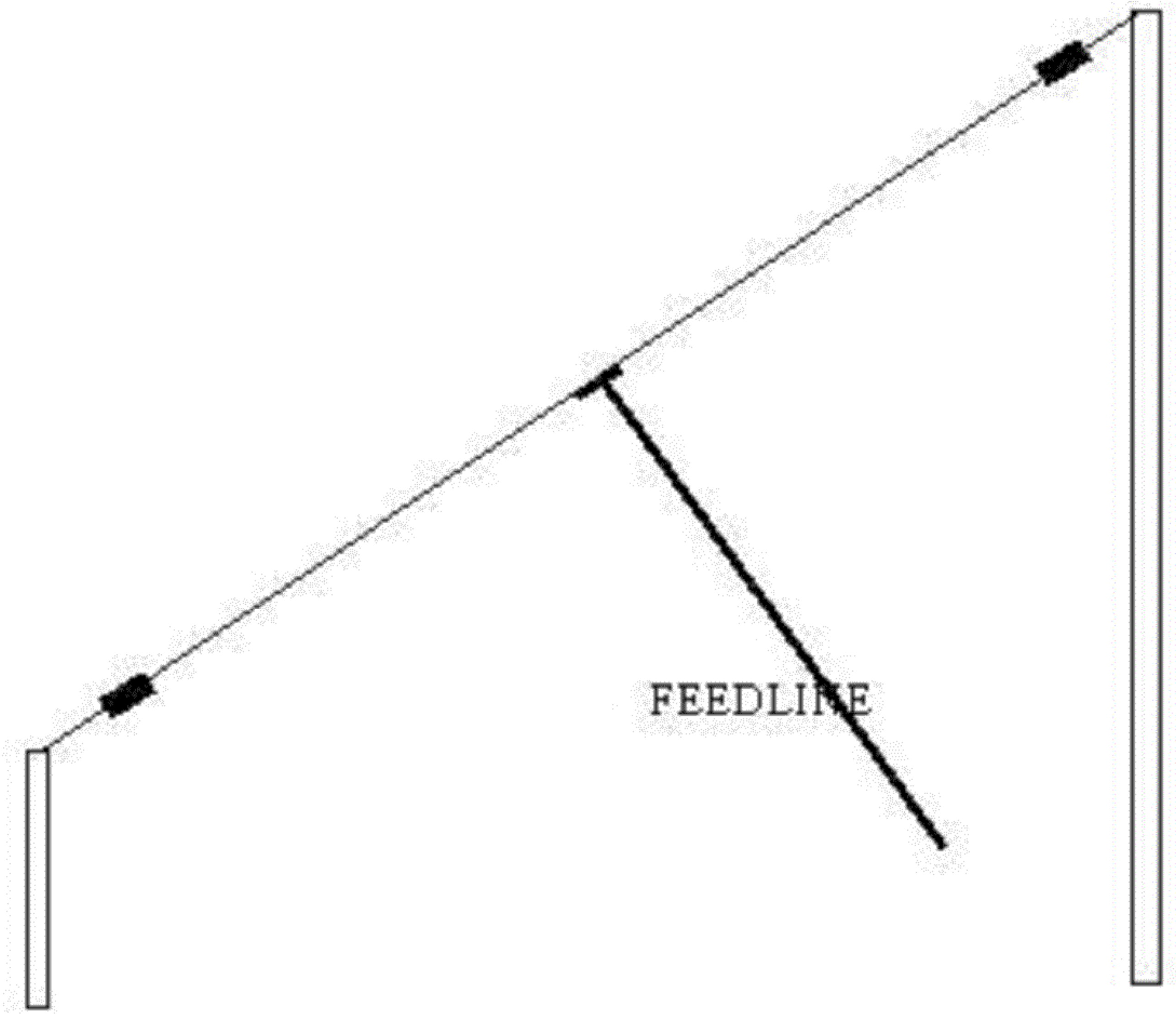
If you can take along a small tuner (such as the excellent Emtech ZM-2 or the clever NorCal BLT) and carry a little more weight, a very good multiband antenna replaces the coax cable feedline with open wire line or 300 ohm "window" feedline. Such a dipole with 33 foot (or longer) legs operates effectively from 80 through 10 meters.



INVERTED VEE CENTER-FED DIPOLE

For portabling, the inverted vee is often the best way to hang your dipole. It needs only one high support and the center support line allows using small-gauge wire for the dipole elements. The ends should be as high as possible but can usually be tied off to easy-to-find supports like shrubs, fences, picnic tables or cooperative on-lookers.

Of course you want your antenna as high and in the clear as you can get it but there are a couple of rules of thumb to help you decide how high to shoot for. Try to get the center up at least 15 to 20 feet or you will do no more than warm up earthworms. If you are operating on 80 or 40 meters most of your contacts will be fairly close in so you may want to optimize things for NVIS (Near Vertical Incidence Skywave) operation. Low horizontal dipoles or inverted vees are best. Anything less than a quarter wave (33 feet on 40 or 66 feet on 80) is low. On the higher bands you should aim to get your antenna up at least a quarter to a half wavelength or more up to emphasize low angle radiation. If your antenna is higher than these guidelines it will work for either local or dx operation.



"SLOPER" DIPOLE

Another way to get low angle radiation is by putting the dipole up as a sloper. It is somewhat directional toward the downward sloping end. And if you have a really high support, you can always put up your dipole vertically. This ensures a low angle of radiation. Just remember to bring the feedline away from the dipole elements at least a quarter wave.

So there you have it! In my opinion, if you want good repeatable portable antenna performance use a dipole!

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George Heron, N2APB

Enhance your Warbling Experience with …

“Warbler RF Output Indicator”

“Warbler Audio Amp”

“Deluxe Warbler Enclosure”

Here’s a super useful accessory for working PSK31 with your Warbler transceiver -- a power output indicator to let you know relatively how hard you’re driving the RF finals, and an audio amp to let you hear all PSK31 activity in the Warbler’s passband. Both of these circuits are contained in a deluxe homebrew ABS plastic enclosure. You’ll be the envy of everyone at your next club gathering!

It’s really convenient to have an indication that your computer’s sound card is driving the Warbler PSK31 transceiver at the proper audio level to produce the cleanest possible output RF. If you don’t, it is difficult to see at a glance if your Warbler is transmitting (“did I click yet on the Rx button in DigiPan?”), or if you left your sound card’s volume control at the blasting level from the last time you were playing Linda Ronstadt’s “Blue Bayoo” through the computer’s multimedia speakers.

Don’t Splatter that Signal!

Seriously, as most Warbler owners and PSK31 operators know, it is critically important to have the correct drive level on the audio tones going to your transceiver so as to not over-modulate (“splash”) and thus inadvertently present a much wider signal on the band than necessary. Conversely, it’s important to make sure you’re getting as much of the available 3-4 watts out of your Warbler.

This project will help you do just that in a flashy way. The LM3914 used in the circuit in Figure 1 is a dot/bar display driver chip that senses analog voltage levels and drives up to 10 LEDs to provide a linear analog display. The chip contains its own adjustable reference and accurate 10-step voltage divider. When a voltage is presented at the input pin, the corresponding “level” is indicated in its output pins that cause an LED bar graph array to operate like a level meter. This display technique is similar to the way an LED “vu” meter operates on your stereo amplifier system. For example, when full-scale voltage is applied on the input pin, all LEDs are illuminated; when a half-scale voltage is sensed, the leftmost five LEDs are illuminated; and when only a small voltage level is sensed, the single LED on the left is illuminated.

This IC has been used in other QRP projects as a battery voltage indicator. This time, however, we sample the RF signal being delivered out of the Warbler, rectify and low pass filter it to produce a DC voltage, and apply it to the input of the LM3914. The internal analog comparators of the LM3914 sense this voltage and illuminate a corresponding number of LEDs connected to its output pins.

In order to calibrate this RF power indicator circuit, I first set up the Warbler as stated in its manual by adjusting the audio output level from my sound card in the computer to get the maximum rated “clean” RF power output. I then adjusted the trim pot on the LM3914 circuit to indicate about “6 LEDs” of output. Setting it up in this way allows me to see at a glance that I have the proper sound card setting. If I want to back off the power, I can easily do so by adjusting the computer’s volume control and watching the bar graph array while transmitting. And if it ever should be that LED’s 7, 8, 9 or 10 are also illuminated (remember that I like playing my Linda Ronstadt music loud), it’s an indication that I need to drop the sound level back to a level suitable for PSK31 operating.

If you don’t want to use a bargraph array, individual LEDs would also work fine. Alternatively, you could get even fancier and use a multi-colored 10-element bargraph array. One LED segment could indicate when PTT is activated, while the remaining LEDs indicate the power output. There are lots of display possibilities!

For more information about the LM3914, see the data sheet referenced in Note 3 at the end of this article.

Listening to PSK31

After building my Warbler, I figured that it would be pretty cool to actually hear the PSK31 signals present in the transceiver’s 1.5 kHz passband. I could then easily monitor the band as a way to determine when stations were present in the passband of this nifty little transceiver.

I used an LM386 audio amplifier circuit shown in Figure 2, as first described in this way by Dave Ottenberg, WA2DJN in the last issue of QRP Homebrewer [Note 4]. The amp was added to the same perf board that contained the RF power indicator. I was careful to use shielded input wires so as to reduce the possibility of feedback or crosstalk, and the audio amp circuit worked well.

I mounted my prototype board alongside the speaker in the top half of my Warbler enclosure. The bar graph array and the amplifier's volume control slip neatly through the front panel when it's all buttoned up. Photo 2 and Photo 3 show how everything fits together.

Bringing it all together in the Warbler Deluxe Enclosure

To top off my "Warbler Deluxe" I followed the guidelines of Bill Jones, KD7S to produce one of his ABS plastic enclosures. By following his clear instructions, I was able to fabricate some 1/8" sheets of black ABS plastic into a small, sharp-looking, no-screws clamshell enclosure for my Warbler. See Note 2 at the end of this article for a pointer to KD7S's website containing a good tutorial for constructing enclosures made in this manner.

Operating the Warbler Deluxe

Operating my special Warbler now is a dream. I can see a very positive and proper-level indication whenever I transmit from DigiPan, and I can listen to the 1.5 kHz passband of the Warbler during receive. By the way, an added benefit of the audio circuit is that it picks up the faint audio transmit signal as well, thus serving as a "PSK31 sidetone"

I often set the volume to a low level in the shack during the evenings and go about my other business while listening in the background for warbling activity to appear on 80m.

Give these simple circuits a try and enhance your own warbling experience!

Reference Notes

1. The Warbler is a simple, single-board PSK31 transceiver designed by Dave Benson, K1SWL and provided as a kit by the NJ-QRP Club. It was described in detail in QST for March 2001 and has captured the intense interest of hams worldwide. For further Warbler information, including kit availability, visit the NJQRP website at http://www.njqrp.org/warbler/ or contact N2APB (see Authors note below).

