HOMEBREWER
Magazine

A quarterly publication of the American QRP Club

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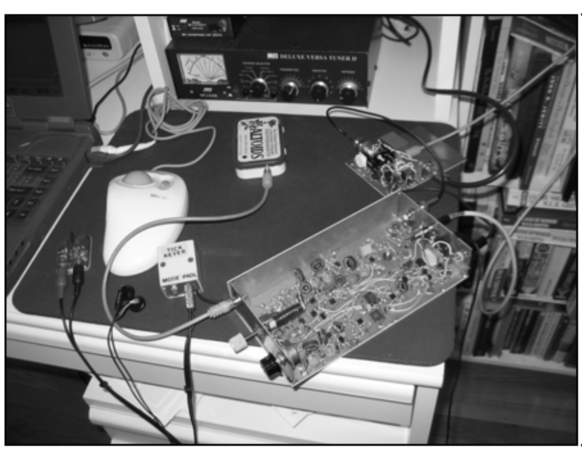
CONTENTS

Features

Columns

Odds 'n Ends

Advertisers



Our Cover ...

The 40 Meter Superhet CW Transceiver, designed and constructed by Wayne McFee, NB6M, is our feature article this time.The rig is shown in use with homebrew paddles and keyer, a FreqMite frequency annunciator in the Altoids tin, and a Miniboots Power Amplifier. It was the subject of a presentation made during the QRP Symposium at Pacificon, 2003, which focused on the process of designing and building a transceiver from scratch by selecting portions of proven circuits and carefully interfacing them to achieve the desired results.

From the Editor

"The Secret of Life"

Those who really know me will recall that I play the guitar and that my favorite artist is James Taylor. Over the years I've played and sung his tunes in the wee hours after our QRP weekends – often with a brew in hand while N2CX grimaces off to the side because of my atonal voice. KI6DS, W3CD, W4IM and others have joined with us too – even NK6R was even planning to join in at Atlanticon this year, as "JT" is one of his favorites.

I believe the best JT tune around is "The Secret of Life", which gently espouses a philosophy that I've recently learned can apply equally well to QRP … and herein lies the pearl.

Whether your particular niche in QRP is contesting, obtaining the latest popular rig, getting your hands on every kit produced by clubs and individuals, or perhaps just actively exchanging with other QRPers on the Lists, have you considered your priorities lately?

Hey, I know this is "just a hobby," but are you still trying to grow as an individual and share with others along the way? Are you able to transcend the issues of petty arguments in order to make your own contributions more valuable to others?

Lots of questions, I know. One of my friends since childhood was always "dying" to get onto the varsity team, dying to get the good job, dying to get a new *mongo* tractor, dying to retire ... and now he's just dying. He didn't take any time along the way to *carpe diem,* or seize the day, and make things really "count" for himself and the people around him.

How can you make things count for you here in the QRP community? Perhaps your *carpe diem* is sharing your particular skills and fascination with radio at the local Cub Scout meeting. Or perhaps visiting an aging ham in the neighborhood who can no longer see too well or who shakes uncontrollably, and work with him to get an antenna up in the backyard. Or perhaps write a short article for your favorite ham magazine (sorry, I couldn't resist) in order to share your experiences with some aspect of "your niche."

Oftentimes we feel that our particular skills do not measure up to others' standards and thus are unworthy of sharing; but that is exactly where we are missing the point. It is not how well we need to show off our expertise, but instead how we are able to ascend to the next level of helping others along their path and actually enjoy that passing of time.

QRP, and ham radio in general, is often about understanding the science of communication – but it is also about how we interact with other humans along the way that helps determine where we stand at the end of our lives.

QRP-L

This spring marked the demise of QRP-L on the Lehigh.edu server.This service was maintained by Jim Eschleman, N3VXI. As list manager for the hugely famous and popular QRP-L listserv for over seven years, Jim has provided a quality communications service that greatly helped facilitate explosive growth in the QRP community and along the way has become a landmark in QRP history.

Jim's concerted efforts and generous contribution of time and resources over the many years helped the QRP community to grow in the many dimensions as demonstrated by what we have today. A large percentage of the 2,200+ subscribers read the QRP-L on a daily basis, obtaining valuable information on such topics as homebrewing, parts availability, operating tips and experiences, equipment reviews, contesting, Fox Hunts, club events, and everything in between.

Leveraging the now-ubiquitous Internet, Eschleman helped turn a tool with "instantaneous perfect copy" that some said had the potential to destroy ham radio, into a tool that served to actually increase the interest and aspirations of the 2,200 list members around the world. Static resource files and list archives were even maintained by Jim on the QRP-L server for the use of everyone - reviews, instruction, contest lists and rules, QRP club directories, technology explanations, book review, atlases, technical white papers, rig modifications and simulation tools.

> ***Learn from the past, lean into the future, and carpe diem.***

Eshleman's service and dedication to the QRP community has left an indelible glowing mark of "A+" in our hobby. Over these seven years of QRP-L operation, thousands of QRPers around the world have learned of countless others who share our sometimes-arcane interest in QRP. Thus the List has guided, instructed, cajoled, caressed, praised, reflected, reminisced, honored, and even at times admonished hams in the science and fine art of QRP.

Jim's tireless working behind the scenes over these years to enable all this has provided the best years our hobby has ever experienced, and all of us in the AmQRP thank you for those years Jim.

(Note that a new era was recently started when QRP-L was successfully transferred over to the servers at QTH.net.)

This Issue …

The first thing you will note is that this winter issue is actually reaching you in late spring. As editor, I take full blame for that and thank subscribers for bearing with us as we shake out the delivery bugs during our first year of publication. We are getting better each time and I am confident that we will soon have the magazine on the regular quarterly schedule.

Next, you'll note that we have our usual heavy doses of homebrewing technical content. Under the philosophy of "Teach a man how to fish and he'll never be hungry", Wayne McFee brings us a wonderful **nuts and bolts approach** to designing a transceiver that can be applied in many other projects. Nick Kennedy had a ball with his K8IQY **"PVXO" project** and he suggests some useful improvements, and he presents a terrific analysis of the **Norton Amplifier.** Ron Skelton and George Heron each present some material that you will find helpful in getting into **homebrewing with surface mount technology.**

We have four very effective **antenna projects** that should be interesting for many: **an inverted L** by Bob Logan that often outperforms his 80/40-M inverted vees; a **20M fishing pole vertical** by Ron Stone that is lightweight and inexpensive; a **DCTL** from Richard Fisher's wonderful regular column on QRP Operating; and Rick Hiller brings introduces readers to a very cool (and very free) software program that **details transmission line losses**.

Joe Everhart gives a low-down on a topic of great interest all of us – **batteries**. Chuck Adams concludes his review of **Manhattan-style building techniques** with some excellent soldering guidance and example projects that you can easily build. James Bennett suggests what a **minimalist station** could be, from his mega on-the-road travel experiences. We also have an intriguing article from John Farnsworth that details an **isolator circuit** that can be used to drive a digital panel meter on our next homebrew project. Rex Harper presents a humorous-yet-real view of how **roadside transformations** can help out in your next homebrew project.

I think you will be very pleased with the content mix this issue. In fact, you'll probably have a strong desire to grab your soldering iron to melt some solder before you're even half way through the issue! The authors contributing to HOMEBREWER Magazine are a special breed of ham and I very much enjoy working with them to bring their work to all subscribers.

So, what is the Secret of Life?

Well, James Taylor says it is "Enjoying the passage of time," and I must agree. We have many good resources, great people, and the right conditions here within our QRP community to do just this … all we need to do with all this is learn from the past, lean into the future, and *carpe diem*.

As we always say at this point, and it doesn't grow old: We do homebrewing here in this magazine, and we love it!

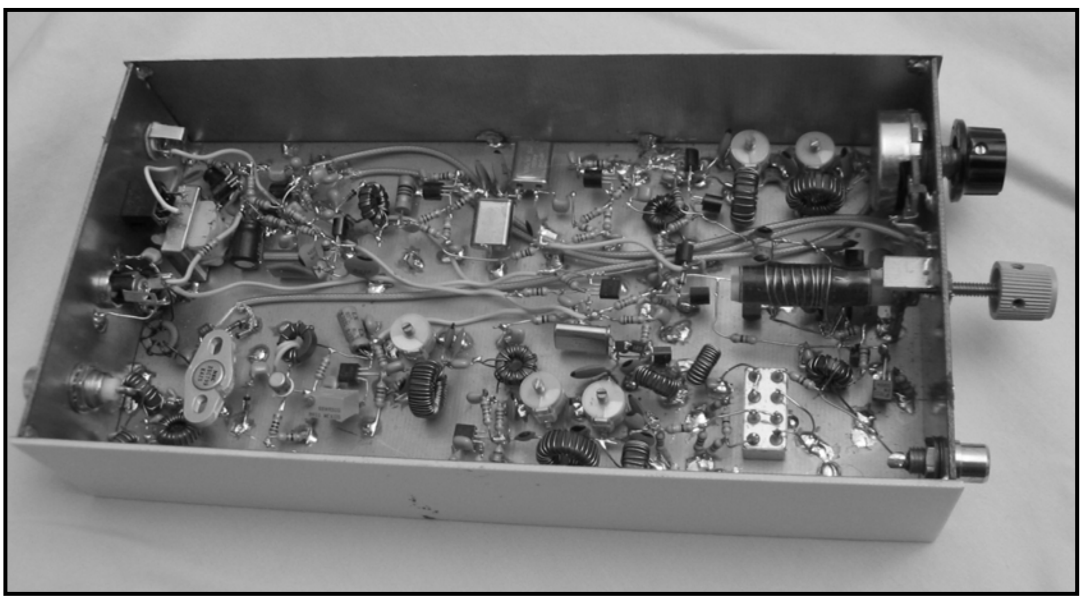
Carpe diem, y'all!

72, George Heron, N2APB
email: n2apb@amqrp.org

Wayne McFee, NB6M

A Nuts and Bolts Approach to RF Design

Let's say you are like many other homebrewing hams ... you might have a limited understanding of how radio circuits work and don't have a shack full of test equipment. You probably have an HF amateur band receiver, an oscilloscope, a digital multimeter with an RF probe, an SWR meter or bridge, a dummy load and an antenna. You have a basic set of tools and you have at least begun to get comfortable with the Manhattan, Island, or Ugly style building methods. And most important, you have the desire to design and build some gear of your own. If you fit this profile, this project is for you!



A 40 Meter CW Transceiver designed and built using the Nuts & Bolts approach.

"Nuts & Bolts 101"

The principal idea behind the Nuts & Bolts approach is to make use of what others before you have done. There is no need to re-invent the wheel. Certainly there are new ideas all the time but all of us in ham radio will continue to use both ideas and proven circuits that others have previously developed. All of the best engineers have files of proven "building block" type circuits that they fit into an overall circuit in order to achieve the desired result.

As you know, every electronic circuit, no matter how complex, is made up of individual stages. These are shown in simplified drawings as blocks with either their individual stage names or a symbol of their purpose in the blocks.

An entire circuit is depicted in simplified form as a "block" diagram. Even if we do not have the knowledge needed to be able to design the individual stages, we can still design and build a complete transmitter, receiver, or transceiver. Just select proven circuits for the stages or blocks and carefully connect them together.

Suppose we want to design a transceiver, and because of the changing availability of electronics parts, we want to use generic, readily available discrete parts throughout. Using this Nuts & Bolts approach not only makes it easier to troubleshoot and fix the rig if anything should go wrong, but it also helps us learn more about how the individual stages work and how they work together to produce the desired result.

Philosophy

- Use discrete, readily available parts throughout.
- Design for reasonably low current drain on receive.
- Use a VFO as the LO, in order to realize full band coverage.
- Provide appropriate audio output for modern, low impedance headphones.
- Provide for transmitter power output up to 1.5 Watts.
- Use electronic T/R circuitry

Building Blocks

Keeping our design philosophy in mind, and perusing available proven designs, one relatively simple superhet receiver circuit described in Chapter 12 of "Experimental Methods in RF Design" is called the S7C. It seems to fit our needs, so for this exercise we will use it as the basis for our 40 Meter transceiver design. The S7C circuit is shown below, minus the VXO LO which we will not use.

This receiver uses all discrete parts, has low current drain and provides a reasonable amount of selectivity in a superhet configuration. For more detail on the design, see Chapter 12 of Experimental Methods in RF Design. As published, the S7C receiver has a 10 MHz IF frequency and uses a VXO LO with limited frequency range. Crystals for 4.000 MHz were already on hand so the IF frequency was changed. We would like full coverage of the CW portions of 40 Meters, so a VFO will be used as the LO.

If we use this receiver circuit as a base, what do we need to add in order to design a complete transceiver? To make it easier, let us look at the S7C as a block diagram and consider a block diagram of the remainder needed to complete a transceiver circuit. Both block diagrams are shown on the next page.

Design Discussion

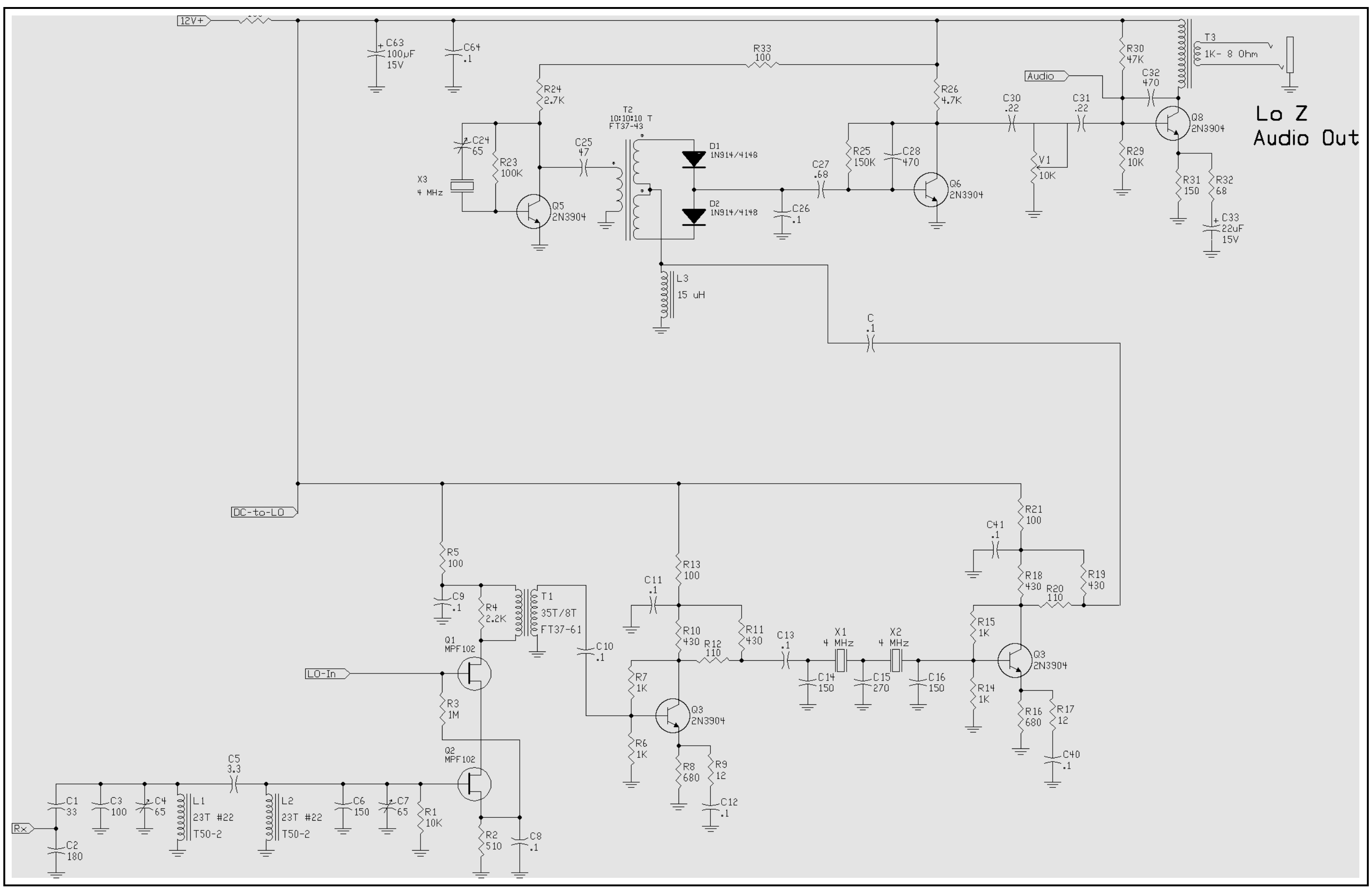
In order to form a complete transceiver, we will add all of the building blocks shown. Using the Nuts and Bolts design philosophy, we will peruse available published circuits and use parts of several in order to provide the needed circuitry.

Let us start with the Local Oscillator ("Permeabililty Tuned VFO" on next page). We changed to a VFO configuration to realize a much wider frequency range. The choice of oscillator is up to the builder and anything from crystal control to a digital VFO could be used.

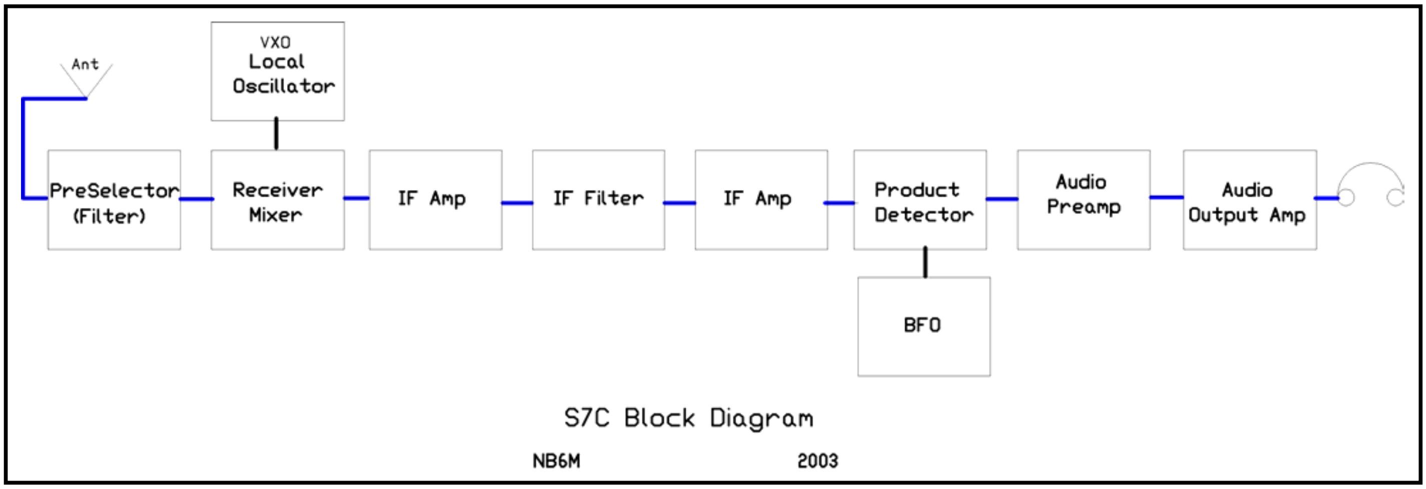
For simplicity I have used an analog VFO that I have had very good luck with. It is stable and is relatively easy to build. It uses permeability tuning and can provide us with entire band coverage if we so desire. The basic circuit was published on the WA6OTP website and I have modified it and added it to this rig. It is a nice little VFO.

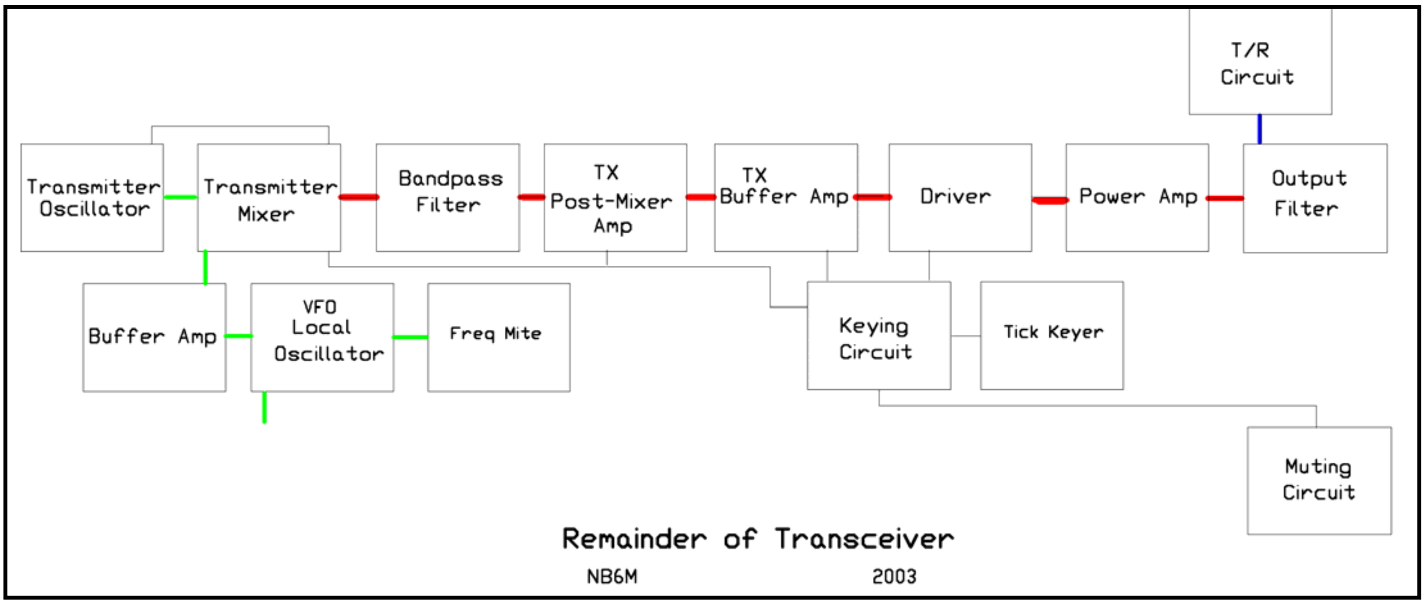
Next in our chain of blocks is the LO Buffer Amplifier. The circuit chosen is the very familiar one from the "Ugly Weekender" by KA7EXM and W7ZOI, and is a design by W7EL.

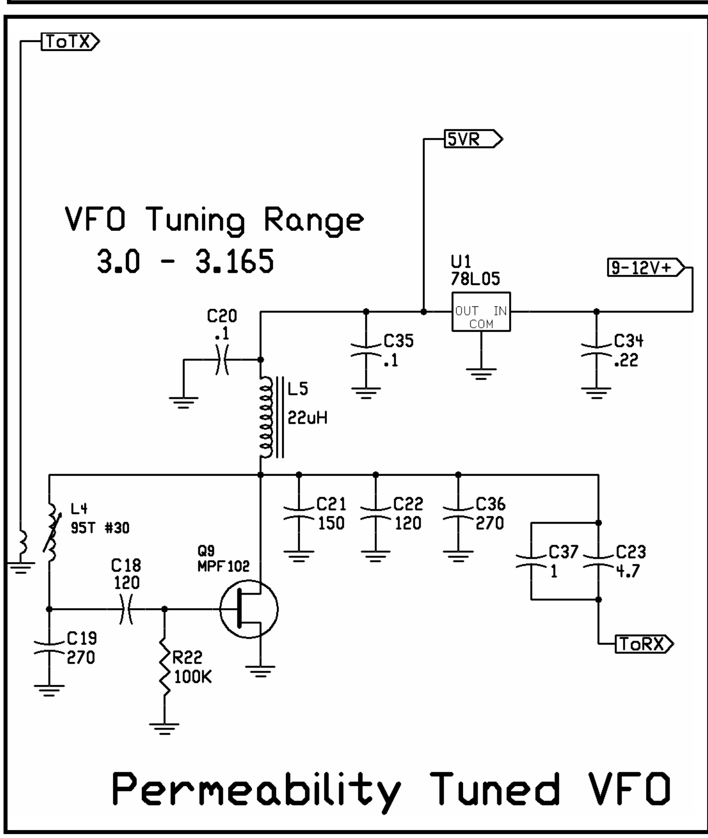
The next block we need to consider is the Transmitter Mixer. We could simply duplicate the dual JFET mixer used in the S7C, but since it is a single ended mixer with no balance, it might either allow or introduce spurs into our transmitter signal. In order to help prevent this, we will use a diode ring, doubly balanced mixer. We can either use a commercial +7 dBm mixer, such as the TUF-1 or SBL-1 from Mini-Circuits, or build the mixer from discrete parts.

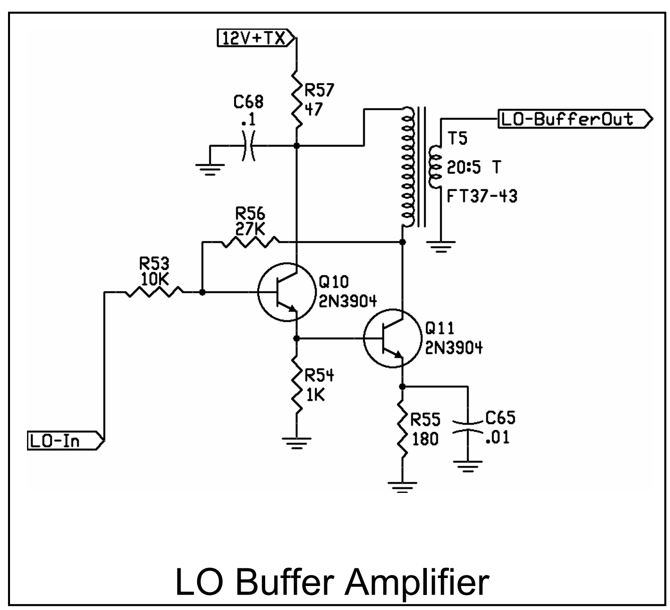


S7C Transceiver, Minus LO



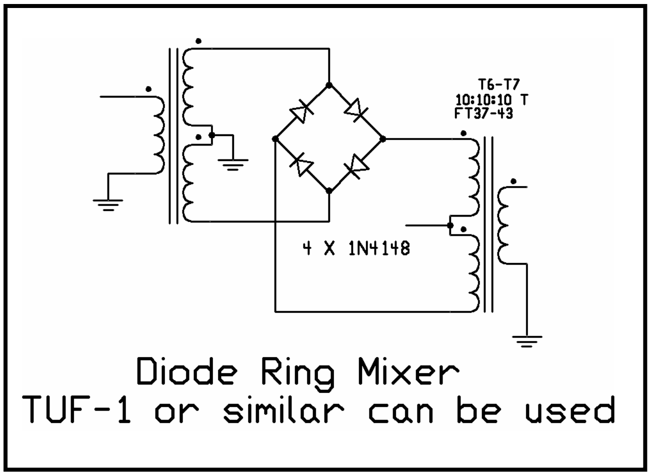


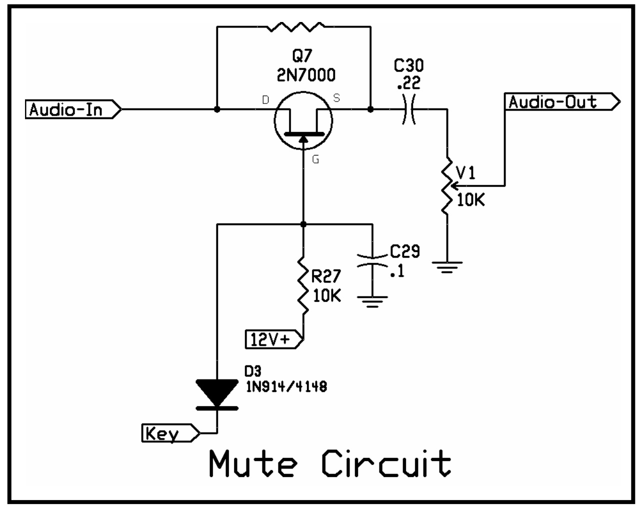




Because of our desire to use all discrete parts, and our choice of the diode ring, doubly balanced mixer, we will discuss the mixer and its requirements in terms of input signals.

Some things to consider in our design process are the characteristics and input signal level requirements of the mixer we have chosen. The diode mixer has no gain. In fact it has about a 6 dB loss. It needs an input





from the LO of at least +6 dBm. At the same time, we want the signal from the Transmitter Oscillator to be down around the –10 dBm level. This is done to help reduce spurious output.

We used the BFO circuit from the S7C receiver, changing the trimmer cap to an inductor to create the needed amount of frequency offset. We will also add a resistive attenuator pad to adjust the signal level. Because we don't know yet exactly how much output we will get from the oscillator, we will have to build it, measure the output, and choose an appropriate amount of attenuation in order to set the injection level to the mixer at the desired –10 dBm.

Let us discuss the next stage: the Transmitter Bandpass Filter.

In order to get the most out of our bandpass filter and to define the impedance felt by the output of the mixer, we will use a 50 Ohm, 6 dB resistive attenuator pad between the mixer and bandpass filter. This will ensure that the mixer will be properly terminated for all frequencies present.

From there, we can use readily available computer software to design a 50 Ohm bandpass filter. This one is designed for a center frequency of 7.1 MHz and a 300 kHz bandwidth.

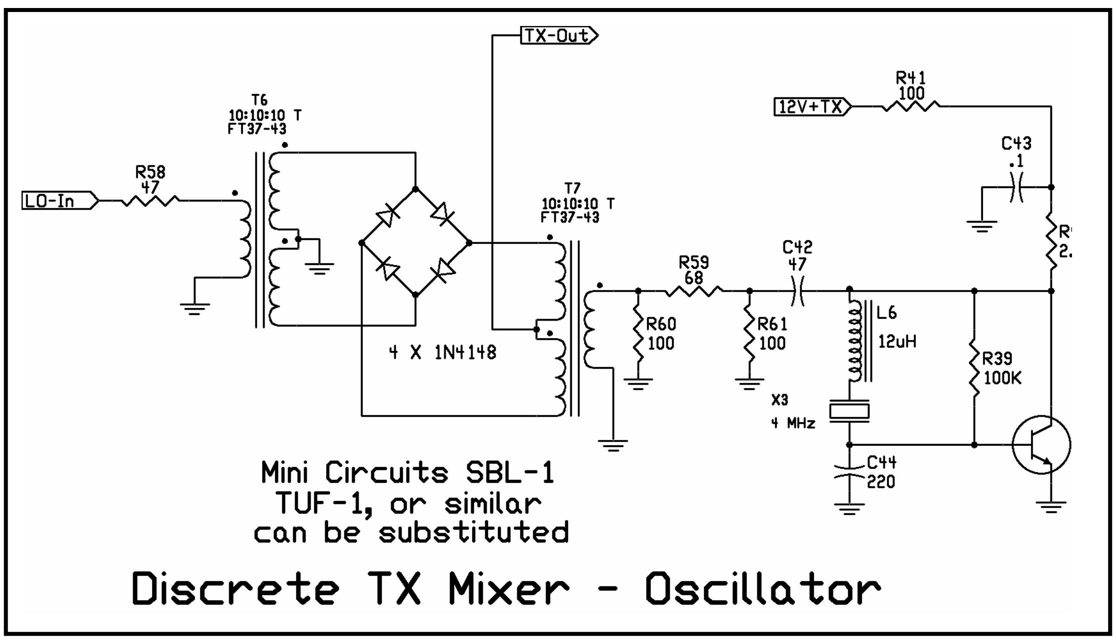
We purposely kept a low RF level from the transmitter oscillator. This fact, in combination with the 6 dB loss in the mixer, the 6 dB loss introduced by the 50 Ohm pad used to provide a good termination for the mixer, and the loss through the bandpass filter, means we need to add a 20 dB Post Mixer Amplifier. This brings the transmitter signal back up to a usable level for the following stages.

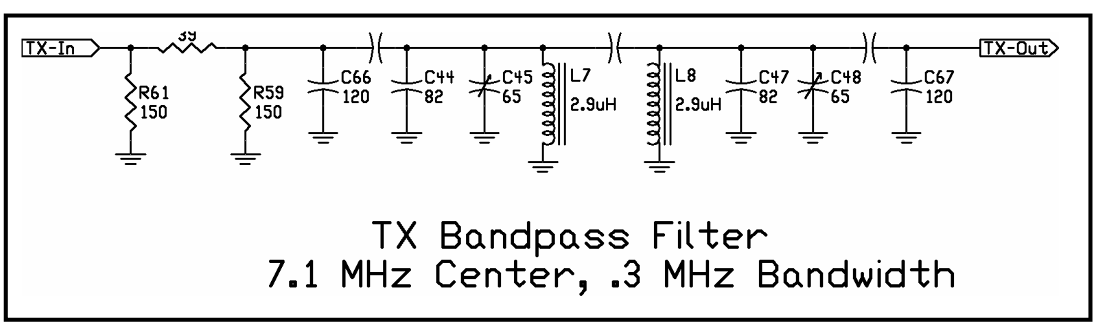
At the coupling capacitor from the output of the Post Mixer Amplifier, we add a PI network that is designed to provide an impedance transformation from the 50-Ohm level that we have been working in to the 2.2 K Ohm level that is defined by the 2.2 K resistor to ground at its termination.

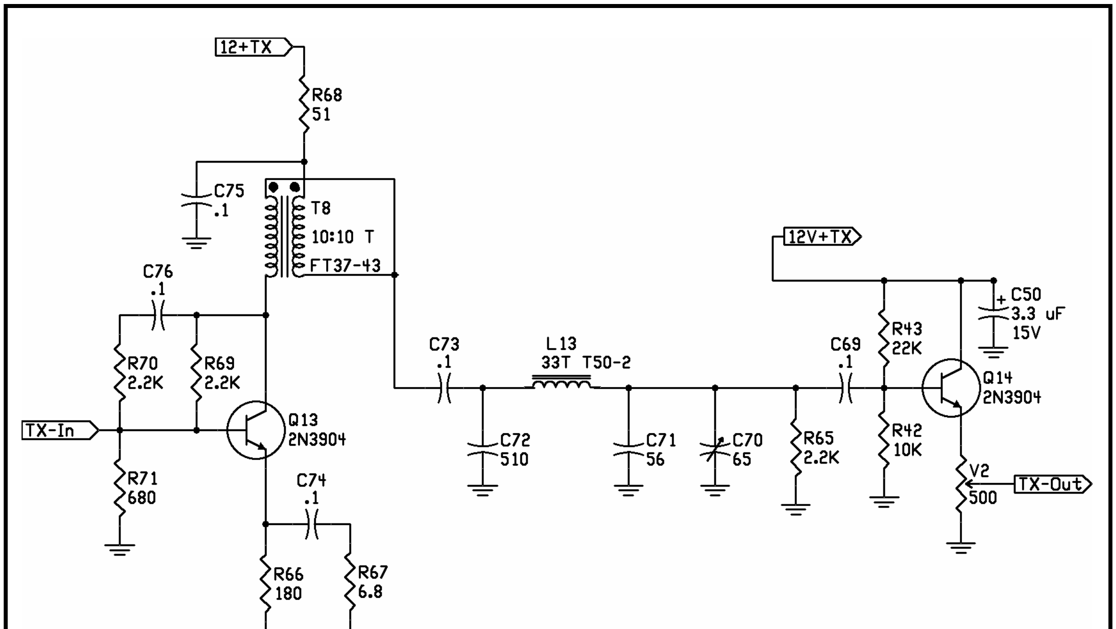
At that point, we add the 0.1 uF DC blocking cap and go right into the input of the emitter follower TX Buffer Amp, which is the next link in our transmitter chain. To simplify the remainder of our design, we will use a large portion of the transmitter circuit used in the SW40+, from the end of the bandpass filter to the output, including the buffer amplifier, driver, PA, output filter, keying circuit, and T/R circuit.

In the SW40+ transmitter, either a 2SC2078 or 2SC1969 is used to produce 1.5 Watts of output. A 2SC799 was used here because it was on hand. The output filter is the familiar half wave design. The T/R circuit is a version of the circuit introduced by W7EL in the Optimized QRP Rig.

With the transmitter, keying and T/R circuits all now complete, the only things left are the muting circuit for the receiver and the peripherals -- the FreqMite CW frequency enunciator and the Tick Keyer.







Post Mixer Amplifier and Tx Buffer Amp

In order to provide receiver muting, we inserted the very familiar JFET switch that was introduced by W7EL, but we integrate it into the discrete component chain as shown below. This allows us to hear the transmitter signal, so no sidetone oscillator is needed.

The value of the resistor bridging the JFET will have to be determined by experimentation in order to set the tone to the desired level. In the Small Wonder Labs "SW" series rigs, a value of 4.7 MegOhms is used and that should be a good starting point for us.

