YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

QRP Quarterly

Volume 51 Number 2
Spring 2010
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- Get Ready for FDIM 2010! Info Inside...
- An Interview with QRPp Builder AA1TJ
- G3UUR Analyzes Ladder Crystal Filters
- QRP Portable with W5ESE in the Texas QSO Party
- Contest Results—
  2009 Top Band Sprint
  2009 Holiday Spirits HB Sprint
  2010 Pet Rock Celebration
  2010 Fireside SSB Sprint

QRP ARCI[SM] is a non-profit organization dedicated to increasing worldwide enjoyment of radio operation, experimentation and the formation and promotion of QRP clubs throughout the world.

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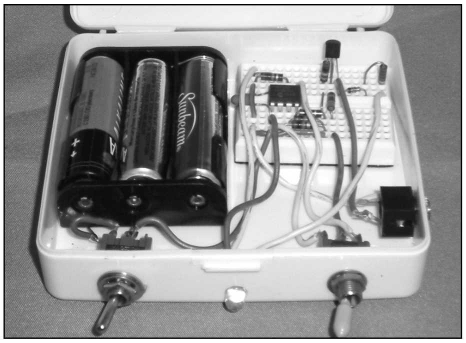

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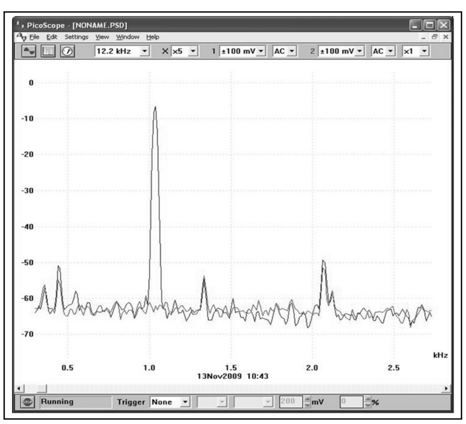

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Technical Articles

The Joy of QRP

The World of QRP ARCI

From the President

Ken Evans—W4DU president@qrparci.org

In the winter 2010 issue, I announced that the terms of three members of the board of directors will expire on June 30, 2010, and asked for nominations for these three positions. The deadline for nominations was March 15, 2010. The three board members whose terms are expiring are Jay Bromley, W5JAY; John Cumming, VE3JC; and Hank Kohl, K8DD. The deadline has passed, and two of the existing members decided to submit their names again for another four year term. These are Jay Bromley, W5JAY; and Hank Kohl, K8DD. John Cumming, VE3JC decided not to run for re-election as job responsibilities are consuming. He has served the club well and his voice of reason will be missed. One other nomination was submitted from Jeff Hetherington, VA3JFF. Jeff has served as the club contest manager since 2005 and is a great ambassador for QRP in Ontario.

On March 15, the cut off date for nominations to the board, we had three candidates for three positions. Per the club bylaws Article IV (b.) If the number of willing candidates is equal to the number of open positions, the candidates shall be considered elected and no vote will be necessary.

Therefore, on July 1, 2010, Jay, W5JAY; Jeff, VA3JFF; and Hank, K8DD will begin four year terms on the board. I welcome both Jay's and Hank's continued service. They are tireless workers and have/will serve the club well. Jeff, VA3JFF is a welcome newcomer to the board. He has served us exceptionally well as contest manager and we welcome his expertise and willingness to serve in this new capacity. Elsewhere in this issue, are resumes (along with pictures) submitted by all three board members

The preparations for FDIM 2010 are at full speed. We have a great line up of speakers, a large number of popular QRP vendors and sponsors, and some interesting entries for the various home brew contests. It's mid March, and we already have 150 attendees booked—well on our way to 220+ registered that usually attend. I hope FDIM is in your plans—the camaraderie among those that attend makes it a great event. You will find details on FDIM in this issue.

Hopefully we will have an eyeball at FDIM, if not, look for me at the various QRP watering holes.

—72, Ken Evans, W4DU

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FDIM - XV
Four Days in May
2010

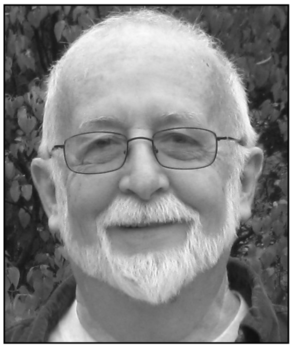
A Last-Minute Reminder: **FOUR DAYS IN MAY is Coming Soon!**

***When*? May 13-16 (Seminars May 13)**
***Where*? Holiday Inn, Fairborn, OH**
***Why*? It's the top QRP event anywhere!**
***What*? Seminars, Build-a-thon, Banquet, Homebrew Contest, Vendors, Door Prizes, Show-and-Tell, Spouse Program, Socializing, ...and the nearby Dayton Hamvention®**

QRP ARCI News

New and Returning QRP ARCI Board of Directors Members

Hank Kohl, K8DD



I was first licensed in early 1958 as KN3DCB, upgrading in 1959 to K3DCB, changed to W8GLC in 1965, and finally receiving K8DD in 1977. A member of QRP-ARCI since 1995, I've served on the QRP-ARCI board since about 1998. I operated the Toy Store for about 5 years and now handle the *QRP Quarterly* back issues and missed issues. I've been involved with FDIM and the "QRP Hotel" rooms for the past 12 years and worked to move FDIM from the old DIDS/Ramada to the present location at the Holiday Inn. The thing I have always worked for is the "International" part of QRP Amateur Radio Club International. I was pleased to be inducted into the QRP-ARCI Hall of Fame three years ago.

Jay Bromley, W5JAY

My name is Jay Bromley and I have been one of your ARCI Board of Directors for the last 4 years and also your ARCI Awards Manager for the last year.

Early in my QRP career I built QRP kits, and loved to operate QRP, especially participating in 20M and 40M QRP Fox hunts. Later, with the help of Chuck Adams, Doug Hendricks and many locals in Fort Smith area, I helped form the Fort Smith QRP Group which later held a QRP forum called Arkiecon for a number of years. While helping out with those duties, I also helped FSQG provide a few QRP kits for Arkiecon funding. In addition to the above individuals, I enjoyed the help from many QRP notables, too many to mention here at this time.

I have the following operating interests which seem to be all over the ham radio map. QRP (of course), DXing, and Contesting. I am no where near the ARRL Honor roll, but stuck right around 300 countries over all. I work all modes including phone, CW, and digital. The last few years since losing my tower and beam, digital operation has been the main mode for me. I have 8BDXCC lacking 12M, but I am closing in on that band now. My ARRL 160M DXCC and 160M WAS awards I treasure as much as some of my QRP awards. Speaking of QRP awards I have QRP WAS and KMPW. Last year I enjoyed the ARRL Triple Play. I am not very good at contesting, but enjoy the challenge of it, especially RTTY contests. Other operating activities I like to do is check into the 4SQRP 80 CW and Wabler nets.

In addition to building QRP gear, I enjoy building AM gear, both with solid and hollow state devices. I have an interests in HiFi audio and audio processing. I enjoy RF and experimenting with antennas, especially field portable antennas. My latest interests has been in SDR receivers.

Two years ago I had enjoyed the trip of a life time with my very good friends Hank K8DD, Stan AC8W, and Jim KB8TXZ, to Suriname for a mini DXpedition from South America.

Over the years I have enjoy the support of the QRP community and making many new QRP friends, that have now become life long friends.

Most of my days now are spent being a QSL manager for two of my dear friends, being your awards manager, and of course, one of your ARCI directors. I enjoy helping with FDIM, filling in where I can. I spend a lot of hours behind the scenes Elmering hams on QRP, digital modes, and LOTW.

I have enjoyed serving as a board member.

Jeff Hetherington, VA3JFF/VE3CW

I was first licensed in 1992 as VE3ZXX while at university, then changed my call to VA3JFF when the new VA3 prefix block was opened. I am also the holder of callsign VE3CW.

I volunteered at IARU Region 2 conference in 1995 in the hospitality/radio room and was shown the ropes of HF operating by many top operators while operating CY3IARU. Immediately after the conference, I upgraded to full HF privileges.

My first QRP operating was in 1995 November Sweepstakes with my mother's (VE3KTX) HW-8. I discovered QRP-L in 1996 and built my first kit, the NorCal 49er and I was completely hooked on QRP.

In 2000, married my wife Wendy (VE3TKS), and son Ian was born in 2003. We have been 100% QRP since buying our home in the spring of 2000.

I have been a QRP-ARCI member since 1998 at my first FDIM encounter, and returned to FDIM in 2004, 2007 and 2008. I have enjoyed being the QRP-ARCI Contest Manager since 2005. I've also served on the executive board of the local Niagara Peninsula Amateur Radio Club and am a member of the Contest Club Ontario. Soon, I will be hosting the first Maplecon QRP gathering in Ontario in the summer of 2010

My primary interests in radio are kit building, portable operating and contesting. Other interests include camping, HO model trains, wood turning, geocaching and metal detecting. I have lived in southern Ontario my whole life, and have worked in retail management for 15 years, the last 7 years with Walmart Canada.

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FDIM - XV
Four Days in May
2010

Thursday a full day of Seminars

Friday spend some time with vendors or attend one of our training sessions

Friday daytime, take a break attend the Hamvention

Wednesday evening Registration and get together

Friday Afternoon and Evening
Vendor Night
Judged Competition
Home Brew Displays

Guest/Spouse Program

Saturday Evening
Awards Banquet
Door Prizes

Thursday Evening
Meet the Speakers

Thursday Evening
Casual Show and Tell

Thursday Afternoon
Buildathon

Saturday Morning
Off to Hamvention or see the sights

Much More!
Watch the web site
www.qrparci.org

Four Days in May
May 13-16 2010
Thursday thru Sunday

- Registration and getting acquainted begins Wednesday evening.
- Seminars are most of the day Thursday, with "meet the speakers" and an open room for some casual show and tell and plenty of time to swap tales during the evening. Thursday afternoon will be the Build-A Thon (requires registration)
- Friday daytime is open to attend the Hamvention® and visit the QRP-ARCI Toy Store.
- Friday afternoon and evening activities usually include "show and tell", vendor displays and a judged home brew contest.
- Saturday is again open for the Hamvention. For the evening, and we have our great annual banquet, awards presentations and door prizes.
- Sunday is the Hamvention®, and check-out.

FDIM Registration and Hotel Reservation

Home Brew Contest	Door Prizes
Build-a-thon	Discounted Hotel Rooms
Banquet	Complimentary Breakfast
Seminars	Hamvention just across town
Meet the Speakers	Nearby Restaurants
Vendor Displays	New Product Announcements
Discounted QRP Products	Spouse Program

This is preliminary information. Some changes will most definitely occur.
Please check the web site, www.qrparci.org, for the latest details and registration information.

12.14.2010

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

Quickie Test Transmitter Controller—Joe's Quickie #73

Continuing the endless series of articles he promised me ages ago, Joe Everhart, N2CX, finally hits the magic number—

Quite often a Quickie will arise as a necessary but impromptu gadget. This is often not some revolutionary new idea but likely a project that incorporates an old idea or design in a unique way. In this case I was preparing for some comparative loop antenna testing on a small scale antenna range. The idea was to measure the relative field strengths of a new design with a known loop antenna under controlled conditions. I decided that I wanted to automatically control a transmitter at one end of the link rather than to simply key it manually. The net result was a simple microcontroller unit to key the test transmitter.

While the current application is for a specific test transmitter keying pattern, the same basic circuit could be used to control a transmitter used in a hidden transmitter hunt or a propagation beacon with proper simple reprogramming. Lest this seem scary, it's not. I designed the circuit and programmed the chip from scratch within 2 hours of coming up with the controller idea.

This was obvious to me since I'd done something very similar for a broadcast band hidden transmitter controller described in an earlier Quickie (Ref 1). For that project the transmit pattern was simply a text string in Morse code. To operate the test transmitter I wanted to send my call sign "N2CX" in Morse code followed by a short silent period then a transmitter "on" period. The call sign in Morse is for transmitter identification, the silent period is for monitoring the frequency to see if it is occupied and the "on" period is for measuring field strength. Actually the whole comparative test setup might be interesting but it's beyond the scope of the Quickie to do this right now. It may be a handy future article.

Figure 1 is the almost trivial controller schematic diagram. U1, the PICAXE 08M chip is powered by three series-connected AA cells to supply about 4.5V DC operating power switched by S1. C1, a 10 µF tantalum capacitor, bypasses the DC power line. Resistors R1 through R4 terminate unused PICAXE pins to prevent erratic operation or damage due to static charge buildup. The keyed output of U1 appears on Pin 5. SPDT switch S2 is used to switch keying transistor Q1 between 5 volts and the programmed keying pattern. The steady 5 volt position keys the test transmitter on continuously for antenna tuning or transmitter power level adjustment while the other setting is used for keying with the programmed pattern. S2's center arm is fed through current limiting resistor R5 to keying transistor Q1, a 2N2222, 2N3904 or other low power NPN transistor. Q1's base is connected to the key line of the test transmitter through J1 and it also illuminates LED D1 to verify that keying is taking place. In this application the

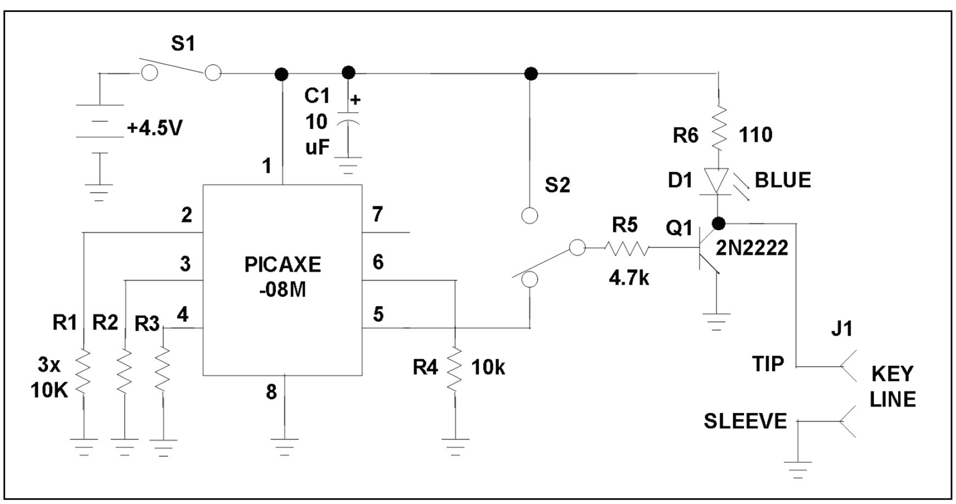


Figure 1—Transmitter controller circuit diagram.

Figure 2—The transmitter controller.

```
'Mag loop comp test xmtr controller N2CX 20100226
'Cycles test xmtr on and off and provides CW id
'Cycle is N2CX cw id @ 24 wpm, 2 sec off, 4 sec on then repeat

symbol KEYOUT = 2 'keying output pin

begin:
'send CW id N2CX
high KEYOUT 'dah - begin "N" - dah dit
pause 150
low KEYOUT 'unit space
pause 50
high KEYOUT 'dit
pause 50
low KEYOUT      'char space
pause 150
high KEYOUT 'dit - begin "2" dit dit dah dah dah
pause 50
low KEYOUT 'unit space
pause 50
high KEYOUT 'dit
pause 50
low KEYOUT 'unit space
pause 50
high KEYOUT 'dah
pause 150
low KEYOUT 'unit space
pause 50
high KEYOUT 'dah
pause 150
low KEYOUT 'unit space
pause 50
high KEYOUT 'dah
pause 150
low KEYOUT 'char space
pause 150
high KEYOUT 'dah - begin "C" - dah dit dah dit
pause 150
low KEYOUT 'unit space
pause 50
high KEYOUT 'dit
pause 50
low KEYOUT      'unit space
pause 50
high KEYOUT 'dah
pause 150
low KEYOUT 'unit space
pause 50
high KEYOUT 'dit
pause 50
low KEYOUT      'char space
pause 150
high KEYOUT 'dah - begin "X" - dah dit dit dah
pause 150
low KEYOUT 'unit space
pause 50
high KEYOUT 'dit
pause 50
low KEYOUT      'unit space
pause 50
high KEYOUT 'dit
pause 50
low KEYOUT      'unit space
pause 50
high KEYOUT 'dah
pause 150
low KEYOUT 'unit space
pause 50
' end of  cw id
low KEYOUT '2 second carrier off
pause 2000
high KEYOUT        '4 second carrier on
pause 4000
low KEYOUT 'char space
pause 150
goto begin      'repeat pattern
end
```

Figure 3—PICAXE BASIC program listing.

transmitter is either a Small Wonder Labs DSW20 or a Yaesu FT-817, although any rig requiring a key closure to ground with 12V at less than 10 mA can be operated.

Figure 2 is a photograph of the controller. Since the whole thing was impromptu and probably not going to see hard, long term usage, I used very rudimentary construction techniques. The PICAXE and other electronic components are mounted on a simple experimenter's plug board and the case is a repurposed plastic first aid kit box from a dollar store.

Figure 3 is a two-column program listing for the controller software written in PICAXE BASIC. Simple in-line code is used to manually generate the Morse code stream and the keying pattern. This is really something anyone could cobble together and modify to suit their needs.

Earlier PICAXE programming was done using the Revolution Education Ltd PICAXE Programming Editor on a Windows computer. For this effort I used an ASUS 1000H netbook running Ubuntu Linux so the LinAXEpad program was employed. While the Windows computer had an RS232 port that could program the PICAXE driving though a couple of resistors (see Ref 2), the 1000H had only USB ports. Fortunately I found a "PICAXE USB Protoboard" available from Peter H. Anderson, http://www.phanderson.com/picaxe/, that will program using the USB port. This programmer ran flawlessly using LinAXEpad with no additional setup required. Peter H. Anderson is a college prof who sells inexpensive microcontroller hardware and projects to support education of students and experimenters so I highly recommend as a satisfied customer that you check out what he has to offer.

As mentioned earlier, this controller could be used for hidden transmitter hunts. Several interesting ones are in the queue for future Joe's Quickies. The first was a 2 meter ham band hidden transmitter hunt that was a lab exercise for an after hours engineering level course I taught at one of my employers. The victims … errr … students were technical personnel who were not hams who were able to be successful in finding the transmitter in a several acre parking lot in under 10 minutes. The second T-hunt was at an Atlanticon QRP activity where several transmitters were hidden in a large exhibition room and 20 or so hams valiantly scoured the area to find them. It was almost a Keystone Kops event! Stay tuned for details in future Quickies.

Reference

1. Joe's Quickie No. 64—Good Enough Fox Xmtr, N2CX, included in the Idea Exchange column, *QQ,* January 2008.

—DE N2CX

Caution on Diabetic Test Strip Containers

A while back this column contained an item on using old 35 mm film canisters, and later GM3OXX suggested also using the plastic containers that diabetic test strips come in. I recently received this caution about the latter from Allan Koch, KA8JJN—

I disagree with GM3OXX concerning the use of diabetic strip containers for storing parts or otherwise. I received a notice in the mail a while back concerning a recall of my strips if I found powdery residue inside the canister. It advised me to discard the canister immediately, after noting the batch number, and contact the company for a free replacement. It seems that all diabetic strip canisters (the 35 mm film canister lookalikes) are lined on the inside with a chemical powder to keep the strips "fresh" for use.

This could be harmful, as I understand it, if we get it on our hands and then don't wash our hands before licking our fingers after eating or such. I for one would not use these canisters for that reason. I especially wouldn't use them if I were to cut or drill holes in them as that would break loose the powder on the inside. I strongly suggest using the plastic pill containers instead as noted in the article, since they are just plastic with no coatings.

—DE KA8JJN

Inexpensive Stand for the FT-817

A while back on QRP-L, Alex Krist, KR1ST, posted the URL to his web page, showing a neat homebrew stand for the FT-817. You can see the full color original article at http://www.kr1st.com/ft817 stand.htm and be sure to look at the rest of the page for other interesting things. (Alex is one of 3 US hams that I know of whose last name is the same as their call sign; the others are KØPP and KØEHL.)

The Yaesu FT-817(ND) is a marvelous little radio with lots of features. One feature, however, is notably absent from this radio. A stand that will lift the front of the radio, so you can actually read the display and reach the controls, is not included. There are several solutions on the market that are well worth looking at, but they will set you back by $20 to $60. If you like to homebrew things and are interested in building your own stand that is sturdy, compact and is virtually free, then read on.

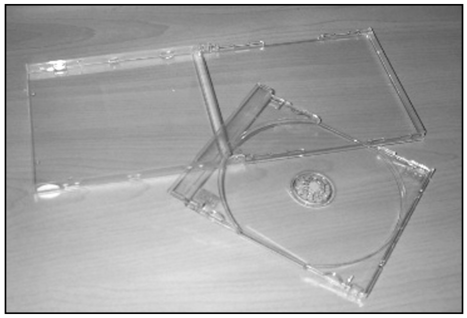


Figure 4—Start with a full size CD or DVD case (not slimline).

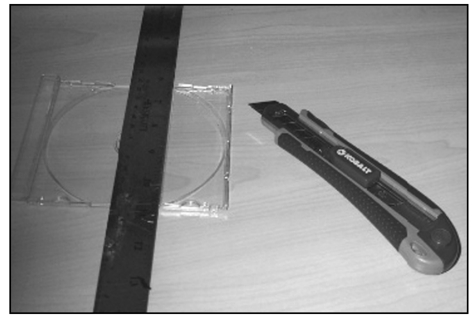


Figure 5—Use a ruler to guide the cutter.

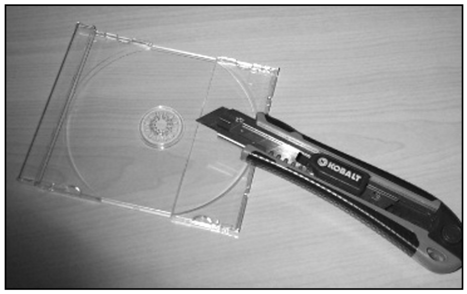


Figure 6—Make a series of shallow cuts until the plastic is thin enough to break off.

Figure 7—Carefully break off the end.

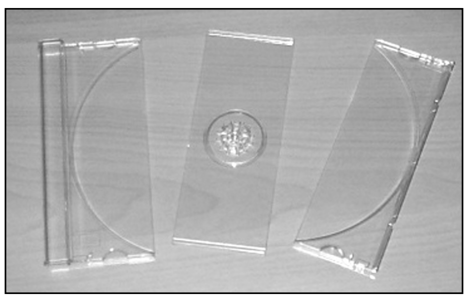


Figure 8—Cut the remaining piece. Position the cut so all 3 pieces are different widths.

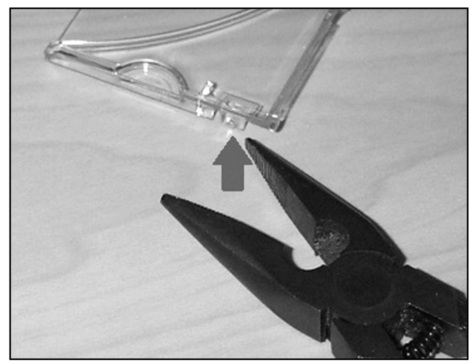


Figure 9—Break off the tabs (4 places).

If you have a spare jewel case from a CD or DVD, you're in business. That is all you need to build this stand. If you want to build the deluxe version, you will also need 4 self adhesive rubber feet that you can buy for a buck or two at any hardware store, furniture store or even the supermarket.

Turning the jewel into a pearl: What follows next are step by step instructions on how to turn the jewel case into a stand. A ruler, sharp knife, needle nose pliers, and a surface that will only look better with a few extra scratches and cuts are all the tools you need to build this pearl of a radio stand.

Step 1: Some disassembly required.

Take the jewel case apart and remove paper booklet and cover (Figure 4). The outer case stays intact, so you can put that aside for now. The actual CD or DVD holder is what we're going to cut. We'll cut it into slices and each slice can be used as the vertical support for the stand.

Step 2: Cutting.

Take a ruler, preferably a metal one, and position it where you want to cut the CD holder. The CD holder has indentations at the top and bottom, against which you can rest the ruler, ensuring a straight cut. Press down on the ruler so it will keep the CD holder in place and cut along the ruler (Figure 5).

Don't expect to be able to cut the plastic in one stroke. You will have to carve the plastic several times to make a deep groove in it. You can even carve the plastic on both sides. At some point you will

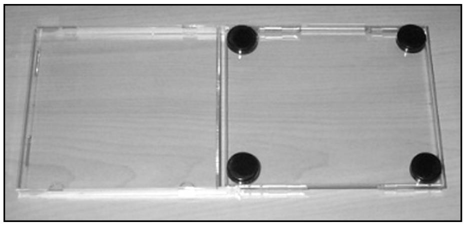


Figure 10—Add rubber feet for the luxury version.

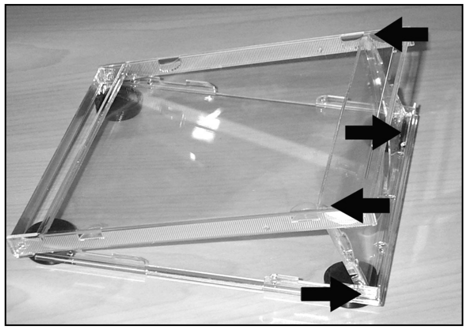


Figure 11—Assembling the unit.

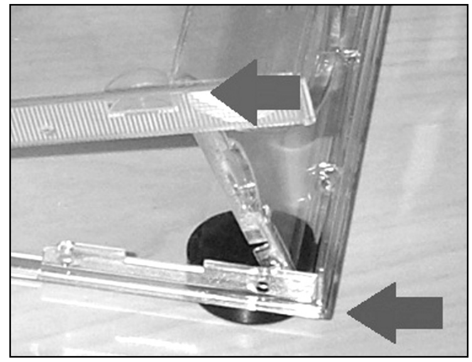


Figure 12—Close-up view.

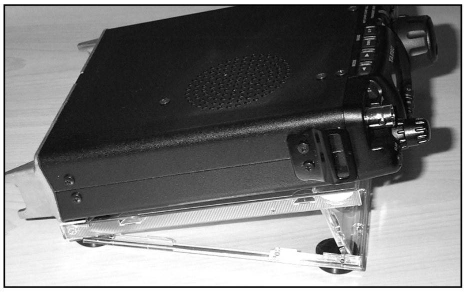


Figure 13—The FT817 on the stand.

Figure 14—Front view.

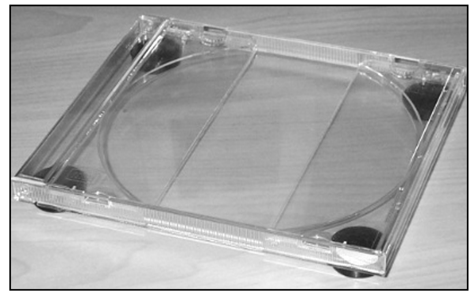


Figure 15—The stand folded up for easy storage with pieces inside.

Figure 16—The FT-817 and stand in the shack.

notice that the slice you're trying to cut off is about to break (Figure 6).

Step 3: Breaking.

Carefully break the CD holder along the groove as shown in Figure 7.

You can do this again with the left hand side of the CD holder, which will give you three different vertical supports of different heights that will position the radio at different angles (Figure 8).

Step 4: Hit the tab.

There are four tabs on the CD holder that keep it in place in the jewel case. These need to be removed. This can easily be done by breaking them off with small needle nose pliers. One of the tabs is indicated by the arrow in Figure 9.

Step 5: Going for luxury.

To get the "luxury" version of the FT-817 stand, all you have to do is attach four self adhesive rubber feet to the bottom of the jewel case, one on each corner, as shown in Figure 10. (The bottom is the thinner of the two parts that make up the jewel case.)

Step 6: Some assembly required.

The hard part is done. Take a moment to wipe the sweat off your forehead, or even take a shower after completing all those laborious prior steps. Now it's time to put it together.

Open the jewel case and place it with its feet down. Position one of the cut pieces vertically inside the bottom part of the case, against the edge opposite of the hinge (arrows facing right in Figure 11). Close the lid and make sure the top of the vertical part leans against the tabs on the inside of the lid that used to hold the booklet (arrows facing left).

Figure 12 is a close up picture for a better view of how the vertical part is positioned.

Step 7: Fitting time.

As you can see in Figure 13, the FT-817 will fit perfectly onto the CD/DVD stand. In fact, the metal enclosure of the FT-817 is almost the same size as the jewel case. Only the display portion of the radio will stick out of the stand, as it should. Figure 14 shows another view.

Parting Remarks

The stand is very portable because you

can simply put the vertical pieces inside the case and close it (Figure 15). Because the vertical pieces you cut in the steps above are not equal in size, you will be able to put the radio at different angles.

In Figure 16 you see the FT-817 on the shelf next to an HW-101 and an FT-897. Notice that the FT-817 is positioned almost at the same convenient angle as the FT-897 to the left of it. Of course you don't have to make the stand from an all transparent case as I did. Maybe you prefer to use a jewel case with a traditional dark CD/DVD holder inside. If the jewel case stand color clashes with the decor of your shack, then you can spray paint it to match the interior perfectly.

—DE KR1ST

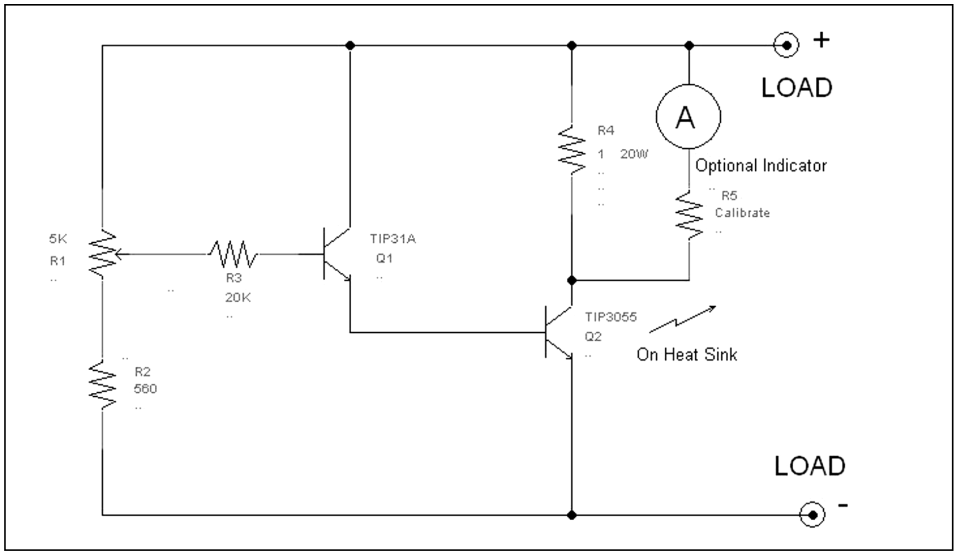


Figure 17—A low voltage electronic power load for up to 3 amperes.

Update on Sweeping the HP 8640B

The HP 8640B signal generator, and it's big, yellow military version, the USM-323, have been around for quite some time but are still prized for their very low phase noise. In the last issue I had some info from K8ZOA on using it as a limited range sweep generator, using it in FM mode with DC coupled input to feed in a sawtooth sweep signal. It does have fairly limited sweeping range, which is a function of the frequency range it's on. For instance, on the 4-8 MHz range a maximum sweep of 80 KHz is possible, and sometimes you might need more.

I received an e-mail update from Jack a while back with some additional comments on the subject.

"For a wider range frequency sweep, such as for a complete ham band plus some, the 8640B can still be used, with a bit of extra work, via a fixed VHF oscillator and mixer arrangement—say a 400 MHz crystal oscillator and a mixer with the 8640B as the second mixer input. This heterodynes down the 8640B's output to the difference frequency. If the 8640B is set at 414 MHz, the mixer output is 14 MHz. And, more importantly, the 14 MHz output has the full DC FM deviation of the 8640B at 400 MHz. This gives you close to 1 MHz of sweep at 14 MHz. (WA8MCQ comment—To put this in perspective, at 14 MHz the 8640B is on the 8-16 MHz range, where the maximum possible sweep would be 160 KHz.)

"The phase noise of the 14 MHz heterodyne output is not as good as if the 8640B were used to directly generate 14 MHz, but it gives you a wide sweep and generally phase noise is not so important when measuring a wide filter.

"This is how sweep generators used to be made "back in the old days." The Kay "Megasweep," for example, used a pair of 10 GHz Klystrons and a mixer to generate a wide range linear swept output in the 10's of MHz range."

WA8MCQ comments—Jack operates Clifton Laboratories and has an excellent web site with a lot of good technical and homebrewing info on it. The URL is http://www.cliftonlaboratories.com/ and then click on Adventures in Electronics and Radio.

—DE K8ZOA

Electronic DC Power Load

From Merton Nellis, WØUFO—

If you want to check a power supply, solar panel or battery, a variable load that can sink from 0 to 3 Amps comes in handy. I took a look at the price of power rheostats and decided that I would build an electronic load instead. I had enough parts in my junk box to make it. The schematic of Figure 17 uses a power BJT transistor to sink an amount of current determined by the drive from another transistor that is controlled by a linear 1/2-watt potentiometer. The actual control current is low and the current gain of the transistors provides a load current of over 3 Amps. The power transistor has to dissipate the power delivered to it so a good heat sink is necessary and/or low duty cycle must be observed.

The schematic shows an optional current indicator based on a 1 ohm shunt. I used a 1 mA analog meter with R5 included to calibrate the meter so that 3 Amps gave full scale on the meter, thus I could multiply the meter scale by 3 to read Amps.

With this electronic load I can easily get data to plot V vs I output for various wall-wart power supplies and solar panels. A maximum of 20 volts and 0 to 3 Amps is a good range for QRP power.

—DE WØUFO

Common Shop Tools Explained

Rob Matherly, WØJRM, posted this helpful information to the Flying Pigs QRP Club list a while back. He later told me he has no idea who the original author is, and as best he can remember it was one of those things that gets forwarded and reforwarded by e-mail ad infinitum.

I know there're a lot of newbies to homebrewing on the list. Perhaps they could benefit from these explanations of what particular tools are used for.

Drill Press: A tall upright machine useful for suddenly snatching flat metal bar stock out of your hands so that it smacks you in the chest and flings your beer across the room, denting the freshly-painted project which you had carefully set in the corner where nothing could get to it.

Wire Wheel: Cleans paint off bolts and then throws them somewhere under the workbench with the speed of light. Also removes fingerprints and hard-earned calluses from fingers in about the time it takes you to say, "Oh, crap!"

Skill Saw: A portable cutting tool used to make studs too short.

Pliers: Used to round off bolt heads. Sometimes used in the creation of blood-blisters.

Belt Sander: An electric sanding tool commonly used to convert minor touch-up jobs into major refinishing jobs.

Hacksaw: One of a family of cutting tools built on the Ouija board principle. It transforms human energy into a crooked, unpredictable motion, and the more you attempt to influence its course, the more dismal your future becomes.

Vise-Grips: Generally used after pliers to completely round off bolt heads. If nothing else is available, they can also be used to transfer intense welding heat to the palm of your hand.