2. The ABS plastic “Warbler Deluxe” enclosure is a custom design created from the detailed plans of Bill Jones, KD7S, a notable craftsman in the QRP community. An excellent tutorial on making ABS enclosures, called “Be Your Own Cabinet Maker”, can be found at the KD7S website: http://www.psnw.com/~kd7s/hbcabs.html. While you’re there you should also check out his version of a Warbler Deluxe at http://www.psnw.com/~kd7s/warbler.html).

3. You can obtain lots of application details for the LM3914 from the Jameco website (www.jameco.com). Do a search from that home page for “LM3914” and select the “data sheet” link when it appears.

4. QRP Homebrewer is a 64-page quarterly journal dedicated to the combined topics of QRP and homebrewing. For details, see http://www.njqrp.org/data/qrp_homebrewer.html .

5. The authors may be contacted as follows:

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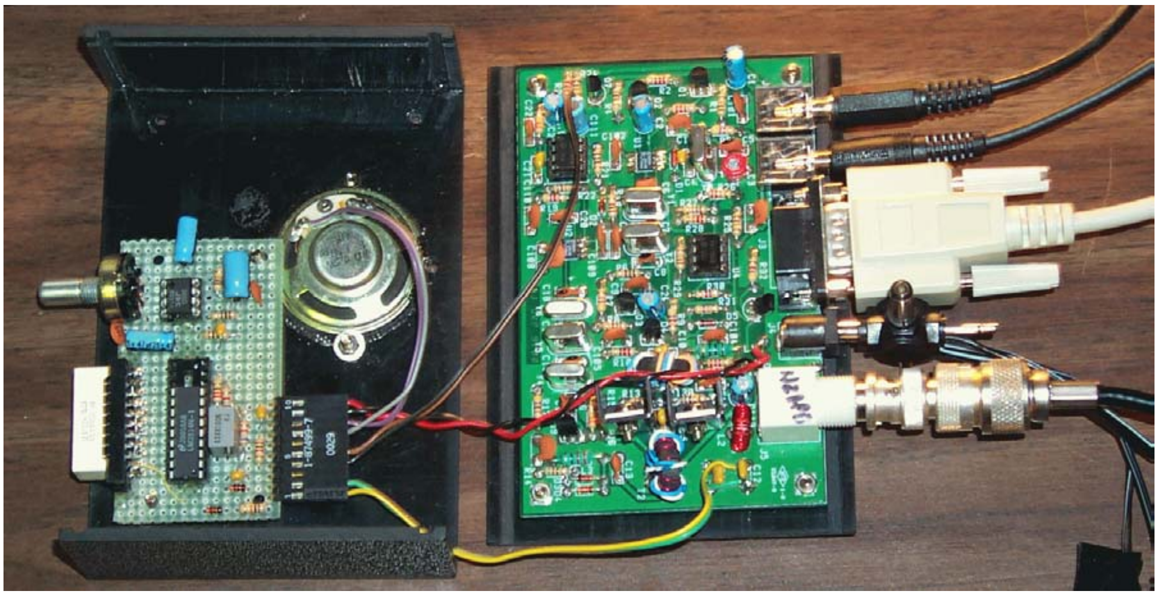
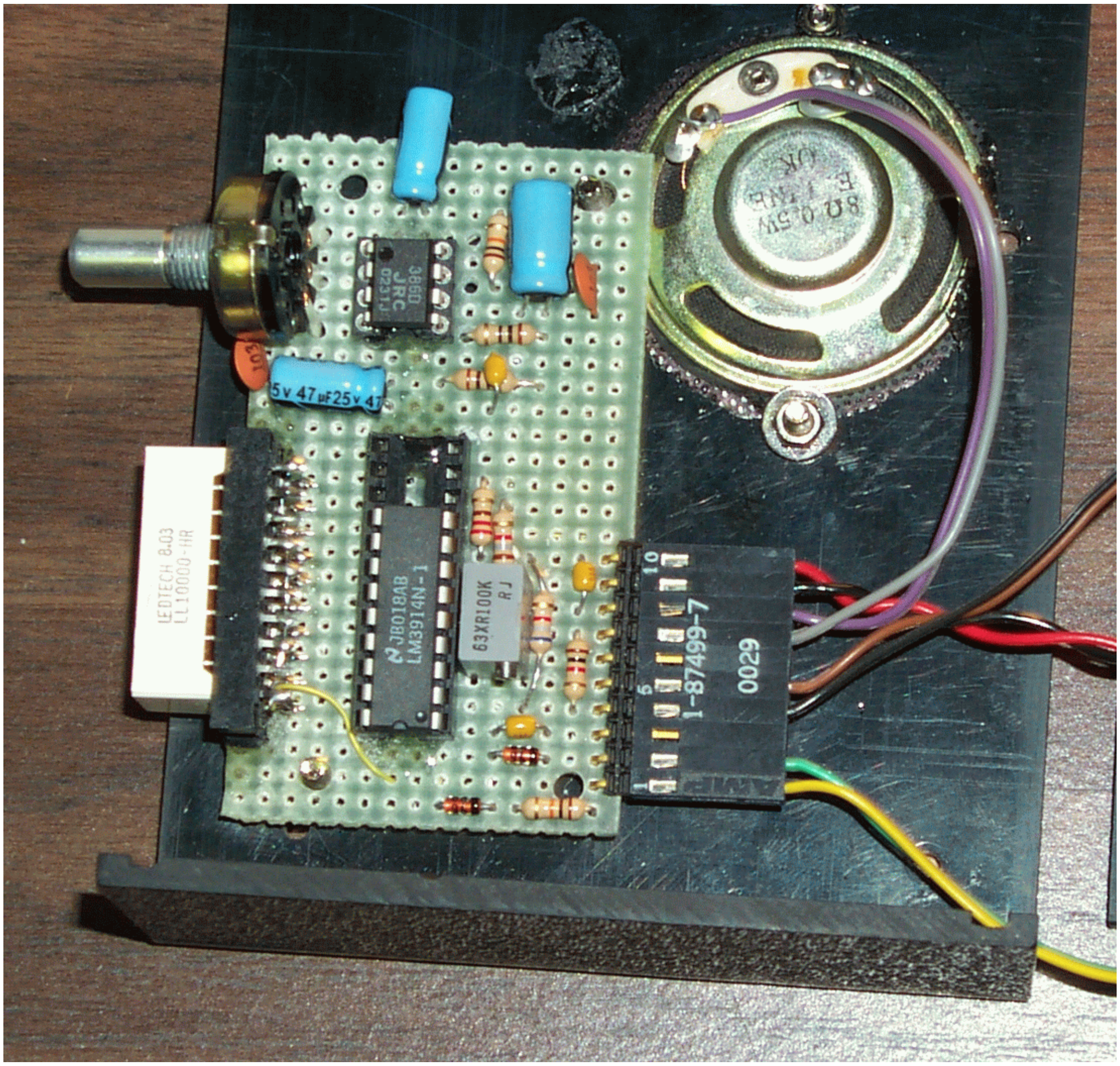
This is N2APB’s custom Warbler Deluxe enclosure, created from ABS plastic, housing the Warbler plus the audio amp and power indicator circuitry. The bargraph array mounted on the front panel has six segments illuminated, indicating a full and proper audio drive level being delivered to the unit (generating the proper RF output power level). The volume control adjusts the audio level coming from the speaker mounted in the top half of the enclosure.



The ABS plastic enclosure comes apart easily by bending the sides outward, yielding an overall view of the internal layout. The power indicator and audio amp circuits are mounted on the inside of the top cover along with the speaker. The Warbler is the board on the right, of course, showing the cabling for power, antenna and connection to the computer.



This is a closer view of the power indicator and audio amp circuits. Note the bar graph array and the volume control extending past the edge of the unit. When the front panel is in place, these components protrude from the holes in the panel to form an attractive front presentation of the unit.

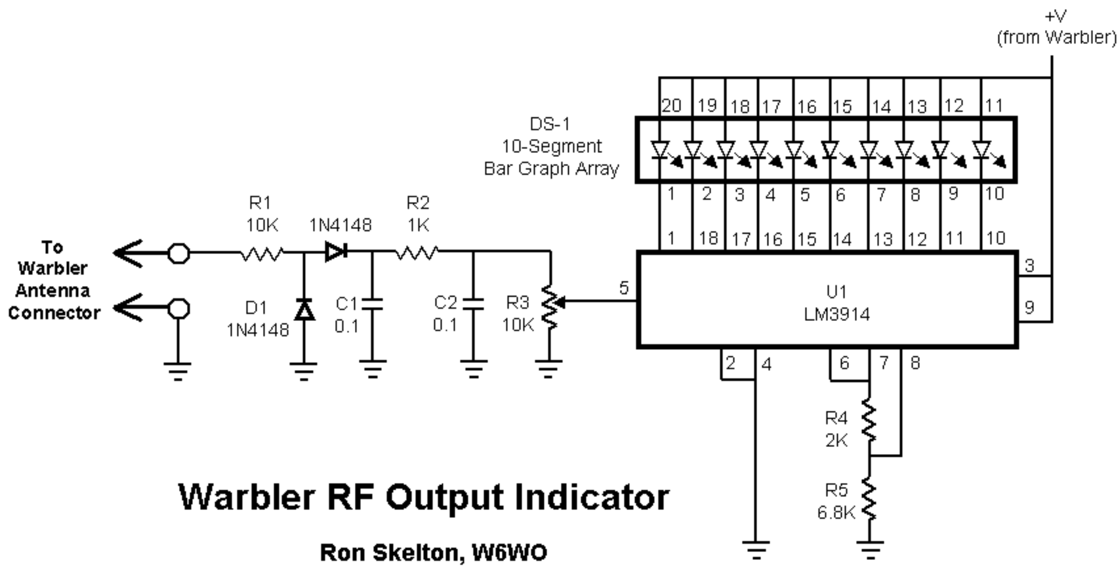
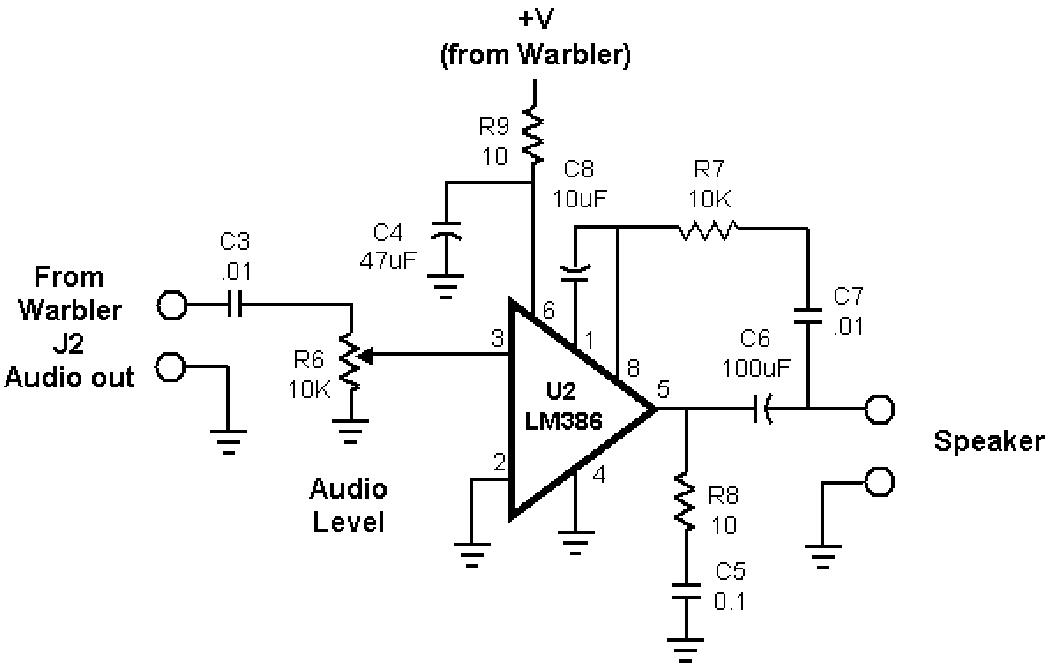


Figure 1: Schematic of the RF Power Indicator. All resistors are ¼-W, 5% tolerance carbon-composition units. Part numbers in parenthesis are from Mouser Electronics (www.mouser.com). Equivalent parts can be substituted.