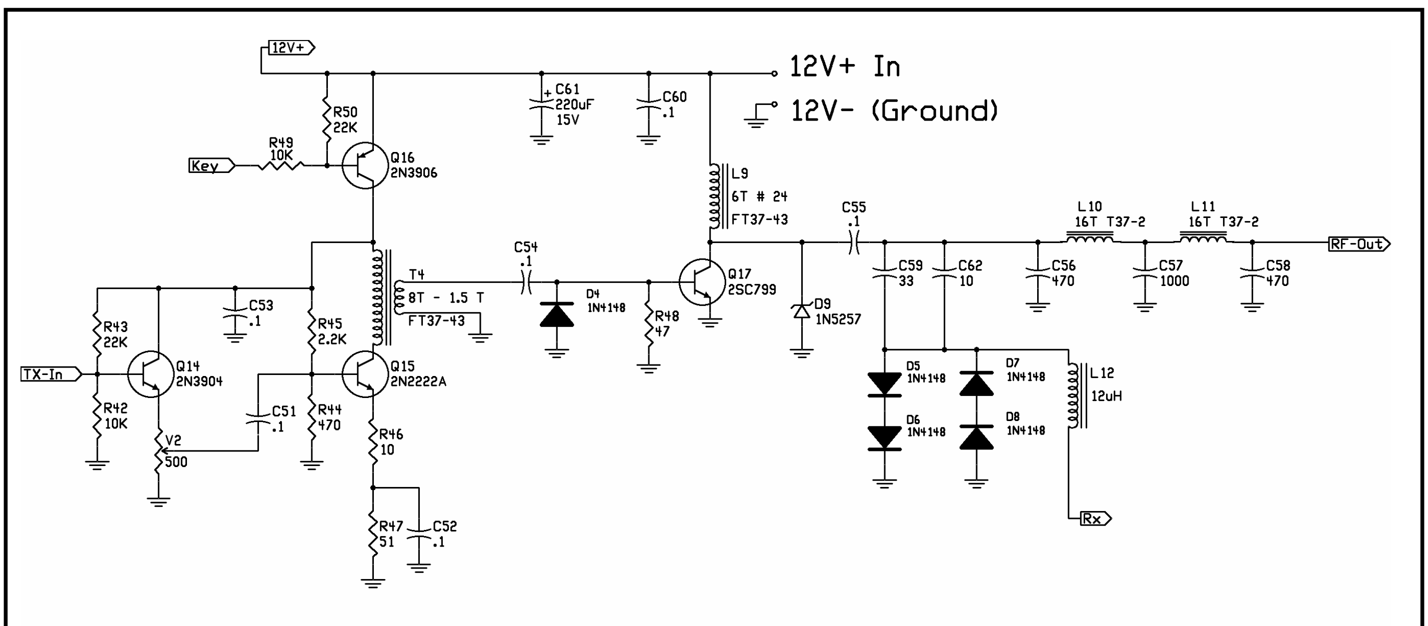
The addition of the FreqMite and TICK keyer will make the rig complete. The audio from each is fed into the audio output amplifier at the point specified in the complete circuit diagram. Next let us take a look at the block diagram for the entire transceiver.

The complete circuit diagram is appended on the last page of this article, also showing how the FreqMite and TICK Keyer are tied into the circuit.

Construction

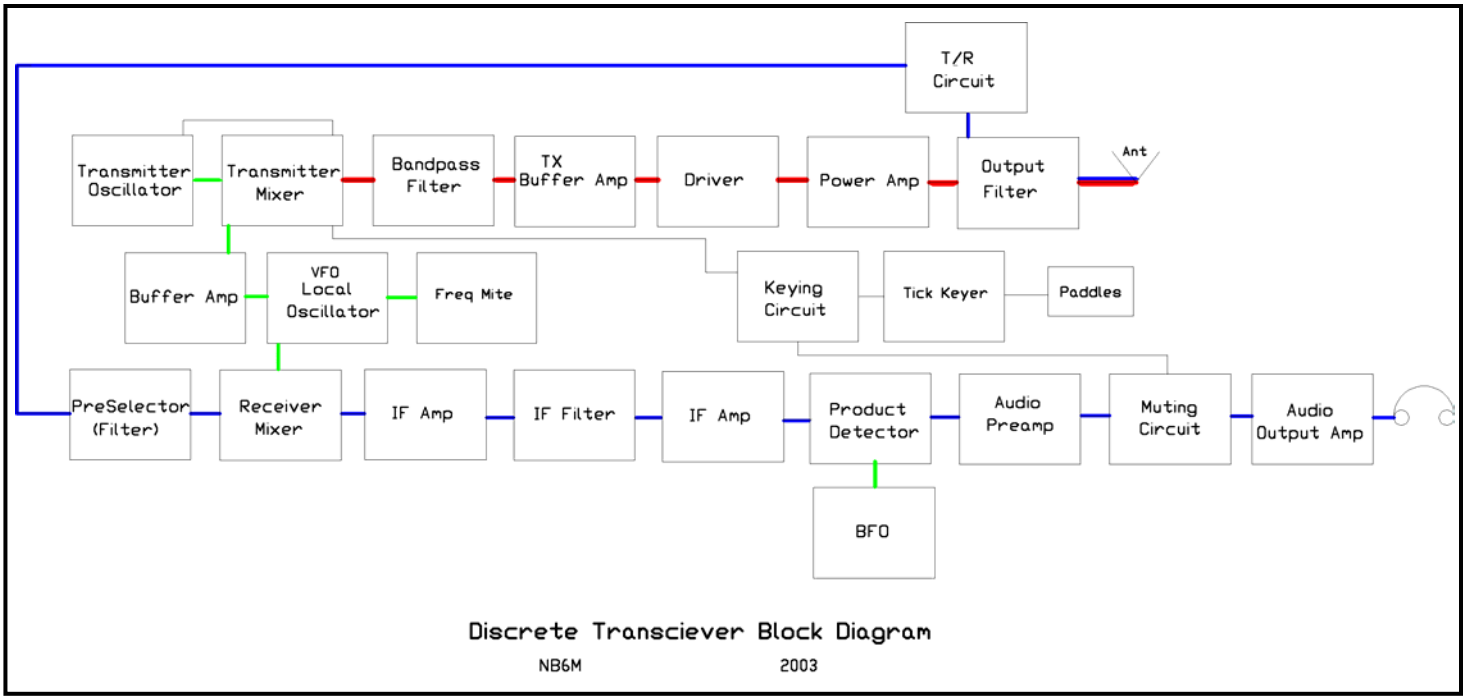
In order to demonstrate the viability of this Nuts & Bolts design approach, a 40 Meter CW transceiver was built, using the "Ugly" method, completely without "Manhattan" or "Island" type pads. This method is straightforward and easy. No supporting structure such as Manhattan pads or a printed circuit board have to be made, so circuitry goes together very fast and lends itself to easy modification or change. To make changes, all you need do is remove and replace the actual parts themselves, with no other changes needed to the basic circuit structure.

As shown in the overall photo at the start of the article, the circuitry is laid out in a "U" shape, beginning with the receiver audio amps in upper



Discrete Transmitter Chain

NB6M 2003



left, the product detector and BFO next, then the IF amps and dual crystal filter, the cascode FET mixer, and the double-tuned Receiver Input Filter in upper right. Centered behind the front panel is the permeability tuned VFO, and to its left are the Keying Circuit and Receiver Muting Circuit.

Just below the VFO Tuning Coil is the VFO Buffer Amplifier, and to its left are the SBL-1 Mixer and the Transmitter Oscillator. The RCA jack on the front panel is where an outboard FreqMite Audio Frequency Annunciator plugs in. Continuing to the left of the SBL-1 Mixer are the Transmitter's Double Tuned Filter, RF Amplifier, LC Impedance-Matching Network, Buffer Amplifier (with small trimpot), Driver Amplifier (2N2222A), Power Amplifier (2SC799) and Output Filter. The diode T/R circuit can be seen just above the PA heatsink.

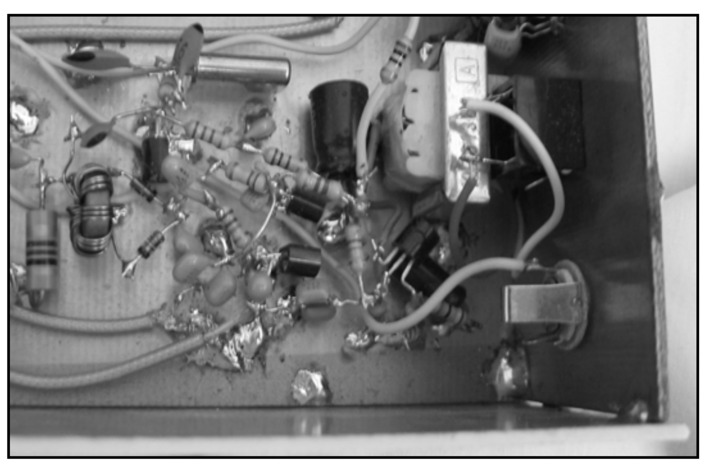
At first this method might seem daunting. In actuality however, it is really quite easy if one lays out the circuit logically, in almost the same fashion as the circuit diagram itself is arranged.

Construction started with the Audio Output Amplifier at one corner of an eight inch by eight inch sheet of single-sided pc board material, and followed the signal chain as it was described above. Let us take a closer look at the layout and construction of individual stages and sections of the entire circuit. Stages were built in the following order:

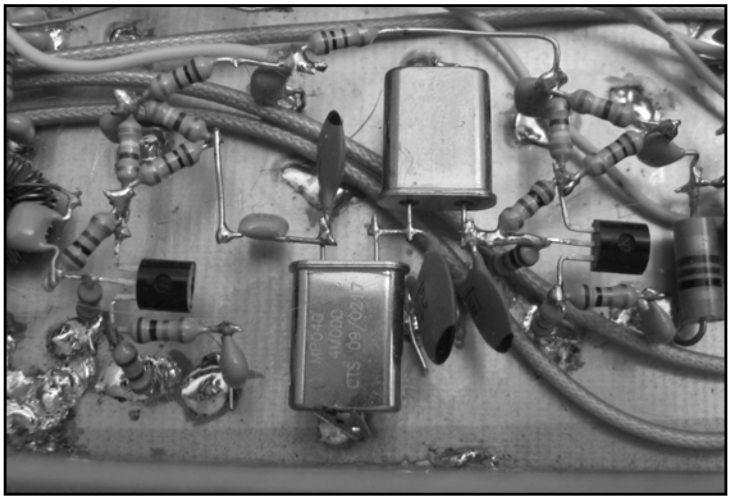
- Audio Output Amplifier
- Audio Preamplifier
- Product Detector
- BFO
- 2nd IF Amplifier
- Dual Crystal IF Filter
- 1st IF Amplifier
- Cascode FET Mixer
- Double-Tuned Receiver Input Filter
- VFO
- VFO Buffer
- Transmitter Mixer
- Transmitter Oscillator
- Transmitter Double-Tuned Bandpass Filter
- Transmitter RF Amplifier
- LC Impedance Matching Network
- Transmitter Buffer Amplifier
- Driver Amplifier
- Power Amplifier and Output Filter
- T/R Circuit
- Keying Circuit
- Receiver Muting Circuit

Each stage was tested as it was built by injecting test signals into the circuitry for the Audio Amplifiers, IF Amplifiers and Receiver Mixer. An oscilloscope and a multimeter with RF probe were used to test the BFO. Signal level from the BFO injected into the Product Detector is set by the value of the coupling capacitor between the two, at +7 dBm. Transmitter stages were tested with a combination of frequency counter, 50-Ohm dummy load, multimeter with RF probe, and Oscilloscope.

As already stated, construction began with the receiver's Audio Amplifiers. The picture below shows the layout of the Audio Amplifier, BFO, and Product Detector stages. The top of the large inductor to the left of the tri-filar-wound toroid transformer is the signal injection point into the Product Detector from the 2nd IF Amplifier. The shielded cables running off to lower left go to the Audio Volume Control on the front panel.



Product Detector, BFO, and Audio Amplifiers



First IF Amp, IF Filter, and 2nd IF Amp

Next in the receiver chain is the 2nd IF Amplifier, Dual Crystal IF Filter, and 1st IF Amplifier. Although some might want a narrower IF Filter, this one provides good opposite-sideband rejection, and has a nice, clean and crisp sound.

The inductor on the rightmost side is the input to the Product Detector. The 0.1 uF capacitor at left is the signal injection point from the Receiver Mixer to the 1st IF Amplifier.

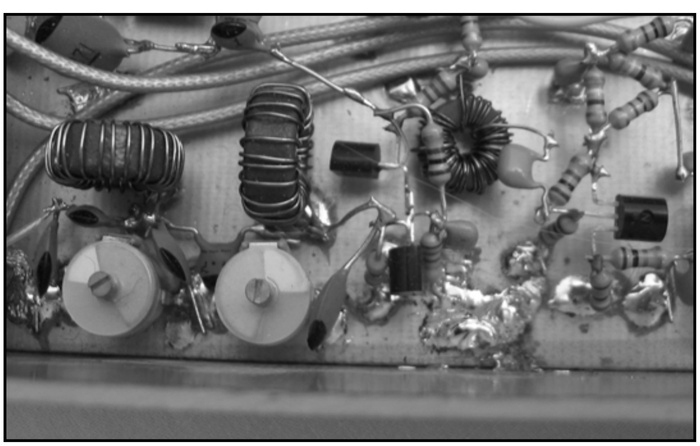
The Cascode FET Mixer and Double-Tuned Bandpass Filter complete the Receiver Chain, as shown here.

The small, shielded cable running underneath the upper edges of the two larger toroids is the signal input to the receiver from the T/R Circuit. The shielded cables above that are the audio lines going to the volume control pot on the front panel.

Now, the project really started to get exciting. With the addition of the LO, the receiver section could be brought to life and its very first received signals could be heard.

The VFO used as the Local Oscillator in this superhet-based transceiver is shown below. It is a permeability-tuned oscillator using a tuning coil wound with #30 wire on a 5/16th-inch diameter plastic drinking straw. The actual tuning element is a 6-32 brass screw. All NP0 capacitors were used in frequency determining locations and very short leads were soldered, where appropriate, directly to the copper substrate.

The 9-turn link taking RF to the VFO buffer is wound with #22 magnet wire around the outside of the main coil. The entire coil is covered with five-minute epoxy so as to prevent any shifting of the coils which would cause drift. Tuning is smooth throughout the approximate 165 kHz range. The tuning rate is such that there are about 4 kHz per full turn of the tuning knob at the low end of the band, and about 8 kHz per turn at the upper end of the tuning range. This tuning rate is more than slow enough to ensure ease of tuning individual signals.



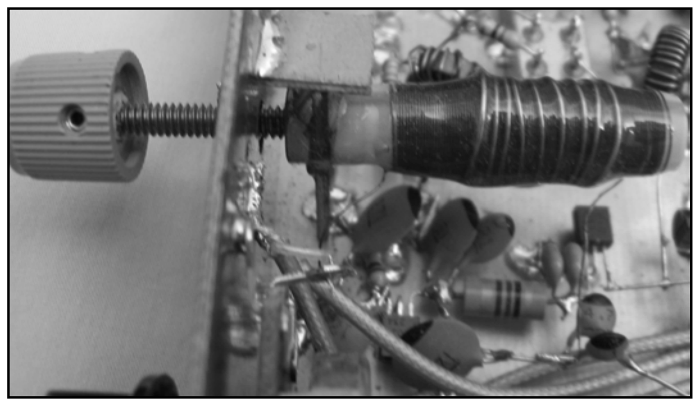
Double-Tuned Receiver Bandpass Filter, Cascode FET Mixer, and 1st IF Am

The coil mount was made from a small piece of double-sided copper-clad board material, with a 6-32 brass nut soldered to either side of the bracket. One nut was rounded to provide a slip fit for the drinking straw coil form, and a clearance hole for the tuning screw was drilled through the coil mount.

The coil mount was soldered to the copper substrate of the main piece of single-sided PC board material, and a clearance hole for the tuning screw was drilled in the double-sided PC board front panel. Using the tuning screw as a guide, a brass nut was soldered to the outside of the front panel. Having this nut, and the pair of nuts on the coil mount itself, separated by a little over a quarter of an inch provides good physical stability for the tuning screw.

Another small piece of PC board material is soldered into place as a strut between the upper edge of the tuning coil mount and the inside of the front panel, rigidly holding the assembly in place.

The lower end of the tuning range of the LO was set by adjusting the value of C36, in the circuit diagram shown below, in addition to that of C22. The final tuning range is from just below 3.000 MHz, to about 3.165



MHz, which, with the 4 MHz IF frequency, provides for coverage of the lower 165 kHz of the 40 Meter band.

C37 was placed in parallel with C23 in the VFO circuit, so as to set the signal injection level to the Receiver Mixer at just over 5 Volts, peak to peak. That injection level is recommended for this mixer, as detailed in the S7C Receiver article in Experimental Methods in RF Design.

It is always a thrill to bring a receiver to life, even more than a transmitter, and listen to those first signals it receives. This receiver did not disappoint. One very nice advantage of the all-discrete construction is the very low noise level. When no antenna is connected no noise is heard at all. However, upon plugging in the antenna, it immediately comes to life with whatever signals are out there. This receiver has plenty of gain for 40 Meters. Although it would be nice to have speaker-level audio output, there is more than sufficient audio when good quality stereo headphones are used .

The VFO Buffer Amplifier was built next, and is shown below. The lead taking RF to a jack for the outboard FreqMite Audio Frequency Annunciator can also be seen. This Buffer Amplifier provides +7 dBm input to the Transmitter Mixer.

Next to be added were an SBL-1 Mixer, the Transmitter Oscillator, a resistive, 50 Ohm, 6 dB attenuator pad, and the transmitter's Double-Tuned Bandpass Filter.

The LO tuning coil can be seen at lower left in this photo. The crystal oscillator is the Transmitter Oscillator, with its output running through a filter to a resistive attenuator pad that sets the injection level at –10 dBm.

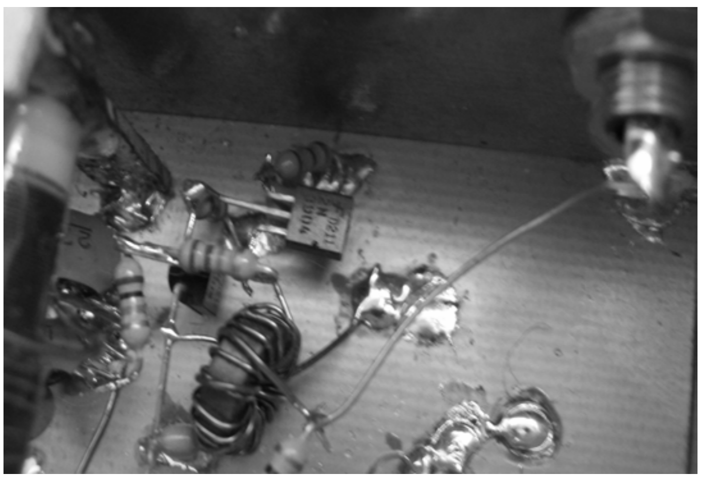
An SBL-1 diode ring mixer was used in this transceiver. Its case is soldered directly to the copper substrate, locking down its location. The two transistors below the crystal oscillator are part of the Keying circuit. The toroid transformer at the right edge of the picture is part of the RF amplifier that follows the bandpass filter.

Two 12 uH surface mount inductors were placed in series with the crystal in the Transmitter Oscillator in order to provide the correct amount of transmitter frequency offset to match that of the receiver.

A 50-Ohm Input, 50-Ohm output RF Amplifier, an LC Impedance Matching Network, and the Transmitter Buffer Amplifier were added next, and are shown next.

The trimcap at far left is part of the Transmitter's Bandpass Filter. The trimcap at lower right of center is part of the LC impedance matching network that transforms the 50-Ohm output of the RF Amplifier to the 2.2 K Ohm impedance set by a resistor at the input to the Buffer Amplifier. The trimpot is in the emitter lead of the Buffer Amplifier and is where the signal is tapped off going to the Driver Amplifier.

Completing the transmitter, the Driver, Power Amplifier, and output



VFO Buffer Amplifier

filter were added next. The Diode T/R circuit can be seen just below the PA heat sink. The toroid to the lower right of the PA transistor is the RF Choke in its collector circuit.

Construction Summary

As usual with any electronics project, changes have been made in this transceiver since it was first completed in order to improve its operation, ensure that it functions completely as desired and ensure that its transmitter output more than meets FCC specifications for a rig of this power level.

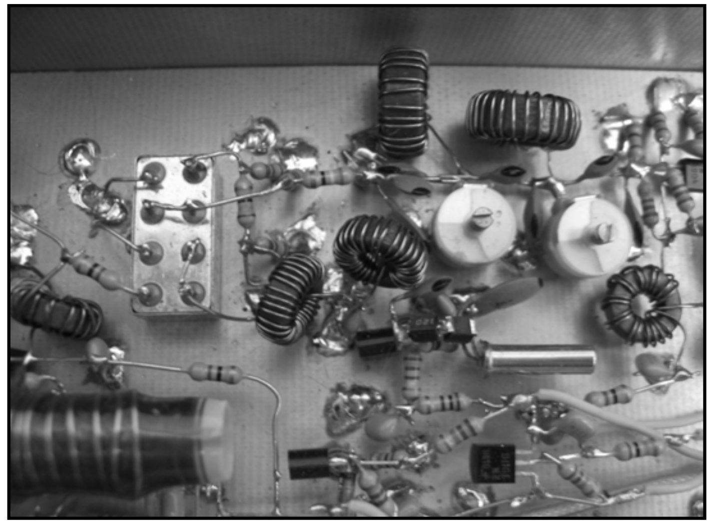
All changes were very easily made since there was no pc board to redesign and order and no Manhattan type pads to break away from the copper substrate. Parts were simply unsoldered and removed, new parts were installed in whatever new location was needed, and the transceiver put in operation once again.

Those changes are discussed in detail in a follow-up article to this presentation, coming in the next issue of HOMEBREWER.

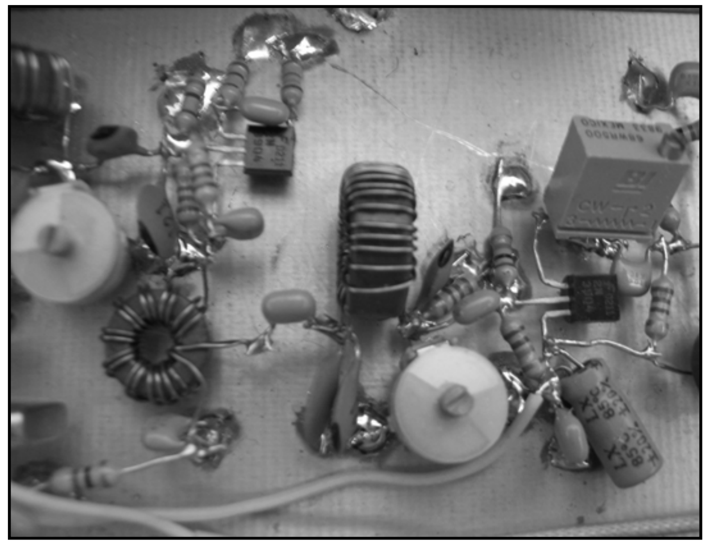
Closing Thoughts

Quite a bit of circuitry goes into the making of a superhet-based transceiver. However, taken one stage at a time, it is a relatively simple matter to pick and choose proven circuits and use them to complete your own design.

A few key considerations come quickly to mind. Impedances should be properly matched between stages. Signal levels between stages should be adjusted so that subsequent stages can function as intended. Overdriving either amplifier or mixer stages very definitely causes spurious output. When the rig is built one stage at a time, so that the performance of the stages can be evaluated, some adjustment or even stage substitution may



TX Osc, Mixer, 6 DB Attenuator, and Double-Tuned Bandpass Filter



RF Amplifier, LC Impedance Matching Network, and Buffer Amplifier

Buffer Amp, Driver, Power Amp, Output Filter, and Diode T/R Circuit

be needed in order to achieve the desired result.

In a Superhet design we depend on signals from the BFO and the Transmitter Oscillator to mix with signals from the LO or the IF to transmit and receive on another frequency. Those oscillator outputs need to be clean and free from spurious output or the result will be either a spurious output from the transmitter or a very rough and distorted audio output from the receiver.

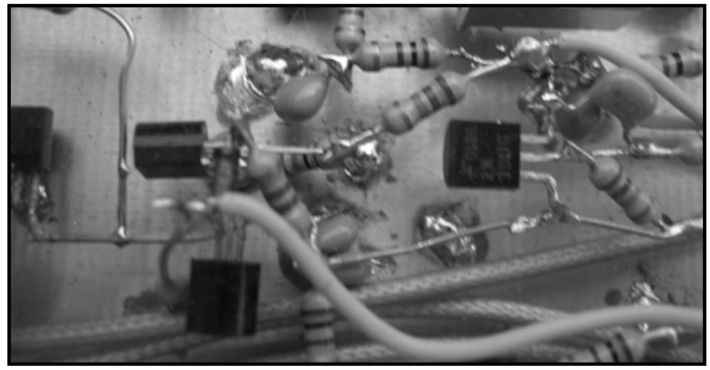
In this transceiver, the outputs from the LO and the BFO were fine, but the output from the Transmitter Oscillator was not. The fix was simply to place a filter between the Transmitter Oscillator's output and the resistive attenuator pad used to adjust the signal injection level to the Transmitter Mixer. This is detailed in Part II of this article.

If you get stuck there is nothing wrong in asking for help, either online at such places as QRP-L, or individually to any of several more experienced designers. Wes Hayward, W7ZOI, provided me with very valuable guidance on this project, particularly with avoiding the pitfalls in designing the transmitter chain from the Transmitter Mixer through to the emitter follower Buffer Amplifier. Many thanks, Wes.

Designing a rig can be a lot of fun. Building, testing, adjusting, modifying, and, finally, operating it on the air is even better.

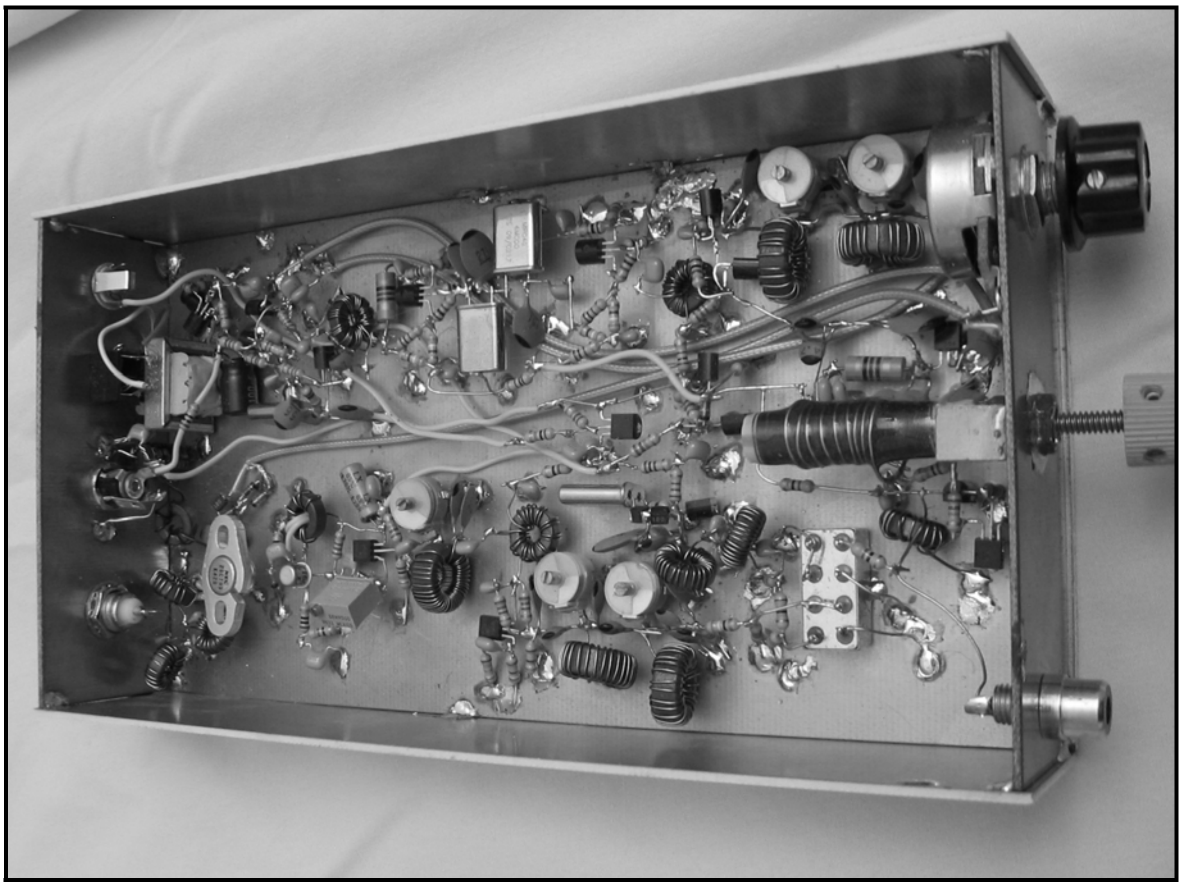
Give the Nuts and Bolts approach a try!

The author may be reached by mail at 2379 Saint George Drive, Concord, California 94520, or by email at NB6M@aol.com.



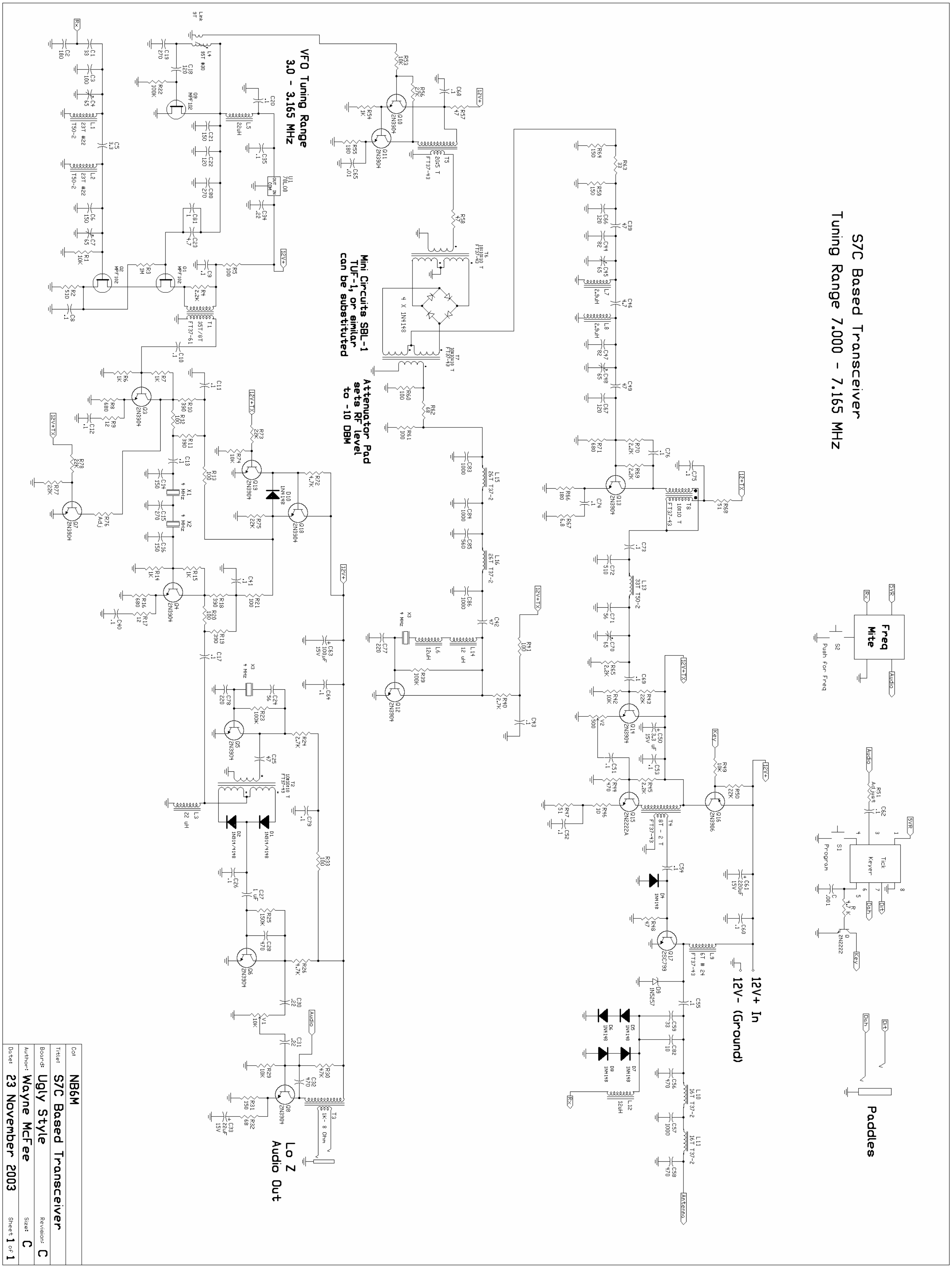
The addition of the Keying Circuit, and a Receiver Muting Circuit completed the transceiver.

Be sure the check out the online ***HB Extra!*** *web pages on the AmQRP website containing a complete set of full-color and full-resolution images presented here in this NB6M article. Point your browser to to www.amqrp.org/hbextra.*



Another view of the completed transceiver. Note that the circuitry is laid out in a "U" shape, beginning with the receiver audio amps in upper left, the product detector and BFO next, then the IF amps and dual crystal filter, the cascode FET mixer, and the double-tuned Receiver Input Filter in upper right. Centered behind the front panel is the permeability tuned VFO, and to its left are the Keying Circuit and Receiver Muting Circuit.

NOTE: *The full schematic of the 40-Meter transceiver appears on the next page.*


S7C Based Transceiver
Tuning Range 7.000 - 7.165 MHz
VFO Tuning Range
3.0 - 3.165 MHz
Mini Circuits SBL-1
TUF-1, or similar
can be substituted
Attenuator Pad
sets RF level
to -10 DBM
Freq Mite
Push For Freq
Tick Keyer
Program
12V+ In
12V- (Ground)
Paddles
Lo Z
Audio Out
Co: NB6M
Title: S7C Based Transceiver
Board: Ugly Style
Revision: C
Author: Wayne McFee
Date: 23 November 2003
Size: C
Sheet 1 of 1

Ron Skelton, W6WO

Getting Started With Surface Mount Devices

Look inside any commercial modern rig and it is hard to find more than a few traditional components. Gone are the brightly colored resistors and capacitors with clearly marked values. Tiny anonymous rectangular chips known as surface mount devices (SMDs) have taken over and much of our compact technology would be impossible without them. At first glance this can be discouraging to experimenters and home brewers as clearly such complex products cannot be built, or in many cases even repaired, by human hands ... but take heart - it's not as difficult as you might think!

No one in their right mind would attempt to build a HT from scratch, however it appeared to me there are many projects that can be constructed by hand using SMDs—but why would we want to? Here are a few reasons apart from their obvious space requirements.

- They can be much cheaper than through-hole components.
- There is a huge range of values, which is very helpful if you want 1% accuracy.
- They perform very well at RF well up into UHF.
- Most common passive and active component types are available.
- I believe that more home brew projects will use them in the future.

The obvious down side is the difficulty of handling them. Their small size was certainly a deterrent for me but curiosity eventually took hold. As SMDs come in various sizes the first question was "how low can I go?" Considering resistors, for example, the Mouser catalog lists seven package sizes ranging from the 0402 at 1.0 x 0.5 mm which is a 65 mW device, to the 2512 at 6.4 x 3.2 mm with a 1 Watt rating. In the middle there is the 1206 size at 3.2 x 1.6 mm and these are rated at 250 mW. The 1206 components are listed at a unit price of 10 cents for 1% accuracy and 8 cents for 5%, almost all values are available. The 1206 size looked do-able so to get started I purchased a few to play with.

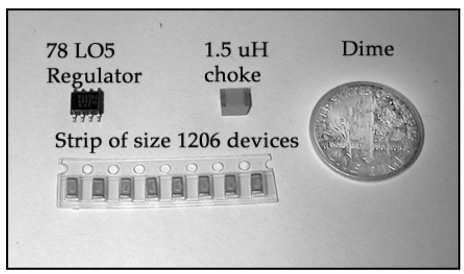


Figure 1: A small selection of SMD devices

The next question becomes how to place them on a copper faced board. I have tried various techniques including adhesive pads and the NJ QRP club diamond-tipped pad cutter. All have merit but for SMD I developed a technique that uses a fine Dremmel engraving bit #108 to cut traces by hand. This bit cuts a path in the copper about 1mm wide—just right for 1206 devices. By using a 6-inch steel rule as a guide, a few strokes with the battery powered hand tool and the bit will cut nice clean straight lines. For initial practice I cut a pair of lines about 4 inches long and 4 mm apart then broke these into a pads 4mm x 4mm, each separated by the 1 mm cuts.

The next step was to tin the copper with a thin surface of solder. It is important to have a smooth tinned surface and with a little practice satisfactory results can be achieved. The technique for soldering the devices in place is critical and requires a combination of three essential tools. A temperature controlled soldering iron with a long conical tip preferably no larger than 0.01 inches in diameter. The rosin-cored solder should have a diameter in the 0.015 to 0.02 inch range. Last but not least is a box of wooden matchsticks, pointed at each end.

Once out of the box it is going to be very difficult to identify component values. The devices will arrive in an unlabelled strip so sticking your own label on the strip is a good practice. Also, once out of the box the little critters seem to take on a life of their own. If they get away on a crowded workbench you might as well get an-

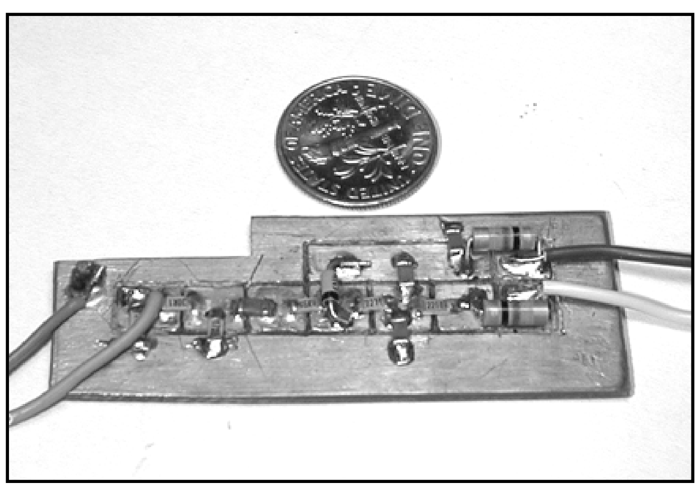


Fig 2: An example of SMD construction

other out of the pack. It is a good idea to clear the work area or use a tray of some kind. Work with a very good light and if possible sit down and have your work near to eye level.