Oxyacetylene Torch: Used almost entirely for lighting various flammable objects in your shop on fire. Also handy for igniting the grease inside the wheel hub out of which you want to remove a bearing race.

Table Saw: A large stationary power tool commonly used to launch wood projectiles for testing wall integrity.

Hydraulic Floor Jack: Used for lowering an automobile to the ground after you have installed your new brake shoes, trapping the jack handle firmly under the bumper.

Band Saw: A large stationary power saw primarily used by most shops to cut good aluminum sheet into smaller pieces that more easily fit into the trash can after you cut on the inside of the line instead of the outside edge.

Two-Ton Engine Hoist: A tool for testing the maximum tensile strength of everything you forgot to disconnect.

Phillips Screwdriver: Normally used to stab the vacuum seals under lids or for opening old-style paper-and-tin oil cans and splashing oil on your shirt; but can also be used, as the name implies, to strip out Phillips screw heads.

Straight (Flathead) Screwdriver: A tool for opening paint cans. Sometimes used to convert common slotted screws into non-removable screws and butchering your palms.

Pry Bar: A tool used to crumple the metal surrounding that clip or bracket you needed to remove in order to replace a 50 cent part.

Hose Cutter: A tool used to make hoses too short.

Hammer: Originally employed as a weapon of war, the hammer nowadays is used as a kind of divining rod to locate the most expensive parts adjacent the object we are trying to hit.

Utility Knife: Used to open and slice through the contents of cardboard cartons delivered to your front door; works particularly well on contents such as seats, vinyl records, liquids in plastic bottles, collector magazines, refund checks, and rubber or plastic parts. Especially useful for slicing work clothes, but only while in use.

S.O.B. Tool: Any tool that you grab and throw across the garage while yelling "SON OF A B****" at the top of your lungs. It is also, most often, the next tool that you will need.

Addition to the list by KB9BVN:

Mr. Blowtorch: Used to set the garage on fire when you least expect it, also useful in detecting flammable items within five feet of your project. Wear protective goggles, heavy gloves, and have the phone number to the nearest burn unit written on the wall next to the phone. Sometimes useful in antenna creation.

Additions from WA8MCQ:

Battery Operated Portable Electric Drill: Used to put holes in wrong locations that are far from the nearest 110VAC outlet. (Wrong hole locations are not always conveniently located.)

Hand Operated Vacuum Pump Style Solder Sucker: A tool used to create a pile of tiny solder bits and flakes to scatter all over the workbench and rug. Extra points are awarded if they fall on a piece of powered-up electronic equipment with the cover removed. (If you have ever used one, or even better, cleaned one, you know what I mean.)

Diagonal Cutters (AKA Dikes): Dual purpose tool, used to simultaneously strip insulation and remove excess strands from stranded wire.

CNC (Computer Controlled) Milling Machine: Device used to snap off expensive tungsten carbide end mills and to carve intricate patterns into the vise and bed of the milling machine.

Anonymous Postscript:

Toolbox: Sturdy metal case holding tools you forgot you owned, stored way in the back under the workbench.

Why Silver Plated Wire with Teflon® Insulation?

You've probably heard of this for years. The reasons for having Teflon insulation are fairly obvious (such as not melting at soldering temperatures), but have you ever wondered why it always seems to go together with silver plated wire? Briggs Longbothum, AB2NJ, asked the question on QRP-L a while back, then answered it himself—

I often see silver plated copper wire under Teflon insulation but I'm not sure why. I'm told that Teflon is corrosive to bare copper and that any oxidation of silver won't matter (silver oxide being conductive). Is there another reason for silver plating wire under a Teflon sheath? I hear conflicting reports and explanations and am still left wondering why. Does anyone know the truth about this?

And his later post—I just answered my own question with a call to Times Microwave. [They are a manufacturer of high performance coaxial cables, connectors, etc. —*WA8MCQ*] The answer to why copper wire under Teflon is silver plated is interesting but not for the reason I had!

It turns out that once you choose to Teflon insulate your conductors (copper wire) because of a need for higher power handling and/or proximity to very high temperatures, as in many military applications, the process of extruding the Teflon to actually apply it as an insulator requires such high temperatures that the copper would instantly oxidize. Hence the need for silver plating over it.

I have seen bare copper braid over Teflon insulation/dielectric which is over a silver plated center conductor in coaxial cable which left me wondering why silver on one copper surface and not the other. Now I (we) know.

Teflon is really quite inert and stable, hence its use on cooking surfaces, etc. In and of itself, it is not corrosive. And my understanding was incorrect all along until just now.

[*WA8MCQ comments*—Anyone who has ever soldered insulated wires and coaxial cables knows that there is a huge difference between Teflon and other insulations. Most insulations melt and make things miserable, but with Teflon you can use all the heat and time you need to make a good connection easily.]

—DE AB2NJ

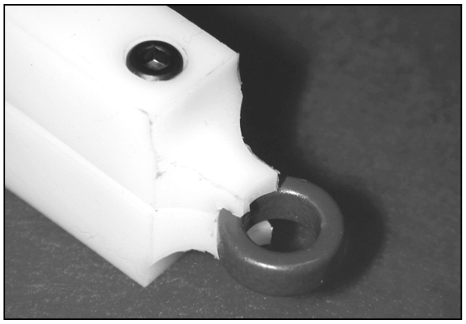


Figure 18—The clamp is made from two pieces of 0.5 × 0.5 inch Delrin (acetal resin). The clamp's nose is 0.2 inches across and is curved to match the core's inner diameter.

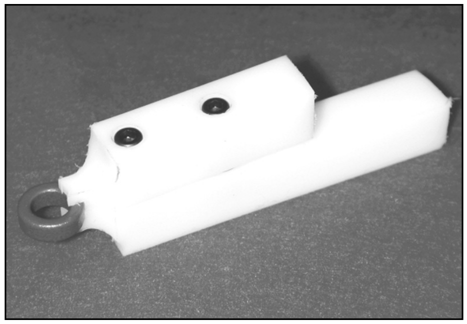


Figure 19—The two sections are held together with 6-32 cap screws.

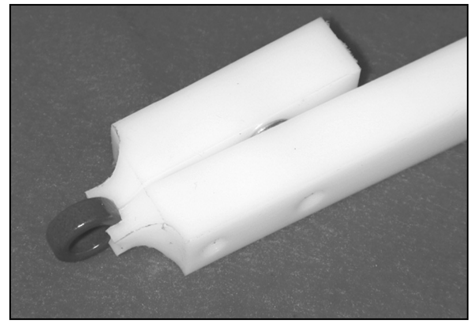


Figure 20—Side view of the toroid holder.

Figure 21—A needle for winding the core is made from a piece of a scrap PCB.

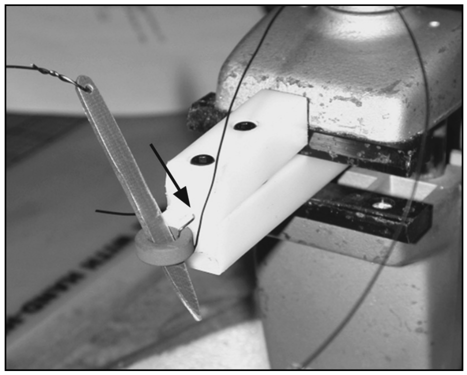


Figure 22—Holder clamped in a vise. Arrow (added by WA8MCQ) shows wire coming out of hole in clamp, mentioned in text.

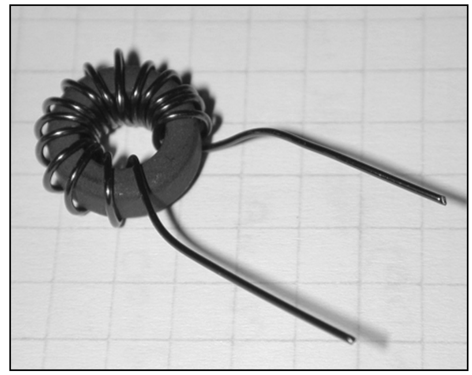


Figure 23—A toroid wound with the clamp and needle.

Holder for Winding Toroids

Here's another item from the Web page of Jack Smith, K8ZOA. You can view the original with color photos at http://www.cliftonlaboratories.com/toroid_holder.htm and while you're there, click on "Adventures in Electronics and Radio" and browse around for a lot more good info. (Jack has also had several articles in QEX in the last few years.)

I tried to add up all the toroid inductors and transformers I've wound over the years and came up with four hundred. Probably 90% of these are wound on 0.5 inch diameter cores, either powdered iron or ferrite. Almost all of these have been wound by holding the core between the fingers of one hand and threading the wire through with my other hand. After winding a half dozen cores, my fingers are usually stiff and it's time for a break.

I've tried clamping the core in a small soft-jaw vise, and found that worked after a fashion, but the vise gets in the way of the windings.

My latest project, a band-reject filter [see Ref.] has seen me winding more toroid inductors. This time, however, I decided to build a clamp to hold the core securely whilst providing clearance for winding. Figures 18 and 19 show the clamp I made.

In order to provide a downward clamping force on the core, I added three stainless steel washers between the upper and lower clamp bars in the rear cap screw.

The recess in which the core rests is cut with a 0.5 inch diameter so that the core makes contact with the clamp over its full length. The retaining pocket is about 0.040" smaller than the core height so that the clamp can generate an adequate retention force. Figure 20 shows a side view.

The clamp lip is milled away in both the vertical and horizontal dimensions so that wire can be wound right up to the clamp. I designed the clamp to occupy about 12.5% of the core circumference with the thought that value is typical of the open space between winding start and stop.

In addition to the clamp, I made a small wire needle from a piece of scrap printed circuit board, shown in Figure 21. The needle is sized to fit through a 0.5" core's inside diameter even with the core fully wound. The needle allows me to grip the wire without straining my fingers and lets me apply more uniform tension when winding the core, particularly with small diameter wire.

Figure 22 shows how the clamp and needle are used. The clamp is held in a Panavise, but I'm considering making a dedicated arrangement to hold it in place.

I've added a small diameter hole crosswise through the clamp's upper jaw to hold the wire in place. The end of the starting turn can be seen sticking out to the left of the needle's center. Having the winding start firmly anchored makes a big difference in comfort as it's no longer necessary to tightly grip the core and wire for the first few turns.

Figure 23 shows the inductor wound on the core with the clamp and needle. I find it much easier to uniformly space the turns and to keep them under greater tension than when gripping the core in my hand. This inductor is wound with no. 22 AWG, which is sufficiently stiff to make it difficult to closely conform to the core's edge. I'll also note that this is a ferrite core

(FT50-61 as a matter of fact) and that most ferrite cores commonly available to hams are not tumbled and coated so the edges are sharp and will remove magnet wire's insulation if tightly wrapped around the core.

The tools I used in making the clamp are a band saw to cut the stock and a milling machine to cut the jaws and to form the nose relief plus a 6-32 tap. I'll probably make another clamp for T68/FT68 size cores. The next one I make will probably have a longer nose. I might also consider milling an angle on the top bar to remove the need for washers. Otherwise, the original design works pretty well.

Reference

See Inductor Selection for an AM Band Reject Filter, http://www.cliftonlaboratories.com/inductor_choice_for_band_reject_filter.htm

[Jack later supplied the following update via e-mail.]:

One thing I've found with my toroid holder is that using the right material is important. I made it from Delrin and it grips a ferrite core without a problem, as most ferrite cores are rough surfaced.

With a painted powdered iron core, such as the ubiquitous T50-2 or T50-6, the combination of a slick Delrin holder and smooth core does not generate enough friction to provide good clamping. Until I can get around to making a new holder from a better material, a temporary solution is to use a small strip of rough paper between the jaws and the powdered iron core. Paper from a thin brown envelope is fine. A supermarket paper bag might work as well, but could be too thick—haven't needed to try it. The key is that the paper must have a rough surface on both sides.

A revised holder might have a rubber jaw insert to solve the problem. Or it might be made from aluminum with cross-hatched lines to provide some grip. There are too many projects on the list for me to get to it soon, however.

It's also important that the jaws be close to parallel when clamping the core. Otherwise it's like shooting a pumpkin seed from your fingers, except pumpkin seeds don't break when they hit the floor, like powdered iron cores do. I added shims to one of the clamping screws to improve the parallelism, but it should be made like toolmaker's clamps with the screws threaded from opposite sides so as to permit the jaws to close parallel.

—DE K8ZOA

Zero Beat Indicator

From Steve Ray, K4JPN—

I recently built a Zero Beat Detector, based on the LM567 tone decoder circuit; the basic idea came from the LA3ZA design [which uses the low power version of the LM567], and also the March 1983 article in Ham Radio by W6KVD. I used the design of the Ham Radio article for the components. In it, I found that the 100 ohm input resistor reduced the audio input to too low a value for use with my Elecraft K2, also I did not need to use the diodes on the input. I built the indicator into my homebrew K1EL keyer, as I feed the command mode audio, through a cap, into my main station speaker and headphones, so I had audio to feed into the zero beat indicator. The keyer had a built in 5V power supply, which I could use to run it. I used a red/green LED for the indicator, with the red being "keyer on" and the green being zero beat indication.

I had an LM567 so I built it using that tone decoder and I am happy to report it worked great. I have several old telephones, built cheaply for clock radios, etc. In looking at them I found they all had IR3N05 tone decoders. After some digging I found the IR3N05 is the same as an LM567. I tried the IR3N05 in the circuit and it worked just like the LM567. So dig around that junk box and you may find you have everything you need to make a zero beat indicator.

[*WA8MCQ notes:* The LA3ZA circuit can be found http://www.qslnet.de/member/la3za/index.html]

—DE K4JPN

An Improved RF Bench Generator

Bob Kopski, K3NHI, posted the design for his bench RF signal generator to the BITX20 forum on yahoo.com and the next year made the following post to the EMRFD forum with a modification to improve the spectral purity—

Back in the Spring of 2008 there was a discussion on the BITX20 Group about RF test generators. About that time I had finished one of my own and posted the details into that discussion. The post was #4730.

Figure 24—Front view of the K3NHI signal generator.

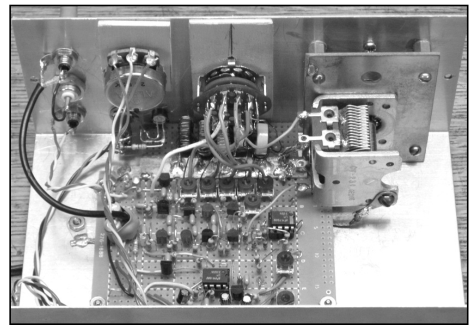


Figure 25—Inside view.

The generator tunes from about 0.5 MHz to 50 MHz in 5 overlapping ranges. It features a very level RF output over that entire range as well as an adjustable output level of about 0 dBm to +15 dBm. Harmonics are everywhere less than –30 dBc [dB below the carrier]. Figures 24 and 25 show two views of the unit. Table 1 gives data for the coils needed.

More recently I've been reviewing that design with an eye to replacing the tuning cap and mechanism for finer adjustment. In the process, upon reviewing present performance, I came to the realization that the largest harmonic present in the output was the second and I thought this curious. Upon a further look I realized this was likely the result of the leveling circuit implementation and this indeed proved to be true.

The block diagram in Figure 26 shows the overall generator circuit with its leveling loop. The basic generator circuit (everything to the right of the dashed line) is a familiar Hartley FET oscillator with band switching followed by wideband unity gain buffers. True to classic form, there is a diode limiter in place on top of the tank. However, instead of it being a diode to ground, this diode is returned to a variable DC pedestal voltage established by the leveling loop. This in turn controls

Band MHz	Core	Primary	Approx L uH	Secondary	Trim pot Ohms
0.65 - 2.7	FT50-61	50 turns #30	162	3 turns #30	10K
2.2 - 8.6	T50-2	50 turns #30	13.4	6 turns #30	5K
3.8 - 15	T50-6	30 turns #28	4.7	6 turns #26	2K
6.6 - 27	T50-6	14 turns #26	1.5	6 turns #26	1K
13.0 - 53.0	T50-6	6 turns #26	0.35	4 turns #26	500

Table 1—Coil data.

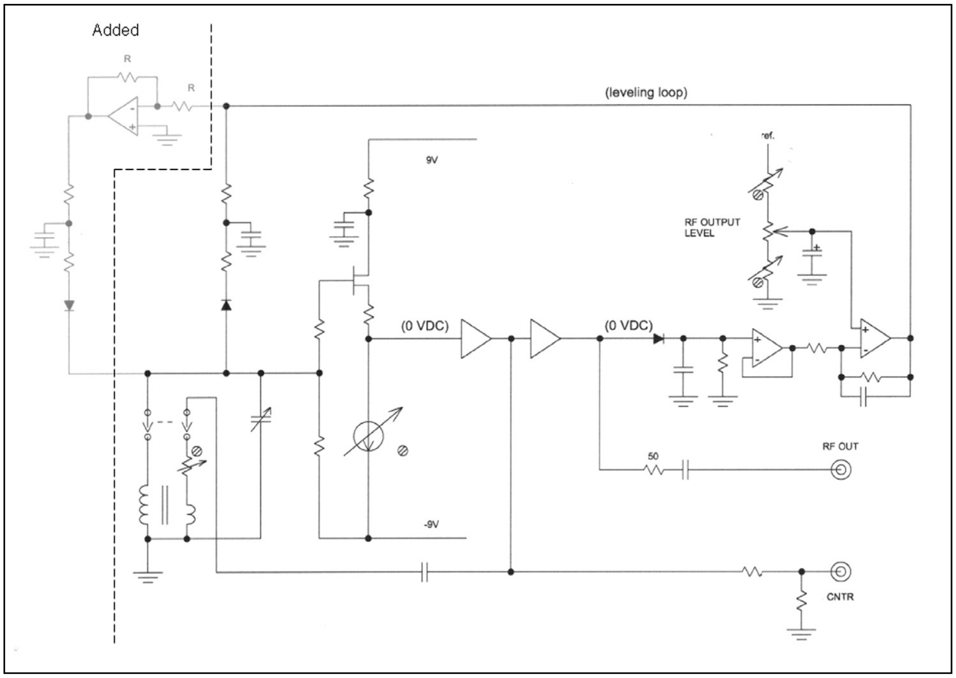


Figure 26—Block diagram of the generator with modification.

the signal swing on the tank and therefore on the final output.

Operation of the leveling loop begins with the desired output level being set with the RF OUTPUT LEVEL pot. Signal peaks at the output are sampled with a simple diode detector circuit, buffered, amplified, and fed back as the tank-associated limiting diode pedestal voltage. This all works very well, but in that only the positive-going swings on the tank get "tugged down" by the leveling diode the waveform is slightly amplitude-unsymmetrical. This accounts for much of the second harmonic content in the final output.

Once I understood this it seemed reasonable to make the tank swing limiting symmetrical. This was accomplished with a simple "tracking limiting diode" circuit addition to the left of the dashed line in Figure 26, which also appears in the schematic of Figure 27. The result: the second harmonic is on average more than 14 dB below previous levels throughout the entire tuning range.

The average second harmonic level measured at +10 dBm output over the entire tuning range is more than –57 dBc. The worst value is (not surprisingly) to be found at the highest frequency (~53 MHz) and is –34 dBc, the result of the obvious beginnings of slew limiting in the buffer stages. As an incidental, output flatness is better than ±0.5 dB over nearly the entire tuning range. It deteriorates to about 1.3 dB reduction at 53 MHz and +15 dBm output—again—obvious slew limiting.

I have not looked at whether this dual limiter diode technique would be as useful in the classic FET Hartley (or Colpitts) "VFO" circuit but it certainly performs impressively in my homebrew RF generator!

—DE K3NHI

[*WA8MCQ notes:* Both groups he refers to are on yahoo.com. BITX20 is for discussions about the bidirectional SSB transceiver for 20M of the same name designed by Ashhar Farhan, VU2ESE, in 2004. EMRFD is a forum for topics along the lines of those found in the ARRL book *Experimental Methods in Radio Frequency Design*.]

Cooking a 2N3904

How much heat can transistors take while soldering without being destroyed? Probably a lot more than they could decades ago, due to improvements in design and manufacture. In my youth I remember reading how fragile they were and it was always recommended to use heat sinking on the leads when soldering them. You could even buy little spring loaded aluminum clips designed for that. But things have changed over the years. Here's a post that Nick Kennedy, WA5BDU, made to an online QRP forum a while back—

I got interested in seeing how much heat a plastic 2N3904 could take in soldering after seeing a post on the Elecraft list.

The data sheet for the transistor gave 150°C (302°F) as the maximum junction temperature. I curled the three leads of the transistor and hung it from the tip of my temperature controlled soldering iron set at 600°F (316°C), then melted a little solder for good thermal conductivity. I let it hang there for at least 20 minutes or maybe until the iron did its auto-shutoff thing after about an hour. I don't know how hot the junction got, but when I grabbed the transistor by its body a couple days later (not realizing the iron had turned itself back on after a power failure) I got a burn on my finger tips.

The length of leads between the iron and the transistor body was maybe 3/8 inch. My crude test to determine if the transistor still "worked" afterwards was done using a really useful test circuit shown in Solid State Design for the Radio Amateur, figure 72. It's an oscillator circuit and you can connect a known good transistor and check crystals with it, or use known good crystals and test transistors, possibly seeing how high in frequency they can go. A meter gives a relative indication of the amplitude of oscillation.

I noted the meter indication before the test using a 14.3 MHz crystal, then after

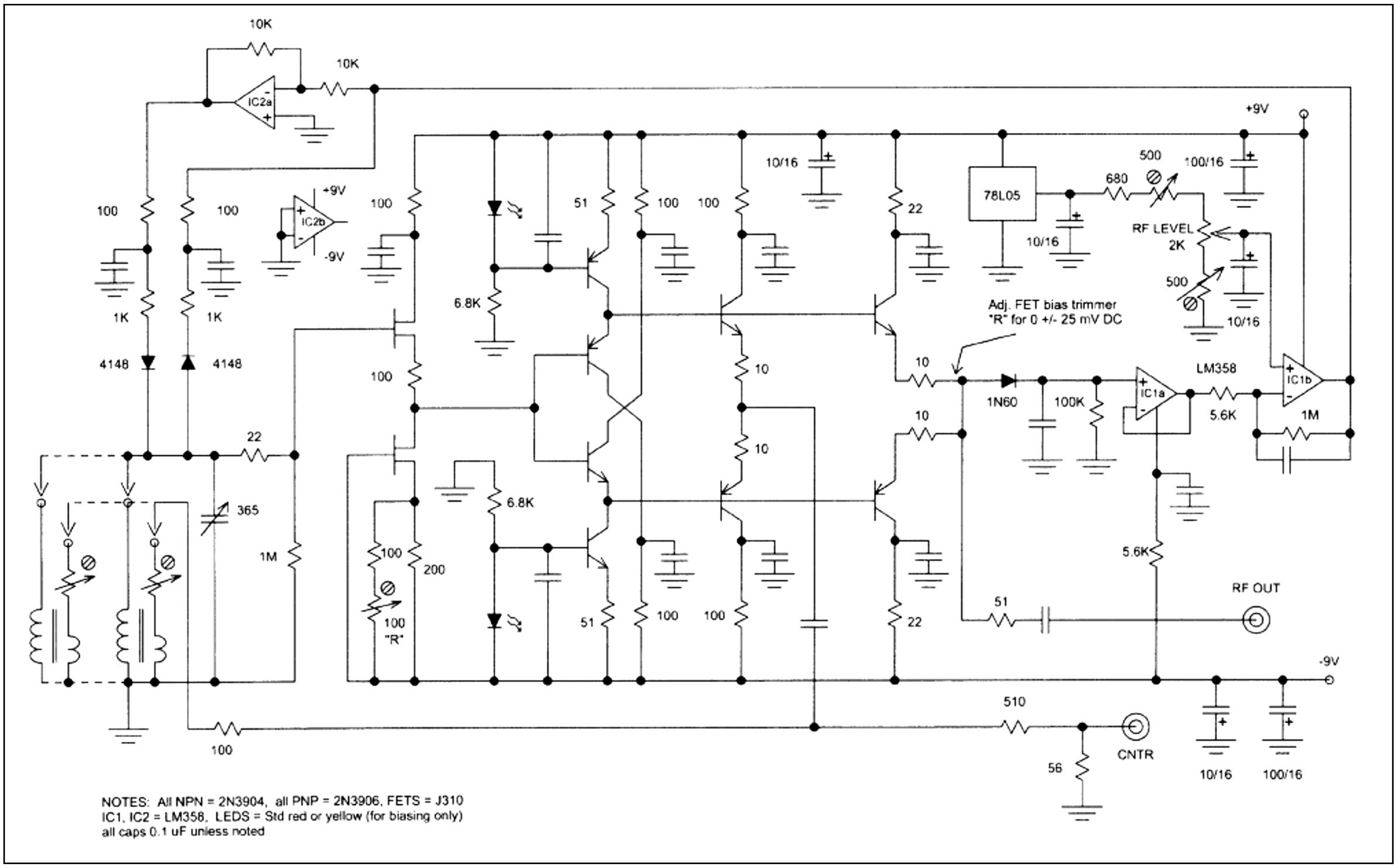


Figure 27—Schematic of the improved signal generator.

the extended “destructive” high temperature test. Oscillation was still good and the relative amplitude was still the same.

What does this anecdote prove? Not much, really, although it might mean it’s OK to use sufficient heat to melt the solder and make a good joint without worrying excessively about damaging the device.

—DE WA5BDU

The Fine Print

You know the drill—send your info to Severn any way you can get it here (e-mail, snail mail, floppy, CD, handwritten on a napkin, etc), or tell me where you found something of interest on the Internet. We take care of the rest, editing, redrawing, etc. The readers are waiting!

QQ Wants Your Ideas!

Send your short technical notes to ’MCQ at wa8mcq@verizon.net

Longer technical articles should be submitted to the Editor, or to any of the Associate Editors listed on page 3.

20 Meter MMIC-Based QRP SSB Transceiver

Pete Juliano—N6QW radioguy90@hotmail.com

Anyone who has seen my website knows that I am an inveterate builder with a motto of "Build it, don't buy it." Much of the fun of amateur radio, at least for me, is trying new ideas and making them come to life. Of course like many other hams, I have two boxes of radio projects. The smaller box has the ones that work; the much larger box has the ones that didn't. But, I sure learned a lot from the projects in the larger box.

In 2007, I started on a project to build a pocket sized QRP SSB transceiver. While the effort was successful, meaning it worked, it definitely was not pocket sized. But, the effort did show me that shrinking down a transceiver would involve something other than through-hole components and conventional circuits. My latest version of this project is a 20M sideband transceiver with some surface mount components and several bilateral circuits, meaning that the same circuits are used for both transmitting and receiving. This allows a reduction of some components, such as transformers and filters, with a consequent reduction in size. Some purists would argue that the circuits are not bilateral but bi-directional as two separate devices are required per circuit stage to achieve the forward and reverse directions. Some more recent bilateral circuits use a singular device with diode steering to route the signals forward and backward through the same device. A good example of this type of circuit can be seen in the GQRP *SPRAT* magazine, nr. 128. Ron Taylor, G4GXO was the circuit designer.

A goal of this project was to investigate the use of monolithic microwave integrated circuits (MMICs) as gain blocks in the previously mentioned bilateral circuits, with a view toward further reducing the transceiver's size. A second goal was to gain knowledge as a building block to the next generation transceiver, which will be an all band, dual conversion MMIC based QRP SSB transceiver. That transceiver probably won't be pocket sized, but it will be useful to me for other purposes and further my goal of learning more about electronics.

At present, the current transceiver is a "work in progress," but it is functional and quite a few QSOs have occurred with it. While there is sufficient information given in this article and on my website, http://www.jessystems.com/20M_MMIC_XCVR.html, to replicate the transceiver, my objectives were experimental. My focus was really on determining how the MMIC devices could be successfully employed in a modern homebrew transceiver. The transceiver uses the experience I gained on a 40M QRP CW transceiver built in 2009 using four MMIC devices. With that experience, I decided to try for a pocket sized QRP SSB transceiver using eight surface mount MMIC devices from TriQuint. These MMICs, Model #AG303-86G, are good from 0 to 6 GHz with 20.5 dB of gain. The real purpose of this article is to share with the readers how I went about building this transceiver, focusing on the decision processes, parts selection, the design criteria and construction techniques.

As an up front disclaimer, I have not made any MDS measurements, IP3 calculations nor subjected the radio to spectrum analysis. Listening tests on my Ten Tec Omni VI + and on the air reports have confirmed that indeed it is a viable transceiver and puts out a respectable signal. I do hear weak signal stations and have made many contacts with the transceiver operating at one watt output power. However, I must confess I have occasionally driven my homebrew 3CPX1500A7, RF amplifier to 1 kW using this tiny transceiver with a small intermediary amplifier at 40 watts.

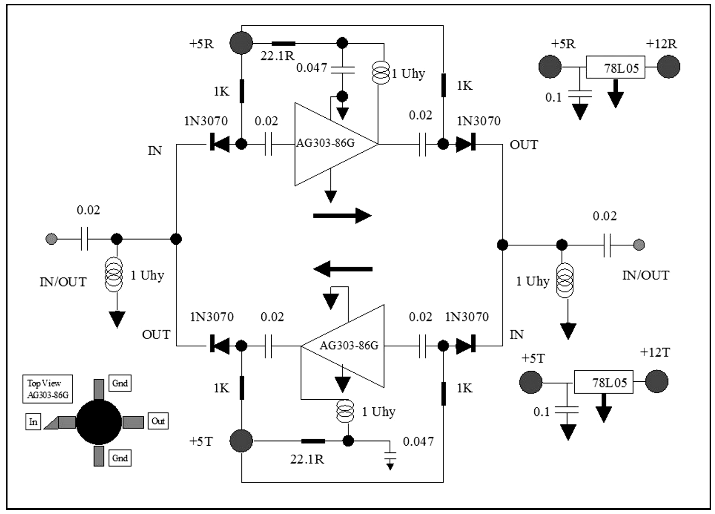


Figure 1—Bi-directional amplifier schematic.

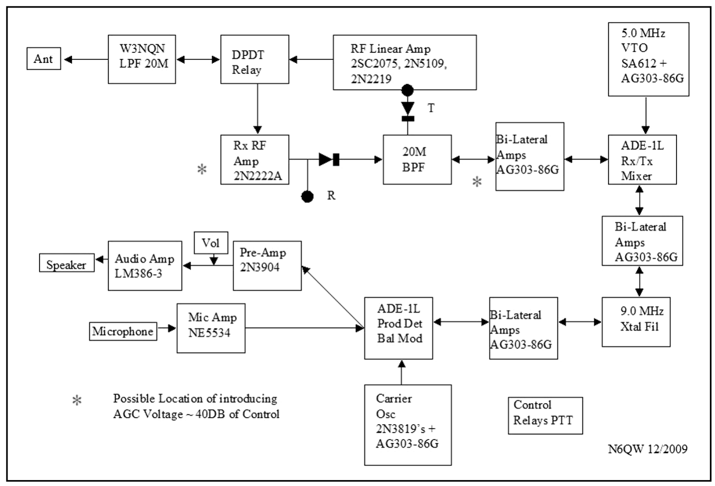


Figure 2—Bi-lateral transceiver block diagram.

The Design Process

My first thoughts on the design were about how to use the MMICs in bi-directional circuits. I had already bought the MMICs, (TriQuint P/N AG303-86G) in 2008 with the idea of testing them out in one of my projects. That particular MMIC was chosen as it had great specs and it was of a physical size that I could see and actually solder to a board.

Typically, the bi-directional (or bilateral) approach involves biasing certain circuit elements to the "on" state, such as those involved in the receive mode, while others are biased to the "off" state. To go to transmit, receive circuits are biased "off" and transmit circuits are biased "on." Think of the bi-directional

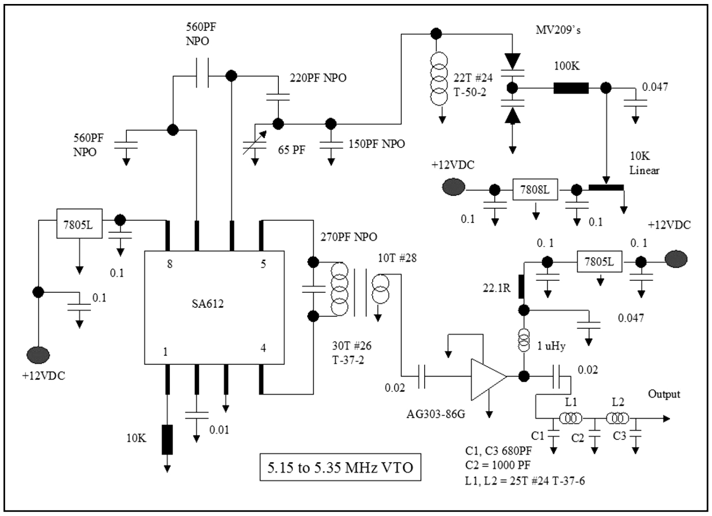


Figure 3—Varactor tuned oscillator schematic.

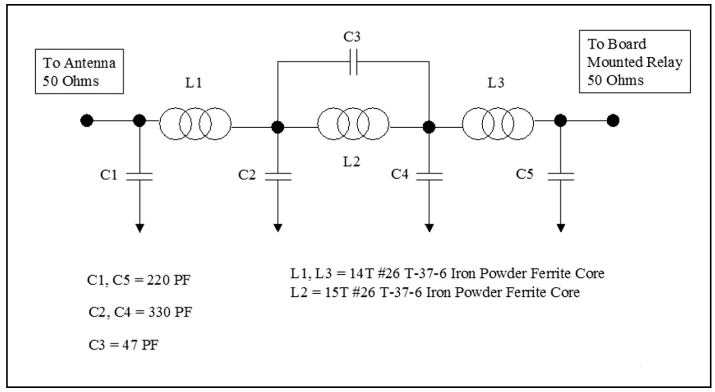


Figure 4—W3NQN low pass filter.

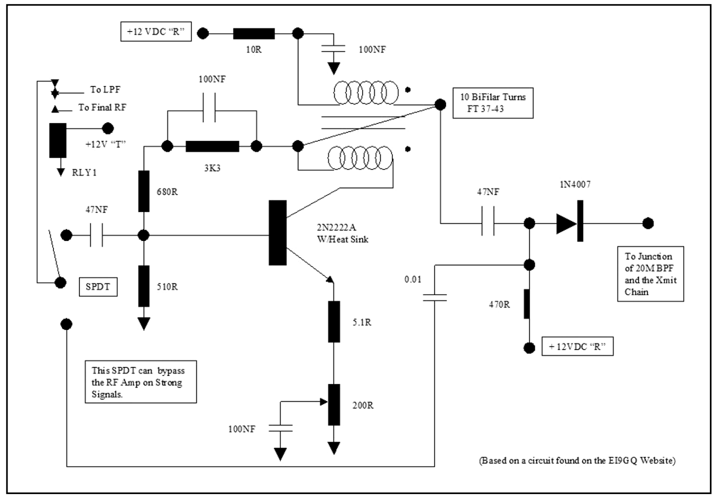


Figure 5—Receiving RF amplifier schematic.

amplifiers as two amplifiers in parallel but feeding the signal in opposite directions based upon which of the two amplifiers is turned "on." In this case, bi-directionality could be easily achieved by simply turning on the supply voltage to a particular MMIC. Finally, John Bellantoni, WB1LAZ, from TriQuint (www.TriQuint.com) assisted me with the selection of circuit components so that the design gain (20.5 dB) and an input/output impedance of 50 ohms would be preserved in either direction. A constant 50 ohm input/output impedance requirement would be critical for those instances where the amplifiers would be at the input or output of mixers and filters. Otherwise, the filters or mixers would likely not operate as expected.