R1 – 10K-ohm (291-10)
R2 – 1K-ohm (291-1K)
R3 – 10K-ohm potentiometer (31CQ401)
R4 – 2.2K-ohm (291-2.2K)
R5 – 6.8K-ohm (291-6.8K)
C1, C2 – 0.1uF ceramic disk capacitor (21RX310)
D1, D2 – 1N4148 silicon diode (512-4148)
DS1 – bar graph array (512-MV59164)
U1 – LM3914 dot/bar graph driver (526-NTE1508)



Warbler Audio Amp

G. Heron, N2APB

Schematic of the Warbler Audio Amplifier. Part numbers in parenthesis are from Mouser Electronics (www.mouser.com). Equivalent parts can be substituted.

R6 – 10K-ohm potentiometer (31CQ401)
R7 – 10K-ohm (291-10K)
R8, R9 – 10-ohm (291-10)
C3, C7 – .01 uF ceramic disk capacitor (21RX410)
C4 – 47 uF, 16V electrolytic (140-XRL16V47)
C5 – 0.1 uF ceramic disk capacitor (21RX310)
C6 – 100 uF, 16V electrolytic (140-XRL16V100)
C8 – 10 uF, 16V electrolytic (140-XRL16V10)
U2 – LM386N audio amplifier (513-NJM386BD)

Joe Everhart, N2CX

TEST TOPICS …and More!

Coming to terms with SINAD or Signal plus noise plus distortion to noise plus distortion.

This column will discuss some terms that are important to those of us who build or use communications equipment – signal-to-noise radio and the related newer quantity – SINAD. Both have to do with the quality and intelligibility of communications signals. When you compare receive sensitivities in manufacturer ads or product reviews you will run across SINAD. After reading this column you will know what it means.

Coming To Terms

The term signal-to-noise ratio (SNR) seems easy to understand. We usually think of it as something that applies to the output of a radio receiver or other communications device. As the name states, it is the ratio of the desired signal to unwanted noise. An example is shown in Figure 1.

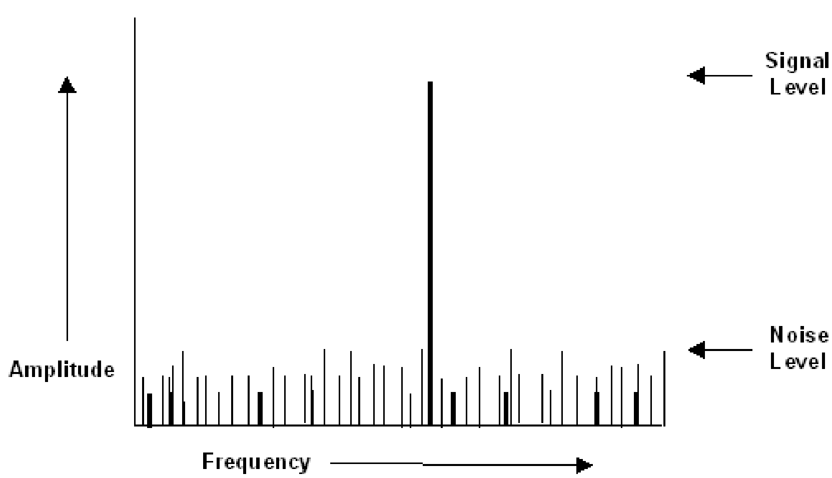


Figure 1 – Visualizing SNR

It should be obvious that it also applies to other parts of a radio link and within both transmission and reception equipment. Within a transmitter we certainly hope that the intelligence (the signal) is much stronger than any unwanted noise that may be present. Similarly when a signal is transmitted the RF we put out needs to much stronger (higher SNR) than any local noise or interference present since it will be weaker at the other end of the transmission link and ever-present noise will cause a lower SNR that will degrade its intelligibility.

For best understanding of measurements dB notation is used to express SNR since that type of expression is inherently a ratio that is independent of actual signal levels.

Measuring SNR is not always an easy task. Noise tends to be broadband while the signals we communicate with have a limited bandwidth. This means that we have to define a bandwidth in which to measure SNR since out-of-band noise will not usually degrade our ability to detect or understand the wanted signal. So any equipment used to measure SNR needs filtering to reject noise that is not within the desired signal bandwidth.

Common devices that techs and engineering folks use to measure SNR are either a tuned detector or a spectrum analyzer. Either can be quite expensive so are not something that the average homebrewer has available. Fortunately when homebrewers want to measure SNR they are interested in a measurement that is in a part of a circuit that is already band-limited such as an intermediate frequency (IF) amplifier or in an audio circuit. A spectrum analyzer would be ideal but we generally have to measure using less expensive equipment such as an RF or audio voltmeter or an oscilloscope. Though these measurement devices do not have any selectivity the narrow bandwidth of IFs or audio amps preserve accuracy caused by out-of-band noise.

For the rest of the discussion we will assume that SNR measurements are made in a receiver in the audio chain though similar techniques are used in other situations.

The first thing to do is to disable any AGC to set the receiver gain to a known stable level. For voice signals the received carrier is applied without modulation and the resulting background noise level is measured. Next the carrier is modulated by a known signal (usually a 1 kHz tone) and the resulting signal level is noted. With a meter calibrated to read dB the ratio is simply the ratio of the second value to the first or SNR(dB) = S(dB) –N(dB). If a voltmeter or 'scope is used the readings will be in volts so the dB ratio can be calculated from the voltage readings with the formula SNR(dB) = 20*log[S(V)/N(V)]. For high SNR levels the ratio is accurate but for low SNR (say below 10 dB) the readings will have reduced accuracy.

For CW measurements the procedure is the same except that the noise reading is made with no input signal and the signal reading is made with a steady carrier that produces a beat note at the desired frequency.

In modern voice communications systems a more common measure these days is made that is more representative of reality in communications systems. The quantity measured is called SINAD or Signal plus noise plus distortion to noise plus distortion [(S+N+D)/(N+D)].

This is more of a practical real-world quantity that is easier to measure outside a well-equipped laboratory. It is also more "honest" because it recognizes that inevitably distortion occurs and cannot be easily removed.

You may recall commercial equipment ads that specify receiver sensitivity in dB. For example a 2 meter FM receiver might have a sensitivity of 0.25 uV for a 12 dB SINAD while a receiver for SSB or CW might have a sensitivity of 0.15 uV for a 10 dB SINAD and an AM receiver would have a spec of 2 uV for a 10 dB SINAD. As you can see sensitivity figures are usually given with a 12dB SINAD for FM and a 10 dB SINAD for SSB, CW and AM modulation.

SINAD measurements can be more easily made than SNR since they are made on a modulated signal. A single tone modulates a transmitter (again usually 1 kHz) and a SINAD meter compares the receiver output signal to the output signal with the desired modulation notched out electronically. No bandwidth calculations or other interpretation needs to be made beyond db measurements of an audio signal.

Designed For Test

In the previous section we saw that modern signal quality measurements made to evaluate or compare voice communications links and equipment are in terms of SINAD. There are commercial test sets that radio comm. shops use to do these measurements, most prominently the SINADDER ™ from Helper Instruments. However we homebrewers do not need these on a regular basis so we might consider the less costly alternative of rolling our own. Let's look at the functions needed to measure SINAD then how to make these functions ourselves.

Figure 2 illustrates the functional blocks that make up a SINAD measuring system. On the transmitter end the input signal comes from a sine wave source that has low distortion. Signal purity is important since any distortion present sets the lower limit of our measuring ability. As mentioned earlier we will assume a 1 kHz sinewave.

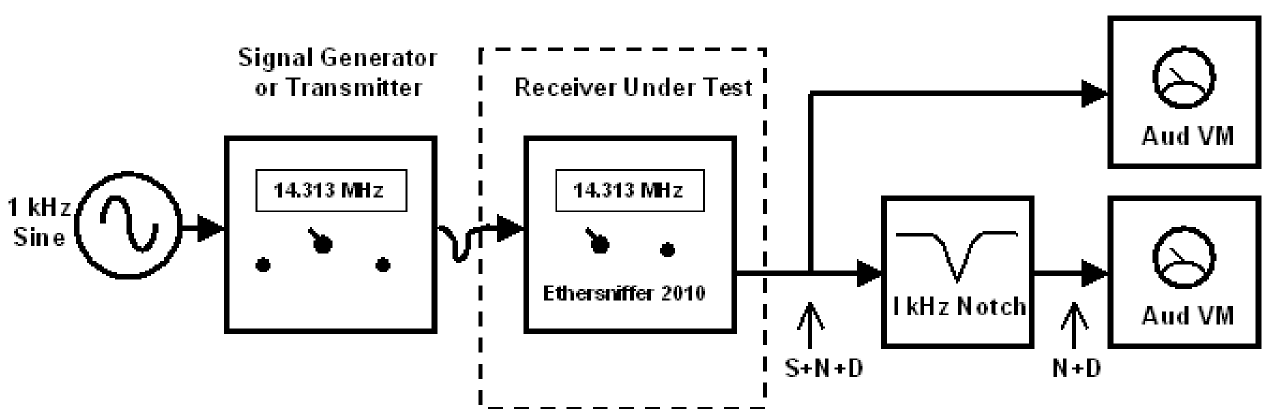


Figure 2 – SINAD Measurement blocks

Receiver audio output is first measured with an audio voltmeter. This is the reference signal plus noise and distortion (S+N+D). Next the same measurement is made with a notch filter connected between the audio output and audio voltmeter. The filter removes the audio tone to this time only the residual noise and distortion (N+D) are measured. While Figure 2 shows two audio voltmeters for ease of explanation, a single voltmeter is usually used and the notch filter is switched in or out to get the two readings.