Picking them up can be tricky, one's fingers seem suddenly huge and I have found tweezers have a tendency to propel the chips away, never to be seen again. A crude but effective way is to use a fine-pointed modeling knife barely moistened with solder paste to place the chips. The use of the solder paste also helps the solder to flow onto the device connections.

The fine knife point is used to position the chip with one metal end on each side of adjacent circuit pads and spanning a 1 mm cut. The iron should be at a fairly hot temperature to minimize the amount of time in contact with the chip; 750 degrees F seems to be a good choice. Now comes the moment of truth. Using a toothpick, press down on the chip and move it into its final position. Next, apply the iron tip to the pad and one metal end cap of the chip. This should be a very quick action, don't worry about solder flowing and with a bit of luck the chip will tack down nicely. Be satisfied that the chip is positioned well and make adjustments if necessary before soldering the other end. If you like to see a little more solder then revisit the first end and apply a very small amount there. After a few such efforts you will be feeling quite confident and will begin to think of an actual project.

It is difficult to see by eye that solder joints are successful so I recommend that each resistor be checked for value using a multi-meter as soon as it is in place. Similarly I use the wonderful LC meter from "Almost All Digital Electronics" to check L and C values.

One project long on my back burner is the calibrated noise source described by William Savin, W0IYH in May 1994 QST. I have also wanted to build a precision low power stepped RF attenuator. The design described by Agilent in their application note 1048 has great appeal. This uses a pair of HSMP 3814 twin PIN diodes as a voltage-variable, low-distortion attenuator. Both projects are useful well into the UHF range and seem made for each other. I ordered about three times the number of components actually needed as I expected some would just disappear.

A small board was constructed for the noise source using the same techniques as in the initial practice. At the junction of several components I increased the pad size to 10 mm x 5 mm. Agilent was good enough to provide a sample of their evaluation board for the attenuator so all I had to do was to place the components. I used 1206 size chips but the 3 terminal dual PIN diodes are the much smaller SOT 23 size. Fortunately, these yielded to the same tack down and solder technique but called for a cheap pair of magnifying reading glasses. The two boards were combined on a common ground plane with associated voltage regulators.

The final version of the project enables the attenuator to be used alone. An Omron G6Y relay selects the RF input to the attenuator either from the noise source or an external source. The noise source and attenuation level is accurately controlled by regulated voltages derived from three 9-Volt batteries in series. A switch selects from six voltages set by trimpots giving fixed attenuation levels from 3 to 50 dB. One additional switch position selects a front panel pot for continuously variable attenuation control.

A final word. I am 70 years old and not so steady as I used to be but it really wasn't too difficult. If I can use SMDs then most likely you can too.

Ron Skelton (W6WO) was first licensed as G3IHP in 1951. He spent many years in the colonies and old timers may remember him as VS4RS back in the 60s. Ron is a Fellow of the Institution of Electrical Engineers and retired in 1998. Ham interests are technology oriented, making lots of little boxes with knobs on them. Operating interests are mainly CW and his greatest delight is the magic of working 35,000 km long path to Europe with a simple vertical.

W6WO may be contacted by mail at 4221 Gull Cove Way, Capitola, California 95010, or by email at ron-skelton@charter.net.

Figure 4: Inside the Calibrate Noise Source, board containing SMD is mounted on side panel.

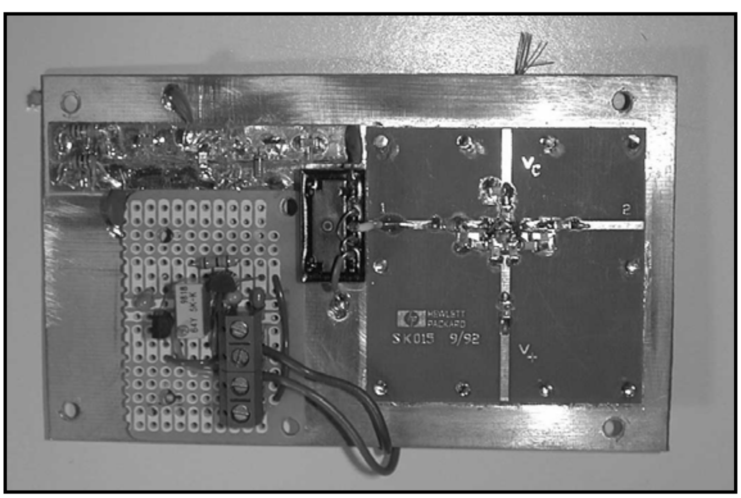


Figure 3: Composite Noise, Attenuator and DC supply board

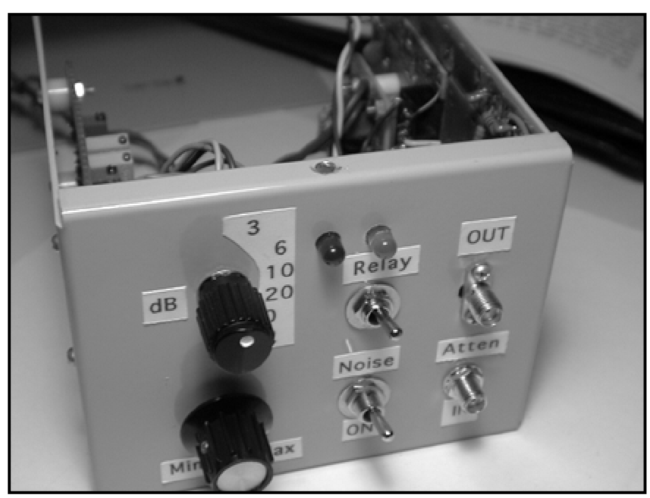


Figure 5: Calibrated noise source project

George Heron, N2APB

Surface Mount Construction Techniques

"Oh no, this project uses SMT parts!" Some homebrewers recoil at the thought of assembling a kit that uses surface mount technology (SMT) components. They fear the parts are too small to see, handle, solder or debug when assembled. I had these same concerns until I tried it and found that it wasn't so difficult when using the right tools. Further, I discovered some benefits of using SMT parts that made my QRP projects smaller, lighter and more portable for optimized field use.

I've chosen two quite different projects to illustrate some successful SMT assembly techniques. One is a small DDS signal generator "daughtercard" kit that comes with an assortment of SMT capacitors, resistors and inductors, and an SOIC integrated circuit. The other example circuit is a small one-stage audio amplifier built "Manhattan-style"! Yes, you can homebrew using SMT parts – results can sometimes be even better than when using conventional leaded parts.

But first, here is some component history and what you need to do to get your work area ready for constructing an SMT project.

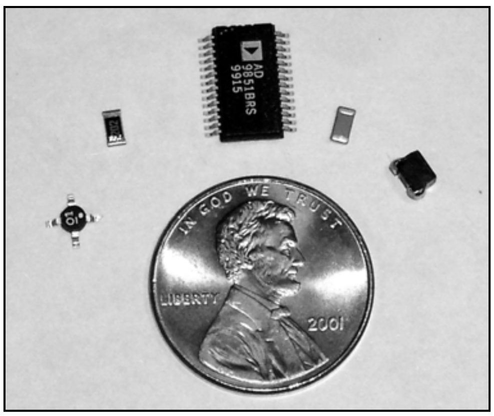


Figure 1: SMT components are small but they offer a dimension of compact design for portable projects. Clockwise from left: MMIC RF amp, 1206 resistor, SOIC integrated circuit, 1206 capacitor, ferrite inductor.

What is an SMT component?

Resistors and capacitors with axial or radial leads have been most common over the years. Same too for integrated circuits arranged in dual inline package (DIP) format with rows of leads separated by a generous 0.3"-or-so. This open leaded component and easily-accessed IC pins made for easy circuit board assembly back in the Heathkit days. Although these types of components are still available today, parts miniaturization has brought about more compact and less expensive products. Discrete components packaging has shrunk to .12" x .06", as shown in the '1206' capacitor in **Figure 1**. Even smaller packages are common today, requiring much less pc board area for the same equivalent circuits. Integrated circuit packaging has also been miniaturized to create 10mm x 5mm 'SOIC' packages with lead separations of .025", as shown in **Figure 1.** Truly, one needs some extra skills beyond what was necessary when assembling that SB104 Transceiver back in 1974!

Preparing for the job

As described at the beginning of this section, the key to being successful with any construction project is selecting and using the proper tools. For SMT projects, the tools are easy to find, as shown in **Figure 2.** A magnifying lamp is essential for well-lighted, close-up work on the components. Tweezers or fine-tipped pliers allow you to grab the small chip components with dexterity. Thinner solder (.015") than you might normally use is preferred because of its being quicker to melt and smaller in solder volume on the component lead. Use of a super fine-tipped soldering iron make soldering the leads of these small parts straightforward and easy. A clean work surface is of paramount importance because SMT components often have a tendency to fly away even when held with the utmost care in tweezers – you'll have the best chance of recovering your wayward part if your table is clear. When the inevitable happens, despite your best efforts of holding an SMT part in your tweezers, you'll have lots of trouble finding it if it falls onto a rug-covered floor. It is best to have your work area in a non-carpeted room, for this reason as well as to protect static-sensitive parts.

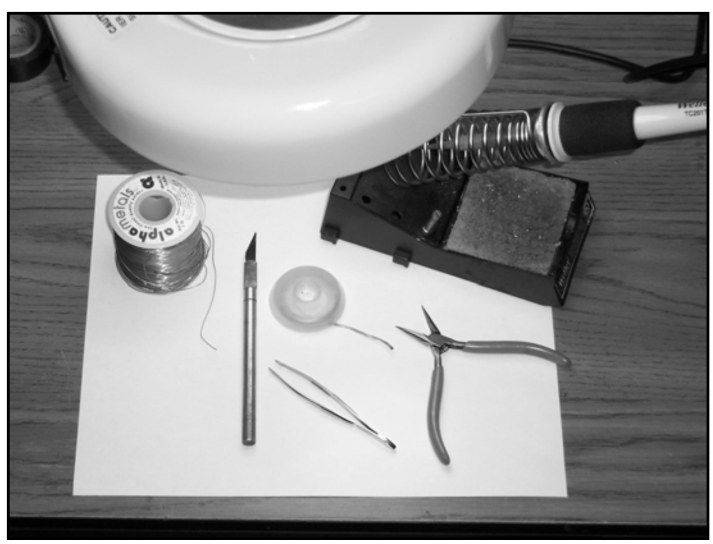


Figure 2: SMT soldering tools: magnifying lamp, .015" solder, fine-tipped soldering iron, tweezers, Xacto knife, Solder-Wick, needle-nose pliers.

Assembling SMT parts on a PC board

The first project example is the **DDS Daughtercard** – a small module that generates precision RF signals for a variety of projects. This kit has become immensely popular in homebrew circles in spite of its use of SMT parts. The kit is supplied with the chip components contained in color-coded packaging that makes an easy job of identifying the little parts - a nice touch by a kit supplier.

Taking a look at the DDS pc board in **Figure 5** shows a typical layout for SMT components – all traces are usually on one side since the component leads are not "thru-hole", and little square pads denote the places where the 1206 package-style chips will eventually be soldered. The SOIC-packaged integrated circuit will attach on the left side at the dual row of pads.

The trick to soldering surface mount devices to pc boards is to (a) pre-solder one of the pads on the board where the component will ultimately go; (b) hold the component in place with needle nose pliers or tweezers on the tinned pad; (c) reheat the tinned pad and component to reflow the solder onto the component lead, thus holding the component in place; and lastly (d) solder the other end of the component to its pad. See **Figure 6** (attaching an IC) and **Figure 7** (attaching a capacitor) for details of using this technique.

Homebrewing with SMT parts

The second project example is the **K8IQY Audio Amp** – a discrete component audio amplifier that is constructed "Manhattan-style". This is a technique of gluing little pads to the board wherever you need to attach component leads or wires. Instead of using little squares or dots of pcb material for pads, another popular way to create isolated connection points is to cut an "island" in the copper using an end mill, as illustrated in the diagrams of **Figure 9**. No matter how the pads are created, SMT components may be easily soldered from pad-to-pad, or from pad-to-ground plane to build up the circuit.

Homebrewing with SOIC-packaged integrated circuits is a little trickier and typically requires the use of an "SOIC carrier board" such as the one shown in **Figure 11**, onto which you solder your surface mount integrated circuit. You can then place the carrier board onto your homebrew project, copper-clad base board or whatever you're using to hold your other circuit components.

So start melting solder!

The techniques are easy, the SMT components are actually cheaper than conventional thru-hole leaded components and you'll have a smaller, more portable project when you're done. Go for it!

NOTES

1) Full details on the DDS Daughtercard, the K8IQY Islander Audio Amp, and the Islander Pad Cutter may be found online at www.njqrp.org/dds, www.njqrp.org/islanderamp, and www.njqrp.org/islanderpadcutter, respectively.

The author may be reached by mail at 2419 Feather Mae Court., Forest Hill, Maryland 21050, or by email at n2apb@amqrp.org.

Figure 3: A magnifying visor is a good alternative for close-up work on a circuit board. These headsets are often available for less than $10 at hamfests and some even come with superbright LEDs mounted on the side to illuminate the components being soldered.

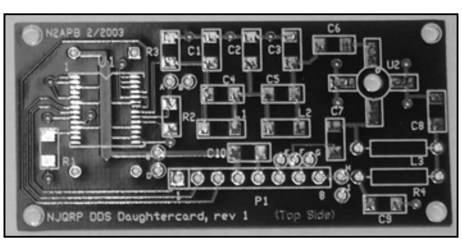


Figure 5: This bare DDS Daughtercard pc board shows a typical layout for circuit traces. All interconnections are on the top layer, as there are no thru-hole parts. Connections to the ground plane on the backside of the board are made by the use of "vias" on the pc board.

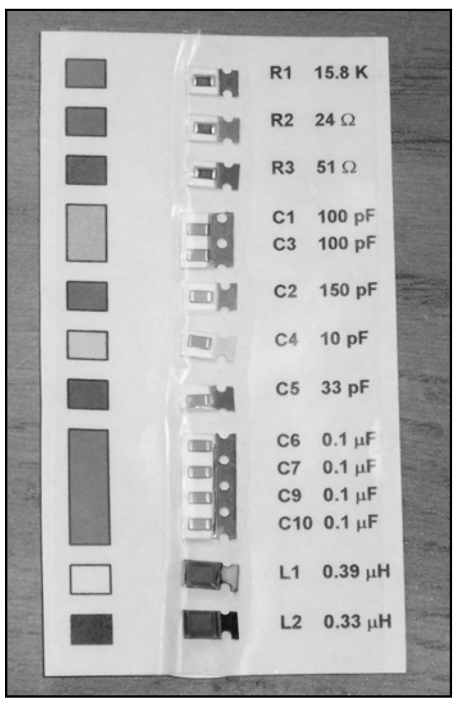


Figure 4: SMT Parts Kit. A great technique developed by the AmQRP kitting team of Tom (W8KOX) and Nancy (NJ8B) Feeny is to provide each SMT part on a color-coded card. This allows the builder to remove each part as-needed and be assured of its type and value.

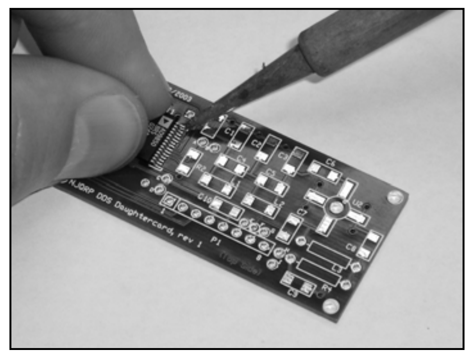


Figure 6a: Attaching an IC – Pre-solder the pad in one corner of the layout (for pin 28), then carefully position the leads of the IC over its set of pads on the pc board. I generally use my fingers to carefully align the IC over all its pads and then reheat pad 28 to reflow the solder onto the IC pin. This should leave the IC attached by pin 28. Again making sure the IC pins are aligned over all pads, carefully solder the opposite corner lead (pin 14) to its pad. This should leave all other pins of the IC aligned over their respective pads, making it easier to solder them. Next, solder each of the other pins to their respective pads, being careful not to bridge solder across any adjacent pads or pins. If this does happen, that's okay! Just grab some solder wick or a solder sucker and use it to draw off the excess solder, which should be fairly easy and clean because of the solder mask on the circuit board.

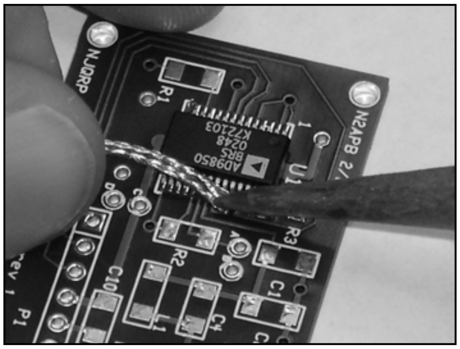


Figure 6b: Remove solder bridges from closely-spaced leads using SolderSponge, Solder-Wick or SolderSucker. The IC can take a fair amount of abuse, so don't worry too much about applying too much heat.

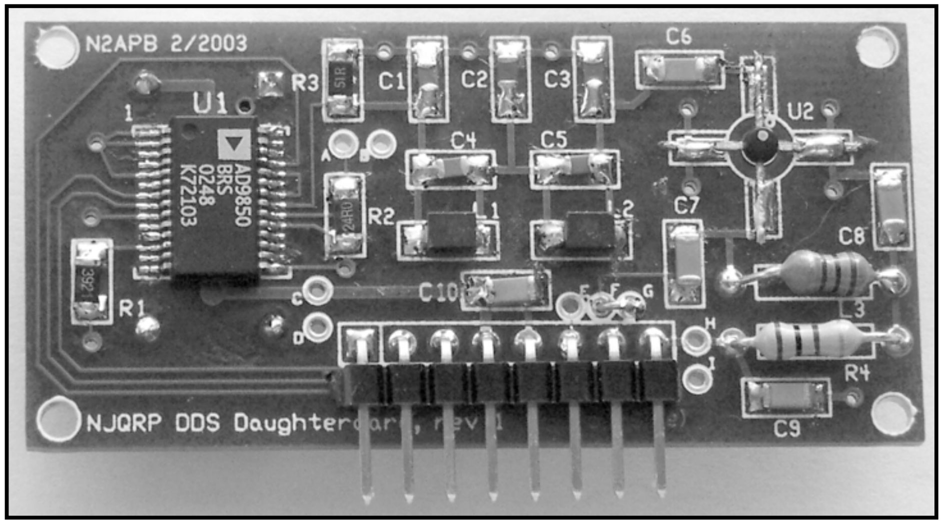


Figure 8: The fully-populated DDS Daughtercard pc board contains a mix of SMT and thru-hole parts, showing how the packaging technologies can be used together.

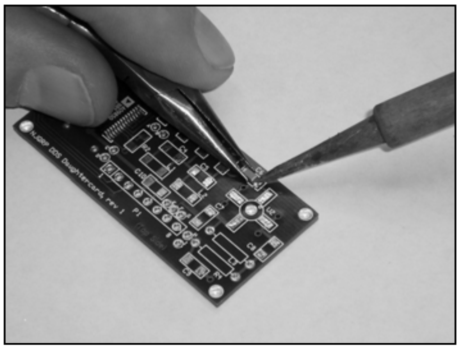


Figure 7: Attaching a Capacitor – Things get lots easier when attaching capacitors, resistors and other discrete components. Carefully hold the component in place and properly aligned using needle-nose pliers or tweezers and then solder one end of the component. Then reheat the joint while gently pushing down on the component with the pliers to ensure it is lying flat on the board. Finally, solder the other side of the component.

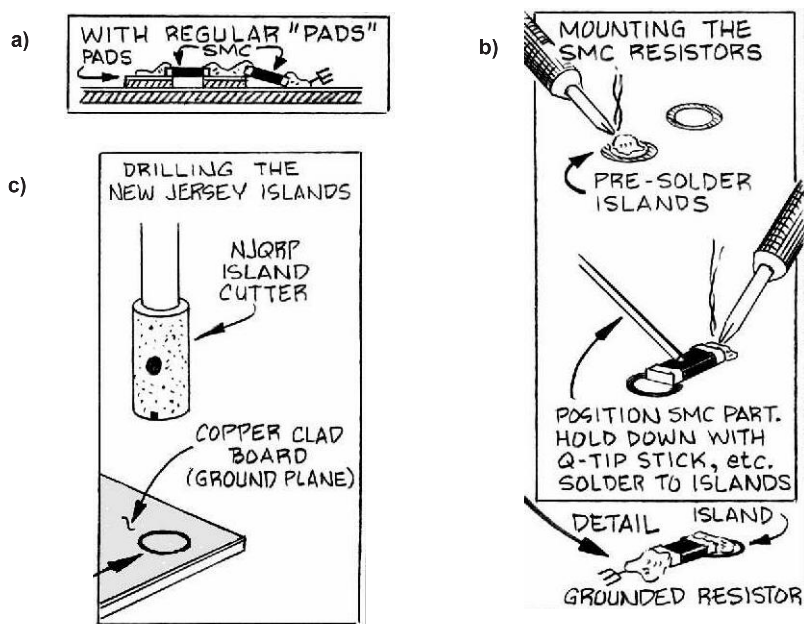


Figure 9: These three diagrams illustrate ways of attaching SMT components to a copper-clad base board. (a) Using regular glue-on pads; (b) Using island "cuts" in the copper ground plane; and (c) Making the island cuts with an end mill. [Illustrations provided by Paul Harden, NA5N.]

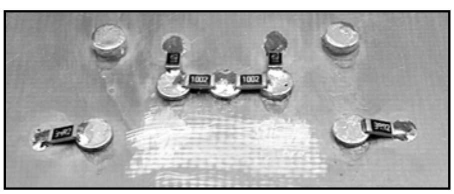


Figure 10: SMT resistors soldered to base board of the Audio Amp in the beginning stages of assembly.

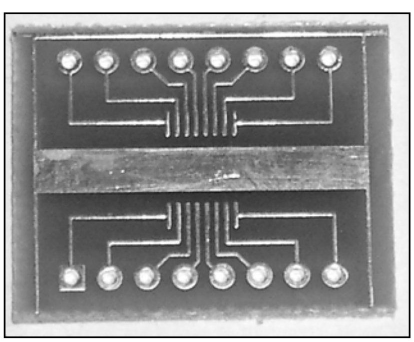


Figure 11: Surface mount ICs can be mounted to general-purpose carrier boards, then attached as a sub-module to the base board of the homebrew project.

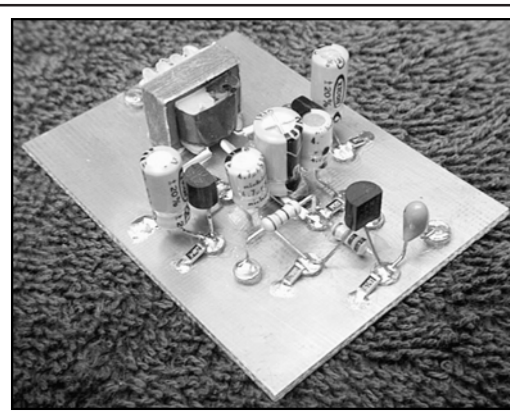


Figure 12: The completed homebrew Audio Amp assembly shows simple, effective use of SMT components used with conventional leaded components when constructed Manhattan-style.

Rick Hiller, W5RH

A Detailed Look at Transmission Line Performance Using Software

Transmission line power losses are extremely important at QRP power levels. A marvelous (and free!) software program called "Transmission Line Details" shows you what you are losing and why.

The Smith Chart is a wonderful tool when dealing with transmission line issues. But now with Transmission Line Details (or TLDetails for short) on my computer, it might be more proper to say that the Smith Chart "was" a wonderful tool. The 'pencil powered' Smith Chart has been replaced with interactively driven software, at least in my Ham Shack.

What is TLDetails?

TL Details is a transmission line analysis, freeware, Windows application written by Dan McGuire, AC6LA. It is down-loadable (78 Kb zip file) from Dan's web site at www.qsl.net/ac6la/tldetails.html.

The program is very intuitive, although a tip is in order before you start to use the program. If you are not familiar with the nomenclature of the transmission line world, I suggest that you take some time and read through the transmission line portion of one of the antenna handbooks.

Have a read of the QST article, " A Beginners Guide to Transmission Line and Antenna Tuner Modeling" that is available on-line.

From a practical standpoint, what can TL Details do for me?

First, it can provide insight into the performance of your antenna system in the transmission line portion, that was typically, in the past, passed over with a cursory glance, a nod and a wink. This insight is most important, for example, when you are trying to figure out why your coaxial-fed 80 Meter dipole doesn't perform very well on 20 meters.

Second, it can help you select the best feed line for that new antenna system, whether it be a single band or multiple band situation in the HF, VHF or UHF range.

Third, TL Details can be used as a tool to complete your antenna system modeling functionality. It complements EZNEC, AO Wires or other modeling programs very well.

Fourth, it can be used as a marvelous demonstration tool during self-learning or license class instruction of transmission line theory. It provides that always needed 'Elmer' when you are trying to understand transmission line theory articles and books.

Required Input Parameters

Reference the picture of the TL Details GUI at the end of this article, or download the program and run it. I will lead you through it.

1. Choose Transmission Line, Modify Parameters ... pick a coaxial or open wire feed line type. The characteristics for all of the standard types of feed lines are kept within the program so you don't have to enter them. You can, however, modify them if you wish.

2. Set Frequency, R and X … pick the frequency where you are intending to operate. Also, pick the value of Z that has been measured or modeled (more on this later) and select that it is the value at the input or at the load. This will vary depending on what situation you have. For example, a measured Z at the shack-end of a cable would be an input, as the antenna would be the load. A feed Z from an EZNEC modeled antenna would be an input too, with the receiver end as the load. Input is the source of the power and load is the sink of the power.

3) Set Line Length and Input Power … pick the physical line length that you have in either feet, meters, wavelength, etc. The Electrical Length is figured automatically, based on the velocity factor of the particular transmission line. It is represented in Modulo ½ Wavelength format, as the properties of a transmission line repeat every ½ wavelength. Input power is important, so select your choice of input level, QRP, QRO or anywhere in between.

Results from the Program

A nice feature of TL Details is that you don't have to wait for a 'computational result'. As soon as you add or change one of the required input parameters, the program immediately figures the results. This is very beneficial, as you can instantly see how the Z or loss characteristics change as you vary any of the input parameters.

By providing TL Details the type of cable, the length, the power level and the Z at one end, it will calculate all losses (conductor, dielectric and SWR), the power delivered to the load, and the transformed Z at the opposite end of the feed line. Essentially, everything you need to know is provided.

All of these answers are given in the bottom half of the GUI in the Results box. The two most important areas are At Input/At Load on the left and the Loss area on the right. In the middle is a rudimentary Smith chart, so you can see the result graphically, if you are familiar with the Smith Chart's layout and meaning.

Some Practical Examples

The main goal of the transmission line is to transfer the maximum amount of power output from the transmitter to the antenna. Obviously, no transmission line is totally lossless. Loss is relative, in that some transmission lines are more lossy or less lossy than others, depending on many factors. You could certainly purchase extremely low loss 1-inch hardline and use it for a transmission line in any antenna system. This would be perfectly fine except for the fact that you would be paying $5.50 per foot. At that rate your transmission line cost would be equal to that of the yagi and the rotator - simply not cost effective at all. But what coax can you use and still get good performance for your situation? That is what TLDetails will tell you.

Yagi Example

If your Cushcraft, Hy-Gain, Force 12, or whatever 20 meter yagi at 45 feet gives you an approximate 50 ohm feed Z, then select a coax with 50 ohm 'Ro'. RG-58, RG8X, RG-213 are good starting points. Set up TL Details for one of these coaxes, say (*RG-58*); set the Frequency at *(14.05)*; set the length of the coax, say (*120* feet).

Since the antenna feed Z is close to that of the coaxial cable the 'impedence transformation' is minimal but the loss situation is critical. You can see that if you are running 5 Watt QRP levels that the loss will be 1.625 Watts. If you are running 100 Watts the loss will be 32.493 Watts. Now change the coax type to RG-213 and look at the results. Much lower loss, 18.541 Watts and more power out, 81.459 Watts, to the antenna. The choice is obvious, performance-wise, but now it is in the realm of your pocketbook: spend 30 cents a foot or 70 cents a foot? Keep in mind that this loss happens both ways, for transmit and receive.

Multi-band 80 meter Dipole Example

The feed Z of a modeled 80 Meter antenna is 65 ohms -j025 (load). Use RG-8 coax and model this for 75 feet of coax. You can see the Z at the input of the coax (shack end) and the losses involved. Now, take the length and vary it a few feet plus or a few feet minus. Notice how the Z changes. In certain situations you will be able to vary the Z enough that your antenna tuner can handle this mis-match. Although the losses will remain, you will be able to at least match it and send the antenna the maximum power that the transmitter has to offer.

This demonstrates a well know antenna system tuning trick. If, for example, you are unable to match to your system with your tuner, simply lengthen or shorten the coax by a few feet (easiest is to add a jumper) and it will change the input Z. This alternate input Z might be what your tuner needs to provide you a match. Cecil Moore, W5DXP (see references) has a web article that uses switched, stepped transmission line length variations to match his antenna on multiple bands.

Now let's use the 80 Meter antenna on 20 Meters. It models out to have a feed Z of about 1250 -j49 ohms. Not close to 50 ohms at all but that is just what TLDetails tell us. Enter 1250 for R and -49 for X and select At Load. Look at the 'solved for' Z at the feedline input, 11.47 +j80.36. Also, and more importantly, look at the Losses incurred, 2.499 dB or 43.75 Watts. With 5 watts in only 2.813 watts arrive at the antenna. These high SWR caused losses occur with RG-213, a fairly low loss coax at HF frequencies.

Change the transmission line type and see what happens. We've all heard that open wire lines are less lossy, so trade out the 213 for 600 ohm open wire. This still has the impedance excursions at the input, 305.25 +j249.85, but more importantly look at the losses. They are down significantly, .047 dB; this is similar to losses expected of a transmission line that is being utilized near its characteristic Z. With the 600 ohm line, 98.918% of the power input to the feedline arrives at the antenna versus 56.4% with 50 ohm RG-213.

From this one can see that in a situation where an antenna is being used away from the designed frequency, it is especially advantageous to opt for low loss open wire types. You might have to provide additional tools, such as 4:1 baluns, etc. to bring the match in to the tuner range, but at least your losses will be much lower. For years the ultimate multi-band antenna has been a 102-foot flat top fed with open wire line. Now you can see why it was such a good overall multi-band performer.

Example of figuring your antenna's feed point Z from inside your shack

If you have one of the marvelous MFJ-259B, or other similar Z bridges, you are one lucky antenna person. With these emperical measuring devices and TLDetails, you have the world by the tail.

For example, say you have a 40 Meter delta loop with the apex oriented upward. The feed point is 1/4 wavelength down from the apex, feeding for maximum low angle, vertically polarized radiation. However, the feed point just happens to be 25 feet in the air and the only test point to which you have access is the end of the coax in the shack. Lucky you, you have TLDetails and with it you can determine the feed point Z of your antenna.

Simply measure the Z at the shack end of the coax using your bridge, place this Z value within TLDetails, note the transmission line type and length and you have an immediate number for the feed Z of your antenna. Plus you will know the losses occurring within the coax.

This 'remote measurement' is quite helpful when you are trying to 'tune' a gamma match of a yagi or some other network at the feed point of an antenna. This is true especially if the antenna is at 65 feet. You can see just what variations the Z is taking and take the correct tuning action. Even better, you can figure what Z you need to achieve with a correctly adjusted gamma match and simply vary the gamma match until the remote measurement is what it should be.

Summary

A simple rule concerning antenna design and implementation is that the more information you have concerning your antenna system, the better off you are. TLDetails helps you compile all of this information and formulate it into constructive data for your analysis.

There are many other ways to utilize TL Details than the few samples I have shown. For a free piece of software it is fantastic in that it will help you make decisions on coax versus open wire, RG-58 versus 213 or it will even allow you to determine the efficiency of your antenna 'system'. For us QRPers, it will show you how much of that "QRP Gallon" is reaching the ether.

One point of instruction before I end. If you have a situation where you have multiple types of coax or transmission lines in a system, you will have to model each section separately, saving the results for each on paper and then going to the next section with a different type of transmission line. It works fine like this - just keep track of what you are doing.

I hope this article provided you with a detailed look at TLDetails and its capabilities. It is a great program and the price is definitely right. By the way, if you like the program or have any questions about it, send Dan McGuire an e-mail. He's a really great ham and would sincerely enjoy hearing from you. Let him know how his program helped you improve your antenna system.

When we improve our antenna systems, we attain better communication with our fellow QRPers. Better communication means more fun, and fun is what QRP and Amateur Radio is all about.

References and Additional Reading:

- TL Details Software Dan McGuire – www.qsl.net/ac6la/index.html
- A Beginners Guide to Transmission Line and Antenna Tuner Modeling – Dean Straw, N6BV available in PDF at www.arrl.org (Membership required) or QST Jan 2001
- W5DXP's No-Tuner, All-HF-Band, Horizontal, Center Fed Antenna – www.qsl.net/w5dxp/notuner.htm
- TLW Transmission Line Modeling Software ARRL Antenna Handbook 19th edition
- Reflections II Book – Walt Maxwell via World Radio Press
- My Feedline Tunes My Antenna – Byron Goodman, W1DXB available in PDF at www.arrl.org (Membership required) or QST Nov. 1991
- Suppose I Could Have Only One Wire– web article — W4RNL – www.cebik.com/aledz.htm
- Many additional transmission line references – www2.arrl.org/tis/info/reflections.html

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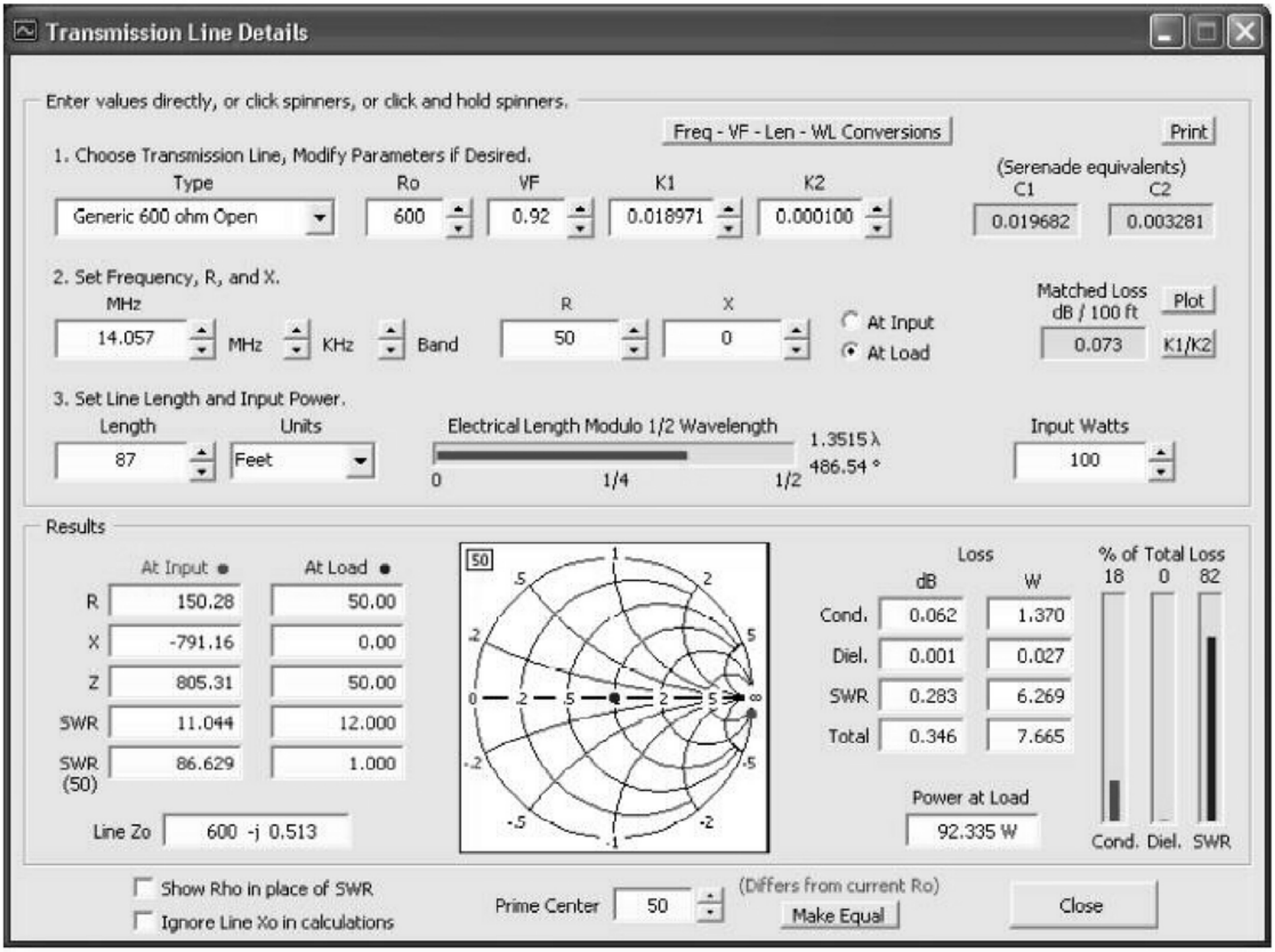
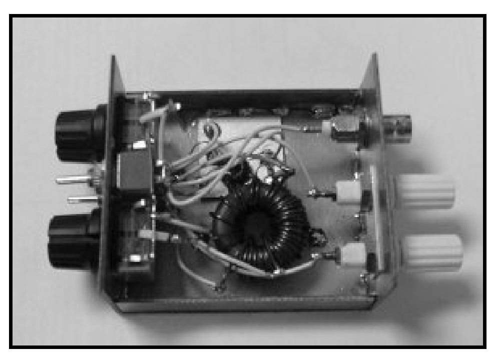


TL Details is a transmission line analysis, freeware, Windows application written by Dan McGuire, AC6LA. It is down-loadable (78 Kb zip file) from Dan's web site at www.qsl.net/ac6la/tldetails.html . (See Rick Hiller's article describing its use on the previous pages.

