YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

Volume 44 Number 4
Fall 2003
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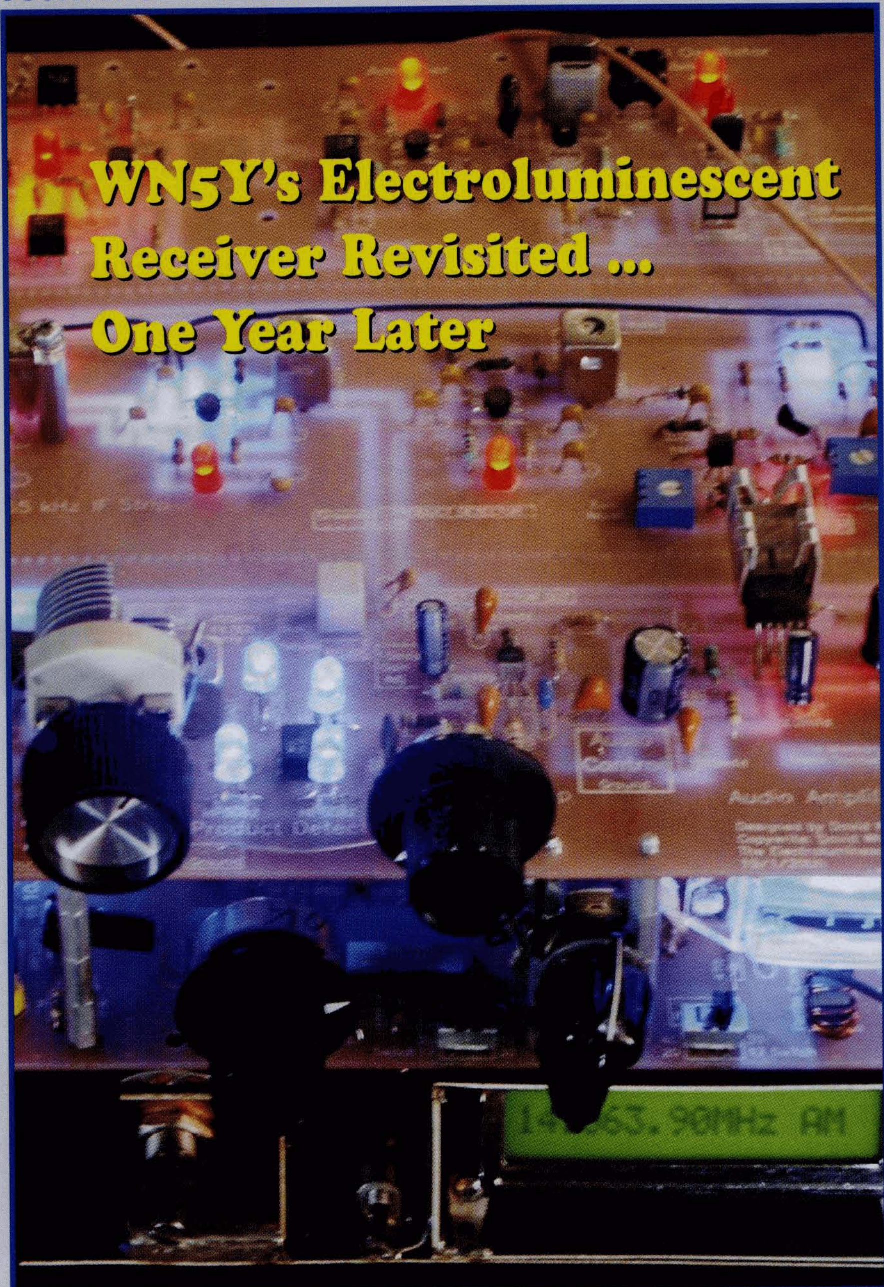
QRP Quarterly

Journal of the QRP Amateur Radio Club International



- Portable Antenna Advice from W4RNL: 'Just Tall; That's All'
- A Transmitter Design for 'Building Day'
- QRP World News from New Columnist RV3GM
- VE3SMA's Spartan Sprint 40M XCVR
- Contest Results: Hootowl Sprint Milliwatt Field Day Summer HB Sprint

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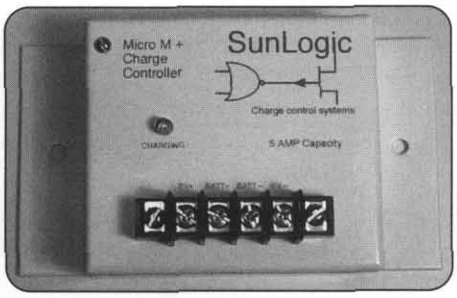

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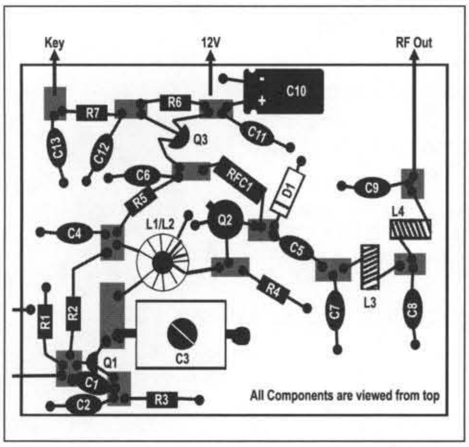

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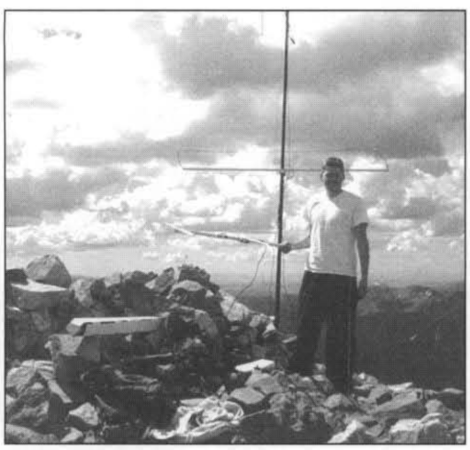

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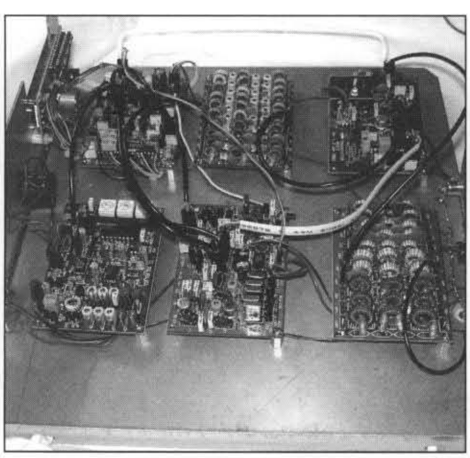

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Technical Articles

The Joy of QRP

The World of QRP ARCI

From the Editor's Desk

Mike Boatright, KO4WX—Editor ko4wx@mindspring.com

Every so often, you see a really long thread on the QRP-L winding its way in and out of the indents on some topic or another about which all of the posters seem to have really strong opinions. I try to avoid these threads—not because the topic isn't interesting, because it often is, but because I have to remember that in the end, amateur radio is a hobby.

The American Heritage® Dictionary of the English Language, Fourth Edition defines "hobby" as "An activity or interest pursued outside one's regular occupation and engaged in primarily for pleasure."

Folks, if this hobby ever gets to the point were we are no longer engaging in it primarily for pleasure, I don't know about you, but I think I might consider getting another hobby. Life is simply too short to take oneself or others too seriously.

"Thank You" to the QQ staff

Which brings me to the point of this editorial: a very special "Thank You" to all the volunteers who day in and day out work make the running of QRP ARCI and the *QRP Quarterly* part of their hobby.

These folks get nothing in return for their service to the QRP community except for the satisfaction of a job well done, and the occasional admiration of their peers. Nonetheless, they meet their deadlines, they answer the e-mails, they track down the glitches—all because they love QRP ARCI and because it is part of the way they "engage in primarily for pleasure."

So, when you get the chance to chat with one of these folks—whether they be the columnists, authors and staff, or part of the ARCI "management" (and remember, they're amateurs, too, although so was the famous golfer, Bobby Jones, for his entire career)—take just a minute to say "Thank You" and if you have ideas of how to make things better, then be prepared to dig in and help implement them, OK?

One special "Thank You!" goes to Mike Czuhajewski, WA8MCQ, who with this issue becomes our new Assistant Editor. Mike is responsible for a big chunk of the content that you see every issue and we simply would not have the quality magazine that we all strive for.

I am very pleased to welcome two new columnists to the staff—Oleg Bodorin, RV3GM, who joins us in this issue with his column, "QRP World News" and Steve Hudson, AA4BW. Some of you may know Oleg as the Chairman of the RU-QRP club, and really "in the know" about what is happening throughout the world in QRP. Steve gave us an "Introduction to Building Day" and I'm placing the "QRV?" column in to his loving hands.

Mike Branca, W3IRZ, SK

Finally, it is with great sadness that I announce that Mike Branca, W3IRZ, became a silent key on September 29, 2003.

I once said that the way you go through the boneyard at Dayton is to take Mike with you—it was like taking along your own private museum curator.

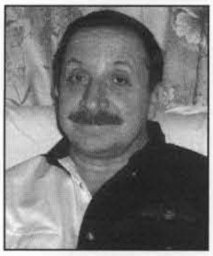
Mike was my elmer in every possible sense of the world. He constantly gave to others. He was a prolific writer, appearing in such publications as the *QRP Homebrewer*, *QRPp*, *CQ*, *QST*, the *NOGA Compendium* and *QRP Quarterly*—most recently, his Differential-T Tuner appeared on the cover of the Spring 2003, issue.

Sadly, there were some ideas and projects that he was never able to share with us, but if you've ever built a W3IRZ design, you've built a piece of real amateur radio gear. Mike was a dear friend and will be missed by us all.

—72 de Mike, KO4WX

From the President

Joe Spencer—KK5NA kk5na@quadj.com



Fall has arrived and it is finally cooling off a bit here in Texas. Hope you all had a good summer and are now ready for the coming holidays and the many great contests and radio events on the horizon. We have found some new volunteers to keep QRP-ARCI running efficiently. We have new certificate manager to create the very nice certificates we award to those who achieve special qualifications and win contests.

Dick Pascoe, GØBPS, will become the President of QRP-ARCI in January, and Ken Evans, W4DU, who has served on our Board of Directors for many years will be the next Vice President.

We are currently looking for new board members to take Ken's place and Jim Larsen, AL7FS, is resigning his board position so we will need to find a replacement for him as well. Many thanks to Jim for his many years of service!

As the year comes to an end and my term as president does too, I want to thank those who have helped me through the last two years and wish QRP-ARCI continued success.

—72 Joe KK5NA

Call for Board of Director Nominations

The By-Laws of the QRP Amateur Radio Club International call for a Board of Directors. The duties of the board are as follows:

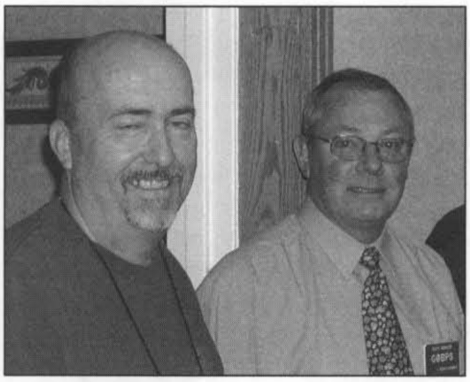
BOARD OF DIRECTORS: The Board of Directors shall elect Club Officers and conduct an annual meeting and such other meetings as needed (either face to face or virtual via e-mail). During the period between meetings, the Directors shall establish policies and programs for the Club. In all matters of concern or dispute, the Board of Directors shall be the final authority.

Currently there are six directors on the Board. Their terms run for four years and are staggered such that three directors are elected every two years. The following Directors terms expire on April 1, 2004:

Ken Evans, W4DU
Jim Larsen, AL7FS
Dick Pascoe, GØBPS

Please contact the Secretary, Jack Nelson, K5FSE at jack.nelson@mindspring.com to make a nomination.

Announcements



New QRP ARCI officers are President, Dick Pascoe, GØBPS (right) and Vice President, Ken Evans, W4DU (left).

New QRP ARCI President: Dick Pascoe, GØBPS

Beginning with the new year, 2004, Dick Pascoe, GØBPS (QRP ARCI # 7161), will become the new President of the QRP Amateur Radio Club International.

Dick has been the DX representative of QRP-ARCI since 1990 and was elected to the HOF in 1997. He was elected Vice President in 2001 after being chased around Pacificon by President Jim Stafford who persuaded him to join the Board of Directors in 1999.

He has been licensed as an amateur radio operator since 1984, first as G1DGO and then to the full UK license in 1985 as GØBPS.

Although he now lives with his wife Daphne in semi-retirement in Folkestone, Kent, in the UK, Dick has traveled the world—as a youth, upon leaving school, he joined the Merchant Navy sailing to ports of call in Portugal, Canary Isles, Brazil, Uruguay and Argentina, all before his 18th birthday.

Dick worked as a Fire-Fighter with Kent Fire Brigade from 1964-1986. He was involved in several rescue and recovery operations then got trapped on a ship fire 10 miles of the coast and had to be rescued himself! During his service he was a service evidence photographer and also specialist vehicle instructor. During some of his off duty time worked as a contract diver in Dover Harbor (he still enjoys SCUBA diving with his son David). He retired as Watch Commander at Dover Fire Station.

Dick, GØBPS, and his wife Daphne welcome HM Queen Elizabeth and the Duke of Edinburgh along with President and Mrs Mitterrand of France to the opening of the Channel Tunnel.

In 1986, Dick started Kanga Products, the UK kit company with Ian G3ROO, after his retirement. He bought the company in 1989 and continued it until 1999, building the company into an internationally known QRP kit company.

An avid writer, his first article appeared in the UK *Short Wave Magazine* in 1984, titled "Moonbounce on a budget" after trying EME from the urban back yard. He worked 4-1/2 stations, (the half got away). In 1989, he wrote the first the first dedicated monthly QRP column in the UK *Ham Radio Today* magazine (the magazine ran for over 10 years until it folded in 2000). He has written many reviews of QRP equipment for the UK magazine *Practical Wireless* and was also a contributor to its "Antenna Workshop." He has also written for the Radio Society Great Brittain's magazine *RadCom*, *QRPp*, and of course the *QRP Quarterly*.

Dick has written three books about Ham Radio. The first, titled *Pascoe's Penny Pinchers* was all about cheap wire antennas taken from his articles in *Practical Wireless*. The second, *Introducing QRP* gives an insight into how to get into the hobby and what QRP is all about. His latest is *The History of QRP 1949-2003*.

In addition to being a very active member of the G-QRP Club, Dick has been the Data/SSB manager of the G-QRP club since 1991. He is an avid DX chaser on VHF-largely because for the last 10 years he has lived on one of the highest points in the UK, and house looks out over the English Channel at France and the rest of Europe.

He served as Chairman of the Shepway Council from 1993 to 1995 (equivalent to being a small state governor in the US) and was present at the opening of the Channel Tunnel, the link between the UK and France. He was just second in line with his wife to welcome HM Queen Elizabeth and Duke of Edinburgh along with President and Mrs. Mitterrand of France (see Photo 2). He has been to Buckingham Palace for a Garden Party with the Queen and shown the late Queen Mother around the area.

While Dick's interests have mellowed over the years, he still often carries a camera, still enjoys SCUBA diving and of course ham radio (especially PSK31) and enjoys teaching, both radio and lawn bowls. He is a keen swimmer, windsurfer, sailor and white water canoeist and Lawn Bowler, and is currently a Lawn Bowls Referee and Coach.

New QRP ARCI Vice President: Ken Evans, W4DU

Ken Evans, W4DU (QRP ARCI #696), will become the next Vice President of QRP ARCI.

His amateur radio career began in 1961 when he was first licensed as a novice under the call, KN8ANW. The first rig was a Heath AR-3 receiver with a homebrew crystal controlled transmitter. A move to the third call area changed the call to KN3RFN and later to K3RFN with an upgrade to General. He joined the QRP ARCI in 1964 when it was a "100-watt" QRP Club. His amateur interest at that time was home brewing and contesting and continued until college, the military and marriage intervened.

Ken maintained his license but was relatively inactive until 1980 when he jumped back into amateur radio with a focus on contests. He burned his way through commercial rigs until he rediscovered his roots in QRP and homebrewing in 1988. He has been active in QRP ever since and enjoys kit construction and homebrewing. His current operating interest is mainly CW and his rigs include an Elecraft K2 (serial #17, he was a beta tester), an MP+, an AT Sprint and a homebrew VXO rig, along with other assortments of components on copper lying on the bench.

He is past President of the Basking Ridge QRP Group and of the Metro Atlanta Telephone Pioneer Amateur Radio Club. He was a founding member of the North Georgia QRP Club (NOGA QRP). He has served as QRP ARCI as Secretary, Treasurer, Chairman of FDIM (from 1998 through 2001) and is currently a member of the QRP ARCI Board of Directors.

Ken has been married for thirty-five years; is the father of four children (one being N4XXR) and eight grandchildren. He currently works as an engineer for Cingular Wireless telephone company.

W4DU claims that his most notable accomplishment was at the recent NOGA picnic: When they ran out of beer, he was able to change the water in the swimming pool into Samuel Adams Summer Ale!!

●●

On the Cover

In this issue we have really ugly radios and we have really beautiful ones. Pictured on this month's cover is probably the prettiest radio you might ever build—David White, W5NY's, Electroluminescent Receiver. First introduced a year ago in *QRP Quarterly*, David's article in this issue decribes how this radio has become very popular with kids, and offers some timely updates on the project. *—72 de Mike, KO4WX*

QRP Amateur Radio Club International — Annual Financial Report

For years ended June 30,	**2003**	**2002**
Beginning Cash:	$26,689.66	$23,229.70
Cash Receipts:		
Memberships	31,106.00	28,947.29
Toy Store, net	-455.60	-185.98
Dayton banquet, net	-136.36	-218.27
Dayton FDIM, net	-571.53	-2.93
Sale of Quarterly magazines, net	-1,783.86	-156.95
Advertising revenue	1,867.56	2,370.42
Gifts and bequests	10.00	5.00
Interest income	246.29	435.44
Totals	**30,282.50**	**31,194.02**
Cash Disbursements:		
Quarterly magazine costs	25,014.47	24,740.14
Prizes and awards given	1,186.80	834.60
Contest expenses	188.68	60.00
Dayton booth	1,060.00	650.00
Treasurer and legal expenses	223.88	211.53
Membership expenses	427.05	471.23
General administration costs	1,435.14	766.56
Totals	**29,536.02**	**27,734.06**
Net Receipts over Disbursements	**746.48**	**3,459.96**
Ending Cash:		
Working funds	8,436.14	8,689.66
Reserve funds for unearned subscriptions	19,000.00	18,000.00
Totals	**$27,436.14**	**$26,689.66**

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewski—WA8MCQ wa8mcq@comcast.net

IN THIS EDITION OF THE IDEA EXCHANGE

Comments on Reversing FET Leads

A while back someone on QRP-L mentioned that they had picked up some surplus junction FETs with obscure markings and wanted to characterize them. The question was how to tell the drain and source apart, and whether it made any difference in a circuit if the two were swapped. I later asked Wes Hayward, W7ZOI, and this is his reply.

(If there is anyone who does not recognize the name and call, Wes is legendary in QRP and homebrew circles, and was inducted into the QRP Hall of Fame years ago. He has had numerous articles in *QST*, *QEX* and *Ham Radio* over the years, wrote *Introduction to Radio Frequency Design*, and coauthored *Solid State Design for the Radio Amateur* as well as the recently released *Experimental Methods in RF Design*.)

Good question. Really, this is one that goes to the very physics of the device and the way it relates to the circuit parameters.

I'm going to treat this with an unusual approach: I'm going to talk initially about a different FET type. The JFETs related to the question are simple and the most common, but I'll talk about a more exotic type, GaAsFETs. It's what I"m more used to using. Moreover, the structures are actually simpler than those used in JFETs. But the ideas are the same. Generally, it's easier to get an intuitive feel for what happens with a FET than it is to describe the behavior of a bipolar transistor without mathematics.

The FETs that I used in my prior life at TriQuint Semiconductor were GaAsFETs, or in greater detail, GaAs MESFETs. That is, they were built on a substrate of Gallium Arsenide and they were metal-semiconductor field effect transistors.

We built our GaAsFETs with the following steps (this is abbreviated): First, we started with wafers of GaAs (see Figure 1). This is a majority carrier N type material, so conduction is via motion of electrons. The interesting property of GaAs is that it is a good circuit board material. The dielectric losses are low if you merely use it as a substrate to built high frequency parts. If a region on the wafer is to become a FET, it is doped. We used ion implantation. So, a region of interest has its conductivity altered in the same way that we might alter the conductivity of a silicon region through doping, either with diffusion or implantation. See Figure 2.

Once we have a region that is suitable for FET behavior, we put a couple of ohmic contacts down. These would be parallel stripes of metal that, in effect, make electrical contact to the doped semiconductor region, as shown in Figure 3. A typical contact stripe might be 10 x 50 microns (micro-meter or 1/1000 of a mm). The two stripes, which will eventually become the drain and source, are parallel to each other and are spaced 2 or 3 microns from each other.

If we were to put a potential between the two stripes, we would observe the flow of current. This device will eventually become a depletion mode FET like our familiar silicon JFETs. But at this time, it is no more than a resistor. If we reverse the applied polarity, but keep the supply voltage the same, the same current will flow, but in a reversed direction. Current flow is shown in Figure 4 where the "E" represents an electric field within the doped semiconductor.

The longer dimension, 50 microns in our example, is called the device width. If we were to make the device larger with, for example, a 100 micron width, it would show twice the current for the same applied voltage. Eventually, this will allow us to establish the FET I_{dss}, a common parameter. But we are getting ahead of the discussion.

Let's now place a gate electrode on the structure, shown in Figure 5. This is another stripe of metal. However, it is attached to the GaAs in a different way. Rather than forming a simple ohmic contact to the resistor below, it forms a Schottky barrier junction, just like those found in hot-carrier diodes. This is a rectifying diode that is dominated by majority carriers rather than the minority carriers of the junction diode. This third electrode is the gate.

We can control the flow of current between the source and the drain (our two ohmic contacts) by applying a bias to the gate. Only a small amount of positive bias is possible. After the gate becomes about 0.6 volt above the source, the gate diode is conducting (clamped), discouraging further increases. If a negative bias is applied to the gate, a depletion region is formed where the carriers are removed from the region between the source and gate, causing the drain to source current to decrease. We reach zero drain current when the gate is at the familiar pinchoff voltage. Further negative bias does nothing more.

The critical "action" happens in the space just under the gap between the gate

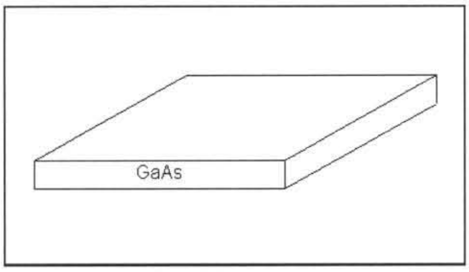


Figure 1—First step in making a GaAsFET, a wafer of gallium arsenide.

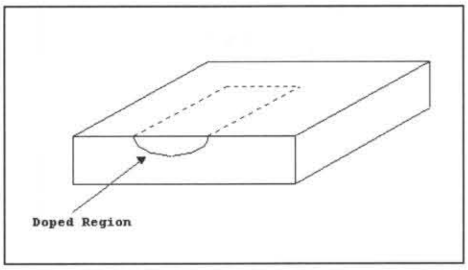


Figure 2—Next step, dope an area of the wafer..

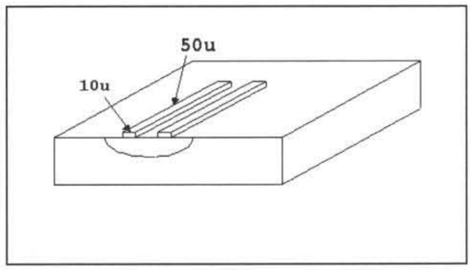


Figure 3—A pair of metal contacts are placed over the doped region.

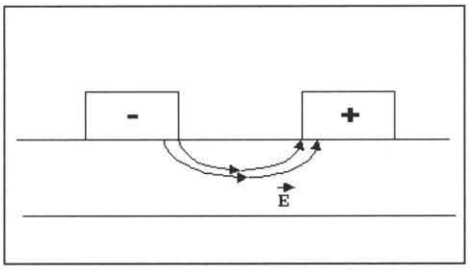


Figure 4—Current flows when voltage is applied.

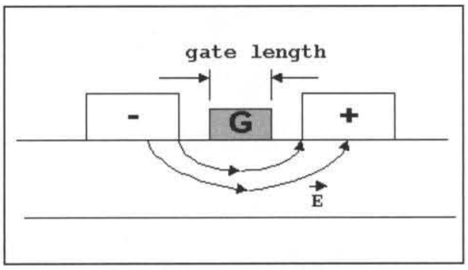


Figure 5—The gate contact is added.

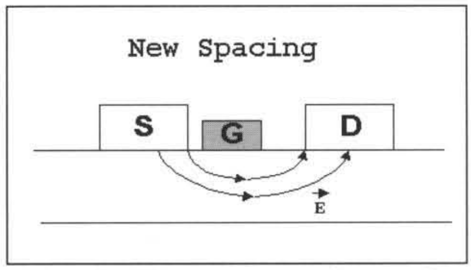


Figure 6—The gate contact is moved to one side.

and the source. This is the depletion region where the electric fields related to the gate-source potential are greatest and can alter the number of carriers available for drain-source conduction.