If the audio readings are made with meters that indicate in dBm, SINAD is simply the (S+N+D) reading minus (N+D). The result is in dB which is a ratio. For voltmeters that read out in volts or millivolts we first do the division (S+N+D)/(N+D) to get the numeric ratio then compute the dB value with the formula 20*log(voltage ratio).

Except for the audio notch filter many already have the equipment needed to do their own SINAD measurements. Each component of the test setup will now be described so that the appropriate pieces can either be selected or built.

The 1 kHz sine wave generator can be a common one though care must be taken to ensure that it has a very pure sine output. A good rule of thumb is that the distortion should be at least 10 dB better than the measurement being made. So for 10 dB SINAD we need distortion of less than 20 dB and for 12 dB SINAD tests we need distortion suppressed by more than 22dB. My own preference is to use a source that has a distortion of less than 1% (40 dB).

The commonly used twin-tee oscillator (see the ARRL Radio Amateur Handbook or Ref 1 and 2) is good for many ham shack uses but does not have low enough distortion. Similarly the common Wein bridge oscillator can be employed but it needs to use an AGC feedback loop to keep distortion in check. Ref 3 shows a suitable Wein bridge design and other sine wave generator circuits.

Faced with the need to test notch filters with notch depths in excess of 40 dB some years back I found yet another approach to high quality sine wave generation from one of my favorite references, the CMOS Cookbook (Ref 4). A digital divider chain can be used to generate a good sine wave using only a couple of added components. The result is a stepped sine wave. The beauty of this design is that the first significant harmonic is the 7^{th} and it is already almost 17 dB down.

The complete circuit for the sine generator shown in Figure 3 has three functional areas. The first is an astable multivibrator that provides an 8 kHz clock signal. In the middle is a Johnson counter that divides the clock by 8. Outputs of the dividers in this counter drive a resistive network that is summed to synthesize a stepped sine wave. The simple low pass filter on the schematic's right hand side easily filters out all harmonics providing an easy-to build no-adjustment pure sine wave source.

Parenthetically I have to add that in writing this article I looked in vain for my well-worn copy of the CMOS cookbook. A plea on the Internet resulted in many offers to supply the info to me. Marvin Moss graciously scanned the info for me and Chuck Carpenter, W5USJ sent me a copy of the book that he no longer needed.

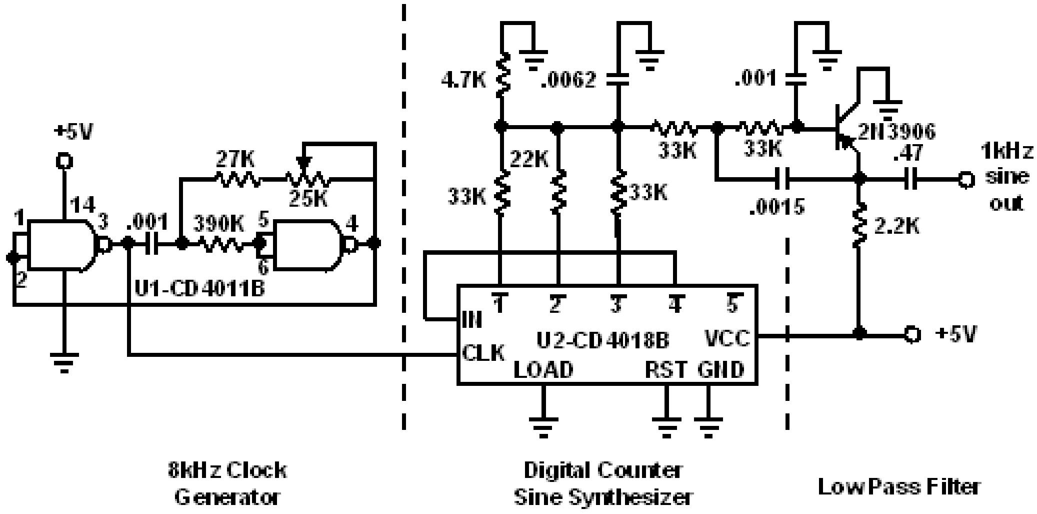


Figure 3 – Low Distortion Sinewave Generator

The audio notch filter can be easily implemented using the circuit of Figure 4. Though the schematic may look a little busy it is straightforward to understand. Op-amp sections U1, U2 and U3 form a state variable active filter with high pass, low pass and band pass outputs. High pass and low pass outputs are fed to U4 and the net result is signal cancellation at the peak of the filter response, forming a notch filter. Only the notional circuit is given in Figure 4. A wealth of design info on filters in general and the notch filter mentioned here can be found in yet another Don Lancaster book – the Active Filter Cookbook (Ref 5). As with the CMOS Cookbook this tome is always at hand in my workshop for quick reference info.

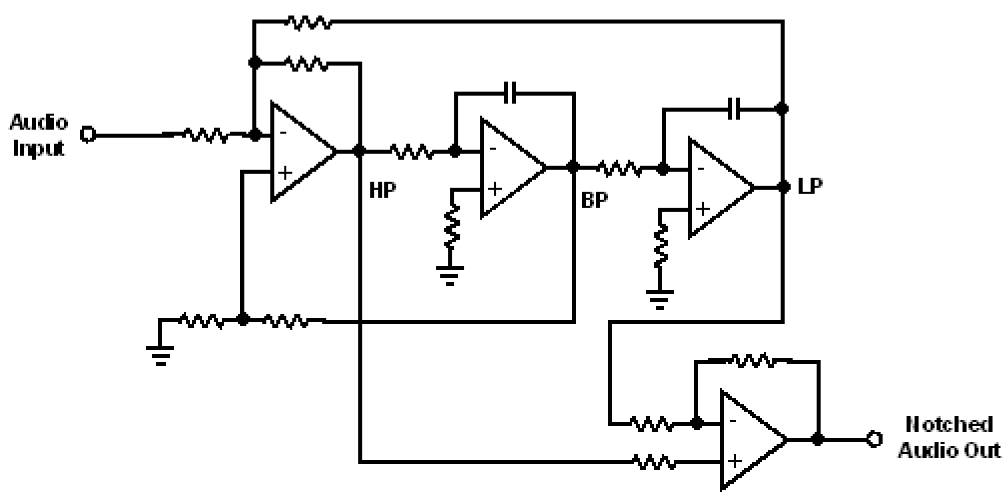


Figure 4 – State Variable Active Notch Filter

Lab grade audio voltmeters are the best choice for measuring the audio voltages and for best accuracy should measure true RMS voltage. Check specs for the meter you have to see if they indeed measure true rms values or are merely peak reading instruments calibrated to read the rms equivalent for sine waves. I'm fortunate to have an HP3400 that is a true rms reading instrument.

There are several ways to roll your own audio voltmeter. The simplest scheme is to use a precision peak-to-peak detector such as the one in Figure 5. The output is a dc value equal to the peak-to-peak value of the input voltage. It's fine to use in measuring relative SINAD but will not be absolutely accurate in reading the noise plus distortion voltages. Details of this circuit can be found in the CMOS Cookbook.

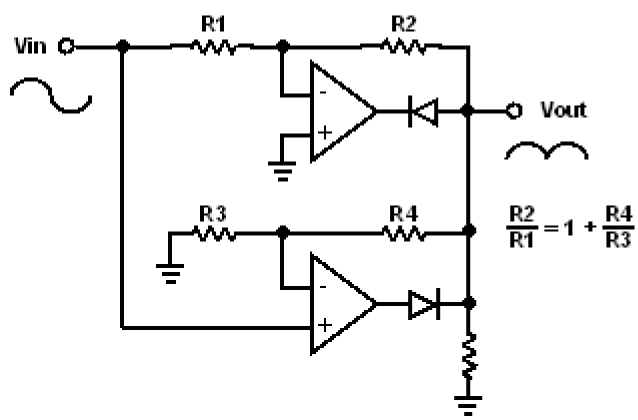


Figure 5 – Precision Rectifier

A somewhat more complicated circuit gives real rms readings. See the CMOS Cookbook or the National Semiconductor application brief LB-25 (see Ref 6.)

Possibly the most elegant RMS metering scheme uses an integrated circuit specifically designed to measure RMS voltage. The Analog Devices AD8361 is a great solution. A rudimentary circuit is detailed in Figure 6. The AD8361 was designed as an RF device though it is broadbanded so that it will work in the audio range as well. Its output is a DC voltage in the range of 0 to about 4.5V corresponding to an input range of 0 to about 600mVrms. See Ref 7 for the AD8361 data sheet.

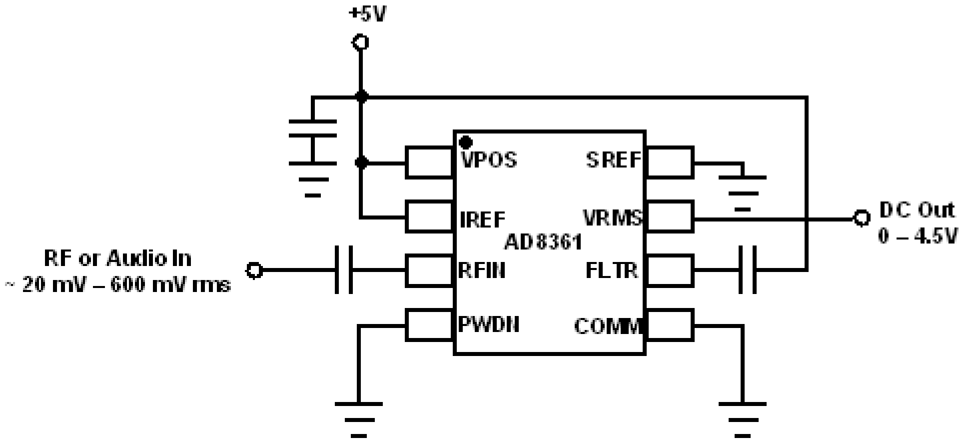


Figure 6 – AD8361 True RMS Detector

Stimulus and Response

First some background is in order. Several years back Doug, KI6DS asked me to design a simple kit that the Northern Texas QRP club could sell as a fund raiser. At this writing it is still available from them at: http://www.kk5na.com/kk5na_files/accuprobe.htm.

The kit is an inexpensive compensated RF detector to allow accurate RF measurements at RF levels down to the 100's of mV by using diode feedback on an op-amp to counteract the Inherent non-linearity of a diode peak detector. It also tailors the resultant DC output so that the output voltage corresponds directly to the RMS value of the input RV sine wave.

Unfortunately an error found its way into the manual I wrote for the kit. Several folks have written to me for clarification of my error.

The next to last paragraph of the manual states, in part:

"The DC reading on the DMM will be 1/10th the RMS value of the transmitter output voltage. At 1 watt this will be 70.7 mV, ranging up to 158 mV for a 5 watt transmitter."

This should have read:

"The DC reading on the DMM will be 1/10th the RMS value of the transmitter output voltage. At 1 watt this will be 707 mV, ranging up to 1.58 V for a 5 watt transmitter."