NorCal BLT Tuner Kit

The BLT is a simple Balanced Line Tuner ("BLT") that works from 10-40 meters, based on the famous Z-Match tuner and designed especially for NorCal by Charlie Lofgren. When used with the NorCal Doublet, it tunes 10-40 meters. We rate the tuner at 5 Watts, but it will probably be safe at 10 W. It comes with the Dan Tayloe N7VE LED SWR indicator built in, and is an absorptive bridge, so you won't fry the finals as you tune. All parts for the tuner are in the kit, including the case. It uses polyvaricon caps. There is already a mod to convert it to end-fed wire and coax. All you have to do is add one BNC and a SPDT switch, and you can use end fed wires and coax antennas. The connectors included are two 5-Way Binding Posts for the balanced feedline, and a BNC to connect to your rig.



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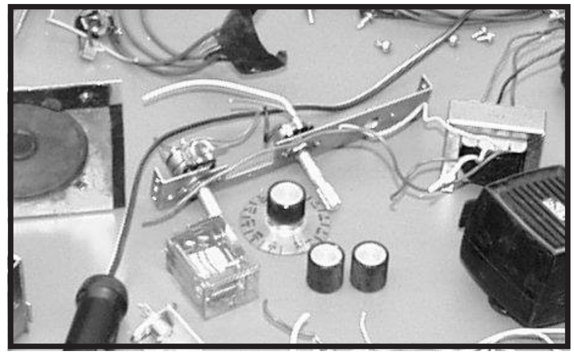
Rex Harper, W1REX

Transformations



They say beauty is in the eyes of the beholder. For W1REX, every piece of old, discarded, rusty or malfunctioning equipment is a diamond in the rough. Rex starts here a short, irreverent series of "mission impossibles" that may just give you some ideas of your own.

This is the first in a series of articles on the fine art of transforming that piece of roadside, yard sale or hamfest junk into a fine piece of QRP equipment.

Project [Old]

Build a QRP do-hickey, with an analog meter, INSIDE an Altoids tin.

Problem

Altoids tins have the dimensions: 3.625" x 2.25" x 0.75". It's that pesky 0.75" that creates the bottleneck. That 0.75" is also the overall outside dimension. In order to stuff the meter inside the tin with a circuit board, it must be thinner. An overall meter height of 0.625" or smaller looks ideal.

Background

I have been trying to build a piece of metered test gear into an Altoids tin for a very long time. I know, someone has been there and done that already. See QRP Hombrewer Magazine issue #3. I want my tin to remain whole, however, by stuffing the meter completely inside an Altoids tin. It is quite a challenge primarily due to the depth of the tin.

My junque box has the words Great Dane written of the side and back, and is 48 feet long. I acquired most of my junque box inventory not so much over time but over a weekend! I was a pretty new ham with but few ham friends. One was a basement 'stripper'. He spent all his spare time in the basement playing with radios, building radios and stripping old radios for parts to build 'new' radios. Unfortunately, he became a SK and over the course of one very long weekend a short time later, the SK's XYL was finally rid of 'all that junk', and I then had a rolling junque box that now vexes my XYL to this very day!

***Aside**: How that much "priceless antique electronic equipment" could cause so much grief to two XYLs over so much time, I'll never know. I just look at it as a future lifetime subscription for pleasure in the pursuit of QRP fun.*

Within the confines of my junque box, one can find probably fifty complete radios mostly military, and the "good stuff" stripped from another 50 to 100. I have sold off over time at least another 50. I have somewhere between 50 and 100 meters stripped from military radios discarded by the government. You know the meter type: big and round and heavy and black! Needless to say, the meters are all QRP-worthy but alas, none of these meters is QRP tin-worthy! Ditto on the newer, lighter, more radio friendly square commercial panel meters. I have some of these too; but they too require a lot of hacking to the lid. The meter movements are usually too deep to enable the meter to fit on the lid without some sort of clunky build-up. I once bought 150 edge view panel meters because I thought they would fit inside an Altoids tin. I say thought because, since I don't like Altoids mints, I was not carrying a tin in my pocket to check whether the meters would fit. Ever since that fateful purchase, I have had a back burner project of designing a kit using an edge view panel meter that does NOT involve a tin! You guessed it! The meter was a little too large to stuff inside a tin unless I hacked a big honkin' hole in the lid. No way!

I prevented that type of unfortunate purchase from happening again by creating Zomboids mints. I love these tasty spearmints so I always keep a tin of them with me, especially at hamfests where I can usually be found with 100 or so tins! So I come up empty in the junque bin department and have to go 'shopping' for my meter.

Project [New]

Build a QRP do-hickey, with an analog meter, inside a Zomboids tin.

Objective

Find a meter, any meter, to use as the basis of a QRP metered do-hickey in a tin.

So where can I find a dinky panel meter, probably edge view, to use inside a tin?

Think. Think. Think…

It will probably come out of something small, portable or semi-portable and have some reason for displaying an analog level … analog level? … recording? … ALC? ... VU meter?

Or analog battery status … portable battery powered device? Or signal strength … receiver? … transmitter? … tranceiver?

What is small, portable, battery operated, and is probably a recording device or transceiver, and can be found at hamfests for practically no cost? How about old clunky tape recorders, walkie talkies or CB radios! Many hamfest vendors have boxes full of these items and they are usually found scattered around the periphery of the main vendor table with notes scribbled on the box flaps: "All items $1", or "50 cents each", or some such wording.

Mission

Check out all sources of old portable tape recorders, walkie talkies and CB radios for a tiny analog panel meter that fits inside a Zomboids tin.

Scenario

In New England, the best destination for completing my mission is Hosstraders. Hosstraders or the Rochester ("Rainchester") hamfest, are held on the first weekends of May and October. They start Friday afternoons and run through Saturday afternoons, giving me plenty of time to complete my mission. I gladly attend several gatherings of Hosstraders; but alas, each gathering fails to produce that quintessential item in which lies the meter that completes my mission.

Finally, after a half dozen or so failed attempts, pay dirt! A particularly enticing vendor 'booth' containing a fine assortment of tarps spread out on the ground with heaps of dusty, dirty junk and boxes of similarly grungy items with flaps boldly stating "All items 25 cents" or "$1 each" and "make an offer" or my personal favorite "FREE" draws me in. Right there in the first box I look in, marked "FREE" of course, is a old 'Citizens Band Radio'. You remember those CB radio things that just everyone had to have to listen in on the truckers avoidin' those 'Smokies? Well, in the front panel of that CB is a teeny tiny analog panel meter. Wow, it's beautiful! And the 'piece d' la ohms' is that it has no brand name and a very simple universal scale of 0 to 5.

I now introduce you to W1REX's first rule of hamfests:

RULE #1

If it's free, it must be worth many times the 'asking' price!

So I gladly transfer ownership of this prepackaged assortment of QRP parts and hurry back to my truck to stash it safely inside. Other items are picked up here and there along the way back to the truck; but the CB remains the item of the day. Back home at the QRP bench, a quick ten minutes of time with a power screwdriver, a pair of side cutters, and a soldering iron is all that is needed to separate the prepackaged parts.

I toss the parts that have no QRP value into the real junk box and take inventory of the parts that remain.

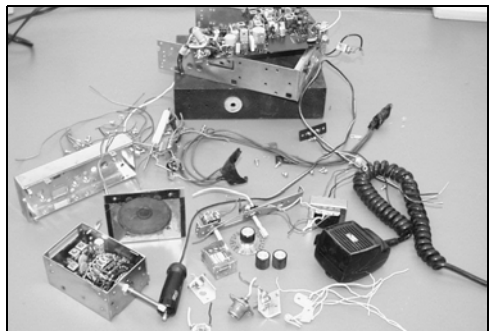
Notable parts with high probable use are: analog meter, microphone, pots, grain of wheat bulbs, transistor finals, cigarette lighter plug, speaker, knobs, antenna connector, and rotary channel switch. It all probably amounts to $10 worth of parts from the surplus houses. I did not really pay attention to the brand of this CB until I went to look up the final transistor specs on the Internet. This was a Raytheon CB that was made in the USA and it had American made transistors whose specs popped right up as the first item in my Google search. Lucky Day! I store all the parts away into an empty baby wipes container and think about my new mission …

Mission [New]

I now have the analog meter, so what kind of do-hickey do I build?

W1REX is now taking do-hickey suggestions at W1REX@megalink.net. The author can also be reached at 9 Intervale Road, Windham, Maine, 04062.

The Radio



The Parts

Nick Kennedy, WA5BDU

Hacking the K8IQY Precision VXO

Including ... "Analysis of the Norton Amplifier"

I really like the Precision VXO circuit that appeared in the Atlanticon 2002 Proceedings and later in QRP Homebrewer. With the kit available you can end up with a really nice looking signal generator. I wanted to customize it a bit, so I started putting it together Manhattan-style. Here's the tale with some of the variations I put in and some things I learned along the way. Some feedback from K8IQY has been added, along with an interesting analysis of the Norton amplifier.

This is a story of some useful modifications I made to the K8IQY "Precision VXO". For the full description of the original project, see the publications mentioned above, or visit its online pages at the NJQRP website: www.njqrp.org/pvxo. For an overall view of the PVXO circuit diagram with my modifications noted, see the schematic at the end of this article.

First, I didn't have a handful of nice DPDT mini-toggles to spare, so I decided to do the inductor switching thing with a DIP switch. It consists of SPSTs, so instead of "switching around" the molded inductors, I put them all in series and have the DIP switches shorting out the unused ones.

Jim said: *"I had thought about doing it that way originally, but decided on the DPDT approach since it does a bit better job with the distributed capacitances and parasitic inductances of the switches. All the same reasons that precision attenuators use DPDT switching."* Yep, I was concerned about the same thing, and in reality my version might be limited a bit by this, even though "it works fine for me".

I built the oscillator, FET follower, and amplifier and used a 2K-ohm 10-turn potentiometer instead of 5K-ohm, because that's what I have. Jim concurs: *"Really not an issue. As you know, the pot provides a variable voltage, and isn't at all critical."* It worked and looked good on the scope, tuning was smooth and the waveform and amplitude remained undistorted and constant over the tuning range. I was getting about -2 dBm output. I wanted a little more juice out of the thing because I was planning to use resistive matching instead of 4:1 transformers and needed to make up the losses. So I changed the circuit between the follower and the Norton amp to give lot more drive to the amplifier. I didn't see any need to match the input of the amplifier to the circuit driving it and a check of the waveform indicates that the amplifier is not overdriven. Anyway, I got the output up to about +10 dBm or so now. This was accomplished by lifting R9's grounded end and putting it in parallel with R8.

As I said, I used resistive pads to put my test crystal in a 12.5 ohm environment. Someone had suggested this on QRP-L earlier. With resistors OR transformers, the effect is to narrow the bandwidth and also to make the crystal's equivalent series resistance easier to measure, as it has a greater sway here than in the 50 ohm world. Due to the narrower bandwidth, you need a good stable generator that is easily adjustable to about one Hertz. The K8IQY PVXO is great for this if you don't have a DDS lying around. My matching circuit consists of two Tee matcher/attenuators, one on each end of the crystal. The attenuation of each is 16 dB. The 50 ohm ends are 44.2 ohm resistors. The middle leg to ground is 8.1 ohms (two 16.2 ohm resistsors in parallel). These are standard values from the usual sources, by the way. The 12.5 ohm end calculates to be about 5 ohms but is omitted in this case. The resistance of the crystal is approximately 10 ohms and it makes up this leg for both matchers. Typical variations in resistances won't throw off the resistance seen from outside looking in or from the inside looking out by a significant amount. Jim's take on this is: "*Your resistive approach may in fact be better than the step down transformers that I used. We should "round robin" some crystal sets just to see what the differences are.*" I like it too, for minimal interaction with the crystals, but that big attenuation factor may make another gain stage necessary if a simple diode detector is used.

For a detector in crystal testing, I use the Kanga log power meter. It'll go down to about 70 dBm, so I didn't have to worry about the 32 dB I was throwing away in the matcher. I also added a switchable -3 dB pad between the output and the detector (Figure 5). That makes looking for the -3 dB points a little easier. You switch it in at the peak response frequency and note the reading. Then switch it out and vary frequency up and

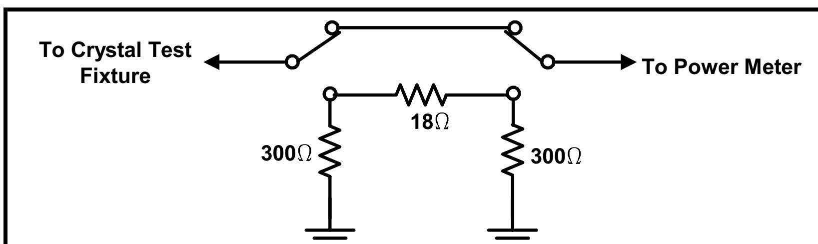


Figure 5: Switchable -3dB Attenuator

down. The -3 dB points are the frequencies where you obtain the same reading. The log power meter is really overkill here. The simple diode detector is ideal since the actual value of power is of no consequence.

I also added a separate amplifier driven off of the FET follower to provide an input to my frequency counter. It's an old and none-too-sensitive Goldstar. I used what I call the Bad Amp circuit. It's bad because it breaks all the rules – the gain varies with beta, and with frequency, and so on. But it is an easy way to get high gain and is really easy to build with a transistor, two resistors and two coupling capacitors. Connect a 2.2k resistor from Vcc to collector, and a 220k from collector to base, and ground the emitter. Place the input to the base and take the output from the collector. I think I've seen variations on this in NJQRP's frequency counter, and in Paul Harden's regen receiver. Tom Engdahl's page has a version as a microphone preamp. Make the valule of the big resistor "beta" times the smaller one and the collector voltage will be at about 1/2 of supply. Jim: *"A MMIC amp would also be a quick and dirty way of getting more gain too."*

Norton amplifier digression

The coolest thing about studying Jim's PVXO was trying to figure out the Norton amplifier. Don't say "read the book" on this one – it's not easy to find this topic in The Book or on the web. It is easy to build but hard to analyze due to the strange 3-winding transformer with two unequal windings in the collector lead and a one turn winding in the input (emitter) lead. I finally found a fairly good rundown in Hayward's Introduction to Radio Frequency Design. It turns out that you can characterize the thing just by considering the transformer as an ideal transformer. That means all fluxes cancel, and the total ampere-turns of currents flowing into the three dots equal zero. Take it from there. Jim: *"Cool amp design, isn't it?! Very low noise, and very predictable gain, and terrific stability, if built with the correct phasing on the transformer."*

The transformer keeps everything in lockstep and the transistor supplies the power gain. See more detail in the Norton Amplifier section below.

This amplifier is also called the Norton Noiseless amplifier. I think that is because you do not have noise producing resistors in the signal paths. Is that right? Jim: *"YES. No noisy resistors in any signal paths."*

Analyzing the Norton Amplifier

Let's look more closely at the Norton amplifier. Maybe we will see why it is a favorite of many.

What do we want in an amplifier? Predictability is good. Predictable and adequate gain and predictable input and/or output resistance. We also want low noise and broadbanded operation. Relative easy and non-critical construction is also desirable. It is also nice if you can understand how it works. You can then apply it with more confidence in different situations.

The key is of course in the three winding transformer. It looks anything but simple at first glance, but we'll analyze it with nothing more complicated than simple algebra and some basic assumptions about how transistors and transformers work.

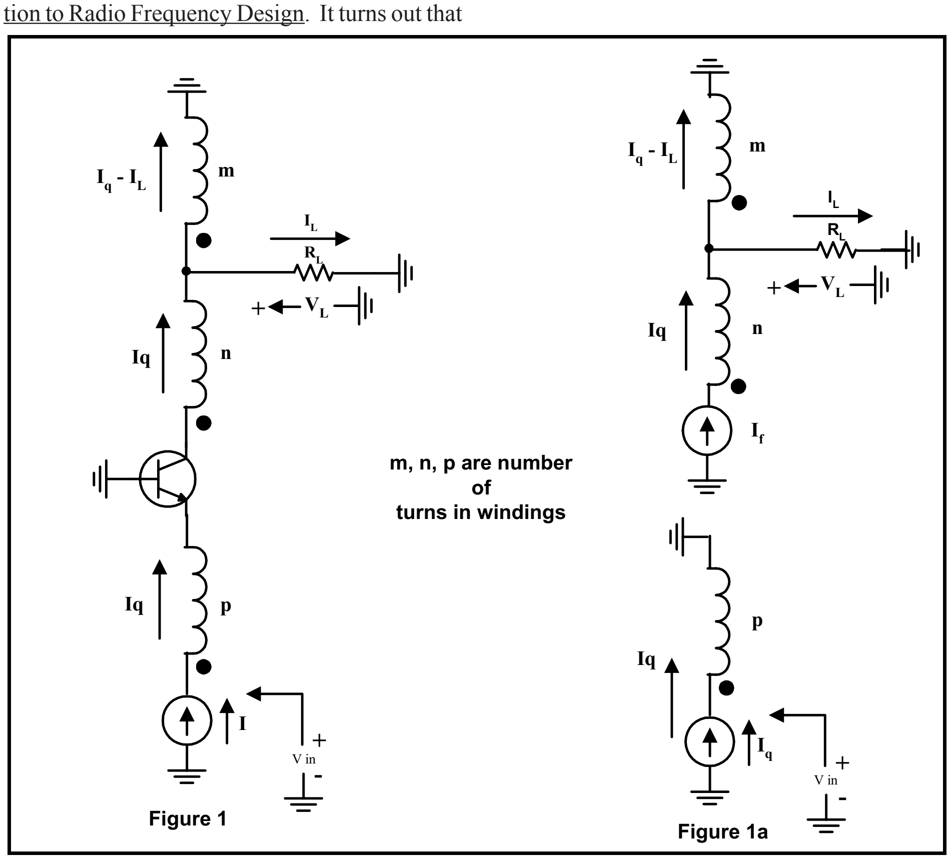


Figure 1

Figure 1a

The Norton design prescribes certain relationships for the three transformer windings, which tend to simplify analysis. I think it's interesting to start with the general case and then simplify it to the specific Norton configuration. That way we'll have equations to play with should we decide to experiment with the circuit outside the constraints of a "true" Norton amplifier.

Start with the simplified diagram (DC biasing omitted) in Figure 1. Here are the assumptions:

1. The resistance looking into the emitter is low enough to call zero. This will be true when DC current biased up to a reasonable level. It is key to understand that we are talking about resistance referenced to ground here. That leads us directly to the even more simplified Figure 1a.

2. Emitter current equals collector current. This means that base current is small enough to ignore in this analysis. You can see that the input generator current is the same value of current flowing into winding 'n'.

3. The transformer behaves like an ideal transformer. Meaning what? Well for starters, we can make this statement: Take the current flowing into the dotted end of each winding times the number of turns in that winding and add all the resulting ampere-turns together and you will get zero.

Okay, here we go. Since emitter and collector currents are the same, Ig flows in both the p and the n windings. I have arbitrarily drawn load current I_L from the transformer junction toward the load. That makes the current in the m winding Ig - I_L. From the bit about ampere-turns adding to zero:

$$I_g(p+n+m) - I_L(m) = 0 \quad \text{(Eq. 1)}$$

Rearranging gives,

$$I_L = \frac{I_g(p + n + m)}{m} \quad \text{(Eq. 2)}$$

Now, the voltage across the load is of course I_L times R_L. Note that the voltage across winding 'm' is the same as that across the load, as they are in parallel. Finally, the ratio of the voltages across the windings of a transformer is the same as the turns ratios. The load voltage can then be referenced to the input voltage (across p) as below.

$$V_{IN} = Ig\left(\frac{p}{m}\right)\left(\frac{p+n+m}{m}\right)R_L \quad \text{(Eq. 3)}$$

The p/m term is the voltage (turns) ratio of those two windings and the rest of the equation is just I_L from equation (2), taken times R_L.

Now with an expression giving Vin in terms if input current (Ig), we can solve for the input resistance, as Rin = Vin/Ig by dividing equation (3) by Ig.

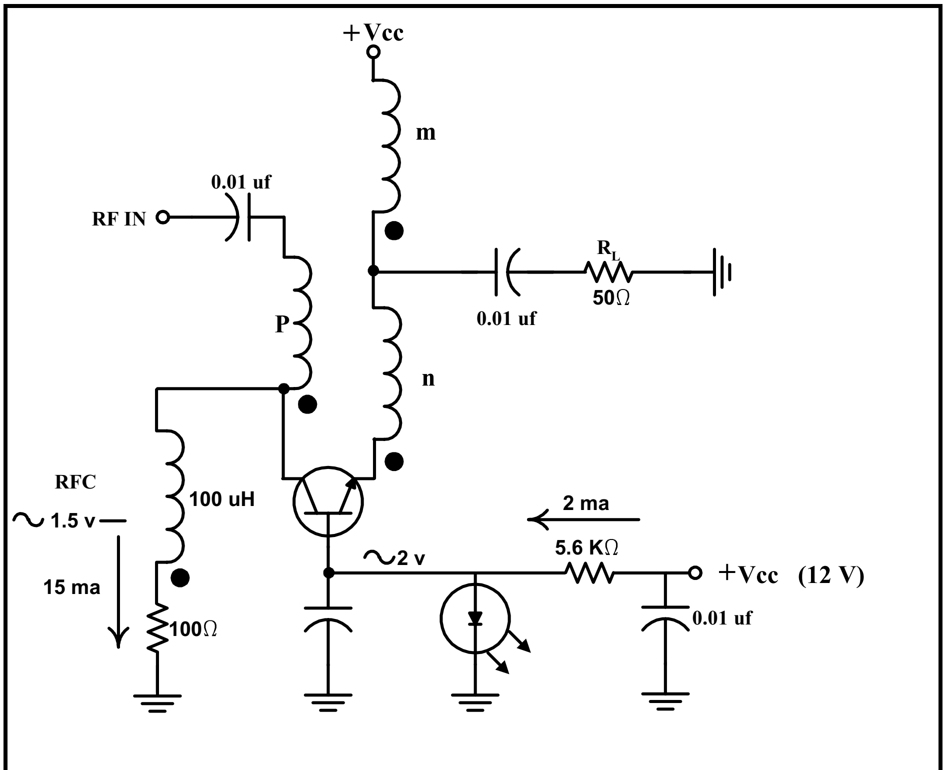


Figure 2: Norton DC Biasing

$$R_{in} = p\left(\frac{p+n+m}{m^2}\right)R_L \quad \text{(Eq. 4)}$$

$$G=\frac{p+n+m}{p}$$

That is for the general case, without regard to specific values of p, n, and m. But the Norton amplifier defines a specific set of conditions for these values, shown below.

$$p=1; \quad n=m^2-m-1$$

(Norton transformer conditions)

By substituting those conditions into equation (4), we get the familiar and much prized relation:

$$R_{in} = R_L \quad \text{(Eq. 5)}$$

for the Norton case only.

Or in words, the resistance looking into the input of a Norton amplifier is equal to the connected load resistance.

Now, what about power gain? Well, power input is equal to Ig squared times Rin. And power to the load is I_L squared times R_L. Using the expression for I_L on the right side of equation (2), we can finally arrive at a ratio of power output to power input as:

(Eq. 6)

for the general case, which simplifies (incredibly) to

$$G=m^2 \quad \text{(Eq. 7)}$$

(Power gain for the Norton circuit.)

And of course the gain expressed in decibels is just **10Log(G).**

Let's look at some sets of transformer turn counts that satisfy the Norton design rules and the resulting gains:

p	m	n	Gain (dB)
1	2	1	6
1	3	5	9.5
1	4	11	12
1	5	19	14

It is interesting, though not necessarily productive, to let p, m, and n vary beyond the Norton design rules and see what you get for Rin (equation 4) and gain (equation 6), but I'll leave that exercise to the reader.

What about DC biasing?

At this point, the alert reader is going to say "Okay, that's fine when you can cheat and just draw the AC current paths, but how am I supposed to bias this crazy thing to the DC levels needed to make the transistor do its thing? Having the input connected to the emitter is just weird!" Let's look at Jim's +12 dB amplifier in Figure 2 as a good example of how to do it. The collector requires a connection to Vcc. This goes to the grounded end of the 'm' winding. There is no contradiction here. DC "hot" (Vcc) is equivalent to AC ground because Vcc is always well bypassed to ground with capacitors.

Next, establish the base to emitter biasing and resulting emitter DC current. Although AC feedback in this circuit is established by the transformer, DC feedback is also needed for stable biasing. That is the function of the 100 ohm resistor in the emitter lead. It is desired to establish about 15 mA standing current. This will set the maximum AC current swing attainable without clipping, and therefore the power capability of the amplifier. For 15 mA, you need 1.5 volts across the emitter resistor, so after adding the junction drop about 2 volts is needed at the base.

Now comes a neat trick. A green LED drops about 2 volts while conducting and so makes a decent 2-volt regulator. The 5.6k ohm dropping resistor from the LED to Vcc gives about 2 mA through the LED with a 12-volt Vcc. A rule of thumb is for this to be ten or more times the base current. Base current is 15 mA divided by DC beta. A good conservative guess for beta is 100, so base current is 0.15 mA and the rule is satisfied. That takes care of DC at the base, but what about the AC ground? The 0.1 uF capacitor takes care of that. By the way, you can just use an old fashioned resistive divider and drop the sporty LED if you wish. I had fun ripping a green LED out of an old computer keyboard though. Those things have got to be good for something!

Back to the emitter, looking at AC paths this time. We'll generally build this amplifier with an AC (RF) input resistance of 50 ohms. If the emitter resistor used for DC biasing were large with respect to 50 ohms, we would not worry much about the RF trying to sneak out that path. But 100 ohms doesn't cut it, so the RF choke in series with the 100 ohm resistor completes the resolution of AC vs. DC in the circuit. I guess I should also mention that the RF input to the 'p' winding is capacitively coupled to keep DC out of there.

Conclusions

The Norton amplifier meets our requirements: it is low noise, has well defined input resistance, has well defined and ample gain, is fairly easy to build, and is fun to analyze! It is also worth mentioning that a common base configuration avoids

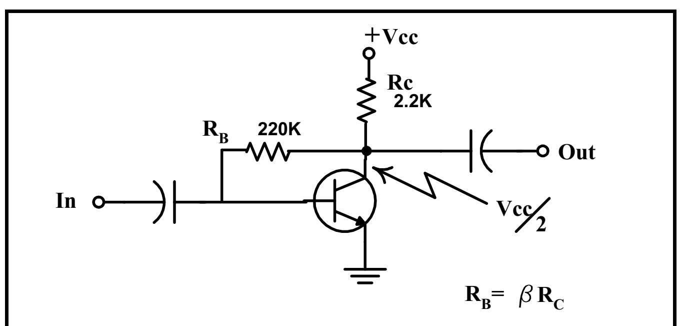


Figure 3: The "Bad" Amp

the Miller effect and therefore has better bandwidth. This is a good amplifier for a receiver preamp with 50 ohms input and output resistance. It is also good for test equipment and/or filters requiring a well defined termination.

As far as drawbacks go, Hayward points out that an advantage in some situations is a disadvantage in others. For example with the Norton circuit, if your load resistance varies wildly, then so will your input resistance since they are equal. The advantage of constant and defined input resistance is realized, therefore, only when the load is constant.

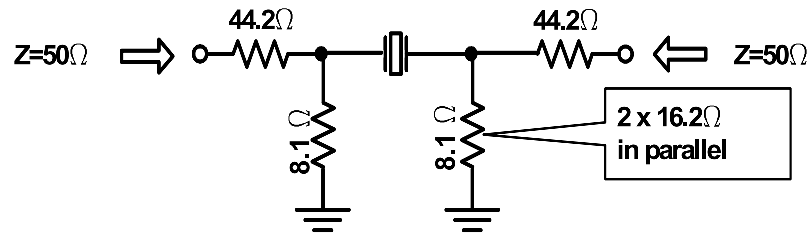


Figure 4: Crystal Test Fixture

The author may be reached my mail at 300 S. Vancouver Avenue, Russellville, Arkansas 72801, or by e-mail at nkennedy@tcainternet.com.

NOTE: Hand-drawn graphics were electronically reproduced by Carl Hyde, W2CSH.

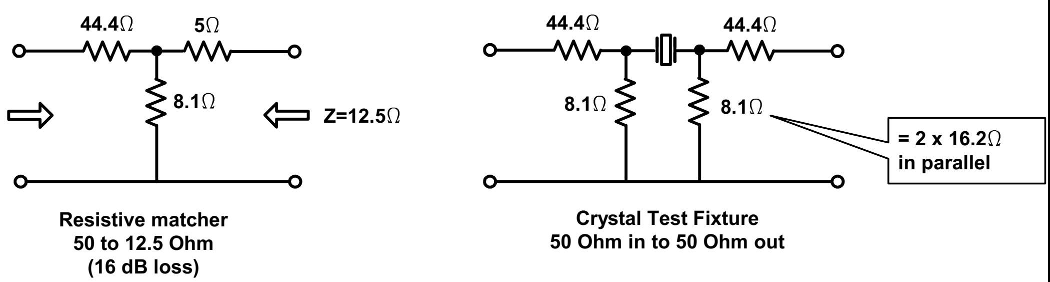


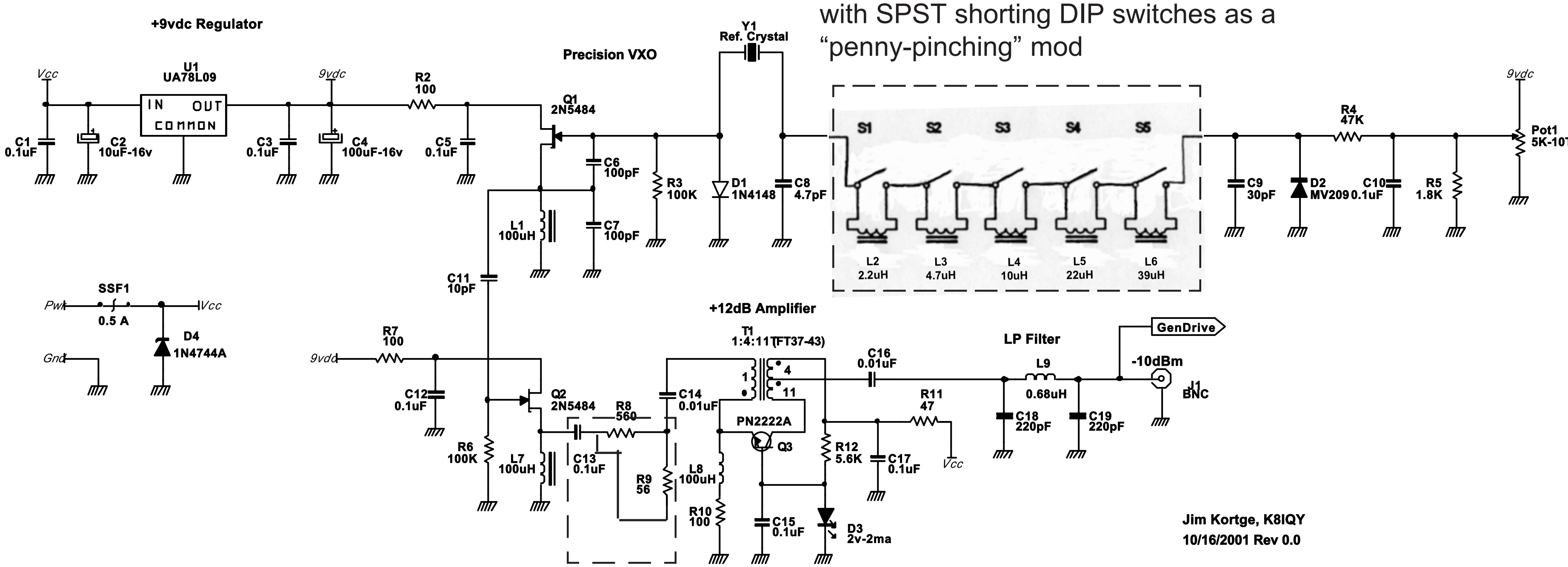
Figure 4: Crystal Test Fixture

Mods for "Hacking the PVXO."

by Nick Kennedy, WA5BDU

Precision VXO

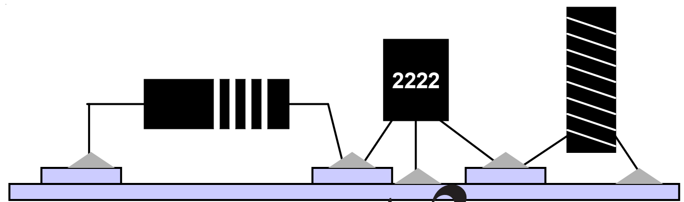
DPDT switch-around scheme replaced with SPST shorting DIP switches as a "penny-pinching" mod



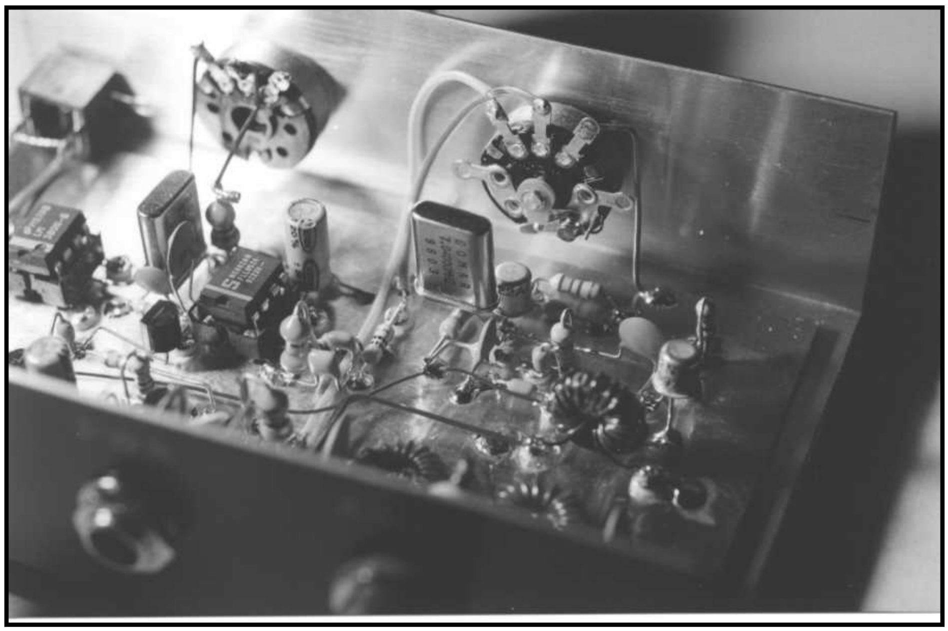
Lifting the grounded end of R9 and connecting as shown gives about 12 dB increase in output signal.

Chuck Adams, K7QO

Manhattan-Style Building Techniques Part 3



In Part 1 master homebrewer K7QO described the selection process for material and tools, and in Part 2 he described how Manhattan pads are created, mounted and used as circuit nodes on the bare copper-clad base board. In this concluding installment, Chuck overviews the basics of soldering and converting a circuit diagram from paper schematic to a Manhattan-style layout.



Combination Tuna Tin 2 Transmitter + MRX-40 Receiver was built Manhattan-style on same board with K7QO final PA, Cheby filter and W7ZOI keying circuit. Also note homebrew case with 040 aluminum and use of Harbor Freight shear. This rig took first place at the NorCal Pacificon QRP Forum building contest several years back.

Soldering Technique

In this section let's take a look at soldering and soldering tools and equipment as used at the workbench of K7QO in beautiful Prescott, AZ.

Now the ARRL Handbook has some excellent information on soldering and the equipment needed, but I have my own way of doing things that have worked well for me over the years. Thank you for allowing me to share them with you.

First of all, you do not need to spend an arm and a leg for a soldering iron. Yes, I know that soldering stations sell for big bucks and are worth every penny spent on them - but I have built over 125 kits in the last seven years and built a lot of test circuits and odds and ends and all of these were done with a simple Weller soldering iron model number SP-23. The soldering iron can be found in the tool section of Home Depot. Mine is a 25W iron with an Ungar tip (PL-823) that is also no longer being manufactured, but there is hope that you might find one in your searches through the piles of stuff at Dayton and other swap meets.

Why do I like the tip? It has not degraded over the years with pitting, etc. It has a fine enough tip that I can do the smallest of soldering and it has flat surfaces large enough to provide both the surface area and thermal area to coat the thermaleze wire being used in most kits now for toroid windings.