The FET we have described is completely symmetrical about the gate with a source identical to the drain. If we merely reverse the connections to the outside world, the roles will reverse without difficulty. It is, however, possible to make GaAsFETs that are not symmetrical, as shown in Figure 6. Here, we have moved the position of the gate toward the source. The reduced spacing leads to higher controlling electric fields in the gate-source space, which will then mean a higher transconductance for that connection. The FET will still continue to function when the drain and source are exchanged, but we expect the pinchoff to differ.

The structures for silicon JFETs are different than those described with GaAsFETs. The conduction may not be in one direction (along the gate length) as we saw in this discussion. A JFET is usually fabricated with several junctions. A "tub" is created with an implant, creating both the source and drain regions. Then another implant of the opposite type is put into the "tub" to create the gate.

The GaAs FETs that we built at TQS (and generally within the GaAs IC community) were made to be repeatable and uniform, for they were used in integrated circuits. The linear structure helped this uniformity, producing well-controlled and predictable FETs when compared with typical discrete silicon JFETs that may have a 3 to 1 variation in I_{dss}. Our depletion mode FETs only varied (as I recall) by a few percent in I_{dss} and V_p. The process also allowed us to built enhancement mode FETs on the same IC. An enhancement mode FET is one with zero current when the gate is at the source voltage, but then grows in current as the gate is positively biased. Most MOSFETs are enhancement mode parts.

Although I have no direct experience with silicon parts at the device level, it seems reasonable that conclusions drawn here regarding GaAsFETs would carry over to silicon. FET I_{dss} will be dominated by material doping and device width, but would not be expected to change a lot with gate position. I would expect pinchoff voltage to change with relative gate position with closer spaced FETs being easier to pinch off. Gate-to-source and gate-to-drain capacitance will certainly be different. However, care must be exercised in determining the viable C. The values we usually see in data sheets relate to the device when biased for amplifier operation. Hence, the drain voltage will be high while the gate-source voltage might be part way between the I_{dss} and pinched off states. The voltages are quite different, and the capacitances will also differ. The effect of the changes in device geometry might better be evaluated with similar bias between the gate and the source or drain.

A simple circuit that I used to determine FET pinchoff is shown in Figure 7. The gate is grounded. Then either the normal drain or the normal source may be biased with a positive voltage (N-channel FET assumed) to function as a drain. The functioning source is then self biased with a very large resistor, causing the source in use to take on a voltage nearly equal in magnitude to the FET pinchoff. Three different FET types were evaluated with this setup. In all three, there was virtually no change in Vp in normal V_s reversed operation. The FETs were J310, 2N5454, and MMBF5459.

Experiments are pretty simple, even

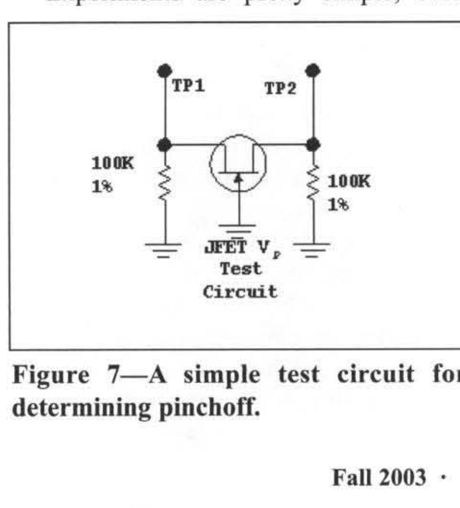


Figure 7—A simple test circuit for determining pinchoff.

those at RF. A simple RF amplifier could be built and performance measured, even in a home lab. Then drain and source could be interchanged to produce a new set of results. My guess is that we will have a hard time telling the difference, even with parts operating near their upper frequency limits.

It can be interesting to interchange the leads on other devices and see the result. You may be surprised just what does happen. For example, using the usual emitter as a collector (and collector as emitter) will still produce transistor action with most bipolar parts. The NPN is still an NPN. The new collector breakdown is much lower than the normal configuration and the beta is very low. But it still operates.

—de W7ZOI

The "Good Enough Oscillator"
Quickie #47

Although he has moved his column to the American QRP Club's *Homebrewer* magazine, Joe Everhart, N2CX of Brooklawn, NJ, continues in his long series of technical Quickies. Inducted into the QRP Hall of Fame several years ago, Joe is one of the guiding lights of the NJ QRP club, and now also of AMQRP as well.

The very first Joe's Quickie printed over 10 years ago was a very simple twin-tee oscillator. It has been built by a number of folks since then and I've built new ones, too, since I always seem to misplace the older ones. Most recently it was resurrected and provided as a handout at an NJQRP meeting. Dubbed the "Good Enough Oscillator," the kit handed out at the meeting came with components, a small piece of PC board and some pads for constructing it "Manhattan" style. This embodiment is written up on the NJQRP web site at www.njqrp.org/geo-oscillator/index.html. But I can't leave "good enough" alone.

The original circuit is shown in Figure 8. (The entire Quickie is reproduced at www.njqrp.orq/quickies/quickie1.htm). [WA8MCQ note—although shown with a PNP transistor and negative 9 volt supply, a common NPN transistor such as the 2N3904 or 2N2222 could be used if the supply polarity is reversed.] Its shortcomings have been apparent to many who have written to me after duplicating the project.

The most common problem is that builders have difficulty getting it to oscillate. Generally this happens for one of several reasons:

It's very tempting to use whatever components are at hand. The most common capacitors are of the ceramic dielectric style. The usual types of ceramic capacitors have high loss for AC signals. This is fine for bypass caps but useless for oscillators! Only NPO dielectric capacitors have the necessary low loss characteristic needed for oscillators and they are not at all common at values above 1000 pF or so. You must use polyester or other plastic film dielectric caps. The good news is that the usual parts houses do carry them. In a pinch you can even find them at your friendly local Radio Shack.

The second cause for failure to oscillate is also due to inferior components. This oscillator circuit is fairly tolerant of transistor characteristics. Frankly I've never had the problem, but a couple of builders have reported that "no-name" or "generic" transistors have produced problems. Any good quality 2N2222 or 2N3904 should work just fine. [Don't forget to use a positive 9V source instead of negative if either of these NPN transistors is used—WA8MCQ]

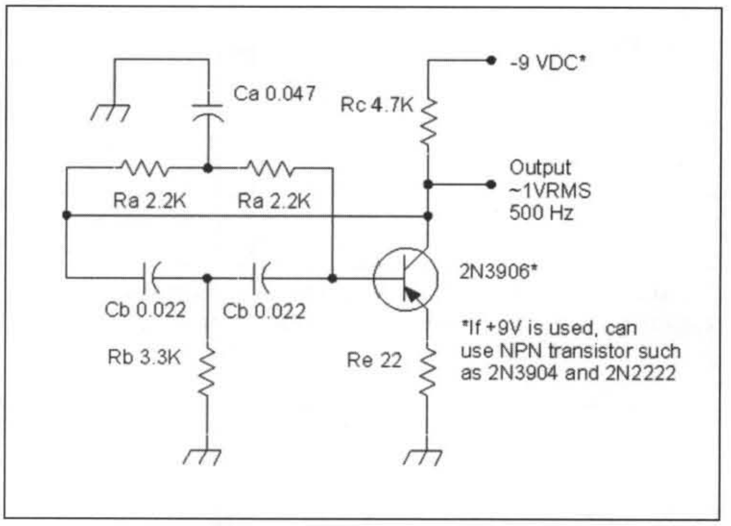


Figure 8—The original Quickie "Good Enough" oscillator.

The third reason for oscillator failure is a little more subtle. A couple of users noted that the circuit oscillated well by itself but the output sometimes disappeared when it was connected to another circuit. This was likely due to circuit "loading." The oscillator needs a certain minimum voltage gain so that it can feed enough signal back to its input to oscillate. The amount of gain depends on (among other things) the value of the collector resistor Rc. When the oscillator output is connected to another circuit the resistance of that circuit parallels Rc. That's no problem if it's much larger than Rc, say 47k or so, but if it's not that large it can reduce the gain and either reduce the output voltage or completely kill any oscillator action.

Furthermore, if you need an attenuated output you have to add an external resistive divider as shown in Figure 9. R1 in the divider loads down the oscillator, dropping the voltage level. And if it's too low as described above, it stops it from working entirely.

The cure is rather straightforward, although it adds a small level of complexity to what was a very bare-bones project. Figure 10 adds a single transistor emitter follower buffer to lessen output loading. Direct connection to Q1's collector provides DC biasing without additional components. Q2 is a PNP to provide maximum output voltage swing. Ro sets Q2's operating current level. The final buffered output impedance is now Rc divided by Q2's current gain. Assuming a beta of 100, this value is now 47 ohms

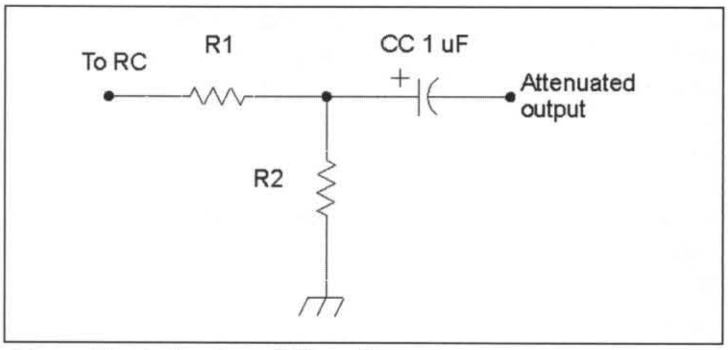


Figure 9—A simple resistive attenuator.

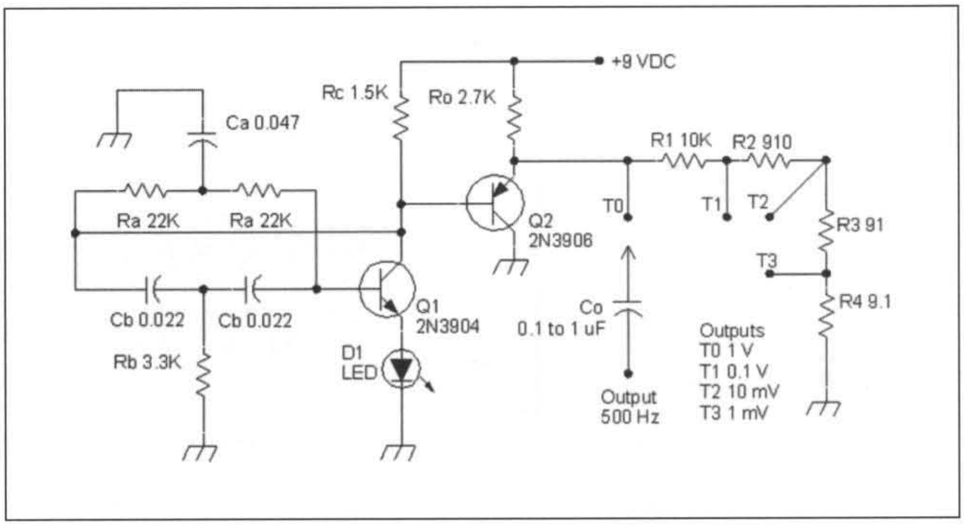


Figure 10—The updated oscillator circuit, with buffer amplifier and variable output attenuator.

instead of 4.7k, a substantial improvement. Q2 can be any garden variety PNP silicon audio transistor such as the 2N2907 or 2N3906. Another change to the circuit is that the emitter resistor RE is replaced by a red LED. This provides some degree of negative feedback to stabilize the circuit as well as providing a built-in pilot light to prevent you from accidentally leaving the circuit powered up and drain the battery—not that I've ever done this…

Another shortcoming of the oscillator that is not fixed by adding the output buffer is accuracy of the output level. The first couple models I made produced an unloaded output pretty close to 1Vrms. However, that is not necessarily the case. The final output level depends on the bias point of the oscillator transistor and this varies quite a bit with the current gain of the individual device used. A simple "fix" for this problem is simply to select a value for Rc that will produce an output of 1V rms. You can easily measure this at the output of the second transistor using a common DMM on its AC voltage range. Typical values for a whole bunch of transistors I tried varied from about 1.5k for high gain transistors to about 4.7k for low gain devices. The output level will also vary with supply voltage so be sure to use a fresh 9-volt battery to ensure that the level stays accurate.

Yet another improvement is the addition of a built-in resistive attenuator. Several output levels between 1 V and 1 mV can be can be selected by connecting the output coupling capacitor (Co) to the appropriate tap. A small alligator clip makes this convenient.

There is one more inadequacy that has been pointed out any number of times; the waveshape is not a perfect sine wave. Alas, making it so would add lots of complexity. On the other hand, the distortion has been measured on several samples at under 5%. For most uses in the ham shack this is—you guessed it—good enough!

I could list the uses of this circuit but in the interest of saving space in Mike's column and as a sneaky way to get you to look at a typical NJQRP meeting project, I direct you to check out the GEO at the URL listed in the first paragraph!

—de N2CX

Noisy Epson Programmable Oscillators Revisited

A few years ago Epson announced what appeared to be a really exciting and promising product, a programmable crystal oscillator in a small package, about the same size as the regular computer clock oscillator cans. They are carried by DigiKey; you specify the frequency when ordering and they program a blank before shipping. At under $5, the price was unbeatable. Unfortunately, people soon realized that they aren't all that great for RF use due to the rather high phase noise. (They use phase locked loop technology.) There was some discussion of them on QRP-L and I also mentioned it in this column; I announced them in October 1999 and then in October 2000 ran an item about the phase noise.

Someone recently noticed them in the DigiKey catalog and asked on QRP-L whether they were worth looking into. This produced a few replies, as well as the URL for a test report on them on the KØLR web site.

Steve Ratzlaff, AA7U, had this to say about them—

Recent comments about clock oscillators mentioned the Epson Programmable Clock Oscillator as a possible candidate for a use as an oscillator in a radio. Its stability is fine; it's the horrible phase noise that makes it unsuitable for use in any sort of radio-type application as an oscillator.

We had intended to use it as the local oscillator in a recent *QST* article I co-authored—for use at 3.500 MHz or 7.000 MHz, or other convenient frequencies where crystals are not commonly found without special ordering them. But when the breadboard was tested with the Epson part (programmed for 3.500 MHz), its very bad phase noise quickly became apparent, both close-in and far-out phase noise. I don't recall the exact phase noise values, but something like –70dBc/Hz at any spacing up to several hundred kilohertz from the carrier comes to mind. If you're not up on phase noise, this is a very, very bad figure. Even simple GHz oscillators using PCB inductors don't have phase noise this bad.

ARRL Lab test reports on radios include phase noise both for reception and transmission. At a typical spacing of 20 kHz from the carrier, modern radios typically offer synthesizers with phase noise in the –120 to –140dBc/Hz range. The larger the negative number, the better the phase noise performance of the synthesizer/oscillator. Many vintage radios using tubes and large airwound inductors in their oscillators, such as the R390A, had excellent phase noise, often below –145dBc/Hz at 20 kHz offset from the carrier, dropping even lower at increased offsets.)

Conrad Murray, WS4S, followed up with this posting. He gives a good, real life example of what bad phase noise numbers translate into—

Steve is right—these things don't belong anywhere near a radio. I tried one as the local oscillator for an LF converter and performance was terrible. Any signal below the "super strong" level was simply washed out by the noise from the LO. Replacing the Epson module with a crystal oscillator fixed the noise.

Conard later provided additional comments by e-mail—

I was part of a group that obtained a limited license (WC2XSR) for testing on some of the old 600 meter ship frequencies. The receive converter was part of that research. I was trying to convert 400-500 kHz into a ham band in order to use the Elecraft K2's fantastic receiver and possibly as a full transverter.

I used some filter tables and cobbled up a low pass filter at 500 kHz to keep the AM broadcast band from overloading everything. I used a Mini-Circuits SBL-1 DBM for the mixer and the Epson module for the LO. Performance was absolutely miserable. All my firebottle-type [tube] receivers as well as the Drake SPR-4 and the Kenwood TS-570 did a much better job. Super strong signals made it through, but noise from the oscillator masked anything of a normal strength or weaker. Truly hard to believe something could be that bad, but it was.

We did make a few QSOs on 480 kHz before the Coast Guard suddenly woke up and complained loudly to the FCC to have us QRT immediately. They had been consulted as part of the license approval process and had no objections. We're still not sure why they freaked out like they did, but I'm sure it was part of the DGPS transmitters that are going in that part of the spectrum. It was fun for the week or so that it lasted. I was running 100 watts output from a SRT-14 transmitter into a 50 foot vertical and worked out 1000 miles of so with fairly good signals. I had lots of SWL reports from the Lowfer guys as well. If we had been allowed to continue working with the band I'm sure we could have done better with less power and better antennas.

Final WA8MCQ comments: I looked through a DigiKey catalog recently and noted that 3 other companies now have programmable oscillators as well. Two of them even sell blanks so you can program your own, along with programmers. Unfortunately, those are not cheap and ordering small quantities of programmed units is going to be the most cost effective. One manufacturer has an asking price of $489 for their PC based programmer and $1,560 for a standalone unit, while the other company only has a PC based programmer, for $1,521.

Epson Programmable Oscillators—
A Brief Test Report

Although not a QRPer, Lyle Koehler, KØLR, is interested in the LowFer and MedFer aspects of radio. (He does admit privately to having built a QRP rig or two, though.) Used with permission, here's a condensed version of an item he has on his web page, posted in July 2000. If you want to see the full report, go to http://www.cpinternet.com/~lyle/ and scroll down to Epson Programmable Crystal Oscillators. And while you're there, you'll find a lot of other interesting items, many dealing with LowFer operation and construction. Even if that's not one of your interests, it's still well worth taking a look at.

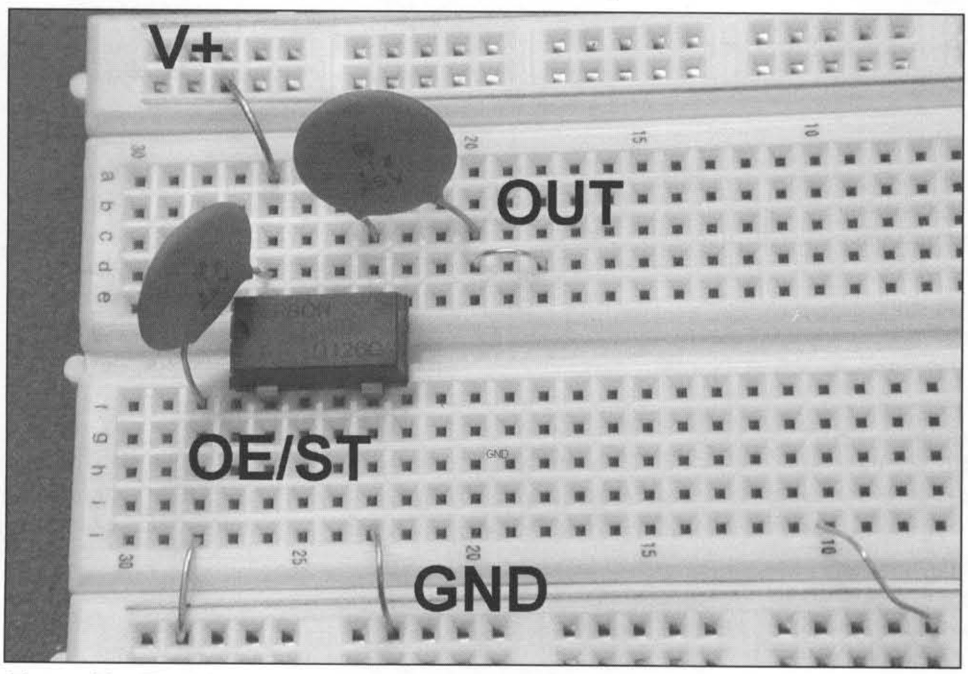


Figure 11—The high tech oscillator test fixture.

(For those not familiar with the terms, LowFers are those who experiment with the unlicensed, low power band at 160 to 190 k Hz, where the power is limited to something like one watt and the antenna system, including feedline, is limited to 50 feet. MedFers operate in the medium wave region, just below and just above the AM broadcast band. You can find more info on these topics by entering LOWFER or MEDFER into an Internet search engine, or you can go to the Longwave Club of America home page at http://www.lwca.org/index.htm, as well as the KØLR page mentioned above. I listened to some of the beacons in the 160-190 kHz region a few years ago, and it's a fascinating part of the spectrum.)

I ran across a mention of Epson programmable oscillators in the rec.radio.amateur.homebrew newsgroup. I was aware that DigiKey carried a series of crystal oscillators with programmable dividers, but the frequency choices are fairly limited. The SG-8002 programmable oscillators are a different animal, using phase-locked-loop (PLL) technology to generate any specified frequency between 1 and 125 MHz. To view the DigiKey catalog page that describes the available versions of the SG-8002, go to www.digikey.com and search for "SG-8002."

[WA8MCQ note—At this point he gave the URL to download data sheets from the Epson web site, but the URL is no longer valid. Here's how to find it now: go to http://www.eea.epson.com/go/products, and under Timing Products, click on Crystal Oscillators, and then Programmable Oscillators. From there, you can select specific versions to get the specs.]

The parts are available in surface mount, 14-pin or 8-pin DIP package footprints (the packages actually have only 4 pins). It wasn't clear from the data sheets just how closely you can specify the frequency, although if you follow the links on the Epson web site, there is a place where you can enter a desired frequency and it will tell you if it is valid. But there were still a lot of questions, like how close do they actually come to the specified frequency? Are they stable enough to put out a "clean" CW note on HF, or are they useful only as clock oscillators for digital circuits? How much phase noise? Since they are only $3.33 apiece, it doesn't cost much to find out (except that DigiKey has a $5 service charge on orders under $25).

I ordered two oscillators, both with 8-pin DIP footprints, CMOS type, 50 ppm stability. One of the four pins on the package is either an "output enable" or "standby" pin, depending upon which option you specify. I ordered an 18.573000 kHz oscillator with the output enable option, and a 1.703915 MHz oscillator with the standby option. The 18-MHz part could be used with a 74HC390 dual decade counter to provide a square wave output at 185.730 kHz, which was chosen because it falls midway between 60 Hz harmonics.

Although I don't have any plans to get back into MedFER operation, the 1.7 MHz part could be used to directly drive a MedFER final. The frequency of 1.703915 was chosen to be near the top of the expanded AM broadcast band, and is not a multiple of any common reference frequency like 10, 100 or 1000 Hz. The idea was to see if the oscillator could be programmed to the nearest 1 Hz increment. When I called DigiKey, the person who took my order contacted the person who does the oscillator programming on another line, and verified that both frequencies were OK. The parts were shipped out the same day.

The elaborate fixture shown in Figure 11 was used to test the oscillators. People with soldering anxieties should find it comforting that they work fine on a plug-in protoboard, at least up to the 18 MHz region.

The DC supply voltage was applied to the points marked V+ and GND, and a scope/counter lead was connected to the OUT point, which is the oscillator output coupled through a 0.1 μF capacitor. Another 0.1 μF capacitor is used as a bypass between V+ and GND. If the OE/ST pin is left floating, the oscillator runs continuously. When it is grounded, the oscillator is either placed in STANDBY or OUTPUT DISABLE mode, depending on the chip option.

The difference is that chips with the STANDBY option will turn off completely when OE/ST is grounded. In chips with the OUTPUT ENABLE option, the oscillator keeps running but the output stage is turned off. There apparently is an internal pull-up resistor of a couple of megohms on the OE/ST line, because the current from the pin is only about 2 microamps when it is grounded. If you want to be able to shut off the oscillator with a logic-level signal and minimize power consumption while in the disabled mode, you would want a chip with the STANDBY option. For rapid on/off switching, as in a CW transmitter, you'd need the OUTPUT ENABLE option.

What about the phase noise? A quick test was made by tuning in the 18 MHz oscillator on my IC-751A receiver. Coupling to the receiver was by means of a very short piece of wire connected to the end of a coaxial cable in the vicinity of the oscillator test board. I adjusted the coupling by moving the coax around until the received signal strength indication was S9 +20 dB when tuned to the oscillator frequency. The received note sounded very clean and stable, but there was definitely a lot of noise as I tuned away from the carrier. At this signal level, and with the receiver set to 500 Hz bandwidth, the oscillator noise was down to S6 at 5 kHz off frequency, and there was no reading on the S meter at 20 kHz off frequency (although some noise could still be heard in the speaker).

From this crude test I would say that the 18 MHz oscillator is too noisy to use for anything but a very low power transmitter. It would be unacceptable in a high-performance receiver or converter application, because you'd hear the same kind of noise when tuned near any strong signal. Fortunately the phase noise in oscillators tends to follow a frequency-squared law, so that after dividing by 100 to get down into the LowFER band, the phase noise would be reduced by nearly 40 dB (not quite that much, because the division process isn't noise-free either). It should be adequate even for BPSK operation at MS100 (10 baud).

Perhaps a 7-MHz Epson oscillator would be OK for a QRP CW transmitter running less than half a watt—something I'll probably try some day. By the way, when the output is loaded with a 50 ohm resistor, the peak-to-peak voltage drops to about 4 volts (with a 5-volt supply). That's about 80 milliwatts of RF, most of it at the fundamental frequency of the square wave.

Although they have their limitations, these oscillators look great for LowFER and MedFER applications, and the price is hard to beat for a "custom" crystal oscillator.