Reference:

1. Joe's Quickie # 1 – "Quickie Audio Oscillator" from the WA8MCG Technical Topics column in the ARCI QRP Quarterly, Jan 1991

2. Joe's Quickie # 47 – "Good Enough Oscillator" from the WA8MCG Technical Topics column in the ARCI QRP Quarterly, Oct 2003

3. "Design of op amp sine wave oscillators" a Texas Instruments Application note
http://focus.ti.com/lit/an/slyt164/slyt164.pdf

4. CMOS Cookbook by Don Lancaster, Howard W. Sams, Inc

5. Active Filter Cookbook by Don Lancaster, Howard W. Sams, Inc

6. National Semiconductor Linear Brief LB-25
http://www.national.com/an/LB/LB-25.pdf#page=16.

7. Analog Device AD8361 IC data sheet
http://www.analog.com/en/prod/0,,770_852_AD8361,00.html

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AmQRP.ORG HOMEBREWER

Richard Fisher, KI6SN

QRP Operating

2-Meter FM Mountaintopping

with a simple 3 element beam.

Bring up QRP operating, and most often conversation turns to the high frequencies – 40- and 20-meter CW leading in the popularity polls.

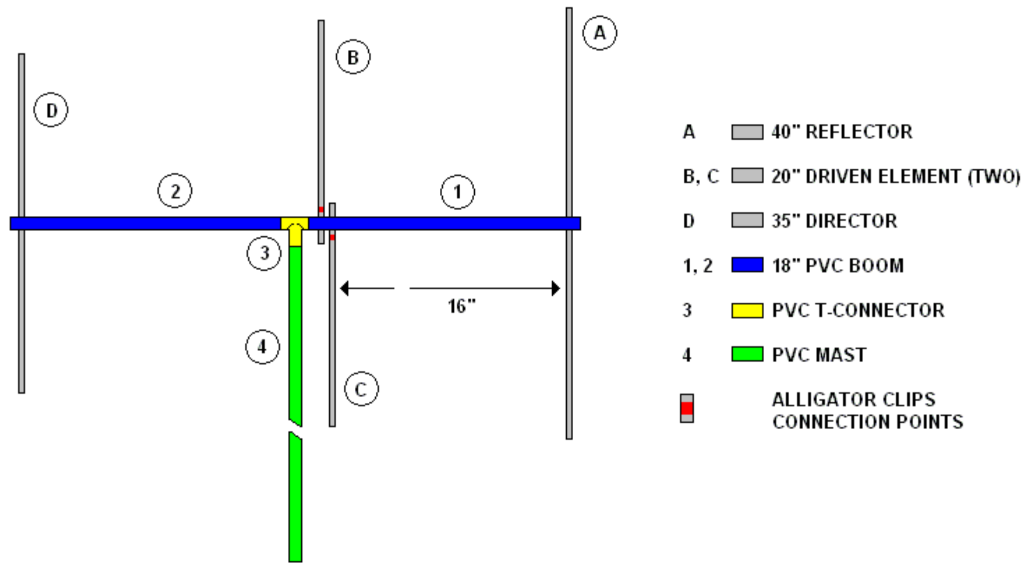
But there's a fabulous low-power world to explore at very high frequencies, VHF – with 2-meter FM offering an easy, inexpensive entrée to phone operations that can be every bit as exciting and satisfying as working DX using Morse on the low bands.

Repeaters across the 144 MHz spectrum have long been a portal to all sorts of interesting contacts. But it's line-of-sight simplex operation – especially from mountain-topping locations – that can really show what a few watts and a good antenna are capable of delivering. At KI6SN, we've found this especially true during ARRL Field Day and VHF contesting periods from the summits of local mountains.

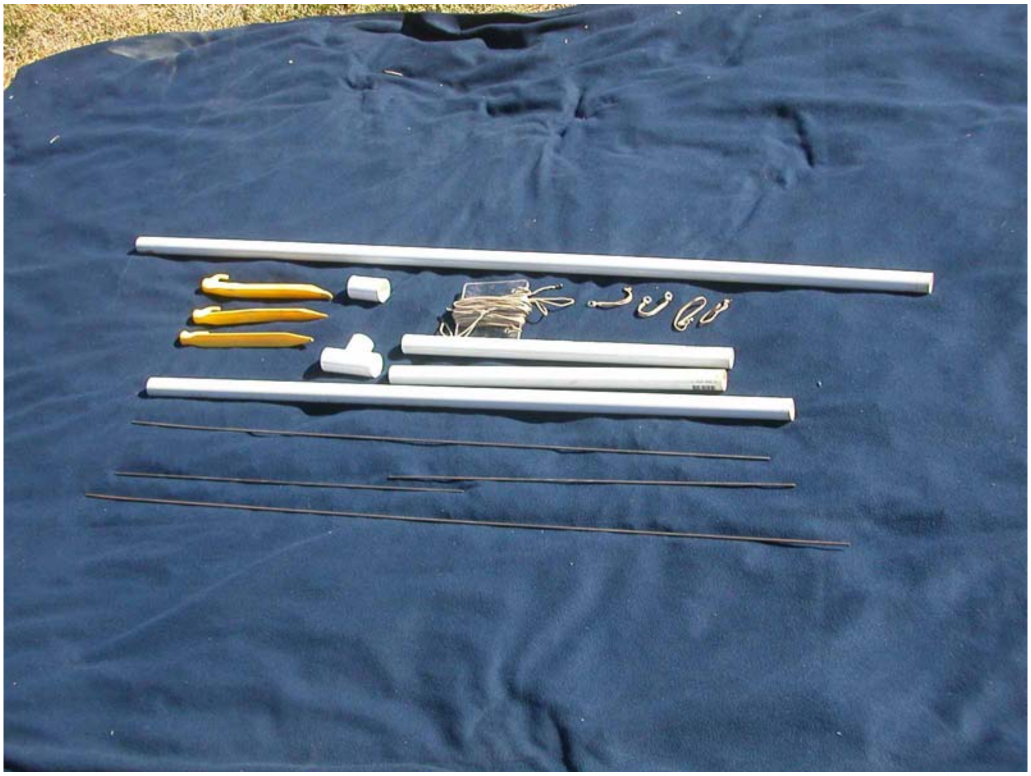
Of course, lightweight gear and ease of portability are key factors when considering your rig, power source and antenna set-up.

The 3-element beam shown in the accompanying diagram and photographs has been described in articles by Nathan Loucks, WBØCMT – "7 dB for 7 bucks." His was a fixed-station antenna that we've modified here for easy assembly and breakdown when engaged in backpacking operations.

A QRPER'S PORTABLE 2-METER BEAM



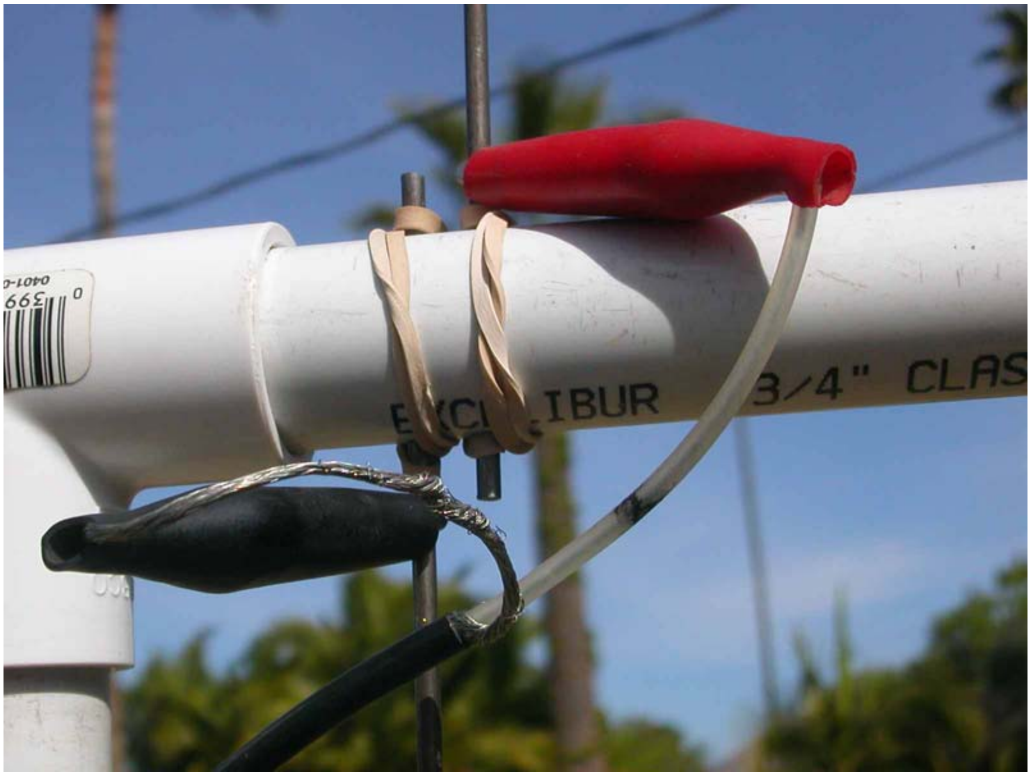
Accompanying photographs and a diagram show details of this great little antenna. Most of the antenna parts can be purchased inexpensively from your local home improvement store – standard PVC pipe, T- and in-line joints for the boom and mast, and lightweight metal rods for the driven element, reflector and director.



A short run of 72-ohm coax from the antenna to your HT or mobile FM transceiver is easily connected to the driven element with garden-variety alligator clips. Easy on. Easy off.
The accompanying chart shows the dimensions of each antenna piece. At KI6SN, ¾-inch PVC was used to support the metal elements and for the mast.

Two 18-inch long PVC pieces (shown on the diagram in BLUE) were fitted into a standard PVC T-connector – shown in YELLOW in the diagram – to form the boom. Two 3 ½-foot pieces form the mast (shown in GREEN) – with a PVC in-line connector between them. This keeps all the pieces short enough to carry in a backpack.

You'll notice that the two parts of the driven element – which at KI6SN is actually a simple dipole cut for 146.52 MHz – are parallel and slightly out of line with one another. This allows each leg of the dipole to pass through the PVC boom and overlap one other slightly.
By positioning each rod to protrude ¼-inch through the side of the boom, the metal rod overlap acts electrically as a matching device. No gamma match needed. Neat! From tip to tip, the total length of the two rods in the driven element should be between 37 and 39 inches, depending on what part of the 2-meter band you're operating in.



By affixing the alligator clips – connected to the braid and center conductor of the coax – to each side of the driven element in the areas in the diagram indicated in RED – you should have a very nice impedance match for your handheld or mobile FM transceiver.
The antenna is made up of four metal rods: one at 40-inches (REFLECTOR), one at 35 inches (DIRECTOR) and two at 20-inches (DRIVEN ELEMENT). Use the formula 475 divided by frequency (MHz) to determine the precise total length in feet of the driven element.

At 146.52 MHz, the dipole rods' combined length – with overlap – is right around 39-inches for the 2-meter FM calling frequency: [475 / 146.52 = 3.24 feet, or about 3 feet, 3 inches – 39-inches].