I bought a Radio Shack soldering iron stand at a hamfest somewhere and I think I paid $2 or so for it. It is the one with the small metal "sink" that holds a sponge. What most people do is have the sponge with a small amount of water to clean the tip of the soldering iron from time to time while working with it. You simply swipe the tip of the iron across the sponge and the process removes excess solder and flux on the tip of the iron. I dislike this physical process for two reasons. First of all it cools the tip slightly. Also the sponge tends to trap a glob of solder (like that high tech talk?) and then sling it in my direction while it is still molten and hot! I consider this dangerous and an unpleasant experience when it happens.

Here is my technique. I always solder with blue jeans on. I recommend that you never solder while wearing short pants since you might drop the iron or something that is hot onto one of your legs. While soldering, I use a dry heavy or thick washcloth that I bought at a Wal-Mart or Target store. I place the washcloth across the right pants leg as I am right handed. While soldering and when the tip has flux residue or too much solder on it, I just drag the soldering iron tip lightly across the washcloth to clean it. I have been using the same cloth for over a decade with still no holes in it. Of course, you can't use it for anything else! I'm sure some one will rant and rave about this, but I find it does a great job of cleaning the tip and it doesn't cool it down.

Each of us has his or her supply of favorite solder. Jay Bromley, W5JAY, in Ft. Smith, AR, gave me a one pound supply of Kester Solder with the following info on the top: CAT 24-0062-0018 with diameter 0.025", Core 66, Flux "44", and alloy SN62. This will be 62/36/2 meaning that it does have 2% silver content. It has a low flux residue and you don't have to clean the work after soldering. I built a K2 using this solder, and with the silver the contacts almost look like miniature mirrors – they are that shiny. This will be my solder of choice for everything that I build from now on. You can get this solder at Mouser and most other places. Also Kester CAT 24-7150-8800 which is 0.031" diameter solder.

Okay, we have the iron hot, the solder, the cleaning rag and we are ready to go. What I do when soldering is I use what I call the “3 second rule”. I do everything that I can to melt the solder and make the connection in about 3 seconds or less. I do not want to overheat any component, as some may easily be damaged internally or externally due to excessive heat. Manufacturers may specify a maximum component temperature for 2 seconds that if exceeded may cause permanent damage to the part.

I usually place the solder between the solder joint and the iron. I also attempt to get a good physical contact between all three items at the same time. I know what the books say and this is in disagreement with most, but here is my reasoning. Remember I have a PhD in Physics. The solder will melt almost instantly. The heat from the melted solder and its “wicking and coating” on the lead and the pad will rapidly distribute heat, coats the parts, and then I can quickly get the iron off the area and allow it to cool rapidly without conducting a lot of heat along the lead to the component, thus keeping it relatively cool the whole time. At the time you touch the solder and component lead with the iron start counting 1001, 1002, and then 1003 and remove the iron. After a little experience doing this you don’t have to count. You’ll know when the feel is right.

During this three second period, feed just enough solder to make the connection and give enough material to make a solid mechanical joint when it cools and to also have good conductivity electrically. Don’t put too much solder so that the connection looks like it has a quarter pound of lead on it. I assure you that the connection will hold just as well with a small amount of solder as it will with too much solder. I always strive for neatness on the finished piece. I just hope the accompanying photographs for this article will show just what I mean.

Some tools that I use almost daily include: tweezers from Harbor Freight, an extruded aluminum sanding block, Kester solder, solder iron station, the Weller soldering iron with Ungar tip, chain nose pliers (a finer tip than needle nose pliars), Exacto hobby knife with #11 blade, and Sears diagonal cutters (4.5" Craftsman #45171).

Solder & asembly tools used at K7QO

Practice Exercise #1

Okay, we are now at a point where you should be able to do the following exercise and apply the techniques discussed so far. Get the tools and materials together. It is my hope that you won’t put off this series of exercises and building projects. I fear that you won’t ever get to them otherwise. You will need the following items:

- printed circuit board material
- shear or cutting tool for straight edges
- punch or nibbler
- Tarn-X and cotton balls
- solder iron
- solder
- super glue
- tweezers

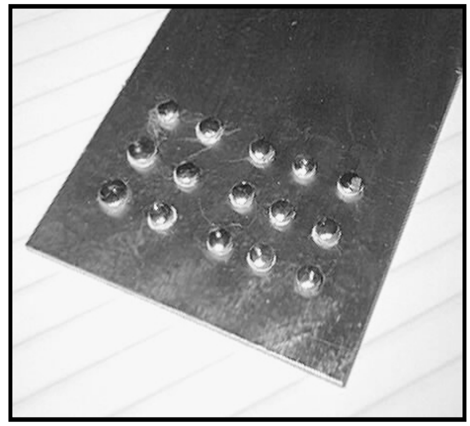
First, cut up a couple of small pieces of circuit board. One will be used to make pads and the other we will mount the pads upon. I’d make them both about 6 cm by 6 cm or so. This doesn’t have to be exact as we are just practicing here. Don’t waste too much material and hopefully this exercise will prevent expensive errors later on.

Next, sand the edges of both boards to prevent injuries due to sharp corners and edges. Then take the Tarn-X and clean both boards as outlined earlier in Part 1 of this article series.

Use one of the boards with a punch or nibbler and make up a couple dozen or so pads. I recommend that you make up about half-a-dozen each of the different sizes if you are using the circular punch. This will give you some experience on making the pads and getting them glued to the board, and give you a feel for what each size looks like and how much area it takes up. It will take time to change the punch size, so you have to study just how to do this and read the instructions.

Now take the other board and with a pencil and ruler (oops, not on the list, but you have those) and make a nice grid on the board with equally spaced horizontal and vertical lines. Make enough intersections of lines whereby you can mount pads at these points and have some room between them. Maybe ten to sixteen points will do nicely.

Take the super glue and place a small dot of glue at one of the intersections. Follow this up by using the tweezers to place a pad on top of the dot of glue. I use the tweezers because I know what will happen if my fingers touch the board, the pad, and the super glue simultaneously! Try to center the pad the first time you place it and use just a little pressure to set it in place. You can now do all of the remaining pads at one at a time or do them separately one at a time. Since this is a test case, you may want to experiment with different quantities of glue for the dot and look at the effect.



Pads glued to board.

Now that we have the pads in place, let us tin each pad. Using the soldering iron and solder, put just a small amount of solder on the top of each pad. Experiment here to see what soldering techniques give you just a small amount of solder that covers the top layer of the pad and looks nice and smooth and shiny. Use the K7QO counting procedure. I put the solder on top of the pad and then put the solder iron on top of it to melt and cover the pad at the same time. Feed just a little solder after the first portion melts to get the amount that you want.

After doing this take a magnifier and look at your work up close and personal. Does it look good? I’m sure it does. Now take a multimeter and check to see that there is no short between each pad and the board layer, which will be the ground plane.

If you want to experiment further, see how close you can get two pads together without a short between them. How about a triangular configuration with three pads as close as possible? We’ll be using this arrangement for mounting a transistor.

Set this board aside until the next exercise. Here is a photo of my results for this experiment. I won’t ask you to do something that I have not already tried myself. It makes us both look good.

Pads, Nodes, and Capacitance

In this section I will discuss how to use the pads for common connections between components.

In order to build a complete circuit using the Manhattan-style construction you use the pads glued to the printed circuit board.You first determine where to put the pad, then you glue it down and tin it. Next, you solder the leads of the components to the pad that are common to that connection point.These points in a circuit diagram are called nodes. I’ll give you some pointers on how to determine how many pads you will need in a moment.

I knew this was going to happen on QRP-L when the Manhattan-style construction discussion started up after Dayton and the discussion has been brought up since then. Someone always has to ask the question of just how the capacitance between the pad and the ground plane affects the circuit and should it be a concern. My answer is a resounding no. Please do not worry about it. There are many more important issues to focus on rather than worrying about the small amount of capacitance due to a pad.

I took several pads made from double sided copper-clad material, tinned both sides of each, and added small wires to make up capacitors. I measured the capacitance with the L/C Meter IIB from Almost All Digital Electronics (www.aade.com). If you do not already own one of these instruments, then you need to consider purchasing one, or perhaps making an AmQRP ELSIE L/C Meter, if you are going to get serious about construction and experimenting in general. It is the most useful piece of equipment that you can own other than a DVM. With this meter I measured 0.58 pF capacitance for the 4.76 mm pad and 0.49 pF for the 3.18 mm diameter pad. I then super glued a 4.76 mm pad to a small piece of printed circuit board and measured a capacitance of 0.37 pF for the resulting structure. "Oh," you say. "Why is the capacitance smaller for this configuration?" Well, look at it this way. You have a capacitor made up of the two copper layers of the pad. You then have a layer of dielectric material made up of the super glue and then another layer of copper for the printed circuit board. This configuration makes up two capacitors in series and the total capacitance is thus reduced. If this doesn't mean anything to you, then look at Chapter 6 of the ARRL Handbook. It will come to you, I promise or send me email. Sometimes when you solder the pad to the ground plane the metal will make contact and the capacitance will go back to that of the pad. No biggie, in my opinion.

Now don't send me email if you do your pads and find that capacitance varies from my measurements. The factors that make up the capacitance vary due to material type and thickness of the board material. You should be getting values on the order of 1 pF or less. This isn't rocket science here and your mileage may vary.

OK, how about wires that are close to the board between nodes. Does that capacitance amount to a large value? No, it is not too great an addition to the distributed capacitance of a circuit. I leave it as an exercise for the student to build up a test circuit to measure this. If you have two pads separated by some distance and a wire, say a length of #28 magnet wire, for an interconnection between the pads (and you will be doing this from time to time) then you add the capacitance of the two pads and the capacitance between the wire and the board. I can do the physics for you on this, but that is beyond the scope of this article. Trust me, I recommend that you don't worry about this at this time.

Circuit Layout

In this section I will mention the use of the schematics to determine board and circuit layout.

When you get ready to build a circuit using the Manhattan-style you have to get all the parts together with the schematic and then sit down with pencil and paper to make a layout of where you want things to go on the board. I usually find that if a schematic is well layed out I can usually build going left-to-right in the same order as the schematic. I'll do the NN1G transceiver from the January 1994 issue of the QRP ARCI Quarterly and the 1995 issue of the ARRL Handbook in detail in a future article. I think that it is an excellent project, the rigs work well, and it can easily be laid out in a small area.

From the schematic you can determine the number of pads needed by counting the number of common points for components. All dots that are connected by a single wire usually are done with one pad unless there are too many component leads to fit on a single pad and/or if there is some physical distance between the connecting leads. You can get a good estimate without too much effort. Practice will improve your guesses.

Using the schematic, pencil and paper you can roughly sketch out the logical areas of the schematic (like for the VFO, IF filter, amplifier stages, etc.) and determine how they connect. Watch out for large components like IF cans and other things that take up a large area on the board.

If you have never built anything ugly style or Manhattan-style, then by all means start out with simple projects first. You have to learn to walk before you run. I don't recommend you attempt a receiver or transceiver as your first project although a number of people have successfully done so with the K8IQY 2N22/40 transceiver, but they had great guidance in the Winter 1998 issue of QRPp with illustrations done by Paul Harden, N5AN. Some used the Arizona ScQRPion board layout with silkscreened pad and parts locations. If you are on your own and doing something that maybe no one else has tried, then do a lot of work up front doing the physical layout. It will greatly improve your chances for success.

Here are some things that I recommend you do before building a project. This list is by no means complete and you should use it for some starting ideas.

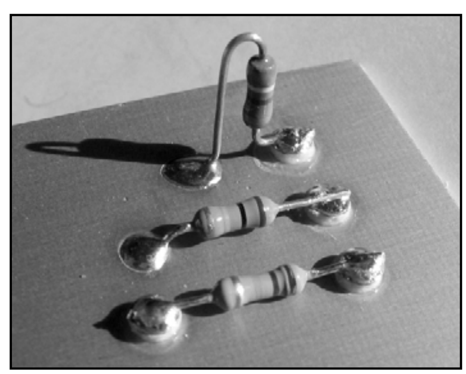
- get schematic
- get parts
- decide if project will fit on one board
- if project is to go into case what connections and controls are needed and where do you want them to go
- make a rough diagram of layout by logical stages of the circuit
- approximate area requirements for each section
- how do the stages interconnect
- do a final examination of your design and adjust for obvious problems that might occur

Building and Testing

In this section we will look at some things to consider during the construction phases of your project.

Hopefully, at this point you have your work area cleared out and ready to start in building. What I do is take a printed circuit board slightly larger than what I think is needed for the project. You don't want to underestimate here. I usually start in the upper left corner and work left-to-right. Now here are a couple of tricks that I use. I leave about 2 cm edge both from the left and the top edges of the board. If I have a need for additional room then I can use this space, but only as a last resort. You may need this room for clearances when mounting the board in a case for controls and connectors mounted on the case. If I don't need the board space, then I remove it carefully with the shear. I use a cloth to place the board on while I'm working. I have a portion of the cloth folded over the top of the board and to just below the area where I am working. I can rest my hands on the cloth and not touch the board while I am placing parts and soldering. It keeps the unused portion of the board from getting fingerprints, solder spatter, etc. while I work. I thought about using masking tape to cover the board and then peel as I go, but that can get messy if I leave the tape on too long. You might want to experiment with this technique.

Now also keep in mind that you should be now thinking in three dimensions. I mount many components 'on end' – i.e., one lead soldered either to a pad or the ground plane and the other end to another pad. Same with most of the components that have the leads on the ends or what is called axial leads. There will be times when the distance between pads requires that you have a component in the horizontal position. If you like the current trend in using board mounted connectors, then by all means use the same components and mount them to pads on the board edges. For this you'll go ahead and mount the components near the edges instead of leaving room. You



Three different resistor mounting schemes.

just have to be sure to carefully plan your layouts for this. You reduce your margin for error here. Be sure to plan more carefully and take more time in the layout.

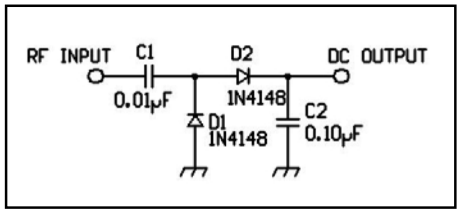
You can take some 1/4W resistors and some other components that you aren't going to be using or old parts and practice mounting them on the previous board we did. What I do is take the resistors that I mount in a vertical position and mount them so that the color code bands are at the top. This makes it easy to read them after the circuit is complete to check for errors, and you will be doing this. The lead that goes on the bottom end I bend at 90 degrees about 2 mm or so from the body of the part. I then take the chain nose pliars and form a half-loop at the top so that the lead now comes down parallel to the body of the resistor or whatever. Now, if the component is to go to two pads the bends are at the same level. Otherwise, the lead that goes to the pad is shorter than the lead that is soldered to the ground plane or printed circuit board by the thickness of a pad. I am fussy about trying to get the component perpendicular to the board most of the time. At least close enough for government work as they say. When you get completed with a project this gives the finished product a beautiful sense of symmetry and alignment.

Another thing about the three dimensional aspect of building. Sometimes you can reduce the area by placing one component over another. Been there, done that. Always be thinking ahead and what if you place one part before another and is there some physical positioning that minimizes the area but doesn't compromise chances of RF coupling. Also, when routing wires from one point to another I prefer going parallel with the board edges and I don't mind going under components in the routing process. Just be careful of paths that are near RF circuits and may pick up stray signals and cause unwanted feedback. For critical RF and signal paths over long distances I will use 50 ohm teflon coax for interconnections from point to point. Also remember that if one section needs to be isolated electrically from another, then a small piece of PC board material may be soldered at right angles to the ground plane between the sections. Even "rooms" with four walls can be constructed for VFO sections, etc. With a shear this becomes very easy to do. You can even cut "mouse-doors" on the bottom to route coax or other connections if you plan ahead. The term "mouse-doors" is a K7QO term in reference to the holes in the walls you typically see in cartoons for mice.

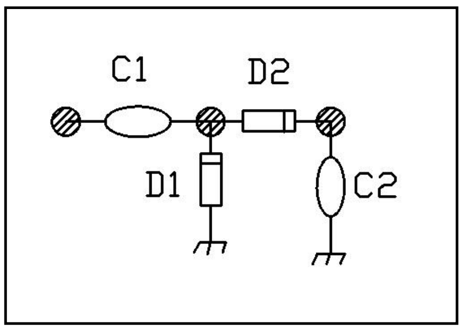
I make an extra copy of the circuit diagram just for building. As I solder parts I will mark the schematic with a yellow highlighter. This marks where I am in the building stages if I need to put the work away for a small time and it also serves as a check to make sure that I do not leave anything out. As you near completion you'll see that things can get crowded and it is easy to miss something.

On the schematic there are many connections that are ground points and are indicated by the ground symbol - the rake looking symbol in most books and diagrams. You just solder that lead directly to the printed circuit board for these. Sometimes in a diagram you'll see a number of leads tied together and then to ground. Don't do that. Just solder each lead individually to the ground plane and in most cases they do not have to be that close together. One significant advantage that Manhattan-style construction has over other techniques is that the problem of ground loops is reduced due to very low inductance of the large ground plane of the base board.

RF Probe



RF probe schematic



RF probe Manhattan-style layout

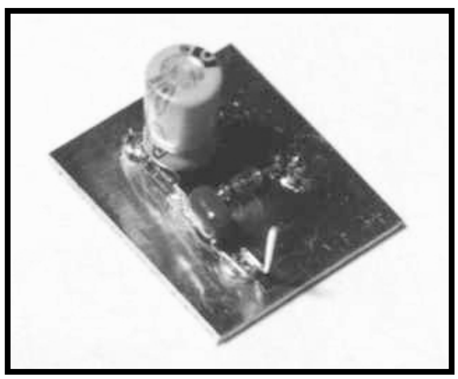


Photo of completed RF probe

In this section we will build a simple circuit to gain experience before taking on more ambitious projects.

The first thing to build is an RF probe. The circuit I recommend is shown here, along with it converted to physical Manhattan-style layout and a photo of the completed assembly.

I won't go into the nitty-gritty details here, but you need three pads and just a small segment of printed circuit board. Because the leads were short I mounted the diodes horizontally. D1 is between two pads and D2 is soldered to the center pad and the other lead soldered to the ground plane.You can with longer leads mount the diodes in a vertical position. The probe will work the same with either configuration. Build two and check it out if you want. I'll wait.

I have a Ballantine RF probe that I purchased for $10 at a Livermore Swapmeet on a trip to CA when I was working. I happened to be in the San Jose area the weekend of the Livermore meet and the NorCal meeting. This probe came sealed in an aluminum pouch with all kinds of military part numbers, etc. Probably cost the tax payers a few hundred dollars. I compared my readings with the RF probe built Manhattan-style and the Ballantine probe and got the same results to over 40MHz. The one shown in the photo probably cost me about a quarter. The commercial probe is nice, but not everyone can find such a great deal. Besides, in the building of homebrew gear you can take extra pride in using something that you personally built and can repair.

Speaking of repair, you will be repairing this probe if you attempt to measure RF levels of several volts or more because the current levels through the diodes will exceed their limits and destroy them. Use this probe only for small signal level tracing. I tested the probe with an HP constant voltage generator from 100 kHz to 100 MHz and from about 1 MHz to 50 MHz the probes work well. The upper and lower frequency limits have some known issues that I don't have room here to cover.

Now since I am writing this article without knowing just how much your budget allows for test equipment and how much you already own and use I will assume that the audience is just starting out. You will need a general coverage receiver or a frequency counter later on.

Okay, let's now build a crystal checker. For this we will need a few more parts than before. You will need 39K and 1K 1/4W resistors. Capacitor values of 680 pF, 150 pF and 56 pF in disk or mono and two 0.001 uF caps and two diodes 1N4148 or 1N914 silicon or 1N270 in germanium. You will also need a 9V battery connector and a NPN transistor like the 2N2222 plastic transistor, meaning that the case is plastic. I use two pins from a machined Augut socket for connecting pins to hold the crystal under test. Here is the circuit diagram and the photo on my final wired circuit. Note just how small the circuit is doing the Manhattan-style construction vs. the printed circuit board. Note that I use two pin leads for the connecting points for the DVM and the frequency counter.

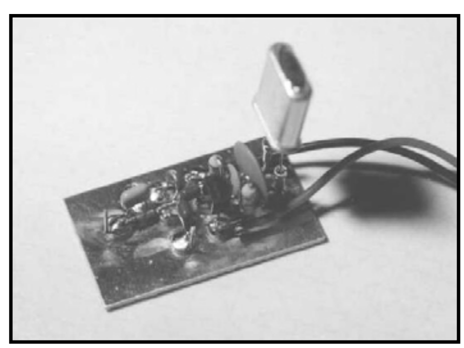
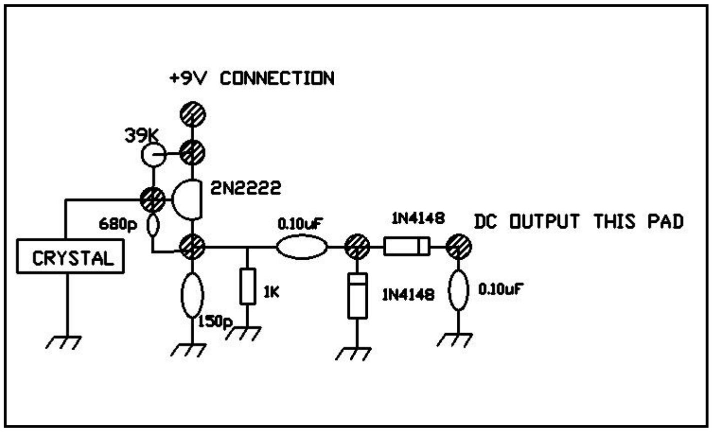
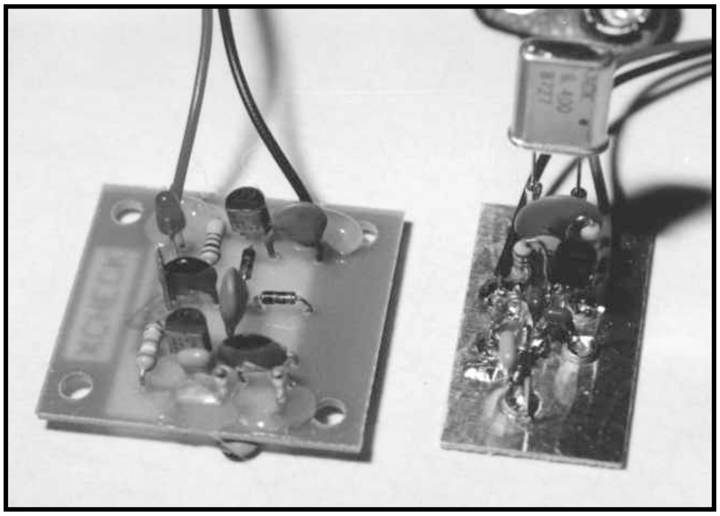


Photo of Crystal Checker



Crystal Checker Manhattan-style layout



G3RV crystal checker (left) vs Manhattan-style

This crystal tester is your basic Colpitts Oscillator with a voltage doubler. The output voltage from the voltage doubler can be used to get an idea of the crystal activity, i.e. just how well it resonants, with an increased voltage meaning high activity. I use this circuit with a frequency counter to match crystals for IF filters. It works well and it is very cheap to build.

I use this critter quite frequently for testing unmarked crystals and crystals in kits to match them more closely. You will find it quite handy. You don't have to make yours look just like this, but mine came out so small I have to take care in putting it up somewhere so that it doesn't get lost in the clutter on the workbench. Here is a photo of a similar crystal checker from the G-QRP club kit and the HB Manhattan style crystal checker. You can see how much less room a circuit will occupy with this technique.

Final Housing for Projects

In this section I will talk about how I install final projects into homebrew cases.

There are many ways in which to house a final project if you so chose. I will not even attempt to start describing all of the ways, but choose to discuss the making of aluminum shells similar to those manufactured by Ten-Tec and others. Using printed circuit board material to make enclosures works and it is a good way to go also.

What I do is make two U-shaped shells from 0.040" aluminum sheet material. I make a paper pattern for each half of the enclosure and tape them to the aluminum sheet. Using the shear I then cut the two rectangular pieces to size, usually from a single sheet of aluminum, and use a file to smooth all the edges.

Then taking the brake portion of the Harbor Freight combo, I very carefully make 90-degree bends along the lines that I have drawn on the plan and then make sure that the two pieces match. So far I have been lucky and haven't made any mistake that would force me to redo one of the halves. If you do, save the "bad" one for use later in another project and you only have to make the matching half.

Once you have the two halves you need to make an L-shaped piece to hold the two halves together. I use brass stock that I buy at the hobby shop. I cut and bend using the shear and brake to make a small L-shaped piece. You can then use a tap to make threads for the size screws that will hold this piece to the bottom half of the case and the screw that will hold the top half in place and also allow you to remove it for whatever reason. Mouser sells these pre-made and threaded as part number 534-621. See their catalog online for details and pricing.

Next, drill the holes in front and back of the case for the connectors and controls after carefully measuring and marking for each. You could do this before you bend the aluminum and be able to use a drill press to do careful work. Carefully sand both halves and clean with any cleaner you choose in order to eliminate fingerprints, dirt and grime from the surface. I personally choose not to prime the surface. I have been using some paint from Wal-Mart that costs $0.98 for the regular and $1.49 or so for the satin finish. The brand name on the paint is ColorPlace and it is an indoor/outdoor paint. I like the results of the satin finish in the royal blue color. The TT2/MRX transmitter-receiver combo that I won first place at Pacificon with was painted with only one coat of the paint. Otherwise, I'd have been drying the paint on the trip! I was that close to the deadline on the project.

I use press-on lettering from the hobby shop to label the controls. If you put a clear coat of Krylon or other paint be warned that the paint will most likely attack the lettering and cause it to wrinkle. Go gently and get advice from others on just how to do this. I am still experimenting on this one. If you do not place a clear coat over the lettering the lettering will eventually wear off the case. The coating of clear is to protect the letters.

The photograph of the combination Tuna Tin 2 Transmitter + MRX-40 Receiver is shown at the top of this article. Note that I have yet to do the bracket as it hasn't been together long enough and I use it for show and tell a lot. Also note that the circuit board is just attached to the lower half-shell with contact cement. I use Design Master Tack 1000 Spray Adhesive that I bought at Ben Franklin Crafts Store for $4.99. It will hold down the board and it is not permanent – that is, I can peel the board up with no damage. I haven't tried it but I followed the instructions on the can. You may choose to use screws or standoffs to mount the board to the case. By directly attaching the board to the base I lower the overall height of the case and reduce the size of the final assembly.

Future Paths Possible

Now, with the basics covered as best I could with resource limits of time and space, I hope that I have given you some insight on building using this technique called Manhattan-style construction. You can build any number of projects using the technique of your choice. It is not the intent here to put Manhattan-style building above any of the others. We each enjoy using what we think suits us best and that is the whole game plan.

I would like to see you research through the ARRL Handbook, your library and your collection of designs, schematics and projects in progress to find some simple things to build. I would recommend you go through the test equipment sections of the Handbook and Wes Hayward's "Solid State Design for the Radio Amateur". You now have the ability to build anything that you want. Bring all your stuff to the gatherings of other QRPers. It will motivate them to do more and we all want to see your work. It is the only way for each of us to learn new things.

My own future plan is to take the NN1G Mark II rig and redo it for 17 Meters. I will build it and then in an upcoming issue write a complete article on everything that I did and why I did it. I have permission from Dave Benson, K1SWL, to use the schematics. I have taken the VFO section and replaced it with the new one from Dave's SWL series because the old one used an air variable which takes up too much room and is now difficult to find and more expensive than the varactor-tuned VFO.

So until the next time we meet may all your projects work the first time and every time.

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Bob Logan, NZ5A

A Kinda, Sorta Inverted L Antenna

Here is an antenna that tunes all HF bands quite nicely, including the new 60 Meter band. Its performance not only consistently equals that of my old 80-Meter and 40-Meter inverted vees at 35 feet, but much of the time it outperforms them! The simple antenna also exhibits some gain on all bands above 40 Meters, and a low angle of radiation helps on long-haul QSOs as well.

Here is an antenna that tunes all HF bands quite nicely, including the new 60 Meter band. Its performance not only consistently equals that of my old 80-Meter and 40-Meter inverted vees at 35 feet, but much of the time it outperforms them! The simple antenna also exhibits some gain on all bands above 40 Meters, and a low angle of radiation helps on long-haul QSOs as well.

I needed a separate antenna to catch multipliers on a second band for contesting. It had to be tunable over all the HF bands and have some vertical polarization to it. It needed to be elevated because that reduces ground loss and because I hate to dig in radials. A back yard sprinkler system makes it risky to poke holes in the ground with a sharp shovel, no matter how shallow the poke. During the course of several contests and weeks of general operating, it became evident that the elevated Kinda, Sorta Inverted L regularly outperformed my inverted vees.

So then I started doing comparisons on a regular basis, and the evidence clearly favored the elevated L. This was true whether the inverted vees were fed with coax or ladder line. I used both in comparisons with the Kinda, Sorta Inverted L. Since putting it up, I rarely use the 80- and 40-Meter inverted vees and have abandoned plans to put up other inverted vees for 20 through 10 Meters.

The Radiating Element

Basically, this is a slightly elevated 80M inverted L in an end-fed inverted vee configuration with radials of dissimilar lengths raised six feet above the ground. The "L" is a *continuous* wire 65 feet, 3 inches long with a 90-degree angle at the midpoint. In my first installation, I formed an equal angle at the apex of the 35-foot mast with the two halves of the radiating element. After operating the "L" for several weeks, I then moved the end of the wire nearest the feedline so that it formed a sharper angle relative to the mast than the other end of the wire. No difference in performance was noted. So if your tie-off points are at different heights, go ahead and use them. Avoid a sharp angle with the end-fed leg, however, because it will skew the pattern in favor of the other leg, do strange things to the impedance and cause a "shadow" in the direction of the end-fed leg. Also, be sure to keep both sides of the "L" equal in length, since that is key to maintaining proper voltage/current relationships on the various bands.

Arriving at the length of the radiating element was simple. Any multi-band wire antenna performs best if its length is no less than a quarter wavelength (vertical) or half wavelength (dipole) long at the lowest operating frequency. The only time I operate 160 Meters is the December and January contests. To fit most of my actual operating needs, I designed the radiating element length for the lower end of 80 Meters. I can still work out 1,000 miles or so with it on 160 Meters with 100 watts, but it is not designed for that band. It can be scaled for 160 Meters, but the elevated height at that frequency is so slight a fraction of a wavelength that I suspect the ground loss would be unacceptable for QRO work

The Radial System

The radials are 55 and 67 feet long. The dissimilar lengths are critical to wide bandwidth on 80 Meters. The radials run along the side of a fence at 90 degrees to each other and at heights varying from four to six feet. The 67-foot radial runs directly under the radiating wire of the antenna. The feedpoint of one end of the "L" is six feet above the ground, and the lower end goes to a fence and is tied off at the same height. Recall, however, that unequal angles of the two halves of the continuous wire due to tie-off points of different heights do not seem to affect performance of the antenna.

The length of the radials was determined by experiment. I first fed the antenna with coax and cut the radials equal in length using the regular formula. The 2:1 bandwidth was about 60 kHz. I knew the radial "system" on an elevated L can actually tune the antenna so I lengthened both radials two feet at a time. The resonant frequency of the antenna dropped about 20 kHz and the bandwidth increased to 70 kHz. Just for grins, I decided to see what would happen if I cut one radial shorter than the other. Maybe it would "tune" the antenna more broadly on the same principle of putting up parallel dipoles cut for 75 and 80 Meters on the same feedline. The resonant frequency increased a little, but the bandwidth change was dramatic. Suddenly, I had almost 200 kHz of 2:1 bandwidth.

After much experimentation, I found that one radial cut for about 3.230 MHz and one for about 4.530 MHz gave the greatest bandwidth. Those frequencies were measured with an antenna analyzer, not by calculation and a formula. They may not be optimum for other locations, heights above ground, or different ground effects, however.

The Feedline

The antenna is fed with 25 feet of 450-ohm ladder line. I replaced the coax with ladder line so the feedline loss would essentially be negligible between the antenna tuner and the antenna. Remember that an antenna tuner at the rig doesn't tune the antenna; it only matches the impedance of the source (transceiver) to the feedline. It does not change the impedance existing at the junction of the feedline and radiating element. In a non-resonant antenna, the SWR at that point can be rather high, and even a good coax feedline can be extremely lossy because of it, especially with a non-resonant multi-band antenna. The charts routinely published in handbooks that show dB loss per megahertz for 100' of coax line are for perfectly matched loads at the other end of the feedline.

The length of ladder line feedline seems to be critical only to the extent that it causes slightly different antenna tuner settings. There is no difference in performance. The longest length I tried was 50 feet versus the 25 feet I settled on. I also reduced the feedline to 19 feet with no degradation in performance.

I have not tried using 300 ohm twin lead and do not intend to do so. To me, using twin lead instead of ladder line is like using RG-58 instead of RG-213. What's the point in a fixed installation like mine? In extreme portable operations such as backpacking in the wilderness, the tradeoff in size and weight for twin lead may be worth it. But I never use it, even in my biennial trips to the Tetons and Yellowstone where I operate portable from a tent or off the back of the truck beside a stream.

The Tuner

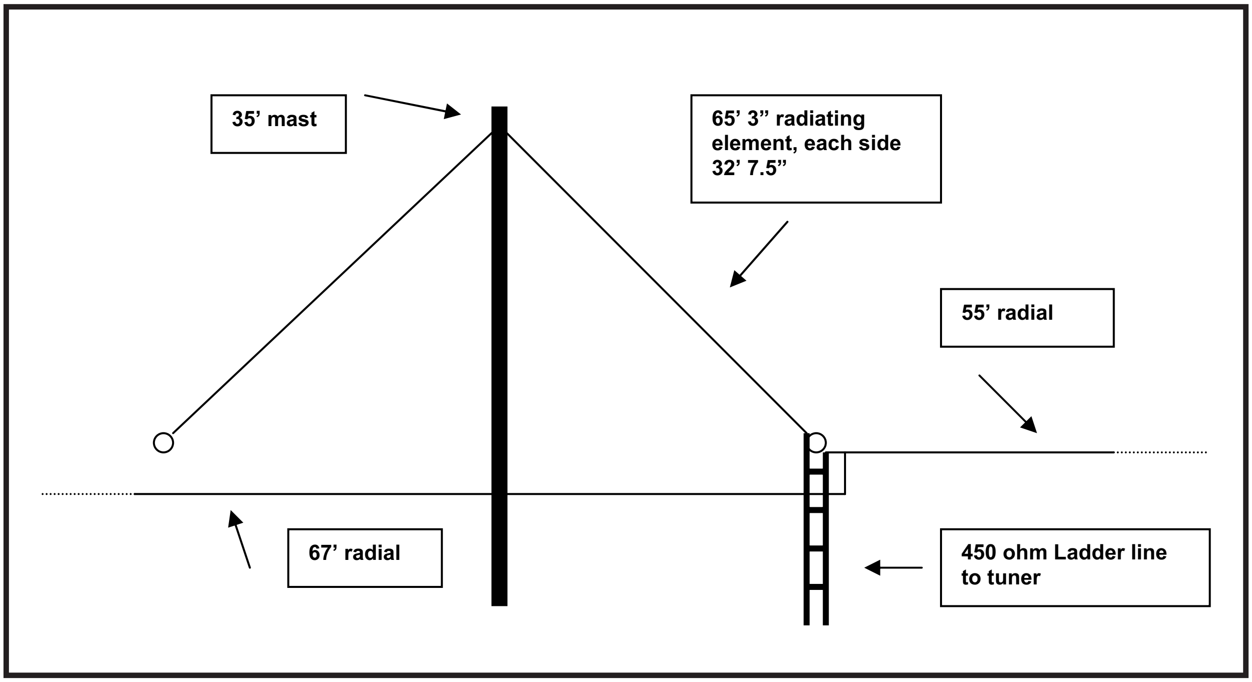
The ladder line is fed to the tuner through a built-in 1:1 balun. The tuners I use are an MFJ Model 949E and an MFJ Model 945C. Any standard T-match antenna tuner should tune the system quite smoothly to a 50 ohm match on all bands. I have not tried it with a Z-match tuner, however.

The Mast

The mast is 32 feet of Radio Shack TV mast topped off with a 3-foot Tee of PVC, Schedule 40, to isolate the feed point from the metal. That is essential since the point of the radiating element at the apex of the mast could be a voltage or current maximum, depending on the band being operated. Separating the apex point of the element from a metal mast by only a few inches, which typically occurs in simple "hang from a hook" installations may, and probably will, cause the mast to re-radiate signal on frequencies on low-impedance voltage maxima. I found from experimentation with wire antennas in general that isolating the feed point from the mast at a distance about 10 percent of the length of the supporting mast is sufficient at HF.

How It Goes Together

A diagram of the Kinda Inverted L is below.



The Theory, or My Best Guess Without Antenna Modeling Software

Without modeling software at my disposal, I can only use antenna theory to attempt to explain why this one performs so well. It seems to be a normal inverted L on 80 and 60 Meters, although the two slanting halves of it might function more effectively than the single vertical portion of a normal inverted L. On 40M, it functions as a normal half wave antenna with the current maximum at the top of the mast. On 30M, it begins to appear as a long dipole and on 20M, it definitely becomes a collinear two half-wave antenna, with current maxima adding near the apex of the antenna. On all frequencies above 18 MHz, the antenna also performs very well, which surprises me. Theory tells us that an antenna with vertical polarization (which is a characteristic of a slanted wire) that is longer than ¾ wavelength tends to radiate most of its energy straight up rather than at some lower takeoff angle. On these bands, I think the Kinda, Sorta Inverted L functions as a long wire with resultant gain depending on its length-to-frequency relationship, but also with some "flattening" of the high-angle radiation due to the horizontal polarization component.