Lyle recently provided these comments by e-mail—I received an e-mail some time ago from someone who said that they are a lot quieter if they are mounted on a proper circuit board with adequate bypassing. The solderless breadboard I was using might not have provided a fair test, and I've never gotten around to checking the Epson oscillators in a better environment. That's the nice thing about LowFER operation—by the time you divide down the frequency to the LF range, almost anything looks "clean." [each divide-by-two stage reduces phase noise by 6 dB, so divide-by-four is 12 dB, by eight is 18 dB, etc.—*ed.*]

—de KØLR

Handles for the HW-8

Here's an interesting mod that I don't think has been published anywhere. A few months ago John Cumming, VE3JC, alerted me (and QRP-L) to an interesting HW-8 for auction on eBay. The subject line of his mail and posting was "HW8...some mods just make you chuckle." The radio for auction is shown in Figure 12; note the handles on the front panel.

My reply to him was, "I think I can understand the thought processes that lead to something like that. There have been times over the years where I'd have something really 'neat' in my boxes of miscellaneous hardware and parts, something which just seemed wasted sitting in the box and screamed out to be used somewhere, anywhere, and yet there was no real place to use it. Sort of like money burning a hole in your pocket." You do have to admit that it gives the rig a certain touch of class, though. And I've been known to use things over the years that weren't really necessary but just looked "neat."

There were a few comments about it on QRP-L. Regardless of whatever other reasons there might be for putting them there, someone pointed out that they make for excellent protection for the front panel and knobs if the rig should somehow be dropped on it's face. I'm not sure if that was the idea in this case, since it's hard to tell if the handles stick out far enough from the panel to protect them all, specifically, the tuning knob. But it's still a good idea.

The seller of the item was Tim Rush, N8DUY, who provided the photo. He thought it was a great idea, too, although he said it was like that when he bought it and could not claim credit.

Figure 12—A unique and original HW-8 mod? Does YOURS have handles?

A Simple Passive Audio Filter

While surfing the web I came across this simple filter on the web page of QRPer Ed Kessler, AA3SJ (http://www.qsl.net/ aa3sj). Scroll down a bit and look under VFO Controlled 40 Meter Micro-Mountaineer. While SCAF and DSP filters are newer and more popular, the "ancient" LC filters still have their place. They do have the limitations of being fixed in frequency and having some insertion loss, but they don't consume power and generate no internal noise. They also have no active components that can fail when you're out on a trail, miles from nowhere. The schematic is shown in Figure 13, and Figure 14 shows one of the versions Ed built.

Ed had these comments on the web page—

"The frequency is centered very close to 750 Hz and the input and output impedances are about 100 ohms. This filter works perfectly, removing hiss and noises. It uses Toko 82 mH coils and standard Mylar capacitors. It inserts some loss into the audio chain, but there is so much gain there already, the loss is actually an asset."

Figure 15 shows the response of the filter. I got this from running the numbers through GPLA, the General Purpose Ladder Analysis program that was on the disk that came with the ARRL reprint of the Wes Hayward (W7ZOI) book *Introduction to Radio Frequency Design.* (That's a DOS program. The newer *Experimental Methods in RF Design* comes with a CD ROM that has an updated Windows version, along with a handy program to make filter files for analysis. I discussed both of them in my review of the book in the April Idea Exchange.) I added some extra frequency and dB annotations.

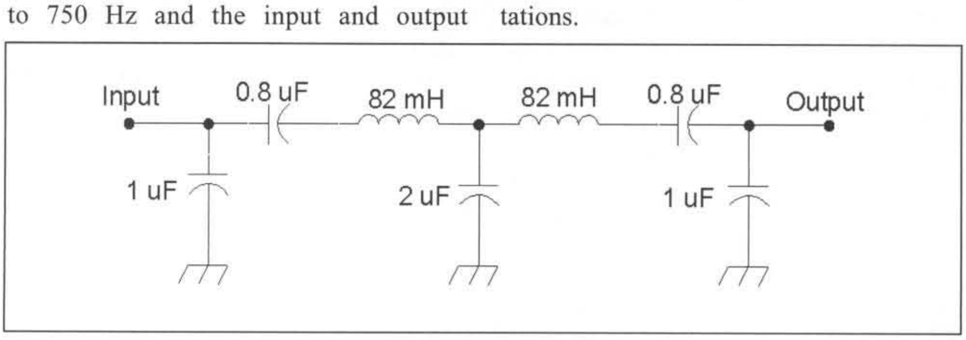


Figure 13—The AA3SJ passive audio filter, built with miniature Toko inductors and mylar capacitors.

The shape of the response is slightly different than the one on the web page, with a bit more insertion loss. I suspect it was caused by using a lower value of Q for the coils than he did. I don't know what his value was, but if I use 250 instead of 50 my response looks more like his. (The latter value is more typical of small coils like this.)

Ed credits Mike Michael, W3TS, with giving him the circuit. Mike told me that the original circuit he built used 88 mH telephone toroid loading coils. Those are larger and heavier than the miniature Toko coils that Ed used. The telephone coils might not be the best choice for a rig that was going to be use for backpacking, although they should have higher Q and thus lower insertion loss. The 88 mH inductance would result in a somewhat lower center frequency; which would be OK for hams who prefer listening to CW at pitches lower than 750 Hz.

Apparently I'm not the only one to notice this filter on the AA3SJ web page. I later discovered that it appears as figure 12.5 on page 12.6 of the new ARRL book *Experimental Methods in RF Design.* (Ed is credited in the text.)

You can find coils at Mouser and DigiKey, but 82 mH (82000 μH) units are rather hard to find; you have to hunt around the catalogs a while. The Q of these coils is a bit low, on the order of 30 to 70 or so, typically 50, but that only gives a little more insertion loss, which can be easily compensated for elsewhere—if it's even necessary to make it up in the first place. As Ed said, there is usually plenty of gain available.

Don't jump on the first 82 mH inductor you run across in a catalog; some can be quite expensive. I remember seeing one (in the Mouser catalog, I think) that cost eleven dollars. Most of them are far cheaper; be sure to check out the inductor section thoroughly.

Every now and then someone asks if they could wind coils like this on a toroid. The short answer is yes, but I'm not sure if it's worth the trouble. To get this inductance with a reasonable number of turns requires a high permeability core, such as type J, AKA type 75, with μ_i of 5000. Depending on the size of the core it will take between 130 and 160 turns of wire. It can probably be done safely in more than one layer without running into self-reso-

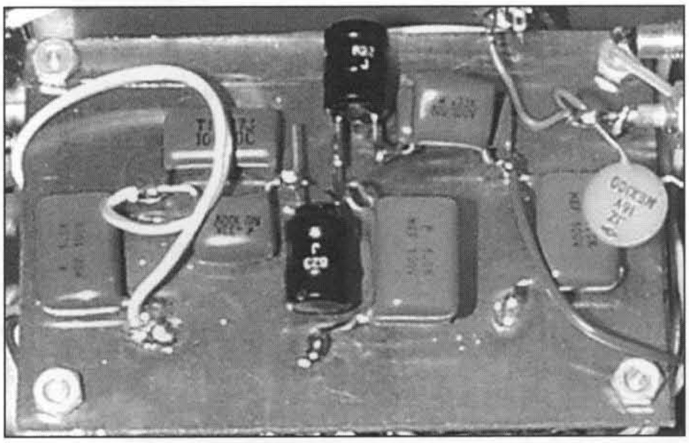


Figure 14—One of several filters Ed built.

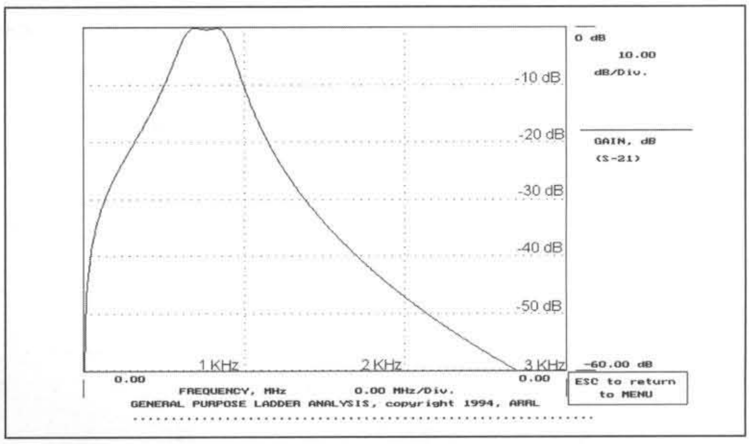


Figure 15—Frequency response of the AA3SJ audio filter.

nant effects (this is a very low frequency), and that allows use of relatively large wire, improving the Q somewhat. That translates into reduced insertion loss, but this is used with an audio amplifier chain, and those usually have gain to spare.

The larger sizes of cores will be easier to wind, and you can get away with somewhat larger wire (higher Q) but the cores can start getting expensive. An FT87 size core is $1.20 from CWS Bytemark; the FT114 is $2.25, and an FT140 is over $4! And you still have to wind it. Myself, I'd go with the commercial coils.

The HW-8 RFC1 Problem

This is not new, but it's one of those things that are worth repeating every now and then. There's a problem that I've encountered on several HW-8s that I've played with over the years, and I've heard of many others having it as well. The fix is quite simple, just adding a resistor, and I've automatically installed it on just about every HW-8 that I've checked out or fixed for someone, whether it needed it (yet) or not. To use a phrase coined by Wes Hayward, W7ZOI, in *Solid State Design*, it's a "band-aid of anticipation." This one is so simple that it's well worth the trouble to do it even if not obviously needed yet.

This particular problem was addressed twice in the old *HW-8 Handbook*, and there were two different fixes for it. I believe the first one added a battery to give some bias, while the other simply lifted one end of choke RFC1 and added a resistor in series. The latter is by far the better choice. It's not critical; the resistor can be anywhere from 470 to 680 ohms, and I've used those and everything between.

Trevor Jacobs, KG6CYN, made a post on QRP-L asking for help with his HW-8. His description of the problem: "When I key the transmitter (into either the antenna or a dummy load) and adjust for proper loading, I get some distortion in the sidetone. It almost sounds like RF getting into the sidetone circuit. It's really bad on 15 and 20 meters, not so bad on 40 meters and not detectable on 80 meters. I notice that when I adjust the loading and decrease the power it goes away."

I sent this reply by e-mail—

"This sounds like it might be related to a somewhat similar problem I've seen a number of times over the years. I believe it is caused by leaky switching diodes. Remember, the diodes are common between transmit and receive circuits, which can give some interesting problems when things start going bad. The way the problem usually manifests itself is that if you transmit and tune the receiver preselector with the key down, you can hear some crud come and go on the sidetone. And if monitoring the output with a scope, you would be able to see some crud appear on the signal, and you can even hear the

Caption: Figure 16—RFC1 (with a box drawn around it) is nestled among the handful of trimmer caps near the volume control/power switch.

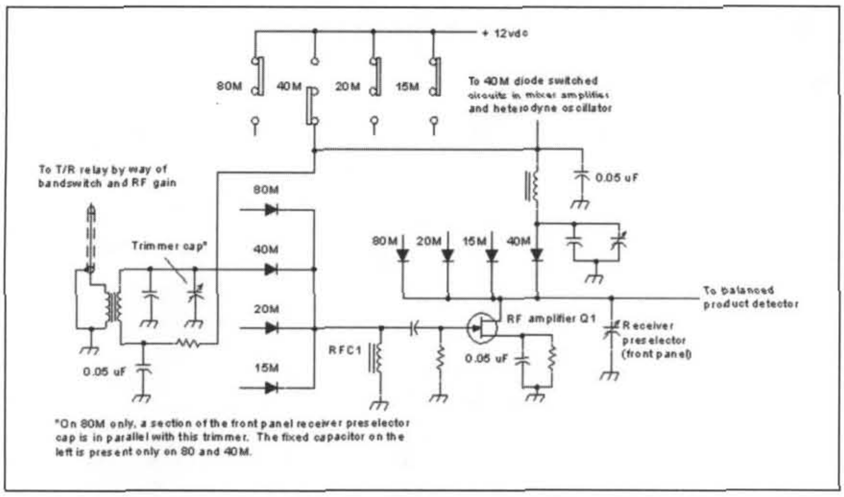


Figure 17—Part of the HW-8 receiver front end.

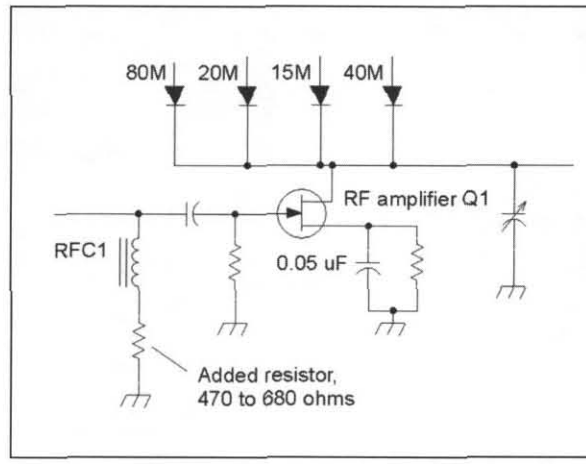


Figure 18--A resistor is added between one end of RFC1 and ground.

crud on the transmitted signal.

"The fix to that specific problem may also help in your case, or it may not, but it's simple enough. If you look at the four band switching diodes on the input side of RF amplifier Q1, you will note that they are all tied together on one end, with a small RF choke going from there to ground. The cure is to lift either end of the choke and insert a resistor on the order of 470 to 680 ohms in series with it. This changes the biasing on the diodes a bit and takes care of the problem.

[Figure 16 shows the location of RFC1, near the receiver preselector capacitor and volume control/power switch.]

"I've fixed this myself on several HW8s over the years that I worked on for others, and also gave this advice to some folks who later told me it cured their problem. This may or not be related to your specific problem but it doesn't hurt to do it anyhow, regardless. In fact, with every last HW8 that someone gives me to check out or work on, I automatically install this resistor whether any problem exists or not. (After all, the diodes may start to get flaky in the future.)

"I hope this helps. There's a good chance that it won't, but it's still good info to keep in the back of your mind for possible future use."

He later replied that it fixed his problem.

Figure 17 shows a portion of the receiver front end from the HW-8 schematic, and Figure 18 shows the addition of the resistor in series with RFC1. Part of the band switch routes the incoming signal to a tuned circuit for the band in use (40M in this case), by way of the T/R relay and RF gain control (not shown). Another section applies 12VDC to the diode for that band (through the tuned circuit) to allow the signal to flow to the RF amplifier (Q1). The ground return is through choke RFC1. On the output side of Q1, another tuned circuit is selected by voltage applied to the 40M circuit, and ground return is through Q1.

So far only the receive preamplifier is involved, and yet the symptom appears while in transmit. Trevor did not mention the receive preselector, but if he had tried tuning it while in transmit he would have noticed changes in the symptom. Initially this is a rather baffling problem, but it makes more sense after some study of the schematic since there is a common connection between the preselector and transmit circuitry. Note that the 12VDC from the band switch also goes to select the proper tuned circuits in the mixer amplifier as well as the heterodyne oscillator, and both of those circuits are involved with both transmit and receive.

I don't pretend to know the exact cause of the problem, but it would appear to involve some sort of oscillation which depends on the setting of the receive preselector. And since a number of diode switched circuits are controlled by a common line from the band switch, there is an easy path between them. True, there are some 0.05 µF capacitors from the line to ground, and the mixer amplifier and heterodyne oscillator have them as well, and they have reasonably low impedances on all the bands (e.g., well under an ohm at 14 MHz). However, at audio the impedance is much higher (over 3000 ohms at 1 kHz) and so they would not be terribly effective at filtering out low frequency signals riding on the control line.

A Single Chip SCAF

In the last issue we had some discussion about using Switched Capacitor Audio Filters (SCAFs). Here's an example of a single chip SCAF filter, built by Steve "Melt Solder" Weber, KD1JV. It was taken from his web page at

http://www.qsl.net/kd1jv/

Although some might consider the SCAF chip and clock oscillator a bit pricey, the cost is still far less than a DSP filter. The design does require a large number of 1% resistors, but those are readily available from DigiKey, as are the chip and oscillator. Here's the text from the page (edited a bit)—

This filter is a four section Butterworth audio band pass filter, with a center frequency of 640 Hz, a 250 Hz band width, 500 Hz stop band width at –20 dB and unity gain in the pass band. The roll off is linear, plotted with log frequency.

A center frequency of 640 Hz was chosen, as this frequency is easily generated using a 16.384 MHz dual output clock chip from ECS, which has a programmable divided frequency output. This frequency is also about midway between 600 and 700 Hz, the beat note which many people like to listen to CW with. The ECS clock chip provides a simple way of generating the

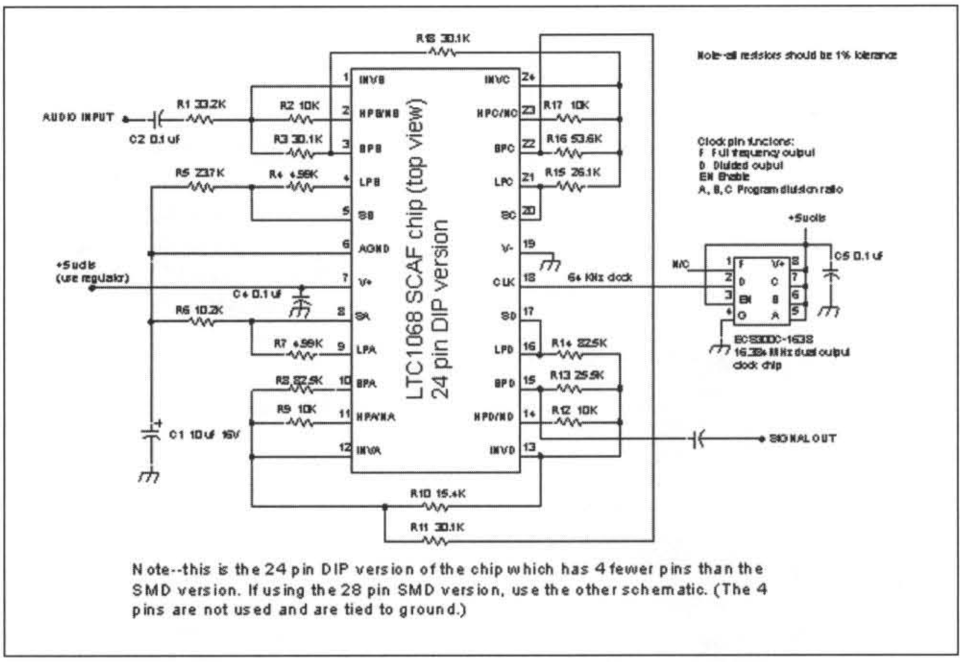


Figure 19—The KD1JV SCAF using the 24 pin part.

required 64 kHz clock for the SCAF which is stable and clean. Keeping harmonics of the SCAF clock out of the rest of a receiver can often be a problem.

Switched capacitor filters are very effective, but sound really bad when overdriven. Therefore, unless the rig it is being added to has AGC, the filter should be installed between the volume control and final audio power amp.

The resistor values needed for this filter were generated by a filter CAD program supplied on a CD from Linear Technology, who makes the IC. [It is also available online; details follow—WA8MCQ] It makes the design of these filters painless. Without the program, calculating the required values can be a tedious job. Changing the center frequency of the filter requires changing both the clock frequency and the filter resistor values.

The filter can be constructed on a piece of perf board. Keep the lead from the clock chip to the LTC1068 as short as possible and use by-pass caps close to the chips. A 5 volt (LM78L05 or equivalent) voltage regulator should be included on the filter board. One percent resistors are required. The LTC1068 and ECS clock chip are available from DigiKey. (Part no. #XC308-ND, $5.54 for the clock and LTC1068CN, $12.00)

WA8MCQ notes:

One percent resistors are also available from DigiKey. The leaded resistors must be purchased in quantities of 5 per value but you can keep the cost down by buying the 1% ¼ watt metal fixed film resistors made by Yageo, at 5 for 54 cents. The catalog also lists 1% resistors from BC Components; the regular ones are 95 cents per 5, while their smaller "Space Miser" resistors are $1.95 for 5.

1% resistors required:

4.99k (2)	R4, R7
10k (5)	R2, R6, R9, R12, R17
15k (1)	R10
23.2k (1)	R5
25.5k (2)	R13, R15
29.4k (2)	R11, R18
30.1k (1)	R3
33.2k (1)	R1
52.3k (1)	R16
80.6k (1)	R14
82.5k (1)	R8

The LTCD1068 chip is available in both a standard 24 pin DIP and a 28 pin SMD package. The pin functions are the same on both, but the SMD chip has an additional 4 pins that are not used and are tied to ground. Figure 19 shows the schematic for the 24 pin DIP, and figure 20 is for the 28 pin SMD package.

The chip has four identical sections which can be configured to get the desired center frequency, response, etc. Figure 21 shows one section. The terminal names are similar, with the last letter indicating the section (HPA/NA, HPB/NB, etc). The first function in each section is a high pass/notch filter, followed by a summing amplifier (SA, SB, etc). These are followed by band pass and low pass sections. The performance of the entire section is determined by how the functions are interconnected, and resistor values determine precise characteristics. The filter chip is quite versatile, and the data sheet shows how to configure it for various uses.

The analog ground pin (AGND) is halfway between the V+ and V– pins,

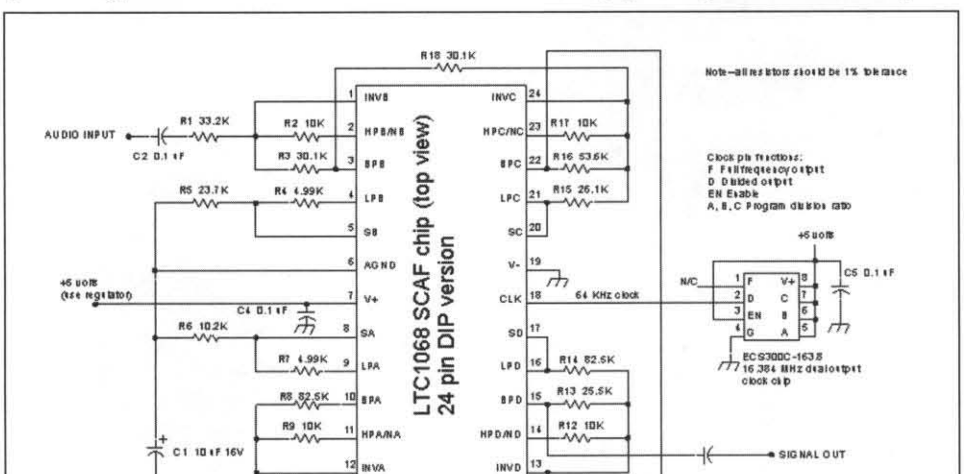


Figure 20—The 28 pin version of the KD1JV filter.

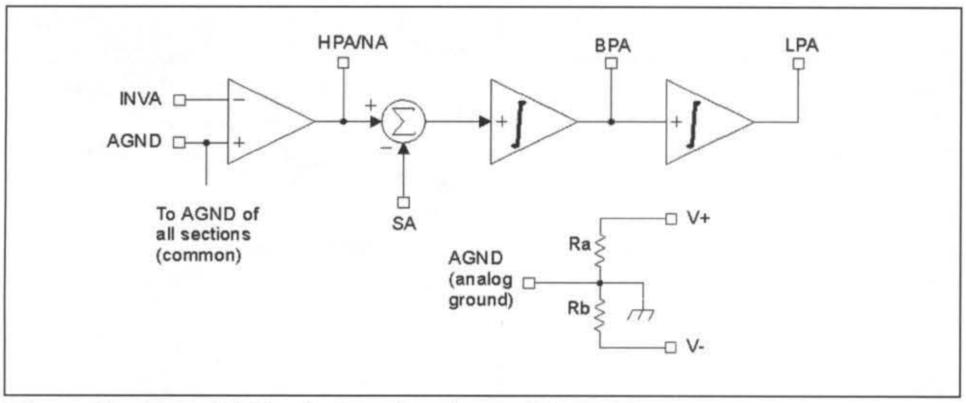


Figure 21—One of 4 identical sections in the SCAF chip.

established at the junction of internal resistors Ra and Rb. The noninverting input of the HP/N function in each section is internally tied to this pin as well.

The data sheet for the chip can be found online at www.linear.com. Search on LTC1068 and follow the leads from there. It's 28 pages and the PDF file is 430k. The Filter CAD software Steve mentioned can also be downloaded. Under "Product Families" on the main page, click on Filters and then scroll down. It's 2.58MB.

Building the AADE L/C Meter

This handheld device has been around for several years now and is fairly well known among homebrewers. Figure 22 shows what the current version looks like; earlier ones are somewhat different. It costs about $100 in kit form, about $30 more if you want it assembled, and Neil Heckt of Almost All Digital Electronics has been making them in one form or another since 1996. It's a very popular item—he says he's sold close to 6000 so far—and quite handy. (Although not currently a ham, he did hold callsign WØNRC back in the '60s.)

I'm not about to give up my beloved Boonton 260A Q meter, which weighs a ton, but the L/C IIB can be held in one hand, isn't tied to the AC power grid, and has a digital display. It doesn't measure Q or allow you to make measurements at selected frequencies like the Boonton, but the accuracy is about the same and it's quick and easy to use—and it isn't filled with impossible to replace components that were last made 40 years ago! Both have their places in my workshop, but the AADE is going to get a lot more use.

The range of the unit is from .001 μH (1 nH) to 100 mH, and 0.010 pF to 1 μF (capacitors must be non-polarized). It's self calibrating, to balance out the effect of test leads, etc. Power is supplied by a common 9 volt battery. The display has several digits of resolution, but don't read too much into that. As with any digital device, resolution and accuracy are two entirely different things, but that's an entire article all by itself!