Start boom construction by cutting your PVC pieces to the lengths specified in the diagram. Then drill holes – about the same diameter as your metal elements – through the PVC about ½-inch from one end of each 18-inch long PVC boom piece. These will be the holes for the 40-inch-long REFLECTOR and 35-inch-long DIRECTOR rods.

When you've chosen which PVC piece to affix the REFLECTOR, measure 16-inches along the boom and drill another set of holes through the PVC for one side of the DRIVEN element. Then measure an additional ¼-inch from that set of holes to drill another set of holes for the other half of the driven element.

Push the REFLECTOR (A) through the boom holes in the PVC and hold it in place with a rubber band with one washer on the end. Simply loop the band over the element and slide the band to the boom. Then wrap the rubber around the boom a couple of times to keep the rod from sliding. Slip the washer under the rubber band wrapping to keep the rubber band and element secure.

Next push each piece of the DRIVEN element (B and C) through the boom – in the two sets of holes 16-inches and 16 ¼-inches away from the REFLECTOR – and tie them off with rubber bands without washers. Loop the rubber band over one of the DRIVEN elements, and slide it to the boom. Next wrap the rubber band around the boom a couple of times, and loop it over the protruding stub. Do the same for the other side of the DRIVEN element.
Last, slide the 35-inch DIRECTOR (D) through the holes as drilled at the end of the other side of the PVC boom and affix it with a rubber band with one washer – just like you did for the REFLECTOR.

Now, slide each boom piece into the T-connector, align the elements vertically and you'll be looking at a pretty snazzy portable beam.

All that's left to do is to attach the coax cable with the alligator clips at the places on the DRIVEN element marked in RED, slide the PVC mast piece into the T-connector and tie-off the coaxial cable to the mast with your remaining rubber bands / washers.

At KI6SN we used a small piece of plastic as an anchor for the guy lines. It rests on top of the in-line joint connecting the two 3 ½-foot PVC mast pieces.

Not only does this keep the antenna standing nicely, it also gives the operator flexibility to turn the antenna easily for directionality and maximum signal strength.

There's nothing magical about the length of the PVC mast pieces, of course. If you have the space or need for longer pieces – or more of them – by all means, go for it!

The accompanying photograph from 2005 Field Day shows this lightweight antenna can be hoisted to a respectable height with the addition of a little more PVC in the mast.

You can use an SWR meter or field strength meter to experiment with the feedpoint or element lengths to get highest efficiency.

The national 2-meter FM simplex calling frequency is 146.52 MHz. That’s a good place to give a call. Once you’ve made contact, suggest moving a bit up the band to keep the calling frequency clear for others to use. I often QSY to 146.55 or 146.58 MHz.

Using this neat little beam with an HT at 3-watts atop a local hill, I was solid copy on 2-meter simplex with a station more than 60 miles to the west of me. Does this little antenna it work? You better believe it. Those 7 dB of gain can make all the difference.

*Richard Fisher, KI6SN, is QRP columnist for **WorldRadio** magazine, executive editor of the Adventure Radio Society's monthly web magazine **The ARS Sojourner,** writes the **Washington Beat** column for Popular Communications magazine and is public information coordinator for the **ARRL's Orange Section** in Southern California. For any updates on construction or use of this 2-meter beam, visit the KI6SN Internet website **The QRPer** at*: www.theqrper.blogspot.com

Rich Arland, K7SZ

TUNING UP

Leave it to the Amateurs to pioneer ***every single mode and method*** of communications that we now enjoy world wide!

Hi Gang. This installment we are going to cover a couple of topics so please bear with me as I digress and ruminate over some things that have been bothering me lately.

One extremely handy reference source(s) I have access to is the complete collection of QST (along with all issues of Ham Radio Magazine, QEX, NCJ, and Communications Quarterly) on CD ROM. My QST collection starts with the first issue in 1914 and goes to present. This is a two edged sword, however, because as I browse the older issues of the most famous Amateur Radio journal in the world, I find lots of things to ruminate upon. One thing that definitely shines through in the older issues of QST is the camaraderie of the early radio amateurs in the infancy of our hobby and the dogged determination of a hand full of visionary hams, led by Hiram Percy Maxim (son of Hiram Stevens Maxim, the inventor of the machine gun) and a fledgling group of hams called the American Radio Relay League.

In the early days of our hobby, there were many entities who didn't want Amateur Radio to flourish at all. Among them was the United States Navy, who wanted the entire radio spectrum for themselves. Begrudgingly the Navy consented to yield the "higher frequencies" (200 Meters and down) to the "amateurs" for radio experimentation, since they (the Navy) thought that these frequencies were totally useless for communications purposes. In effect the Navy was right. In those days rotary spark gap transmitters and coherer receivers were the order of the day as far as "modern" radio equipment was concerned. Communications ranges were extremely short when compared with what we can do today on HF.

Leave it to the Amateurs to pioneer ***every single mode and method*** of communications that we now enjoy world wide! So, what did the Navy know? They were the original 800 pound gorilla when it came to radio communications and they got their way. It was only after much experimentation, with Edwin Armstrong leading the way by finding a method to employ DeForest's Audion tube as an amplifier and an oscillator, that CW was born. CW quickly replaced spark transmissions since it was narrow band, much more efficient and could be employed on frequencies well above those in use from that period. Coherer detectors were replaced with extremely sensitive regenerative, then super-regenerative and finally superhetrodyne receivers. Almost 100 years after Armstrong gave us the superhet method of signal reception, we still use it in virtually all communications mediums today. Talk about staying power.

Although there were patent wars between Armstrong and DeForest that lasted years, without a doubt, Armstrong is the major front runner in the “Who’s the father of radio” contest (No Flames, please….I know all about Fr. Joseph Murgas, Marconi, DeForest, and Sarnoff, the dude from RCA, not to mention Fessendon along with a host of others).

Patent wars aside, the early days of radio forged ahead on the backs of Radio Amateurs world wide. Distance records were set and broken, sometimes within the same 24 hour period. Propagation was totally misunderstood, but thanks to amateur scientists who were also Radio Amateurs, over a period of years we have a very detailed theory of how our Ionosphere works to propagate HF signals around the Earth.

Every so often, Hiram P. Maxim (H.P.M.) would write an article for QST under the pseudo name of The Old Man, or T.O.M., for short. Of course, no one was supposed to know who T.O.M. really was, but it wasn’t too hard to guess. T.O.M. had a rather nasty take on “Rotten QRM”, “Ether Busters”, and bad operating practices in general and wanted to liberally apply the Wouff Hong and the Rettysnitch to offending hams. Glad T.O.M. is not around to hear the bedlam on the bands with the 3Y0X DXpediton on the air! For certain he would wear out the Wouff Hong and bend the Rettysnitch from over use!

In May 1964 QST, the League chose to reprint H.P.M.’s message from the September 1927 QST. I have included it below, because from where I sit, I sometimes think that the majority of the Radio Amateur Community and sometimes even QRPers get caught up in self-aggrandizing, ego trips which are totally unhealthy for our hobby in general and QRP in particular. (***With ARRL permission***)

The Reason Why

By Hiram Percy Maxim, President of A.R.R.L.

Sitting back in the old arm chair, with the last issue of QST read from cover to cover and with everybody else in the house asleep hours ago, I fell to thinking of amateur radio today and amateur radio of other days. As the blue smoke curls slowly upward from the old pipe, visions of early ARRL Director’s Meetings float before me. I see those old timers grappling with problems of organization, with QRM, with trunk line traffic and rival amateur leagues. I see sinister commercial and government interests at work seeking to exterminate amateur radio. They were dark days, those early ones.

Today I see Amateur Radio an institution, recognized by our American government and on the road to recognition by other governments of the world. I see a fine, loyal ARRL membership of 20,000 standing shoulder to shoulder and believing in each other and

still blazing the way in radio communication. I see a rapidly developing world-wide amateur radio brotherhood taking shape, in the form of our IARU.

And as the last embers of the old pipe turn to grey ash, I ask how it all came about; that the ARRL should have succeeded and all its opponents failed. The answer is clear. It is because with our opponents there was always some kind of a selfish motive to be served for someone, whereas in our ARRL we insisted from the beginning that no selfish motive for anybody or anything should ever prevail. Everything that the ARRL undertakes must be 100% for the general good. That policy bred loyalty and confidence. With those two things an organization can prosper forever.

H.P.M.'s words ring as true today as they did in 1927. Before you start thinking I am drumming up business for the League, please understand that while I am a League member, I don't always agree with their policies or what they are currently doing or have done in the past. I am ***NOT*** a League Lap Dog. My purpose in including this excerpt from September 1927 QST is to reinforce what I have said earlier about the beginnings of our hobby and to focus on the last several lines of H.P.M.'s editorial.

Newcomers to QRP are invited to come in and enjoy a facet or the Amateur Radio hobby that is fascinating; actually, it is nothing short of amazing what we can do with a few watts or milliwatts. What the newcomer and us Old Timers (OTs) do not need is in fighting, ego-flexing and demeaning of others with whom we disagree. We cannot abide self-serving motives at any level in our QRP hobby. Over the last several years I have seen this happen much more frequently and I have decided to voice my opinion regarding this waste of precious energy in this issue of ***The Homebrewer***.

Before I begin, let me state that I am NOT in the same league with Hiram Percy Maxim. No way. H.P.M. is "the Grand Old Man" of Amateur Radio; period. However, having been involved with QRP since 1965 I have seen our hobby grow, sometimes fitfully, from an arcane bunch of old farts using CW on the HF bands to full blown ham radio done at the 5 watt (or lower) level. I have witnessed QRP go from a stagnant backwater algae filled pool to the fastest growing facet of the Amateur Radio hobby on a world wide scale. Therefore, I can speak with some authority as to where we have been, where we are now and where I see we are headed.

I was on the QRP ARCI Board of Directors during the 1980s and early 90s. I saw my club wander seemingly aimlessly, struggling under the weight of getting the QRP Quarterly out on time (many, many times it did not make the deadline) and not addressing the needs of the membership. I witnessed misguided attempts to get a club project started in the form of the Two-Fer transceiver. Up until that time, there were virtually no "club projects" offered by the QRP ARCI. A far cry from today, huh?

I listened to and defended the QRP ARCI's QRP Quarterly (QQ) staff to the membership when they couldn't manage to get the publication out anywhere close to on schedule. I heard in-fighting and back-biting aplenty during those days. What's that old saying about pleasing everyone all the time? It is oh, so true.

With the advent of the Internet, QRP and the rest of ham radio came of age. Now, with a stroke of the "send" button we can fire off e-mails to everyone on an Internet reflector, voicing our discontent with whatever issue bugs us at that time. In recent memory I was appalled to watch the e-mails fly regarding the American QRP Club's ***Homebrewer*** magazine being late. For you late comers, that was only a little over a year ago. Since that time, George Heron, N2APB and Joe Everhart, N2CX, and the entire ***Homebrewer*** editorial staff have worked hard to push the envelope and provide the QRP fraternity with a cutting edge edition on CD ROM **on time**. Like it or not, this is the way things are going to go in the publishing world. The day of the hard copy magazine and newsletter are just about over. Wouldn't it be nice if the League offered a reduced membership fee to those who wanted to get QST as a PDF off of their website? My, how they would save money!