The various antenna modeling software packages available now could be used to profile this antenna. Modeling software, for example, could identify impedances on the various bands so maybe you could develop a set of fixed tuners and switch them in-line automatically for the band in use. It could show E and H radiation patterns on the various bands so you could see any high-angle radiation patterns and perhaps model radiating element lengths to reduce them on the higher bands. Finally, it could analyze various scenarios of different radial lengths to see whether the lengths specified here are, in fact, optimums, or whether radials cut for each individual band would improve theoretical performance.

Performance

Why did I concentrate so much on optimizing a multi-band antenna for a single band? My thinking, perhaps faulty, was that if a multi-band antenna works best if designed for the lowest operating frequency, then it would be most efficient on multiple bands if it is also most efficient on the lowest band. I am addicted to symmetrical thinking, whether true or not.

Whatever the case, as proof of performance, using 5 watts with a battery and a solar cell in the 2003 Field Day exercise, I made 340 CW contacts on 80 through 15 Meters with stations in 65 of 80 ARRL sections, 43 states, 5 VE provinces, and 2 DX countries. On 30 Meters, using the same power, I have very little trouble working whatever DX happens to be on. In a week of operation on the new 60-meter band, using the maximum authorized output of 50 watts USB, I worked six states, including the West Coast (California) and East Coast (Massachusetts) from central Texas. In a word, the Kinda, Sorta Inverted L seems to be a very effective multi-band antenna that can be put up with minimal effort and cost.

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John Farnsworth, KW2N

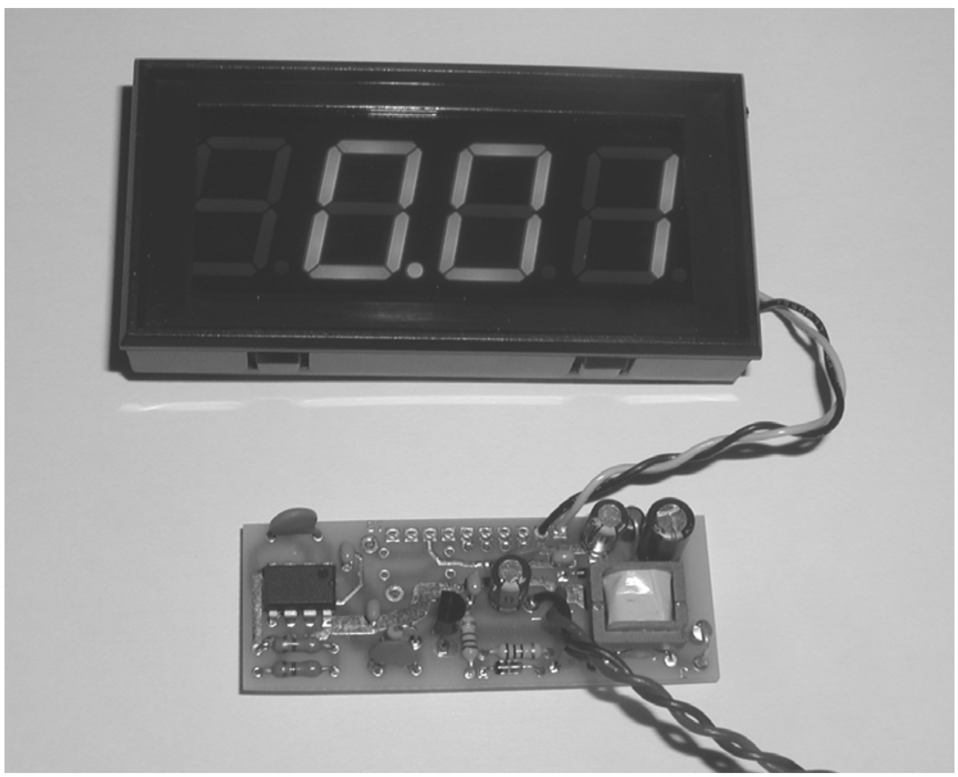
Power Isolator for a Digital Panel Meter

Ever been tempted to buy one of those digital panel meters (DPM) advertised for around $10-$15? They look inviting: 3-1/2 digit readout, about 1% accuracy, and they could give that professional look to your next project. You can use them to display voltage, current, or other parameters with appropriate shunts or dividers. They are available from Marlin P. Jones, All Electronics and others. But there's a catch.

Panel Meter Overview

Most of them use the same IC – a dual-slope integrator design that has been around quite a while. If you look at the back of the meter, it's under that black blob on the pcb. The die is mounted directly to the board, with bond wires to the traces, then it is covered with something that keeps oxygen and other contaminants out. This process is called COB, or chip-on-board. While dual slope integration is not fast, about 2-3 conversions per second, it is actually quite accurate. It will measure both positive and negative voltages, and has a basic resolution of 200 mV. Some of them have places for a pair of resistors that make a divider and turn it into a 2V or 20V or even 200V readout. Others require you to provide your resistors. Check the documentation that comes with the unit. So what's the catch?

The catch is that they require an isolated power source. In other words, the ground for the voltage being measured must be isolated from the ground of the power supply that is running it. This can either be a minor inconvenience or a major project stopper. Many applications solve this problem by using a 9 volt battery, which can have its negative terminal floating from the rest of the circuit. For the units that have LCD displays, this is a workable solution since they draw about 1mA, and battery life is acceptable. That is, IF you remember to turn it off every time when you are done using it. This also requires a DPST power switch, one pole for the 9V battery and the other for the rest of the circuitry. On the other hand, if you are using one of the LED versions, which are much more readable, 9 volt batteries are out. These versions draw 50 mA or more, and the bigger the display, the more power it draws. So what is needed is a power isolator, something that can take the voltage available in your project and galvanically isolate it. This little circuit does just that.


Completed power isolator pcb driving a digital panel meter

Basic Circuit Description

Figure 1 shows the basic circuit. It is a simple flyback power supply that works by loading up an inductor with energy during transistor Q1 on time, then transferring it to the output when Q1 turns off. Although the circuit looks similar to other power supplies like the forward converter, its operation is quite different in that there is no transfer of energy from the primary to the secondary during the Q1 on time. Flyback converters have found favor in very-low to low power applications because they can have multiple regulated outputs and do not require output inductors on each channel. This is especially attractive in high voltage power supplies where voltage breakdown in the output inductor can be a problem. When designing this circuit, the main objective is to keep the magnetics as simple as possible. I think you'll see that goal has been achieved.

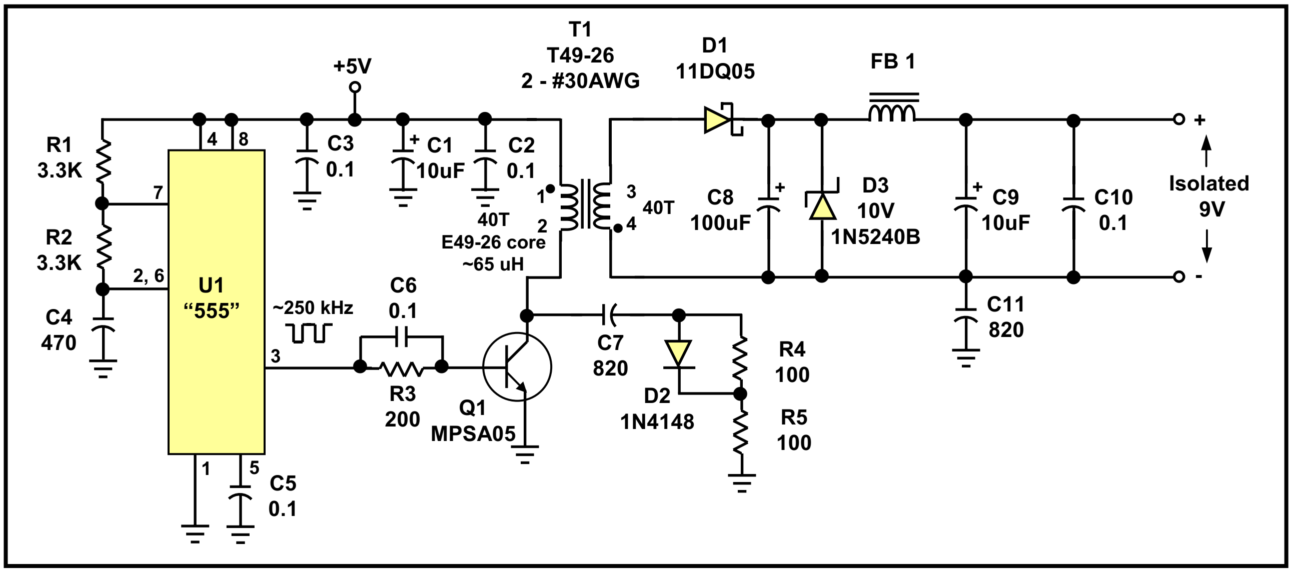


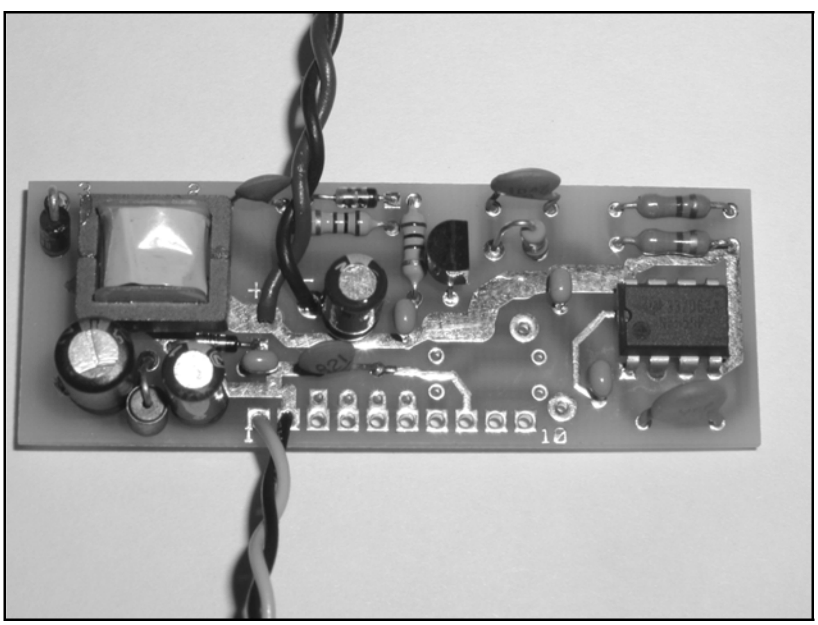
Figure 1: Schematic of the author's Power Isolator

One thing this circuit is NOT, and that is QRP. If you need low power, use the LCD version of the panel meter and a 9 volt battery. Built for bench use, this circuit requires almost 200mA in order to deliver 60mA to the load. This is because the flyback topology must load up the inductor with all the energy for the worst case, since there is no feedback to roll back the duty cycle under light load.

A 555 timer IC provides the basic drive to Q1. Modern versions of the 555 have good speed and great drive current. Do not substitute a CMOS version for U1, as they don't have the output current required to switch Q1 on and off quickly. This design is unregulated, since regulation would require feedback across the isolation boundary. An optocoupler would normally be used for this, making the circuit considerably more complex. This lack of regulation is acceptable because the DPM is quite tolerant of voltage fluctuations. Most are rated to work from about 7 volts to 11 volts. As long as it is powered by a regulated 5 volt supply, the output will stay in this range easily. The circuit is designed to run off 5V since it is available in most projects. If you have another voltage available, you can change the duty cycle to accommodate it. More about this later.

The 555 drives an NPN bipolar transistor, an MPSA05. This was chosen instead of a FET merely for cost considerations. You can buy a small quantity of a bipolar transistor for about 10 cents each. The day of the 10 cent FET is yet to come. Bipolars switch fastest when you turn them off by pulling base current out of the device during turnoff. This is achieved by the R3/C6 combination. During the ON time, the base current flowing through R3 causes a drop that charges C6. At the end of this time, the 555 output goes to ground and the cap places a negative voltage on the base, pulling stored charge out and turning it off quickly. The circuit switches at about 200-250kHz, which is not critical, but I found it a good tradeoff between inductor size and switching losses. If you feel inclined to substitute another device for Q1, do so with caution. The inductor current, and thus the collector current, ramps up to 250-300 mA, so pick something with good gain at this current level. 2N3904's are out, and the 2N2222 variants are marginal. Since the MPSA05 is available for 10 cents in single quantity (from Mouser), the most likely reason to substitute something else is not cost, but the "junk box factor". If you have a favorite transistor, try it. But if it gets hot, it is probably pulling out of saturation; don't use it.

What has been called an inductor above is really two coupled inductors, which looks schematically like a transformer. I guess it is, of sorts, but since primary and secondary current flow at different times, it does not fit the category of a normal transformer. It does have some of the traits of a transformer, like leakage inductance from primary to secondary, which can cause voltage spikes during switching transitions. When Q1 turns OFF, the current that has built up in the primary cannot cease flowing instantly. This is the characteristic of an inductor. In an attempt to keep the current flowing, the polarity across the primary reverses, driving the non-dot end positive, forward biasing D1 and causing energy to flow out the output winding, recharging the output capacitors and supplying current to the load. But because coupling between the primary and secondary is not perfect, the leakage inductance prevents current from flowing immediately in the output. Once it is flowing, the primary voltage is clamped by the output winding through transformer action, holding the collector voltage of Q1 to a safe value. Until the current can get flowing in the secondary, the primary voltage is free to "fly up" to whatever value is required to keep the primary current flowing. This can destroy Q1 if not limited. This is the purpose of C7, D2, R4 and R5. As the voltage rises, D2 conducts, hanging C7 on the collector to ground. This slows the rise of voltage, since it has to charge C7, and limits it to a safe value. The next time Q1 turns on, C7 is discharged, with the current limited by R5.



The author's pc board holds all the components. (Contact the author for pcb availability.)

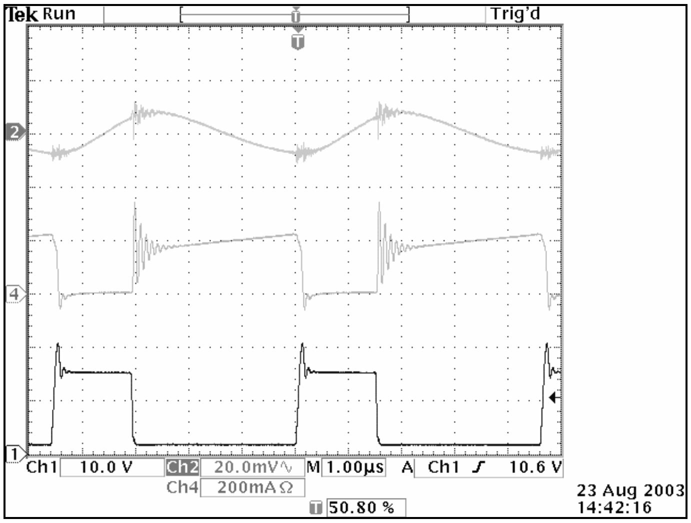


Figure 2: Circuit waveforms

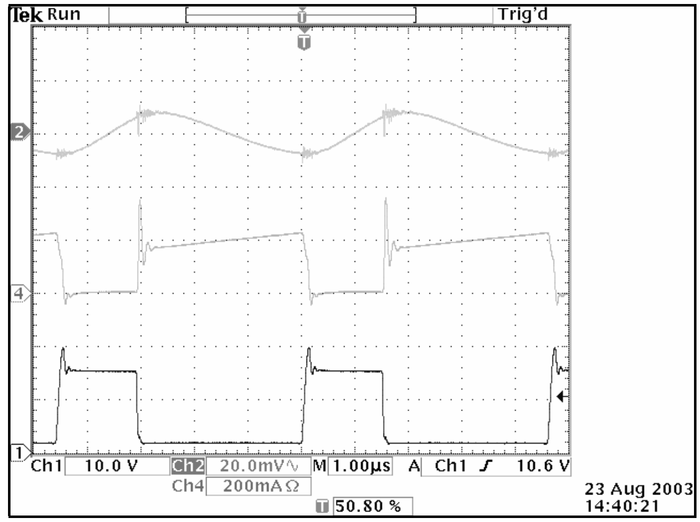


Figure 3: A "snubber" can dampen the oscillations

Over on the secondary side, the circuit looks familiar. It is your standard rectifier/filter cap setup, with a second spike minimizer using ferrite bead FB1 and final output caps C9 and C10. Zener diode D3 should not be omitted. It clamps the output to 10 volts if there is no output load. Without this clamp, the output could rise to a level that would damage the DPM connected to it if it is the LCD variety with very low current drain. This high voltage is caused by D1/C8 rectifying and peak detecting the narrow spike at the switching transitions.

The only other important thing to mention is C8. It should be a low ESR part, able to handle high ripple current. This is because in a flyback regulator, during the ON time, when the primary inductor is being loaded up with energy, all output current is provided by this cap. It must therefore have a low series impedance to hold output ripple voltage to an acceptable level. The Panasonic FC series from Digikey is fine.

Figure 2 shows the circuit waveforms. Output voltage is on the top, the next trace is collector (primary) current, and the bottom is collector voltage. Notice the high frequency noise in the output trace during switching transitions. Although this level of noise is quite small, about 10 mV peak-to-peak, and causes the DPM no problem, purists may want to add two parts to clean it up. A "snubber" consisting of a 220 pF cap and 82 ohm resistor in series around the output diode D1 dampen this ringing and produce waveforms seen in textbooks; see figure 3. The addition of these components is left up to you. Experiment!

How to Build it

The simplicity of the circuit makes it a likely candidate for Manhattan construction. The IC can be plugged into a socket whose legs are flared out and soldered to pads. Alternatively, a pcb is available, as well as a kit of parts, which makes putting it together a snap. Choose the method that is best for you. Layout is not critical, just keep the leads short between T2, Q1, D1 and C8. These components carry the high frequency currents.

Winding the transformer

Various transformers were tried during the development of this supply. Hams are fond of toroids – maybe "fond" is the wrong word – but we all know they are hard to wind. I finally decided on an "E" core, since the bobbin can be wound with an electric drill in about 30 seconds. Take a #6 screw, about 1 inch long, put the bobbin on it and tighten (lightly) a nut down on it.

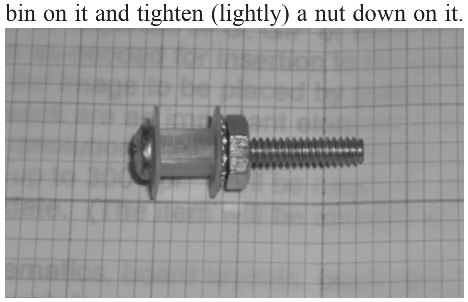


Figure 4: #6 screw used for winding the transformer

See figure 4.

Then chuck the screw in a variable speed drill clamped to the bench. Get some fine wire, 30AWG is good, and take two pieces and wind them onto the bobbin at the same time. This creates a "bifilar" winding. Small slots in the side of the bobbin made with a hobby knife allow you to bring out the wires.

Wind the bobbin full, the exact number of turns is not important. If you use a wire much bigger than 30AWG, you won't get as many turns, which will give a lower inductance, and the operating current will be a little higher. When the bobbin is full, wrap it with tape to hold the wire in place and bring out the ends. Tin all four ends, scraping off the enamel if necessary. Use an ohmmeter to determine which pair is which and mark one of the pairs with small pieces of tape so you can identify it later. The two ends you started with are "starts" and they are shown on the schematic with dots. The two ends that are at the outside of the coil are "finishes" and are the unmarked ends on the schematic with no dot shown. Slip the two core halves into the bobbin and hold them firmly together with a small clamp or a clothespin. Be careful not to crack the cores with excessive pressure; they are quite brittle. Place a drop of super glue on each joint. If you have a choice, use the thin glue that wicks into small cracks. Resist the temptation to put glue on the faces of the cores before mating them together. This can cause a small gap, which will lower the inductance dramatically.

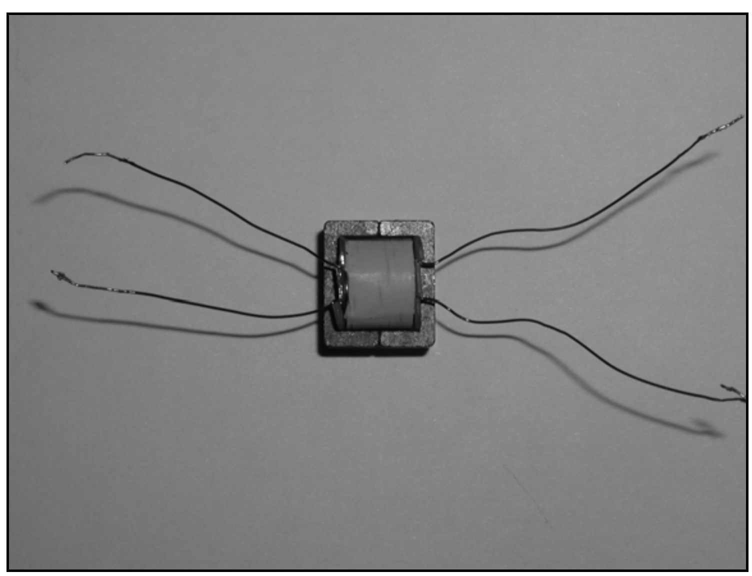


Figure 5: Completed transformer

When you connect up the transformer, make sure that starts and finishes match the schematic. It will not hurt anything if the polarity is wrong, but it also won't work!

Bringup and Test

The best way to turn it on for the first time is with a current limited power supply. That way if there are any wiring errors, it won't do anything spectacular. Carefully check all your wiring against the schematic before applying power. If you slowly bring up the supply, starting from 0 volts, the output voltage should rise slowly as well. If there is no output voltage, stop and find out why. You can check to see if the 555 is oscillating by looking at the output, pin 3, with a voltmeter. It should be about 2.3 volts. If it is either 0 volts or 5 volts, the 555 is not oscillating. Once it's up and running, measure the output voltage. It should be around 10 volts no load, and about 9 volts with a 50-60 mA load. That's it!

Circuit Improvements

There is plenty of room for circuit tweaks and improvements. One would be to replace the zener clamp in the secondary with a three terminal regulator, like a L7808. This would improve regulation and allow a larger input voltage range. Another is to change the duty cycle by changing R1 and R2, thus programming it for another input voltage, one you already have available in the circuit to which you are adding the DPM. If you make changes, I'd love to hear about it!

Conclusion

These digital panel meters are quite a bargain. You can take advantage of them and add functionality to your projects with one. The isolated power can be generated by a simple isolated supply using a 555 and a small handwound transformer. Kits of parts are available, and the supply can be used anywhere a source of unregulated, isolated voltage is required. The circuit values are non critical, and experimentation is encouraged.

The author has pc board available for those interested in constructing this project. You can contact him directly at 84 Halfmoon Way, Clyde, North Carolina 28721, or by e-mail at jfarnsworth@direcway.com.

Ron Stone, KA3J

Fishing Pole Vertical for Twenty Meters

Building this light weight, inexpensive antenna is a snap!

Having decided to tackle portable QRP operation, I began my search for a suitable antenna. I quickly discovered a wide range of excellent homebrew and commercial options. However, I couldn't quite find something that fully met all my needs. I expected to operate from a variety of settings including barren mountaintops, the beach and vacation houses, primarily on 14 MHz and higher frequencies. So, I needed an antenna that would be very flexible and could travel well. Specifically, I wanted a fully self-supporting antenna that would weigh no more than two pounds, fit into a small knapsack, cost less than $50, offer quick set-up without a tuner, and perform well. In addition, I wanted it to be as simple as possible to build.

Candidate antennas included the usual suspects — inverted vee, sloper, ground plane vertical, and a vertical with a tuned counterpoise. It seemed like a quarter-wave vertical would offer the lowest weight and fastest set-up, and these are commonly used for portable operation. However, several questions came to mind:

- How much performance would I give up with a vertical relative to my home station or other simple antennas?
- How much additional performance would I give up by using a shortened, center loaded vertical?
- Would a ground plane vertical with four radials work better or worse than a vertical with a single elevated counterpoise?
- How consistent would the performance and SWR be with various ground conditions?

It was time to do some modeling.

EZNEC Analysis

I found the free, fully featured demo version of EZNEC 3.0 to be a perfect way to begin modeling and analyzing fairly simple antennas. [1] The program is very easy to use and an excellent, very educational tutorial and manual are included.

Table 2 summarizes some of the key results using data extracted from the elevation plots for the various antennas. The last column is helpful for comparing the antennas' longer distance performance. My modeling efforts resulted in the following conclusions:

- A dipole up at least a half wavelength should generally outperform the ground mounted vertical by at least 1 S unit.
- Although a low dipole will radiate mostly at less useful higher take-off angles, it should still usually outperform the vertical.
- The vertical with an elevated counterpoise should perform slightly better (~ 2 dB) in the direction of the counterpoise relative to the ground plane vertical. However, there will be a fairly steep null behind the counterpoise and degradation on the sides.
- A shortened, 12-foot vertical should only perform about 1 dB worse than the full size vertical.
- Performance and SWR should be fairly consistent for all the antennas over most types of ground. However, over salt water, a vertical's performance improves significantly – about 5 dB.

Figure 1: Author, Beach House and Vertical

It looked like I could expect reasonable performance from a vertical. Now, it was time to build one.

The Design

My basic approach was to attach a quarter-wave wire to a self-supporting mast. The main challenge was to come up with a simple support structure. My low weight and easy construction goals pointed me toward using CPVC pipe and a telescoping fiberglass or graphite pole for the base and mast, respectively. CPVC (off-white color, similar to PCV) is very easy to work with. A variety of telescoping poles are available that could serve as the mast. The 14-foot Cabela's fishing pole listed in Table 1 seemed ideal because it weighs only six ounces and collapses to less than 16 inches. In addition, this pole is strong and fairly rigid and has a narrow profile to minimize wind loading. Its graphite composition gave me some pause, but tests have shown that this causes minimal loss (less than 1 dB) at HF frequencies.[2] I used ¾" CPVC pipe to create a solid base with a four-foot vertical section to support the fishing pole (see Figure 1). This provided an overall height of 18 feet – more than enough for a full size 20 Meter quarter-wave vertical.

Building the Support Structure

Now comes the really good part. The sup-

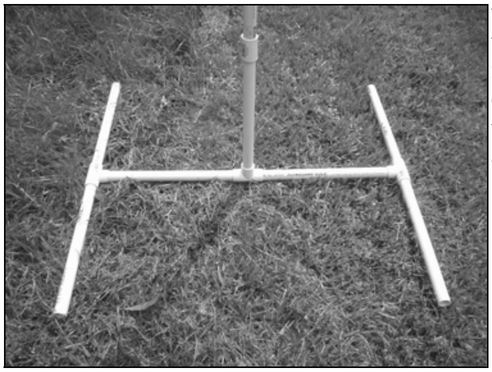


Figure 2: Antenna Base

port structure requires just a few parts and is a real breeze to build in just a few steps. No hardware is required.

- Remove the cap from the fishing pole, gently invert the pole and extend the top (thinnest) section that has the chrome tip. Thread a piece of fishing line or similar material through the small hole in the tip and tie a loop – about 1" in diameter. This loop will allow you to extend the pole after it is mounted in the base and it will support the end of the antenna wire.
- Cut the 10-foot CPVC pipe into ten one-foot sections.
- Referring to Figure 2, assemble the right, left and center sections of the base. For each, join two one-foot sections of the pipe using a T coupling. Note: Always press the pipe sections very firmly into the couplings. This will greatly enhance the stability of the base and the overall structure
- Assemble the base by connecting the three sections, keeping the open end of the center section T coupling facing upward.
- Connect the remaining four sections of pipe using three straight couplings. Mount this 4-foot section in the center T coupling of the base. This will support the fishing pole.
- Wrap several turns of ¾" (or wider) electrical tape around the base of the fishing pole. Wrap just enough tape to ensure a snug fit with the remaining straight coupling. Mount the pole with coupling on top of the 4 foot mast. Note: Do not remove the coupling from the fishing pole after it is firmly attached.

Assembling the Antenna

Basically, the antenna is built like a dipole. As shown at the right in Figure 3, I made a simple center insulator out of a roughly 1" square piece of perf-board. I tried various types of wire and the #20 stranded seemed to offer the best combination of low weight and resistance to tangling. I cut two 16.7-foot pieces of the wire, passed each stripped end through two holes at the outer edge of the perf-board, twisted each end back over the wire to form a loop and soldered. I then soldered a 15-foot section of RG174 to the wire loops as shown in Figure 3 and secured the coax to the perf-board with a wire tie. The short length of thin RG174 has minimal loss at 14 MHz (less than 1 dB) and can be snaked though small gaps in door or window frames. During my tests, I coupled a 20-foot piece of lower loss RG58 to the RG174 using an RCA jack and plug. The antenna can be attached to the mast as follows:

- Pull on the fishing line loop to extend the top section of the fishing pole.
- Solder a 1¼" alligator clip to the wire that is attached to the center conductor of the coax and clip it to the fishing line loop.
- Pull out each successive section of the fishing pole very firmly to lock it in place. Using a Velcro wire wrap, secure the wire to the pole about every three feet or so. Make sure the wire runs straight down one side of the pole (i.e., avoid twisting the wire around the pole.)

Tuning

I first set-up the vertical with a single elevated counterpoise. The antenna feedpoint and the far end of the counterpoise were both about two feet above ground. At first, I secured the end of the counterpoise to a bush or tree. Later, I built a scaled down version of the support structure using ½" CPVC with a mast height of 3 feet. For travelling, the one foot tubes of ½" CPVC slide inside the larger ¾" tubes. To tune, I trimmed the counterpoise until I achieved a 1.2:1 SWR. For the ground plane version, I attached three more radials to the center insulator using alligator clips (see Figure 3) and spaced them 90 degrees apart. The radials were then trimmed to achieve a reasonable 1.5:1 SWR. I later obtained an even better SWR by shortening the vertical wire by about 5 inches.

Alternate Center Loaded Design

I also built a somewhat shorter, center loaded version to reduce weight and improve sturdiness. This version eliminates the top three feet of the CPVC mast section and the top two feet of the fishing pole (i.e., the top two sections remain collapsed.) The vertical wire that is soldered to the center conductor of the coax was cut to 5.5 feet and terminated with an alligator clip. A 5.5-foot upper section of wire with alligator clips on both ends was prepared. A small coil was placed in between the two sections of wire as shown in Figure 4. The coil was built on a 1 ¾" length of the ¾" CPVC as shown in Figure 5. A straight coupling also could be used as the coil form and should result in a few less turns of wire due to its somewhat larger diameter.

Figure 3: Center Insulator

Figure 4: Loading Coil on Pole

The coil can be built as follows:

- Drill a 1/8" hole straight through the coil form about ¼" in from both ends.
- Place the end of a 5.5-foot length of 20 gauge wire through the holes on one end of the coil form, bend the wire sharply at a 90-degree angle, allowing about 4" of wire to extend beyond the end of the coil form.
- Tightly wind 16 turns of wire around the coil form; place the other end of the wire through the remaining two holes, again bend the wire sharply and extend it about 4" beyond the end of the coil form.
- Strip about ½" of insulation from each end of the coil and bend it in a semi-loop to facilitate attaching it to the alligator clips at the ends of the 5.5-foot wire sections.

Assembly is similar to that for the full size vertical:

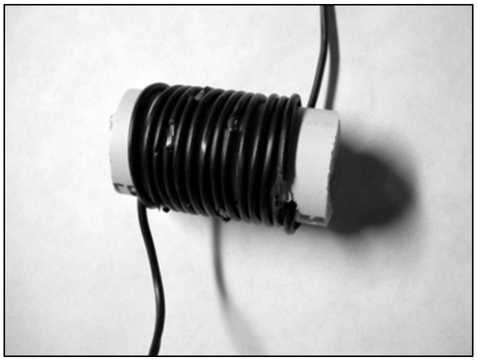


Figure 5: Loading Coil

- Place the fishing pole on top of the 1-foot CPVC mast.
- Extend the top four sections of the fishing pole and then collapse the upper two so that the fishing line loop is accessible.
- Slide the coil over the end of the fishing pole and let it drop to the bottom.
- Attach the 5.5-foot upper wire section to the fishing line loop and begin raising the sections of the fishing pole. Secure the wire to the fishing pole using the Velcro wire wraps as described earlier.
- When the lower end of the upper wire section is up about six feet, attach the coil to it. Then attach the end of the 5.5-foot lower wire section to the bottom of the coil.
- Continue raising the fishing pole until it is fully extended, securing the wire to the pole with the Velcro wire wraps.

The antenna now has to be tuned. Check the SWR at the lower and upper portions of 20 Meters. You should find the SWR to be lowest at the lower frequencies indicating that the antenna is somewhat long. Then remove a turn or two from the coil until a good SWR is achieved. My coil ended up being 14 turns.

I also experimented using a lighter base made of ½” CPVC but found that it wasn’t nearly as sturdy. The total weight of the full size vertical using ¾” CPVC is 2.5 pounds and the shorter version is 2 pounds.

The Beach Vacation

It was time to see how the vertical would actually perform. Every year, my family spends a week at Chincoteague, Virginia. Chincoteague is a quaint little fishing town known for its annual pony roundup and is adjacent to a lovely beach in Assateague National Park. It was very windy at the beach so I did all my operating from the house, a few miles away. I used a Wilderness Sierra transceiver running less than two watts on batteries. Unfortunately, I left the loading coil at home so I only used the full size vertical. Propagation conditions on 20 Meters were at best, fair. During the four days that I operated, the solar flux and A indices ranged from 120-137 and 14-43, respectively.

Given that this was a family vacation, I really didn’t have that much time to operate. So, being able to set up and establish QSOs quickly was critical. The antenna was a breeze to set up and the coax slid under the edge of the screen door of the porch that served as my shack. The SWR was the same as at home even though the soil was much sandier. Generally, it only took me 10-15 minutes to initiate a QSO.

Was portable operation fun? You bet! I really didn’t find it much different from operating QRP at home. I was able to have a series of solid, enjoyable QSOs, including some DX. The antenna only blew over once during a QSO on the windiest day. I quickly reconnected the CPVC sections, to ensure they were really tight. I then completed the QSO while the wind continued.

Performance Comparisons

At home, I set up the vertical behind the shack and connected it and my longwire to an antenna switch. I experimented with three versions of the vertical: full size with 4 radials; full size with elevated counterpoise, and the shortened center loaded version with 4 radials. I again used the Sierra running at just under two watts for all tests. The longwire is an inverted L with a 60-foot height and a 35-foot horizontal section tuned with a MFJ 901B tuner. It performs at least as well as my dipoles that are at about the same height. As shown in Table 3, the vertical generally did not perform as well as the longwire. However, about half of the time, there was little, if any, difference. The vertical performed best when working other verticals or over longer distances.

During contests, I found that my QSO rate was about 25%-40% less than what I typically achieve with the longwire. The three versions of the vertical seemed to perform similarly. As a result, I’m inclined to use the shorter, center-loaded vertical for future portable activity due to its weight advantage and enhanced stability.

Conclusions

The fishing pole vertical met my design goals and its performance was consistent with the EZNEC analysis. I hope you will enjoy its simple construction and decent performance. It should be easy to adopt the antenna for other bands by changing the coil, and wire and radial lengths. I encourage you to experiment with it and give portable operation a try!

The author may be reached at 4 Park Overlook Court, Bethesda, Maryland 20817, or by email at rsstone@juno.com

NOTES:

[1] EZNEC is available from Roy Lewallen, W7EL, www.eznec.com

[2] http://groups.yahoo.com/group/hfpack/message/18183

Part	Quantity	Cost	Source
14' Panfish Graphite Fishing Pole	1	24.99	Cabela’s (ID-11-5800) www.cabelas.com
10' ¾" CPVC Pipe	1	4.43	Most Hardware Stores
¾" CPVC Coupling	4	.72	Most Hardware Stores
¾" CPVC Tee	3	.99	Most Hardware Stores
75' #20 stranded copper wire	1	4.69	Radio Shack (278-1219)
1¼" Alligator clips	12	2.99	Radio Shack (270-0380)
Multicolor Wire Wraps (velcro)	5	2.99	Radio Shack (278-1676)
TOTAL COST		**$41.80**	
Miscellaneous (coax, coax connector, piece of perf-board, string or fishing line, electrical tape)			

Table 1 – Materials for Antenna

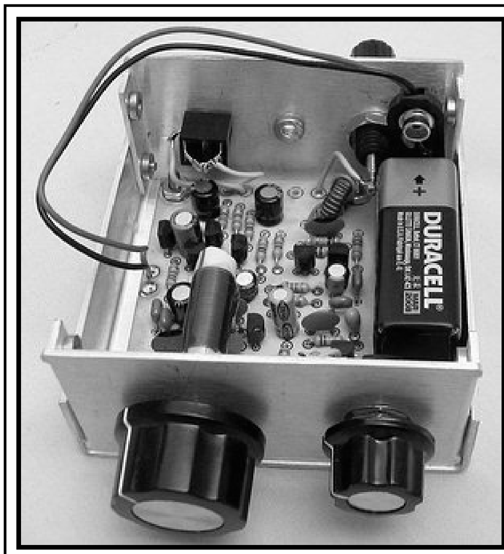
	# QSOs
Longwire Significantly Better (1 S Unit or More)	11 (55%)
Longwire Somewhat Better (< 1 S Unit)	4 (20%)
No Difference	4 (20%)
Vertical Somewhat Better (< 1 S Unit)	1 (5%)

Table 3: Longwire versus Vertical Performance

Antenna	Max Gain (dBi)	Elevation of Max Gain (degrees)	3 dB Beamwidth (degrees)	Gain at 20° Elevation (dBi)
Dipole at 40 ft.	7.81	24	27.9	7.52
Dipole at 18 ft.	5.77	60	131.8	1.60
Inverted Vee at 18 ft.	4.42	90	121.4	-1.03
Vertical: ¼ λ – 2 ft. elevated counterpoise*	-.49	29	56.7	-.94
Vertical: ¼ λ – 4 radials	-2.89	27	44.3	-3.21
Vertical: 12 ft. center loaded – 4 radials	-3.99	28	45.9	-4.39

* Results only hold in the direction of the counterpoise

Table 2: Key Modeling Results



NB6M Tin Ear Receiver Kit

The American QRP Club is pleased to announce that we are still able to taking orders for the latest AmQRP Club kit: the TinEar Receiver, designed by Wayne McFee, NB6M.