Figure 1 depicts the resulting MMIC bi-directional amplifier schematic and this is the basic building block for the entire transceiver. TR switching (discussed later) consists of providing 13 VDC to one of the two on-board 5 VDC regulators so that the appropriate circuits are powered "on" depending whether the radio is receiving or transmitting. Separate on-board 5 VDC regulators, each connected to one of the MMIC devices, were used to further de-couple the MMIC source voltages.

After convincing myself that the bidirectional amplifiers were achievable, my thoughts then turned to gain distribution throughout the transceiver.

Two critical components were the combination transmit/ receive mixer and the product detector/ transmit up-conversion mixer. Strong signal performance and the local oscillator (LO) power required were important considerations in the design. Choices included the TUF-1 and/or SBL-1, which are frequently seen in amateur designs. These are +7 dBm devices and have a conversion loss of around 8 dB. Another product made by Mini Circuits Labs is the ADE-1L, which is a +3 dBm device (0.9 V PTP) and has only a 5.8 DB conversion loss. The TUF series or SBL series mixers are generally larger devices than the ADE-1L but do exhibit better dynamic range characteristics. In the end, I chose the ADE-1L because of the smaller size and lower LO power requirements, and because this was an experiment into a shirt pocket radio where size and power minimization were important issues. If performance were paramount, I would probably have chosen a TUF series mixer

Typically, the output of a mixer requires an amplifier at the output in order to isolate the mixer from any follow-on filtering. Otherwise, the mixer output is presented with a frequency-dependent load impedance and neither the filter nor the mixer are likely to operate properly. This meant I would need amplifiers at two of the transmit/receive mixer ports since different ports are used for output on transmit and receive. However, too much gain at the front end before filtering and you end up amplifying the signal and the noise. I used a bi-directional MMIC amplifier on the transmit output port since (a) the small transmit signal out of the mixer would need considerable amplification before achieving output power levels and (b) with transmit/receive switching in the proper places, the bi-directional amplifier used on transmit could also be placed in the receive chain, thus lowering parts count in the transceiver. Each bi-directional gain block stage is good for about 20.5 DB. So ahead of the crystal filter on the receive side, we have 41 DB, not including the Receiver RF amplifier which adds in another 10 to 15 DB. The ADE-1L takes up 5.8 DB and a bi-directional gain block amplifier following the crystal filter gives another 20.5 DB. Assuming another 5.8 DB loss in the Product Detector the overall gain to this point in the receive chain is about 60 DB not including the audio stages. That seemed like a good starting place. Any further gain needed in the transceiver could easily be provided in the audio stages.

With the gain plan in hand, I was ready to sketch out the

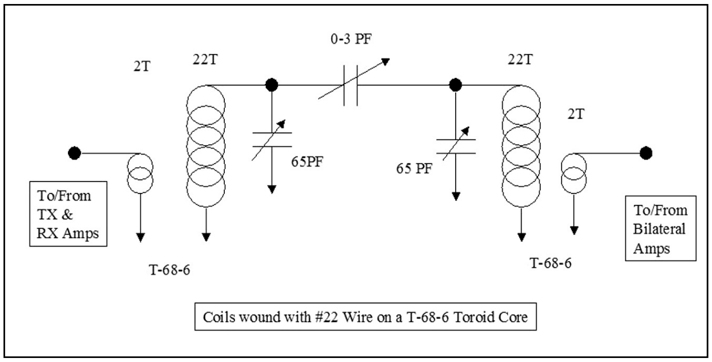


Figure 6—20 M band pass filter.

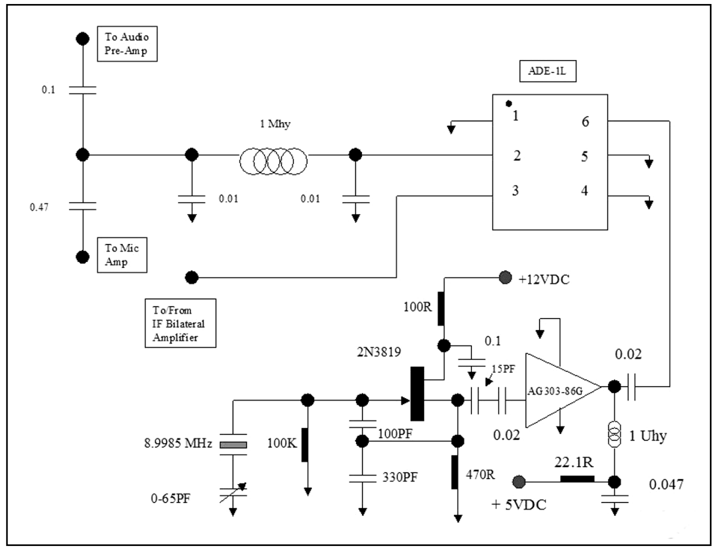


Figure 7—Carrier oscillator schematic.

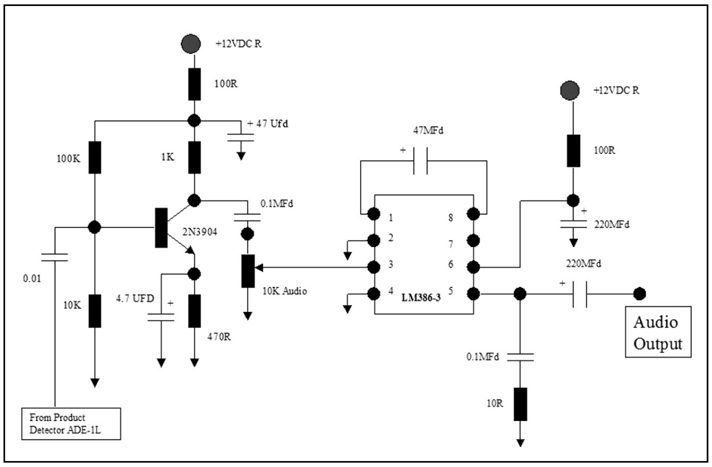


Figure 8—Audio stages schematic.

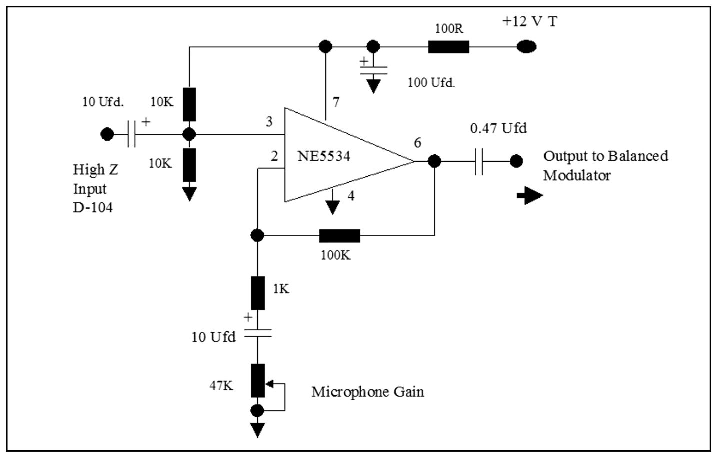


Figure 9—Microphone amplifier schematic.

transceiver block diagram of Figure 2. Eight MMICs appear in the diagram. Three pairs of MMIC devices are used as bi-directional amplifiers on receive and transmit. One pair follows a 20 Meter Band Pass Filter ahead of a Mini Circuits Lab ADE-1L Double Balanced Mixer used for both transmit and receive. A second set of MMICs follows the ADE-IL ahead of the Crystal Filter and a third set follows the Crystal Filter ahead of a second ADE-1L that is used both as a Balanced Modulator and Product Detector. One additional AG303-86G follows the carrier oscillator and another follows the variable frequency oscillator (VFO) used for tuning (labeled VTO in the diagram). These latter two devices are intended to boost the signal level to the 3 dBm that is necessary for the LO level on the ADE-1L's.

Now that I had an overall design, I began to design the various blocks in the diagram. Selection of the other meat-and-potatoes circuits was based purely on past successful implementations and the use of commercial components. Using familiar designs from past projects meant I didn't have to invent new circuits and could rely on their ability to perform in this radio After all, this was an investigation into bi-directional MMIC amplifiers, and it made sense to minimize the efforts associated with other parts of the transceiver.

For the above reason, I chose to use a commercial 9.0 MHz Crystal Filter, an eight-pole unit that came from a Yaesu transceiver. I could also have used the less expensive crystal filter sold by the GQRP Club, which is also 9.0 MHz but a six-pole unit. Or, there is no reason why a homebrew filter could not also be used with this radio! I have built several 4 pole and 6 pole filters using frequencies from 4.9152 MHz, to 10 MHz, with stops at 8.0, 9.0 and 9.8304 MHz. However, I opted for the Yaesu filter because of the steeper skirts and to avoid the effort of a homebrew filter which would have required effort not immediately associated with the bilateral MMIC amplifiers.

The choice of a 9 MHz center frequency for the filter meant that I could use a 5 MHz variable frequency oscillator for tuning, and that gave me the option of a two-band radio. By selection of an appropriate bandpass filter and lowpass filter, 20 and 75 Meters could be covered with the IF and VFO combination. Such a transceiver could use a plug in filter approach for band changing.

As is the case with many homebrew transceivers, most of the interfaces are at 50 ohms. This is a convenient choice because many components expect a 50 ohm interface and keeping all interfaces at this value where possible makes it very convenient for simply tying various circuit blocks together. One exception is the commercial Crystal Filter impedance which is 500 ohms (in and out). That exception is easily taken care of with a 4T to 13T transformer wound on a FT-37-43 core. I used #26 wire for the transformer.

My original choice for the VFO was the Varactor Tuned

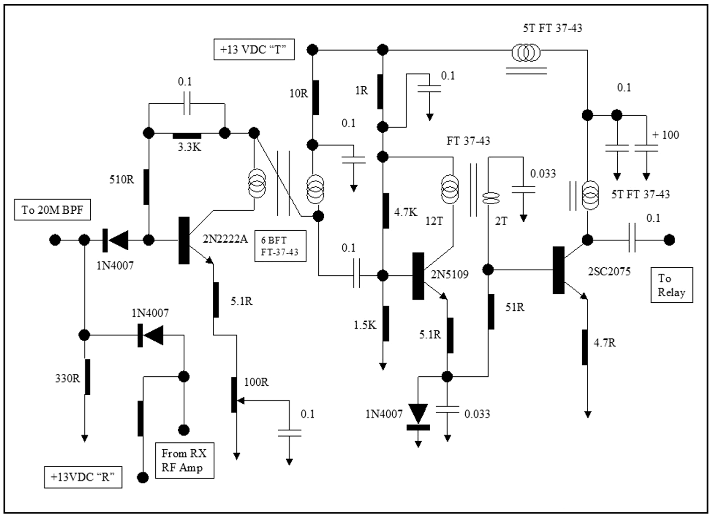


Figure 10—Transmitting linear amplifier chain schematic.

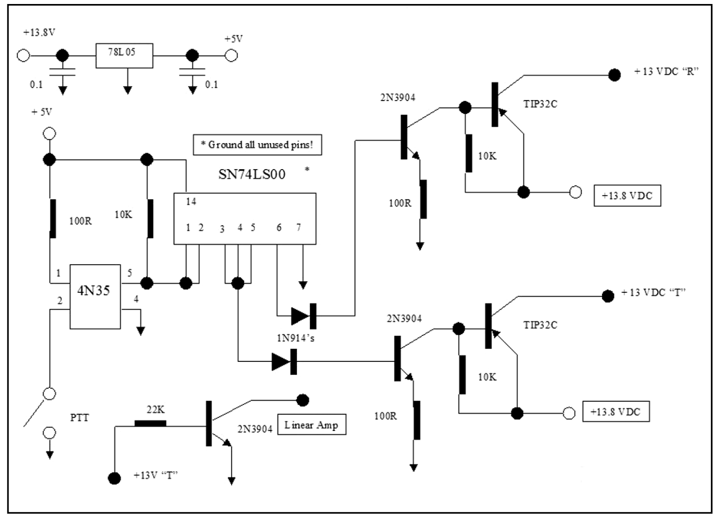


Figure 11—Solid state T/R switch schematic.

Oscillator (VTO), shown in Figure 3, which is built around a Phillips SA612SM. [The NXP (Phillips) website has good info on using the SA602 and SA612 as Oscillators.] Following the SA612 is another one of the ubiquitous AG303-86G MMICs. Earlier in 2009 I had built a similar unit for a 40M MMIC XCVR and was amazed at its stability and performance.

While the VTO was a reasonable choice and could have remained as the transceiver frequency control, I have made a change in implementation since getting the transceiver operational. The means of frequency control has been under constant evaluation and shortly after entering the operational period I shifted from the VTO to a Drake TR-7 PTO coupled with a LCD frequency display that has been offset with the IF frequency. This has been in use for almost a month and has proven itself both in frequency stability and the ability to know where you are in the band. The Drake PTO of course tunes the whole band whereas the VTO only tuned 200 kHz. Plus, the VTO even with a 10-turn pot had to be "eased" onto the appropriate frequency. However, the Drake PTO and the LCD Display are literally larger than the whole transceiver and that prompted the purchase of a Si570 Frequency Generator kit and LCD Display kit available from K5BCQ. Not only is the K5BCQ kit physically smaller, but it is also more accurate in holding the frequency than the Drake TR-7 PTO. The Si570 Frequency Generator now installed in the radio is superb and just about the size of the VTO board. The added bonus is the display. See the sidebar to this article if you are interested in this option.

Other circuits used on the receive side or for common components include the following. The lowpass filters (Figure 4) are a direct lift from a paper published by W3NQN. For the receiver RF amplifier, I used what I call a 2N2222A utility gain amplifier (Figure 5). The bandpass filter (Figure 6) was designed using the design equations in the W7ZOI *Solid State Design* manual. A 2N3819 circuit was used for the Carrier Oscillator (Figure 7). The audio stages (Figure 8) consist of a 2N3904 with an LM-386-3 for the audio output amplifier. Both the Carrier Oscillator and audio stages are from previous projects.

For the transmitting RF chain, I used a design that was an amalgam of many circuits I have seen on the Internet. For the Microphone Amplifier (Figure 9), a NE5534 does the duty here. The only other transmit component not common to the receiving chain is the transmitting RF Linear Amplifier chain shown in Figure 10. The RF Linear Amplifier is a design that I have used about 5 or 6 times, always with good success—except for this time when I encountered oscillation problems in the transmit chain. The radio would work fine into a dummy load but connect it to an antenna and the oscillations were evident. I addressed that problem by placing a gain pot in the emitter on the first transistor RF stage and then added swamping resistors across the broad band transformers. That has solved the problem; but the gain now is only one watt. Usually this amplifier chain can do 4 to 5 watts. Some shielding and a more linear layout of the circuit very likely would prevent the unwanted coupling and solve this problem.

There were two exceptions requiring new design—a T/R switch and a tone amplifier for tune-up.

In my design, the appropriate set of bi-directional, gain block amplifiers are biased "on" based on whether the radio is in a receive or transmit mode. In the receive mode, in addition to those MMICs that are "on," the receiver RF amplifier and the audio stages are "on." The microphone amplifier is "off," as is the transmit RF chain. In transmit, the process is reversed as well as the signal path through the balanced modulator/product detector, crystal filter and receive transmit mixer and so on. In transmit the receiver audio stages and receiver RF amplifier are in the "off" state. A solid state, switching scheme provides T and R voltages to turn on the various amplifiers and stages depending upon whether the circuits are being used for transmitting or receiving. See Figure 11. In addition, I have one board-mounted DIP DPDT relay wired as a DPST. It is used to switch the Low Pass Filter from the receiver RF amplifier input during receiving to the output of the RF Linear Amplifier chain when transmitting.

In designs where I have used an SBL-1 or a Balanced Modulator and Product Detector made from discrete components, I have a method of unbalancing the circuit so that a carrier is provided for tune up. The ADE-1L as well as the TUF-1 double balanced mixers are essentially 4 pin devices and the circuit unbalancing is not possible. So to have something a little more elegant than whistling into the microphone or shouting "Hola" several

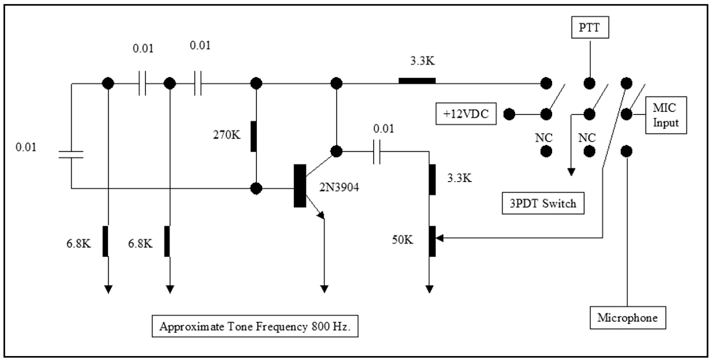


Figure 12—Tone oscillator schematic.

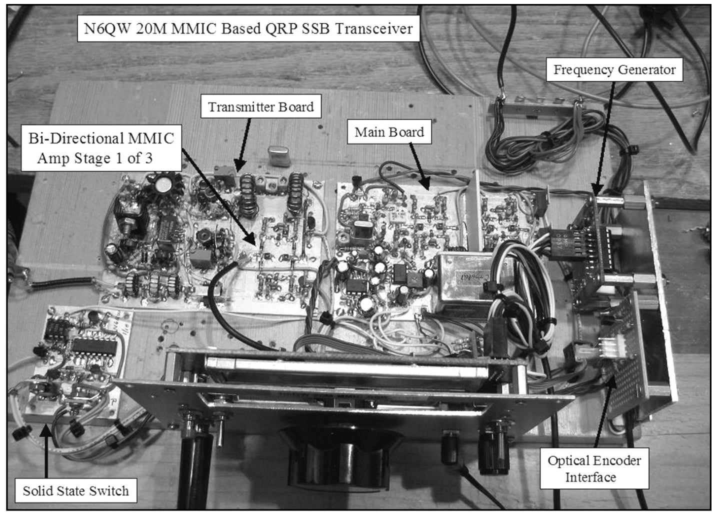


Figure 13—To 20M MMIC-based transceiver.

hundred times, I designed a Tone Oscillator that is controlled by a 3PDT switch. One set of poles switches the main board transceiver microphone input from the microphone to the tone oscillator. A second set applies 12 VDC to the tone oscillator and the third set of contacts engages the PTT switch. The whole circuit is built on a small "perforated" board, which is in turn soldered to the switch. In my case I used a 4DPT switch as it was in the junk box and the 4th set of terminals provides solder anchor points for the perforated board. The Tone Oscillator schematic is shown in Figure 12.

Construction Information

Figure 13 shows a top view of the transceiver in its current state, with the optional Si570 frequency generator. Figure 14 is a front view of the transceiver. As you can see from Figure 13, the transceiver boards are currently mounted on a wooden board that is a part of the PC board construction process. Leaving the copper board attached provides an elevated work platform so that it makes the soldering process ten times easier than trying to chase a board around the workbench. It also is a handy platform for the transceiver during the experimentation phase.

For reference purposes, the two larger boards are 2.75" × 4". The larger board on the left side has one bilateral amplifier stage (following the ADE-1L mixer stage), the 20 Meter bandpass filter, the Receiver RF Amplifier (can be switched in or out of the circuit), the transmitting RF chain and the 20 Meter lowpass filter. The larger board on the right side contains everything from the first ADE-1L transmit and receive mixer through the audio amplifier and microphone amplifier. Extra care was taken on the larger board to the right as it houses the crystal filter and the input and output of the filter need to be isolated. The filter case plus a "T" section shaped copper board soldered to the main board provides a modicum of isolation and reduces the possibility of signal leakage around the filter. That has worked nicely. The boards by design are also a common ground plane, so that helps too! The vertical boards on the right side contain the Si570 frequency generator and optical interface. These two boards together are approximately 2" × 2", which is about the same size as the original VTO. The T/R switching board on the left was constructed on a 1" × 2 1/2" scrap PC board. My plan was to stack the two larger boards and thus shrink the size. I envisioned that the two stacked boards plus the VFO and solid state switch could fit in a metal box 3" × 4" × "5—small, but not quite shirt pocket size! But I am getting closer to my goal.

My PC board construction process derives from a Mini-Milling Machine I purchased several years ago to try my hand at making circuit boards. I use a 1/32-inch end mill and that seems to be about the right size for electronics work. The Mini-Milling Machine costs about $500 so it is hard to justify the purchase price, but it is a big factor in being able to shrink the size of the boards.

My process for making a board takes about two hours from board grid lining to the final board. The advantage of the milling process is that you only remove a minimal amount of copper and the remainder provides an excellent ground plane. I start by laying out 5 mm grid lines using a mechanical pencil and a good square on copper side of the single sided copper board. After the board is laid out I identify the squares that will become islands for connection points.

After that step is done, I drill 1/8 Inch holes in each corner. These holes are on the grid and must be done with care. Once that is complete, I simply screw the copper board into a wooden base that fits into a machining vise on the mill. See Figure 15. A critical step before attaching the board to the wooden board is to align the copper board to the wooden board using the square. The wooden board when it was made was aligned to the bed of the mill. So by using this process, all cuts will align with the grid lines on the copper board. As noted earlier, leaving the PC board attached to the wood also aids construction and experimentation.

How well does it work?

The radio has been in constant daily use for the past month and I can truly say I am amazed at how well it works as I have worked over 100 stations. At the one-watt level, I have contacted stations from Coast to Coast and Alaska from my QTH near Seattle, WA. With the small outboard amplifier running at 35 to 40 watts, DX has been worked in Australia, Spain, Japan, France, Wales and England. I find that at the 30 to 40 watt power levels many US stations think I am running far more power. I have also used the radio on 75M by swapping out the 20 Meter transmitter board for a 75M transmit board that was installed in another radio and that has worked as expected.

I should mention that my antenna is an extended Lazy H up in the pine trees. The top dipole is at 50 feet and the overall length is

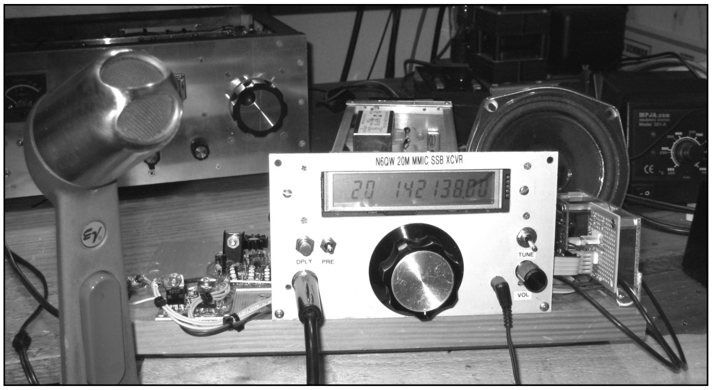


Figure 14—Front view of the transceiver.

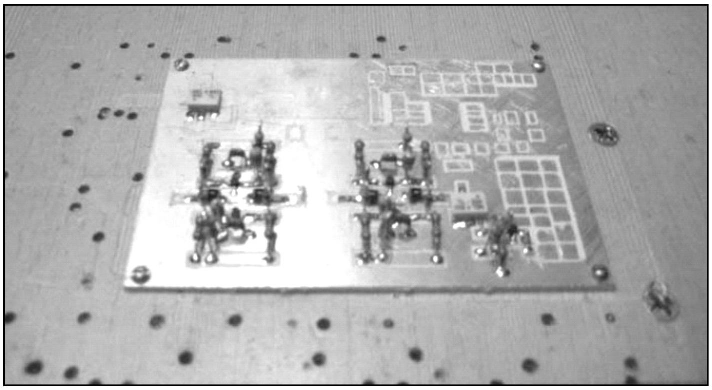


Figure 15—A machined PC board during construction.

110 feet. The lower dipole is 25 feet off the ground and the two dipoles are connected with 25 feet of 450-ohm open wire line fed in phase at the center of the connecting line. Paul Carr, N4PC is the antenna designer.

This radio has proven itself at the one-watt level and with more effort could be made even smaller which would make it an ideal radio for QRP portable operations. It does not have CW capability and that is a limitation for some whom would want both modes of operation. A CW-only MMIC based radio would be easier to construct and has been done by me for 40 Meters. That project can be seen at http://www.jessystems.com/40M_MMIC.html.

Early in the operational phase, audio signal reports consistently stated that it has very clear audio, but possibly lacked some lows. That I attributed to the Heil DX microphone cartridge and possibly some of the circuit components in the microphone stage. I also thought that it might be where I placed the carrier oscillator frequency on the filter slope. Initially I was concerned about carrier leak-through, and so the lack of the lows might be also caused by the carrier placement. Switching to a high impedance Turner hand-held dynamic microphone has resolved the lack of lows and resetting the carrier oscillator using a different crystal has resolved any carrier leak-through problems.

Possible Improvements

The receiver hears the weak stations; but let us be realistic - this is a single conversion, no frills radio. It does not have roofing filters, audio tailoring, a dual noise blanker and AGC. And, until recently there was no DDS synthesizer.

Moreover, the radio is currently sitting on the wooden board

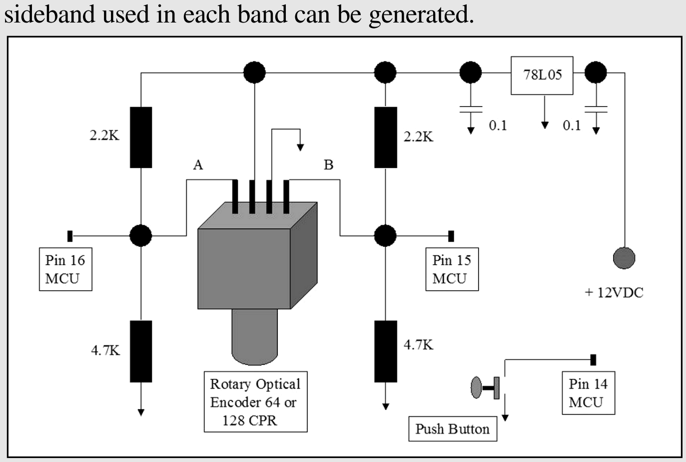
Option—Using the Si570 Frequency Generator as a VFO

The Si570 kit offered by K5BCQ is an excellent means of upgrading the bilateral transceiver, especially if you are considering operating on more than one band. However, the kit does require a small modification and additional circuitry to optimize its use.

The main modification comes about because the kit contains a mechanical encoder for changing frequency. While the encoder is adequate for use with the Soft Rock-type transceivers for which it was designed, use in a hardware-oriented transceiver demands a more durable optical encoder. Optical encoders are easily available, but do add a small cost to the overall transceiver. In the original kit, the mechanical encoder presents a ground to one of two Micro-Controller Unit (MCU) input pins. The other pin is kept at a higher voltage. As the encoder control knob rotates, the 0 V condition alternates between pins indicating that the frequency is being changed. The direction of rotation is transmitted to the MCU by noting which input pin went to ground first. The Si570 can be adapted to an optical encoder by using the simple circuit shown in this sidebar, with the outputs going to the input pin connections originally used by the mechanical encoder.

In addition, the output from the Si570 generator must also be modified in order to properly drive the ADE-1L mixer. The generator is intended to drive an analog switch, and so produces a square wave at a voltage that is too high for the 20m bilateral transceiver. This condition is easily alleviated by a 10 dB pad and a low pass filter which removes the higher harmonics of the square wave. The resulting output should be a sine wave at about 1.4 V peak-to-peak.

By making the low pass filter such that harmonics of the output frequency are significantly attenuated above 32 MHz, additional amateur bands can easily be added to the transceiver by operating the generator above the IF frequency on each band. With this arrangement, I have operated the receiver on 160M (LO= 11 MHz), 75M (LO = 12.5 MHz), 40M (LO = 16 MHz), 30M (LO = 19 MHz), 20M (LO = 23 MHz), 17M (LO = 27 MHz) and 15M (LO = 30 MHz). The only downside is that the sideband generated prior to mixing with the VFO is reversed. Thus, two crystals must be available to the carrier oscillator so that the conventional sideband used in each band can be generated.



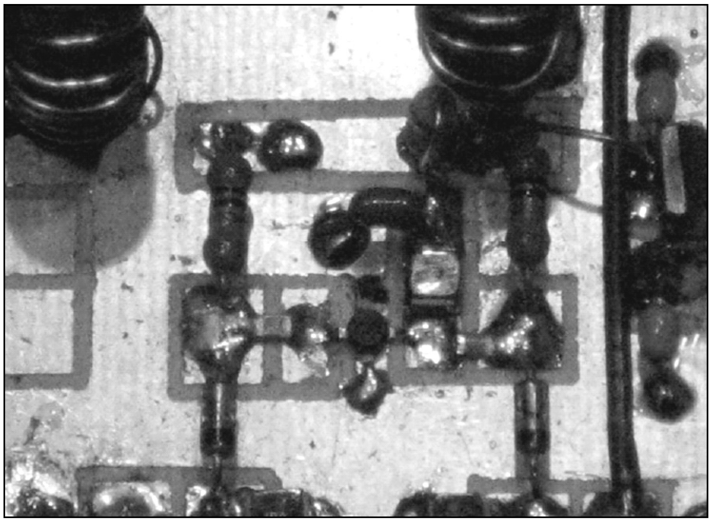


Figure 16—Close-up of a bilateral MMIC amplifier.

and perhaps may never be put in a case. The two major boards are interconnected by a piece of RG-174/U coax. Thus lots of possibilities for further experimentation—not easily done when buried in a case.

On the subject of the AGC, two additions have been incorporated into the "as built" radio. The first addition is the installation of a 10-turn gain pot trimmer in the emitter lead of the receiver RF amplifier. This pot could have been replaced with a single turn pot on the front panel to provide a RF gain control. This is not a desirable approach as it is not a true RF gain control and with strong stations this could make the problem worse. It also would involve routing signal leads to/from the front panel. The pot should remain board-mounted pot and an optimum gain level set to provide a 10-15 dB gain boost then left alone. One fault of adding too much front end gain is that the noise as well as the signal gets boosted. Too much gain also results in overload. 10 dB of gain appears just about right!

The second addition is a miniature bypass switch soldered to the receiver RF amplifier circuit board. This switch could also be implemented using a small board mounted relay controlled by a SPST switch on the front panel. With the gain pot set for full gain and the RF amp "on," a strong station can overwhelm the receiver. Bypassing the RF Stage as well as cranking back on the audio gain clears things up nicely. That is why setting the RF stage gain for around 10 dB and using the switch in/out is a better approach.

A third approach, not in the current radio, would be to replace one of the receive gain block amplifiers with a dual gate MOSFET or a pair of J310's in cascode and this would provide a port for the introduction of AGC voltage. I have done this on other transceivers I have built using these two devices. Reference 1 has several detailed circuits for such a stage employing either approach.

A fourth approach would be to construct an audio-derived AGC. There are well-known circuits for accomplishing this purpose. However, I am not aware of many users of audio-derived AGC for SSB transceivers. Ah well, so many opportunities to learn.

Summary

As stated earlier my real goal was to test the concept of using bi-directional MMIC Gain Block Amplifiers in a QRP SSB Transceiver. To that end I would say it was extremely successful. The TriQuint MMICs as used in this project are just under $2 in single lot quantities and so are somewhat expensive.

When compared to recent work by W7ZOI and K3NHI who have constructed superb bilateral amplifiers using relatively inexpensive common components, the only advantage may be less board space. Shown in Figure 16 is a close-up of one of the amplifiers that was used after the 20M bandpass filter. This circuit has a mix of SMD and through-hole components. For reference, the copper area that has been removed is 1/32 inch wide. Clearly, it would be hard to produce an amplifier of this size with discrete components. However, the lower cost common components do have a cost advantage. I have not done a cost trade study on the two methods but certainly 2N3904 and 2N3906 transistors can be bought for pennies. The real measure is performance and I believe both approaches will do the job.

I would guess the real measure of any completed project is an answer to the question: What did you learn from this project? For me it was many new lessons such as working with surface mount components, the use of MMIC devices and a challenge to use minimum board space. I have as a future project, an all band, dual conversion, QRP SSB transceiver that will employ the same bi-directional amplifiers as used in this project.

References

1. Hayward, W., Campbell, R., and Larkin, B. *Experimental Methods in RF Design,* ARRL Press.

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QRP Clubhouse

Timothy Stabler—WB9NLZ

About two months ago, the editor of this publication asked me to do a write-up about QRP clubs in North America. I sent out a letter to clubs that he and I knew about and I got very few responses. So instead, I looked up Web sites and gathered that information into this article. For clubs not mentioned and for any Canadian clubs, please send me information so I can write you up.

New England QRP Club

Many clubs are scattered throughout the states, but the NE QRP Club is seldom mentioned. The New England Club is one of the oldest QRP clubs in the country and has a lot to offer.

Total membership ranks over 800 hundred members, however, activity wise, there is probably a strong foothold of 100 to 125 warriors. The club's first project was an 80 Meter transmitter (no receiver) rock bound which had an output of 2.5 watts. This was early in the 90s and was well received by the locals in the area. The kit was word-of-mouth and not used as a club fund maker. We simply wanted to produce a fine kit.

The club's latest project is the NEScafe filter…or SCAF filter. The name is a combination of New England (NE) and the filter's name…SCAF. Hence, NEScaf. The NEScaf filter has sold over 900 orders and the club is presently in the process of revising the "thru hole" chip to an SMT. The filter has sold world wide and rivals many commercial renditions, plus it's much less expensive. The club has the world renown and famous New England Logo QRP coffee cup designed by the club's very own in-resident professional artist Jack Frake, W1IU (ex-NG1G). The cup's design has been touted by many professional journals throughout the country and Europe and its clever logo exemplifies what Ham radio is all about. The club is very proud of what Jack designed nearly three decades ago and the logo continues to set the motif of how amateurs operate today.

The New England QRP Club's mantra is "The Excitement Is Building…." And it surely is. There is an ellipsis at the end of the word 'building' followed by a period, thus, 4 periods in a row. This is grammatically correct. The club's cup has seen three major re-orders and continues to be a successful item for every ham shack throughout the QRP community. The only problem is the high cost to mail these cups across the nation. The postal rates have sky rocketed to the point where the shipping costs more than the actual cup, however, many are sold at various ham fests as well as word of mouth meetings. A club patch resembles our logo as well.

The New England QRP Club for a decade in the 90s had a newsletter titled *72*. Of course, as it is known today, the sign off '72' means best regards…but being QRP…is low power. Dennis Marandos, K1LGQ, was the editor for the newsletter, which at one time was monthly and extended into quarterly publications. With the advent of the internet, it was establish sending the newsletter was easier than by snail-mail. The publication rose from 4 to 8 pages to that of 36 and 40 pages, which was too monstrous for one person to handle. The earlier issues of "72" newsletter, which contained some very high level materials, have since been placed on the New England QRP archive Web site. As editor, manager and proofreader, *72* was well received and scholarly written.