Change is good. Unfortunately, many people don't like change because…..well, it forces ***THEM*** to change. We saw this same mind set when spark was replaced by CW, when SSB replaced AM and when FM became the mode of choice for short range VHF communications. In the long run everything worked out and we have enjoyed the benefits of these efficient modes for years. I suppose that when digital radio gets a foothold on the HF bands, it, too, will have its growing pains with people failing to see the advantages of a digital format versus a noisy analog one. Eventually, over a period of time, analog HF will be a thing of the past. Likewise on V/UHF: The Japanese D-Star protocol is rapidly catching on through out the world. We should embrace change and not fight over it. Life is way too short for that sort of negativity.

Speaking of fighting and negativity, going back to the debacle over the Homebrewer, I privately e-mailed many of the OTs who were throwing stones at the AM QRP Club reminding them of the times that the QQ was not published on schedule. I also reminded them that we need to pull together as members of the hobby, not tear down folks whose volunteer efforts are responsible for one of the most successful QRP journals to ever hit the streets. My, how easy it is to forget our past when a fresh target comes up on the radar. I even wrote a list manager in one case asking him why he had not taken action against some of the more vocal and, to be really honest, nasty members of the list who were slinging stones. His reply was less than satisfactory, as far as I was concerned, since I had seen him in action when several others in the past had dared to impugn a certain large QRP club and a new QRP kit manufacturer. These "offenders" were immediately banned from that very list. Hmnmmm…consistency would be nice at times like these.

OK, I've vented my spleen. I feel much better, now. AND….the meds are kicking in. Suffice it to say that we do not need the negative impact of in-fighting, ego-centricity, back-biting, and self-aggrandizing at the expense of an individual or a club. Selfish motives and a lack of tolerance force some folks to do and say some really stupid things. When those "things" are broadcast world wide on the Internet there is a whole different audience out there that will look and say, "Those QRPers are nuts! I don't want to have any part of that action!"

Stop this nonsense! Imagine what someone just coming into QRP thinks when he/she sees all this unconstructiveness on the Internet lists, over the air, or in person. It's not good for our hobby; it's not good for us as human beings. It takes away from our creative process and prevents us from growing and reaching our individual potentials. I guess now is the time that I echo the sentiments of Rodney King, "Why can't we all just get along?" Damn, Rodney, I certainly don't know. Anyone? Please?

The Needle Swings to QRP

Although I never met Howard Pyle, W7OE, I had several QSOs with him over the years. Howard was a prolific author of ham radio and technical papers. He was published in just about every professional electronics/ham radio/electronics hobby magazine in existence until the late 1960s. The title of this portion of the column is taken from a piece he did for Ham Radio Magazine in the December 1968 issue (pg 36).

At this particular time I had been involved with QRP for a grand total of about 3 years. Yes, even I was a newbie at one time. (I was young once, too, but just try to convince my kids!) Howard was an early proponent of QRP and one of the founding members of the Pacific Amateur Radio Guild (PARG) which I joined in 1970. He always had very interesting and technically adroit articles about QRP, antennas, rigs, operating tips, etc. He was the Doug DeMaw, W1FB (SK), of the day. The Ham Radio article of which I speak was one that touted the use of milliwatts to make long haul HF contacts; something extremely "cutting edge" for that period of time.

Using the International Crystals oscillator and amplifier boards, many hardy QRPers were kluging together milliwatt transmitters and hitting the HF bands to shatter miles-per-watt records on a weekly basis. For the time, Howard's article on micro-power was, shall we say, almost heresy. These were the days of the big linears; HT-45 Loundenboomers, KWS-1s, 30L-1s, 30S-1s, etc. If you weren't running four 811As modulated by four 811As you just weren't in the competition! ***NOBODY*** uses milliwatts for HF! Bet me!

The International Crystal PC boards opened up a whole new avenue for those QRPers brave enough to tackle it. And, tackle it they did. W6TYP in California worked New Jersey with a whopping 50 milliwatts to set new record of 210,000 miles-per-watt! Howard's article heralded a new era of ham radio, one where power meant nothing and operator skill was everything. W7OE has often been credited with the saying, "Power is no substitute for skill". It is very sad that Howard did not live to see where QRP has gone over the last 30+ years. Even he would be amazed.

With W7OE's article fresh in my mind I want to offer a challenge to all QRPers out there in QRP Land: crank back the power and work some milliwatt or even microwatt contacts this year. Sure the sunspot cycle is low, but that adds even more fuel to the challenge. Imagine breaking a M-P-W record on a band at the bottom of the cycle! Now that is worth writing home about.

There is no shortage of tiny rigs. Almost every QRP organization out there offers some form of milliwatt transmitter or transceiver kit for a very reasonable price (The Rock Mite immediately comes to mind.), so get out the soldering iron, solder, dykes and needle-nose pliers, and get on with it! Homebrew up a flea powered rig and work some DX. Use the Internet to set up schedules, choose a “code word” that must be copied by the receiving station to insure that a valid contact had been established, and hit the air waves with a vengeance. Make this the year of MicroPowered QRP. C U on the bands!

Rich Arland, K7SZ
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AmQRP.ORG HOMEBREWER

Ken Newman, N2CQ

QRP Contesting Calendar

June, July, August

JUNE:

Wake-Up! QRP Sprint (CW) * QRP Contest *****
Jun 3, 0400z to 0600z
Rules: http://www.qrp.ru/sprint_e.htm

IARU Region 1 Fieldday (CW) ... QRP Category
Jun 3, 1500z to Jun 5, 1459z
Rules: http://www.sk3bg.se/contest/iarur1fd.htm
[First full weekend in June]

Look Around in the Field (LAITF) (CW) ... QRP Contest!
Jun 3, 1600z to 2159z
Rules: http://mysite.verizon.net/vze7v384/nj2om/index.html

QRP TACtical Contest (CW/SSB/PSK) ... QRP Contest!
Jun 3, 1800z to 2359z
Rules: http://www.n3epa.org/Pages/TAC-Contest.htm

Adventure Radio Spartan Sprint (CW) ... QRP Contest!
Jun 6 , 0100z to 0300z (First Monday 9 PM EDT)
Rules: http://www.arsqrp.com/

GACW WWSA CW DX Contest (CW) ... QRP Category
Jun 10, 1500z to Jun 11, 1500z
Rules: http://gacw.no-ip.org/contest.html

ARRL June VHF QSO Party QRP Portable Category
Jun 10, 1800z to Jun 12, 0300z
Rules: http://www.arrl.org/contests/calendar.html?year=2006

NAQCC Straight Key/Bug Sprint (CW) * QRP Contest *****
EDT: Jun 13, 8:30 PM to 10:30 PM
UTC: Jun 14, 0030Z to 0230Z
Rules: http://www.arm-tek.net/~yoel/contests.html

West Virginia QSO Party (SSB/CW)... QRP Category
Jun 17, 1600z to Jun 18, 0200z
Rules: http://www.qsl.net/wvarrl/wvqp.html
[third Saturday of June?]

AGCW VHF/UHF CW Contest ... QRP Category
Jun 17, 1600z to 1900z (144 Mhz)
Jun 17, 1900z to 2100z (432 Mhz)
Rules: http://www.agcw.org/agcw-con/2006/Englisch/agcw-dl0_e.htm

Quebec QSO Party (All) ... QRP Category
Jun 17, 1700z to Jun 18, 0300z
Rules: http://www.raqi.ca/qqp/regs.html

RUN FOR THE BACON (CW) * QRP CONTEST *****
EST: Jun 18, 9 PM to 11 PM
UTC: Jun 19, 0200z 0400z
Rules: http://fpqrp.com

ARRL Field Day (CW/SSB/RTTY)... QRP Category
Jun 24, 1800z to Jun 25, 2100z
Rules: http://www.arrl.org/contests/calendar.html?year=2005

QRP ARCI Milliwatt Field Day (ALL)... QRP Contest!
Jun 24, 1800z to Jun 25, 2100z
Rules: http://www.qrparci.org

JULY:

RAC Canada Day Contest (CW/SSB) ... QRP Category
Jul 1, 0000z to 2359z
Rules: http://www.rac.ca/service/infocont.htm

"RUN WITH RAC" for more awards from QRP-Canada
See http://www.qrp-canada.com/

Original QRP Contest (CW) ... QRP Contest!
Jul 1, 1500z to Jul 2, 1500z
Rules: http://www.qrpcc.de/contestrules/oqrpr.html

Adventure Radio Spartan Sprint (CW) ... QRP Contest!
Jul 4, 0100z to 0300z (First Monday 9 PM EDT)
Rules: http://www.arsqrp.com/

MI QRP Fourth of July Sprint (CW) ... QRP Contest!
Jul 4, 2300z to Jul 5, 0300z
Rules: http://www.qsl.net/miqrpclub/contest.html

VK/trans-Tasman Contests (160m Ph) ... QRP Category
Jul 8, 0800z to 1400z
Rules: http://home.primus.com.au/vktasman/

IARU HF World Championship (CW/SSB) ... QRP Category
Jul 8, 1200z to Jul 9, 1200z
Rules: http://www.arrl.org/contests/calendar.html?year=2005

FISTS Summer Sprint (CW) ... QRP Category
Jul 8, 1700z to 2100z
Rules: http://www.fists.org/sprints.html

QRP ARCI Summer Homebrew Sprint (CW) ... QRP Contest!
Jul 9, 2000z to 2400z
Rules: http://www.qrparci.org

North American QSO Party (RTTY) /QRP Entries Noted
Jul 15, 1800Z to Jul 16, 0600Z
Rules: http://www.ncjweb.com/naqprules.php

CQ WW VHF Contest (All, 6 & 2 Meters) ... QRP (10W) Category
Jul 15, 1800z to Jul 16, 2100z
Rules: http://www.cq-amateur-radio.com/awards.html

RSGB Low Power Field Day (CW) ...QRP Contest!
Jul 16, 0900z to 1200z
Jul 16, 1300z to 1600z
Rules: http://www.contesting.co.uk/hfcc/calendar.shtml

RUN FOR THE BACON (CW) * QRP CONTEST *****
EST: Jul 16, 9 PM to 11 PM
UTC: Jul 17, 0100z 0300z
Rules: http://fpqrp.com

NAQCC Straight Key/Bug Sprint * QRP CONTEST! *****
EDT: Jul 19, 8:30 PM to 10:30 PM
UTC: Jul 20, 0030z to 0230z
Rules: http://www.arm-tek.net/~yoel/contests.html

VK/trans-Tasman Contests (160m CW) ... QRP Category
Jul 22, 0800z to 1400z
Rules: http://home.primus.com.au/vktasman/

Islands On The Air Contest (CW/SSB) ... QRP Category
Jul 29, 1200z to Jul 30, 1200z
Rules: http://www.contesting.co.uk/hfcc/calendar.shtml