The TinEar is a simple DC receiver that covers approximately 400 kHz of the 40 Meter band. This receiver has a stable VFO, and is quite pleasant and fun to operate. The kit is easy to build, and uses all through hole components. Everything is included in the kit, even the straw that is used to wind the tuning coil!! It tunes by means of a simple PTO (permeability tuned oscillator) and uses a 9V battery for power. The receiver uses common earbud or walkman headphones and has controls for Tuning and RF Gain. The battery even fits inside the case!

A neat feature of the kit is the great custom metal enclosure that is the exact same size as the BLT tuner. It is 3" x 3" x 1.625" and is made from .063" aluminum. All parts are included - case, AmQRP quality soldermasked, silkscreened, plated-through pc board, knobs, connectors, hardware, etc.

The kit ships with an extensive manual on CD-ROM that will also be downloadable from its web page: www.amqrp.org/kits/tinear

TEST TOPICS ... *AND MORE!*

Joe Everhart, N2CX

Batteries

This installment of Test Topics and More is yet another with a theme that unifies several sections. Many homebrewers and most QRP operators frequently rely on batteries to power their equipment. Naturally all of us want to get the most we can from batteries so while the column won't tell you which is the ultimate battery, Coming to Terms discusses a number of battery characteristics, and Designed for Test shows how to perform battery life measurements based on understanding what makes them work. Stimulus and Response provides some tips on asking for technical assistance to help you get quicker, more accurate answers to your queries.

Coming To Terms

Batteries are often the most practical power source for portable operation, at least for rigs at QRP levels. We all want the most life we can get from batteries and find quickly that there are a number of tradeoffs involved. Several important characteristics of batteries that aid in maximizing life are the rated life in ampere-hours and the rated service life of the batteries. You might think that you could do direct life comparisons between battery types by directly comparing the ampere-hour capacity and rated service life. But as with most things, the story gets more complicated. The following discussion will be in terms of single cells with a nominal voltage of 1.2 to 1.5 volts for ease of presentation. I'll be loose with the terms cell and battery though strictly speaking a cell is an individual item while a battery is considered to be a series connection of multiple cells with an overall voltage between 12 and 15 volts or so.

The table below shows the ampere-hour capacities for typical AA-size cells. These are taken from several manufacturers' sources so they are for comparative purposes only. The same basic cell type may be rated quite differently by different vendors.

TABLE 1: AA-size Ampere-Hour Capacities

Cell Type	Capacity (A-H)	End Voltage	Rechargeable?
Carbon-zinc	1.1	0.8 volts	No
Alkaline	2.7	1.0 volts	No
Lithium	2.9	1.0 volts	No
Ni-Cd	0.7	1.0 volts	Yes
NiMH	2.1	1.0 volts	Yes

At first glance it seems that the carbon-zinc type cell might be better than the Ni-Cd and have half the lifetime of an alkaline. Ah, but the rated capacity is only part of the story. First off note that the carbon-zinc end-of-life voltage is 0.8 volts while the other types are (usually) rated at 1.0 volts. Secondly, yet another touch to quantify characteristic comes into play. Any practical battery will have a relatively high voltage at light loads and a lower voltage when supplying high currents. This is due to their internal resistance. It is not a resistance that you can measure directly and it varies (generally it gets worse) at high currents and close to the end-of-life voltage.

The upshot is that even though a Ni-CD or NiMH cell may have a lower rated A-H capacity than others in the table, they usually offer longer useful lives due to their low internal resistance. Battery manufacturers give A-H ratings for very light loads, usually 10% of the rated A- H capacity or less in order as a matter of specsmanship. A battery that lasts seemingly forever in a simple portable AM/FM radio might die very quickly in a digital camera or QRP rig with high peak current needs.

There is something else to consider. The discharge curve of each battery type is different. Figure 1 shows the relative discharge curves for each of the types in Table I. The time scales are normalized so direct life comparisons cannot be made with this chart.

It is pretty obvious that the carbon-zinc and alkaline type batteries gradually drop off in voltage while the other types have an almost flat discharge curve with a sharp drop in voltage at depletion. The flatter discharge curve gives steady operation and constant transmitter power rather than a slow degradation.

The combination of the discharge slope and internal resistance make judging useful life very complicated for a battery in usage where current consumption varies with time. Most QRP or other portable rigs have a relatively low drain during receive and take ten times as much current during transmit periods. But the combination of the two makes discharge conditions very dependent on the internal resistance.

Figure 2 shows an idealized battery discharge curve with alternating receive and transmit periods. Note that the battery voltage vs. the transmit level drops due to internal resistance as described above. High internal resistance very drastically reduces the operating life. In normal operation, the transmitter will be operating less frequently than the receiver so the discharge curve has voltage "dips" during key-down periods as shown. This means that "end of life" occurs when those dips take the voltage below the end of life voltage. The voltage rises back to follow the low discharge rate for receiving. Thus there is plenty of "soup" left in the battery but you can't use it for transmitting. The curve shown is representative of an alkaline battery and would be much worse for one using carbon-zinc chemistry. Their relatively high internal resistance makes both less than ideal for high discharge rate applications. However the comparable Lithium, NiCd and NiMH cells have significantly lower internal resistance giving the superior operating life under heavy drain.

The above discussion is very cursory but I hope it gives a feel for how complicated it is to predict battery operating life for transceivers. Much more information on battery types and their characteristics can be found in references 1 through 5 at the end of this column. What is conspicuously absent in them is an in-depth treatment of the material discussed above.

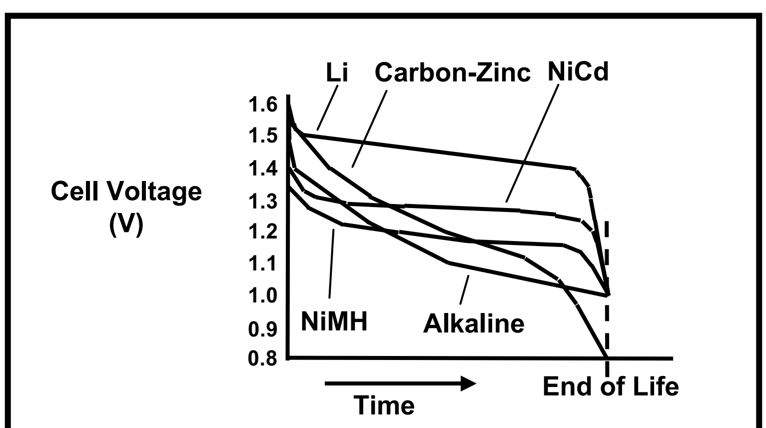


Figure 1 - Comparative Discharge Curves

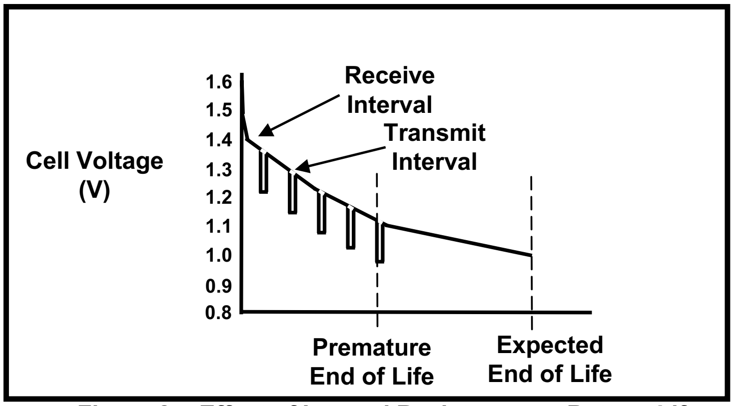


Figure 2 - Effect of Internal Resistance on Battery Life

Designed For Test

It is tough to predict how long a given battery type will last based on data sheets and nearly impossible to accurately compare different battery chemistries. What's a ham to do? The time honored method of choice is operate using each type of battery and compare results. Of course this will work though it requires control of operating conditions and careful data recording to be more accurate than the usual anecdotal "wisdom". Being smart homebrewers we can set up an automated test scenario that can give reproducible results with usable accuracy.

The basic idea is to set up some sort of fixturing to load the batteries similar to the way they are operated with radio equipment and to monitor the battery voltage until end of life. Digital camera buffs face a similar situation and a fellow named Dave Etchells who has described a test method and presented some test results in "The Great Battery Shootout!" (Ref. 6) The tester concept to be described in this section uses ideas from that work, adapting it to battery usage for ham transceivers rather than digital cameras.

For the digital camera testing a single load was switched on periodically. However as described above a real-life transceiver will switch between two loads, one representing the current consumption of a receiver and the other the transmitter drain. For the sake of argument the receiver drain will be presumed to be 50 ma and the transmitter drain is 1 amp. This is a reasonable number for simple transceivers like the Wilderness Sierra operating at the 5 watt level. The actual test current levels are easily changed by selecting load resistors. Testing will be described for a single cell for simplicity. The same idea can be scaled up, however, to test a multi-cell battery pack at 12 volts by appropriate load resistor choice and scaling of ADC input voltage. In addition, a resistive divider must be used to scale the ADC input to a maximum of 5V.

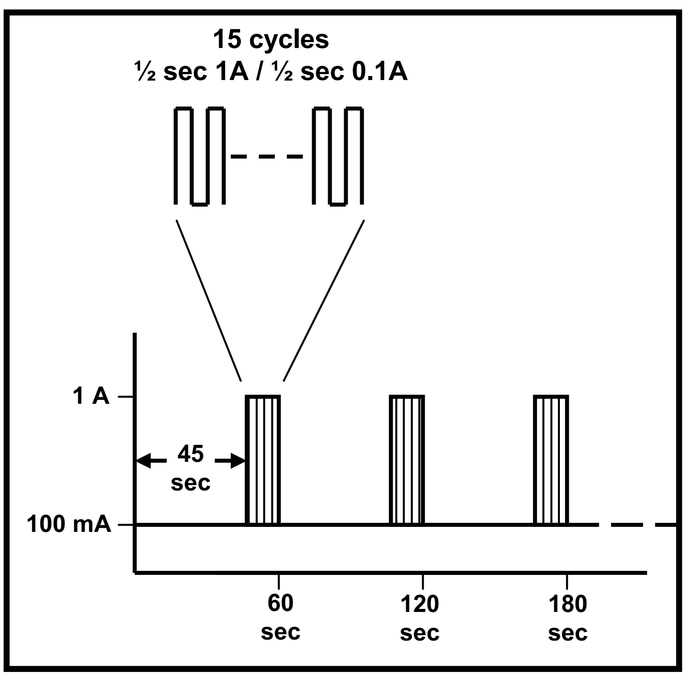


Figure 3 – Battery Tester Load Profile

For descriptive purposes the transmitter will be presumed to be receiving 75% of the time and the transmitter will be keyed 25% of the time. To simulate CW keying, the transmitter will be keyed on and off at a 50% rate during the keydown period with a 100ms on then 100 ms off period. As can be seen in Figure 3, the pattern repeats once a minute. A computer program is used to control timing so all of the timing parameters can be set to simulate virtually any operating pattern desired.

As with a number of projects described in this column the heart of the battery load tester is an NJQRP QuickieLab (QL) (Ref. 7). It uses the Parallax BS2 chip as its controller and incorporates many of the functions needed for the load tester. The controller provides outputs that can be used to exercise external relays which switch appropriate load resistors across the battery being tested. An Analog to Digital Converter (ADC) controlled by an Input Output eXtender (IOX) monitors battery voltage. A Liquid Crystal Display on the QL gives a visual indication of battery tester operation by displaying battery voltage in real time plus showing the amount of elapsed time since a test run has begun. Figure 4 shows a block diagram of the tester.

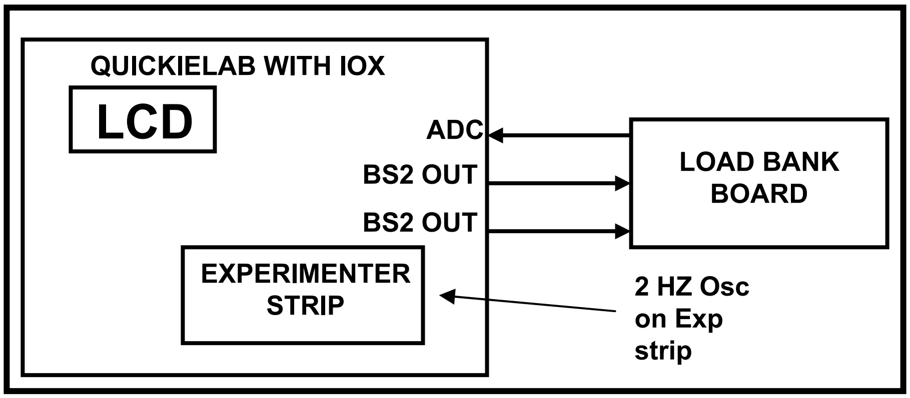


Figure 4 - Battery Tester block diagram

Some additional circuitry is required in addition to the QL. Internal timing provided by the BS2 is too inaccurate and temperature sensitive for accurate time measurements. However a simple circuit addition can be employed to overcome this. Figure 5 is an oscillator/divider controlled by a common 32768 kHz clock crystal. It provides a stable 2 Hz output with reasonable accuracy. It is good enough as-is but those obsessed with dead-on accuracy can replace C2 with a 15 pF fixed capacitor and a 10 pF trimmer to adjust oscillator timing. The circuit can be built up on the QL experimenter strip plugboard.

Figure 6 shows the tester "load bank" and battery holder. The battery holder can be any single cell AA holder. Common 2N7000 FETs transistors are used as relay drivers since they can be switched on with logic level outputs from the QL and handle the 90ma or so relay current with no problems. Relays such as the Radio Shack ™ 275-232 are suitable as are many carried by Digikey and other mail order suppliers. Be sure to use protective diodes across the coils as shown or you will fry the drivers very quickly.

Resistor R3 sets the receive current level. A value of 15 ohms will set the receiver simulation current at 100 mA for the no-rechargeable cells and for the rechargeable types 12 ohms is appropriate. A ¼ watt resistor is fine though a ½ watter will run cooler.

R4 needs to be about 1.5 ohms for a 1 A load. For the non-rechargeable cells listed three Radio Shack ™ 0.47, ohm 5W resistors (p/n 271-130) are appropriate. For rechargeable types eight Radio Shack ™ 10 ohm, 1W resistors (p/n 271-151) are close enough. If you use other resistors be sure to use power type resistors since you will be dissipating about a watt when the load is switched in. Good practice is to use a power rating twice the calculated value.

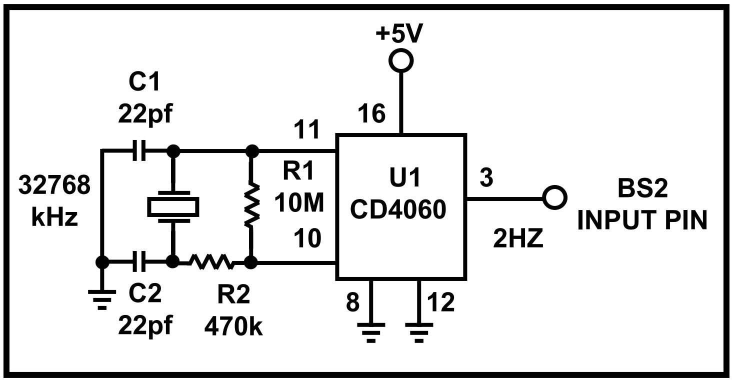


Figure 5 - Precision 2 Hz oscillator/divider

Construction is pretty much non-critical. Perf board is fine to use as is point-to point wiring. Use wire that is at least 20 ga for interconnection to minimize unwanted extra resistance. Use of multiple 5-way binding posts (Radio Shack ™ 274-662 or equiv.) for connecting the load resistors will allow changing resistance values for loads if you will want to use different current levels.

Figure 7 is a top-level flow chart for the QL program. It turns on appropriate load resistors in the sequence hat has been described. Each basic timing period is one second. Battery terminal voltage is measured during each of the thirty transmitter on cycles (remember the 50% on-off duty cycle during the 15 second transmit period each minute). Those thirty measurements are sanity checked to be certain that there was no error, then averaged. The resulting value is then checked to see if the end of life voltage value has been reached. A count of the number of one minute test cycles that has occurred is tallied and converted to the equivalent number of hours and seconds. The last voltage measurement and elapsed time are displayed on the LCD. The test ends when the end-of-life voltage has been reached. The QL sounds a continuous alert when this is noted and the final time value is displayed. A more detailed flowchart can be found on the AmQRP website. Check www.amqrp.org/homebrewer/homebrewer.html for a link to the "Extras" section.

The tester is intended to be used for comparative checks of battery life under simulated typical load conditions. Accurate comparisons are assured by careful control of the testing conditions without the need for operator intervention. All you have to do is plug in a battery, start the program running then wait for it to sound the alarm.

The QL does not have enough memory to log each measurement. However the program could be modified to store the number of cycles needed to reach intermediate voltage (e.g., 1.5V, 1.4V, 1.3V, 1.2V, 1.1V and 1.0V) to recall once the test has been completed.

Stimulus and Response

A number of readers routinely ask questions. A number of them have been answered directly and those that may have wide interest find their way into Stimulus and Response. A large number though are simply from folks who have a technical question or ask for assistance in troubleshooting or repairing a piece of equipment. I'm glad to assist and request that the questions keep coming.

Sometimes these queries require clarification since they are stated in very general terms. This means that there has to be several back and forth responses unit the real "meat" of the issue is clear. I'd like to suggest a couple of guidelines to help in getting to the heart of the matter sooner.

The first step is to clearly state the problem or question. A vague question such as "what is the best DVM/scope probe?" or "my rig doesn't work right" can't be answered directly. Specificity helps narrow down choices. For example, you might ask "what is the best DVM under $25.00 for general hamshack use?" or "where can I find an oscilloscope probe rated to 100 MHz," or "I think my transmitter has low power out. How can I check it?" Bounding things this way helps to answer your questions without having to ask questions to clarify what you mean.

Another important point is to determine whether or not you actually have a problem. An example is when someone asks why the SWR of his short loaded antenna is not 1:1 "like it should be". In this case a SWR above 1:1 might be a good thing. Short loaded antennas have a radiation resistance well below 50 ohms and if used with a good ground system might have a feedpoint resistance of 15 or 20 ohms which would indeed give a high SWR but be perfectly reasonable. A better question might be "My 12-foot loaded vertical gives me a minimum SWR of 3:1 on 20 Meters when I use it with a 12-radial ground system. Is this normal?"

Have you outlined what you have done to determine whether or not there is a problem or what you have done to try to isolate the difficulty? A little homework ahead of time saves lots of time that could be wasted by my recommending things that you have already thought of.

Have you tried verifying your problem in another way? Troubleshooting is an iterative process much like the scientific method. You observe a condition then try to change something and observe the results. Many things you try may have no effect, but you just might find something that either improves the original problem or makes it worse. For example if you suspect that a receiver is losing sensitivity you might try listening to the same signals on another receiver using the same antenna. You might find that the antenna is bad or that propagation is lousy. Be sure to describe what you have already done to try to verify or isolate the problem.

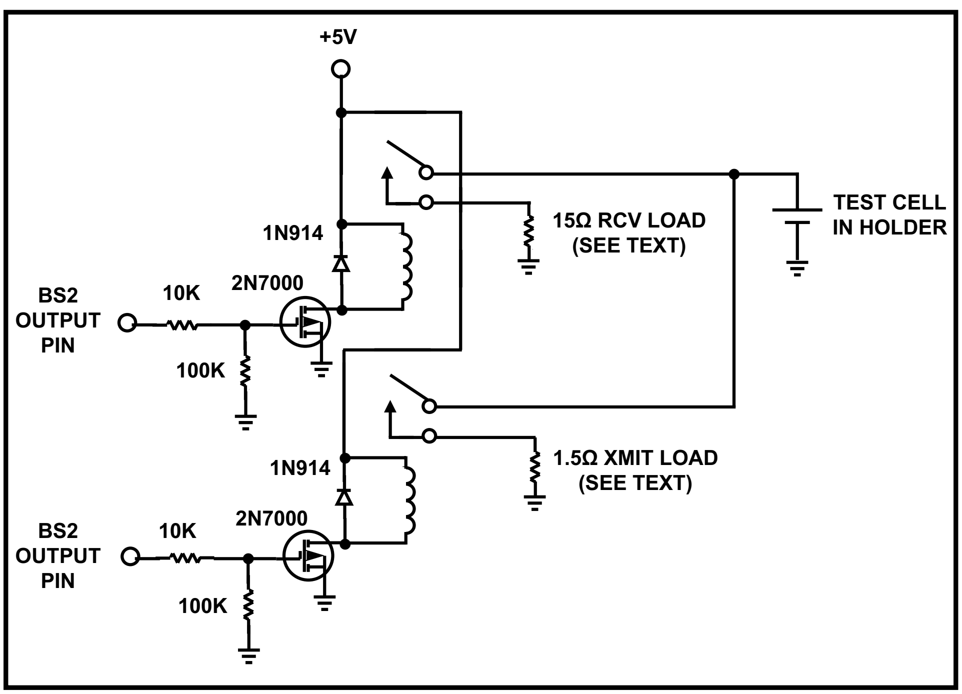


Figure 6 – Load Bank Board

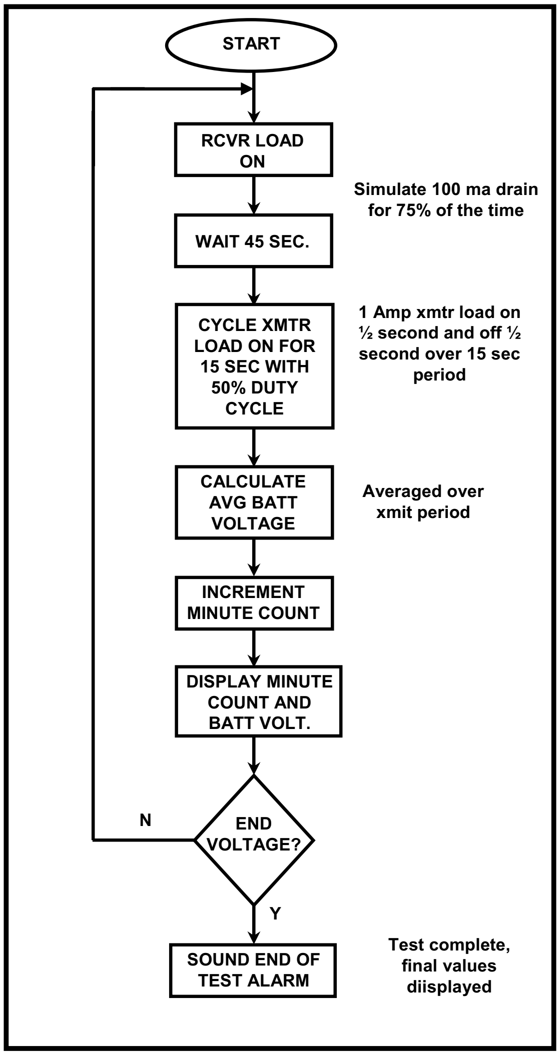


Figure 7 – Simplified battery tester flowchart

Have you done a web search? If your question concerns a popular piece of equipment or some type of component you just might run across a discussion group or private web site where someone else had the same question and found an answer. A year or so ago I bought a PDA and unwisely carried it in my shirt pocket. Needless to say it fell out and hit the floor one time when I leaned over. Noting that the screen looked damaged I used Google with the search string "Handspring Visor display damage" I found over 1000 "hits" on the web. Refining the search I eventually found a users group on Visor Village where my exact problem was discussed. Better yet someone there had already posted info on a West Coast company that sold repair parts and had an on-line tutorial discussing repair techniques. You never know what you'll find if you don't check.

An example of a good exchange began with the following query:

"I've been trying to use my QuickieLab as a digital clock. I've been using the PAUSE command to count the number of times through a 1-second loop. The problem is that the time is inaccurate for times over one minute. I also tried counting for 1000 seconds then 2000 seconds without stopping and found that the time was off by about the same amount about 5 seconds too much in 1000 loops and 10 seconds in 2000. How can I get accurate time?"

My answer had several suggestions:

- The BS2 has a built in ceramic resonator with a specified accuracy of 1%. This means that you could be off as much as plus or minus one second in 100. Assuming that the resonator did not drift you might be able to do some long term timing checks and compensate for the initial inaccuracy.
- In addition, as you convert the second count into minutes and hours, the instructions to do this conversion will vary in length depending on the time value. This will add a time uncertainty that can't be easily calibrated out.
- A better plan might be to build a simple crystal controlled oscillator and divider to a half-second square wave. Then the QL can poll the stream and count transitions. The crystal oscillator can be set exactly on frequency and will produce unvaryingly accurate timing outputs with no variable delays due to timing. The program needs to complete its conversions within the half second so that it does not introduce program instruction related varying delays.
- The problem has actually been solved by Scott Edwards. He documented the oscillator and technique in his Nuts N Volts column. This article can be downloaded from the Parallax Inc site at:

www.parallax.com/dl/docs/cols/nv/vol1/col/11.pdf

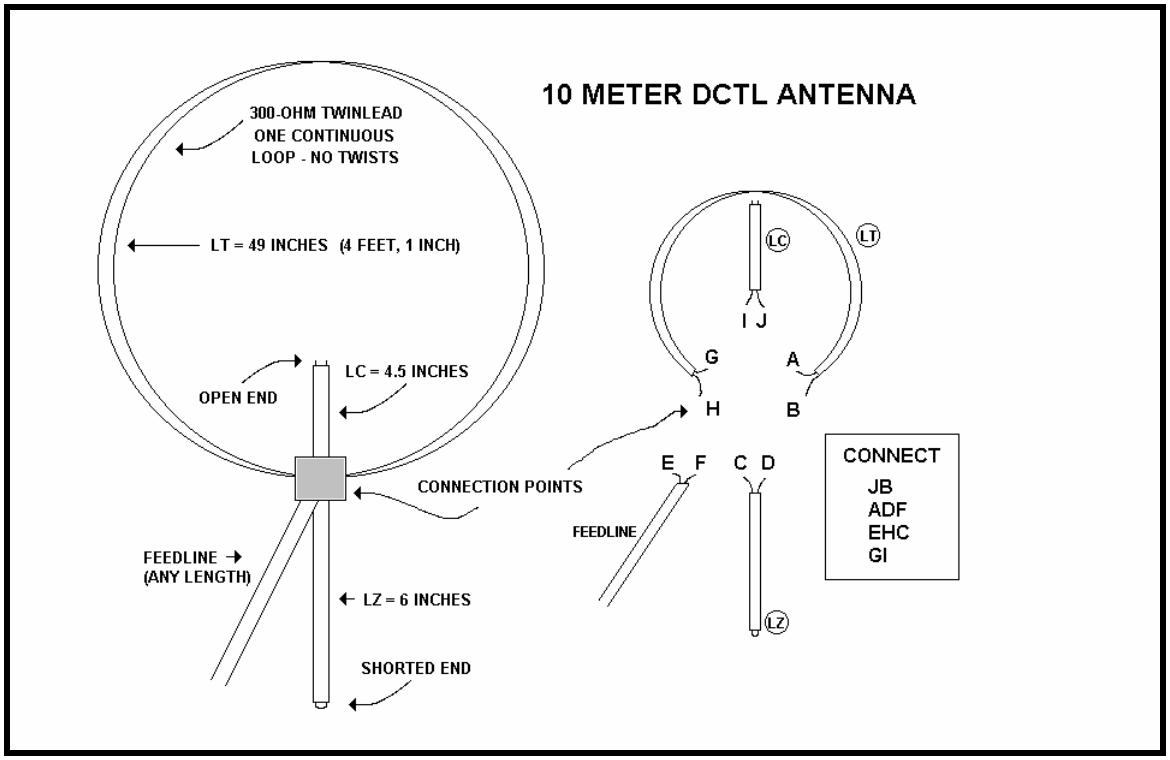
The bottom one is that if you do a little homework and help refine your questions you can help me answer them more quickly and efficiently. Please don't hesitate to ask questions. I get lots of material for this column through this correspondence and have helped a number of homebrewers with their problems. The only dumb question is one you don't ask. If you have a question it is quite likely that others do too but they may be afraid to ask. Don't worry, I won't mention your name in the column unless you give me permission.

References:

1. Duracell - http://www.duracell.com/oem/default.asp
2. Panasonic - http://www.panasonic.com/industrial/battery/
3. Eveready Energizer - http://data.energizer.com/
4. Battery questions - http://www.arrl.org/tis/info/batteries.html
5. http://www.vencon.com/articles/reds1.html
6. The Great Battery Shootout! - http://www.imaging-resource.com/ACCS/BATTS/BATTS.HTM
7. http://www.njqrp.org/quickielab/index.html

QRP Operating

Richard Fisher, KI6SN



The 10 Meter DCTL Antenna is perfect for indoor operations with a diameter of about 1.3 feet.

A MINIMALIST'S APPROACH TO 10-METER QRP OPERATION

Phil De Caire, WB7AEI, of Kent, Washington, writes that "I just have to tell this story - I giggled with most every QSO made.

"Due to impending house repairs and wind damage to a fence that my 40 meter full wave stealth loop runs (or rather, used to run) along, I took the loop down recently. That was my one and only all-band antenna. That left me with no antennas - almost, except for a borrowed 40 meter DCTL (Distributed Capacitance Twisted Loop) that I was playing with. Oh, and the ARRL's 10 meter contest was on that weekend. What to do?

"I'd made some contacts on the 40 meter DCTL sitting indoors next to my rig, and it seemed to work, so why not build one for 10 meters? I did.

"You have to picture this antenna: 4-feet, 1-inch of 300-ohm twinlead formed into a loop. The diameter of the finished loop is about 1.3 feet, smaller than the computer screen I'm looking at.

"You look at it and laugh and can't help saying 'You're not serious here, are you? Is this really supposed to be an antenna?' I didn't allow length for connections, so I needed a bit more length on the open stub capacitor to resonate it. Tacked on about 25 feet of 300-ohm feedline (only needed about 3 feet, but didn't want to cut the long piece) and ran it into the tuner. Where to put it? Indoors, obviously.

"I ended up looping it over a cardboard box sitting on top of the bookshelf next to my operating desk. That helped it keep a loop shape. So there it sits about 2 feet from me and 3 feet from my rig. I was ready for the 10 meter contest, although about 20 hours late."

Although the DCTL is described as a "twisted loop," the twist is made electrically. When referring to the accompanying construction diagram, note that the 4-foot, 1-inch loop portion of the antenna (LT) is not physically twisted. During construction, it is critical that the 300-ohm twinlead forms a continuous, untwisted loop and that the connections from the loop to the shorted and open stubs (LZ and LC) and feedline be made precisely. Which sides of each twinlead element are connected to the others is identified in the small box in the diagram labeled CONNECT. And keep in mind that G and A are ends of the same piece of wire in the loop, as are H and B. Remember: No twists.

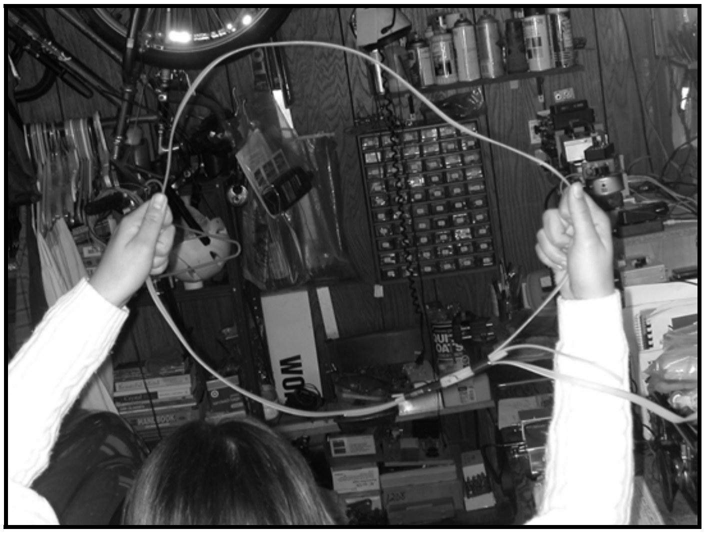
"The loop itself was 49 inches. The shorted stub was 6 inches. The open stub ended up being about 4.5 inches to tune it. I didn't allow any extra length for connections, which was probably a mistake. The open stub was supposed to be somewhat shorter according to the formula, but whatever works, works.

"I've got to credit my QRP buddy Steve Barrett, N7BVY, for getting me off my behind on this antenna. I'd known about it for years (saw the original QST and CQ articles), but it wasn't until he loaned me a 40-meter version (after I told him about it and he built a couple) that I got around to playing with one.

"No magic involved, of course, and nothing I invented. It's a 'small loop,' the same in theory as some of the tunable HF loops one can buy, but this one is CHEAP and can be built in less than an hour without any mechanical expertise.

"The best source for information on this antenna that I've found is: *www.n5nw.org/antennas.html*

"It has complete design information, connection diagrams, and equations for the lengths."



The DCTL was developed by James McLelland, WA6QBU, of Cotati, CA, and appeared in articles in CQ and 73 Amateur Radio Today magazines in 1994. The entire antenna is made with inexpensive 300-ohm twinlead – which includes the loop, both stubs and feedline. If you're going to use a tuner, it will need to be capable of handling balanced lines.

"Keep in mind, of course, that this is QRP. While I think contests are fun, I'm strictly a casual contest operator, or rather I like the opportunistic QSOs that contests can provide. No aspirations here about high scores with low power and makeshift antennas.

"I run my old FT-101ZD at about 5 watts output, which is less power than the 6146 finals' filaments take. As the rig warms up, the power sometimes drifts down to the 2-watt area if I don't catch it and crank it back up.

"Turning on the rig brought the sound of signals! (That's always a good sign, isn't it?)

"Some Texas stations S9 and better were coming in on this little loop. The rig and tuner tuned up just fine and seemed to be happy with the little antenna.

"I tune around – here's a loud signal, W9WI - got him on the first call!

"Then some Texans starting with K5NZ, and as the band died I worked some local Washingtonians. I worked all the loud ones I could hear, 10 QSOs in about half an hour - not a bad rate for me.

"Hmm . . . maybe this tiny antenna DOES work!

"Sunday the band was better. I ended up with 42 QSOs with a total operating time of about 2 hours.

"The tally was 14 states and VE3. The contacts weren't an accident. The most fun was a run that lasted about 20 minutes where I made 14 contacts, starting at the low end of the band and worked every strong signal on the way up.

"Got most of 'em on the first call, too.

"It was just like I had a real antenna. I even worked some guys who didn't have S9 signals. Of course, there were the usual few contacts that I had to work pretty hard for.

"A few weak DX stations were heard, but none worked. The band was marginal but open to Texas, Louisiana, Indiana, Ohio, and Maryland, with the usual 'specific propagation' that 10 meters is famous for.

"Oh, and of course I never got a signal report less than 599!

"I've been QRPing all the years since I got back into hamming, usually with makeshift / stealth antennas, and you'd think by now I'd have learned that almost anything works.

"But I really didn't expect such good results with a miniature, indoor antenna. I keep being surprised by how much one can do with very little.

"Minimalism is just too cool. I'm not so worried anymore about moving to a smaller house, where antennas may be more of a problem."

Philip was first licensed at age 13 in 1962 as WN8DND while living in Muskegon, MI.

He got his General class ticket in 1963 -WA8DND - and operated primarily 40 meter CW.

About 1966 he got his Extra class license. At that time, Philip had to sell his gear to help pay college tuition.

He graduated with an EE degree from Michigan Tech in 1972 and came to the Seattle area where he has since worked for Boeing as an electronics designer.

He got the call WB7AEI and since becoming active again in the early '90s has enjoyed CW and QRP operation on 40 through 10 meters.

"I do more tinkering than operating and spend many hours breadboarding circuits and playing with them," Philip writes. "Minimalism seems to be my thing.