The newest form of communicating our ideas is the Web site shared by all members throughout New England and beyond. The URL is: www.NewEnglandQRP.ORG. Messages and pictures are uploaded and dispersed as well as downloaded and disseminated. The Web site is truly the adhesive which keeps the membership in touch and binds the activity of what others are doing. Also, as with all Web sites, it is maintained carefully and supervised by the Master Web operator stationed in Vermont. If you go to the Web site, you can look at the membership list. I am member #269.

Each July, many members travel to Brunswick, Maine to share good stories and new projects at LobsterCon. Although the club does not sponsor this event, ninety percent of the summer travelers are members of the New England QRP Club and venture to be together. The event is held in the spirit of QRP operations, where many hams, along with their spouses (wives, husbands, and children!) camp in tents, campers or large trailers for two or three days, a week after the Fourth of July. The camping site is a minimal cost and registration is low as well for this is truly a family gathering. Many hams throughout the New England area, as well as the Ohio valley, up state New York, and Canadian provinces converge to renew old acquaintances, strike up new friendships, and enjoy burgers, hot dogs and of course lobster.

Often meetings are held at the ARRL Headquarters in Newington, CT when space and personal are available. Inasmuch this is a New England membership, our meetings are scattered throughout the area both north and south. We have scheduled meetings in New Hampshire, LobsterCon in Brunswick, Maine, ARRL meeting in Newington, CT as well as our biannual meeting at the ARRL.

Lastly, the club sponsors a QRP contest the third week in September called QRP AFIELD. Since the contest's inception, many other clubs have copied or at some point, paralleled what QRP AFIELD is. There is a similar contest shared on the west coast called "QRP to the Field," which is mastered from the original challenge established by the New England QRP Club.

North Georgia QRP Club

The North Georgia QRP Club (NoGa) is not a club in the traditional sense of the word since there are no officers, no rules and no dues. The "club" is actually a loose knit group of like minded low power amateur radio enthusiasts. Membership is 25-35 at any one time.

NoGa began its existence in the mid 1990's as the result of several of the founders making QRP presentations to more traditional radio clubs in the Atlanta area. Meetings originally were held quarterly and by late 1998 a decision was made to meet bi-monthly. Interest and activity continued to built so much that by the end of 1999 meetings were being held monthly and it has been that way ever since.

Since there are no officers, committees, appointees or anything activities such as operating events, hamfest tables, kits and such happen because a single member volunteers to head up that activity. When there are no volunteers then there are no activities.

Meetings are normally a 2 hour "show and tell" although we do have speakers and other presentations from time to time AND someone has to volunteer to chair each meeting.

NoGa was recently characterized at an Atlanta wide ham radio meeting sponsored by one of the larger, more traditional clubs as having "no leadership." While the the presider is somewhat humorus, the truth is that NoGa has had substantial volunteer leadership now for over 10 years. If you look at the number of kits that NoGa has produced and operating activities that NoGa has participated in you will know that this could not have been possible without leadership.

Check out the NoGa Web site at http://www.nogaqrp.org and look at "Past Meetings" and "Activities" to see how this volunteer leadership has performed.

Recent operating activity included 2 camp outs. One of these was scheduled to coincide with the "Flight of the Bumblebees." NoGa also has become a regular presenter at a local "Technical Festival" sponsored by one of the traditional ham clubs in the Atlanta area. There is no Email daily or digest mailings and no publications.

There are kits available including a NoGaWaTT dual meter power/swr meter, a NoGa Compendium of projects in printed and CD form, a NoGa Guppy TR switch and a NoGa PiG power/indicator guard.

Weekly club nets include a weekly SSB net on 80 meters on Tuesday evenings and a weekly CW net on 80 meters on Tuesday evenings. Check the Web site for current times and frequencies.

Members of NoGa have been staunch supporters of QRP ARCI over the years. Two QRP ARCI presidents (including the current President, Ken Evans, W4DU) have come from the NoGa ranks. NoGa has also produced a number of Vice Presidents and FDIM Chairs over the years.

Midwest Home Brewers and QRP Group

This is an interesting group and I am sure there are others out there like it. Membership to this group is free and all one has to do is say you would like to be a member and you are one. Like to North Georgia QRP Club there are no officers, rules or dues.

The group was founded in November, 2004, by Darrel Swenson, KØAWB, Darwin (Dar) Piatt, W9HZC, and Brian Zdan, KMØY. The purpose was to promote QRP and building. All forms of communication are integrated into activities of the group.

Although there are no business meetings, the group does get together every other month for building and just good old QRP fun. Meetings are held at the Breadeaux Pizza Place in Ashland, Nebraska at 11:00 AM where the group has been given the back room for their meetings. I was at a meeting in January, 2008, (see their January, 2008 news letter) where I finally learned how to do SMT.

Last year at Ozarkcon, Darrel and Dar took the tracer/injector built the night before at the Friday night build, where they were in charge of the build, and at the Saturday meeting showed how it was used to trace a circuit. This year, they will be in charge of the build again. This year, The build will be the AAØZZ EZKeyer kit. The EZKeyer is a PIC-based iambic Morse code keyer which features three memories and is very easy to use. Visit the OzarkCon site to find out more, see: http://www.ozarkcon.com/workshop.htm. One member of this group, Joe Eisenberg, KØNEB, now does the kit building column for *CQ* magazine.

Their Web site is found at: http://hbqrp.org/hbqrp/. If you want to receive their email, go to: http://mailman.qth.net/mailman/listinfo/hbqrp.

4SQRP

The Four State QRP Group pulls members from a wide geographic area, NC to WA and TX to MN. The club numbers about 200 members who are subscribed to the email reflector,http://www.4sqrp.com/reflector/reflector.htm. The club maintains a Web site located at http://www.4sqrp.com/ index.htm

Four State conducts weekly nets, has monthly meetings in Seneca, MO. They also produce and sell kits to provide funds to underwrite their annual conference, OzarkCon, which is now held in Branson, MO.

Currently available kits include:

AAØZZ EZKeyer: http://www.wa0itp.com/aa0zzkeyer.html

NT7S VRX-1 DC Receiver: http://www.wa0itp.com/vrx1.html

Clear Top TIn enclosures: http://www.wa0itp.com/cleartoptin.html

K8IQY Enhanced Manhattan Islander Amp: http://www.wa0itp.com/emislander.html

NMØS NS-40 Class E Transmitter: http://www.wa0itp.com/ns40.html

NB6M HF Test Set: http://www.4sqrp.com/kits/hf_testset/hf_testset.htm

Several more kits are in the making, so watch for announcements.

Four State conducts 3 weekly nets, all on Wednesday evenings commencing at 8 PM Central time including a 80M Comfortable CW net on 3563, 8:30 PM 160M at 1810 in the Winter months, and 7122 in the Summer months. At 9 PM is the PSK net, also called the Warble, convenes at 3580.5. Terry Fletcher, WAØITP, is NCS for all the above.

The MI-QRP Club, WQ8RP

The Michigan QRP Club was organized on January 19, 1978 in Michigan's Lower Peninsula and has grown to include members from many parts of the country and around the world. Their quarterly publication, *The Five Watter*, is published in March, June, September and December. The products, projects, features, and fantasies described are solely for the delight for our readers. Members are encouraged to submit items for publication. Contact the editor for more details. I receive this publication and the articles included are excellent reading for any QRP operator.

The club net is held weekly on 3.535 MHz. each Tuesday night. The net starts at 9:00 PM Eastern Standard Time or 9:00 PM Eastern Daylight Savings Time. The start time does not change between Standard Time and Daylight Savings Time. Members and Non Members are encouraged to check-in. All amateurs are welcome. Operating QRP is not mandatory.

Code speed is about 18 WPM. Net control will respond to a QRS request.

The MI-QRP Club Reflector is located in "Yahoo Groups." To participate, no cost membership in the group is required, you'll find directions when you enter the group site. The purpose is to get, post,and share information with other members via e-mail. In addition to receiving e-mail updates, questions, and responses you can view all communications as they are retained within the reflector.

The monthly Breakfast (First Saturday, 9.30am) is held at Old Country Buffet, 4190 East Court Street, Burton (Tel: (810) 743-1810). Directions for attending are I-60 & Center Rd, go north to the Courtland Mall and turn right on E. Court Street. The Old Country Buffet is about 3/4 of the way down the mall on the south side of Court St.

The Eastern PA QRP Club

The Eastern PA QRP Club was formed in December 1997 by Ron Polityka N3EPA. The purpose of the club is to have the QRPers who live in and visit the Eastern PA area get to know each other. The club now has 163 members who are active on the HF bands and keep in touch via a list server, EPA QRP-L. Wow, they never thought the club would have 100 members when it was first started the club iin 1997. The members live in CA, CT, DE, GA, IL, NH, NJ, NY, MA, MD, MI, NC, OR, PA, SC and VA. The club acquired the KB3DBJ call in October of 1998. Shortly afterwards the club applied for N3EPA through the vanity call sign program. The club had their first meeting on Feb. 26, 2000, which was a great success. They also participated in the 1999, 2000, 2002, 2004, 2005, 2006 & 2007 Field Day.

The Appalachian Trail Award program was created to promote QRP operations on the trail. There are five different types of awards that are available for all amateurs. Details are on the Web site. The program is new as of Jan. 1, 2000, and it already seems to be a hit with the QRP community.

The Eastern PA QRP Club members participate in many contests through out the year. The members hunt the different states, DX, and counties as well as rag chew on the HF bands. A large number of the club members like to build radio kits. They have built everything from the basic 38 Special to the Elecraft K2 and K1 transceiver. The members like to go camping, hiking and canoeing. Of course they always take along their QRP radios. You could probably bump into a member or two at a hamfest in the Atlantic Division area. The latest pastime for the group is activating the Appalachian Trail for the award program.

The club Web site is found at: http://www.n3epa.org. The list server is found at: EPA QRP-L. Membership in the club is free and can be requested online or via snail mail under "membership" on the Web site.

The Colorado QRP Club

The Colorado QRP Club, Inc. (CQC) was formed in January, 1994 for the purpose of promoting low power amateur radio in Colorado and around the world.

In the Denver area, from the early 70s to the club's formation in 1994, there were many on-the-air gatherings of QRPers. Much of it centered around 10 meters since that band was more conducive to DX at low power levels and QRP gear could be easily converted from 11 meter surplus. WBØGAZ, WBØIEA, WBØJNR and many others conducted informal nets catering to QRPers in the 70s. In the 80s it became a little more formal with regular nets being conducted by WDØFQK, NFØZ and a host of others who came and left the Denver area during that turbulent economic period.

Richard High, WØHEP, and others announced what would be the tentative club's first official meeting on January 22, 1994. WØHEP hosted the meeting at his place of business. It was at that meeting that asked the most important question; "Is there a need for not only a QRP Club in Colorado, but another in the nation as well?" The answer was a resounding "Yes!" from all 13 present.

In 2001 the membership reached the 700 mark with members all over the United States and in a number of other countries around the world. Membership has always been open to anyone with an interest in QRP (Low Power Operating). Easy membership sign-up, dues, and other related information can be found on our membership page.

Meetings are held bimonthly in January, March, May, July, September and November of each year. Our award winning newsletter, "The Low Down," is also published bi-monthly. Articles in The Low Down come from members as well as other publications and the internet covering just about every aspect of amateur radio.

The Colorado QRP Club participates in Field Day and a variety of other contests and operating events each year. CQC Also sponsors various QRP QSO parties each year in addition to maintaining an awards program. Additional info can be obtained by contacting any of the club's officers.

Their email reflector is at: cqclist@yahoogroups.com. Their Web site is found at http://www.cqc.org.

Flying Pigs QRP Club

This club was formed in August of 1999 by a small group of hams in the Cincinnati Ohio area. In the mid 1800s, Cincinnati was known as "Porkopolis" as they were the leading pork processing center at that time. Hence, the name Flying Pigs. The main function of the group is to "have fun." The Flying Pigs QRP Club International has sponsored many Build-a-Thon events at FDIM, and even had a "hog roast" there in 2001. One can join the group by going to the Web site below and signing in. There are about 2400 members now and this writer is proud to be #243.

The club does have a newsletter, *The BaconBits Newsletter* and issues are on line. Every once in a while the club sponsors a group build but nothing is going on now. The Flying Pigs QRP Club International also has a sprint on the third Sunday night of the month. The "Run for the Bacon Sprint" has been managed by Larry Makowski W2LJ for years, and it has become quite popular in the QRP community. The motto here "No Rules, No Dues, Just Fun…and if we don't like it, we fix it." They have no treasury, no officers, and no clubhouse., but they have managed to put together a great Field Day team for the last 10 years. They can be found operating from Caesar Creek State Park in southwest Ohio.

The main club Web page at www.fpqrp.com. Please stop by from time to time and see what's going on.

NorCal QRP Club

NorCal was founded in May of 1993 by Jim Cates, WA6GER and Doug Hendricks, KI6DS. Its purpose was to promote QRP. The club has grown beyond all expectations, and now has members all over the world.

Membership in NorCal is free. All that you need to do is say that you would like to be a member and you are one. There is no journal, and no regular business meetings, but there are regular social meetings every month. The reason to be for NorCal is to have fun with radio. There are no dues, no membership requirements, no treasurer's reports, no secretary's minutes at our social meetings, just good old QRP fun!!

The club is probably best known for its many kits, which started with the NorCal 40, designed by Wayne Burdick, N6KR, that is credited with giving the club a huge boost when thery were getting started. Wayne later designed a couple of other famous kits for us, including the 49er and the Sierra. They have kitted antennas, antenna tuners, transmitters, swl receivers, ssb transceivers, simple receivers, QRP amplifiers, paddles etc. The club has broken new ground by establishing benchmarks for quality manuals and kits. The club will continue doing kits, with the profits made from them all being used to promote qrp as we give back to the hobby.

Jim Cates, WA6GER, one of our cofounders, became a silent key in April of 2004. He is missed by all, but the work that he started will continue with the club. The club is now in the hands of Doug Hendricks, KI6DS, Paul Maciel, AK1P, and James Bennett, KA5DVS. The club will continue to produce kits, and will continue to host annual QRP Forum in October during Pacificon. we will continue to have our monthly meetings and we will continue to have an active Web site.

The club plans to have monthly reports with pictures from the meetings. Manuals for all club projects are available or their Web site plus featured articles from past issues of QRPp. If you have a project or an article that you would like to put on the site, the club would love to have it. Contact Dean Davis, N7XG or Doug Hendricks, KI6DS, for information.

The club's Web site is at: http://www.norcalqrp.org.

New Jersey QRP Club

The New Jersey QRP Club is a group of Amateur Radio operators sharing a common interest in QRP (low power) communications, building equipment and swapping tall tales. By mutual agreement, our club has no formal officers, rules or dues. Our members are mostly from the New Jersey area but anyone can join and we have members from almost "everywhere" thanks to the Internet.

While there is no formal leadership, several individuals have voluntarily stepped forward (or did everyone else take a step back?) to keep things running. The club's founder: Vince Passione, WA2ECP, is in charge of membership (just contact Vince at this email address to join: wa2ecp@arrl.net). QRP Hall of Famers: George Heron, N2APB, and Joe Everhart, N2CX, coordinate and run the meetings and supply technical expertise. Ken Newman, N2CQ, is our contest guru. Other members participate according to their desires and interests.

Periodic meetings are held, usually on Saturday mornings near the end of each month. Most meetings are held in the Princeton Red Cross center. Meetings are very informal, there is no "business meeting" (i.e., no reading of minutes, secretary or treasurer's report, etc.) and almost no formal agenda. Folks usually bring their latest project for "show and tell" and many bring along excess parts to share with other members.

Most club coordination is done here on the club's Web pages, http://www.njqrp.org and also through our Yahoo! Group, which you are welcome to join.

American QRP Club (AmQRP)

Last in the grouping is the American QRP Club. The American QRP Club was formed in June 2003, and later incorporated, as a organization of ham radio operating enthusiasts interested in low power operation—these types of hams are called QRPers. The AmQRP Club is not affiliated with any geographic area and its membership does not meet monthly as do many regional radio clubs. Instead, the AmQRP provides online information, instruction, goods and services to the general QRP population for educational and enjoyment purposes.

The name of the organization was purposely selected as such because it is predominantly an American club, sharing the goals, dreams and passions of our great country. There are also many Canadian members in the club, and the name of the organization can also be extended to represent our valued North American neighbors. The club wants to ensure that they know that they are valued and welcomed members. The focus of the American QRP Club is on US and Canada, but will always welcome members from DX countries, just as the G-QRP club welcomes members from the US and Canada to join their organization. The current leaders of the American QRP Club, Inc. include: George Heron (N2APB) as president, Joseph Everhart (N2CX) as treasurer, and Richard Arland (K7SZ) as secretary. The leadership team meets quarterly to review club directions, finances and leadership team membership.

There are no dues for AmQRP membership ... in fact there is not even an official membership affiliation. The AmQRP Club exists to provide technical and operating information, electronic projects and kits, and other goods and services to the QRP community at large. At times various items (kits, magazine subscriptions, useful tools, etc.) are sold at near-cost to QRPers at large for educational and enjoyment purposes, and for raising funds to seed the creation of additional goods and services.

The AmQRP previously published a journal called *Homebrewer* magazine, and have created seven spectacular issues over time while blazing new methods of publication in CD-ROM format. Content summary for each issue can be found at the *Homebrewer* Web page, and reprints of the magazine available for purchase on CD-ROM.

The Web site, http://www.amqrp.org, currently contains over forty kits from present and past, either currently available for sale or with enough technical information that can be used as a guide for one's own construction. Additionally, the Web site contains detailed technical information and photos on more than 30 different projects with sufficient detail for use as a guide in homebrewing the project.

The North American QRP CW Club

Sometimes, underestimating can take an amusing twist. The North American QRP CW Club started with just such an assumed underestimate.

In the summer of 2004 John Shannon, K3WWP, and Tom Mitchell, then KB3LFC, got an idea to form a "different" QRP/CW club. Mitchell, who was at that time a staff writer for a local newspaper, struck up a friendship with Shannon after interviewing him for an article. Mitchell's previous call was KC3YD, but until meeting Shannon, he was in a 10-year hiatus from radio and his license had expired. As a result of meeting Shannon and learning about his QRP activities, Mitchell was inspired to get back on the air and rekindle his own interest in QRP operation. He obtained a Technician license and a few weeks later, upgraded to General. (He has since upgraded to Extra and his new call is WY3H).

Shortly after obtaining his General ticket, Mitchell suggest that the two work on forming a QRP club, but one with a difference. By his own admission, Shannon's first thought was that such a club might attract 50 or so members. Mitchell was a bit more optimistic and held the belief that at least 100 amateurs would sing up. Little did either man realize that five years later the membership roster would approach the 4,500 mark.

Today the NAQCC has active members in all 50 states; nine Canadian provinces; and 87 foreign countries.

Like other QRP clubs, the NAQCC offers free, lifetime membership. However, unlike other clubs, the NAQCC is devoted 100-percent to CW operation. The club also encourages (but does not mandate) the use of simple wire antennas and straight keys (or bugs). Moreover, the winner(s) of some of the club's monthly sprints receive a prize. Prizes have consisted of amateur radio related books, antenna parts, plaques, and in one case, a custom lamp with an Amateur radio theme and in another, a Vibroplex bug.

"We try to be a club that 'gives'," Mitchell said. "We also issue some nice certificates for our monthly sprints and challenges. Some of the most popular challenges have been building theme related words from call signs the operator has worked. For example, this February's challenge consisted of getting enough letters to spell the names of three famous groundhogs. Last February, the goal was to spell out the first names of 12 First Ladies."

Shannon developed and maintains the club Web site, www.windstream.net/yoel and he is assisted by Mitchell's son, Ethan, W3IRS, NAQCC Member 2222. Ethan, now age 16, was first licensed at age 14.

"We're not only a club that 'gives,' but we try hard to be different," Shannon said. "We encourage our members to recapture the true spirit of amateur radio by encouraging straight key operation and simple antennas. The Club also encourage 'rag chewing' and have periodic challenges that involve rag chew QSOs. We're also affiliated with FISTS and enjoy a cooperative effort with that long established club. The idea more or less puts everyone on a level playing field when it comes to the monthly sprints. Both the sprints and challenges encourage operators to be more active in radio operation. Our motto is: If you like CW and QRP, the NAQCC is the place to be. We do not insist, however, that our members operate QRP or CW exclusively. That requirement is only for sprints and challenges. Amateur radio is something for everyone."

That is all I have at this time. I am sure there are other clubs and groups out there even if only a part of some other club. I am also sure there are Canadian QRP clubs and groups that I have no knowledge of. If there are clubs or groups are out there, please email me (wb9nlz@yahoo.com) and let me know you are out there. I would like to know more of the clubs and would ask that you contact me with information about your club and what you are doing. Thanks much.

—72, Tim, WB9NLZ

3rd ZL3 Radio Buildathon

David W. Searle—ZL3DWS ZL3DWS@nzart.org.nz

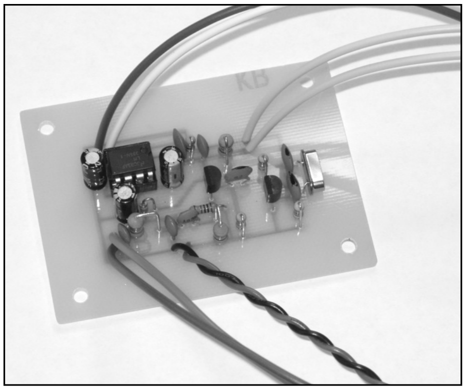
Over 60 builders, parents and helpers assembled at a Christchurch NZ school for the 3rd ZL3 Radio Buildathon held on Saturday January 30th. Two projects were built during the morning. An MK484 AM broadcast receiver was successfully completed by 21 builders, mostly of school age.

The second project was the ZL3 Pixie Twins transceiver. 12 sets of Pixie Twins took their first gulps of RF and ether on the day. These 80m CW QRP transceivers are a variation on the world famous Pixie 2 in that there is space to build two Pixies on the same PCB for different bands, encourage experimenting and modification.

When Rory ZL3HB and David ZL3DWS were considering QRP transceiver projects for the 3rd ZL3 Buildathon they couldn't decide what band to offer the Pixie for, 80m or 40m. Which would be the most popular with builders? But what was clear, was that there were dozens of modifications available for this very popular QRP CW transceiver. Adding modifications, however, to a small board could quickly damage it and space was already at a real premium.

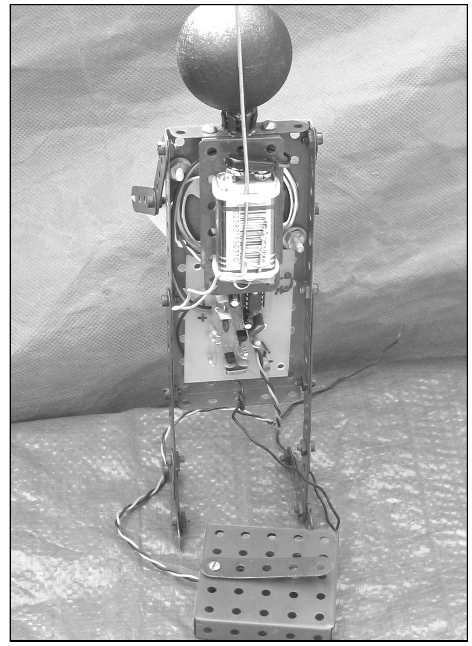
David W. Searle, ZL3DWS, welcomes everyone with safety briefing.

So the ZL3 Pixie Twins were born. A printed circuit board with two identical designs was created. You could now build two transceivers, one for 80 and one for 40m! Seriously, the intention was you built one Pixie at the ZL3 Buildathon event for 3.560 MHz.



The ZL3 Pixie.

ZL3AGS Pixieman—Front.



ZL3AGS Pixieman—Back.

Then having quickly learnt how much fun you can have with such a simple QRP circuit, you can:

1. Build a second Pixie for 40m or 20m say.
2. Cut the extra PCB off and give it to a ham friend to spread the fun of QRP
3. Add a 8 Pin DIL IC holder to the second board, pop in an NE555 and tack solder the other bits needed for a side tone oscillator
4. Build another Pixie on the second board but use a 2N3866 or BFY51 (or similar) as the transmitter final, run it at 12V and get a huge 1W out!
5. Performance of the LM386 can be improved in many ways. Try a second LM386 AF stage on the other board and try out all the ways you can wire up an LM386 until you find the one that works the best for you!

The ZL3 events are sponsored by the Christchurch City Council, The NZART Radioscience Education Trust Inc and NZ Vintage Radio Society, Christchurch. They are designed to encourage electronic construction by anyone of any age and spark an interest in Amateur Radio. For this reason they have attracted considerable interest at a recent IARU R3 Conference in NZ, and from groups in the US and UK.

Fred at Far Circuits, Dave Benson from SWL and Chuck N1TEV (Mr Regen extraordinaire!) have all supported ZL3 Buildathon events and their early help has made each event better. There may be 5,000 miles between us, but the helpful ham spirit travels well.

If your club is considering holding a Buildathon, David W Searle ZL3DWS / GM8WNY ZL3DWS@nzart.org.nz offers a helpful Getting Started Guide with 16 minute DVD, or visit http://sites.google.com/site/zl3buildathon/

Just licensed Jason Light, ZL3LD (12), proud as punch after finishing his Pixie.

Credit for the photos goes to John Walker, ZL3IB.

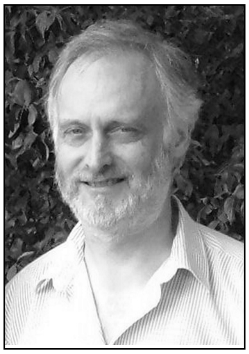
●●

Byron Engler, ZL3DXT (L), and Malcolm Gordon, ZL3UU (R), soldering with great care.

Brent Officer, ZL3TUI, Buildathon station, explains operation of MKARS80 UK QRP.

Further Thoughts on Crystal Ladder Filter Design

Dave Gordon-Smith—G3UUR daveg3uur@googlemail.com



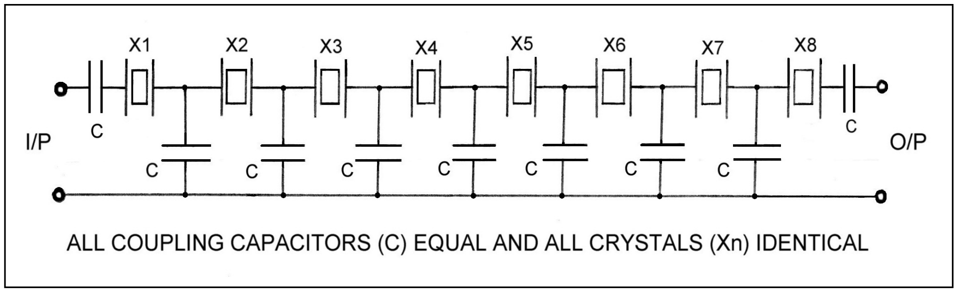


Figure 1—Circuit arrangement of 8th-order Cohn min-loss crystal ladder filter.

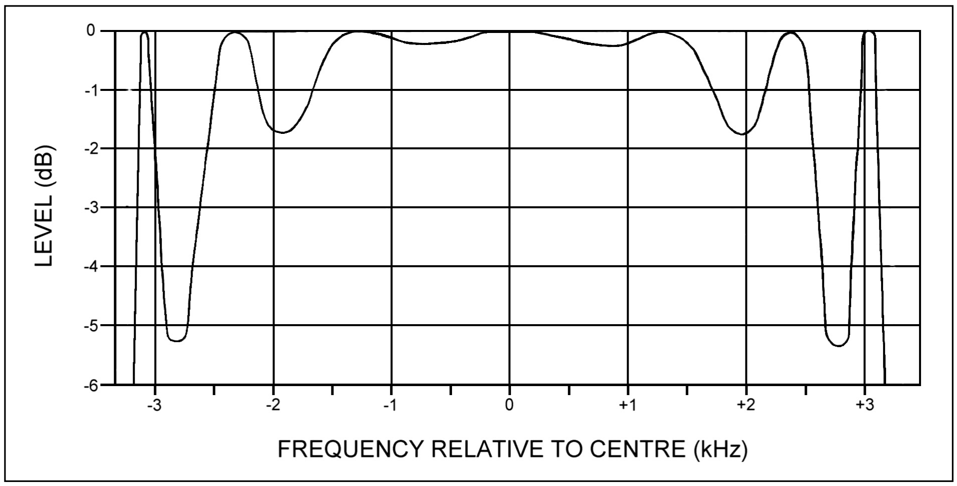


Figure 2—Passband response of an 8th-order Cohn min-loss crystal ladder filter if made with "perfect" crystals (infinite Q).

The availability of cheap, mass-produced crystals in the HF range and the simplicity of the ladder configuration have made this form of crystal filter increasingly popular with home constructors over the past three decades. Undoubtedly, the Cohn min-loss type [1] shown in Figure 1, with all of its coupling capacitors equal and all its crystals identical, is the most appealing design for shear simplicity. However, there are both advantages and disadvantages to using this type of filter. The first disadvantage is that considerable ripple develops over the pass band as the order of the filter increases, and although resonator losses smooth this out to some extent in narrow filters, higher orders and wider bandwidths can produce unacceptable levels of pass-band ripple. Figure 2 shows what the pass band of an 8th-order Cohn min-loss filter would look like if it were made with crystals of infinite Q. Note the 5.3 dB deep valleys at the outer edges. Loss in the crystals reduces the level of the outer peaks more than the inner ones, very often leaving deep shoulders at the edges of the pass band when the loss is insufficient to completely round the pass-band response. Also, the Cohn min-loss has noticeable "ringing" when used for very narrow CW filters, as pointed out by Bill Carver [2] (W7AAZ/K6OLG). Despite these deficiencies, the fact that identical resonators and the same value of coupling capacitor are used throughout is very convenient when using mass-produced crystals that are quite closely matched in frequency. There are other, less obvious advantages to using the Cohn min-loss design as well.

Ladder filter designs with a spread of coupling capacitor values also require a spread of crystal frequencies because each mesh (each crystal and its associated coupling capacitors on either side) in isolation must resonate at the same frequency. Ideally, these frequency differences should be the result of variations only in the crystal motional capacitance values because the Dishal LSB ladder design is based on all the motional inductances being equal. However, frequency differences amongst crystals of nominally the same frequency are usually the result of both inductance and capacitance variations. Not maintaining a close enough match in motional inductance values between the various crystals of a high-order ladder filter has a detrimental impact on the pass-band response, and Butterworth filters can suffer quite badly in this respect. Chebyshev designs with 1 dB, or more, ripple usually have sufficiently close mesh frequencies that a small spread of crystal frequencies can be used to satisfy individual mesh requirements for SSB bandwidths without adversely affecting the pass-band response too much, but Butterworth designs really need closely matched crystals with series tuning capacitors in some meshes to produce satisfactory results. Obviously, this increases both the component count and physical size of a Butterworth crystal ladder filter, making it one of the least desirable responses to use in this configuration.

Bandwidth Compression

In addition to better meeting the requirement for motional inductance matching, there is considerable benefit to using an arrangement where all the coupling capacitors are identical in value, because the effect of bandwidth compression due to crystal parallel capacitance is less for these designs. The presence of parallel static capacitance across the series-resonant element of a crystal causes its effective motional inductance to increase with increasing frequency between the resonant and anti-resonant (parallel resonant) frequencies. This produces passband asymmetry and reduces the overall bandwidth of any ladder filter made with real crystals compared with theoretical designs

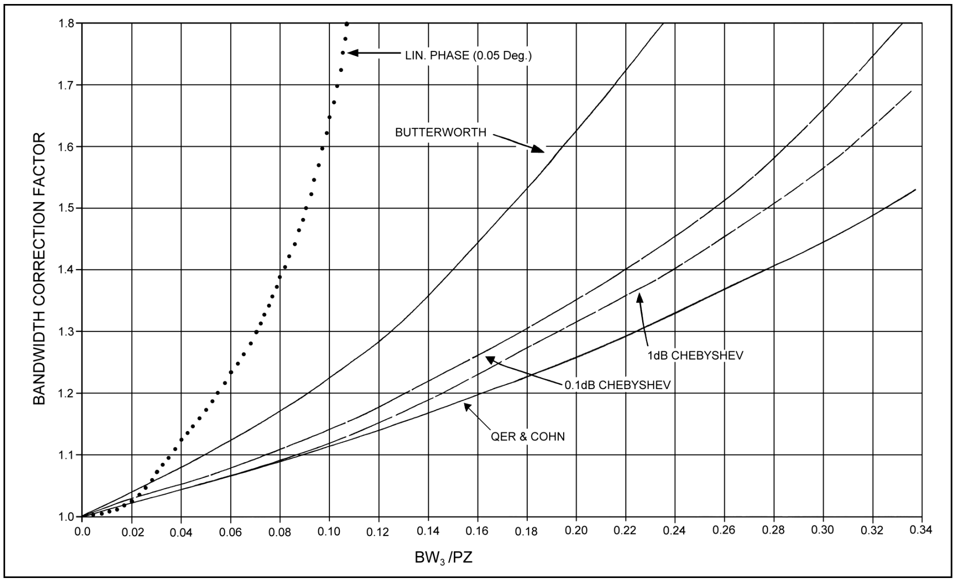


Figure 3—Correction curves for effect of C_0 on bandwidth of various types of crystal ladder filter.

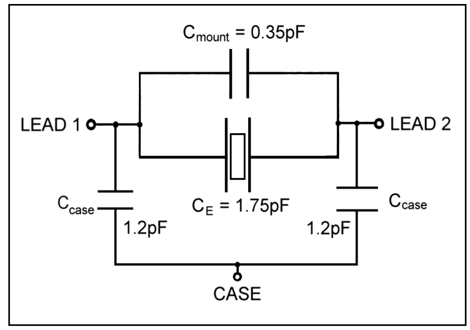


Figure 4—Diagram showing contributions to measured value of crystal C_0.

using simple series LC circuits for the resonant elements. The degree to which any crystal ladder filter is affected by this bandwidth compression depends on the type of response chosen for the pass band, but all require their design bandwidth to be increased to some degree to achieve the desired final bandwidth in practice. Figure 3 presents bandwidth correction curves for a number of commonly used filter types. For this set of curves the target –3 dB bandwidth (BW_3) of the crystal ladder filter is normalised in terms of the interval between the resonant and anti-resonant frequencies of the crystals (pole-zero separation, or PZ for short). The reason for doing it this way is not to complicate things but to allow these curves to be used for any bandwidth (up to about one-third of the PZ spacing) at any crystal frequency.

It can be seen from the increasing slope of these curves that as the bandwidth becomes a larger and larger proportion of the PZ interval, the correction factor becomes disproportionately greater and there is a limit to the bandwidth that can be achieved without the coupling capacitors becoming unrealistically small and the ultimate attenuation disappointingly low. This limit is strongly influenced by the type of filter response chosen for any given design. To find the correction factor required for a particular bandwidth and filter type, simply locate the normalised target bandwidth (BW_3/PZ) on the abscissa of Figure 3 and go up vertically to the curve that corresponds to the desired filter response. Then, go horizontally across to the ordinate to find the correction factor. The target bandwidth can then be multiplied by this correction factor to find the actual bandwidth that needs to be used in the design procedure to achieve the right bandwidth for the final filter.