Flight of the Bumblebees (CW) ... QRP Contest!
Jul 30, 1700z to 2100z
Rules: http://www.arsqrp.com/

AUGUST:

Ten-Ten QSO Party (PH) ... QRP Category
Aug 5, 0001z to Aug 6, 2359z
Rules: http://www.ten-ten.org/calendar.html

TARA "Grid Dip" Contest (PSK/RTTY) ... QRP Category
Aug 5, 0000z to 2400z
Rules: http://www.n2ty.org/seasons/tara_seasons.html

North American QSO Party (CW) ... 100W Max. (/QRP noted on entry)
Aug 5, 1800z to Aug 6, 0600z
Rules: http://www.ncjweb.com/naqprules.php

Adventure Radio Spartan Sprint (CW) * QRP CONTEST! *****
Aug 8, 0100z to 0300z (First Monday 9 PM EDT)
Rules: http://www.arsqrp.com/

NAQCC Straight Key/Bug Sprint (CW) * QRP Contest *****
EDT: Aug 8, 8:30 PM to 10:30 PM
UTC: Aug 9, 0030Z to 0230Z
Rules: http://www.arm-tek.net/~yoel/contests.html

Maryland/DC QSO Party (SSB/CW) ... QRP Category
Aug 12, 1600z to Aug 13, 0400z
Aug 13, 1600z to Aug 13, 2359z
Rules: http://www.w3cwc.org

QRP ARCI Silent Key Memorial Contest (CW) * QRP CONTEST! *****
Aug 19, 1500z to 1800z
Rules: http://www.qrparci.org

?BUBBA Summer QRP Sprint * QRP CONTEST! *****
Aug 19, 1600z to 2200z
Rules: http://www.azscqrpions.org

North American QSO Party (SSB) ... 100W Max. (/QRP noted on entry)
Aug 19, 1800z to Aug 20, 0600z
Rules: http://www.ncjweb.com/naqprules.php

RUN FOR THE BACON (CW) * QRP CONTEST *****
EDT: Aug 20, 9 PM to 11 PM
UTC: Aug 21, 0100z 0300z
Rules: http://fpqrp.com

Hawaii QSO Party (CW/SSB/Digital) ... QRP Category
Aug 26, 0700z to Aug 27, 2200z
Rules: http://www.karc.us/hi_qso_party.html

Ohio QSO Party (CW/SSB) ... QRP Category
Aug 26, 1600z to Aug 27, 0400z
Rules: http://www.oqp.us/

Colorado QRP Club Summer VHF/UHF QSO Party (CW/SSB/FM)
Aug 27, 1600z to 2000z
Rules: http://www.cqc.org/contests/index.htm

Kentucky QSO Party (CW/SSB)
Aug 27, 1600z to Aug 28, 0400z
Rules: http://www.ky4ky.com/kyqsopartyrules.html

QRP BARBERSHOP QUARTET CONTEST (CW QRP)... QRP Contest!
Aug 30, 9 PM to 11 PM EDT
Rules: http://www.io.com/~n5fc/barbershop_contest.htm

Thanks to SM3CER, WA7BNM, N0AX (ARRL) and others for assistance in compiling this calendar.

Please forward the contest info you sponsor to N2CQ@ARRL.NET and we will post it and give it more publicity.

Anyone may use this "N2CQ QRP Contest Calendar" for your website, newsletter, e-mail list or other media as you choose. (Include a credit to the source of this material of course.)

72 de
Ken Newman - N2CQ

http://www.amqrp.org/contesting/contesting.html

http://www.n3epa.org/Pages/Contest/contest.htm

QRP Contesting "Tips & Techniques"

I may not have anything new in contesting but it wouldn't hurt to review on these points. Anyone with more to add, PLEASE DO, and we'll add your input to the review.

ANTENNAS, ANTENNAS and ANTENNAS. Many would agree that antennas are the first three things to improve our results in contesting for any kind, whether Sprint or Contest.

Sample of the above:

QRP Afield '96 was won easily by AC5AM, Bob Stolzle. Having been in the contest, we wondered how it could be that this guy was S9 the whole contest, and always there sending 950 MW power. Now we know. The complete story was published in the "72" of Jan. '97. Again, antennas. He found the highest point in the area which just happened to have an old, unused broadcast radio tower. He raised two full wave delta loops (20 and 40 meters) and inverted vee's (20/40 mtrs) at the 100' level. A coax switch is used to choose the best antenna for the incoming signals.

The 100' level probably made the difference, being a strong signal from a QRPp station. His point too is that resonant antennas do much better than those with tuners. The idea was to call CQ on the loop. If no answer, call CQ on the Vee, and so on. If answered on a weak signal, switch to the other one if received better.

Now on to the rest of the real QRP World. Not many are going to find an unused 100+ foot tower to raise these types of antennas. Given that for the Contest type of event, the next thing would be the Op.

For the Op, the biggest thing would be the amount of operation time he is having fun with. Very few put in the 24 hours for the QRP ARCI Spring and Fall contests. The ones in the "TOP TEN" list reached that level according to the hours spent, assuming they are more than average stations. How do they do that? First one have to have the desire. It becomes less desirable at the 15 hour level unless you had plenty of sleep before the contest. To stay there, you have to have the necessary operator comforts. You know what they are for you. Things like a comfortable chair and headphones will take you further.

The first thing that took me to longer operating duration was the memory keyer. With this you can be relaxed much longer and your fist won't give out.

In recent years, computer logging will go even further. I use "NA" for the QRCI contests. When calling CQ, you can set a repeat every few seconds. All you need do is listen. If a station is answering, press the "ESC" key to stop the repeats, and enter his callsign. Press the "INSERT" key, and the station is answered and your info is sent. (You can input an RST if you wish). Enter his info and press the "=" key and you have sent an OK and a QRZ. That is it. (Except the log that is printed at the end.) Given that, you could be there a much longer time.
What else for the operator? **Practice, practice, and practice!** The more you do the better you get.

There are some excellent links to more contest tips. I would recommend the K3WWP link first. If you have been in contesting, chances are you worked John. He is using a homebrew QRP tube transmitter with an indoor antenna. If you don't have the antenna like AC5AM had, you can relate to K3WWP. Look for his tips at:
http://home.alltel.net/johnshan/contest_ss_tips.html

After that, you may want to check the tips from the top contesters. Check them out at: http://www.contesting.com. This is not QRP but many of the suggestions will help us all in contesting. This covers the pre-contesting, equipment, operating, and post-contesting. Most tips assume that you are running a KW, beams and contest software.

Anyone have more QRP contesting tips? I'm sure all would like to hear about them and we'll add any that can help us along.

CU in the next 'test!

72/73,
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http://www.amqrp.org/contesting/contesting.html

http://www.n3epa.org/Pages/Contest/contest.htm

Atlanticon QRP Forums

Held Each Spring in Timonium, Maryland

The Atlanticon QRP Forum is a weekend of QRP fun, presentations and social gathering hosted by the NJQRP Club and sponsored by the AmQRP Club each year in the spring. QRPers from all over the US (and internationally) show up for this annual event held in Baltimore, Maryland. The annual event is held in Baltimore, Maryland at the end of March during the weekend of the ever-popular **Greater Baltimore Computerfest and Hamboree**. The hotel is very close to the state fairgrounds in Timonium, Maryland and special rates are established for QRPers planning to attend. All who register in advance for Atlanticon receive our famous "Atlanticon Kit" prior the weekend.

QRP presentations all day Saturday -- About 140 QRPers usually show up for Atlanticon and on Saturday get treated to QRP seminar topics presented by acknowledged leaders and experts in our hobby. These are hour-long audio/visual presentations made by knowledgeable hams in fields of transmitter design, antenna analysis, homebrew construction, electronic simulation, operating from the field, microcontroller hardware & software design, and more. We normally run straight through from 9am to 5:30pm, with only shorts breaks for lunch and stretching of legs. Each attending QRPer gets a bound copy of the QRP presentations in the form of the Atlanticon Proceedings. These Saturday QRP seminars are one of the great highlights of the weekend.

The Atlanticon Kit -- As has become a custom for Atlanticon, we send a special "Atlanticon Kit" to all those who pre-register for Atlanticon. This is a small-but-useful project that you'll be able to use in the shack for years to come. But even more important, it serves as the basis for the Saturday evening fun & games we have planned.

The Venue – Atlanticon is held on the same weekend as the Greater Baltimore Hamboree and Computerfest, which is the most popular hamfest in the mid-Atlantic region. Many QRPers in attendance at Atlanticon find it very enjoyable to catch an early Saturday at the Fairgrounds' hamfest, and then do it again even longer on Sunday morning.

The Hotel -- The "Atlanticon hotel" is our usual one: the Holiday Inn Select Baltimore North in Timonium, MD. Located just off exit 16 of Interstate 83 North, this quality hotel is just minutes away from the hamfest fairgrounds, and only about 45 minutes from Baltimore-Washington International airport (BWI). A reduced room rate is arranged with the Holiday Inn Select to help QRPers with weekend expenses. Be sure to ask for the "Atlanticon rate". See the hotel's information-packed website at http://www.bal-north.hiselect.com/

Atlanticon starts at 7:30 on Friday night with a social evening where we meet up with old friends and make new ones. Vendors and QRPers alike often show their projects at tables around the large banquet room in which we meet, right up until 11pm.

Saturday is the main event, wherein the illustrious QRP speaking staff delivers the presentations from 8:30 until 5pm, with a box lunch provided to all. We break for individual dinnertime cuisine at local restaurants and reconvene at 7:30 for an evening of wild QRP fun - a homebrew building contest and a special Atlanticon Event are the usual activities for Saturday evening. We normally go until 11pm and then many of us then carry on in the hotel bar, quenching the insatiable QRP thirsts (both knowledge and liquid.)

Sunday morning finds most QRPers hustling over to the hamfest for a morning of looking for that gem of a deal during the last hours of the 'fest. The Timonium Fairgrounds is only a short ride away and is well worth the trip.

Greater Baltimore HAMBOREE & Computerfest -- The Atlanticon hotel is only a short distance from the very popular Greater Baltimore Computerfest and Hamvention, being held the very same weekend! See their website for complete details: http://www.gbhc.org. Many Atlanticon attendees plan their weekend to make it over to the hamfest very early on Saturday morning or on Sunday morning, thus making the over weekend a true ham adventure.

Register for Atlanticon -- With your $10 registration, either in advance or at the door, you will be entitled to sit in on the full day of presentations on Saturday and you'll get the "Atlanticon Kit" mailed in advance of the weekend.

Over 140 QRPers normally attend Atlanticon ... sure hope you too can join us for our very special QRP extravaganza next spring. When you see the specific date announced on the Atlanticon web page (www.njqrp.org/atlanticon), mark your calendars and make your travel reservations early to get the good rates. See you there!

72/73,
George Heron, N2APB n2apb@amqrp.org
Joe Everhart, N2CX n2cx@amqrp.org