The principle of operation is simple enough. It contains an oscillator which starts out at about 750 kHz with nothing connected to the unit, and adding an unknown inductor or capacitor lowers the frequency. (According to the manual, it can go down to 60 kHz or even lower, with larger components.) A custom programmed PIC chip reads the change, does some math, and spits out the value to a digital display. It's accuracy has been compared to expensive pieces of test equipment and found to be very competitive.

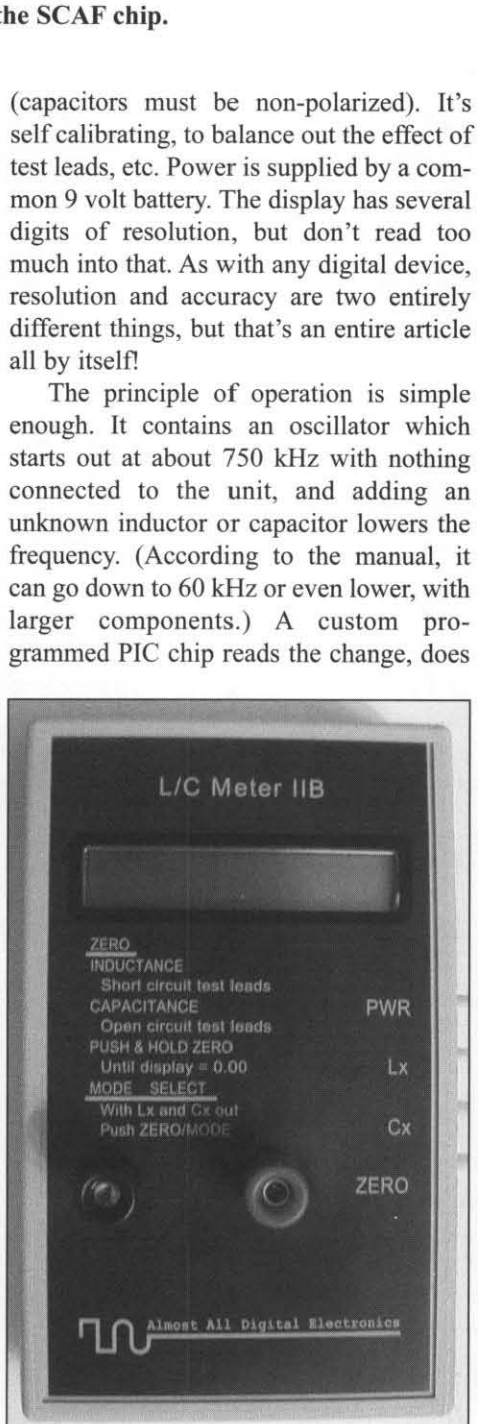


Figure 22—The AADE L/C IIB.

You can find more info on it on the AADE web page, at www.aade.com. Among other things, you can look at the complete manual, including schematic, and there are even links to Japanese and German versions of it. The page also contains a review of the unit that appeared in "antenneX," which is an online magazine devoted to ham radio antenna topics. And while you're there, look around the web site a bit since it has a lot of good info and other interesting products, including an inexpensive software program for filter analysis.

The meter went together pretty quickly and worked the first time I turned it on. Lots of people have reviewed and talked about it over the years, and there's not much I could say that hasn't already been said. About all I can add are some comments on mechanical issues of the construction process, and these are very minor issues that in no way detract from the unit.

The kit has a pair of binding posts that you have to disassemble completely and reassemble in the unit. I had some trouble tightening the nuts. The only way to do it was to screw on and hold the cap (the plastic end) with one hand and use a wrench or nut driver on the nut. The problem is that this not only tightened the nut but the cap as well. As a result, when I tried to unscrew it to connect a component, the nut started loosening up rather than the cap, since the cap had been jammed on very tightly when the nut was put on and it wasn't about to let go! I needed some way to hold the body of the binding post while tightening the nut without tightening the cap as well.

I could have used a pair of pliers and taken a chance on mucking up the threads, but I ended up drilling a small hole through the larger threaded end of the body (Figure 23), and put a small hex wrench through it to hold the shaft while tightening the nut. This way the nut was tightened firmly without having to screw down the cap as well, making it easy to unscrew the latter. As a bonus, the binding posts now have holes through the center of the shaft just like regular 5-way binding posts, which allows you to insert a component lead through it if desired.

A jumper lead with alligator clips was

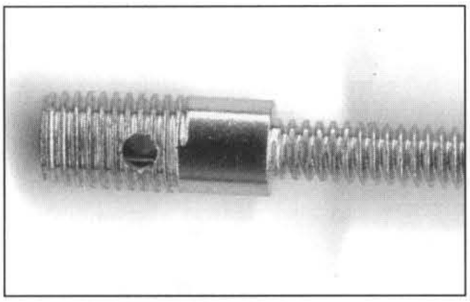


Figure 23—A hole drilled through the binding post lets you hold it with a small hex wrench while tightening the nut.

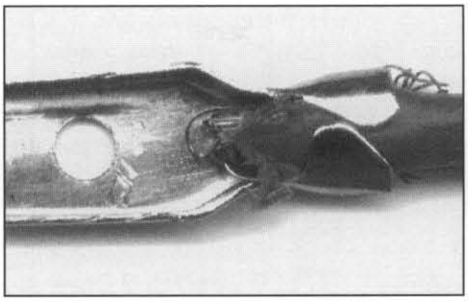


Figure 24—Lots of plastic and a few strands of wire, but not a bit of solder in sight.

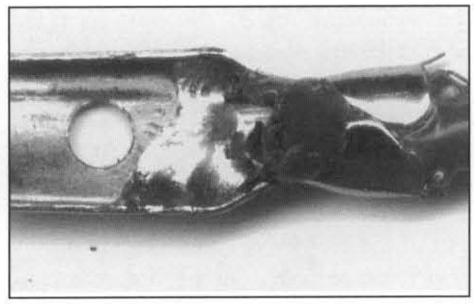


Figure 25—After the wire has been soldered. Not a pretty sight, but it will be covered up by the plastic boot.

included in the kit, for use as test leads. (Cut it in half, strip the ends of the wire and connect to the binding posts, or maybe put banana plugs on them.) To head off possible future problems, I immediately pulled back the plastic boot from the clips and soldered the wires. They were only crimped in place, and sooner or later the contact could start becoming intermittent. I learned this the hard way quite a few years ago, and mentioned it a few times in this column. Inexpensive alligator clip leads invariably have the wires crimped on rather than soldered, since it's much less expensive to produce. The down side is that after a lot of use they can start becoming intermittent and it could take a while before you realize the clip lead is bad rather than the project you're trying to make work.

I buy a new set of jumper leads every several years, as they usually get lost one by one, and I automatically open them all up and solder them. I don't worry about dressing and trimming the wire to make things look nice, since it will be covered by the plastic boot after soldering. I just hit it with the tip of a soldering iron and feed in some solder until it flows well. Yes, part of the joint will be contaminated with a bit of molten plastic insulation and look terrible, but the joint is still a good one. Figure 24 shows an unmodified clip, and Figure 25 shows one that has been soldered. (It's not a bad idea to crimp the tabs again with a pair of pliers, since the plastic has flowed a bit, to insure that there's some strain relief on the soldered joint.)

This certainly isn't a complaint about the AADE meter, of course. It's just about impossible to buy a set of alligator clip leads that isn't crimped; in fact, I have never seen one that was soldered.

The L/C IIB also comes with a handy adapter for measuring surface mount parts, as well as leaded ones, and owners of older units can get the adapter for just a few dollars (see the web page for details). This all started out with an adapter made by Chuck Adams, K7QO, shown on the web page and also mentioned on QRP-L several years ago. It consists of two scraps of PCB material, notched out to fit the binding posts, and each with a machined IC socket soldered to it to insert component leads.

Jon Iza, EA2SN, took this a step further, using a single piece of PCB material notched to fit the binding posts, and with a gap in the center so SMT parts could be tested. He also soldered a strip of header sockets to it, to accept leads of components. (This one is also on the AADE page.)

Finally, Neil refined the concept and came up with his SMD adapter. Instead of mounting under the caps of the binding posts, he uses banana plugs mounted on the board, to plug it into the L/C IIB. Figures 26, 27 and 28 show it from different angles. Surface mount parts can be placed over the gap between the two sides and held in place with something nonconductive such as a toothpick or pencil eraser while a reading is taken. (Don't worry about the added capacitance of all the copper and the sockets, since the meter has a zeroing function that balances out added inductance or capacitance.)

The long strip of copper without a gap (at the top in Figures 27 and 28) has its own pair of banana plugs, although he has since stopped supplying this second pair. It's for use as a shorting strap to calibrate

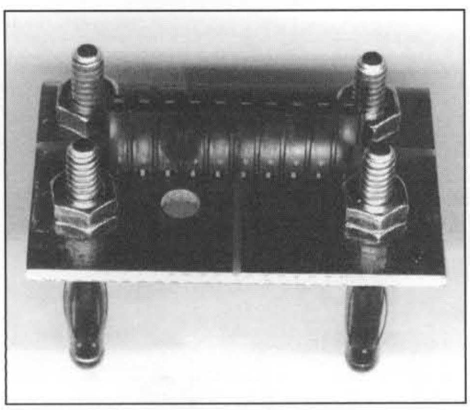


Figure 26—Oblique view of the SMD adapter.

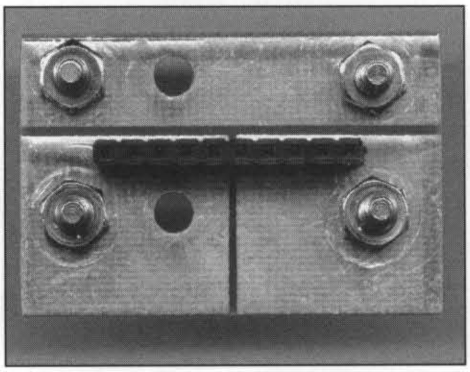


Figure 27—Top view of the adapter. The 2 lower banana plugs go into the meter. Hold SMD parts over the gap down the center or insert component leads into the sockets.

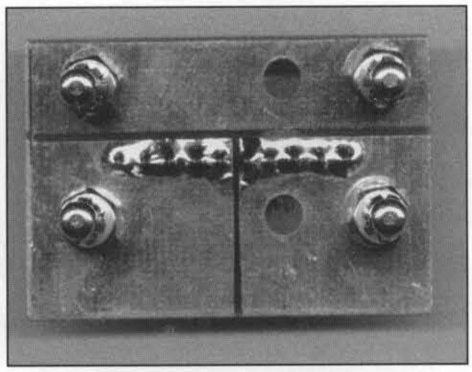


Figure 28—Bottom view of my adapter, with 4 banana plugs staring at you and the soldered pins of the socket. The two plugs on the top are no longer supplied.

the inductance mode. He said that the SMD adapters will be available as long as his finite supply of banana plugs holds out. Starting some time after I bought mine back in the spring, he has been supplying only one pair of plugs in order to stretch his supply. And you can still use the front part of the adapter as a shorting bar if necessary, by putting a jumper into the contacts. (If you really want that second pair you can probably find some at a hamfest if you look long enough. DigiKey also lists them in their current catalog, both with a threaded stud like the ones in the photo or with a tapped hole to accept a screw. Either type could be used here, and they are a little over a dollar each.)

There are two extra holes in the board since the meter can be ordered with 3/4" test jack spacing if desired, at no extra cost. (That's the standard used on commercial test equipment. I presume that the "stock" spacing on the meter was made somewhat larger for ease of connecting components with leads.) Put the banana plugs in whichever holes match your unit.

If you already own an older version of the L/C meter, either II or IIA, you can upgrade to a IIB for about $20 plus shipping. According to Neil, that gets you a new PIC chip with increased functionality. It also includes a new crystal to make it go at twice the speed, although he admits that doesn't really make a great deal of difference. (There was also an L/C I a long time ago, before the PIC chips became widely available. He said it was a complicated device with 11 integrated circuits, and he sold a few hundred of those, some of which are still in use.)

As I said earlier, I'm not about to give up my Boonton 260A Q meter but the AADE will get a lot more use. And it's certainly a lot easier to carry along to a hamfest and check inductors and variable capacitors on the run! There are a lot of things in life where you really can't justify the expense of buying it, finally give up and buy it anyhow, and then wonder how you ever got along without it and why you waited so long. This is one of those things.

Labels for Black Enclosures

The last issue featured a number of Rock Mites, including one made by Chuck Carpenter, W5USJ. It was in a black box with white labels on both front and rear. As I mentioned in the article, the labels didn't really exist. He added them (with yellow letters) to the picture on his web page with his computer, and I did the same to the picture that he sent me (using white). I recently got this e-mail from him—

I have now actually labeled my Rock Mite with real black labels that have yellow lettering. I tried several different ideas but the only one that worked for me in this instance was to use [self adhesive] paper labels. I did them with a black background and yellow lettering. White lettering would work too, but I liked the yellow. The font is bold face Arial. Figure 29 shows an example.

I tried several different labels, including translucent ones. Because color ink jet printer inks are transparent, the label needed to be opaque. I have a 30-label template made up that I used for this job. Once printed, I used a SHARP Xacto knife to carefully cut between the individual labels. A 6-inch steel ruler made a good cutting guide.

The hard part for me was to align the labels with the panel controls. A full-panel label would probably be better—if my controls were accurately placed.

I tried this with a gray background and yellow letters too. For the color gray that I use to paint my enclosures, a 65% gray worked quite well. It looks better than the translucent labels with black printing. It's not an exact match but unless you have a calibrated color system, it's pretty close.

Some cautions:

Make sure the labels are well dried before doing any cutting. Even with a sharp knife, wet paper can tear. And, even when dry, the paper will tear if the knife is not sharp enough.

Try not to cut through the label backing. It makes the labels harder to remove and can tear up the edges.

If the edges show the white paper around the black background, carefully use a black pen to cover what shows.

[Although Chuck didn't say what computer program he used, you can easily do this with Microsoft Word or PowerPoint. Turn on the Drawing toolbar (View, Toolbars…). On the toolbar, select the Text Box tool, type in the wording you want,

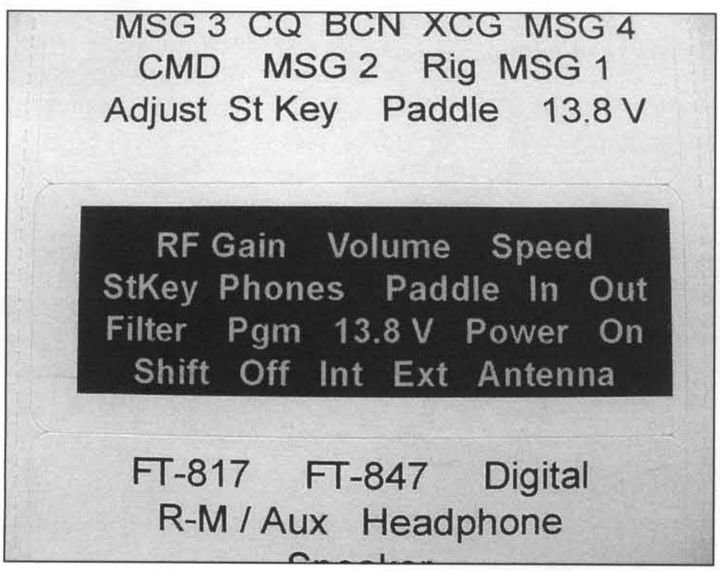


Figure 29—An ink jet printer can produce equipment labels with various colors of text and background. (The letters on black are yellow in this case.)

Figure 30—Modify an old mouse a bit, put a different connector on the cable, and it becomes a free set of paddles for your keyers.

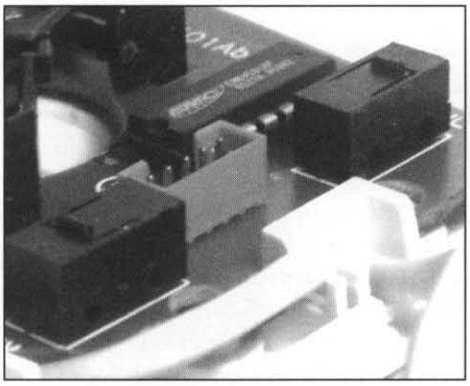


Figure 31—The left and right switches of the mouse become the paddle contacts.

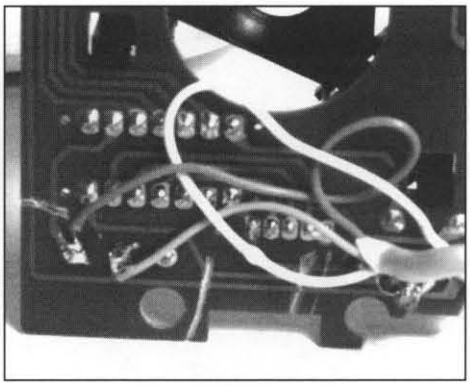


Figure 32—Cut traces as needed to isolate the switches, and solder the cable wires to them.

select an appropriate font size and style, then set the Fill Color (the paint bucket icon) to black or other color of your choice. Next, select the text and then change the Font Color to whatever you want. Print out on an inkjet printer. If you don't have self adhesive label stock you could print it on plain paper and tape them in place. I've done that many times over the years. The visible tape doesn't make for a work of art, but it does get the job done—WA8MCQ]

—de W5USJ

The Mouse Keyer

The computer age has given us many useful things for the shack, such as the amplified speakers that are so cheap and plentiful now. Another is the common mouse. Wayne Gunnell, KB1JQX (wgunnell@attbi.com), sent this along.

I have tried and built several keys and just wasn't satisfied with what I had found. I tried several straight keys as well as single and double paddles, but nothing felt right to me.

I was cleaning out a drawer and ran across an old computer mouse, and while deciding if I wanted to keep it or toss it I found myself playing with the buttons. Right, right, right....left, left, left...right, right, right...I tossed it into the trash can, amused at myself for clicking Morse code on a mouse. (I had just received my Technician license and was now trying to learn Morse code.)

Then it hit me—that felt right!

I disassembled the mouse and, using the switches for the right and left buttons, I wired it for a CW keyer. It works great! Spending a lot of time on the computer I am really comfortable with using a mouse, so this was perfect for me.

Figure 30 shows the completed unit, Figure 31 shows the momentary contact switches on the mouse board, and wiring the cable to the switches is seen in Figure 32. (I cut the traces on the board so no other components affected or interfered with the switch operation.)

Enjoy, and please feel free to share this and e-mail me with any questions!

—de KB1JQX

Mobile CW Through the Car Radio

Many people like to run CW from a car or other vehicle, but not all rigs have overpowering audio stages that can be heard easily in that environment. You could always haul along an external audio amp but that's more weight, clutter, and cables. Another option is to use the car radio. Here are a couple of ways of doing that.

From Bill Kelsey, N8ET, via QRP-L—

I just take one of those adapters the kids use to plug in their portable CD player to the car audio system and use it. It looks like an audio plug with a cassette tape on the other end. The tape cartridge goes into the tape player in the car, the plug goes in the earphone jack on the rig, and the rig's audio comes out of the sound system.

George Heron, N2APB, travels a lot on business and drives a lot of rental cars. He sent me these notes by e-mail—

I had trouble with using the audio cassette insert approach in some vehicles, as the "end of tape" sensor would detect it as an end of tape (or jammed tape) and automatically eject it. This condition varied from vehicle-to-vehicle, so I'd never know what to expect. (Unfortunately, this is a condition that is often encountered when traveling on business and renting cars in different cities.)

WA8MCQ—Another possible drawback is that not all vehicles will have tape players. My 1997 Honda Accord takes cassettes, but the radio in my 2002 Accord has a CD player instead. But one thing that all car radios have in common is the FM broadcast band. The following item is from Bob Liesenfeld, WBØPOQ (wb0poq@visi.com). The N8ET post on QRP-L was in response to this one that Bob sent. In the original, Bob offered to send the schematic to anyone who was interested.

I asked for a copy and redrew it, appearing in Figure 33. If you also receive the NJQRP club's *QRP Homebrewer* you might recognize it. George Heron ran this project there first. (He used my drawing, so if there are any problems with the schematic that he ran it's my fault!) Bob had this to say—

I'm just boxing up my latest project. I run mobile CW and have trouble hearing the receive audio sometimes. So, I have put together a 'Mr. Microphone' that transmits the HF rig's audio output on about 99 MHz so I can tune it in on my car stereo.

I played with one of these in the past but it was plagued by poor frequency stability and insufficient transmitter power. This model is a VCXO (voltage controlled crystal oscillator) with a final that does about 90 mW into a 10-inch antenna. That seems to capture the FM tuner just fine.

WA8MCQ comments—The crystal frequency isn't terribly critical. I did the math and found that anything from 14.66667 MHz to 18.000 MHz will work, covering 88 to 108 MHz at the output. (The crystal frequency is tripled and then doubled, with final output at 6 times the fundamental.) You have to look through the offerings of several companies in the DigiKey catalog to find the one with the widest selection of frequencies, but one of them has about ten within that range. (You may have to choose carefully to hit a spot of the band that doesn't have any strong stations.)

If you have trouble finding the MPSH10 transistor used at Q2, you could try a 2N2222. It might require some tweaking of other components, but it should work.

After the article appeared in *QRP*

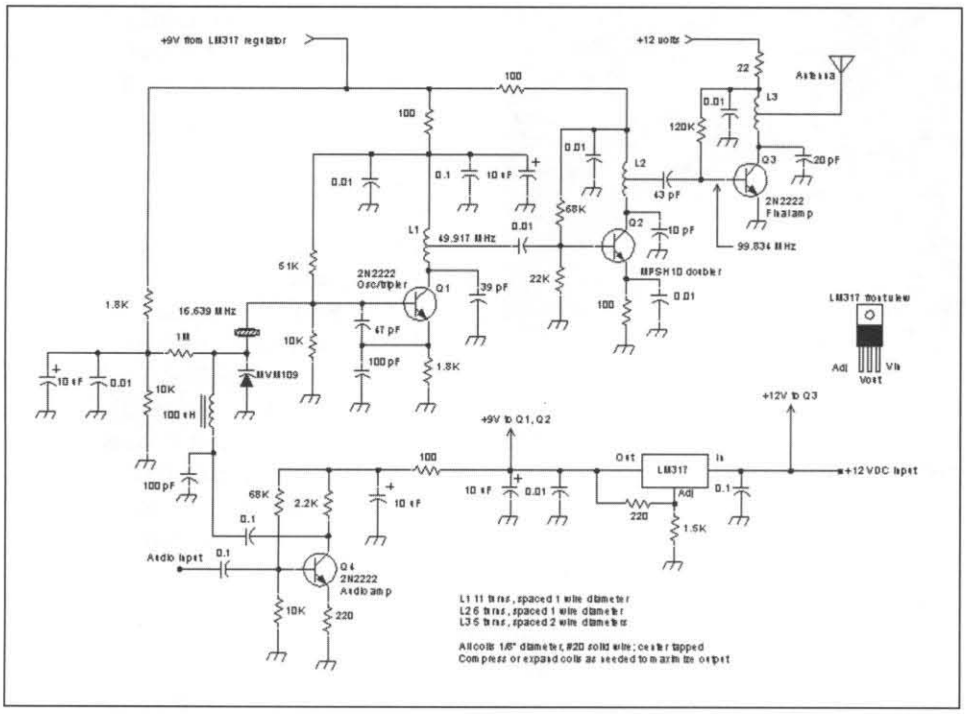


Figure 33--This low power transmitter sends the audio output of a rig through the FM radio in a car or other vehicle.

Homebrewer (which has since been merged with NorCal's *QRPp* and is now named simply *Homebrewer*, published by the American QRP Club), someone asked about the MVM109 varactor diode, saying that he couldn't find anything on it with an Internet search and wondered if it was similar to the MVAM109 tuning diode. My reply—

"I just typed in what was on the hand drawn schematic on his web site; it may have been written down as MVM109 by mistake. If you already have the MVAM109, I'd give that a try and see how it works out.

"Or if you have some other tuning diodes but not that one, you can use the advice that W3TS gave me on another circuit. I wanted to re-run an HW-8 RIT circuit that he published years ago, and the schematic showed an obsolete tuning diode that is no longer available. I asked about some replacements, and his answer was, essentially, hey, I needed a tuning diode so I grabbed one and it worked, and if someone builds my circuit they can use pretty much anything they have and it will work well enough to get them in the ballpark. [WBØPOQ agreed with that!]

"It may not be optimum engineering and may require tweaking for perfect performance, but you could always use any tuning diode that you happen to have on hand. It will probably function to some extent; perhaps not perfectly, or quite up to snuff (in this case, maybe not enough deviation and thus low audio in the receiver), and that's when you tweak some other parts of the circuit a bit.

"A lot of people take that approach. You can tell who they are; they're the ones that always say they learned a lot more about electronics by taking what was on hand and then making it work even though it was the "wrong" part, rather than not building in the first place because they didn't have the exact part that an author called for."

QRP Online

As I say every issue, there's been a huge amount of QRP info flying around the Internet for years, and it's still there! Here are some of the online forums available.

QRP-L, which I call the "QRP Daily," is the online QRP discussion forum started in 1993 by QRP Hall of Fame member Chuck Adams, K7QO (K5FO at the time). It continues to run several dozen postings per day on a variety of topics related to QRP. And as I said in the last issue, if you unsubscribed because of all of the sniping, personal attacks, etc, it's safe to go back. It's a moderated list now and back to what it used to be.

QRP-F is an alternative QRP forum started by the QRP ARCI in October 1999 to take some of the load off QRP-L. The activity is much lower than on QRP-L, but so is the noise level.

While not specifically a QRP list, the Elecraft reflector is dedicated to owners of those products, most of which are QRP. Even non-owners may find it interesting since they cover a number of homebrew topics.