Practical Details

Resonators mounted in metal cases have several components contributing to the overall parallel capacitance measured between their leads, as shown by the equivalent circuit in Figure 4. C_E is the natural capacitance between the two plated electrodes of the resonator with the quartz as dielectric. The contribution added by the two crystal-to-case capacitances (C_{case}) in series across the resonator needs to be subtracted from the overall parallel capacitance (C_0) to find the effective parallel capacitance ($C_E + C_{mount}$) for calculating the PZ spacing when the metal case is grounded, as it often is for screening purposes in crystal ladder filters. In such cases, the pole-zero spacing can be found from the resonant frequency, f_r and motional capacitance, C_m, using

$$PZ = C_m \cdot f_r/(2\ (C_E + C_{mount})) \qquad (1)$$

C_{mount} is usually in the region of 0.3 to 0.4 pF for miniature crystals. If no facilities for measuring C_0 and C_{case} are available, using the physical relationship that $C_E = 175\ C_m$ will usually suffice for a first attempt. C_{case} can be taken as 1.2 pF for the average miniature metal-cased crystal, and this needs to be added to the value of the coupling capacitors used on either side of the crystal when its metal case is grounded.

It can be seen from Equation 1 that the PZ spacing is proportional to the crystal frequency, and the maximum achievable bandwidth for the band-pass ladder configuration therefore increases with increasing frequency up to the point where fundamental crystals give way to 3rd-overtone types. Typical PZ spacing is 5.5 kHz at 3 MHz and 20 kHz at 9 MHz for fundamental crystals, but this varies a bit with electrode and case size, and the method of crystal mounting. Overtone crystals have a considerably reduced PZ spacing in proportion to their resonant frequencies because their values of C_m are much smaller than those of fundamental crystals, whereas their electrode areas and effective parallel capacitance are about the same. This severely limits the maximum bandwidths achievable with overtone crystals in crystal ladder filters, even though their resonant frequencies are higher.

It's evident from the graphs in Figure 3 that each type of pass-band response from Linear Phase (equi-ripple 0.05°) to Cohn min-loss requires a different amount of correction to achieve the same final bandwidth. Linear Phase filters require the greatest amount of correction, and this severely limits the maximum bandwidth that can be achieved with this design in crystal ladder filters below 3 MHz. Generally, in QRP work, this type of filter is only used for narrow bandwidths at frequencies above 3 MHz, so this should not pose a problem. Less correction is required for Chebyshev designs with high ripple than for those with little or no ripple—Butterworth designs with no ripple at all require more correction, for example, than low ripple Chebyshev designs. The filter types with the least variation in their coupling coefficient values, such as the Cohn, require the least correction. This means that larger values of coupling capacitor are required to achieve a given bandwidth with a Cohn min-loss design than practically any other, and as a consequence its ultimate attenuation is greater and its symmetry better than most any other type. However, the ratio (q_0) of crystal unloaded Q_u, to filter Q, defined as f_o/BW_3, is likely to be higher for wider bandwidths, and the deep ripples of 6th-order and greater Cohn min-loss filters are unlikely to be smoothed out to acceptable levels as they are in narrow CW filters. This usually results in noticeable shoulders at the edges of the pass band in Cohn min-loss SSB filters.

Final Remarks

The sheer simplicity of a 4-pole crystal ladder filter makes it an excellent choice for a first attempt at building a crystal filter. These simple 4 crystal filters can use identical crystals regardless of the type of response used because the input and output capacitors can be chosen to tune the end meshes to the same frequency as the inner meshes even when the middle coupling capacitor is different in value to the other two, as it is for Butterworth and Chebyshev crystal ladder filters. More experienced constructors might want to use more crystals to get improved performance. They should consider the linear phase design for narrow CW filters with 6 or more crystals because it's less likely to cause ringing problems and has lower insertion loss than a Cohn min-loss, which can be an important issue when trying to build a narrow filter at 9 MHz, for example. In fact, despite its name, many types of filter have a lower insertion loss than the Cohn min-loss; Butterworth, Bessel, and Guassian being but three of them. Those contemplating making more advanced CW filter designs will find it useful to consult Bill Carver's article [2] before embarking on such a project.

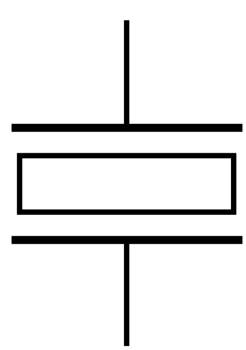
Judging by the catalogues from some of the major crystal filter manufacturers, professional designers seem to have pretty much standardised on the 1 dB-ripple Chebyshev for SSB, AM and FM bandwidths, although many specifications for the ripple are given as 2 dB to allow for the effect of production spread. The 1 dB-ripple Chebyshev ladder design does not require much of a spread in crystal frequencies to get each mesh resonant on the same frequency for SSB bandwidths, so the individual mesh requirements can normally be satisfied by the production spread in crystal frequencies, and very often it can produce a better pass-band response than the Cohn min-loss because of the deep shoulders in the response of the latter.

Filters for wider bandwidths with 6 or more crystals can be a bit of a problem, however. Even the 1 dB-ripple Chebyshev design would require some of the crystals to have series capacitors to tune all the meshes to the right frequency for wide SSB or AM bandwidths, and the increasing ripple of high-order Cohn min-loss filters can produce poor pass-band shapes in wider filters where q_0 is high. There is, therefore, a requirement for a filter with all the useful features of the Cohn min-loss, but without its drawbacks at higher orders and wider bandwidths. The quasi-equiripple (QER) design, which is indicated in Figure 3 as having the same correction curve as the Cohn min-loss, is such a filter. Details of the QER design can be found in the 2010 *ARRL Handbook*. It uses identical crystals in all positions and equal coupling capacitors throughout. The only difference is that it uses two crystals in parallel in the end sections, making the crystal count 2 more than the order of the filter. This is offset partly by the fact that no tuning or terminating capacitors are required at either end. A QER crystal ladder filter can produce a better pass-band response than the Cohn min-loss design, and equals or surpasses it in ultimate attenuation.

References

1. W. Hayward, "Designing and Building Simple Crystal Filters," *QST,* July 1987, pp 24-29.

2. W. Carver, "High-Performance Crystal Filter Design," *Communications Quarterly,* January 1993, pp 11-18.



FDIM - XV
Four Days in May 2010

Get FDIM on your calendar now! Thursday-Sunday, May 13-16.

What a great FDIM we have planned for this year. If it's your first or 15th, there will be something here for you. QRP-ARCI is sensitive to the first time attendee and will try to make your first FDIM as fun and interesting as possible. We will also have spouse/guest activities.

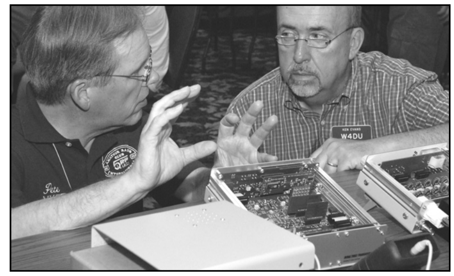
Seminars are most of the day Thursday, with "meet the speakers" and an open room for some casual show and tell, vendor displays and plenty of time to swap tales. We will also host a Build-a-thon Early Thursday Evening (tickets required). Most of Friday daytime is open to attend the Hamvention® and visit the QRP-ARCI Toy Store. We'll have plenty of room at the hotel for casual meetings and visits with old/new friends.

Friday evening activities include "show and tell," vendor displays and a judged home brew contest. Don't miss it!

Saturday is again open for the Hamvention, and we have a great social event, our annual banquet and awards presentation. There will be plenty of door prizes that evening.

On Thursday, we'll have a build-a-thon for a QRP project, a judged project contest ,and it shouldn't surprise you to find a contest or two during the weekend. We've had QLF, split paddle, and other fun activities in the past.

QRP related Vendors are invited to exhibit both Thursday and Friday evenings. We're sure you'll find many



interesting new products and a few special FDIM discounts.

We will again be at the Holiday Inn, Fairborn, OH. Reservations and special room rates for FDIM are available through Remember, all discounted hotel rooms are released only through QRP-ARCI. Just send an e-mail to us at QRPRooms@qrparci.org or visit www.FDIM.QRPARCI.org.

See you at FDIM!

Norm Schklar, WA4ZXV
FDIM2010 Chair

Four Days in May 2010:
May 13th, 14th, 15th, 16th

Speakers:

- Jim Everly, K8IKE
- Jay Slough, K4ZLE
- George Dobbs, G3RJV
- Hans Summers, GØPDL
- B. Scott Andersen, NE1RD
- Gary Breed, K9AY
- Anthony Luscre, K8ZT

Topics will include QRSS; DXpeditions for the QRPer; Test Equipment; Homebrew receivers; QRP Contesting; QRP on the Low Bands; along with some great humor and interesting tales.

Bus to Hamvention:

Last year's bus transportation to the Hamvention was a success. Bus tickets will be available for purchase this year at the hotel year.

Buildathon (Thursday, May 13):

This year's FDIM Build-a-thon event will feature surface mount construction and techniques designed to encourage hams that have yet to build a project using SMD. Participants will build a fully functional iambic keyer with a vast feature set that includes speed adjustments by paddle or potentiometer, 6 non-volatile memories with embedded commands, 4 keying modes, serial number generation, HSCW, QRSS, adjustable weight, adjustable letter spacing and much, much more. It can be easily added inside a transmitter, transceiver, or put into an enclosure as a stand-alone keyer. Its builder friendly layout will make it easy to construct.

The Build-a-thon will be held on Thursday, May 13 beginning at 4 p.m. EDT. Registration fee for this event is $30. This will include the project board and parts, solder paste, tweezers and elmering. Participants are asked to bring wire cutters, needle nose pliers, a small, fine-tipped solder iron and, if available, a hot air gun.

Space is limited to 30 participants.To register please visit the ARCI FDIM web page at http://www.qrparci.org. This year's event is being hosted by Chapter Three of the Michigan QRP Club and the project is being lead by Pete Meier, WK8S. For further details about the project go to http://web.me.com/pmeier/Build-a-thon_2010

Homebrew Contest—Show and Tell:

As with 2009, we intend to allow entries in the Homebrew Contest* to be displayed in the Ballroom on Thursday night, May 13; and Friday night, May 14, between 8 p.m. and 10 p.m. To enter an item in the contest and insure that it is part of the voting (on Friday night), you must register your item on either Thursday or Friday night between 7 p.m. and 8 p.m. A registration table will be outside the main Ballroom at that time on both nights. Each entry will be given a card that lists the category and item number, along with a description of the item and the call sign of the owner. This card must be displayed with your entry.

Judging will be done between 8 and 10 p.m. on Friday night, so although you can display you item on both Thursday and Friday nights, your entry must be displayed Friday night to insure it is part of the voting. The judges will be the attendees of the Vendor night on Friday. Each will be given a ballot that must be submitted by 10:00 PM on Friday. There will be six award categories:

1. All Homebrew (Xcvr, Xmtr, Rcvr)
2. Modified Kit (Xcvr, Xmtr, Rcvr)
3. Station accessories (homebrew or modified kit)
4. Test Equipment (homebrew or modified kit)
5. Antennas
6. Special Category
7. Best of show

The FDIM 2010 QRP Challenge

This year we have added a special category to the Homebrew Contest. It is called The FDIM 2010 QRP Challenge. The objective is as follows—Design and build a QRP Transceiver using the following rules:

- The transceiver is limited to a maximum of 72 parts.
- The receiver must be a superhet or other “single signal receiver.”
- Keying and muting must be included.
- Covers at least one of the standard QRP Frequencies as listed at www.qrparci.org/qrpfrequency
- Capable of battery power for portable use.
- Schematic w/parts list and functional XCVR be brought (or sent) to FDIM 2010.
- Only one of the active components may be an IC, all other parts must be discrete components.
- Knobs, sockets, tuning dials, copper board, power source and enclosures are not considered parts.
- See http://www.qrparci.org/fdim72 for further details, including a FAQ section.

Winners will be announced at the awards banquet on Saturday, May 15. If you are bringing an item for the Show & Tell* and do not wish it to be judged, you need not register, simply come to the ballroom between 7 p.m. and 8 p.m. and set it up on a table that we will assign to you. Whether you are part of the Homebrew Contest or the “Show and Tell,” please let us know your intentions when you register so that we can assure we have adequate space for all.

***Definitions:**

Homebrew Contest—You bring one of your latest projects and display it. On Friday night, attendees will be able to vote for a winner in one of six tentative categories.

Show & Tell—You bring one of your latest projects and display it. Your project will not be part of the voting in the Homebrew Contest

FDIM Event Schedule (subject to change)

Wednesday May 12th

7.30 pm - 9:30 pm—Registration

Well be in the Challenger room for registration. There will be tables set up for visiting with old friends or making new ones.

Thursday May 13th

7:00 am—Registration will be outside the ballroom.

8:00 am - 4:00 pm—Seminar in the Main Ballroom. This event requires Seminar Registration. Raffle tickets will go on sale during the break.

4:00 pm - 8:00 pm—Buildathon. Requires separate registration.

8:30 am - 5:00 pm—Stitchin’ in Dayton. Alternate activity for the spouse in the Armstrong Room.Requires a separate registration; please see the web site.

7:00 pm - 8:00 pm—Homebrew Contest Registration. Setup display for home brew projects.

8:00 pm—Meet the Authors/Show and Tell (Main Ballroom) + Fun night + (Ballroom). This is a great opportunity to come out and visit with the Speakers from the days seminar as well as a chance to meet some avid QRPers. A few vendors will probably setup tables. There will be space available to bring your favorite amateur radio items for a casual show and tell. We’ll be in the large banquet room and should have plenty space to enjoy the speakers, company, and equipment.

Friday May 14th

8:30 am - 5:00 pm—Stitchin in Dayton. Alternate activity for the spouse in the Armstrong Room.

7:00 pm - 8:00 pm—Homebrew Contest Registration. Setup display for home brew projects.

8.00 pm Radio Show and Tell—Meet and Greet (setup 7:30-Ballroom).

7.30 pm—Vendor setup at in Ballroom

8:00 pm—Vendor Night open to public.

8:00 pm—Homebrew Display and Judging (Ballroom).

Saturday May 15th

Hamvention!

8:30 am - 5:00 pm—Stitchin’ in Dayton. Alternate activity for the spouse in the Armstrong Room.

7:00 pm—Awards Banquet. Requires banquet registration.

9:00 pm—Post Banquet, chat session, Bring QSLs to exchange! (Ballroom).

Sunday May 16th

Hamvention and home.

FDIM Hotel Information and Room Reservations

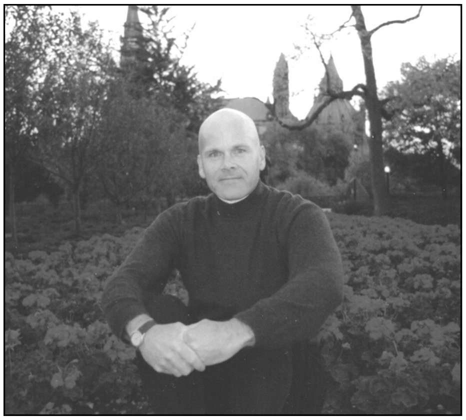
Rooms at the Dayton/Fairborn Holiday Inn are $110/night
E-mail room request to: QRPRooms@qrparci.org

Vendor Night / Sponsorship Opportunities

Vendors! Register online at www.fdim.qrparci.org
Or, contact Norm, WA4ZXV, at: norman@schklar.com

A QRPp Builder Extraordinaire—Mike Rainey, AA1TJ

John King—W5IDA
w5ida@arrl.net



Mike Rainey—AA1TJ.

Mike's Worksite atop Mt. Mansfield.

During the last few weeks, it has been my great pleasure to interview via e-mail one of the most interesting members of the QRPp community—Mike Rainey, AA1TJ. Mike has graced our pages twice before with articles on his unique creations. [1, 2] Those creations and quite a few more are available on his Web site, http://www.aa1tj.com/home.html. Those of you who have not had the opportunity to check out this treasure trove should head for the website immediately, after reading this interview of course.

W5IDA: Tell us a bit about yourself, Mike

AA1TJ: My wife and I moved to Vermont in 1984. Together, we built Chippingstone Cottage, on the site of a former 19th Century sheep farm. We modeled our place on the cottages that we'd seen while on a coast-to-coast hike across England.

I've worked since 1988 as a "transmitter guy" for the local CBS-TV affiliate, where I spend several days each week atop Mt. Mansfield, Vermont's highest mountain. I believe this may be the last manned, remote television transmitter site east of the Mississippi River. The station is accessed during the winter months via snowmobile.

W5IDA: Some of our readers may not be aware that your workshop is actually underground, carved out of some very sturdy New England stone. What led you to place your workshop underground, especially considering the difficulties you had in excavating for it? Do you find the size of the workshop (two levels, each 36 square feet) to be confining or limiting in some way?

AA1TJ: I love my underground ham shack! It satisfies my childhood fantasy for a tiny, woodland hatchway, or portal, leading into a magical world. It's no accident that I refer to it as the "Hobbit Hole," as Tolkien's beautiful tales greatly inspired me at a tender age.

Yes, I expect that most folk would find the space too confining, but it fits me like a glove. It has the feel of a small yacht cabin: tidy, organized, gemütlich. It's a 12 year-old boy's dream come true for a 52 year-old man. :o)

W5IDA: How and when did you get interested in amateur radio? What sparked your interest?

AA1TJ: I think it may have been a table-top radio that my parents owned. I remember it was made by Philips and it had a dial calibrated by city: Paris, Budapest, Bern, and the like. Something about it caught my fancy. Crystal radios came next, followed by several regenerative shortwave receiver kits. The first person that I met who shared my interest in radio became my Elmer. Dennis, AAØA, had at least ten children of his own, on top of a very demanding career. Nevertheless, this wonderful man availed himself to a kid from the neighborhood that wanted to become a ham radio operator. Truly, there's no such thing as a "self-made" man. Each of us is the product of innumerable helping hands and kind words of encouragement.

W5IDA: Do you have other hobbies or pastimes that occupy a significant percentage of your time? If so, what are they and what do you enjoy about them?

AA1TJ: I've had a life-long interest in philosophy and mathematics. Although my instrument-sized machine shop is presently in storage, I hope to return to making chips with my lathe and metal shaper in the next year or two. I have a longstanding affinity for intricate mechanical mechanisms.

My wife and I also enjoy working in our organic vegetable garden. It provides us with roughly a quarter of our total foodstuff.

W5IDA: Does your interest in philosophy influence your electronics activities and if so, how?

Inside Mike's shop.

AA1TJ: No doubt, my philosophical meanderings influence most everything that I do. I suppose a common thread between philosophy and radio-electronics is the fact that I enjoy working through a select number of puzzles that (for one reason or another) fascinate me.

The mathematician, Carl Jacobi, wrote, "Man muß immer generalisieren." ("One must always generalize.") I think it is good advice for someone with an intellectual bent of mind. A specific circuit is normally a member of a larger class. You might recall James Burke's *Connections*; a television series that enthralled me a kid. A steam engine, for example, is a mechanical oscillator; a capstan is an amplifier. Philosophy is a natural extension of this kind of "connection making." A philosopher strives to examine his or her beliefs by the widest possible standpoint.

W5IDA: You obviously have an excellent knowledge of electronics. Was this knowledge gained through formal training or through your own study and experimentation?

AA1TJ: It's kind of you to say so. No, I've had no formal training in electronics. Frankly, I didn't get on well at school, despite the fact that one of the ongoing joys of my life has to do with what Richard Feynman aptly described as, "the pleasures of finding things out." Typically, following an interest of the moment, instead of a proper syllabus, leaves gaping holes in one's educational background. On the other hand, I remember hearing some of my school pals in the EE program complain that their course load was akin to trying to drink from a fire hose. In thirty years I haven't covered all of the material they were exposed to in four years. My one saving grace is that I've enjoyed the luxury of lingering over interesting things they had no choice but to traverse on a dead-run. For example, I was so intrigued by Laplace transforms that I made a detour into the general theory of orthogonal functions lasting several years.

Broadly speaking, the history of engineering has always fascinated me. This may partly explain why I'm drawn to dabble with tunnel diodes, fluidics, magnetic amplifiers and the like.

W5IDA: How long have you been engaged in the types of experiments and projects shown on your web site?

AA1TJ: "Two years," is the short answer. That's how long it's been since I've been back on the air after a lapse of twenty-five years. The more complete answer is that I've never stopped thinking and dreaming about these things. I returned to ham radio with a vow to only operate with what I have built from salvaged electronics components, so far as it's possible. I further vowed to generally limit my output power to QRPp levels.

W5IDA: Are there other parts of amateur radio that you also enjoy? DX? Contesting? Ragchewing? Operating outdoors?

AA1TJ: Working DX with QRPp is a great thrill; not that it happens very often!

While I doubt that I have a competitive bone in my body, I certainly do enjoy getting on the air for the various QRP contests.

I've had some wonderful ragchews since I've been back on the air, although I'm not really big on "small talk." To my mind, a short QSO is the radio equivalent of exchanging a "high-five" with a fellow ham. As such, I value the short contacts as much as I do the long ones.

Although I haven't yet operated from the outdoors since my return, it's an activity that I look forward to in the coming years.

W5IDA: What do you consider to be the end goal of your experiments and projects? Reducing a technique or circuit to its essentials? Conserving materials? Using less power? Or, just having fun?

AA1TJ: Ooh, I generally react to talk of goals as Dracula does the sight of crosses! I'm just having fun and loving every minute of it.

W5IDA: What do you learn from your projects, aside from an obvious gain in electronics knowledge? Or, is the gain in electronics knowledge the whole point?

AA1TJ: That's an interesting question. If greater knowledge is a byproduct of doing what I love…well, I'll take it as a bonus. But a quest for knowledge is not at all what motivates me.

I enjoy learning. I enjoy puzzles. But

the fact is that I'm a little slow on the uptake. Let me put it this way; when I tell people that I enjoy doing mathematics the oft-heard reply is, "Oh, I was never good at math." Their implicit assumption is that someone who enjoys mathematics must be naturally gifted at it. On the contrary, I'm remarkably thick-headed when it comes to grasping explicit mathematical ideas. Nevertheless, I love it. I'm aesthetically attracted to the beauty of mathematical ideas despite the fact that it's a struggle for me to fully appreciate their implications. Electronic circuit design allows me to do mathematics with both my mind and my hands (admittedly, sometimes with my nose as well!).

W5IDA: How long does it take you to complete a typical project, in terms of total hours spent and calendar days?

AA1TJ: It's a difficult question for me to answer, inasmuch as I typically have three or more irons in the fire at any one time. I jump back and forth from project to project as the spirit moves me. It's rare that my ideas work "right out of the box." More often than not, I'll shelve a breadboard while I go back to the books. There's a telling quip that says, "A week at the workbench saves an hour in the library." For me, they both go hand-in-hand. I enjoy doing research and dreaming about circuit design as much as I enjoy melting solder. Finishing a project is akin to losing a friend. Fortunately, my projects tend to remain forever incomplete.

W5IDA: Many of your projects are extremely clever, but somewhat off the beaten track and not something everyone would think to do. How do you get your ideas for these projects? Where do they come from? Does your job give you time to think up some of the experiments you do? Does it give you ideas for the experiments?

AA1TJ: Thanks again, John. I don't consciously choose the road untaken; I head down whatever path piques my interest. I get my ideas the old-fashioned way; I steal them. I glean them from magazines and journals, such as IEEE, Wireless World, Frequenz, ETZ, and the like. Inexplicably, I'm fascinated by the "cutting-edge technology" dating from the 1950's through the early 60's.

I think about these things while I'm at work, but I also think about them when I'm out walking, shoveling snow or working in

Mike entering his shop after a Vermont snowfall.

the garden. The things that you love are never really out of your mind. When do you stop thinking about your wife or your mother? They're part of the color of my sky. Their images are imprinted on the inside of my eyelids. And so it is for anything that I'm passionate about. I think about circuit design when I get up to go to the bathroom at 3AM. I think about QRPp while I'm flossing my teeth. There's a lovely quote by Emerson that says, "A man is what he thinks about all day long."

W5IDA: Do you have a favorite project, or all they all your favorites for different reasons? If the latter, what are the reasons for each favorite?

AA1TJ: I had a dear uncle that used to proclaim every holiday to be the best ever. No matter what the circumstances were, the present Christmas or 4th of July was certain to be the best that he could recall. In memory of him, I can attest that indeed I do have a favorite project; it's the one that I'm working on at the moment!

W5IDA: All the projects on your website are obviously successful. What percentage of your projects is not successful, aside from successfully adding to your knowledge of electronics? Are there any of your unsuccessful projects that you find to be particularly interesting, and if so why?

AA1TJ: Given my druthers, I'd druther be fascinated by a project that never quite worked than have one simply fall out of my hands and land on its feet. Honestly, there are days when I feel that I couldn't wire up a light bulb. And speaking just as honestly, I'm thankful for them.

If the circuits that I touched quickly "turned to gold," I'm certain that my interest in circuit design would soon vanish altogether. I'd far rather be baffled than bored. I prefer that my projects are just beyond my intellectual grasp; at least at the outset. There is little incentive to tear into a circuit that is working perfectly. On the other hand, there's a genie contained in the little puff of smoke that consumes your transistor. Our mistakes are opportunities to learn, disguised as setbacks.

"Tis said, best men are molded of their faults, and for the most, become much more the better; for being a little bad." Shakespeare, Measure For Measure

W5IDA: What projects are you contemplating for the future?

AA1TJ: Recently, I was happily working on an audio amplifier made from magnetic amplifiers when I happened to rediscover an amazing idea; the brainchild of an engineer working at the old National Bureau of Standards in 1954. This fellow figured out a way to harness what is commonly viewed as a defect in semiconductor rectifiers (minority carrier charge-storage) in order to build an audio amplifier. The "diamp" was improved by a couple of GE engineers in the late 50's before being all-but-forgotten.

This is precisely the sort of thing that I love; an initial discovery, followed by a bit of history, a little technical detective work, a search for documents and patents, followed by many happy hours at the workbench. These last two weeks have been simply magical! I built an 80m direct-conversion receiver in which all of the gain is provided by a two-stage diamp. One of the first stations that I heard on it was Dick, K4JJW, running his newly refurbished, 1948-vintage, Meissner Signal Shifter, with 5w into a vertical! I could scarcely envision a more perfect evening in the ham shack. Since then I've used my new receiver to work a number of QRP stations; one running as little as 120mW. Every contact made with it has been a thrill. I hope to build the diamp into an "all-diode" transceiver using some vintage, Russian-made, high-power tunnel diodes that I recently stumbled upon.

Afterwards, I intend to return to my audio frequency, half-wave bridge-type magnetic amplifier circuit. With luck, it will become part of what is a larger, long-term project that I have named, the Graf von Arco. This is my attempt to construct an 80m amateur radio station that is built around an electromagnetic RF alternator.

Once I have my instrument machine shop set up I hope to build an electromechanical radio receiver based on a tiny, high-gain, capstan-torque amplifier, using negative-feedback stabilization. I have a plan to amplify AM radio signals to loudspeaker level without the use of commonly known detectors.

I should like to take up my interest in horology again someday. My particular interest is a certain non-electrical magnetic-escapement (circa 1948), using both pendulums and tuning forks as the time base.

I would like to build a W9TO-type CW keyer using fluidic logic. I've settled on turbulent amplifier NOR gates, as they may be produced using nothing more complicated than a metal lathe. Two tiny air jets will form a fluidic "touch" keyer paddle. The variable timebase as well as the sidetone will be provided by "whistle" oscillators.

If I live long enough, I would like to someday build my own thin-film field effect transistors. I once spent most of a year working thorough a plan wherein metal contacts would be evaporated and sputtered over a chemically sprayed compound semiconductor. I planned to use Schottky-type, metal-semiconductor junctions in order to circumvent the surface-state produced instability that plagued so many of the early thin film transistor efforts. The evaporation/sputtering would be done in the end of a small test tube that is evacuated by an adsorption pump, backed up by a peristaltic fore-pump.

I would still count myself as lucky if my present project were my last. And yet, what would we be if not for our dreams?

—Cheers, Mike, AA1TJ

References

1. Rainey, M. J. "Minimalist Radio: Adventures in Homebrewing," *QRP Quarterly,* Winter 2009.

2. Rainey, M. J. "Reggie: A One-Transistor Transceiver," *QRP Quarterly,* Spring 2009.

A Frequency Counter Project—Part 3 (Making it all work together)

Dieter (Diz) Gentzow—W8DIZ w8diz@tampabay.rr.com

Part 3 of the Frequency Counter project will bring together all the things we learned in Parts 1 and 2. For Part 3, you will need a built prototype of the frequency counter, either from your own parts or purchase the Frequency Counter Development Kit offered at the end of this article. You should also have reviewed the internals of the ATmel AVR microprocessor, part number ATtiny2313-20, and the articles referenced in the addendum files noted at the end of this article.

We will write assembly code on a Linux or Windows PC, assemble the code, download the code to the target prototype hardware and hopefully get the target hardware to function as intended. If you do not have access to the first two articles of this project, you may download them from the links in the notes section of this article. All references to computers will be for the Linux Mint operating system, but conversion to Windows is easy. Any reference to the GEDIT text editor can be read as NOTEPAD or your favorite TEXT editor for Windows. The AVRA assembler and AVRDUDE are both available for Linux and Windows.

The AVRA Assembler

If you have not installed the AVRA assembler on your PC, then you need to install it now. For Windows, go to http://sourceforge.net/projects/avra/files/ and download and install version 1.2.3 filename avra-1.2.3-win32.zip and for Linux Mint, follow the installation procedure listed in the addendum at http://w8diz.com/qq-fc-project/part-1/

Now that you have AVRA installed, let's test the program. Create a directory on your Desktop called "qq-fc-project" by right-clicking the Desktop and selecting "Create Folder."

Inside this new directory, create a subdirectory (Folder) called led-code. Start GEDIT and save the file as led.asm in the led-code subdirectory. Enter the following code exactly as shown using GEDIT:

```
;led.asm
;cd Desktop/qq-fc-project/led-code/
.include "tn2313def.inc"
    nop
```

Save the program by holding down the ALT key and typing "F," then release the keys and type "S." The first 2 lines of the code are a comment lines, indicated by the starting semicolon. The third line tells the AVRA assembler to insert (include) a file into the source code. The fourth line is the OP-CODE for "no operation" which is usually used as a place holder or to literally waste CPU time.

Now we are ready to assemble the code. For Linux users, open the TERMINAL program by clicking on Menu and then Terminal under the System column. When the Terminal program pops up on the screen (in Linux), it is running from your default directory, a sub-directory of the /home directory. Let's cut and paste the command in line 2 of your source code into the Terminal program. Highlight "cd Desktop/qq-fc-project/led-code/" with your mouse; hold down the CONTROL key and hit the "C" key to copy the line of code into your "buffer."

Now paste the command into the Terminal program by holding down the CONTROL & SHIFT keys and type "V." This should make the terminal command line look like:

```
username@username-desktop ~ $ cd Desktop/qq-fc-project/led-code/
```

Now hit the enter key to execute the command. The new command line should look like:

```
username@username-desktop ~/Desktop/qq-fc-project/led-code $
```

Now we are ready to assemble the source code into usable "machine code" for the target hardware.

At the new command line, type avra led.asm and hit the Enter key. Note the avra program name must be entered in lower-case. If all went well, your source code should have compiled with "no errors" and "1 warnings." The warning is telling you that the avra program could not find the ".DEVICE definition" which is part of the ATtiny2313def.inc file.

To fix this, download the include file and place the file into your led-code subdirectory. Instruction is in the addendum. Let's compile the source code again by executing the last command in the terminal program; hit the UP-Arrow on your keyboard.

This should display the last command on the Terminal command line; now hit the Enter key. With the include file placed into the led-code sub-directory, the source code should compile with no errors and no warnings. So what did we accomplish?

Not much except that we verified the assembler is working and that we are now ready to write some serious code.

Writing Code to Make an LED Blink Exactly Once Per Second

We are now going to "learn by doing" a simple example that employs the most important functions of the ARV microcontroller, the INTERRUPTS.

From Wikipedia: "In computing, an interrupt is an asynchronous signal indicating the need for attention or a synchronous event in software indicating the need for a change in execution. A hardware interrupt causes the processor to save its state of execution and begin execution of an interrupt handler."

In order to make an LED blink for an exact time period, we must first have an accurate clock source. Our project uses a 20.48 MHz crystal that can be trimmed to oscillate at exactly 20,480,000 Hertz. The 20.48 MHz oscillator signal is used as the heartbeat of the ATtiny2313 CPU. Inside the CPU is a divide by 1024 circuit that can be activated through software instructions that produces a 50 µsecond time period. Also inside the CPU is an 8 bit timer overflo interrupt that we activate by initializing(presetting) the 8 bit timer to (256-200) or 56. After the timer counts up to 256 (a total of 200 times 50 µs), it triggers the timer0 overflow interrupt, thus the timer0 overflow interrupt is activated every 10 milliseconds.

```
;led2.asm - demo program to blink an LED once every second
;open Terminal and move to active directory : cd Desktop/qq-fc-project/led-code/
;to assemble code in the directory that holds led2.asm : avra led2.asm
;to write fuse bits : avrdude -P usb -p t2313 -c avrispv2 -U lfuse:w:0xFF:m
;to upload code to the target : avrdude -P usb -p t2313 -c avrispv2 -U led2.hex

.include "ATtiny2313def.inc" ; include file that defines the variables in ALL CAPS

.equ Led = PIND4 ; The Led is connected to PORTD PIN4
.equ LedMask = 0b00010000 ; Bit 4 ($10) mask for the Led

.def temp1 =r16 ; work register
.def temp2 =r17 ; work register
.def delay =r18 ; register that holds the timeout delay value

.cseg ;following is code and goes into ROM space
.org $000 ; this is the start of the Interrupt Vector table
  rjmp Reset ; on power-up, program starts to execute at location $000
  reti ; IRQ0 - not used
  reti ; IRQ1 - not used
  reti ; Timer1 Capture - not used
  reti ; Timer1 Compare - not used
  reti ; Timer1 Overflow - not used
  rjmp Tim0_Ovf ; Timer0 Overflow Interrupt Vector
  reti ; UART Receive - not used
  reti ; UART empty - not used
  reti ; UART Transmit - not used
  reti ; Analog comparator - not used
  reti ; Pin Change - not used
  reti ; Timer1 Compare B - not used
  reti ; Timer0 Compare A - not used
  reti ; Timer0 Compare B - not used
  reti ; USI Start - not used
  reti ; USI Overflow - not used
  reti ; EEPROM Ready - not used
  reti ; Watchdog Overflow - not used

Reset: ;Reset Interrupt Vector points here.
  ldi temp1,low(RAMEND)
  out SPL,temp1  ; Set stack pointer to last RAM loc
  ldi temp1,high(RAMEND)
  out SPH,temp1  ; Set stack pointer, 12 bits wide

  ldi temp1,LedMask
  out DDRD,temp1  ;make the Led pin an output

  ldi temp1,0b00000101 ;set timer0 prescaler to 1024
  out TCCR0,temp1  ;using 20.48 XTAL = 50uS

  ldi temp1,0b00000010
  out TIMSK,temp1  ;enable TIMER0 overflow interrupts

  ldi delay,10 ; init the delay to 100 mSec

  sei ;enable all Interrupts (global interrupt enable)

Menu: ; main program - loops here forever
  rjmp Menu

Tim0_Ovf:
  ldi temp1,256-200 ;10 ms using a 20.48 xtal
  out TCNT0,temp1 ;set for next overflow
  dec delay ; decrement the delay counter
  brne Tim0_Ovf_Exit ; if it is NOT ZERO, then exit the interrupt routine
  in temp1,PORTD ; get the current Led Port Value
  ldi temp2,LedMask ; load the Led bit
  eor temp1,temp2 ; exclusive or the Led bitmask with the PORTD value
  brne Tim0_Ovf_1 ; if it is NOT ZERO, then branch and turn off Led
  ldi delay,10 ; reset the delay counter to 100 mSec
  cbi PORTD,Led ; turn Led on
  rjmp Tim0_Ovf_Exit ; exit the Interrupt routine
Tim0_Ovf_1:
ldi delay,90 ; reset the delay counter to 900 mSec
  sbi PORTD,Led ; turn Led off
Tim0_Ovf_Exit:
  reti ; return from Interrupt
```

Figure 1—The code, with extensive comments.