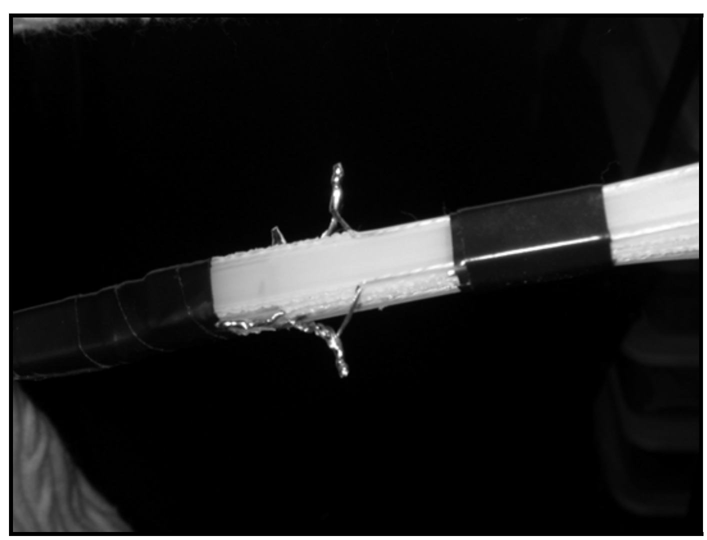
"If you've worked me it's probably on 40 or 10; it's hard to decide which is my favorite, but 10 meters when it's open is hard to beat for QRP. I'll occasionally go on 15 or 20 meters, but I don't spend nearly enough time on either. I operate 100 percent CW and 100 percent QRP.

"The station consists of an old FT-101ZD as my main rig, used on the higher bands, and several homebrew rigs on 40 meters, an HW-7, and possibly my latest breadboard.

"All my accessories are homebrew, too. I can't have antennas, so my full wave 40-meter loop is stealth, with the highest point only 17 feet up.

"I'm active with the BEARS-Seattle (Boeing Employees Amateur Radio Society) club and was president in 2000 / 2001 and vice president in 2002 / 2003," Philip says. "We operate an all homebrew 1-watt 10 meter beacon station K7NWS / B on 28.2645."

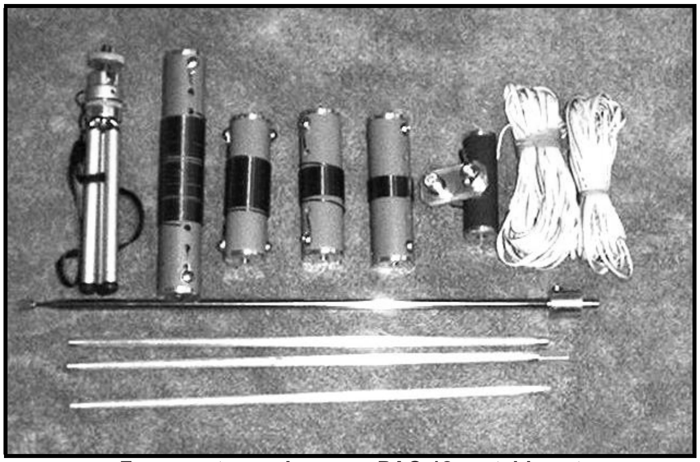
Editor's note: *AT KI6SN, WB7AEI's dimensions were used to build a 10-meter DCTL antenna. It took less than an hour to construct and was hung indoors from the rafters in the garage. Running 5 watts and using a Z-match tuner, a 1:1 SWR was easily achieved. On the first CQ on CW at 28.060 MHz from Southern California, WØLGU, of Center City, MN, answered. Signal reports were identical on both ends: 579. A 15-minute QSO ensued. Later, V73GE from the Marshall Islands was snagged on 28.020 MHz CW. Yes: DX, with a 539 signal report! FM contacts have also been made in the 29.6 MHz portion of the band using the 10-Meter DCTL. Does this little antenna work? You better believe it does. –* ***KI6SN***



Proper connections between the loop, two stubs and feedline are critical to the success of the 10 Meter DCTL Antenna.

Radio To Go

James Bennett, KA5DVS/6



For an antenna, I use my PAC-12 portable antenna

For the Traveler

Welcome back to another installment of radio to go. This time around I decided to go in a bit different direction than previously indicated. I am doing quite a bit of air travel these days both business and personal and this got me to thinking about the process for putting together a travel station suitable for transport in baggage typically carried when traveling by plane.

While I write this column, I am in an airliner at about 35,000 feet on a flight to visit family for the holidays. Sitting here, I began to think about the things that go into preparing a station to take along when traveling by air. Not only how to pack but what to pack. When traveling by air, what we can carry as what we are allowed to carry may limit our ability to play radio at our destination. Since I travel frequently, I thought I would share a few ideas for successfully taking radio equipment along when flying.

Whether traveling to visit friends and or family or on business, having an effective portable station along can make the trip more enjoyable. Operating from a new location can give a new perspective on radio operation. In my case, I live in a relatively dense urban area where setting up a full size antenna is limited by physical space. This is in addition to the high ambient noise level inherent in any urban environment. At my home station, it is not uncommon to have an S8-S9+ noise level on 80 and 40M. It is a bit lower on higher bands but they are not always open. Operating away from home opens up new opportunities for exploration of signals that might not even be heard from a home location. In my case, operating 40M away from the high noise level is a real treat.

Preparing a travel station

A successful travel station needs to contain at least a minimum of basic components. For one, a transceiver power supply and antenna are needed. This setup can take many forms from a simple monoband rig, wire antenna and AA battery pack to a multiband transceiver, with frequency agile antenna system coupled with a rechargeable battery pack and even a solar panel for longer operation. Many options exist in this area to assemble a portable station in bag for travel.

Often, the nature of the trip will dictate to some extent the nature of the station. In this case, with air travel, there are limits on the size and weight of the station as well as the type of power source that may be transported. Lead acid batteries while a good power source are problematic to transport by air due to restrictions and potential hazards. This leaves other rechargeable batteries in addition to primary non-rechargeable cells.

The equipment should also be relatively lightweight and small in size whenever possible. A wide range of monoband QRP rigs fit this bill as well as offerings from Elecraft, SGC, Yaesu and Icom. Many of the latter include features only dreamed of a few years ago. My personal favorite is the FT-817 from Yaesu. It covers all amateur bands from 160M to 70 CM and just about all modes. For a travel radio, I have found nothing better in terms of capabilities and portability. Until we have the Dick Tracy all in one wristwatch multiband radio, this is as good as it gets.

Planning for the trip

One of the toughest things in planning a successful trip that includes radio operation is deciding what and how to pack. While there is the school of thought that says to just bring everything you might possibly need, it is better to plan ahead and take only what is needed for the desired operation. If for example, only a single band operation is planned, a simple monoband QRP rig and simple antenna will suffice. Whereas, if the trip lasts for several days or weeks, and different operation conditions are to be explored, then more elaborate equipment may be needed. The local weather, time of year, and available locations must also be considered.

Making a list and checking it twice

Taking the time to generate a list is a great way to organize for a successful radio outing. To start, just write down everything you think will be needed for the station. Try to include anything you can think of, as we will edit the list later. Once you have a list, gather all the items listed and lay them out on a table. Take a serious look at the stack of equipment with an eye both to what else is needed as well as items that are not really necessary. If time permits, go ahead and set up the station in the backyard or other convenient location, as this is the best way to really see what is actually necessary and what is not. Modify the list based on these tests and after each outing. Over time, you will end up with a concise list and a well organized portable station. The list will also make preparation for a trip much easier and faster as you can just grab the items on the list and not worry about forgetting a critical item.

Things to add

In addition to the items on your list, there are a few "emergency" items that should be included. For example, I pack electrical tape, wire, and clip leads and antenna and power adapters for common sizes. I usually include a lighter socket plug such as one found at Radio Shack. This plug has binding posts and can provide a quick connection to a car lighter socket as a backup power source.

Photo 1: Radio Shack Lighter Plug with Binding Post Connections

Spares of other critical hardware are also a good idea if space permits. If in a sunny location, a small solar panel can supply additional power to extend operating time and or to charge batteries. A small soldering iron and solder are invaluable for repairs. There are also solder pastes that can be used with the heat of a match or lighter. Don't forget spare fuses for all equipment that uses them.

Photo 2: Emergency and spare parts

Seeing Clearly

For nighttime operation, a small light source is really nice to have along. Either a self-standing light such as a booklight or similar or a headlamp will work well for this application. If possible, choose a light utilizing LEDs rather than incandescent or fluorescent bulbs. The former consume a lot of current and the latter can generate RF noise due too the high voltage circuitry. LED lamps are amazing both in the light output and the incredible battery lifetime. I prefer an Energizer LED light available at Wal-Mart. It has 2 LEDS with diffuser tubes and runs on 4 AA batteries for up to 200 hours.

Photo 3: LED Lamp

Containment

I prefer to pack small items in small clear, zipper seal plastic bags to keep the items organized and easy to locate in a larger container. Feedline cables and wire can be coiled and placed into a bag as well to reduce tangling and aid in easy and quick setup. Zipper seal food bags are even available with write on label areas that can be useful for identifying items. Use a permanent marker pen for the labeling. Rubber bands are great to secure loose cables and wires into bundles that are easier to handle.

Photo 4: Items in zipper bags

Packing

Once the small items are corralled in bags, they can be organized into larger containers. There are many options for bags in which to pack, many of which have been suggested on QRP-L over the years. Bags designed for other portable electronics often adapt quite nicely to radio equipment. I have several favorites including bags for external CD drives, zip drives camcorders, etc. I especially like some surplus bags that I came across a while back. They are approximately 3" x 7" x 15" with foam padded sides. They were originally designed for carrying computer accessories but works well for portable station components. The bags also fit will into my luggage for travel and keep my radio "stuff" contained and easy to access. Here are some photos of some of the things I take along when I travel.

Photo 5: Carry Bags

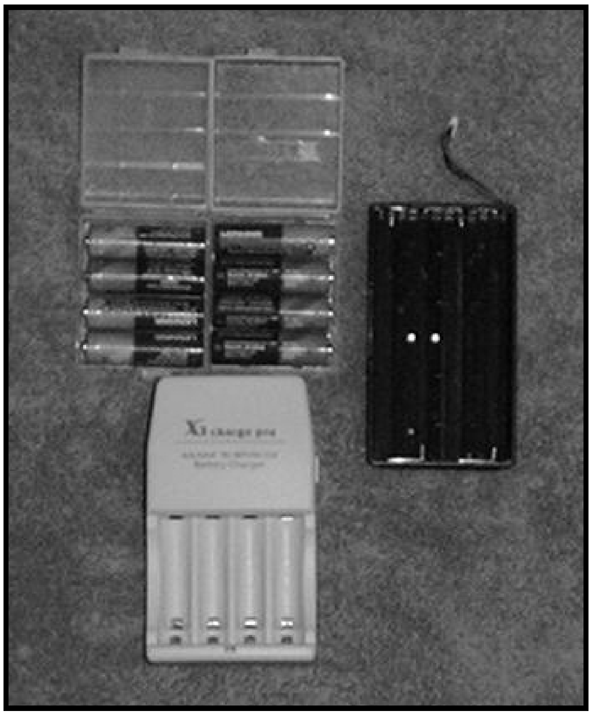


Photo 6: Antenna Analyzer and Bag

Photo 8: Battery Holder, Batteries and Charger
Photo 10: Carry Bags in luggage

With the increased airline security, what we can carry on the plane has changed since 9-11. Some items simply should not be carried onto the plane. In my case, I prefer to pack all antenna components, feedlines and other hardware in my checked baggage and to carry only the expensive radio equipment in my carry on bags. I usually carry my FT-817 in a back pocket of my laptop bag. I also carry the radio manual and a copy of my FCC license in case questions arise.

Thank you for reading my column and I look forward to hearing you on the air. We will continue this theme in a future column and as usual, suggestions and ideas are appreciated.

Please send comments, feedback, gripes, etc via email to ka5dvs@arrl.net

Happy 2004!

May it be a great year for everyone!

N2CQ QRP Contesting Calendar

Ken Newman, N2CQ

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June - July - August, 2004

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IARU Region 1 Fieldday (CW) ... QRP Category
Jun 5, 1500z to Jun 6, 1459z
Rules: http://www.sk3bg.se/contest/iarur1fd.htm

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QRP TACtical Contest (CW/SSB/PSK) ... QRP Contest!
Jun 5, 1800z to 2359z
Rules: http://www.n3epa.org/Pages/TAC-Contest.htm

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Adventure Radio Spartan Sprint (CW) ... QRP Contest!
Jun 8, 0100z to 0300z (Monday evening US/Canada)
Rules: http://www.arsqrp.com/

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Asia-Pacific Sprint (SSB) ... 150W max
Jun 12, 1100z to 1300z
Rules: http://jsfc.org/apsprint/aprule.txt

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ARRL June VHF QSO Party   QRP Portable Category
Jun 12, 1800z to Jun 14, 0300z
Rules: http://www.arrl.org/contests/rules/2004/june-vhf.html

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West Virginia QSO Party (SSB/CW)... QRP Category
Jun 19, 1600z to Jun 20, 0200z
Rules: http://www.qsl.net/wvarrl/2004%20WVQP%20RULES.doc

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Quebec QSO Party (All) ... QRP Category
Jun 19, 1700z to Jun 20, 0300z
Rules: http://www.raqi.ca/qqp/qqp-e.pdf

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Run For The Bacon (CW) ... QRP Contest!
Jun 21, 0100z to 0300z
Rules: http://fpqrp.com

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UK DX Contest (CW) ... QRP Category
Jun 25, 1400z to Jun 26, 1400z
Rules: http://www.srars.org/ukdxcruleseng.pdf

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SP QRP Contest (CW) ... QRP Contest!
Jun 26, 1200z to Jun 27, 1200z
Rules: http://www.sk3bg.se/contest/spqrp.htm

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Marconi Memorial Contest (CW) ... QRP Category
Jun 26, 1400z to Jun 27, 1400z
Rules: http://www.qsl.net/ik6ptj/marconi.htm

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ARRL Field Day (CW/SSB/RTTY)... QRP Category
Jun 26, 1800z to Jun 27, 2100z
Rules: http://www.arrl.org/contests/rules/2004/rules-fd-2004.html

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QRP ARCI Milliwatt Field Day (ALL)... QRP Contest!
Jun 26, 1800z to Jun 27, 2100z
Rules: http://2hams.net/ARCI/mwfd.htm

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RAC Canada Day Contest (CW/SSB) ... QRP Category
Jul 1, 0000z to 2359z
Rules: http://www.rac.ca/downloads/canadadayrules2004.pdf
See http://www.rac.ca/qrpcan/rwrqrp.htm
for more awards from QRP-Canada

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Original QRP Contest (CW) ... QRP Contest!
Jul 3, 1500z to Jul 4, 1500z
Rules: http://www.qrpcc.de/contestrules/oqrpr.html

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MI QRP Fourth of July Sprint (CW) ... QRP Contest!
Jul 4, 2300z to Jul 5, 0300z
Rules: http://www.qsl.net/miqrpclub/contest.html

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Adventure Radio Spartan Sprint (CW) ... QRP Contest!
Jul 6, 0100z to 0300z (US/Canada Monday evening)
Rules: http://www.arsqrp.com/

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IARU HF World Championship (CW/SSB) ... QRP Category
Jul 10, 1200z to Jul 11, 1200z
Rules: http://www.arrl.org/contests/rules/2004/iaru.html

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UK DX Contest (RTTY) ... QRP Category
Jul 10, 1200z to Jul 11, 1200z
Rules: http://www.srars.org/ukdxcruleseng.pdf

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FISTS Summer Sprint (CW) ... QRP Category
Jul 10, 1700z to 2100z
Rules: http://www.fists.org/sprints.html

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QRP ARCI Summer Homebrew Sprint (CW) ... QRP Contest!
Jul 11, 2000z to 2400z
Rules: http://2hams.net/ARCI/sumhom.htm

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AGCW-DL QRP Summer Contest (CW) ... QRP Contest!
Jul 17, 1500z to Jul 18, 1500z
Rules: http://www.sk3bg.se/contest/agcwqrps.htm

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North American QSO Party (RTTY) /QRP Entries Noted
Jul 17, 1800Z to Jul 18, 0600Z
Rules: http://www.ncjweb.com/naqprules.php

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CQ WW VHF Contest (All, 6 & 2 Meters) ... QRP (10W) Category
Jul 17, 1800z to Jul 18, 2100z
Rules: http://www.cq-amateur-radio.com/infoc.html

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RSGB Low Power Field Day (CW) ...QRP Contest!
Jul 18, 0900z to 1200z
Jul 18, 1300z to 1600z
Rules: http://www.contesting.co.uk/hfcc/rules/rqrp.shtml

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CQC Great Colorado Gold Rush (20 Meters CW) ... QRP Contest!
Jul 18, 2000z to 2200z?
Rules: http://www.cqc.org/contests/index.htm

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Islands On The Air Contest (CW/SSB) ... QRP Category
Jul 24, 1200z to Jul 25, 1200z
Rules: http://www.rsgbhfcc.org/

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Flight of the Bumblebees (CW) ... QRP Contest!
Jul 25, 1700z to 2100z
Rules: http://www.arsqrp.com/

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Adventure Radio Spartan Sprint (CW) *** QRP CONTEST! ***
Aug 3, 0100z to 0300z (Monday Evenings US/Can local time)
Rules: http://www.arsqrp.com/

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TARA "Grid Dip" Contest (PSK/RTTY) ... QRP Category
Aug 7, 0000z to 2400z
Rules: http://www.n2ty.org/seasons/tara_grid_rules.html

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Ten-Ten Summer SSB Contest ... QRP Category
Aug 7, 0001z to Aug 8, 2359z
Rules: http://www.ten-ten.org/calendar.html

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North American QSO Party (CW) ... <100W. (/QRP noted on entry)
Aug 7, 1800z to Aug 8, 0600z
Rules: http://www.ncjweb.com/naqprules.php

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Worked All Europe DX Contest (CW) ... <100W category
Aug 14, 0000z to Aug 15, 2359z
Rules: http://www.darc.de/referate/dx/xedcwr.htm

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Maryland/DC QSO Party (SSB/CW) ... QRP Category
Aug 14, 1600z to Aug 15, 0400z
Aug 15, 1600z to Aug 15, 2359z
Rules: http://www.w3cwc.org

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RUN FOR THE BACON (CW) *** QRP CONTEST! ***
Aug 16, 0100z to 0300z
Rules: http://fpqrp.com/fpqrprun.html

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North American QSO Party (SSB) ... <100W. (/QRP noted on entry)
Aug 21, 1800z to Aug 22, 0600z
Rules: http://www.ncjweb.com/naqprules.php

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NJ QSO Party (CW/SSB)
Aug 21, 2000z to Aug 22, 0700z
Aug 22, 1300z to Aug 23, 0200z
Rules: http://www.qsl.net/w2rj/

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Hawaii QSO Party (CW/SSB/Digital) ... QRP Category
Aug 28, 0700z to Aug 29, 2200z ?
Rules: http://www.karc.us/hi_qso_party.html

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TOEC WW Grid Contest (CW) ... <100W category
Aug 28, 1200z to Aug 29, 1200z
Rules: http://www.qsl.net/toec/contest.htm

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Ohio QSO Party (CW/SSB) ... QRP Category
Aug 28, 1600z to Aug 29, 0400z
Rules: http://www.mrrc.net/oqp

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SLOVENIA CONTEST CLUB RTTY Championship .. 100W Category
Aug 28, 1200z to Aug 29, 1159z
Rules: http://lea.hamradio.si/~scc/rtty/htmlrules.htm

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BUBBA Summer QRP Sprint *** QRP CONTEST! ***
Aug 28, 1600z to 2200z ?
Rules: http://www.extremezone.com/~nk7m/

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Colorado QRP Club - Summer QSO Party (SSB/CW) *** QRP CONTEST! ***
Aug 29, 1800z to 2359z ?
Rules: http://www.cqc.org/contests/

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Thanks to SM3CER, WA7BNM, N0AX(ARRL) and others
for assistance in compiling this calendar.
(? = Time or date unknown)

Please foreward 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
N2CQ@ARRL.NET
http://www.amqrp.org/contesting/contesting.html

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QRP Homebrewer Sprint Results -- Spring 2004

Put down the soldering iron and get on the air with other QRP homebrewers! Each spring and fall, the AmQRP and NJQRP sponsor this fun, quick and easy QRP sprint ... *with a homebrew twist!* Includes PSK31 mode and multipliers for home-built gear. Prizes for the winner(s) and special certificates for all.

Mission: Promote homebrewed & homemade equipment on the air together. Warblers too! Anyone with ANY equipment can enter.

Sponsor: New Jersey QRP Club (http://www.njqrp.org)

When: The fourth Monday in March and in September, 0000-0400 UTC (Sunday evening in USA/Canada)

Modes: CW and PSK31. (Both modes considered separate bands)
QRP CW and PSK31 frequencies recommended on 80, 40, 20, 15 and 10 meters.

Exchange: RST - State/Province/Country - Power out

QSO Points:
2 Commercial Equipment
3 Homebrew Xmtr or Rcvr
4 Homebrew Xmtr AND Rcvr or Xcvr
(Kits are okay for homebrew)

Power Mult: The highest power used during the contest determines the multiplier ...
a) >5W = X1
b) 1-5W = X7
c) 250mW - 1W = X10
d) <250mW = X15

Multiplier: State/Province/Country for all bands. The same station may be worked on more than one band for QSO points and SPC credit. CW and PSK31 are considered separate bands.

SCORE: Points(total for all bands)
x SPC (total for all bands)
x power multiplier.

AWARDS: Awards of current NJQRP Club kits or subscriptions to "QRP Homebrewer" will be provided based on the number of entries received. Special certificates will also be awarded.

RESULTS for SPRING 2004

Here are the results for the 2004 Spring NJQRP Homebrewer Sprint. Awards and prizes indications will be posted on the AmQRP "Contesting" web pages. Look for the next Homebrewer Sprint on USA Sunday evening on Sept 27, 2004 UTC I hope all enjoyed the sprint!
Thanks for participating! *72, Ken Newman, N2CQ*

(Continued on next page)

	Mode	Qs	Pts	X SPC	x Pwr	= Score
N9NE	CW	91	364	59	7	150,332
K3ESE	CW	71	284	42	7	84,496
W0UFO	CW	63	252	43	7	75,852
AA9NF	CW	54	216	37	7	55,944
K4BAI	CW	56	112	40	7	31,360
W5KDJ	CW	23	92	18	15	24,840
NJ0E	CW	21	84	18	7	10,584
W2JEK	CW	18	72	17	7	8,568
KW4JS	CW	18	72	15	7	7,560
W2AGN	CW	20	80	19	7	6,080
W1PID	CW	14	56	14	7	5,488
WB7AEI	CW	12	48	9	7	3,024
KL7IKV	CW	10	40	9	7	2,520
W2BVH	CW	9	36	9	7	2,268
W5ACM	CW	8	32	7	10	2,240
W0PWE	CW	6	24	6	10	1,440
WA9PWP	CW	7	28	7	7	1,372
W0CZ	CW	5	20	5	7	700
WG1Z	CW	5	10	5	7	350

OPERATOR COMMENTS

N9NE: Rig: K2 @ 5W to tribander at 55'; 40 meter rotatable dipole at 60'; and a 265' doublet at 55'. Great fun and always good to talk to old and new QRP friends! de Todd, Oshkosh, WI

K3ESE: KX1#11 - multiPIG+#14 - K1#379 - 20/40M RockMites Loop - EDZ - LW - Begali Magnetic Classic Paddles 73, 72 es oo, Lloyd, Reisterstown, Maryland

W0UFO: Elecraft K-1 5W. 20m 3el yagi, 40m dipole inverted V coax fed via UFO balun. Conditions were good and enjoyed working so many of the regular qrp ops. de Mert, Ramsey Cty, MN

AA9NF: Elecraft K2 serial #4074 was born on March 13th 2004, after one month of construction. de Pete, Naperville, Il

K4BAI: Rig: Yaesu FT1000MP, 4W. Ant: TH6DXX Beam & Inverted V dipole. 73 de John, Columbus, GA

W5KDJ: K1-4 at 245MW, ANTENNA(S): Mosley 7 element. Slow contest, not many participants. 20M props not to bad, no props on 40M. CU on the next test. de Wayne, Spring, TX

NJ0E: Rig: ten-tec t-kit 1320 for 20m, and a small wonder labs sw40+ for 40m. I liked it; haven't been active in contesting but enjoyed this one. had been doing some work on the ten-tec t-kit rig for 20m and just got the wrinkles ironed out sunday. a great chance to put it through it's paces. thank you all for sponsoring the sprint. 73, Scott, Dripping Springs, Texas

W2JEK: Rig: OHR-500 5W. Antennas: 20M Gnd Plane(on roof), 40M Dipole & 80M End Fed Hertz Thanks & 72/73, de Don, River Edge, NJ

KW4JS: Elecraft K2, 5W. de John, KINGSTON, TN

W2AGN: Power/Rig 5W/Multipig+ (#16) Antenna: KT34/300' Loop I was mainly in the FP "Run for the bacon," but picked up a few non FPs in the process. Thought I better send in a log, or AmQRP will drop this contest, too. de John, Vineland, NJ

W1PID: Rigs DSW 40 and DSW 20 2W, Antenna Windom RTTY was pretty rough on 40. Pretty much shut down the band. Still made a few Qs there. 20 meters was active, but sigs were on the weak side. I worked the first hour and had a blast. Many thanks to all. de Jim, Sanbornton, NH

WB7AEI: Station: HB 40M superhet receiver, 1W VFO xmtr with 5W MOSFET amplifier, homebrew keyer, tuner, SWR meter, power supply. Antenna WAS (i.e. taken down in the dark after contest!) temporary end fed half wave, up 17 feet at high point. MUCH better conditions than typical for the past year(s)! 40M almost seemed normal, changing markedly over the course, with low noise levels. It got to ESP at the end. Heard twice as many as I worked. Tnx to AA1MY and several others for real good ears! Big signals from K7TQ,W0NTA, K6XR. The outdoor EFHWA was so great after being on an indoor DCTL for the past 3 months! 72's, Phil, Kent, WA

KL7IKV: All QSO's were on 14 mhz cw, using K2 at 5 watts, vertical and dipole antennas. Not so hot but fun anyway! Tnx! 73, Lynn, Anchorage, AK

W2BVH: Rig: K2 @5W, 80m CF Zepp. de Lenny, Cranford, NJ

W5ACM: The antenna was a 3-band inverted "V" in the attic. The Elecraft KX-1 arrived in the mail on Thursday, March 18, as a kit. It was fully up and running on Sunday afternoon, but it wasn't easy! Power output was low due to minor problem, so I operated from the internal AA batteries and set the power output level below 1 Watt. It worked VERY well, and I had a great time on my first Sprint. 72 de Andy, Houston, TX

W0PWE/M I had to take my daughter back to college on the evening of the sprint. I put my 20M Manhattan SST in the car thinking I would make a few contacts on the way home and then operate 40 for the last hour or so when I got home. Well, it took longer at the college than I expected so 20M was about dead and I never made it to 40M. Station: 20M Manhattan SST at 1W and a Hamstick on a Honda Odyssey de Jerry, Mobile in NE/IA

WA9PWP: Rig: K-1 @ 3 Watts de Paul, Stoughton, WI

W0CZ: Elecraft K2 SN 1031 running 5 watts. Antenna on 20 meters CL-33 beam up 22 ft Antenna on 40 meters Hy-Gain Hy-Tower I am not much of a contest operator but I liked this contest because the code speed was not too fast. I tried PSK31 too but never found anyone in the contest. The bands were poor the first hour but were good the third and 4th hour when I got back on. 73, Ken, Fargo, ND

WG1Z: Equipment - iCOM IC-775DSP / Spi-Ro D-68 Trap Dipole Heard more stations soliciting for contact than the 5 I snagged. Hope to do better snagging them next time. de Joe, Woburn, MA

AmQRP "LAITF" Contest -- May 22, 2004

Every year we take our radios out in the field, woods, or parks and operate. Now let's add the dimension of observing the wildlife around us and make it a part of the operating event, which we will call Look Around In The Field or LAITF. The exchange will include the name of some wildlife you have seen on that day.

Wildlife means some animal that you have seen since you left home for LAITF. It could be a deer, a moose, a squirrel, an egret, or a fly. Ants and other bugs will work, too. Heck, we'll even count dogs and cats here! Just for good measure everyone can send "human" just by seeing one.

Send a different wildlife name for each QSO or the same one every time, but make sure you have actually seen it before you send its name. It is your choice if you send "hawk", "red tailed hawk", or "buteo jamaicensis".

You've got to look around and not just concentrate on the radio for this operating event!

Rules

Exchange: State, Province, or Country (S/P/C), Your name, Wildlife name

QSO Points: Each QSO = 1 pt + Each unique first letter of operator's names you worked = 1 pt

Multipliers: Sum of different wildlife YOU sent + Sum of different wildlife you copied from other operators, S/P/C total for all bands

Final Score: QSO points X Wildlife mults X S/P/C Mult

Work stations: once per band.

Categories: Home-Single Op, Home-Multi Op, Field-Single Op, Field-Multi Op

Certificates: for the top 3 scorers in each category

Suggested Frequencies (kHz): 1810, 3560, 7040, 21060, 28060

Full details at AmQRP website: www.amqrp.org/contesting/laitf.html

Good luck! *72, Randy Foltz K7TQ*

AmQRP KITS

TinEar Receiver -- www.amqrp.org/kits/tin_ear
*Simple DC receiver that covers about 400 kHz of 40-Meter band ... **$36** (DX + $6)*

PIC-EL -- www.amqrp.org/elmer160/board
*Multi-function PIC16F84A-based project board used in the online PIC Elmer 160 course. Stock is limited - check web page for kit availability before ordering ... **$35** (DX + $4)*

ELSIE -- www.amqrp.org/kits/elsie
*Low cost L-C Meter with Morse output, built Manhattan-style. Stock is limited - check web page for kit availability before ordering ... **$10** (DX + $5)*

Micro908 Antenna Analyzer -- www.amqrp.org/kits/micro908
Handheld control & computing platform for antenna measurement, PSK31 digital modems, signal source & VFO, audio filters, and more. See web page for introductory price. First round of kits already sold out. Orders for second round accepted starting in July.

HC908 Daughtercard -- www.njqrp.org/hc908
*Self-contained, in-circuit programmable microcontroller for Micro908 Antenna Analyzer II, HC908 Commander, etc ... **$40** (DX + $8)*

DDS Daughtercard -- www.njqrp.org/dds
*A precision dc-30 MHz DDS VFO-on-a-card with 101 uses ... **$25** (DX + $5)*

N2CAU "Tip Tapper" Iambic Paddle -- www.njqrp.org/tiptapper/index.html
*Credit card-sized, tactile contacts, waterproof, customized faceplate ... **$29** (DX +$5)*

N2CX Halfer Antenna -- www.njqrp.org/n2cxantennas/halfer/halfer.html
*End-fed half-wave & counterpoise wires for 40m. Includes insulators & detailed application notes. .... **$9** (DX + $3)*

Atlanticon Proceedings -- www.njqrp.org/atlanticon/proceedings.html
Bound sets of QRP articles and technical material on homebrew projects and operating practices, with fold-out schematics and block diagrams from past Atlanticon QRP Forums. Stock is limited - check web page for kit availability before ordering
*Atlanticon 2002 .... **$9** (DX + $3)*
*Atlanticon 2001 .... **$9** (DX + $3)*

NorCal Keyer — www.amqrp.org/kits/NCKeyer
*Memory keyer, with 3 programmable 40-character memories, iambic A & B mode, straight key and bug mode, 2 beacon modes, and variable speed control by either a 100K pot or the paddles themselves **.... $15***

BLT Tuner -- www.amqrp.org/kits/blt
*A simple Z-Match antenna tuner for QRP use on 10m-40m. Includes new aluminum case! ... **$39 for US & Canada** (DX add $6)*

BLT Case -- www.amqrp.org/kits/blt_case
*Nice aluminum enclosure, drilled or undrilled panels, for use in many QRP projects ... **$14** Undrilled panels (Drilled + $3)*

NorCal Crystals -- www.amqrp.org/kits/crystals
Crystals for QRP calling freqs on 20, 30, 40 and 80 meters ...
***$3 each** for 7.040, 10.116 and 14.060, and **$.25 each** for 3.579*

Ordering Kits from AmQRP:
Shipping is free to US & Canada. DX orders: add extra as indicated.
Write check or MO payable to "American QRP Club" and send to:
American QRP Club
1749 Hudson Drive
San Jose, CA 95124
Or pay by PayPal to amqrpkits@amqrp.org

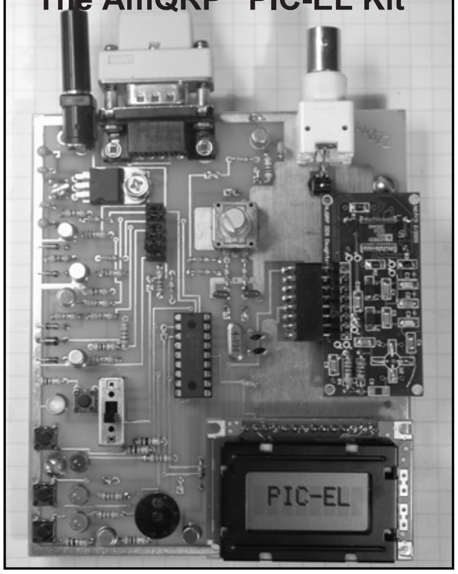
4SQRP KITS

KD1JV Tenna Dipper -- http://4sqrp.com
A low power antenna analyzer and ATU tuning aid ... **$25 for US** (DX add $4)
Order from: Gene Sailsbury, 603 North Free Kings Hwy, Pittsburg, KS 66762

AZ ScQRPion KITS

W5JH Brass Paddle -- www.swlink.net/~w5jh/brasspaddle.htm
Dual-lever paddle made almost entirely of brass ... **$25 for US**
Order from: J. Haigwood, 6926 W. Charter Oak Rd., Peoria, AZ 85381

The AmQRP "PIC-EL Kit"



A multi-function PIC16F84A-based project board that serves as the basis for the experiments being conducted by John McDonough, WB8RCR in the online PIC Elmer 160 course. The course material is geared around use of common I/O components — pushbuttons, LEDs, LCD display, rotary encoder and speaker — and the experiments are designed to take the student through a step-by-step creation of software programs that beep, display and otherwise interact with the user in an instructional manner.

Further, the PIC-EL project board contains an integrated, built-in serial programmer that allows the user to download new programs directly from the PC and "burn" them into the PIC microcontroller ... without requiring any other specialized programming hardware!

We designed the PIC-EL project board with the QRPer specifically in mind. Realizing that hams just love to generate RF and use it in all sorts of ways, we provided an ability for the user to plug in the inexpensive and ubiquitous DDS Daughtercard from the NJQRP Club.

Experiments in the Elmer 160 course provide software that allows the PIC to control the DDS Daughtercard to produce signals in the range of 1 Hz all the way up to 30 MHz. A rotary encoder "dial" provided standard on the board allows one to use the PIC-EL and a stable signal general, a super precise VFO or perhaps even as a signal source for receiver calibration. A BNC connector is also provided in the kit to help enable these common uses.

Not only can the PIC-EL generate signals, it can measure the frequency of an input signal to the BNC connector. Just change the position of an onboard jumper and you'll route signals coming into the BNC jack over to a small circuit that conditions the signal so the PIC microcontroller can determine its frequency. The PIC-EL board also serves as a frequency counter for your bench, displaying the measured signal on the LCD.

Read more about the PIC-EL project on its web pages at www.amqrp.org/elmer160/board, or order it from the information at the top of this page. Supplies are limited.

About ... HOMEBREWER Magazine

WHAT IS HOMEBREWER?

HOMEBREWER Magazine is a full-size, 60-page quarterly publication of the American QRP Club. It is intended for builders, experimenters, ham radio operators and low power enthusiasts all around the world.

Each issue, HOMEBREWER features many of homebrew projects for beginners all the way up to the advanced digital and RF experimenters.

HOMEBREWER also has regular columns and contributions on membership happenings, field operations, commercial equipment reviews and contesting.

FORMAT

HOMEBREWER is a larger-format, increased content version of either QRPp or QHB magazine. It is at least 60 pages containing content-rich homebrewing and construction material, with additional sections dealing with operating, contesting and local club happenings throughout the country.

ANNUAL CD-ROM

On an annual basis, included in every 4th issue starting with HB #5, we include in the envelope a CD-ROM containing PDF versions of each of the previous four issues, including bonus material: software, tools and reference material.

"HB Extra!"

A very nice extra feature for subscribers of HOMEBREWER can be found online at www.amqrp.org/homebrewer/extra ... "reprints" of all graphics published in past issues of the magazine, and most of these reprints are in full color and increased resolution!

Each black & white issue of HOMEBREWER is brought to life in even greater detail for HB readers at this website through the presentation of graphics in their original vivid color. To make it even better yet, we're able to present additional graphics that many times don't make it to the printed journal due to size limitations.

HB Extra! is not a full online version of each issue. HOMEBREWER will remain a printed journal of QRP operating and homebrewing adventures. However, with HB Extra! the staff of HOMEBREWER and each individual author wish to augment the reader's overall experience by providing Extra material to help in understanding and enjoyment of the article topics.

QUALITY

The quality of journal is intended to be first class in every respect, including technical content, editing integrity and journalistic standards. We know the combined subscriber bases of QRPp and QHB will enjoy this publication aspect of the American QRP Club.

HOW MANY ISSUES DO YOU HAVE?

Those with residual QRPp and QHB subscriptions will receive HOMEBREWER in fulfillment of prior subscriptions. For example, if you had two issues remaining in your QRPp subscription, and four issues remaining in your QHB subscription, you will receive six issues of HOMEBREWER magazine. After that, or even before, you can renew your HOMEBREWER subscription at the regular price.

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Subscriptions are also accepted by postal mail. Write a check or M.O. payable in US funds to "The American QRP Club" and send to:

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c/o Paul Maciel, AK1P
1749 Hudson Drive
San Jose, CA 95124

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