To check out the online QRP world, go to these URLs:

QRP-L: go to http://qrp.lehigh.edu/lists/qrp-l/ and you're at the home page where you can sign up, read the archives, etc.

QRP-F: go to http://www.qrparci.org/ and click to enter the site, then click on QRP-F on the menu at the top.

Elecraft: http://mailman.qth.net/mailman/listinfo/Elecraft to subscribe; home page at http://www.elecraft.com/

And while you're on those home pages, don't forget to check out their lists of QRP related links; and at each link that you go to, check THEIR lists as well, since not all sites list all others. In addition to the QRP ARCI site, another excellent place to use as a jumping-off point for checking out QRP related sites is the NorCal home page, run by Jerry Parker WA6OWR, at http://www.fix.net/~jparker/norcal.html. You'll find quite a wealth of QRP info online.

And don't forget to keep an eye on the page of the new American QRP Club, www.amqrp.org/

The fine print

Do you have something you'd like to share with the readers? You can send it by e-mail, floppy disks or even handwritten notes. And I don't mind hand drawn schematics since I redraw most of them on the computer. My job is to edit, rewrite, redraw, etc; yours is to send in the info to share. Send your e-mail submissions to wa8mcq@comcast.net

●●

The Electroluminscent Receiver Kit — A Year Later

David White—WN5Y wn5y@yahoo.com

The cover of this issue of QRP Quarterly *shows one builder's version of the Electroluminscent Receiver. Here is the story of its design, development and how some people are are using it in ways not orignially envisioned—ed.*

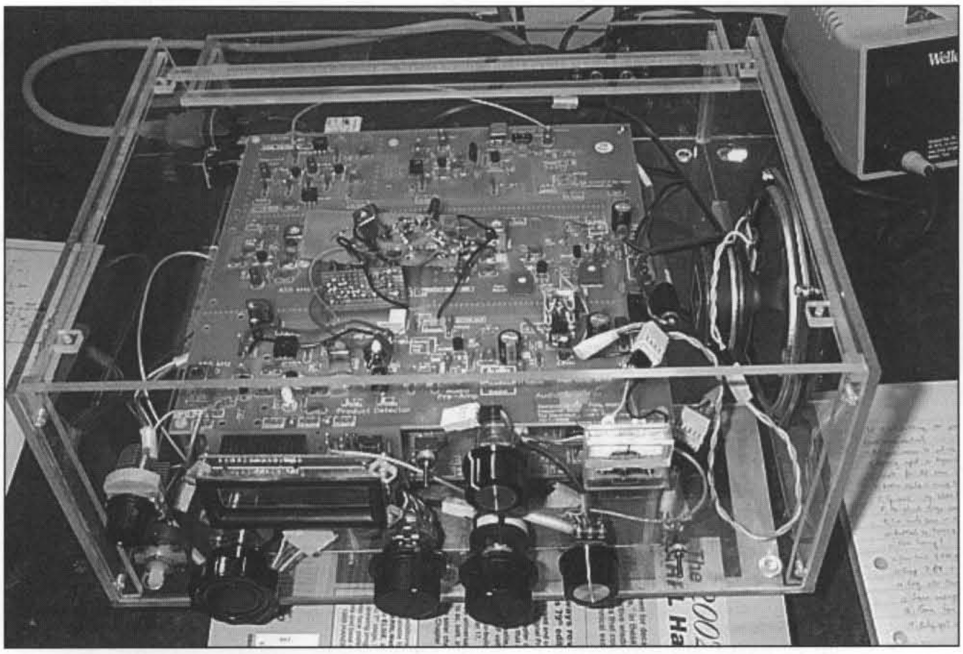


Figure 1—Duncan Watson, from New Zealand built this SWL version of the ELR.

It's Great for Kids!

Although designed as a blood thirsty DX machine, the Electroluminescent Receiver (ELR) kit is becoming increasingly popular with children who find the visual aspects of this radio irresistible. The salmon pink colored PC boards and warm glowing LEDs provide a welcome addition to any kid's room.

This radio was first presented in the October, 2002 issue of *QRP Quarterly*. In this update, I will talk about some of the features of this receiver that make it particularly well suited for kids, and the process by which this receiver came in to being.

One of the most attractive things about this kit is that easy to work on PC boards with its detailed silkscreen component layouts, wide traces and generous layout. The wide traces and layout of the receiver allows almost any soldering tip to solder the parts. Overlooked solder connections are easily located by holding the board against a bright light that will shine through any remaining holes. The detailed silkscreen makes parts placement easy once the parts are identified.

Secondly, the LEDs provide a visual impact that is very attractive to kids—at the Greenville, TX, summer 2001 hamfest, for example, a ham and his son entered the hamfest flea market. The boy made a beeline for the receiver display and couldn't keep his hands off the knobs. His father had been searching for a project to spark his son's interest in ham radio, and was very happy to discover and purchase this kit.

A third feature of this radio is that kids are introduced to science through LEDs and Infrared (IR) devices. The introduction to IR devices provides fun and practical knowledge and is unique to this kit. The photo diodes in the bandpass filter make an IR remote tester that always brings a bit of laughter.

Finally, the ability to build the receiver for the SWL (Short Wave Listening) bands makes the receiver popular to people who may not initially be interested in amateur radio. This fourth feature is a back door approach to ham radio, getting kids interested in listening to foreign broadcast stations, then leading them to the thrill of actually talking to people all over the world.

An Oklahoma City ham, working with a group of kids, thought the SWL version of this receiver would be a good starting point for his group. If a youngster eventually becomes a licensed amateur, then the receiver can be easily modified to work on the ham bands.

Also, Mrs. Barbara Spencer, KK5QA, wife of QRP ARCI President, Joe Spencer, plans to use the kit in her home schooling project this year. The easy-to-build features and the interest her grandchildren showed in the warm glowing LEDs convinced her this receiver could help teach elementary electronics and be a hands on project that would last through most of a school semester.

At the Oklahoma City Ham Holiday 2003, a middle school teacher at the Science and Technology center wanted the receiver for her class. She liked the triple learning aspects of the kit: how to use LEDs, elementary electronics, and application of IR devices.

In Pampa, TX, Mrs. Lloyd Harvey teaches gifted children, organizes a project called "Destination Imagination" where her students build imaginative projects to encourage creative thinking. Mrs. Harvey wanted the receiver for this year's competition.

Platform for testing/development

The second kit produced went to Duncan Watson, an experimenter and SWL enthusiast from New Zealand. He wanted an SWL receiver. The ability to interchange individual sections of the receiver fit his purpose exactly.

His finished product is an SWL receiver that covers all the SWL bands from 3 MHz to 20 MHz, with four FET VFOs and switchable AM/SSB detectors (See Figure 1). A summary of emails between the author and Mr. Watson is on the author's web site showing his schematics and modifications to the receiver at http://www.pan-tex.net/usr/r/receivers/dwswl.htm.

The most mentioned modification is to add a Direct Digital Synthesis (DDS) VFO. Since the bandpass filters cover 4.4 MHz to 21 MHz, a wide range DDS VFO would yield a general coverage receiver.

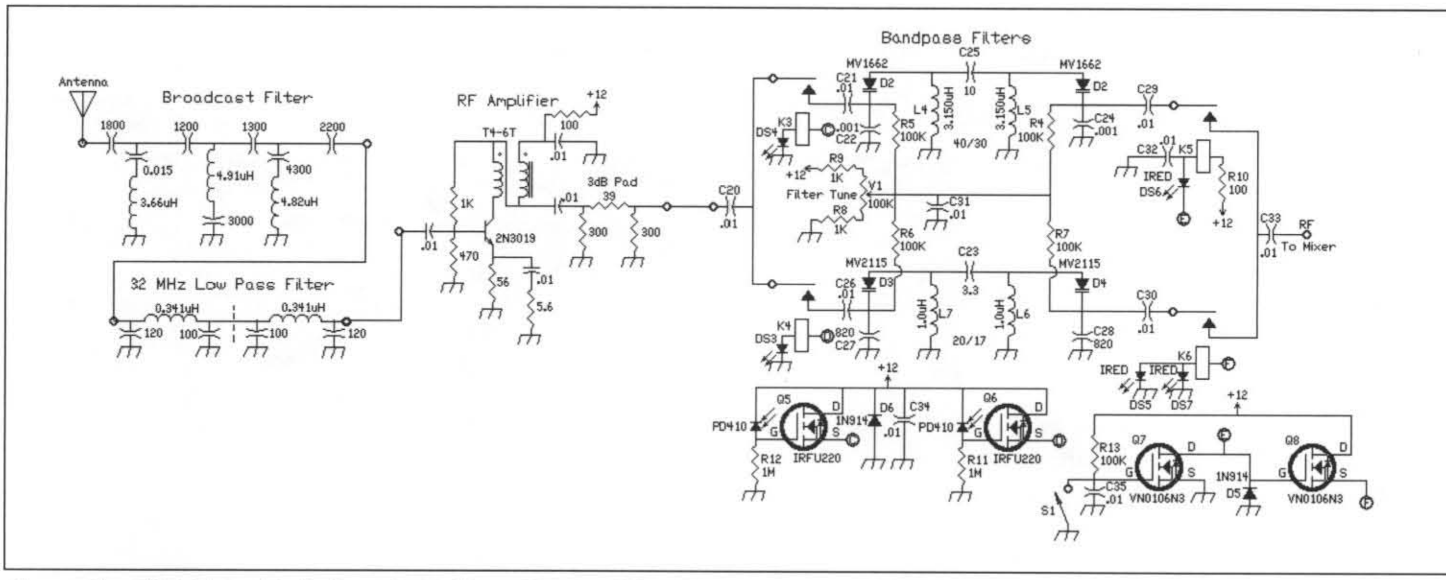


Figure 2—ELR Front End; Broadcast filter, RF amplifier, Bandpass Filter (Board 1).

This receiver would make an excellent platform for those using the popular DDS signal generator/VFO mentioned on the QRP-L email reflector. Information on the DDS VFO can be found at "NJQRP DDS Daughtercard Kit," http://www.njqrp.org/dds/.

Variable VFO Injection

In Dallas, at HamCom 2003, those who had built the kit, most liked the variable VFO injection. The ability to adjust the receiver to antenna and band conditions was greatly appreciated.

The receiver was designed for those living in limited space dwellings with very limited antenna spaces. When the PCB was being prototyped, the author was living in a townhouse with a hamstick mounted inside a large window for the main antenna. Thousands of hams live in similar situations so a high level RF amplifier was included in the front end to provide more front-end gain.

Three methods of adjusting the front-end gain of the receiver are incorporated:

1. The variable VFO injection level adjusts the gain of the mixer for different antenna systems.
2. A 50-ohm pi attenuator pad is incorporated between the RF amplifier and the bandpass filters. This pad can be built with any dB loss to fit the receiver to the antenna farm.
3. The RF amplifier can be switched in or out.

Evolution and Development of the Receiver

A lot of questions at hamfests have been about how the receiver was designed and how the idea for a luminescent receiver came into being. Also, "How long did the design process take?" Most of the time the answer is "I am too embarrassed to say." But now the full truth is revealed.

In 1980, Jim Tanner of Tanner Electronics, gave the author a huge handful of dual gate MOSFETs and suggested the development of a receiver kit. After ten "dead bug" prototypes, including a 7 band version, (which Randy Strouse, KC5MJV, used to get the Worked All States award in the Novice band) and ten PCB prototypes were built and tested, it finally hit the market in 2001.

The first light (LED light) of the receiver occurred during the building of the "Progressive Communications Receiver" (*QST*), by Wes Hayward, W7ZOI and John Lawson, K5IRK. In the IF section of that receiver, they used an LED to raise the AGC action of the strip above a negative voltage. This was done to simplify MOSFET IF strips of a negative voltage for getting full AGC action.

Only an LED freak (the author) would look at this idea with intense curiosity and built all subsequent MOSFET circuits with this LED. After building 20-30 of these amplifiers it became apparent that the LED served many useful purposes.

When building ten MOSFET amplifiers at a time, one tends to become sloppy and not all the resultant amplifiers would work. The LED would either be very dim or not light at all in the bad amplifiers. Investigating this effect, it was discovered that the LED provided a valuable diagnosis feature. This feature brought to light that very little tech support would be needed for the kit: very important when selling a dual conversion superhet that needs an oscilloscope for quick diagnosis. The LEDs would provide a built-in oscilloscope.

Another circuit from the "Progressive" receiver was the AGC circuit, a simple circuit that worked very well. Then enters Doug DeMaw's (W1FB, SK) "His Eminence, The Receiver" a 455 kHz IF design. The high gain of a 455 kHz IF strip put to shame high frequency IF strips. To simplify DeMaw's circuit, the AGC from the "Progressive" receiver was used. Then the IF strip active devices were changed to MOSFETs and a very quiet and simple IF strip emerged. The Hayward/Lawson AGC circuit worked fantastic at 455 kHz and reasonably well up to IF strips about 10 MHz.

A new LED feature showed up in the MOSFET IF strip: the LEDs provided a built-in S-Meter. The LEDs flashed along with the AGC action, the stronger the signal, the more intense the flashing. The LED is in the source circuit and monitors the drain current of the MOSFET. As Gate 2 bias varies from the AGC circuit action, changing the drain current, LED brightness would follow.

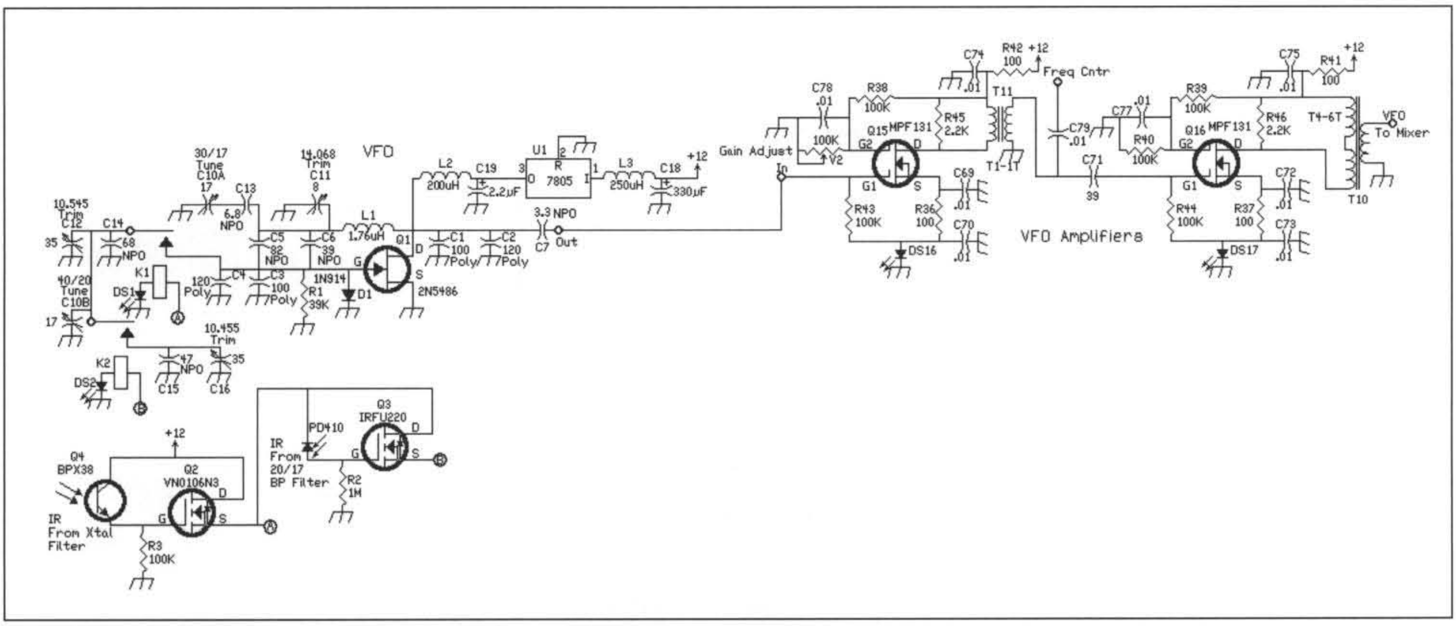


Figure 3—VFO and amplifiers (Board 1).

The next step in the design process was could the MOSFET circuit be used in all the circuits of the receiver? The answer was a resounding "YES." The Electroluminescent Receiver Kit (ELR) follows the design of "DX Receiver for the Ham Bands" (*Ham Radio* magazine), by Ovi Florea, WB2ZVU, who uses MOSFETs in all sections except the VFO and audio circuits. However, it was a very early design; DeMaw and Hayward have simplified the MOSFET circuitry and produced a lot more gain than the Florea design. Some receiver gurus have called the ELR a buildable version of Florea's receiver.

The single-balanced mixer evolved from a section in Doug DeMaw's book, *W1FB's QRP Notebook*, "Balanced Transistor Mixers." Two of the LED MOSFET amplifiers were put side-by-side with DeMaw's broadband transformers at the input and output and the resultant mixer worked great.

A spectrum analyzer was used to fine tune the modified DeMaw mixer and the best performance was obtained when the Gate 2 bias was lowered to 0.5 volt, a suggestion made by Ovi Florea in his DX receiver. Best isolation from the B+ bus was found using a 250 μH choke instead of a resistor/capacitor combination. The RF choke provided a higher voltage on the MOSFETs giving slightly higher gain for the mixer.

Another LED feature showed up when the Gate 2 bias was lowered to 0.5 volt: the LEDs measured the VFO injection level. If the VFO was not oscillating, the LEDs in the mixer would not light. Also, if a builder wanted to experiment with different VFOs, the LEDs would provide an injection level indicator, letting him know whether he had proper injection level for the mixer to work without having to resort to an oscilloscope. Duncan Watson used this feature when adding VFOs for his SWL version of the kit.

Wes Hayward's article, "Simple Crystal Filters," provided a revolution in building high performance homebrew receivers. After this article, an homebrewer could build crystal filters that performed exactly the way he preferred with no math involved. Hayward's design was installed in the receiver exactly as he suggested in his article. The same capacitors (100 pF)

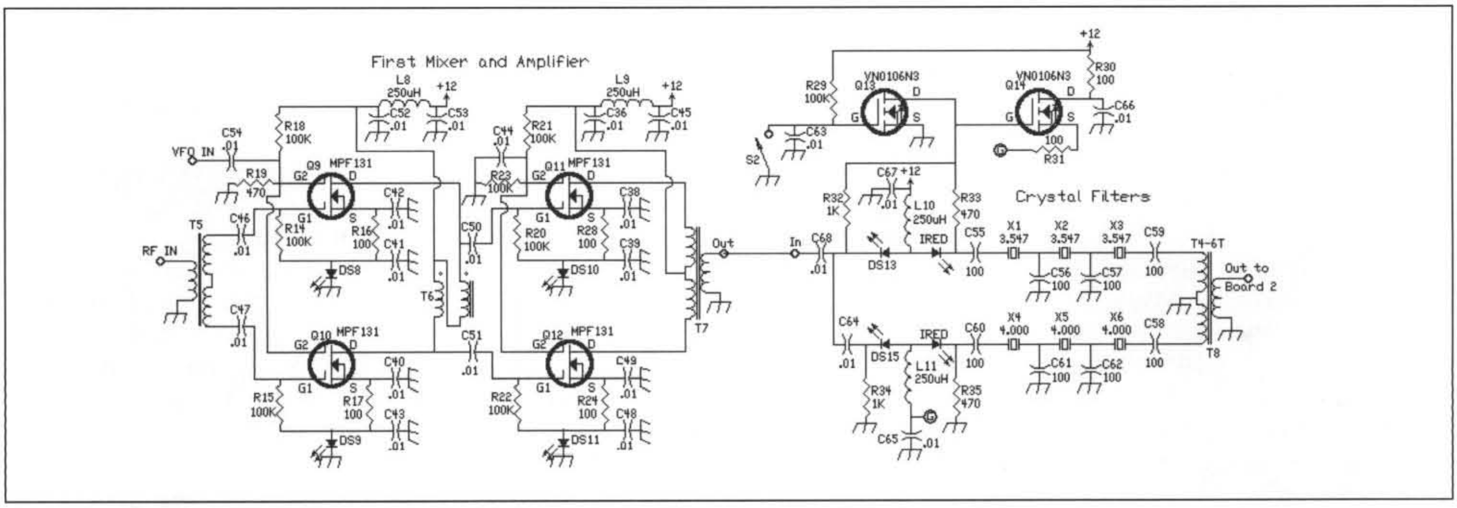


Figure 4—First Mixer and Crystal Filters (Board 1).

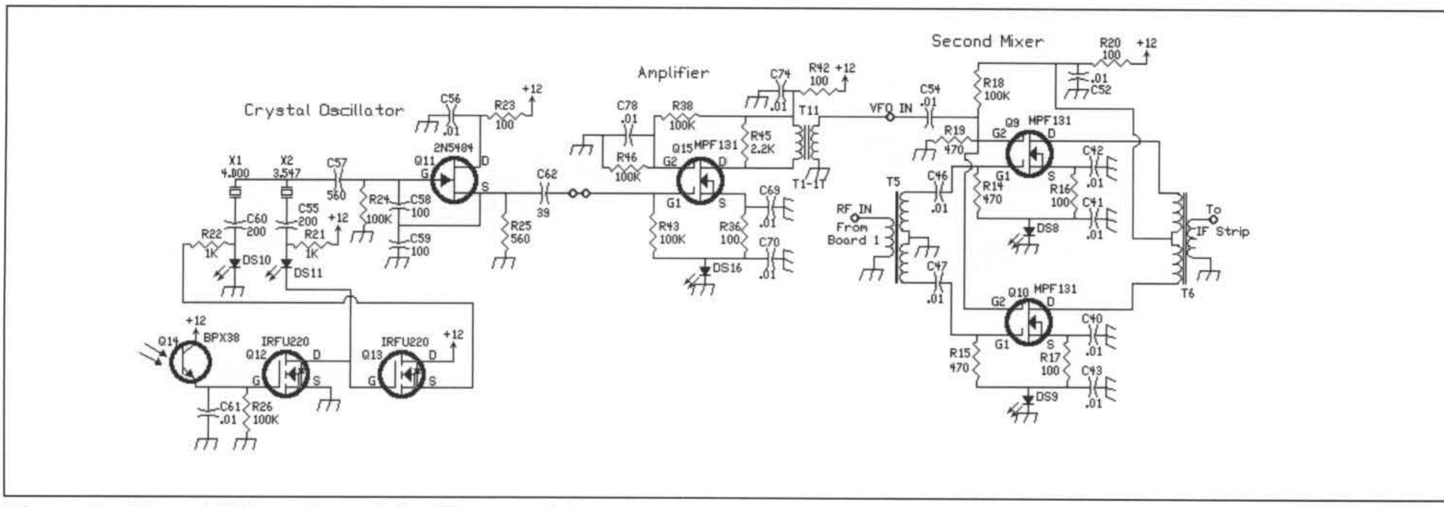


Figure 5—Second Mixer, Crystal Oscillator and Amplifier (Board 2).

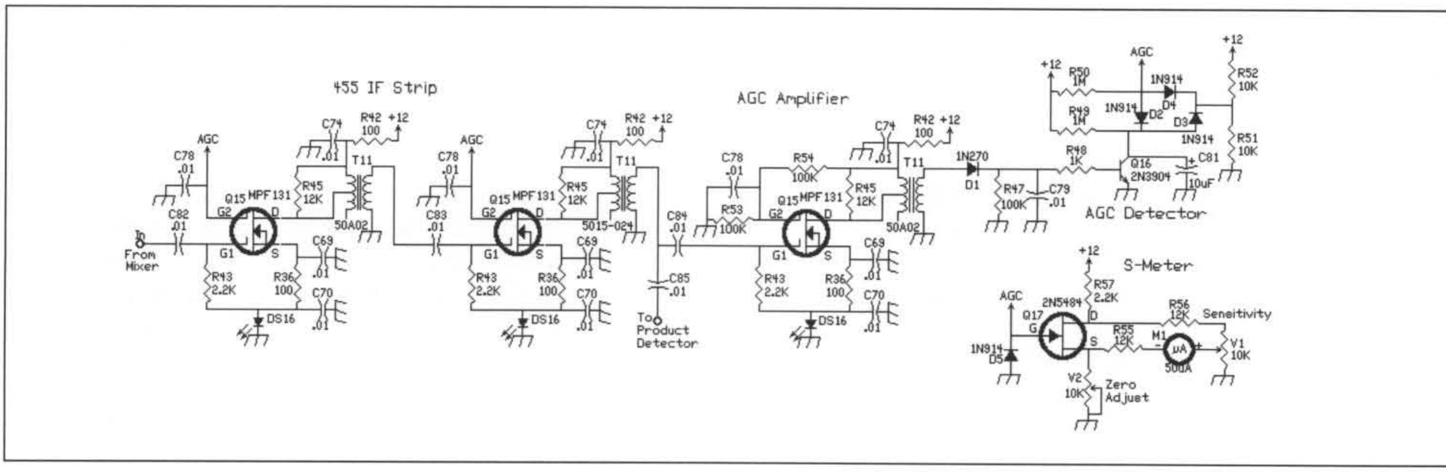


Figure 6—IF amplifiers, AGC Circuit, and S-meter Circuit (Board 2).

are used in the filter and provide a compromise between SSB and CW bandwidth. Raising the value of the capacitors tightens the bandwidth and lowering the value widens the bandwidth. Since the impedance is difficult to change, his other formula, raising/lowering the impedance tightens/widens the bandwidth, can't be used as easily. However, Hayward's article provides a way to change the bandwidth to an operator's preference.