Now all we need to do is to turn on the LED after we count to 900 ms and turn off the LED after another 100 ms, giving us a 10 LED percent duty cycle. Note that the firmware included in the FC Kit causes the LED to bling ON for 1 sec and OFF for 1 sec. The code in Figure 1 was changed after the chips were programmed. Download the led2.asm code into the led-code sub-directory per instructions in the addendum.

To reiterate the code in Figure 1 in plain English: First we include the source file that contains many definitions.

Next, we define the labels and register variables that we will use. Then we fill in the Interrupt Vector table.

Followed by the main code starting with "Reset:" where we place the stack pointer at the top of static memory, aka RAM.

We then enable one of the I/O lines (PORTD Pin-4) to be an output pin to control the LED. Next we set the prescaler to divide the 20.48 MHz clock by 1024 to produce 50 µs timer counts in the CPU. We then enable the TIMER0 overflow interrupt and then initialize the delay timer to 100 ms and then we enable the global interrupt flag as a master interrupt enable switch for the system. After that, the CPU runs in a tight loop doing a relative jump to "Menu:" forever. The first time that the TIMER0 overflow interrupt is activated, the "Tim0_Ovf:" interrupt routine sets the timeout for the next interrupt by loading the "TCNT0" register with 56.

When TIMER0, an 8 bit timer, counts up to 256 (every 50 us.), we get another interrupt. Next in the interrupt code, we decrement the "delay" variable register. If the register has counter down to zero (0) then we need to test the status of the LED and determine if we need to turn it on or off, else we exit the interrup routine. The

Led OFF time and the Led ON time are both independently controlled.

Uploading the LED Code to the Target Hardware

You may disconnect the LCD from the target hardware for this demonstration; the LCD is not used. To upload the machine code file (led2.hex) to the target hardware, we need interface hardware and software. The hardware recommended is the AVRISP-II referenced in Addendum Part-1. There is also a software fix pertaining to the AVRISP in the Addendum Part-2. See the reference at the end of this document under notes.

To upload the machine code to the target, we also need a "PROGRAMMER" or software that talks between the AVRISP and the PC, We will be using the free program called AVRDUDE, referenced in Addendum Part-1.

Connect the AVRISP module between a PC USB port and the 6 pin header on the target hardware. Make sure that the 6 pin header connection has the red wire toward the edge of the target PCB or away from the CPU.

Start the Terminal program and move to the working directory by running the command: "cd Desktop/qq-fc-project/led-code/"

Make sure the response is "username@username-desktop ~/Desktop/qq-fc-project/led-code $," verifying that you are in the correct directory. Next, apply power to the target hardware. Then issue the command: "avrdude -P usb -p t2313 -c avrispv2 -U led2.hex" and take a deep breath. If all is working correctly, this should upload the led2.hex file machine code to the target hardware and start executing the code, once loaded. The Led should start to blink, ON for 100 mSec and OFF for 900 mSec. If you can not get the hardware to blink the Led, review the preceding instruction and find the fault. Should you get stuck, email me.

OK...congratulations are in order (I think), assuming that you managed to control the Led. You may wish to "play" with the code and try different ON/OFF times for the Led.

Uploading the Frequency Counter Code to the Target Hardware

Connect the LCD to the Freq Counter PCB (target hardware) for this exercise. If you have not done so, download the frequency counter source code "fc.asm" per instructions in Addendum Part-3. Place the source code into a directory (folder) called "fc-code" under the "qq-fc-project" folder on your Desktop. In a new Terminal window, execute "cd Desktop/qq-fc-project/fc-code/" and compile the source code by running the avra program in a Terminal window, "avra fc.asm." Apply power to the target board and then upload the machine file to the target by executing "avrdude -P usb -p t2313 -c avrispv2 -U fc.hex."

Your display should look something like Figure 2.

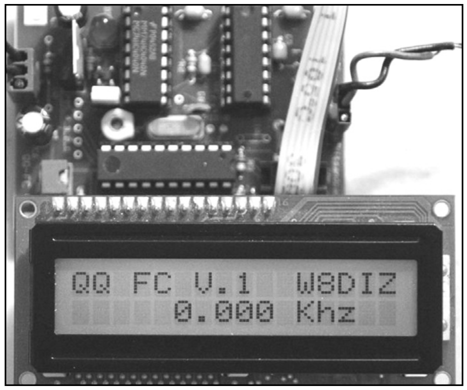


Figure 2—The display.

Firmware/Hardware Review

Open the source file fc.asm in GEDIT as a reference to the following review. To best follow this discussion, you should enable the line numbers in GEDIT. In GEDIT, click on "Edit," "Preferences" and enable Line Numbers. then Close the Preferences window. The Frequency Counter accuracy display resolution is dependent upon two parameters: The gate time and the prescaler. The prescaler is set in hardware by selecting the desired jumper on the 74HC4040 binary counter. For this project, we selected divide by 4. Since the maximum frequency that the basic CPU can measure is about 9 MHz, the divide by 4 circuit enables us to measure up to about 36 MHz. If we set the gate time (measurement period) to one second, then frequency measurements would have a four hertz display resolution, because when the CPU counts the pulses for one second, we need to multiply the count by 4 to display the correct frequency.

A gate time of one second is a bit long for most frequency counter applications so we use a gate time of one half second. This results in doubling our display resolution to 8 hertz because we need to multiply the count result by 2. The gate time and prescaler could be controlled with jumpers of switches, but for simplicity we will stick to a prescale of divide by 4 and a gate time of one half second. The ASM code from lines 48 thru 66 define the FC gate time and prescaler, hence the display resolution.

Lines 68-71 define if you want a frequency offset, but this code is not fully implemented. There will be an update in the Addendum Part-3. The rest of the code is split between frequency counting and the LCD display. The LCD can be controlled using either 4 data bits or 8 data bits. We use 4 data bits, so every command or character sent to the display requires two writes to the LCD, one nibble (4 bits) at a time. Before we send data to the LCD, we read the BUSY bit from the LCD. This is the fasted way to control the LCD. Many LCD interfaces do not read the BUSY bit, but rely on worst case timing requirements to control the LCD. Frequency counting is controlled by the Timer-0 interrupt routine (TIM0_OVF:) at line 476.

The timer is configured to interrupt every 5 milliseconds and accumulates the number of pulses counted on PIN-9 (PD5) of the CPU. The 16 bit count is captured in lines 499 and 500 and added to accumulator registers in lines 502 to 525. After 100 interrupts (100 * 5 ms or half a second) the result is converted to human readable characters (lines 537-580) and displayed on the LCD (lines 354-418). Line 599 is where you can include your callsign.

Change "URCALL" to your callsign. Make sure that you have exactly 16 characters inside the quotes, else you may have some display problems. All data is broken into 16 bit boundaries so we need an even number of characters for the text display storage. Note the zeros at the end of the text line. Zero is interpreted as the text string terminating character.

Next article: "Designing and Producing the PCB—Printed Circuit Board"

About the Author

Dieter (Diz) Gentzow, W8DIZ, aka WB8QYY before April 2000, has been a licensed ham since 1973. Past employment include Honeywell as an Industrial Sales &

Systems Engineer, AC Nielson, Electrical Engineer designing black boxes that monitor TV viewing habits and a handful of other hardware and/or software jobs.

Diz is currently semi-retired, living in sunny Palm Harbor, Florida. You can contact Diz, W8DIZ via e-mail at w8diz@tampabay.rr.com and SKYPE ID = "w8diz_"

Notes

Addendums and/or corrections to this project are available at http://w8diz.com/qq-fc-project/

Frequency Counter Development Kits are available from http://kitsandparts.com

Part 1 of this project is available at http://w8diz.com/qq-fc-project/part-1/part-1.php

Part 2 of this project is available at http://w8diz.com/qq-fc-project/part-2/part-2.php

Parts 1 and 2 of this series were published in the Fall 2009 and Winter 2010 issues of QRP Quarterly.

●●

You Missed the QRP VHF Contest

Bob Witte—KØNR bob@k0nr.com

Unless your callsign is N1QLM, W2JEK, OK1KZ or KØKZ, you missed the 2009 QRP ARCI VHF Contest. With only 5 entries, this contest is still in its infancy but still a lot of fun. This contest runs concurrently with the ARRL September VHF QSO Party, using the same contest exchange and scoring, with the addition of QRP multipliers. The 2010 contest will be held on Sept 11-13th.

In 2009, N1QLM lead the pack with 44 QSOs and 20 grids (an impressive number of grids for operating QRP). W2JEK came in second with almost as many QSOs and a respectable 14 grids. I came in third, dominating the state of Colorado (which is to say I had the only entry from the state).

All of the ham bands above 50 MHz are available for use in this contest, using any legal mode. Most of the activity is on SSB or CW, but FM is definitely worth trying as well. The contest exchange is the 4-digit Maidenhead Grid Locator (e.g., DM79 for the Denver area). To determine your grid locator, take a look at the AMSAT or ARRL web sites listed in the References.

The scoring system gives higher points for the higher frequency bands:

- 1 point for 50 MHz and 144 MHz QSOs
- 2 points for 222 MHz and 432 MHz QSOs
- 4 points for 902 MHz and 1296 MHz QSOs
- 8 points for 2.3 GHz or higher QSOs

Consistent with the ARRL rules, QSOs utilizing repeaters of any kind are prohibited. In addition, the National Simplex Frequency 146.52 MHz cannot be used for contest contacts.

Unique to the QRP ARCI contest is the power multiplier, which rewards ultra low power operation:

>10 W = ×1
>5-10 W = ×4
>1-5 W = ×7
>250 mW - 1 W = ×10
>55 mW - 250 mW = ×15
55 mW or less = ×20

This contest has two entry categories: single operator (one location) and rover. Rovers operate from multiple grid locations, changing locations during the contest.

QRP VHF Contest Results

Call	S-P-C	BANDS	POWER	#QSOs	Pts	Grids	Mult	Score
N1QLM	MA	50-144-432	<10 W	44	55	20	4	4400
W2JEK	NJ	50-144	<10 W	42	42	14	4	2352
KØNR	CO	50-144-432	<5 W	16	21	8	7	1176
OK1KZ		50-144-432	<10 W	12	15	5	4	300
KØKZ	ME	50	<5 W	3	3	3	7	63

For single operators, the final score is Points (total for all bands) × Maidenhead Grid Squares (total worked on each band) × Power Multiplier.

For rovers, the final score consists of the total number of QSO points from all bands multiplied by the sum of unique multipliers (grid squares) worked per band (regardless of which grid square they were made in) plus one additional multiplier for every grid square from which they successfully completed a contact.

Operating the Contest

One of the attractions of a VHF contest is the increased level of activity. On most days of the year, the weak-signal VHF and higher bands can be a bit too quiet. This means contest weekends are a great time to go operate from that special high spot. With QRP power levels on VHF and higher, height above average terrain becomes critical. Here in the Rocky Mountain region, we have plenty of mountains to choose from. If you are in the flat lands, you might need to think in terms of finding a tall building or grain silo. A careful review of the local topography should uncover some kind of "high spot" you can operate from. If you are really lucky, you can combine this with a wilderness trip, operating backpack portable in true QRP fashion.

These vertical antennas with BNC connectors are much more effective than the standard "rubber duck" antenna on a handheld radio.

If you can't decide on one location, you can always try the rover approach. This is a fun category where you can move from place to place, picking up new contacts at each location. You are allowed to work the same stations over again when you move to a new grid.

As mentioned earlier, most of the operation will be on SSB and CW. Yes, CW gets used quite a bit during VHF contests, especially when signals are weak and the contact is marginal. It is common for two stations to start on SSB and then flip over to CW (on the same frequency) to complete the contact. It is also worth giving the FM simplex frequencies a try. In fact, let your ham buddies know that you will be listening on a particular FM simplex frequency (not 146.52 MHz) and you'll likely pick up some additional contacts. The favorite VHF QRP rig seems to be the Yaesu FT-817, which covers all modes on 50 MHz, 144 MHz and 432 MHz.

For best results, you'll want a horizontally-polarized antenna. Most of the VHF contesters will be running horizontal, so a vertical antenna on your end can cause a significant signal loss (20 dB or more). For

6 Meters, this could be the classic dipole or a small yagi. For 144 MHz and higher, a Yagi is an attractive approach. My favorite is the Arrow dualband antenna for 144 MHz and 432 MHz.

My primary rig is the FT-817 but I'll often take along a HT or two to listen on the FM portion of the bands. I have several BNC or SMA vertical antennas (usually 1/2-wave) that are a huge improvement over the standard rubber duck antennas. These are useful with the FT-817 as well. If I need horizontal polarization, I'll tilt the radio over to maximize the received signal.

So get ready for the VHF QRP contest this coming September. Take a look at the September VHF QSO Party rules on the ARRL web site to understand how the bigger contest operates. Then check out potential operating spots in your area. Oh, and you can always operate from home, too!

The Arrow dualband (2M / 70 cm) antenna can be mounted on a standard camera tripod.

The FT-817 is a popular rig for VHF QRP portable operation.

References

ARRL web page for Grid Locators: http://www.arrl.org/locate/gridinfo.html

AMSAT web page for Grid Locators: http://www.amsat.org/amsat-new/tools/grids.php

ARRL Contest Rules: http://www.arrl.org/contests/forms/

—72, Bob, KØNR

Full rules for this contest are on page 62, as well as the QRP ARCI Web site.

Massachusetts QRP Convention

Jim Fitton—W1FMR

The first ever Masscon QRP Convention was held on March 13, 2010, at the Westford Regency Hotel in Westford, Massachusetts, to a sellout crowd. The event featured a fun get-together Friday evening in the lounge and a full featured speaker's forum on Saturday with a vendor room and a great banquet Saturday evening. The event was spearheaded by Scott Andersen, NE1RD, and his able crew of volunteers and managers.

Speakers featured at the forum were Allison Parent, KB1GMX (Other QRP Modes); Dave Siegrist, NT1U, and Bruce Beford, N1RX (NE SCAF filter fame); Michael Rainey, AA1TJ ("The Reggie"); Chuck Kitchin, N1TEV (Regen Receivers); Dave Benson, K1SWL (New 75m AM rig); George Heron, N2APB, and Joe Everhart, N2CX (Midnight Mag Loop); and Joseph Taylor, K1JT (WSPRing Around). The featured speaker at the banquet was Steve Galchutt, WGØAT (Minus Peanut and Rooster). Nice to meet Steve, and he is as amiable in person as he is in his videos.

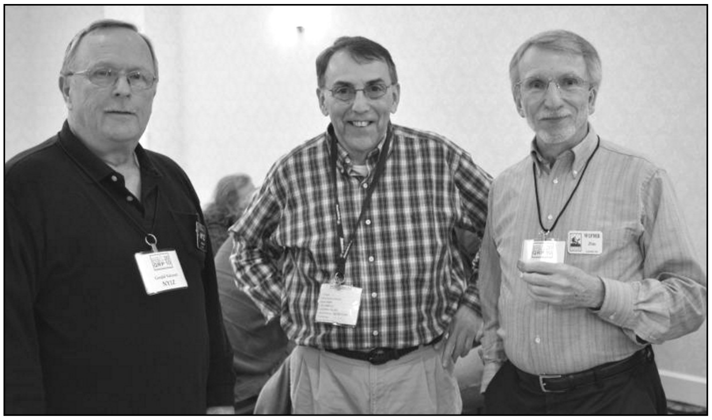
A CD with the forum talks was given to all attendees and I must say that the forum was a fun and informative event interspersed with drawings for excellent prizes. Vendors and sponsors and prize donators included Buddipole Antennas, Ray of the QRP ARCI Toy Store, W1REX the Tin Man from QRP ME, and Ham Radio Outlet of Salem NH was present as a vendor, to name a few.

It was like old home week for me to meet Joe Everhart and George Heron from the NJ QRP club, along with Dave Benson from VT, and Mark Swartwout from WI, both earliest members of the NEQRP club.

Now Masscon is history, and I can't believe how smoothly it went, and with such style and comfort, especially for an inaugural event. The speakers, facilities, attendees, prizes and vendors were

Masscon organizors.

The comfy auditorium.



NY1Z, K1LGQ, and W1FMR.

Discussion in the auditorium.

George Heron, N2APB.

Participants at the banquet.

all first class.

It was great to meet old friends from the beginning of NEQRP from the middle of the country and from next door. I give the event an A+, and it reminded me of the early days and excitement of QRP forums and booths at Dayton back in the early 80s. The only thing missing was the huge flea market.

Congratulations to Scott, NE1RD, and the team of volunteers and organizers for a job well done!

Credit for photos goes to Robert Schmeichel, N1RXV.

—72, Jim / W1FMR

Chuck Kitchin, N1TEV.

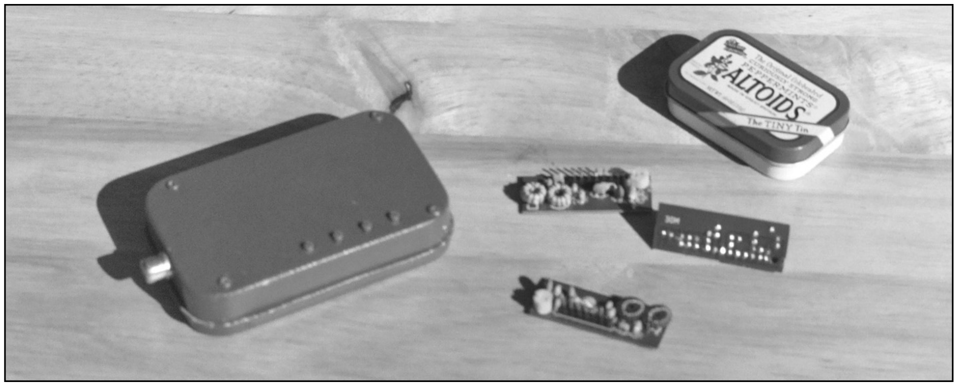
WGØAT and K1AVE.

The Texas QSO Party—QRP Style!

Scott McMullen—W5ESE scottamcmullen@yahoo.com

Mobile stations, activating a number of counties as they traverse a route through the state of interest, will always remain the heart of state QSO parties, but radio amateurs who participate in the fixed QRP categories can operate from unique sites in rare counties, add variety and interest to the mix of entries in these contests. In 2008 and 2009, I backpacked to a primitive campsite in Guadalupe Mountains National Park for the Texas QSO Party. The park is in Culberson County, in a remote part of west Texas, just south of the New Mexico state line. I don't believe there are any licensed amateurs in the county, and it was one of a handful that weren't activated during the 2007 party.

Radios suitable for use on backpacking outings have evolved for decades. Longtime QRPers will remember the appearance of the Mountaineer [1] and the Optimized QRP transceiver [2]. QRP operators who backpack have long been a niche within our niche. In recent years, the appearance of increasingly versatile QRP rigs in kit form, like the Elecraft KX1 and KD1JV's AT Sprint series transceivers, has increased their numbers. On the internet, the Adventure Radio Society [3] has fanned the flames with web articles and on-the-air events that have attracted still more adherents to the ranks of the backpacking QRPers. Yet as far as I've been able to tell, the backpacking QRPer hasn't often made an appearance in the state QSO parties. It's my hope that this article will nudge a few more into giving it a go!



The AT Sprint 3 transceiver.

Backpacking for the QRPer

Although it may not seem so at first blush, backpacking, like amateur radio, is a technical hobby. Computer aided design techniques are used to develop tents that are lightweight, shed wind, and have optimum head room and floor space. New synthetic materials are developed for the packbags of backpacks, and other materials are introduced for use in lieu of down for the insulation in sleeping bags. Cookware of titanium is now available, and new designs for backpacking stoves appear regularly. A recent trend, Ultralight backpacking, establishes a goal of having a base pack weight (all gear except for food and water) of less than 10 pounds [4]!

Backpacking is not necessarily difficult, and I am proof that it's not necessary to be particularly athletic. Like amateur radio itself, it does require some preparation. I learned much of my backpacking technique from Colin Fletcher's *The Complete Walker* [5], although similar works are available that are more up to date. In my opinion, though, *The Complete Walker* is one of the more engaging, and is widely available in second hand form at QRP prices.

Gearing Up

The transceiver I used for the Guadalupe Mountains outing is my AT Sprint 3 transceiver, designed by Steven Weber, KD1JV. The radio covers 80 through 20 meters, and yields about 3W from a 9.6V voltage source. I powered the radio with two sets of NiMH cells; one 2000 mAH, and another 1400 mAH, augmented with one 9V pack of 6 AA alkalines. My transmatch is an Emtech ZM2. The first year, I used a 40 meter doublet fed with 300 ohm TV twinlead (lengthened at night for 80 meter operation). Although it worked well, I found it awkward to erect the doublet in the bushy trees available in desert mountains, as it was difficult to raise the two horizontal elements tangentially from the tree, with many limbs in the way. For 2009, I decided to try an inverted L.

Mountainous Terrain						
s	0.002 (S/m)		soil conductivity			
frequency	3.5 MHz		7 MHz		14 MHz	
		radial length		radial length		radial length
# radials	L (ft)	(ft)	L (ft)	(ft)	L (ft)	(ft)
1	2.36	2.36	1.67	1.67	1.18	1.18
2	9.44	4.72	6.68	3.34	4.72	2.36
3	21.25	7.08	15.02	5.01	10.62	3.54
4	37.78	9.45	26.71	6.68	18.89	4.72
5	59.02	11.80	41.74	8.35	29.51	5.90
6	84.99	14.17	60.10	10.02	42.50	7.08
7	115.69	16.53	81.80	11.69	57.84	8.26
8	151.10	18.89	106.84	13.36	75.55	9.44
9	191.24	21.25	135.22	15.02	95.62	10.62
10	236.09	23.61	166.94	16.69	118.05	11.81
11	285.67	25.97	202.00	18.36	142.84	12.99
12	339.98	28.33	240.40	20.03	169.99	14.17
13	399.00	30.69	282.14	21.70	199.50	15.35
14	462.75	33.05	327.21	23.37	231.37	16.53
15	531.21	35.41	375.62	25.04	265.61	17.71
16	604.40	37.78	427.38	26.71	302.20	18.89

Table 1—Spreadsheet used to determine an optimum number of radials for the inverted-L antenna.

It's single horizontal span could be raised radially away from the supporting tree, and would be fed against a set of radials. I elected to make the inverted L 44' long; about 5/8 of a wavelength on 20 meters, but added a disconnect on the end to lengthen it to 67' for 80 meter use at night. I fed the inverted L and radials with a short length of 300 ohm twinlead, with a 1:1 current balun on the end. This twinlead section allowed the feedpoint of the antenna to be outside the tent, providing a convenient attachment point for the radials. It's necessary to dress the section of twinlead, so that it doesn't lie on the ground.

For the design of the radial system, I used information presented in a recent *QST* article [6]. The article included an equation to calculate the optimum number of radials given a total radial wire length, frequency, and soil conductivity. I rearranged the equation a little, to calculate optimum total wire length, given the number of radials, frequency, and soil conductivity.

$$L = \left(\frac{n0}{2.25 * \sqrt{s * f}} \right)^2$$

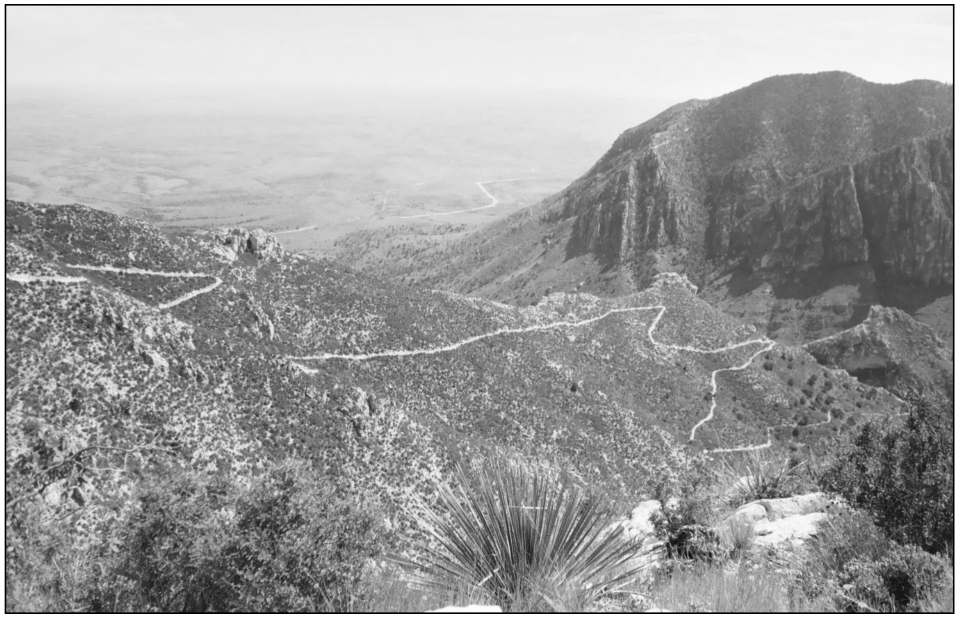
in which:

$n0$ = number of radials
s = soil conductivity (S/m)
f = frequency (MHz)

Using a spreadsheet (Table 1), I calculated L for a varying number of radials and frequency bands. L was then divided by $n0$ to yield radial length.

After studying the spreadsheet and ruminating over how many radials I was willing to fiddle with, I opted to prepare 10 radials, each about 16.5' long.

In most state QSO parties, the contest sponsors ask that mobile participants let them know about their intended routes in advance. Although I wasn't, strictly speaking, a mobile, I informed the Texas QSO Party organizers know about my portable QRP plans. They became about as jazzed about my plans as I was, and posted my planned QRP backpack outing on the Texas QSO party web site along with all the mobile routes. Once on the air, I found that many of the participants I contacted were aware of where and how I was operating, and I believe it contributed in a small way to their enjoyment of the contest.



View from the Tejas Trail.

The W5ESE contest station at Pine Top.

Hitting the Trail

After a long drive, I arrived on Friday morning at Pine Springs Ranger Station, the park headquarters. If you haven't backpacked before, you might assume that in a wilderness, you can camp where ever you please. In most national parks, that's not the case, and in Guadalupe Mountains National Park, there are designated backcountry campgrounds, each with a few numbered sites. You must specify which backcountry campground you would like to stay at when you request a backcountry permit, and then select any unoccupied site when you arrive at the campground. I have stayed at most of the backcountry campgrounds in the park over many years of backpacking there, so I selected Pine Top, which was one that I knew had available trees for antenna supports and terrain that offered the possibility of low takeoff angles in useful directions.

Water is a significant consideration when backpacking in desert mountains. There is none available at the backcountry campgrounds in the Guadalupes. The park service recommends carrying a gallon per person per day, and I carried 9 quarts for my two night outing. The hike to Pine Top campground required an ascent of 2000' in about 4 miles on the Tejas trail. With a bit over 50 lbs of “stuff” in my backpack, this part of the trip can best be described as a pack mule experience! The hike to Pine Top did provide dramatic views of the surrounding Chihuahuan desert terrain. I took my time during the ascent, stopped periodically to remove my boots and allow my feet to cool off, and enjoyed the view.

The Pine Top QTH

After arriving at Pine Top, I began by erecting the antenna. I hurled rocks with attached parachute cords over a couple limbs, hauled up the radiating element, and then lay out and attached the radials. I then erected the tent, set up my stove, unpacked my sleeping bag, and hung another parachute cord over a limb to hang my food, to keep it out of reach of critters (in the Guadalupes, these are usually Ringtails). I enjoyed a freeze-dried meal for supper, then tested the transceiver and antenna. It all seemed to be working well, and I looked forward to the beginning of the Texas QSO party the next morning.

“CQ CQ TQP W5ESE TQP”

The contest began at 1400Z Saturday morning. I began on my favorite band, 40 meters. At that early hour, 40 provided an opportunity to work distant stations in other states. As the E-layer warmed up, paths shortened to Texas and the surrounding states, and I enjoyed working many of the mobiles as they traveled among the counties along their routes. In the 2008 TxQP, 40 had a long skip zone, but I found it was shorter in 2009. This allowed me to work a station near Big Bend (N5DO) and a mobile station traveling through several adjacent west Texas counties (N5NA). The inverted L seemed to play well on 40, and I received good signal reports from other amateurs who knew me to be a QRP portable in a remote part of the state. I worked more distant out-of-state stations on 20 meters.

80 meters has always been an important nighttime band in the Texas QSO Party for me, but on Saturday evening, I found the atmospheric noise to be high, and I didn’t complete as many contacts on 80 as I normally have.

Sunday morning, I had a quick breakfast, and then concentrated on the mobiles on 40 meters. Although the contest continued until 2000Z, I pulled the plug a bit after 1800Z to disassemble the station, break camp, and begin the hike out. My final contact was with fellow QRP ARCI member Steve Yates, AA5TB, who was milliwatting in the contest with a Small Wonder Labs RockMite from his home near Fort Worth. Way cool!

After hiking out the Tejas trail and camping in the Pine Springs car campground Sunday night, I spent a few more days in the park, and went on a couple more short backpacking trips. There is a lot to see and do in the Guadalupe Mountains, and just spending time there in front of a radio would be tragic!

Reprise

State QSO parties are fun events to participate in as a QRP entrant. Because of their light weight and modest power requirements, QRP stations can be established at unique and remarkable locations. These stations add interest and variety to the contest, for all of the participants, so be sure to inform the contest organizers about your plans.

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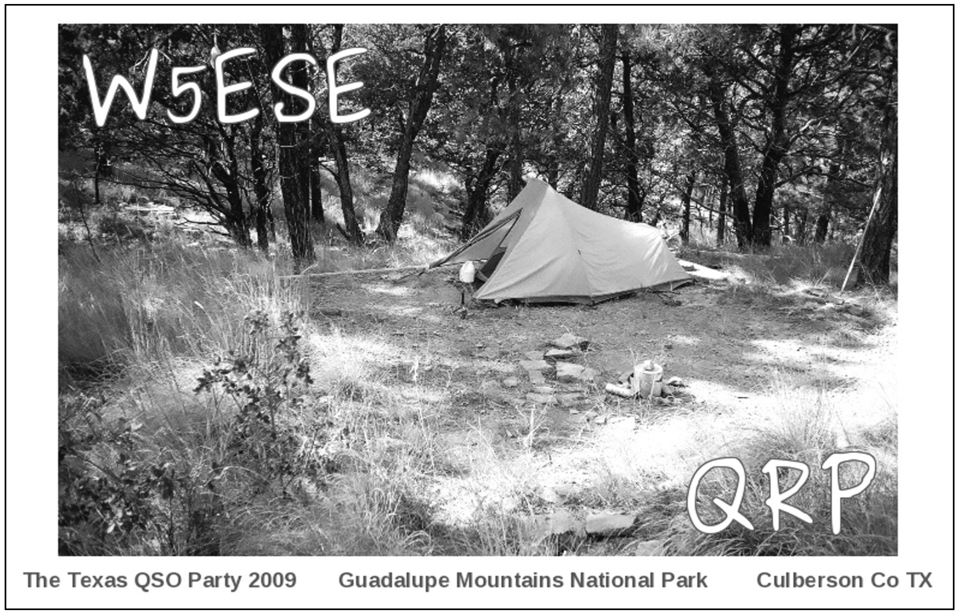

An event this much fun deserves a special QSL card!

Mark Your Calendars for These Upcoming QRP ARCI Contests!

11 July 2010: Summer Homebrew Sprint

21 August 2010: Silent Key Memorial Sprint

11 & 12 September 2010: End of Summer VHF Contest

Making a Software Defined Radio for the QRP Enthusiast—Part II

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In the previous issue we discussed development of the hardware for a self-contained (no PC) SDR radio. Here, we'll explore the development of the first workable software to be used on this hardware. I'm going to do something a little unusual in the article. I'm going to describe some things that worked AND some things that DIDN'T work. I do this for two reasons. First, the goal of this paper is to encourage the reader to learn through experimentation and even failed experiments teach us something. Second, I hope to save you some grief by showing where "obvious" approaches turn out to be harder than I expected.

Before delving in, I'd like to point out that my SDR project is a work in progress. If you go look at my schematics or my PC board layouts or my source code (all of which are on the QRP Quarterly website), things are rather haphazard. You are not going to be seeing a completed project with assembly instructions and parts lists and code documented to commercial standards. Indeed, the software in particular is the coding equivalent of "ugly construction." My hope is that by providing all this information you will be able to poke around and see how I solved any particular problem. Please recognize that I didn't set out to build a world-class rig, I set out to build a usable rig and to explore an emerging technology. I hope what follows will encourage you to do the same.

As for the rest of this article, I won't be describing all of the inner workings of my software. Rather, I hope to explain some of the main problems I ran into and how I went about solving them. Some of these problems were logistical and needed only a modest effort to solve once identified. Other problems took me a while to understand and solve in my own modest ways. I expect this project to continue more or less forever. I guess it is my own version of "the Unfinished."

Microchip IDE

As described in the previous article, this project uses a dsPIC processor from Microchip. One of the big reasons for choosing this processor family was the software development environment provided (free) by Microchip. This environment runs on a standard windows platform. It is called an "Integrated Development Environment" because it provides every tool necessary to write and debug programs for the entire microchip processor family. It provides a basic text editor and an assembler and C compiler. Once the code has been written and compiled, the IDE provides a linker and a comprehensive "standard library" of subroutines familiar to C programmers. (For those less familiar with programming, it is common practice to provide calls within a program to common subroutines. The linker and compiler ensure that the code for these common subroutines is included as a part of the software package, thus saving the programmer from having to write these common functions into his/her code.)