There is also plenty of ground plane around the crystal filters if one wants to experiment with varicaps to provide adjustable selectivity. The varicap circuit has been published in QRP journals and several hamfest attendees have mentioned they might try the modification. Another feature of the crystal filter is that all switching is done at the input and only a transformer is used to couple to the second board of the receiver. If shields are used all around the filter, which is provided for with holes in the PCB all around the crystals and the filter, very little stray RF will reach the second board, a great help in reducing birdies.

The original ELR design used only one crystal filter, 3.547 MHz, providing two bands, 20 and 40 meters. The 3.457 MHz crystal filter was mixed with a 4 MHz crystal oscillator to provide for a 455 kHz IF. After some brainstorming, a realization occurred that reversing the crystal frequencies would give a 4.000 MHz crystal filter which is a popular scheme for double imaging the 30 and 17 meter bands. The 4.000 MHz crystal filter mixed with a 3.547 crystal oscillator would also yield a 455 kHz IF (see Figure 4).

So the last design issue of the receiver was how to fit four bandpass filters on the allocated board space of the PCB. Wes Hayward's bandpass filters from the "Progressive" were used first with varicaps in parallel with the resonator capacitors to try to reach two bands with two filters. The filters were designed for the lower of the two bands, i.e., one for 20/17 with the design initially using the 20 meter values. A varicap was used to resonate the sections and then the capacitance lowered with the bias voltage to reach 17 meters. This worked great using MV2115 varicaps for the 20/17 bandpass filter. But the 40/30 bandpass filter would just not quite reach 30 meters. An MV1662 varicap was used for the 40/30 filter for it was originally designed for AM tuners and has a very wide capacitance range.

The author's new *QEX* came in the mail and William Sabin, WØIYH, saved the day with his article "Narrow Band-Pass Filters for HF." Sabin's article had two features than made the bandpass filters less costly and allowed the 40/30 varicap tuned filter to work.

The first feature was that Sabin eliminated the variable trimmers in Hayward's

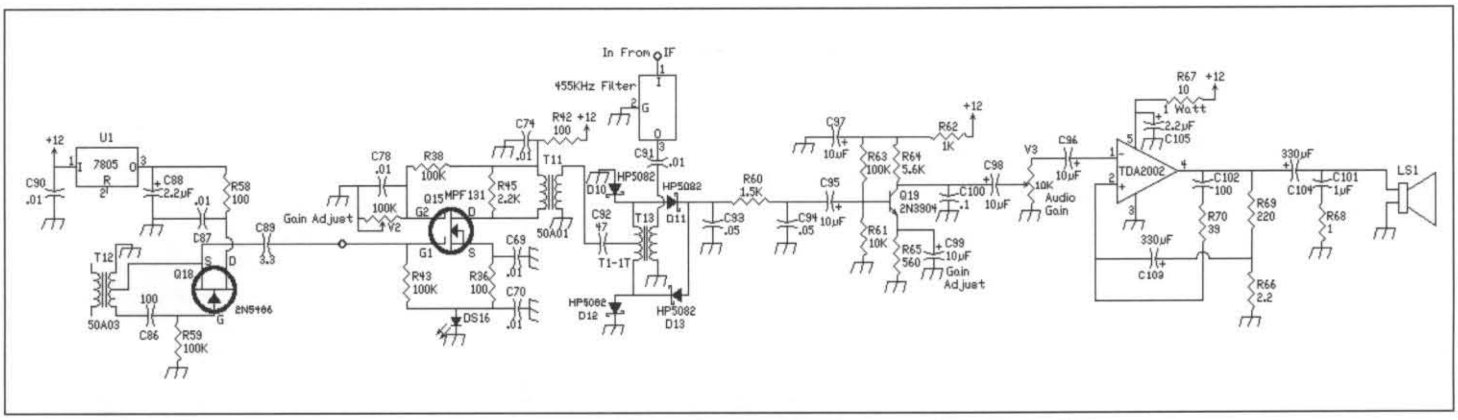


Figure 7. BFO and Amplifier, Product Detector, Audio Pre-amp and Audio Amplifier (Board 2).

design. The elimination of the trimmers is a large cost saving and a tremendous convenience, especially for homebrewers, since small trimmers always seem to be in short supply. The second feature was that the capacitance values between Sabin's 40 and 30 meter filters were a lot closer in value than Hayward's filters. Within one day of experimenting, the 40/30 bandpass filter was hitting both bands with room to spare using the MV1662s. The 20/17 bandpass filter was redesigned using Sabin's design as well.

The final range of both filters was 4.4 MHz to 21 MHz, with a slight overlap between the two filters. The filter range expanded the versatility of the receiver, allowing a builder to modify the receiver for any favorite band between 60 to 15 meters. And with a few easy modifications, allowed the receiver to be set up as an SWL receiver, covering the most popular SWL bands.

Since the crystal filters are 3.547 MHz and 4.000 MHz, it is not recommended to set up the receiver for 80 or 160 meters, though it would be easy to build an upconverter to feed the receiver for those bands. For 12 and 10 meters, the 20/17 bandpass coils could have turns removed at the expense of losing 20 meters and maybe 17 meters. This modification has not been tested. Another option, since the board is spaced out with easy to locate in/out connections, more bandpass filters can be added to the design along with appropriate VFOs, which was the path Duncan Watson easily followed.

Conclusion

I would like to give great thanks to technical writers, especially those mentioned in this article, for taking the time to share their knowledge with the amateur community. It is obvious that part of inventing something new is derived from rearranging the old. Without experimenters sharing what they have found with others in the amateur radio magazines, progress would quickly come to a halt. At the present time, there seems to be plenty of avenues to publish. For those who have not taken the time to write, please do not be shy.

This design was the most exciting work I have ever done, but the most exciting thing is that kids find it so interesting. This kit was built on existing information that should provide hours of study in the art of building and learning about amateur radio development.

[*The Electroluminescent Receiver kit can be found on the Internet at http://www.pan-tex.net/usr/r/receivers or http://www.qsl.net/wn5y—ed.*]

QRV? – A "Building Day" Transmitter

Steve Hudson—AA4BW steve.hudson@cmdg.com

Beginning with this issue, Steve, AA4BW has assumed responsibility for "QRV?" Steve brings a fresh perspective to beginning construction and the staff is excited to have him aboard. —ed.

Whether you're looking for a project for a local "Building Day" gathering or want a workbench project for a rainy Saturday afternoon, this straightforward little transmitter is just the thing!

In the last issue, we looked at what it takes to put on a successful Building Day—that is, a day of homebrewing for the folks in your local QRP community. Judging from the response there's a great deal of interest in that sort of thing.

A number of folks have expressed interest in what makes a good Building Day project. There are all sorts of possibilities, including simple test gear and various other accessories for use around the shack.

But for instant gratification, nothing beats a transmitter.

Why a transmitter? For one thing, well-designed basic transmitter circuits are easy to come by. You should have no trouble finding one to your liking.

For another, simple transmitters don't require any particularly unusual parts. Most of what you need is probably already in somebody's junk box or at the local electronics store or Radio Shack.

Finally, simple transmitters lend themselves well to stage-by-stage construction, testing and (if necessary) debugging. If you have your group build a transmitter stage by stage as described here, making sure each stage is working before going on to the next, you'll be almost assured of a successful Building Day program.

The basic circuit, in one form or another, has been around for a long time. I think I built my first version of it back in the mid 1970s. In the years since then I've seen the same basic design in various forms on numerous occasions, and it's always a winner. It's a neat little three-stage design that includes an oscillator stage, an output stage, and a keying stage.

This is as close to a no-fail circuit as I've ever found. I've built literally dozens of these transmitters, and (if I don't get mixed up and put in a transistor incorrectly) every single one of them has worked the very first time. Now THAT's the kind of project I like!

What follows here is a brief description of how to build this particular transmitter. In this article you'll find not only a full-size layout of the Manhattan-style board but also step-by-step instructions for building and testing the transmitter stage by stage. It should be well suited for building during a Building Day.

But don't forget that it's a great homebrew project in its own right too! You can build one of these in a leisurely afternoon-and when you're done you'll have a transmitter that works like a champ.

Preparing The Board

Step one is to prepare the Manhattan-style board on which you'll be building the transmitter. At its heart is a piece of copper-clad PC board measuring about 3 inches by 4 inches, to which are affixed small islands of PC board material which serve as connecting points for the various components. Note that the size of the board is not at all critical, though one of about that size will allow you to use the pad layout shown in Figure 1. Ground connections are made by soldering directly to the main ground-plane board.

Materials required are simple: A piece of PC board material; steel wool (Brillo pads work well) and suitable pads made from PC board material

Procedure

First, using steel wool, clean the copper face of your piece of PC board material. If you have double-sided board, only one side needs to cleaned. Rinse and dry the board, then set it aside and turn your attention to making and mounting the pads.

The pads themselves are cut from scraps of PC board, then mounted copper side up. They're easy to make. Using shears, cut a strip from the edge of a piece of PC board. Then, using the shears again, cut the strip into short pieces for use as the pads. Note that one of the pads is a bit larger than the rest. Make sure that the pads are flat, and lightly roughen the bottom side of each by pulling it across a flat piece of sandpaper or a file.

For a Building Day, I've found it best to use slightly oversize pads like those shown here. Experienced builders may want to use smaller pads—for example, those that can be made with a nibbling tool-but less experienced builders will be more comfortable with pads of the approximate sizes shown here.

Now begin mounting pads on the main (ground-plane) board. The easiest way is to make a copy of the layout shown here, then use a pen, an awl or even a nail to mark through the layout template to indicate each pad's position on the board. Then all that remains is to mount an appropriate pad at each location.

Alternately, you can go "by eye," placing pads one at a time in the approximate positions shown. If you take the "by eye" approach, it's probably a good idea to start with the largest pad, which provides a good reference point.

Either approach works, but in a Building Day setting it's best to have everyone doing the same thing. I'd suggest that you have folks use the mark-through-the-template approach.

In any case, mount each pad with Superglue-type glue, then apply firm pressure to the pad for several seconds while the glue sets. Be sure to use enough glue. I've found that if I use a little more than would usually be called for, the board holds up better to the rigors of construction and soldering.

As a final check, use your ohmmeter to be sure that there are no shorts between the pads and the ground-plane. Occasionally you'll find a tiny, almost invisible whisker of copper remaining after the pads are cut; the ohmmeter check assures you that there are no undesired shorts to ground. Note that the same pad layout is used for all bands.

Building The Keying Section

The first section of the transmitter to be constructed is the keying circuit (see Figure 2). It's a straightforward transistor switch and works every time (if you put the transistor in correctly—voice of experience speaking). Building it provides a great

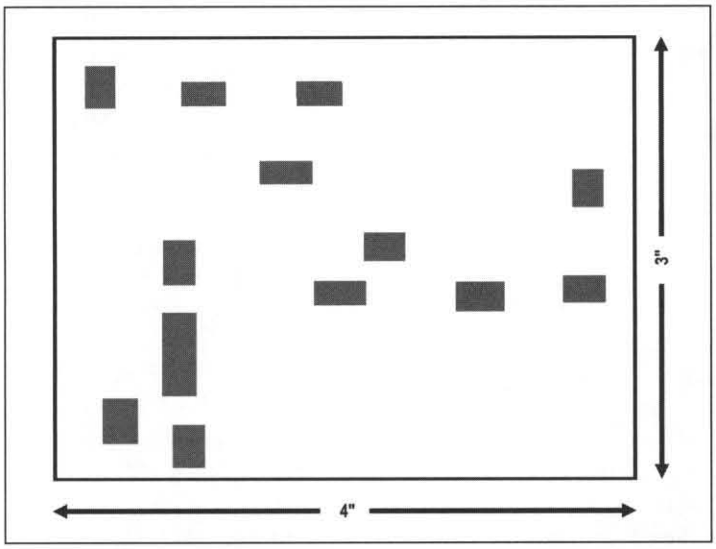


Figure 1—PC Board Pad Layout (for Manhattan-style construction)

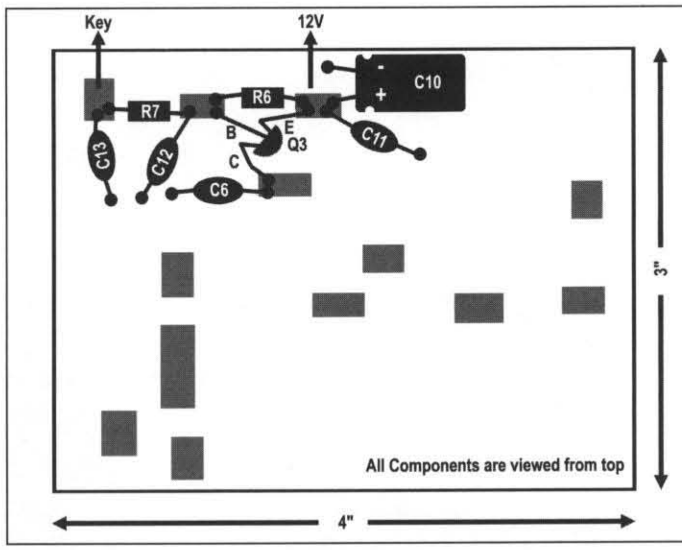


Figure 3. Placement of the keying section components.

opportunity to get used to Manhattan-style building (see Figure 3). For Building Day participants, it provides instant gratification too-just watch those eyes light up when a builder grounds the key line and sees the keying voltage follow!

Here are step-by-step instructions for building and testing the keying portion of the circuit:

___ Locate the following parts:

R6, 4.7k (yel vio red)
R7, 1k (brn blk red)
C6, 0.1 disk
C10, 330 µF or 470 µF electrolytic
C11, 0.1 disk
C12, 0.1 disk
C13, 0.1 disk
Q3, PNP switching transistor, 2N4403 or 2N3906 or equivalent. Make sure you pick the right transistor!

___ Orient board as shown in Figure 3
___ Mount R6, 4.7k (yel vio red)
___ Mount R7, 1k (brn blk red)
___ Mount C10, 330 µF or 470 µF electrolytic. Note polarity. Negative (–) lead is soldered to the ground-plane.
___ Double-check the polarity of the electrolytic installed in the previous step. Remember, the negative lead should be grounded.
___ Mount C11, 0.1 disk
___ Mount C6, 0.1 disk
___ Mount C12, 0.1 disk
___ Mount C13, 0.1 disk
___ Bend leads of Q3 so they will fit as shown
___ Solder Q3 emitter lead to pad as shown
___ Solder Q3 collector to pad as shown
___ Solder Q3 base to pad as shown
___ Prepare and solder wire to 12V pad
___ Prepare and solder wire to KEY pad
___ If it's a Building Day project, swap boards with a neighbor to have someone else check your work.

Testing the keying circuit is easy and provides instant positive feedback. Here's how to test it:

___ Connect 12V to the 12V wire, with the power supply's negative lead connected to the ground plane.
___ Connect voltmeter common to ground
___ Connect the voltmeter's positive lead to the collector of Q3, the switching transistor
___ Turn on power. Check for smoke.
___ If no smoke or flames, check keying action by measuring voltage at Q3 collector. It should be zero volts with key line open and 12 volts with key line grounded.

What if it doesn't work? If parts are installed correctly, this circuit should work every time. If it doesn't work, the problem is almost certainly incorrect installation of the keying transistor. Check to make sure that you installed the PNP transistor and that the transistor is installed correctly (if not, you'll probably need to replace it with a new one).

Winding The Toroids

Now's a good time to go ahead and wind all the toroids used in the transmitter. There are four toroids to wind. One serves as the inter-stage transformer between the oscillator and the output stage, one serves as an RF choke, and two go into the output filter.

None of these toroids are difficult to wind, so you might as well go ahead and wind them now. Here's how:

Output Filter Inductors

The output filter uses two inductors. These are wound on 0.5-inch diameter toroids (2 and 6 material), as follows, and since they're the simplest coils in the project you should wind them first.

The output filter inductors are different for each band; for band-specific data, take a look at the accompanying table (Table 1)

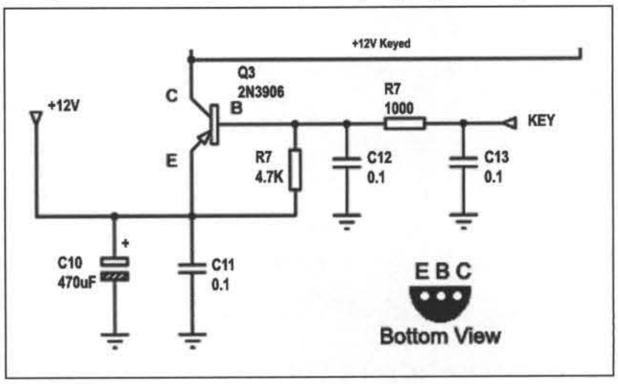


Figure 2—Keying Stage schematic.

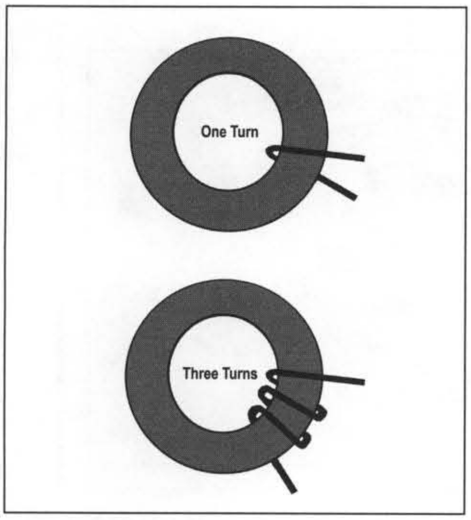


Figure 4—How to wind toroids properly. Each time the wire passes through the center is one turn.

When winding these coils, make sure that turns do not cross over one another. Also, remember that when counting turns, one turn means once through the center of the core (Figure 4). Table 1 lists the number of turns and the core used for each band.

RF Choke

The toroid which serves as the RF choke in the power amp section is wound in the same fashion as are the toroids used in the output filter. Again, note that one turn through the center of the core is one turn. Table 1 includes the ferrite core and winding information for the RF chokes.

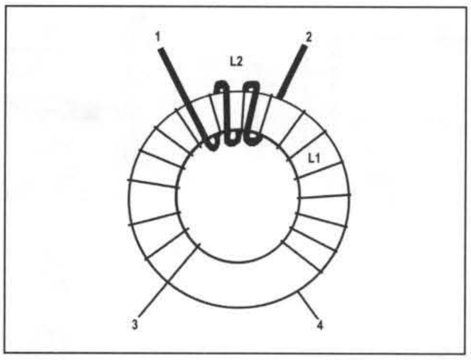


Figure 5—Winding L1/L2.

The Interstage Transformer (L1 and L2)

L1/L2 is an inter-stage transformer that couples the oscillator to the output stage. The primary is tuned to the desired frequency by a trimmer capacitor, C3. Tuning is fairly broad, however, so this trimmer can be replaced with a fixed capacitor.

Though at first glance it may appear complicated, winding of the L1/L2 transformer is really a fairly straightforward affair. It consists of two windings on one core (see Figure 5).

Wind the primary winding, which has the most turns, first. Then wind the secondary winding, being sure to wind it in the same sense (direction) as the primary.

The most difficult thing about winding this transformer is keeping track of which wire leads go to which of the windings, but if you'll use two different colors of wire that task is greatly simplified. Here's another tip that can be helpful—even though such transformers are traditionally wound with enameled wire, there is absolutely no reason that you can't use small insulated solid hook-up wire instead. This works particularly well on the higher bands, where the turns count isn't so high and the slightly larger overall diameter of solid hook-up wire isn't a problem. Using different colors of hook-up wire can help solve the lead confusion problem.

Wind L1 first as shown in Figure 5. Remember that one pass through the center of the core is one turn. Then wind L2 over L1 as shown. Refer to the Table 1 for the number of turns for L1 and L2 for the band you are constructing.

Note the winding identifiers. These should be connected as shown. Remember that once through the center of the core counts as one turn.

PART	80 METERS	40 METERS	30 METERS	20 METERS	15 METERS
C1	200				
C2	100	100	68	33	33
C3	400	200	100	60	60
C7	560	240	220	150	120
C8	1200	560	470	330	240
C9	560	240	220	150	120
R4	39	39	39	47	47
RFC1	21 t. FT37-61 (25 μH)	17 t. FT37-61 (15 μH)	17 t. FT37-61 (15 μH)	28 t. FT37-63 (15 μH)	28 t. FT37-63 (15 μH)
L1	43 t. T50-2	35 t. T50-2	30 t. T50-2	27 t. T50-6	17 t. T50-6
L2	5 t.	4 t.	3 t.	3 t.	3 t.
L3	23 t. T50-2 (2.5 μH)	16 t. T50-2 (1.19 μH)	16 t. T50-6 (0.98 μH)	13 t. T50-6 (0.69 μH)	11 t. T50-6 (0.49 μH)
L4	23 t. T50-2 (2.5 μH)	16 t. T50-2 (1.19 μH)	16 t. T50-6 (0.98 μH)	13 t. T50-6 (0.69 μH)	11 t. T50-6 (0.49 μH)

All capacitor values are in pF. C3 is a trimmer capacitor; the maximum value is shown.

Table 1—Values of parts that vary by band, including the core and winding data for the coils, transformer and RF chokes.

Building The Oscillator

Once you've got the keying circuit up and running, the oscillator (see Figure 6) is next on the list. Note that some of the parts in the oscillator are band-specific or are used only on certain bands; if you're leading a Building Day group, you may need to give any beginning builders in the group a little bit of extra attention here.

___ Locate the following parts:

L1/L2 transformer (wound previously)
R1, 4.7k (yel vio red)
R2, 10k (brn blk org)
R3, 220 ohms (red red brn)
R5, 220 ohms (red red brn)
R4 (varies with band):
  80 meters: 39 ohms (org wht blk)
  40 meters 39 ohms (org wht blk)
  30 meters 39 ohms (org wht blk)
  20 meters 47 ohms (yel vio blk)
  15 meters 47 ohms (yel vio blk)
C1 (used on 80 meters only), 200 pF
C2 (varies with band):
  80 meters: 100 pF
  40 meters: 100 pF
  30 meters: 68 pF
  20 meters: 33 pF
  15 meters: 33 pF

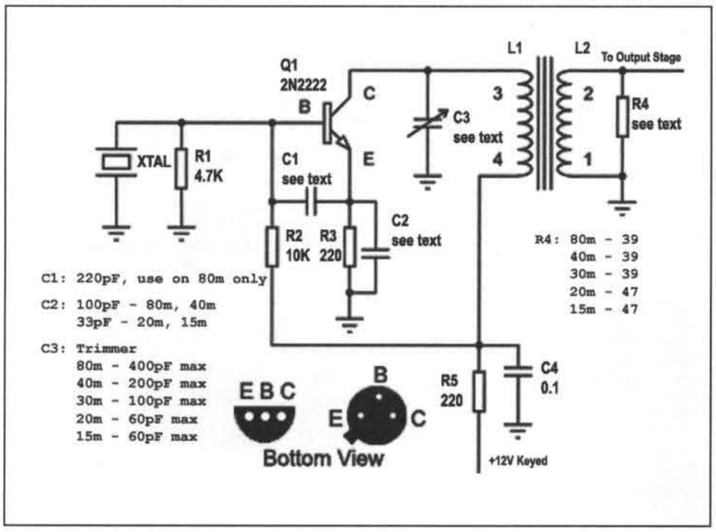


Figure 6—Oscillator schematic.

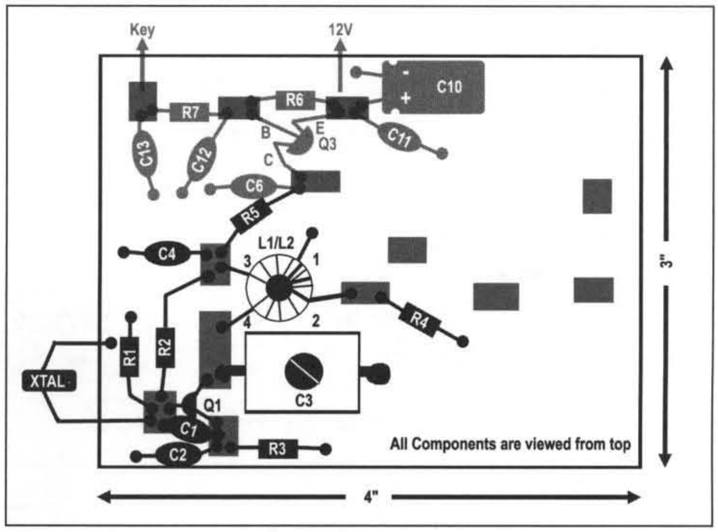


Figure 7—Building the oscillator section.

C3 (trimmer – varies with band):
80 meters: 400 pF max
40 meters: 200 pF max
30 meters: 100 pF max
20 meters: 60 pF max
15 meters: 60 pF max
C4, 0.1 disk
Q1, NPN, 2N2222 or equivalent

Concerning the trimmer capacitor: After alignment, you may want to measure its value and then replace it with a fixed disk capacitor. This eliminates the need to locate trimmer capacitors for each builder. Instead, simply tack in a trimmer and adjust as described below. Then remove the trimmer, measure its value, and replace it with a fixed disk capacitor of the correct value.

Assembly:
___ Mount L1/L2 as shown in Figure 7.
___ Mount R1, 4.7k (yel vio red)
___ Mount R2, 10k (brn blk org)
___ Mount R3, 220 (red red brn)
___ Mount R4, using correct value for your band.
___ Mount R5, 220 (red red brn)
___ If you're building for 80 meters, mount C1
___ Mount C2, using correct value for your band
___ Mount C4
___ Mount C3, the trimmer capacitor
___ Mount Q1, 2N2222 or equivalent
___ Mount a suitable crystal as shown
___ Have someone else check your work.
___ Apply 12 volts and check for obvious component distress (smoke, flames, exploding parts)
___ If all looks good, disconnect power.

Testing the oscillator:

There are two ways to verify oscillator operation:

Method A (high tech): Connect frequency counter to junction of L2 and R4. Key the rig, and look for the proper frequency reading on the counter. Note that you may not get any output until the trimmer is set properly. Depending on the range of your trimmer, you may also be able to set it for various harmonics of your crystal frequency. To resonate the circuit on the fundamental, go with the peak closest to the maximum capacitance setting.

Method B (low tech): Tune a receiver to the crystal frequency, key the transmitter, and adjust the trimmer C3 until you hear the signal. Peak by ear.

Building the output stage

The transmitter's output stage uses a 2N3866, BFQ163 or similar transistor to develop a bit over a watt of output power (see Figure 8). The circuit includes a Zener

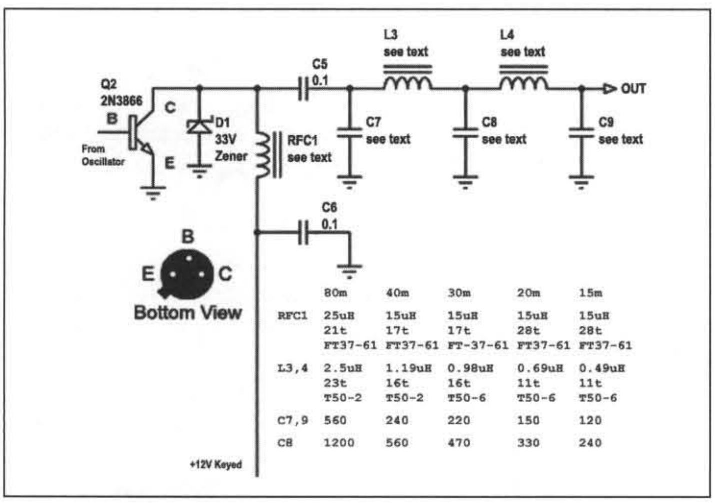


Figure 8—Output Stage schematic

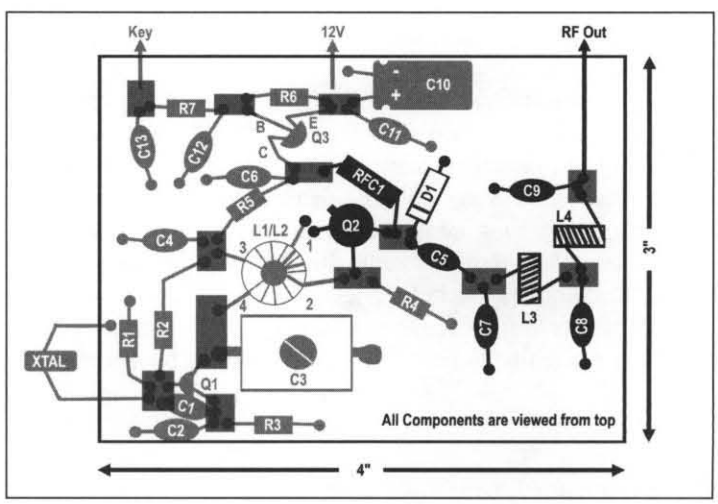


Figure 9. Layout for the output section.

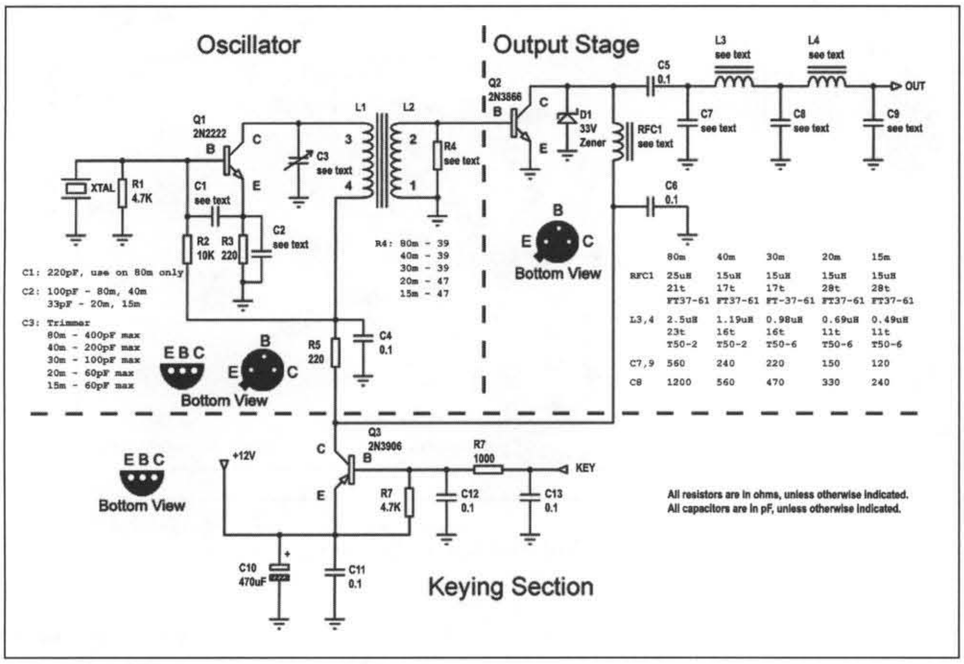


Figure 10—The complete Building Day Transmitter schematic.

Resistors	
R1	4.7k
R2	10k
R3	220
R4	Varies by band.
R5	220
R6	4.7k
R7	1k
Capacitors	
C1	200 pF (used only on 80 meters)
C2	Varies by band
C3	Varies by band
C4	0.1 µF disc
C5	0.1 µF disc
C6	0.1 µF disc
C7	Varies by band
C8	Varies by band
C9	Varies by band
C10	330 to 470 µF electrolytic
C11	0.1 µF disc
C12	0.1 µF disc
C13	0.1 µF disc
Semiconductors	
D1	Zener diode, 33V, 1/2 or 1W zener
Q1	2N2222 or equivalent (NPN)
Q2	RF output transistor (2N3053, 2N3866, BFQ163 or similar)
Q3	2N3906, 2N4403 or equivalent PNP switching transistor
Inductors	
L1	Varies by band
L2	Wound over L1, varies by band
L3	Varies by band
L4	Varies by band
RFC 1	Varies by band

Table 2—Summary of the parts used in the transmitter.

diode to protect the transistor, plus a two-section lowpass output filter.

One comment on the output filter—the capacitor values are fairly standard, but don't hesitate to parallel smaller values to achieve the value you need. Remember that paralleling caps adds the value of each. Veteran homebrewers know this, but if your Building Day includes a less-experienced builder it may come as a surprise that "you can really do that!"

___ Locate the following parts:

Q2, the output transistor
D1, the Zener diode
RFC 1, wound previously
L3 and L4, wound previously
C5, 0.1
C7 (varies with band)
C8 (varies with band)
C9 (varies with band)

___ Mount D1 as shown, noting polarity, as shown in Figure 9.
___ Mount Q2, noting proper orientation
___ Mount RFC 1, wound previously
___ Mount C5
___ Mount L3
___ Mount L4
___ Mount C7
___ Mount C8
___ Mount C9

That completes construction of the transmitter board.

Testing

At this point, construction is complete. To give your new transmitter its big test, follow the following procedure:

___ Have someone else check your work-see Figure 10 for the completed transmitter schematic
___ Connect a wattmeter or SWR meter and a suitable dummy load
___ Apply power and check for smoke etc.
___ Key the transmitter by grounding the key line, and adjust the trimmer capacitor for maximum output as seen on a wattmeter or other output indicator.
___ Listen to keying as you rock the trimmer back and forth a little from the peak, selecting a final setting that balances output and keying quality.

Enclosure possibilities

You'll probably want to mount your transmitter in a cabinet of some sort. Here are a couple of possibilities:

1) Use scraps of PCB material to fashion a cabinet (a future article will discuss how this is done).

2) Mount it in a cabinet from Radio Shack or another supplier.

As far as connections with the outside world go, you'll need to include a key jack, a power jack, and an output connector.

You may want to add T/R switching too. This can be as simple as a toggle switch or as complex as a semi- or full-break-in system.

If you're building for home use where power consumption is not an issue, you can add various pilot lights as well. For example, you can have one LED that indicates when power is connected, and another that follows keying (connected to the collector of Q3). After all, there's nothing like a radio that lights up!

I hope you'll enjoy this project, whether you're using it in a Building Day setting or simply building one up for yourself. Like I said, I've built a bunch of 'em over the years. Some I've kept, some I've shared with others—and as far as I know, they're all still going strong!

—72 de Steve, AA4BW

The QRP Home Companion

Anthony A. Luscre—K8ZT k8zt@arrl.net

I must confess that DX is my ham radio weakness. Given the chance to do any ham activity, DXing usually wins out.

You might remember, from my last column, that I began my ham career with a Ten-Tec Argonaut 515 QRP Transceiver. When I first received my license I was disappointed that I was not working any DX. Initially I feared that my QRP rig would not be able to work DX. Luckily, I found out that QRP level operation was not my problem; my problem was ignorance of propagation and international band plans. Unlike then, I now know that my CQing in the novice portion of 40 Meters did not result in DX because most DX countries did not have privileges above 7.100! Also my late evening calls on 15 Meters were unsuccessful because band propagation had shut down hours ago!

Build this complete portable shack with Ten-Tec Argonaut 509, power supply, antenna tuner, multi-mode controller and filter unit.

Keys to My DX Success

Eventually I became more aware of international band plans and the multiple cycles of propagation (day/night, seasonal and 11 year). Soon being on the right band at the right times began to yield my first DX contacts.

Over the years I have learned a lot more "tricks" to working DX with QRP. Many of these tricks are applicable to not only DXing but also contesting, award chasing and even routine day-to-day operations. If you happen to also operate QRO, skills built with these QRP DXing operation tips can almost give you an unfair advantage over typical QRO operators (HI HI!). Here are my Ten Tips for DX Operating:

1. Operate! — Get on the air! More time on the air can definitely increase your chances, especially if you know when and where to hang out.

2. Listen, Listen, Listen! — Listen carefully, check weak signals that others skip over, thoroughly explore the bands for "hidden" DX. If you find the DX before the horde descends, your chances to work the DX are much greater. Listen to the stations the DX station is working for a good idea of propagation and the DX station's operating style. Listen to how and where the DX station is working other stations. Is he working split—i.e., listening "up" or "down" in frequency, answering late callers, systematically moving his listening frequency or asking specifically for QRP stations?

3. Timing, Timing, Timing — Develop good response timing. Knowing when to respond, pacing, emphasis and calling techniques will increase your chances of success.

4. Learn about propagation — Consult forecasts, check daily numbers (SFI, A and K), use propagation prediction software and review your logs from bygone seasons, years and solar cycles. Choose your operating times to favor the area of Earth you are trying to contact. The ARRL propagation page on the ARRL Web site (http://www.arrl.org/tis/info/propagation.html) has lots more information on this fascinating topic

5. Work contests — Worldwide contests provide a plethora of potential DX contacts—sometimes even the rare stuff. It's remarkable how well your QRP signal can be heard when it means a point for the contester on the other end. For tips on QRP Contesting, see my two ARRL columns—QRP Community: Contesting, http://www.qsl.net/k8zt/qrp-com.html

6. Learn a few key words, phrases and numbers in other languages — Visit my web page http://www.qsl.net/k8zt/racg/racg.html for the Radio Amateur's Conversation Guide by Jukka, OH2BR and Miika, OH2BAD.

7. Optimize your station and Learn how to use your radios' features — Spend a few quality hours with your radios and their manuals. Learn how to properly operate your gear and how to use special features. For example, know how to quickly set up your rig for split-frequency operation. Put up the best antenna(s) you can. Keep your station in good operating condition

8. DX spots and news — Use the many sources of DX information to learn about DX opportunities. Sources range from magazine articles to real-time spotting networks. Visit http://www.benlo. com/dxmon.html for the excellent freeware program DX Monitor by VE3SUN.

9. Keep good records — Use full-featured logging software that can track DX worked and monitor your progress. Learn the most effective methods to get QSL cards from the DX stations you have worked.

10. Set personal goals — Working the 330-plus DXCC entities can be an overwhelming task for the new DXer. Setting more reasonable and modest personal goals can help a DXer to maintain motivation. The first 100 confirmed DX contacts qualify you for the ARRL basic DXCC Award (http://www.arrl.org/awards/dxcc/index.html). Other goals might be a specific number of new ones each year, working all the entities on a specific continent, etc.

Make Mine "To Go" — A Construction Project To Go (Skip the Solder, Grab the Sander)

Building your own portable ham shack is an easy project, even for beginners. There is no "tune up," and it is guaranteed to work the first time. Here are the step-by-step instructions. Feel free to customize

Figure 1—Marking top of side piece.

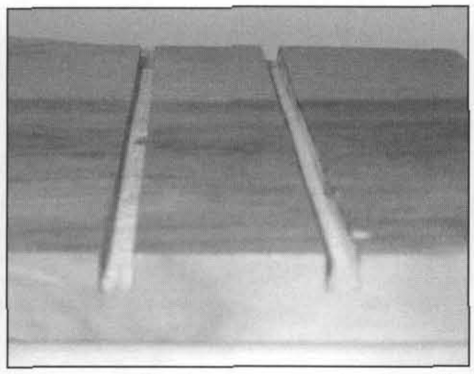


Figure 2—Cutting grooves in the side pieces.

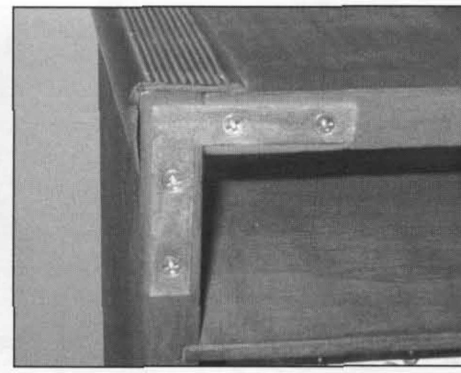


Figure 3—Using "L" brackets to strengthen and maintain square corners.

them for your needs. Please remember, safety first, whenever using power tools.

Gather the equipment you would like to package. Stack and arrange equipment in desired configuration then measure, allowing extra space for dividing shelves.

Select necessary wood. For shallower cases you can use 1-inch pine or hardwood in widths of 6, 8, 10 or 12 inches (remember this is nominal size; actual size of wood is smaller). For deeper cases use 3/4 or 1-inch plywood cut to your desired depth. For the internal shelves you can use 1/4-inch tempered hardwood or plywood.

Measure and mark your wood. You will need two lengths of pine or hardwood for the top and bottom equal to the width of your equipment plus one inch. The 1-inch space will allow you to insert foam strips on both sides of the equipment. This compressed foam strip will then help to hold equipment from sliding out of the case. Cut measured wood, making sure to make a square cut (if you have access to a radial arm saw, this can assure a proper cut).

Prepare strips of shelving material to the same depth as top and bottom pieces; rip using table or radial saw or cut carefully by using a circular or jig saw (clamping a straight edge on the wood to guide the saw is one trick to get a better cut).

Cut prepared shelf strips to length by using length of bottom piece and adding 1/2 inch. Remember to get a nice square cut.

To measure side pieces, place bottom piece under stack of equipment with a piece of shelving material between each layer of equipment. Place top piece on equipment. Mark one side piece by placing it vertical next to stack. Make a mark at top of edge of each piece of shelving material. Mark top of side piece and add 1 inch to allow for finishing.

Using marks of shelf positions on side piece, add thickness of shelving material above each mark.

Using first side piece as a guide, transfer marks to second side piece.

Above each shelf mark cut a 1/4-inch deep groove across the side piece. This can be done with a router, radial arm saw, or circular saw (clamping a straight edge on wood to guide the circular saw will result in neater grove).

Complete all grooves, then assemble, temporarily, to test fit everything. Mark top of side piece and cut to finished length.

Sand all pieces. If staining, apply stain now before assembly.

On a flat surface, align the four pieces, lying on their back edge, into a rectangle. Drill pilot holes for screws on side pieces.

Use wood glue and screws to assemble. Use a square to assure proper alignment of all corners. On the back of the case, metal "L" brackets can be added to strengthen and maintain square corners.

Figure 4—Completed portable shack for K8ZT's FT817, with a multimode TNC and LDG autotuner

Test fit shelves by sliding into grooves; fit should be snug. Sand edges of shelves, if necessary, to fit. Remove shelves and set aside.

Apply desired finish/sealant and allow to dry. Two coats with a fine sanding in between may be necessary to get desired finish. Also apply finish/sealant to the yet-unassembled shelves and let dry.

Use a small amount of wood glue and then slide shelves into final position.

Attach handle(s) to case. Attach rubber feet or rubber molding strips to bottom to prevent scratches where you set the case.

When glue and finish are thoroughly dry, place equipment into their final locations. Then insert foam between equipment and side panels as necessary to hold in place. For foam with adhesive on one side, visit your hardware store's weatherproofing aisle. If equipment heights on a shelf vary, you can also use foam above and/or below pieces of equipment.

You can then customize as desired. Possibilities include attaching a surge protector power strip to back of case to manage multiple plugs, removable "lids" for front and back, create an extra shelf with front and back covers to store accessories (key, microphone, cables, etc.) when not in use. An extra "enclosed" shelf can also be used to store gel cell batteries for truly portable operation. For equipment with microphone, headphone or other connectors on the side you will need to cut a small access "window" in the side piece.

Feedback

I welcome your input and suggestions for this column. Please contact me via e-mail and I hope to work you on the air, QRP, of course.

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International QRP Day 2003

Dick Pascoe—GØBPS

dick@g0bps.fsnet.co.uk

An email from Peter, PE1MHO, arrived inviting my wife and me to join Peter and his wife at their holiday cottage in Scotland this year. Tempting, to say the least. Thereal clincher was that we would be there during International QRP Day too.

Both Peter and I share an interest in data QRP operating and it was agreed that we would take part using PSK31. Much planning took place as we both only took small cars and there was not much space for ham gear. However we managed a pair of laptop computers, an IC706 and a new IC703. Antennas had to be collapsible, light and take up little space.

Peter is handicapped, missing half a leg; not too much of a problem but it is difficult to carry things when "riding crutches," hence 'BPS did most of the antenna work.

The cottage was situated in a valley on the edge of a reservoir just 10 miles north of Glasgow, Scotland. Rolling hills and woodland made it a beautiful spot.

Tall fir trees edged the garden and, better yet, there was a huge tree just over the road. The large roll of wire leapt out of the car just begging to be thrown over the taller trees. Pete had other ideas though; he had made a dipole for 40M which just had to go up. The 10-meter fishing pole bought from Kanga US came into use as did a gate post to mount it on in the front garden. Tests showed that all worked well, with a low VSWR and but a very high noise floor. Search of area found overhead power lines in the back garden—Oh well!

We fired up the IC703 and within an hour had fried the PA. Oh, well! Lucky we had my IC706. I was also convinced that we could do better than the 40M dipole and buried deep in the car was my answer. Off with the dipole and up with a full-sized loop for 20M. Rotated to North America, we still got lots of noise but things were happening. We worked a steady stream of stations getting ready for the big day.

The reel of wire was still itching to mount the trees and my fishing rod magically appeared in my hand, attached to an apple. I am a strong believer in the benefit of fruit. Be it an apple or orange or even a grapefruit nothing is better for getting a clear route over high trees. Heavy stuff like fishing weights can do severe damage to your pocket if it were to hit anyone. Fruit tends to bounce and being soft does much less damage than a lump of lead!

After a few throws with the rod I had about 300 yards of wire up in the air. The highest point was about 75 feet up. Remember the tree by the road? Well, it came into use as I crossed the road and headed 150 yards into the field. A counterpoise cut for 40M proved excellent and soon the bands were loud and clear, a pity about the noise floor though.

QRP Day dawned fine and clear, the wives were dispatched for a days shopping with five pounds each to spend (about $7.50) as Peter and I got the station set up. We had been using the ironing board as the station desk but with the ladies clear and gone we could sneak in and use the kitchen table—luxury!

The rules of the engagement for International QRP Day state that you can operate for up to six hours in not more than two periods and scores are one point for each country worked on a band.

Because of the noise floor we found it very difficult to copy many of the signals but did manage to get a fair number of contacts in the log. I usually use Digipan software but Peter has been working with Simon Brown, HB9DRV, on his latest PSK31 software called PSK DeLux. This is an excellent program that also interfaces with several rigs, check http://www.hb9drv.ch/ for more details.

Peter, PE1MHO, Operating PSK-31 Prior to the Contest

The end result of all this effort saw the ladies return with arms full of shopping—we had forgotten the credit cards! Peter and I had a fun day operating and to our delight found out later that we had gained second place.

This part of Scotland is highly recommended; we visited Stirling Castle built several hundred years ago. We also visited the home of Robert the Bruce and the visitors center nearby. Good food in several local small hostelries and even better real English Ale to be enjoyed.

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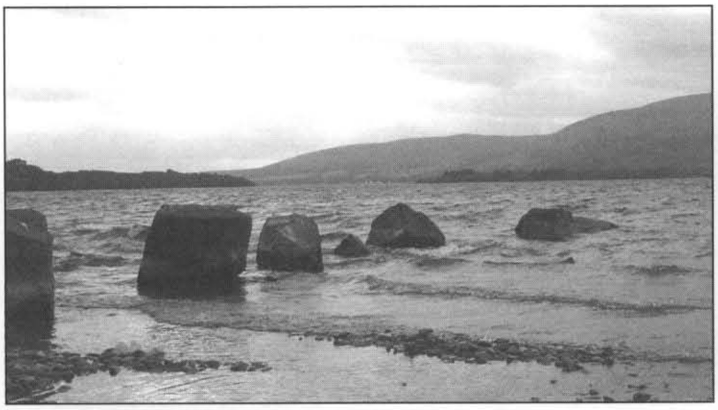


PE1MHO's Scottish QTH, 10 miles North of Glasgow.

Stirling Castle, Built Several Hundred Years Ago

QRP World News

Oleg Borodin—RV3GM

master72@lipetsk.ru

Dear friends!

Welcome to the first installment of the new regular "QRP World News" column! I've known the *QRP Quarterly* for more than ten years and know that it is the largest worldwide QRP journal. I have always read the *QQ* with great interest and now I'm happy to be a part in its preparation. I like to communicate with hams from all over the world, especially in QRP themes and would look forward to sharing with you QRP news from all over the world.

QRP has become a world-wide movement-there are now many QRP Clubs throughout the world making a QRP an interesting hobby in Amateur Radio. The new base of QRP equipment makes it possible to make a transcontinental QSOs using power levels that were impossible to dream of in the past. This is also true about new digital modes as BPSK, MT63, MFSK etc.—these are really QRP modes!

You may notice that I am alone among the *QQ* editorial stuff who is a non-US ham. I am also the lone reader of the journal in Russia—right now! I apologize for my English, but actually Editor Mike Boatright will help me to correct my language mistakes (TNX, Mike!). Hopefully, readers will also help with interesting materials on the topic of QRP World News. Send me any information by e-mail to master72@lipetsk.ru or by snail-mail to P.O. Box 229, Lipetsk, 398043, Russia.

[*Oleg's English far better than my Russian!—ed*]

Russian Radio Voyager's Club International

My first bit of news is about a new club-the Russian Radio Voyager's Club International. The main idea behind the club is to travel the world by radio the same as by ground. For example, to travel around Europe you might go to Russia, Ukraine, Moldavia, Romania. Bulgaria, Turkey, Georgia, Russia—a complete route! Your route must be finished at the same place where you started and the borders of the crossed countries should follow one after another. You can choose whatever route you find pleasant, but it should go completely around the world and should follow the border rule above. Distance and time of the routes will be checked. There are special entries for QRP-stations.

In the future, special awards will be given by mode. Organizer of the Radio Voyager's Club is Vyacheslav Lukin, RW3AA. He is preparing the club's web site, http://www.radioclub.fatal.ru.

QRP World News columnist Oleg, RV3GM and his QRP dog, Alpha!

Dean Manley, KH6B

Well known QRPer, Dean Manley, KH6B, President of the Hawaii QRP Club has worked many stations with the help of W6EL propagation software. This software is used to calculate propagation conditions in accordance with a sunspot, sun-activity, day-time, etc. He will have an article on the subject in the Autumn issue of the "CQ-QRP" journal of RU-QRP Club. By the way, Dean is a RU-QRP Member also # 018. He has had many good contacts with Russian QRPers.

KH6B at the controls of his QRP rig.

International QRP Net

The International QRP Net meets every Saturday at 1000 UTC and 2200 UTC on 14060 kHz. Usually net control is RU-QRP Club Chairman, Oleg, RV3GM. This is different from most DX nets. Its purpose is for QRPers to send their regards to each other and to make 2-way QRP QSOs. Hope to see you there soon!

RU-QRP First Anniversary

Congratulations to the RU-QRP Club on their first anniversary in August! In honor of this achievement, the Lipetsk Technician Group of the RU-QRP Club has built and tested 100 "Micro-80" micro-transceivers, available for the price of the kit-only $15 (USD) packing and postage by air-mail. Add 12V, antenna, CW-key and phones and you will be on the air! To order, email me at master72@lipetsk.ru. You will also for free the Club's pennant.