Once a program has compiled and linked it is downloaded to the target hardware. Once downloaded, the IDE allows the developer to monitor and modify the various program variables and

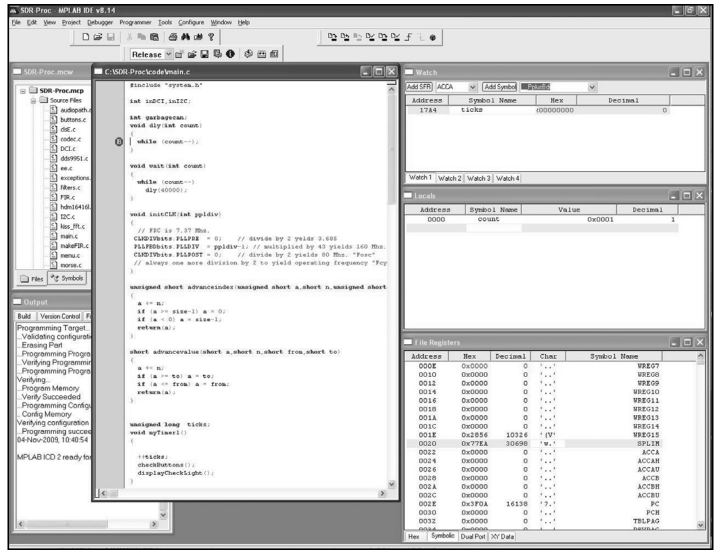


Figure 1—The Integrated Development Environment display screen.

hardware registers using symbolic names. Program execution can be controlled using breakpoints and single stepping at either the C or assembly code level.

During programming and debug, the IDE controls the processor using hardware called an "In Circuit Debugger"; Microchip calls their debugger the ICD3. The ICD3 connects to the computer using a USB interface and to the target processor using a four-wire interface. This ICD3 allows the IDE to control the processor directly on a clock tick by clock tick basis. The ICD3 is designed specifically for the Microchip product family and supports essentially any Microchip processor. (It is useless for other vendors' products.) The ICD3 costs about $190 from Microchip but there are compatible modules available on the web for less. The ICD3 represents an investment which can be used in a large variety of projects. I consider it as essential to my workbench as my 'scope and signal generator.

A very quick glance at the IDE screen may prove informative. Figure 1 shows a screen shot of the IDE which was taken during a typical debugging session. The largest window is called "main.c" and shows the actual source code. The dot on the left hand side of the window shows that a breakpoint is installed at that line. When the processor reaches that line it will halt and repaint all the windows.

To the right of the "main.c" window are three smaller windows. One monitors program variables which are allocated in memory, one monitors "local" variables which are available only in that specific subroutine and one monitors processor hardware registers. After hitting the breakpoint the developer can change variables, single step, proceed to the next breakpoint or even change the code and recompile; all without invoking any tools outside the IDE. It is truly an *Integrated* Development

Environment.

The Microchip tutorials for the IDE are fairly comprehensive and demonstrate the basic capabilities quite well. Those interested in exploring how the IDE can be used can download it, again for free, from www.microchip.com. The basic IDE download does not include the C compiler tool suite; that is an independent (but still free) download.

Getting Started: Divide and Conquer

The first step in writing any fairly ambitious piece of code is to divide the problem into manageable pieces. For this project I ended up dividing the effort into three more or less distinct pieces that interact in very limited and well-defined ways. Just as with hardware, software modules require specified interfaces so that the modification of one module does not impact the operation of any other modules. To the extent possible, each module should "hide" its internal complexity and provide a simple to understand and use interface.

Also, just as with hardware designers, programmers develop particular styles which are followed unthinkingly. There are obvious "style" characteristics such as how they format their programs, where they put their comments, how they name their variables and how they perform trivial tasks. There are hidden characteristics as well, things such as how the source code is arranged and how the programming style simplifies or complicates the debugging process.

I mention all these style issues because they actually make a huge difference to the developer in the long run. Remember: software, almost by definition, is never finished. You may think you'll remember how you structured all the code but in a few months you will probably forget a great deal. Being consistent about how you perform routine tasks will allow you to "come up to speed"much faster once you decide to add a feature or debug a problem several months from now.

A final note: when writing code one should remember most programs are not critical and need only provide basic functionality. Most code should not be clever because "clever" often translates to "obtuse." Generally speaking, code which was difficult to write will have more bugs and be more difficult to repair. Straightforward and consistent coding techniques yield working code in a shorter time and with fewer bugs along the way.

So, without further ado, let's get started. The three major pieces of code I had to write I call:

- The board support package which directly controls the hardware.
- The user interface which fields button pushes and controls the display.
- The SDR piece which processes data from and delivers data to the CODEC.

Board Support

The board support package is the very first piece of software written for any project. The various subroutines are responsible for initializing the hardware and providing low level "idealized" interfaces to the rest of the software. Let's use the I2C (or I^2C) bus master inside the dsPIC as an example:

The board support package must initialize the I2C interface that is used to monitor and control the CODEC and non-volatile memory chips. The initialization of this interface is quite straightforward and requires only a few lines of code.

Once the I2C interface is initialized it is ready to write control commands and read status from the various devices connected to the I2C bus. The I2C bus protocol is implemented in software and requires a few dozen lines of code. The board support package hides these low level details by providing two subroutines that can be called by other programs: write and read. Because there can be multiple devices connected to an I2C bus, the write and read subroutines require a device ID. Additionally, the I2C bus protocol provides for the writing and reading of multiple bytes of data in a single operation. This means that the write and read routines will need to accept a length argument as well. Here is an example of how a call to the I2CWrite routine might be appear:

```
I2CWrite(50,10,"sample string",13);
```

This call requests that 13 ASCII characters be written to device 50 starting at address 10. In this example, the 13 characters are specified using a quoted string "sample string." (The space between the words in quotes counts as one ascii character.) A possible read string routine might look like this:

```
I2CRead(50,10,buffer,12);
```

As expected, this routine would read 12 bytes of data from device 50, starting at address 10 and place the string into "buffer." So you get the idea; each piece of hardware will require some minimal initialization and a few other subroutines which allow other programs to access the hardware. Once these routines have been written they can be used without regard to their inner workings. If there is one word which describes the purpose of these low level subroutines it is this: Abstraction!

Let's return to the general discussion. A quick overview of this project's hardware yields the following list. Some of these elements are pretty obvious while others are less so. For example, it is clear that the DDS will need some kind of control. It is less clear that the processor clock rate will need setting. In most cases a review of the appropriate datasheets will yield a more or less complete list of the subsystems which need attention. In many cases, the vendor will even provide sample code for setting up and exercising a particular feature.

- Processor stack and memory initialization (provided by Microchip).
- Processor clock rate
- Processor Timers
- I2C interface
- I2S interface
- DDS control interface (no status from DDS)
- Keypad polling interface
- Knob 'interrupt on change' interface
- CODEC control/status interface
- Nonvolatile memory (NV ram)
- QSD control register support
- Power Amplifier control register support
- CW Key input

The amount of work involved with each of the above hardware subsystems varied widely. Some subsystems required a few minutes while others required an hour or two. Please note that I am a fairly experienced programmer and these time estimates are for me. For those beginning the journey that is programming, the time estimates are surely short. However, programming these types of routines is a skill quickly learned and after an evening or two the newcomer will be writing initialization code fluently.

The writing of the initialization code is often done more or less in parallel with debugging the hardware. Each part of the hardware is initialized and small test programs are written to verify proper hardware initialization, verify proper operation and verify proper understanding of the hardware functionality. Generally, these test programs morph into the subroutines provided for general use by the upper level software.

Each of the above subsystems was addressed as time and desire dictated. The majority of the board support package was written in a few weeks of spare time. Of course, as with all programs, the board support package continued to evolve as understanding and usage grew. Often times a subroutine needed to be rewritten when it became clear that it did not provide the correct functionality. For example, in the I2C routine above, the initial subroutines provided reading and writing single bytes. While programming other routines it became clear that reads and writes always required multiple bytes. Rather than call "I2CReadByte" multiple times it was easier to change I2CReadByte into I2CReadBlock.

Once all the subsystems have been initialized and debugged it was time to move on to the next phase, the user interface. But first…

Details of Microchip C

All this user interface stuff was going to be written in a high level language called "C." C is very widespread and there are countless books concerning how to program using "C." While C is a "standard," there are differences in how C works on different processors. Table 1 shows the differences in the version used by Microchip for the dsPIC product family, particularly as it applies to describing the menus I used with the SDR. Those readers not familiar with C programming (or perhaps a bit rusty) are encouraged to read the sidebar to this article, "A 'C' Primer: Describing a Menu." [see Notes]. The Microchip tutorial, available on their website, also shows how C can be used to program the dsPIC.

The User Interface

I really didn't pay much attention to the user interface early in this project. However, after only a few evenings it became clear that the user interface was going to be a big effort and would require a certain amount of planning. This was a bit discouraging because I was really trying to get some Digital Signal Processing work done. Still, a little planning and a good foundation would make subsequent development move faster and be less frustrating.

A few programming sessions trying to control the CODEC and DDS quickly taught me most of what I needed to have in a user interface. First, I expected that I would need to control, at most, a few dozen parameters so a simple list was adequate; no menus and sub-menus to complicate things. Second, in most cases, the parameter was simply a number which needed to be adjusted.

Command	Description	Example
long	Declares a variable as a 32 bit integer	long frequency;
char	Declares a variable as a 8 bit integer	char achar;
[ ]	Used in conjunction with declaration statements to declare arrays; may be empty to declare an array of unknown size (pointer)	char name[8];
" "	Used to specify string constants.	char name[4] = "freq";
*	Indicates that the following variable is a pointer rather than a regular variable.	char *p2c;
&	Indicates that the address of the following variable should be used rather than the value.	char *p2c = &foo;
[*n*]	Using the variable as an array, access the 'n'th element of that array.	p2c[1];
struct *name* { }	'Struct declares 'name' as a group of variables.	struct parameter{ char *name; long value; long minimum; long maximum; long increment; Function afunc; };
Function	User defined 'type' that I use to indicate the following variable specifies a function rather than a value.	Function aFunction;

Table 1.

Also, that number always had a "minimum" value and a "maximum" value. I decided that all parameters would be adjusted using a knob and so each parameter would need an "increment" value; how much should the parameter change when the knob is turned. And of course, other portions of the software needed to be told that the parameter had been changed. For example, here is the declaration describing the parameter freq:

```
struct parameter freq =
  { "freq",
    14000000,
    14000000,
    14349999,
    50,
    ddsUpdateFreq
  };
```

Of course, there will be many parameters. I decided to group the parameters together into an array. C allows me to declare an array of parameters in much the same way as a simple parameter and initialize that array. Let's jump to the first real menu I had to write. In this menu I had to control the frequency of the DDS and the gain of the amplifiers in the CODEC chip. The CODEC chip has an amplifier before the A->D converter and I call this "rfgain." It also has an amplifier after the D->A converter and I call this "afgain." The registers inside the CODEC that control the gain of these amplifiers can take on values from -63 to 63. Notice that I don't specify the size of the uMenu array (empty []). C figures out how big uMenu is by counting the size of the initializing data!

```
struct parameter uMenu[ ] =
  {
   {"freq",  14000000,14000000,14349999,50,ddsUpdateFreq},
   {"afgain", 0, -63,  63, 1,codecUpdateAFGain},
   {"rfgain", 0, -63,  63, 1,codecUpdateRFGain}
  };
```

After all this work I had the framework for describing the menu in my SDR. With a small amount of effort, I could now introduce a new menu item and have the user interface software display the parameter values, modify them, and let the rest of the software know that the parameter value had changed. But so far I had only described the menu, I had not yet written any code.

Implementing the User Interface

Once the structure for the menu had been defined it was time to start writing some code. The first code I had to write was a program which would control the ascii display. This display is 16 characters wide and 4 lines long. Since there would be more than 4 parameters in the menu I had to have a way to specify which menu item should be displayed on each line. To keep track of this I introduced an array called:

```
// which menu element is on which line.
long menuLines[ ] = {0,1,2,3};
```

Thus, to start out, menu element 0 would be displayed on the top line of the ascii display and menu element 3 would be on the bottom.

Next, I had to write a routine which would detect knob movements and modify the appropriate menu items. I chose to have four knobs, one for each line of the display. Each knob would control whichever parameter was displayed on the associated line. Each time a knob was turned the software would have to perform a series of actions. For example, when knob 0 was turned clockwise the software would examine the menuLines[0] entry to find out which parameter was being modified. It would then look into the menu array and find that parameter and update the value by adding the increment. It would then make sure the new value was between the minimum and maximum. Finally, it would call the callOnUpdate function and show the new parameter value on the display.

Whew!

There was one final requirement before I could get started on the real SDR software: there had to be a way to choose which parameters would be displayed on which lines of the display. In the first instance of this code I tried to make this simple. The knobs have built in buttons. I changed the knob code a little to check to see if the button was being pushed while it was turned. If the knob was being pushed then the software changed the value in the menuLines array rather than the parameter itself. Thus, by pushing knob 0 while turning it clockwise I would increment the variable menuLines[0] rather than the parameter. In that way I could select the parameter to be displayed rather than the parameter itself.

Enhancements

At this point I had a more or less workable user interface and could get back to work on my real goal which was the digital signal processing code. Before discussing that, though, a few more things need to be said about the user interface.

Above I described the FIRST cut at the user interface. It has been much enhanced since those humble beginnings but almost all enhancements have been cosmetic; better formatting of displayed lines and the ability to display the value as a word (like "USB" or "LSB") were significant efforts. I changed around how the parameters for display are chosen and how the knob operates providing dynamic increments instead of fixed increments.

After using the rig for some time I added two more important features. The first was to introduce the keypad so I could key in numbers directly; frequency is by far the most common parameter directly keyed. At first it seemed a waste to have a keypad for one parameter but other uses have been found.

The second feature I added to the user interface was full support for the non-volatile (NV) ram, a small, 8 pin memory device connected to the I2C bus. The NV ram is updated automatically every time a parameter is changed. "Non-volatile" implies that this memory holds the values in it when power is lost. It is difficult to describe how pivotal this was without experiencing it. Consider what life was like before the NV ram was supported. During operation I would make various parameter changes and occasionally I'd find a problem. I would go modify the program and recompile and download the new version. However, the parameters that I had chosen which caused the problem would be reset by this reload of the program. Then I would have to readjust the parameters hoping that I could remember how they had been set before I started fixing the problem. It was a very tedious process.

Once I had provided support for the NV ram, life was much easier. Upon encountering a problem I would simply fix the program (or hardware), reload the program and restart it. The parameters would be restored to their previous values. It was much easier to determine if the fix had indeed fixed the problem. At this point, I was truly ready to start the DSP part of the project.

Digital Signal Processing

It is finally time to get to work on the Signal Processing code. In the first cut at this software, the signal processing code runs "at the interrupt level" which means that each time the CODEC completes an A-to-D conversion the processor will be interrupted. The processor will stop what it is doing, read in the A-to-D conversion data, process that data and deliver new data to the D-to-A converter which drives the headphones.

In this project, samples to and from the CODEC are 16 bits numbers. In dsPIC C, a 16 bit number is called a "short." The CODEC samples represent fixed point, fractional numbers in the range -1<sample<1. Here's a new C trick. You can tell C that when you say "A" you really mean "B." Now there's no real reason to do this except that we'd like to keep track of when we're talking about a CODEC sample and when we're talking about a 16 bit integer. We do this by telling C that "fractional" really means "short":

```
typedef short Fractional;
```

So from now on, we can write "Fractional" and mean "short."

Of course, the CODEC provides a sample of the I and a sample of the Q at the same time and we're probably going to want to deal with I/Q pairs. In mathematics, an I/Q pair would be called a complex number and we'd like to deal with complex numbers as single units. We've already seen how this is done; the "struct." We can combine the two forms and write:

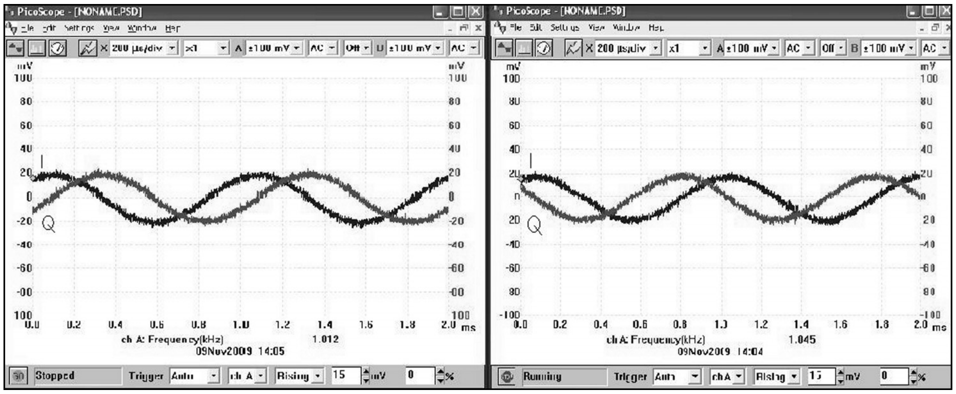


Figure 2—A 1 kHz signal passing through the SDR (no processing).

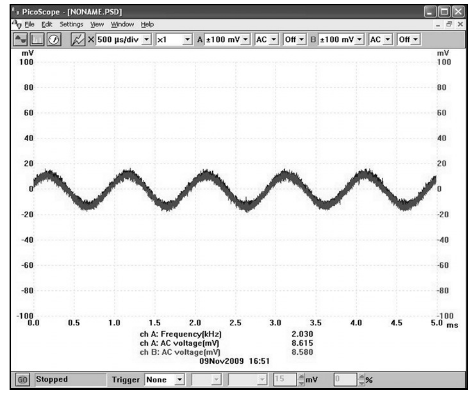


Figure 4—I and the derivative (slope) of Q for 1 kHz signal.

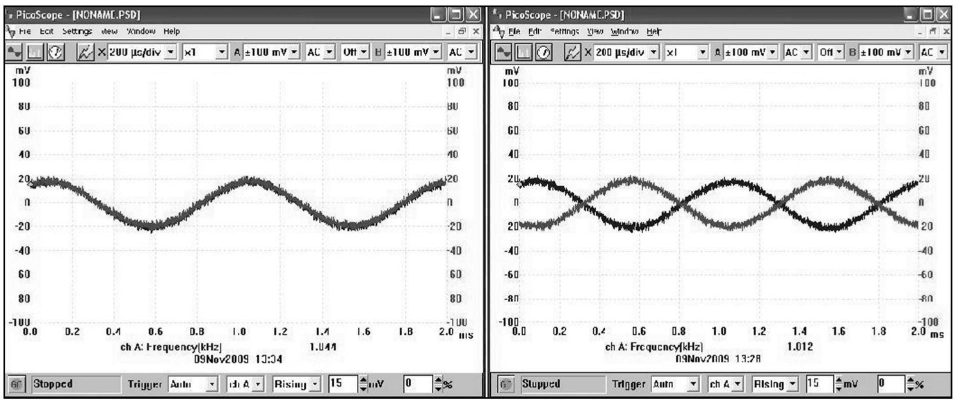


Figure 3—A 1 kHz signal with one channel delayed 900.

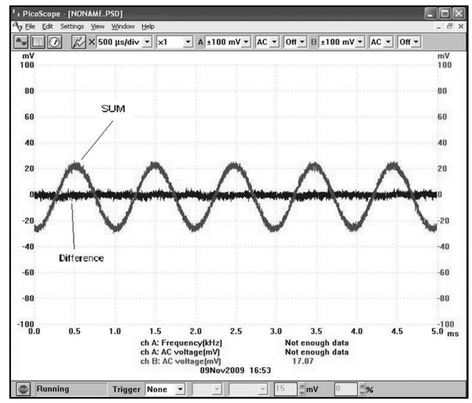


Figure 5—Sum and difference of I and slope of Q for 1 kHz.

```
typedef struct
  {
    Fractional i;
    Fractional q;
  } Complex;
```

In other words, when I declare a variable as "Complex" I mean it is a bucket with two Fractionals which are, of course, really shorts. So I can write:

```
Complex FromCODEC;
```

Oh, and of course, I can write the outgoing variables:

```
Complex ToCODEC;
```

We're getting close here. In C, I need to write a subroutine which will be called each time the CODEC produces a new sample. I'll brush over exactly how the routine gets called and just call it "CODECinterrupt." We will now write our first C program.

Without undue explanation, the following is the declaration of a subroutine which is called every time the CODEC generates a pair of new samples. This routine will simply take the data from the CODEC and hand it back. This is the equivalent of connecting the headphones directly to the QSD down converter. Figure 2 shows a 1 kHz signal passing through the SDR using this code. (Please note that there is lots of "hash" on the signals you will see here. My workbench environment is very noisy and the daemons have been too numerous to exorcise completely.)

```
void CODECinterrupt()   //"void" means this subroutine returns nothing.
  {
     Complex Tmp;    //a temporary holding place.

     Tmp = FromCODEC;      //get data from CODEC
     ToCODEC = Tmp;        //send data on to CODEC
  }
```

Please take a look at Figure 2 on the left hand side. (We'll see lots of dual trace pictures from now on.) On the left hand side of Figure 2, the one trace is the "I" channel and one trace is the "Q" channel. Note that the "I" channel is ahead of the "Q" channel. In this system, this indicates a time when the frequency of interest is above the local oscillator. If the local oscillator were 14.002 MHz then the "Q" channel would lead the "I" channel as seen on the right hand side of FIgure 2. Some people would call this a "negative frequency," but don't get hung up on that term just yet. There are other things to explore right now.

Step One: Opposite Side Band Suppression

One of the true joys of any hobby is the chance to sit back and

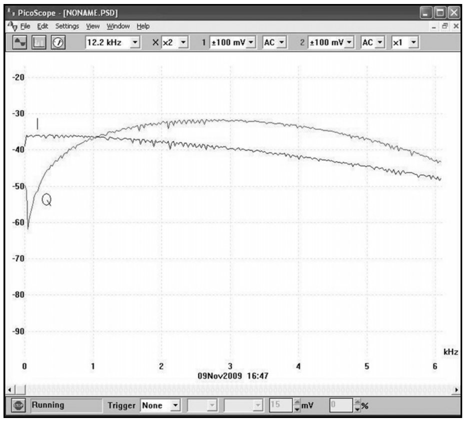


Figure 6—I and slope of Q as a function of frequency.

Figure 7—I and Hilbert Transform of Q as a function of frequency.

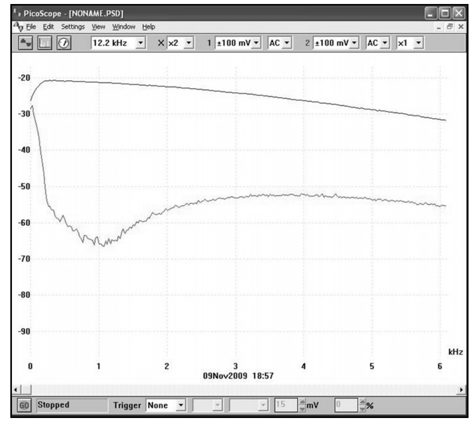


Figure 8—Sum and difference of I and Hilbert Transform of Q.

try some things and ponder the results. Unlike a practicing engineer plagued with deadlines and budgets, the amateur can try some things and learn from the experiments. Even a failure is a lesson because it shows us when our understanding is incomplete. Knowing when we don't understand is important because then we won't proceed in false confidence. One reason for this whole project was to provide a way to try some experiments. Let's try one now.

In order to increase the usefulness of the rig and to reduce the amount of QRM and QRN, I decided to eliminate the "opposite sideband." To do this, the literature suggests using a "Hilbert Transform" because forming the Hilbert transform of a signal is equivalent to adding a 90 degree phase shift to all components of the signal, thus setting the groundwork for generating an SSB signal via the phasing method. I didn't really want to just do things "by the book"; I wanted to try some of my own ideas. So I ignored the literature and did a little thinking. In looking at Figure 2, I saw that what I really wanted to do was to delay one of the two channels by another 90 degrees. Figure 3 shows the results. Note that when the signal frequency is below the local oscillator the I and Q channels are essentially the same and when the signal is above the local oscillator the two channels are opposite.

Now if the signals are added together the "lower" sideband would be selected because the two channels are in phase. The "upper" sideband, however, would have no signal because the two channels are opposite. This is the essence of "opposite sideband rejection using the phasing technique."

The question is how to delay a signal by 90 degrees. For simple sine waves, delaying a signal by 90 degrees is just like "taking the slope" or "taking the derivative." So I wrote a little program like this: I keep three copies of the incoming samples. Then I simply computed the "slope" of one of the channels; here I take the slope of the Q channel. (NOTE: I needed to keep the delay of the two channels the same so I had to delay I by one and take the slope using the "fromCODEC" and an "oldoldCODEC." It is worth playing around with this to convince oneself that this is correct.)

```
Complex oldCODEC;
Complex oldoldCODEC;

void CODECinterrupt
  {
     toCODEC.i = oldCODEC.i;          //match delay.
     toCODEC.q = (oldoldCODEC.q - fromCODEC.q)*scale;

     oldoldCODEC = oldCODEC;
     oldCODEC = fromCODEC;
  };
```

Note that I slipped in a "scale" factor. In my experiment, I simply declared a new parameter in the uMenu and viola! Figure 4 shows the results. The two traces are essentially co-incident. Honestly, this looks pretty good. Figure 5 shows the result of the "addition"; one trace being the sum and the other being the difference. I confess I had to tune the "scale" variable to give the best answer.

What happens if I change the frequency? Figure 6 shows a scan of "I" and "Qslope" amplitude as a function of frequency. Notice how the two traces cross at 1000 Hz. That is where I tuned "scale" to eliminate the opposite sideband. At frequencies other than 1000 Hz, though, this technique really won"t eliminate the opposite sideband well at all. If I had a really narrow filter right after this simple circuit, it is possible this might work. Although not shown, I'd like to point out that at other frequencies the "Qslope" phase is still correct, it is only the "scale" that is wrong because it needs to change with frequency.

An Unexpected Imperfection

OK; back to the Hilbert Transform; no real surprise. Figure 7 shows the I and the Hilbert Transform of Q as a function of frequency. (In Part III of this article, we will talk about how the Hilbert Transform is computed. For now, just assume that we can generate the transform and apply it as shown to our incoming signal samples.) Again, I did some tuning for 1000 Hz. Note that the Hilbert Transform does much better over a wider range but still has a few problems. Examine the two traces closely. At the very left margin, the trace heading down is the Hilbert Transform. This is a well-known shortcoming; The Hilbert Transform has trouble at frequencies near zero. Now look toward the right hand side of Figure 7. Notice that the two traces are diverging. As it turns out, this is unexpected; the Hilbert transform should work well at the

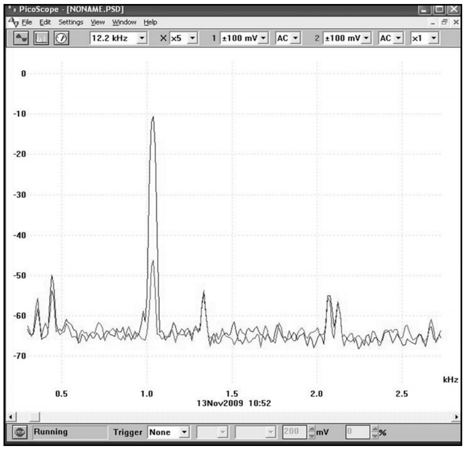


Figure 9—Testing the Hilbert Transform implementation.

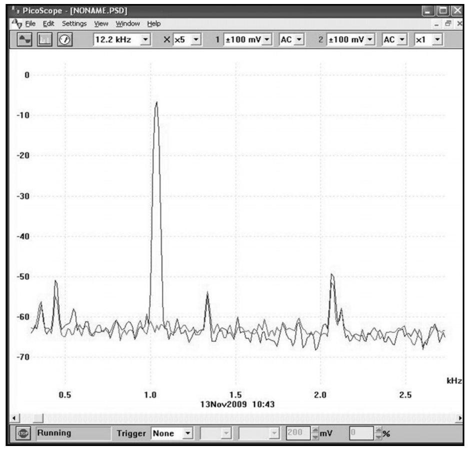


Figure 10—Sum and difference without adjustment factors.

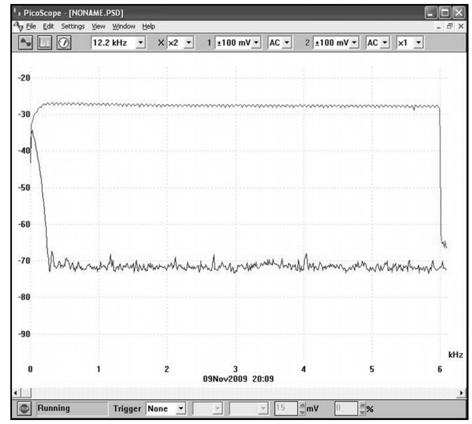


Figure 11—Sum and difference with adjustment factors.

higher frequencies. It often helps to look at the problem in a different light. Figure 8 shows the same data but with the one trace as the addition and the other trace as the difference.

Figure 8 shows that the Hilbert transform does much better than my simple slope detector but problems remain. Near the 1000 Hz, point the Hilbert transform performs better than my equipment's ability to measure. Away from 1000 Hz though, things are different. If you were to listen to this rig on the air you would hear opposite sideband signals. They would be faint but you would definitely hear them. This rig, so far, is suppressing the opposite sideband by only 20 to 25 dB well away from the tuned frequency.

This is clearly unacceptable. The question I asked was WHY this was happening. There were four options: the Hilbert transform did not work as I expected, I coded the transform incorrectly, the CODEC was not digitizing correctly or finally, the QSD board wasn't working correctly.

I decided to find out if the problem was my implementation of the Hilbert Transform. My first step was to write a program which would generate a sine wave of a chosen frequency. This routine would be needed later anyway so now was a good time. I decided to write a routine called "ejm" which would return a complex number with a real part=cos(m) and an imaginary part=-sin(m). I could then use this "ejm" routine to generate a (more or less) perfect input signal with which to test my Hilbert transform. (The interested reader can find the code for "ejm" in my source code.) Here was my test code:

```
long BeepInc;
long BeepPhase;
Complex In, Tmp, S;

BeepPhase = BeepPhase + BeepInc;       //advance generated phase
In = ejm(BeepPhase);                   // get an 'I' and a 'Q'
Tmp.i = Hilbert(In.i);                 //Hilbert transform of I
Tmp.q = MatchHilbertDelay(In.q);       //"Hilbert" delays 'i'… delay 'Q' to match.
S.i = Tmp.i + Tmp.q;                   //sum
S.q = Tmp.i - Tmp.q;                   //difference.
ToCODEC = S;                           //send it out!
```

Figure 9 shows the result. It is clear that the Hilbert Transform I had written was not the problem.

So the first step in examining this problem was to provide for adjusting the relative amplitudes and phases of the incoming I & Q channels. Common wisdom says this isn't necessary for the Quadrature Sampling Detector I was using but I decided to put it in anyway. The routine for adjusting amplitude and phase is fairly simple. (Unfortunately, dsPIC C does not have a built in way to multiply two Fractionals so I had to write a routine "fxf(fa,fb)" which would do that multiplication.) The first step is to add the menu elements:

```
{"AmpAdj",  0,-32000,32000,1,NULL},//no 'update routine' so "NULL"
{"PhzAdj",  0,-32000,32000,1,NULL},//no 'update routine' so "NULL"
```

Then, just after I get the incoming CODEC sample I wrote:

```
In = FromCODEC;
If (AmpAdj > 0)         //should I reduce magnitude of 'I'
  In.i = In.i + fxf(In.i,AmpAdj);
else
  In.q = In.q + fxf(In.q,AmpAdj);        //if not, reduce the magnitude of 'Q'

In.i = In.i + fxf(In.q,PhzAdj);    //adjust phase if necessary.
```

This code is pretty simple and playing with it is HUGELY educational. Take a look at Figure 10. This picture shows the sum and differences as we've seen earlier. The goal is to have the bottom trace be "down in the noise." As you can see, the lower trace is down 35 dB or so. Pretty good. BUT by adjusting the AmpAdj and PhzAdj parameters you can produce Figure 11; down around 60 dB! It is most educational to play with these adjustments. You quickly find that you MUST adjust both amplitude AND phase to maximize performance; no amount of adjusting phase will

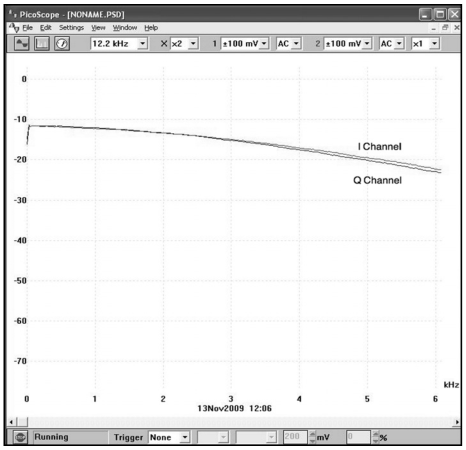


Figure 12—Gain of the I and Q channels vs. frequency.

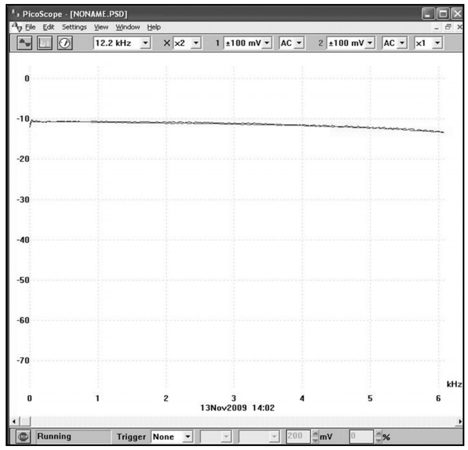


Figure 13—Gain of the I and Q channels with new op amps.

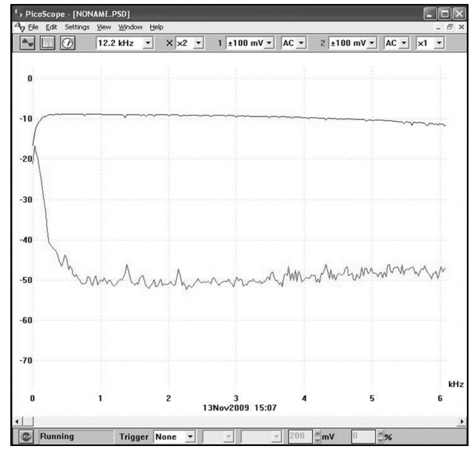


Figure 14—Sideband rejection after new op amps and adjustment.

account for differences in magnitude, nor vice-versa.

Having written that code I went and optimized the performance at a half a dozen frequencies. Here's what I found; as the frequency went up the required AmpAdj and PhzAdj went down. This represented a critical clue. If the AmpAdj was constant then this would indicate a difference in gains of the two channels would be the problem. If PhzAdj was constant then this would represent a problem with the QSD mixer. (Note, I have since learned that this view was overly simplistic.) Since both adjustments changed as frequency changed, I was forced to conclude there was a worse problem. Perhaps there was a difference in the roll-off of the two channels either in the op amps or the QSD integrating capacitors. If one channel rolled off faster than another then this would account for my observations.

Yes, I should have gone and looked earlier, but I had read in several places that differing rolloffs between channels was never a problem. Well, I went and looked and saw what is shown in Figure 12. On the left hand side, Figure 12 shows that the DC gain of the two channels are essentially equal. Because of this, I concluded that resistors used in conjunction with the amplifiers are reasonably well matched. However, as the frequency increases the gains diverge. Thus, the problem is in the roll-off of the two amplifiers. I then went and looked up the data on the LT1636 op amp I was using. It turns out the open loop gain of this device is only about 30 dB at 6 kHz. My QSD board had set the op amp gain to 40 dB. Thus, the op amp itself is rolling off roughly 10 dB from 0 to 6 kHz; almost exactly what is showing in Figure 12. Yes, I had to go change my op amps. Figure 13 shows the results after I had replaced them. As you can see, things are much improved but not yet perfect; notice how the bottom signal rises toward the right of the trace. I suspect that this is an intrinsic property of QSD mixers, their "conversion gain" rolls off with increased frequency; something to look into later.

In the end, I reached a fairly flat sideband rejection. Figure 14 shows a frequency sweep of the upper and lower sidebands. With the exception of low frequencies, the opposite sideband rejection is about 40 dB across a fairly wide band. About what one might expect from fairly casual construction and coding.

Summary

So now my project has achieved a significant milestone. I have a working hardware platform, a working user interface, I can tune the receiver and I can select a sideband. However, the receiver is still "wide open." There is no narrow band filtering yet implemented. When I started this journey, this is where I expected to be out of my element and where I would really start researching and discovering. I was right.

In Part III of this article, I will show how that research and discovery turned out. At that point, the software will be fully described and the transceiver functional with an output of about 200 mV peak/peak. Part IV of this series will describe the class E power amplifier used to boost this 200 mV signal to 5 watts.

Notes

The referenced sidebar, "A 'C' Primer: Describing a Menu," will be made available on the QRP ARCI web site when this article is published.

References

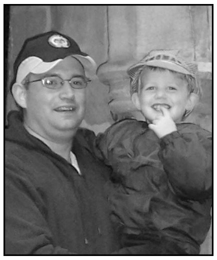
1. Lyons, Richard G., *Understanding Digital Signal Processing,* Second Edition, Prentice Hall, Upper Saddle River, New Jersey, 2004.

2. Hayward, Campbell, Larkin, *Experimental Methods in RF Design,* The American Radio Relay League, 2003.

3. Smith, Steven W., *Digital Signal Processing—A Practical Guide for Engineers and Scientists,* Newnes, 2003.

QRP Contests

Jeff Hetherington—VA3JFF contest@qrparci.org



WOW! Have you been on the bands lately? Signals are jumping into Southern Ontario at strengths that I can almost not remember. 10m has been open! 15m is regularly available for QSOs to Europe and South America … as well as a couple real nice openings to Asia! I've been hanging out on 17m with daily openings to Europe and Northern Africa, and 20m has been alive throughout the day. 30m and 40m in the evening has been providing reliable communications across North America, and regular DX. On 80m, I worked Eurpoe QRP for the first time! It looks like Cycle 24 is finally starting to come alive, and I for one am glad to see it arrive! I can't wait to see the results from our Spring QSO Party in the first week of April. Get on the air and celebrate the start of Spring, and the return of the Sunspots!

The return of Spring often sends many of us out to the yards to fine tune and upgrade our antennas. During the coming months I am going to compile some data from our contests on the antennas that we use. My hopes are to include them in a future issue of QQ. Please continue to let me know what antennas you are using for your contest entries, and please submit details and photos of any special or unique antenna set-ups that you are using.

Throughout the Winter of 2009-2010 we ran four contests, and we crowed four different champions! It's great to see so many new names appearing in the results, and pressing some of the regulars for the top scores. The Top Band Sprint ran at the beginning of December to begin our Winter contesting season. Will Bowser, K9FO, and Brian Campbell, VE3MGY, were locked in a close battle throughout the contest with Will managing to just sneak past Brian at the end. K9FO totaled 49,980 points while running 5 watts from Illinois to beat VE3MGY with 45,080 points running only 1 watt from Ontario. Not to be outdone, Richard Zwirko, K1HTV, and Todd Fonstad, N9NE, were within striking distance with 44,415 points and 43,316 points, respectively. Tim Colbert, K3HX, rounded out the top five with a very respectable 39,494 points.

Mark Your Calendars!

11 July 2010:
Summer Homebrew Sprint

21 August 2010:
Silent Key Memorial Sprint

11 & 12 September 2010:
End of Summer VHF Contest

The great competition in the Top Band Sprint carried over later in the month during one of our more popular events, the Holiday Spirits Homebrew Sprint. This contest has been dominated in recent years by the rigs from Elecraft, and this year was no exception. Dave LeDuc, N1IX, took top score with 105,344 points using his kit built Elecraft K2. Bob Patten, N4BP, took second place with 95,120 points using a kit built Elecraft K3. Arnold Olean, KØZK, put in a strong effort for third place with 81,795 points with his K2. Paul Stroud, AA4XX, broke up the Elecraft top score sweep by running 50 milliwatts from a Wilderness Sierra for 63,300 points and a fourth place finish. Fifth place honours went to Joe Vrabel, KC2JC, and his K2 with 61,644 points.

The second running of our annual Pet Rock Celebration saw a lot of fun again, and also our first non-crystal controlled winner. Jay Schwisow, KT5E, operated throughout the contest to work as many of the rockbound competitors that he could find. His strategy managed him 27,972 points with no bonus points! Second place was last year's winner Dana A. "Mike" Michael, W3TS, with 22,728 points. Steve Hartley, GØFUW, took third place with 10,350 points. Steve Wilson, KØJW, managed 9,636 points and Tim Colbert, K3HX, 7,875 points to round out the top five.

The end of the Winter Contest season is our annual foray into SSB contesting with the Fireside Sprint. This is always a little different, and many of our regulars need to search for months to try to locate that microphone once again, hi hi. Bob Patten, N4BP, returned to the top of the score sheet with 74,613 points to outdistance Michael Jay Stutzer, KDØFDJ, in second place with 10,080 points. Edward Kacura, N7EDK, scored 7,541 points for third place and Dennis Bullock, N6DIT, scored 6,428 points in fourth place. Alan Muldawer, N3ALN, picked up 3,157 points for the fifth place bragging rights. Of special note, while almost all the competitors entered in the 2-10 W category. John Maranca, Jr., KB2HSH, toughed it out running 500 mW SSB to take the milliwatt award.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

Top 5 Top Band Sprint:

Will Bowser—K9FO	49,980 pts
Brian Campbell—VE3MGY	45,080 pts
Richard Zwirko—K1HTV	44,415 pts
Todd Fonstad—N9NE	43,316 pts
Tim Colbert—K3HX	39,494 pts

Top Band Sprint Soapbox

Had lots of computer noise at first. Sorry if I missed you due to it. Had fun hunting up phone QSOs. Band was a little noisy but glad to see you all on.—**K9FO**

Fine turnout. Band was difficult at times with weak signals, QSB, and static crashes. I mistakenly quit an hour before the official end of the contest!—**N9NE**

Lots of QRN from an approaching storm. More activity than I'd expected. Great Fun.—**K3HX**

Planned for Marlene to do the contest on SSB, but didn't hear any activity around 1910, so I did the CW. I've passed the 78 year mark now and am concerned about my hearing loss. **N5ECT**—2nd in command at **WD5R**.

Got on Wednesday night to listen around a bit and realized the Sprint had started ... Not Thursday eve as I mistakenly planned! Quick set up the log in N1MM and off we go. Enjoyed it ... My second QRP Top Band Sprint ... Almost doubled my QSO count from '06. Nice to provide the seemingly only active RI section. Most activity died out here on the East Coast, other than a few CQers, just after 0430Z. K3HX's sigs were strong and steady here

2009 Top Band Sprint

NAME	Call	S-P-C	POWER	#QSOs	Pts	SPC	Mult	Score
Will Bowser	K9FO	IL	< 5W	72	255	28	7	49980
Brian Campbell	VE3MGY	ON	< 1W	50	196	23	10	45080
Richard Zwirko	K1HTV	VA	< 5W		235	27	7	44415
Todd Fonstad	N9NE	WI	< 5W	65	238	26	7	43316
Tim Colbert	K3HX	PA	< 5W	59	217	26	7	39494
Doug Thomas	WD5R	AR	< 5W	52	194	27	7	36666
Dana A. "Mike" Michael	W3TS	PA	< 1W	36	141	18	10	25380
Chalres Moizeau	W2SH	NJ	< 5W	36	141	18	7	17766
William B. Bliss	W1WBB	RI	< 5W	32	133	18	7	16758
Jim Fitton	W1FMR	NH	< 5W	31	113	17	7	13447
Nick Thomas	NT1A	NH	< 5W	28	113	16	7	12656
Philip Schweitzer	KØCD	WI	< 5W	26	91	17	7	10829
Robert MacKenzie	VA3RKM	ON	< 5W		104	14	7	10192
Paul Stroud	AA4XX	NC	< 5W	24	90	15	7	9450
Dennis Peterson	K4CKD	SC	< 5W	22	83	7	11	6391
Garry S. Nichols	WA1GWH	NY	< 5W	16	65	13	7	5915
Joseph Mead	K2JT	NJ	< 5W	19	90	9	7	5670
Edward Swynar	VE3CUI	ON	< 5W		66	10	7	4620
Ken Downs	W1KRT	NH	< 5W		63	10	7	4410
Ray Bilger	W3TDF	PA	< 5W	14	55	11	7	4235
Arnold Olean	KØZK	ME	< 250mW	11	46	6	15	4140
Chuck Guenther	NIØC	MO	< 5W	14	49	12	7	4116
James A. Walter	WT9U	IN	< 5W	14	61	9	7	3843
Joe Vrabel	KC2JC	NJ	< 5W		54	10	7	3780
Dennis Burton	N5DRB	AR	< 5W		49	10	7	3430
Bob Reisenweber	W3BBO	PA	< 5W	12	48	10	7	3360
Jim Cluett	W1PID	NH	< 5W	10	41	8	7	2296
William McFadden	WD8RIF	OH	< 5W		35	9	7	2205
Bruce Olney	WY7N	UT	< 5W	12	39	7	7	1911
Thomas Kuehl	AC7A	AZ	< 5W	10	35	6	7	1470
Donald C. Younger	W2JEK	NJ	< 5W	7	29	6	7	1218
Carl Achin	WA1ZCQ/1	MA	< 5W	6	24	6	7	1008
Edwin E. "Ted" Albert	AB8FJ	OH	< 5W	5	19	5	7	665
Steve Yates	AA5TB	TX	< 5W		21	4	7	588
Larry Card	W9CC	IN	< 5W	4	11	4	7	308
Dennis Bullock	N6DIT	CA	< 5W	3	9	3	7	189

throughout the Sprint. Hope to make it again next year, this time at the starting bell! Longest distance QSO was NØTT in MO at 1206.8 miles besting my next furthest, WD5R in AR by 22.5m. Thanks to all for the QRP Qs ... best callsign in the Sprint—VE9QRP of course.—**W1WBB**

Band was noisy and signals in and out, but I was very glad to work WD5R and N0TT with 2W from NH.—**W1FMR**

QSB and some noise made it challenging at times, but lots of stations to work. —**VA3RKM**

This was fun; however, band conditions were bad-bad-bad—wish I had an altoids tin 160 meter txcvr to use sometime to see what it can do.—**K4CKD**

This is a fun contest—two way QRP on my favorite band! The receive antenna really helped to pull stations out of the static crashes.—**NIØC**

QRN with arriving storm. First time on 160 since last winter.—**KC2JC**

Only an hour to play. Lots of stations and great signals!—**W3BBO**

Used an 80 meter OCF dipole. I was lucky to work anyone! Each QSO was hard work. I operated for about an hour and a half. Thanks to all who pulled me out of the noise.—**W1PID**

Operated "portable one" (/1) from the woods of Harvard, MA. Only operated for about 50 mintues total. Had a great time.—**WA1ZCQ/1**

Holiday Spirits Sprint Soapbox

Got off to a decent start, but after 30 minutes the power line noise switched on at a solid S9 and never let up. Highlight was working KL8DX. 40m was too noisy to copy any but the loudest signals. —**N4BP**

Top 5 Holiday Spirits Homebrew Sprint:

Dave LeDuc—N1IX	105,344 pts
Bob Patten—N4BP	95,120 pts
Arnold Olean—KØZK	81,795 pts
Paul Stroud—AA4XX	63,300 pts
Joe Vrabel—KD2JC	61,664 pts

Portable operation from west end of 22 North Street. I tossed a wire into the trees the previous day. Surprised by 80 meters!—**KØZK**

Condx on 20M weren't as good as I've ever seen, but most stations that I could copy Q5 were hearing my 50 mW. 40M was tough sledding, but 80M was quite good. Thanks to Barry, AI2T for hanging in there to complete our 80M exchange. It was fun having several stations answer my CQs on 20, 40, and 80M, proving that QRP contesters have some of the best ears on

2009 Holiday Spirits Homebrew Sprint

NAME	Call	S-P-C	BANDS	POWER	#QSOs	Pts	SPC	Mult	Bonus	Score
Dave LeDuc	N1IX	NH	ALL	< 5W	58	254	48	7	20000	105344
Bob Patten	N4BP	FL	20/40	< 5W	71	304	40	7	10000	95120
Arnold Olean	KØZK	ME	ALL	< 5W	43	191	35	7	35000	81795
Paul Stroud	AA4XX	NC	ALL	< 50mW	23	115	21	20	15000	63300
Joe Vrabel	KD2JC	NJ	ALL	< 5W	42	192	31	7	20000	61664
Barry Ives	AI2T	NY	ALL	< 5W	39	183	31	7	15000	54711
Joseph G Gay	W4RYW	AL	ALL	< 1W	28	134	26	10	15000	49840
Richard Ferch	VE3KI	ON	ALL	< 5W	27	129	25	7	25000	47575
Pat Cain	KØPC	MN	20/40	< 5W	43	191	28	7	10000	47436
Rob Neece	KK4R	VA	ALL	< 5W		142	27	7	15000	41838
Paul Kirley	W8TM	OH	20/40	< 5W	35	148	28	7	10000	39008
Norman Brooks	WF7T	TN	ALL	< 5W	40	176	31	7	0	38192
Doug Baker	KGØTW	MO	20/40	< 5W		173	29	7	0	35119
Dana A. "Mike" Michael	W3TS	PA	ALL	< 1W	20	88	17	10	20000	34960
Robert MacKenzie	VA3RKM	ON	ALL	< 5W		67	14	7	25000	31566
Carl Middlekauff	K7ZYV	MS	20/40	< 5W	28	125	23	7	10000	30125
Ned B. Newlin	W8VFM	MI	40/80	< 5W	30	129	21	7	10000	28963
John King	KB3WK	MD	ALL	< 5W	19	92	18	7	15000	26592
Will Bowser	K9FO	IL	20/40	< 1W		91	18	10	10000	26380
Jim Fitton	W1FMR	NH	20/40	< 5W		114	19	7	10000	25162
Tim Colbert	K3HX	PA	20/40	< 5W	26	112	17	7	10000	23328
Pete Bodner	AA9NF	IL	ALL	< 5W	18	81	10	7	15000	20670
Raymond A. Franz	WB0SMZ	KS	20/40	< 5W	17	85	16	7	10000	19520
Dennis Bullock	N6DIT	CA	20/40	< 5W	12	54	10	7	15000	18780
Kevin Clements	VE3RCN	ON	ALL	< 5W		131	20	7	0	18340
Bill Gregroy	K2EKM	VA	ALL	< 5W	10	47	10	7	15000	18290
Donald C. Younger	W2JEK	NJ	ALL	< 5W	9	42	9	7	15000	17646
Louis Visconti	KD2MU	NY	ALL	< 5W		40	8	7	15000	17240
Michael R. Zomlefer	WØMRZ	IA	20	< 1W	12	57	9	10	10000	15130
Gregg Mulder	WB8LZG	MI	20/40	< 5W	13	59	7	10	10000	14130
John Marranca Jr	KB2HSH	NY	40/80	< 1W	8	40	8	10	10000	13200
William Ravenel	AI4VE	NC	20	< 5W	10	50	9	7	10000	13150
Russ Mumaw	K3NLT	VA	20/40	< 5W	8	40	8	7	10000	12240
Philip L. Graitcer	W3HZZ	GA	40/80	< 5W	8	31	7	7	10000	11519
William Thompson	N9BT	IL	20/40	< 5W	7	14	6	7	10000	10588
Ron Pettingill	N7RN	AZ	20	< 5W		63	11	7	5000	9851
Larry Card	W9CC	IN	80	< 5W		47	8	7	5000	7632
Art Rank	KB1NHV	VT	ALL	< 5W	15	75	14	7	0	7350
John T. Laney III	K4BAI	GA	40/80	< 5W	14	67	14	7	0	6566
Larry Mergen	KØLWV	MO	20/40	< 5W	15	72	13	7	0	6552
Steve Yates	AA5TB	TX	40	< 5W		30	6	7	5000	6260
Pat Byers	VE3EUR	ON	40	< 5W	5	22	5	7	5000	5770
Kevin McCall	KCØJBU	CO	20	< 1W	1	5	1	10	5000	5050
Rem O'Donnelley	K6BBQ	CA	40	< 5W	1	2	1	7	5000	5014
Jim Cluett	W1PID	NH	40/80	< 5W	8	37	7	7	0	1813
Jeff Hetherington	VA3JFF	ON	40	< 5W	1	5	1	7	0	35

the planet.—**AA4XX**

Snow-bound here, nice way to spend Sunday afternoon before Christmas.—**KD2JC**

Excellent member turn-out—plenty of activity. 20m was open to the south and west, but 15m was dead. The new antennas appear to help—I did over 50% better than last year (or are conditions better?) Thanks to W8VFM for my only 40m QSO which added 5,000 bonus poitns to my score. Congrats to AA4XX in NC for successful 50 mW operations on 80m.—**AI2T**

Signals would rise above the noise floor for a short while, sometimes for long enough to make a contact, then drop down below the noise floor again. 80m was a bit better than 40m and 20m. Thanks to Bob VA3RKM for running the bands with me.**—VE3KI**

20m was the only band that worked for me.—**KØPC**

Every time I started calling CQ and started anything like a run, the phone or the doorbell rang. Too bad those QSOs don't count.—**KK4R**

Was a lot of fun—**KGØTW**

I came home from helping my son work on his new tile kitchen floor and had about 1 hour of sprint remaining, so I jumped in for some fun.—**W3TS**

Noisy on the low bands and poor propagation on 20m by the time I got on the air. But I was glad to work some new calls and some old ones!—**VA3RKM**

This is the first Sprint I have entered for 2 years. It was fun and conditions quite good.—**W8VFM**

Nice contest, but activity was light.

2010 Pet Rock Celebration

NAME	Call	S-P-C	BANDS	POWER	#QSOs	Pts	SPC	Mult	Bonus	Score
Jay Schwisow	KT5E	CO	20/40	< 5W	38	148	27	7	0	27972
Dana A. "Mike" Michael	W3TS	PA	ALL	< 5W	18	69	16	7	15000	22728
Steve Hartley	GØFUW		40	< 5W	5	10	5	7	10000	10350
Steve Wilson	KØJW	IN	40	< 5W		79	12	7	3000	9636
Tim Colbert	K3HX	PA	20/40	< 5W		75	15	7	0	7875
John T. Lainey III	K4BAI	GA	20/40	< 5W	17	70	14	7	0	6860
Willie L. Baber	WJ9B	FL	40	< 5W	9	39	6	7	5000	6638
Larry Mergen	KØLWV	MO	20/40	< 5W	8	37	7	7	0	1813
Robert MacKenzie	VA3RKM	ON	20/40	< 5W		22	4	7	0	616
John Leediker	W5EEX	AZ	20	< 5W	2	10	2	7	0	140
Kevin Clements	VE3RCN	ON	20/40	< 5W	2	10	2	7	0	140

Good news is that 80m was in better shape than earlier contests this year.—**KB3WK**

Conditions fair here, but worked all around the country.—**K9FO**

Beautiful CA day and the sprint made it better.—**N6DIT**

First time entry in a QRP test. Talked into it by Jeff, VA3JFF. I had a lot of fun...even logging it with pen and paper. Amazing what you can hear and work without KWs clobbering you from 1Kc away. I will be back.—**VE3RCN**

Happy holidays to all, and a happy and healthy New Year!—**KD2MU**

It was a wee bit chilly out here in Iowa durng the contest and I operated "in the field" during the entire contest using just 0.5W. I had a great time and look forward to my next ARCI QRP contest.—**WØMRZ**

Tough going at times with the 40 year old circuitry... But fun nonetheless.—**KB2HSH**

Fun but pretty cold on my back deck with 5 inches of snow. I was glad the band died early.—**AI4VE**

This is my first attempt to operate a sprint and with only two hours available, my primary goal was to determine how my under the roof 283 foot signal turn loop would perform with 16" of snow over it. I am generally satisfied with what I could do in search and pounce mode looking for the most distant stations that I could hear. After more than 50 years of operating QRP I am amazed with what you can do when the sunspots are making good propagation, however, I had high QRN on 40 so went back to 20 and worked all I could hear that I had not already worked, except for N6A who appeared to have a pileup and I couldn't break it.—**K3NLT**

Top 5 Pet Rock Celebration:

Jay Schwisow—KT5E	27,972 pts
Dana A. "Mike" Michael—W3TS	22,728 pts
Steve Hartley—GØFUW	10,350 pts
Steve Wilson—KØJW	9,636 pts
Tim Colbert—K3HX	7,875 pts

Top 5 Fireside SSB Sprint:

Bob Patten—N4BP	74,613 pts
Michael Jay Stutzer—KDØFDJ	10,080 pts
Edward Kacura—N7EDK	7,541 pts
Dennis Bullock—N6DIT	6,428 pts
Alan Muldawer—N3ALN	3,157 pts

First ARCI QRP contest. Lots of fun, although I could only spare an hour!—**W3HZZ**

This is my first QRP contest. I am not a member of the ARCI but am submitting my log for at least a "head count" I really enjoyed the experience and look forward to future contests.—**KB1NHV**

Unfortunately, I had very little time to operate but I had fun which is the point of the exercise. My plan was to start on 20m using my NC2030 and switch to my 2N2/40 on 40m later in the day. The contest would be the first real test of my new inverted-L antenna. I expected good conditions on 20m because of recent solar activity but when I listened to 20m, stations were very weak with QSB. Because of poor propagation and high local QRN I didn't use 20m. Instead, I made this contest a 40m single band effort.—**VE3EUR**

First exchange on a homebrewed transceiver made with only discrete transistors having superhet receiver and 0.9 watt transmitter. Very difficult band conditions, so I was thrilled to make that first contact. Knowing the contest was soon

2010 Fireside SSB Sprint

NAME	Call	S-P-C	BANDS	POWER	#QSOs	Pts	SPC	Mult	Bonus	Score
Bob Patten	N4BP	FL	20	< 10W	118	323	33	7	0	74613
Michael Jay Stutzer	KDØFDJ	CO	20	< 10W	36	90	16	7	0	10080
Edward Kacura	N7EDK	AZ	20	< 10W	11	33	11	7	5000	7541
Dennis Bullock	N6DIT	CA	20	< 10W	14	34	6	7	5000	6428
Alan Muldawer	N3ALN	MD	20	< 10W	17	41	11	7	0	3157
Paul Stroud	AA4XX	NC	20	< 10W	7	29	6	7	0	1218
Paul Kirley	W8TM	OH	20/40	< 10W	7	29	6	7	0	1218
Rob May	NV5E	TX	20	< 10W	3	15	3	7	0	315
Charles H McGinnis	ND4D	GA	20/40	< 10W	3	15	3	7	0	315
John Marranca Jr	KB2HSH	NY	20/40	< 500 mW	2	10	2	15	0	300
Jim Cluett	W1PID	NH	20/40	< 10W	2	10	2	7	0	140
Scott McMullen	W5ESE	TX	20	< 10W	2	10	2	7	0	140
John T. Laney III	K4BAI	GA	20	< 10W	1	5	1	7	0	35
Edwin E. "Ted" Albert	AB8FJ	OH	20	< 10W	1	5	1	7	0	35

coming motivated me to finsih the design and construction, with solder still flowing the night before the contest!—**KCØJBU**

I went out portable and made one contact and then left as it was starting to drizzle, but before the rain came down good once I got home.—**K6BBQ**

Lots of fun but need more participation.—**W4RYW**

Prop conditions in AZ were very poor this year.—**N7RN**

Pet Rock Celebration Sprint:

This was fun and it is much easier to do a 3 hour sprint than a full weekend contest. It was fun to hear some DX from Europe. This sprint sure brings out some interesting CW tones!—**KT5E**

Poor conditions caused a lower score this year but it is still fun using crystals and a hand key.—**W3TS**

This is my first ever entry for a CW contest and I don't expect to trouble the judges but I had a great time building the rig, lashing up the antenna and getting my code back up to test speed (just). Whilst I was not out /P, I did operate in the spirit of the contest with battery power and a temporary antenna—I had no choice with the antenna as we had some work done on the QTH roof in December and the roofer had not removed his scaffold from around my main antenna!—**GØFUW**

Not much activity. 20m dead save for KT5E. Great fun even with few stations on.—**K3HX**

Condx not vy gud here Lots of noise.—**KØLWV**

Heard DX ops from DL, EA, GM, and OM but could not work them. Contacts in NA were not easy to come by.—**VA3RKM**

My first QRP-ARCI Contest... Not spectacular results but I had a good time.—**W5EEX**

Fireside Sprint Soapbox:

Imagine working N4BP on SSB! Amazing.—**W1PID**

Some really outstanding QRP signals to be heard. Highlight was probably call from VE8GER from NWT.—**N4BP**

Lucked out with no rain, but still got to play in the mud.—**N6DIT**

20m sure was crowded.—**W5ESE**

Only heard N4BP on 20 calling CQ. Managed to work Bob. Called and listened a lot but did not hear anyone else for the contest.—**AB8JF**

No activity! Lousy conditions. And, oh ... The Superbowl! Great timing!—**KB2HSH**

Operated in the desert, west of Tucson, AZ. Last 3 hours were tough—few contacts. Lots of fun!—**N7EDK**

●●

CU in the next QRP ARCI Contest!

Mark Your Calendars!

11 July 2010:
Summer Homebrew Sprint

21 August 2010:
Silent Key Memorial Sprint

11 & 12 September 2010:
End of Summer VHF Contest

Contest Announcements

FOR ALL CONTESTS:

Email Log Submission:

Submit Logs in plain text format along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation to va3jff@yahoo.ca

Snail mail Log Submission:

Submit Logs along with a summary stating your Callsign, Entry Categorym Actual Power and Station Description along with score calculation to:

(Contest Name)
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

Results will be published in *QRP Quarterly* and shown on the QRP-ARCI website. Certificates will be awarded to the top scoring entrant in each category, as well as the top scoring entrants from each State, Province and Country. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2010 QRP-ARCI Summer Homebrew Sprint

Date/Time:
2000Z to 2359Z on 11 July 2010.

Mode:
HF CW Only.

Exchange:
Members send: RST, State/Province/Country, ARCI member number
Non-Members send: RST, State/Province/Country, Power Out

QSO Points:
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>5 Watts = ×1
>1 - 5 Watts = ×7
>250 mW - 1 Watt = ×10
>55 mW - 250 mW = ×15
<55 mW = ×20

Suggested Frequencies:
160m 1810 kHz

80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound hams)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) × SPCs (total for all bands) × Power Multiplier + Bonus Points.

Bonus Points:

For homebrew gear (per band) add 2,000 points for using HB transmitter; add 3,000 points for using HB receiver; or add 5,000 points for using HB transceiver. Definition of Homebrew is any equipment build and soldered by you, either scratchbuilt or from a kit is acceptable. Plug and Play modular style kits are not eligible for the bonus. If you are operating portable using battery power *and* a temporary antenna, add 5000 points to your final score. (You can *not* be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

All-Band
Single Band,
High Bands (10m-15m-20m)
Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:

Entries must be postmarked on or before 11 August 2010. Results will be published in *QRP Quarterly* and shown on the QRP-ARCI website.

2010 QRP-ARCI Silent Key Memorial Sprint

Purpose:

Our contest celebrates and honors the QRP luminaries who no longer answer CQs. Those generous people who graciously donated to the QRP community their time, effort and knowledge to advance the premise that more fun could be had using less than 5 watts. Some were irascible and some were even considered curmudgeons but when you took a keen look at their accomplishments and listened to those who knew them well you discovered truly wonderful people who would give you their last diode.

The people we are celebrating are well known among the QRP Community. Some passed recently and some have enjoyed their reward many years. They are not forgotten for their accomplishments live on either on the bands, the internet, through published works or organizations that benefited from their largess. This contest celebrates ALL SKs who now call CQ from above, where all sigs are 599 and all contacts QSL 100%. Celebrate the many SK's that we have known and loved in years past.

Date/Time:

1500Z to 1800Z on 21 August 2010.

Mode:

CW Only

Exchange:

Members send: RST, State/Province/Country, ARCI member number

Non-Members send: RST, State/Province/Country, Power Out

QSO Points:

Member = 5 pointsNon-Member, Different Continent = 4 points

Non-Member, Same Continent = 2 points

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 Watts = ×1
>1 - 5 Watts = ×7
>250 mW - 1 Watt = ×10
>55 mW - 250 mW = ×15
<55 mW = ×20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (also 7040 kHz for rock bound hams)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) × SPCs (total for all bands) × Power Multiplier + Bonus Points.

Bonus Points:

If you are operating portable using battery power *and* a temporary antenna, add 5000 points to your final score. (You can *not* be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

All-Band
Single Band
High Bands (10m-15m-20m)
Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Entry Deadline:

Entries must be postmarked on or before 21 September 2010. Results will be published in *QRP Quarterly* and shown on the QRP-ARCI website.

2010 QRP-ARCI End Of Summer VHF Contest

Date/Time:
1900Z on September 11, 2010 through 0400Z on September 12, 2010.

Bands:
All bands abover 50 MHz as outlined in the ARRL September VHF Sweepstakes Rules

Mode:
Any legal mode.

Exchange:
4 digit Maidenhead Grid Square Locator as outlined in the ARRL VHF Sweepstakes Rules

Entry Categories:
Single Operator
Rover (up to two operators allowable)

QSO Points:
1 point for 50 MHz and 144 MHz QSOs
2 points for 222 MHz and 432 MHz QSOs
4 points for 902 MHz and 1296 MHz QSOs
8 points for 2.3 GHz or higher QSOs

Special Note:
QSOs utilizing repeaters of any kind are prohibited. QSOs on the National Simplex Frequency 146.52 MHz are prohibited.

Scoring (Single Operator):
For single operators, the final score is Points (total for all bands) × Maidenhead Grid Squares (total worked on each band) × Power Multiplier.

Special Scoring for Rovers only:
The final score consists of the total number of QSO points from all bands multiplied by the sum of unique multipliers (grid squares) worked per band (regardless of which grid square they were made in) plus one additional multiplier for every grid square from which they successfully completed a contact.

Power Multiplier:
>10 W = ×1
>5-10 W = ×4
>1-5 W = ×7
>250 mW - 1 W = ×10
>55 mW - 250 mW = ×15
55 mW or less = ×20

Score:
Points (total for all bands) × Maidenhead Grid Squares (total worked on each band) × Power Multiplier.

Bonus Points:
There are *no* bonus point for this contest.

Best reason to participate:
A fun mixed mode QRP VHF contest.

Entry Deadline:
Deadline for entries is 12 October 2010. Results will be published in *QRP Quarterly* and shown on the QRP-ARCI website.

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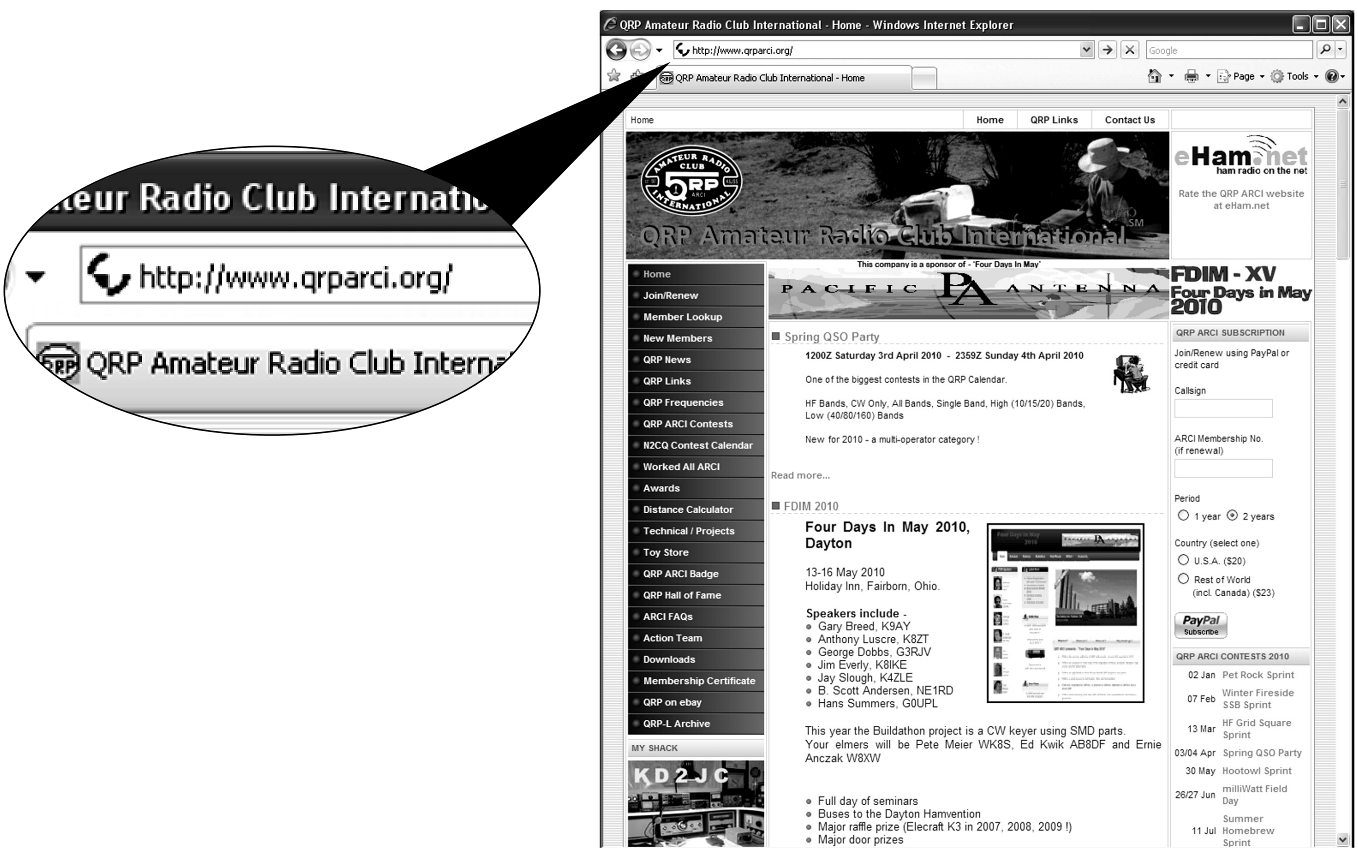

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