OK QRP Meeting

Petr, OK1DPX

Petr, OK1DPX inform me about OK QRP Meeting should be in March 19-20, 2004 in Chrudim, Czech Republic. This is a beautiful place located 90 km east of Prague. All QRPers world-wide are welcome! Hopefully, I will be able to attend this meeting and with my presentation "QRPp QSO with a simple equipment." Still not sure, but will try.

South American News From CX8AT

Our QRP DX operator Alberto, CX8AT writes that while there are not any QRP nets in Uruguay, nor a QRP club there are a bunch of enthusiastic people that like to do things and love low power. They are currently few in number that operate QRP mostly all the time, including, CX2AQ, CX7BBB, CX4GG, and Alberto who work mostly CW QRP. Of course, there are others interested in QRP.

Alberto reports that he is also affiliated with the G-QRP Club. His rigs are a TS-50 (2W), IC-735(2.5W), SW-20+(1.5W), DSW-40(700mW), a Pixie, and a some other homebrew rigs. His antennas are all wire antennas.

Speaking About Wire Antennas

By the way, speaking about wire antennas for QRPing, Vytas, LY2FE (RU-QRP #27) uses a long-wire—200 meters long that is! He has more than 200 DXCC countries on the 160 meter band. Well done, Vytas!

World News Bits

Igor Grigorov, RK3ZK (RU-QRP Club #003), is running a free e-magazine "Antentop" at http://www.antentop.bel.ru. The first issue contains 100+ pages, 25+ topics (including QRP) and I'm very glad to present the project to all amateurs.

Beginning with the Autumn issue, the RU-QRP Clubs journal "CQ-QRP" will publish in the English language like Russian before. Subscription information is available at http://ruqrp.narod.ru.

Scottish-Russian Amateur Radio Society (SRARS) has a global IOTA/LH (Islands On The Air/Light House) program with more than 800 awards, including awards for QRP operations! The founder of SRARS is Jury Phunkner, MMØDFV (RU-QRP#038). Ask him for details by e-mail to: fdxf@connectfree.co.uk. The Scottish Group often visits small Scottish islands for QRP operating using SSB and digital modes.

The World QRP Top List is managed by RW3AA. Send him your results and see the top-list at http://ruqrp.narod.ru .

Finally, the RU-QRP Club has announced the World QRP Federation QRP Party scheduled for 3 January 2004, and devoted to revival of World QRP Federation. See rules at RU-QRP web page, also. E-mail: master72@lipetsk.ru or P.O. Box 229, Lipetsk, 398043, Russia

I wish all the best for all QRPers.

—72! de RV3GM

(with my QRP Dog, Alpha—Hi!)

●●

VHF QRP

Bob Witte—KØNR

k0nr@arrl.net

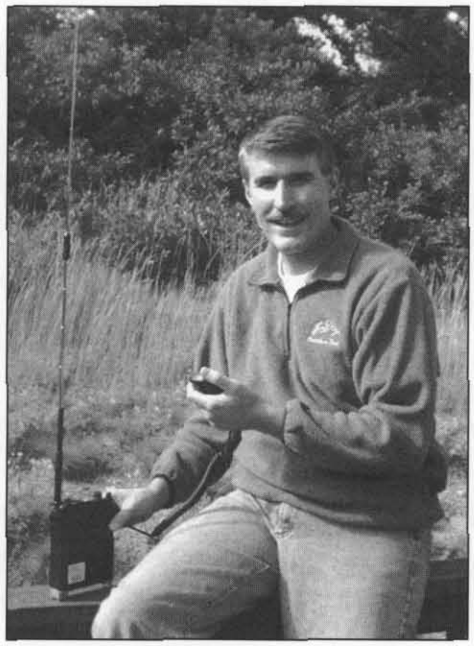
Let's Get Started

Earlier this year, I asked Mike, KO4WX, the Editor of *QRP Quarterly*, whether there was interest in some VHF articles for that publication. The next thing I know, I am writing a column on VHF QRP. In the summer issue, I asked the readership "Is there interest in VHF in the QRP ARCI?" I received a number of positive comments, so thanks to those that responded. I want to emphasize that I won't be able to write this column all by myself as I need your feedback and ideas to make this fly. Let me know what questions you have around VHF operating, ideas for articles, and anything else you can think of. If you have energy around a particular VHF topic, I'd even be happy to hand over the keyboard and let you write the column for an issue or two.

As I started to write this column, I was reminded that the designated VHF/UHF bands vary a bit, depending on the country of operation. My experience is mostly US, so that bias will show through. The "I" in QRP ARCI is "International," so I need your help to round out my US-centric view.

A Little About Me

Let me introduce myself briefly, so you know who is pounding away here on the keyboard. I've been a radio amateur since 1977, when I attended a novice license class offered by the Purdue University Amateur Radio Club (W9YB). A year later, I completed my first degree in electrical engineering, graduated and started work as a design engineer.



Your VHF QRP columnist, KØNR.

Over the years, I've had a number of engineering management positions for Hewlett-Packard and Agilent Technologies. My amateur radio interests are quite broad as I tend to dabble in a lot of different things. Basically, I am interested in all things radio. (I am still fascinated with the basic notion that electromagnetic waves can propagate though the ether and carry information from one location to another!)

Over time, I operate HF through UHF; almost any mode (CW, SSB, FM, APRS, PSK31, RTTY, etc.); repeaters, OSCAR, ARES, QRP and QRO; fixed, mobile and portable. I've operated from a number of countries including the Bahamas, Australia, Honduras and Japan. Despite this range of activity, VHF and higher has always been home base for me. For many years, my callsign was KBØCY, but I recently got a shorter-faster-better 1x2 call.

Even though I considered high school and college English courses to be a legal form of torture, I have found the world of technical writing to be fun and rewarding. I've written a number of articles for ham magazines and electrical engineering trade publications. I am most proud of the two books on test and measurement that I've written (*Electronic Test Instruments* and *Spectrum and Network Measurements*). My web site has more information on my amateur radio interests and the books I've written (see below).

I've noticed that in many human activities, there is a tendency to make fine distinctions between different types of pursuits—to build up walls where there is significant commonality. Amateur radio is no exception, as we often see differences highlighted: QRP versus QRO, CW versus phone, VHF versus HF, etc. To me, it is all about the magic of radio so I tend to see the commonality and discount the differences. I like to put things together, to combine what appear to be different ideas into

Band	Frequency Range	Calling Frequencies	Comments
6 M	50 to 54 MHz	SSB: 50.125 MHz FM: 52.525 MHz	Normally local communications but Sporadic-E and F2 propagation are common.
2 M	144 to 148 MHz	SSB: 144.200 MHz FM: 146.52 MHz	The most popular VHF band, used for local communication via simplex and repeaters. Normally local communications but long distance tropo propagation and Sporadic-E propagation occasionally occurs.
1.25 M	222 to 225 MHz	SSB: 222.100 MHz FM: 223.5 MHz	Propagation similar to 2M but rarely sporadic-E
70 cm	420 to 450 MHz	SSB: 432.100 MHz FM: 446.0 MHz	Propagation similar to 2M but no sporadic-E

Note: This table shows the US amateur bands, other countries may have different frequency allocations.

Table 1—US amateur bands 50 MHz through 450 MHz.

something new. This is probably why I am writing a column on VHF QRP!

Enough about me—let's get started.

Introduction to VHF QRP

I thought I'd start with a simple introduction to QRP as applied to VHF. This will provide some context for the column and get us all grounded in the basics. First, let's talk about some of the more popular frequency bands above 50 MHz. I am going to discuss the bands up through 70 cm because they are the most commonly used (see Table 1). Certainly, there is a huge amount of spectrum above 70 cm with lots of potential, especially if you are into experimentation and homebrewing of equipment.

Equipment

There are a number of transceivers available for VHF QRP. One of the most exciting rigs to appear on the scene is the FT-817 (Figure 1), which covers HF, 6M, 2M and 70 cm. More recently, ICOM introduced the IC-703, which is primarily an HF QRP rig, but which is also available in a version that includes 6 meters. MFJ offers a couple of single-band transceivers, the MFJ 9406X 6M SSB rig with 7 watts output and the MFJ 9402X 2M SSB rig with 10 watts output.

The TenTec Model 526 "6N2" 6M/2M CW/SSB/FM transceiver has an output power of 20W, a bit more than true QRP, but which still fits the general QRP-rig category. Ten Tec also has a line of transverter kits that allow HF rigs to operate on VHF. The Model 1208 is a transverter kit that converts a 20-meter rig to work on 6 Meters, with 8 watts out. The Model 1210 lets a 10-meter rig operate on 2 Meters, with 10 watts out.

Elecraft, the well-known manufacturer of radio kits, recently introduced a line of transverters that will allow HF rigs to operate on VHF (see "CQ VHF Reviews the Elecraft K2 Transceiver," *CQ VHF*, Summer 2003). According to the Elecraft web site, there are three models: XV50 (50 MHz), XV144 (144 MHz) and XV222 (222 MHz) with 20 to 25 watt output.

Figure 1—The Yaesu FT-817 QRP transceiver covers all modes on HF, 6 meters, 2 meters and 70 cm.

Cable Type	Loss per 100 feet (50 MHz)	Loss per 100 feet (150 MHz)	Loss per 100 feet (450 MHz)
RG-58/U	3.1 dB	6.2 dB	10.6 dB
RG-8x	2.3 dB	4.7 dB	8.6 dB
RG-8U/foam	1.2 dB	2.3 dB	4.7 dB
9913FX	0.9 dB	1.6 dB	2.8 dB

Source: Cable X-perts, Inc. catalog, http://www.cablexperts.com

Table 2—Cable losses for typical coaxial cable types.

There are older rigs available on the used market such as the FT-290R series from Yaesu and the IC-202 series from ICOM. These are low power, single-band rigs for 6M, 2M and 70 cm. Check out your local hamfest or online auction such as Ebay (http://www.ebay.com).

Antenna

The antenna for any amateur radio station is a critical component. The key difference at VHF and higher is the shorter wavelength, which means antenna elements are much shorter and perhaps more numerous. The polarization of the antenna is important under most situations, since you want to have your antenna with the same polarization (horizontal or vertical) as the station you are contacting. Most FM-oriented stations use vertical polarization, consistent with easy mobile mounting and simple omni-directional antennas. Serious weak-signal VHFers almost always use SSB or CW and horizontal antennas.

For the 6-meter band, we can adapt many of the standard HF wire antenna designs. For example, the classic half-wave dipole is a good choice, providing an efficient radiator about 9-1/2 feet long. A quarter-wave vertical is also a possibility, especially for mobile installations. Antenna polarization is not an issue for long distance propagation via the ionosphere since the polarity tends to change anyway. For local contacts, horizontally-polarized is generally the way to go. Yagi beam antennas for 6 meters are normally mounted horizontal and provide gain over a dipole.

For the 2-meter band, the wavelength and antenna elements are quite short (about 1 meter or 39 inches) compared to the typical HF antenna. Here, the Yagi antenna is the most popular, with as few as 3 elements and as many as 17 elements (or more). For CW or SSB work on this band, you'll definitely want to be horizontally polarized. For FM, vertical polarization is more common.

The bands higher than 2 meters tend to also use Yagi antennas but with correspondingly shorter elements. The shorter wavelength allows for more antenna gain within the same antenna dimensions. Of course, a directional antenna means that you need a method for pointing the antenna in the desired direction.

Transmission Lines

Transmission line loss is an issue at VHF and higher frequencies. This loss is usually specified in dB per 100 feet of cable length. The losses of some common coaxial transmission lines are shown in Table 2. Small cables such as RG-58 have high loss at VHF frequencies, losing 3 dB (half the power) in 100 feet at 50 MHz. However, RG-58 might be acceptable for shorter cable runs, say 25 feet or less. RG-8x is not much larger in diameter but delivers lower loss. For longer runs, the larger "full size" RG-8U and 9913 are necessary to control transmission line loss.

Operating

The place to start on VHF is to go to the calling frequency and call CQ. Unlike the HF bands, there is a tendency to mix CW and SSB operation on the same frequency space on VHF. For example, on 2 meters you might hear an SSB signal calling CQ on 144.200 MHz then a few minutes later hear a CQ using CW. Someone

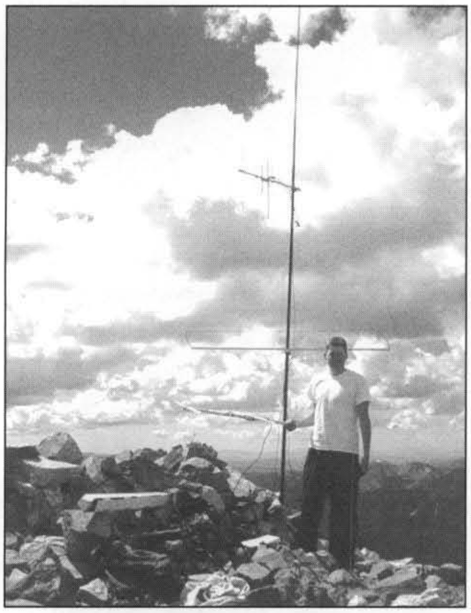


Figure 2—KØCAO operating mountaintop portable on Grays Peak during the 2003 Colorado 14er Event. The antenna in his hand is a 2-meter yagi with "tape measure" elements. (Photo: K3OG)

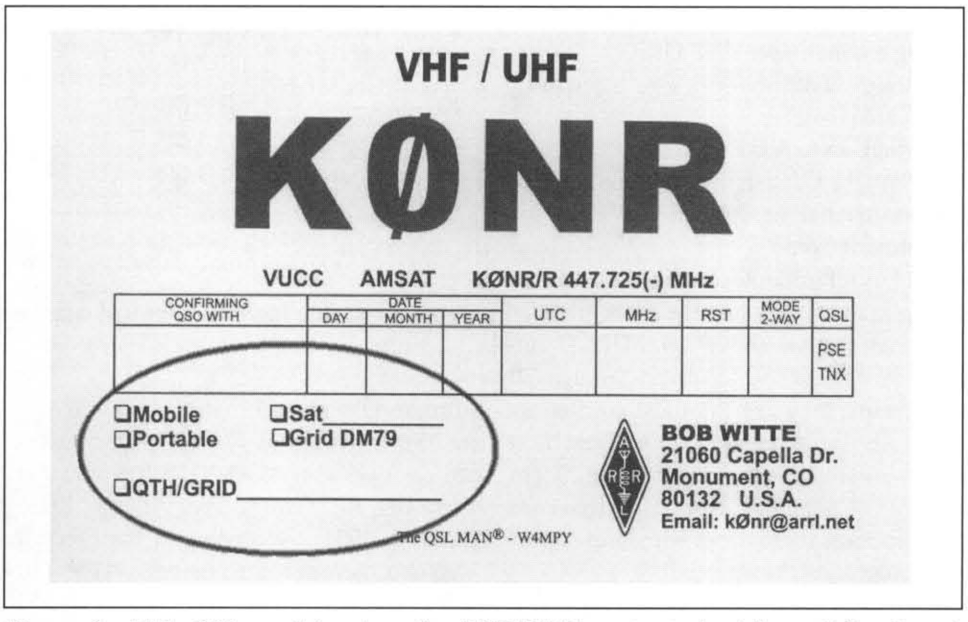


Figure 3—This QSL card is set up for VHF/UHF contacts (mobile and fixed) and includes a place to indicate the grid locator.

might even respond to the CW CQ using SSB and take up the QSO on phone. It is good operating practice to move off of the calling frequency once contact is established. However, you'll hear people ragchewing on the calling frequency, especially in areas that have little VHF activity.

Without a band opening, you are dependent on local activity to make contacts on the VHF bands. Local activity is, well, local, and depends on how many VHF operators there are in your area and how often they get on the air. The amount of activity on these bands will vary dramatically from place to place. Some areas have a formal or informal activity night, sometimes by band. For example, Monday night may be the 2-meter activity night, while Tuesdays might be for 1.25 meters. Obviously, this is a good time to get on the air, check out your equipment and work some of the local VHF crowd. Another opportunity is a local VHF net, most common on 2 meters.

Finally, VHF contests are great for concentrating activity and represent a chance to work lots of stations in a short period of time. These weekends are my favorite weekends to operate VHF, not so much to compete in the contest but to enjoy the higher level of activity on the bands.

Grid Locators

Besides a signal report, a key piece of information that gets exchanged on the VHF bands is the grid locator, which indicates your approximate position on the planet. The Maidenhead Locator System divides the earth into rectangles that are 1 degree latitude by 2 degrees longitude. The VUCC (VHF/UHF Century Club) and other awards are based on the number of grids contacted.

When you get on the SSB/CW portion of the VHF bands, the operator on the other end will likely want to know your grid. For example, the grid that covers greater Denver, CO is DM79. For most VHF and UHF operation the four-character grid is used (e.g., DM79), but two more characters can be added to create a more precise 6-character locator (e.g., DM79nc).

The best way to determine your grid is to take an accurate latitude and longitude measurement and convert it. A GPS receiver is a very convenient and accurate way to determine your position and most of them can display the location in the Maidenhead grid format (usually 6 characters). Otherwise, you may need to consult a map of your area that shows latitude and longitude. The ARRL web site (http://www. arrl.og/locate/gridinfo.html) has more information on the grid system, including a web page that lets you calculate the grid locator based on latitude and longitude.

Summary

We made a quick tour through some basic operating information for the bands above 50 MHz. This is just a start, so please give me your feedback, ideas and suggestions on future topics.

—Adios, Bob KØNR

References

Bob KØNR Web Site: http://www.rwitte.com

ARRL web site, VHF grid information: http://www.arrl.og/locate/gridinfo.html

Yaesu web site, FT-817 information: http://www.yaesu.com/

ICOM web site, IC-903 information: http://www.icomamerica.com

Elecraft web site, VHF transverters: http://www.elecraft.com/

MFJ Enterprises: VHF transceivers: http://www.mfjenterprises.com/

Ten-Tec, VHF transceiver, transverters: http://www.tentec.com/Amateur.htm

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The regular columns in QRP Quarterly are a good way to tell about your personal QRP activity or experiences without writing an entire article. Just contact any of the columnists and tell them what you have been up to in the part of QRP that they write about!

One Ugly Pig

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The explosive growth of QRP in recent years has resulted in the appearance of numerous kits—both by clubs and vendors. These kits have introduced (and sometimes re-introduced) hams to the pleasure of building. Some have used this as a step that leads to home brewing and discovered they can "roll their own."

Making the step from kit to homebrew can be daunting to some of us. Enter the multiPIG+ (MP+) supplied by Kits and Parts dot Com (http://partsandkits.com/index.asp). The MP+ is NOT designed for the beginner but IS designed for hams and hobbyists that have experience with kits and the ability to use an ohmmeter. If you meet these qualifications, and building and operating a high quality 10 band QRP CW transceiver that is easily modified is appealing, then the MP+ may be for you.

The MP+ is NOT a paint by numbers kit. It is a design in progress that will have future improvements, ideas, enhancements and updates. It is designed to be an experimenter's rig, but can be constructed as currently designed and used effectively.

History

As with many kits in QRP, the MP+ started as a club project of the Flying Pigs QRP Club International and evolved into a multi-band (160- through 10-meter) CW transceiver. The base of the MP+ is an all band VFO designed using a PLL/VCO similar to the Elecraft K2. A parallel-controlled PLL (Phase Lock Loop) chip is set with switches and jumpers for band changes. The eventual design ended up using seven (7) PCBs, all the same size (2.5" x 3.8"). These PCBs are supplied as seven individual kits to build the complete multiPIG+.

Building the MP+

The MP+ is really seven separate kits all on 2.5" x 3.8" PCBs. The "kits" are individually priced and thus can be purchased one at a time. All on-board parts are supplied. You need to supply external control parts (10-turn pot for the PLL; pots for audio and IF bandwidth; and a power switch and push button switch for the keyer). The seven board kits that make up the MP+ are:

Phased Lock Loop Kit (PLL)—this is the heart of the MP+ transceiver. The VCO operates from about 6 to 25 MHz. It's output is mixed with a 4.915 MHz IF to generate the transmit and receive frequencies for 160- through 10-meter operation. The VCO can be modified to operate into the VLF spectrum for experimenters. Output is in the 10 to 20 mW range. Using the PLL switches and the fine tune control, any frequency can be generated from 6 to 25 MHz. (See Figure 1.)

Frequency Counter/Controller Kit (FCC)—this kit includes a 10 Hz resolution frequency counter (with backlight) that displays the PLL/VCO output frequency. The actual transceiver frequency is automatically calculated by adding or subtracting the IF frequency from the VCO frequency. The K10 keyer chip (designed by K1EL) is also included, with options to set speed, sidetone frequency and even a beacon mode. Other circuits on the FCC board are an audio derived AGC and the main audio amp. This board also controls the full QSK operation of the MP+. (See Figure 2.)

Receiver Kit—the receiver is similar to classics from W7ZOI, Elecraft and others. Included are a high dynamic range switchable RF preamp, standard diode ring mixer, a five-pole variable bandwidth crystal filter and transmit/receive switching using real PIN diodes. (See Figure 3.)

Low Pass Filter Kit—the low pass filter is a 50 ohm input/50 ohm output 7 pole filter. This board holds 10 filters for all bands from 160- to 10-meters. All values in the design are taken straight out of the *ARRL Handbook*. (See Figure 4.)

Band Pass Filter Kit—the band pass filter is designed to provide very sharp bandwidths at the QRP center frequencies thus reducing the level of unwanted mixing products in the RF amplifier and diode ring mixer. It uses 3 tuned circuits that are adjusted via small trimmer caps. Inputs and outputs are 50 ohms for all 10 bandpass filters on the PCB. (See Figure 5.)

Transmitter Kit—the transmitter is a broadband design covering 160 to 10 meters. Input levels are about 100 microwatts at 50 ohms and output is a minimum of 5 watts into a 50 ohm load. The power output level can be adjusted via a trimmer pot that adjust the gain of a video amplifier circuit. The final amplifier uses a 2SC1945 transistor capable of 15 watts CW output. This transistor has the case connected to the emitter, thus removing the

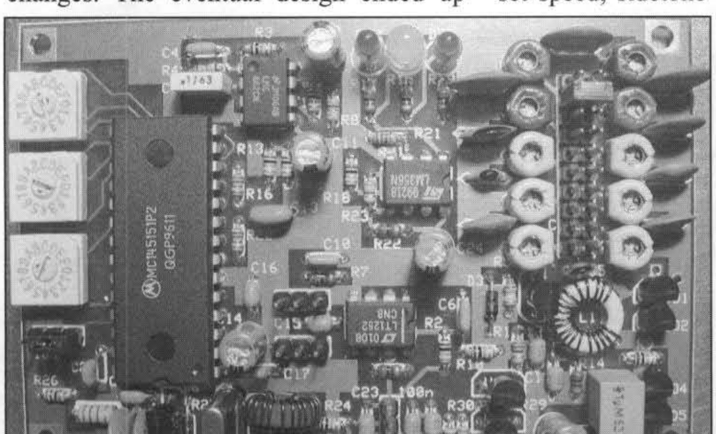

Figure 1—Completed Phased Lock Loop board.

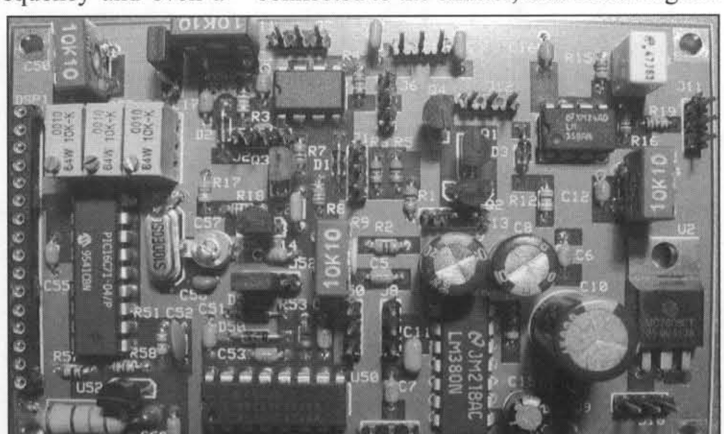

Figure 2—Completed Frequency Counter/Controller board.

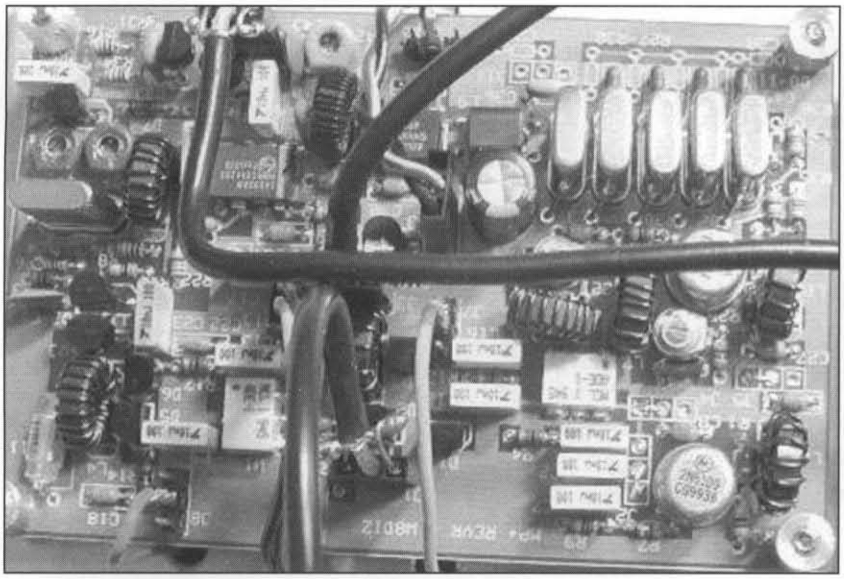

Figure 3—Completed Receiver board.

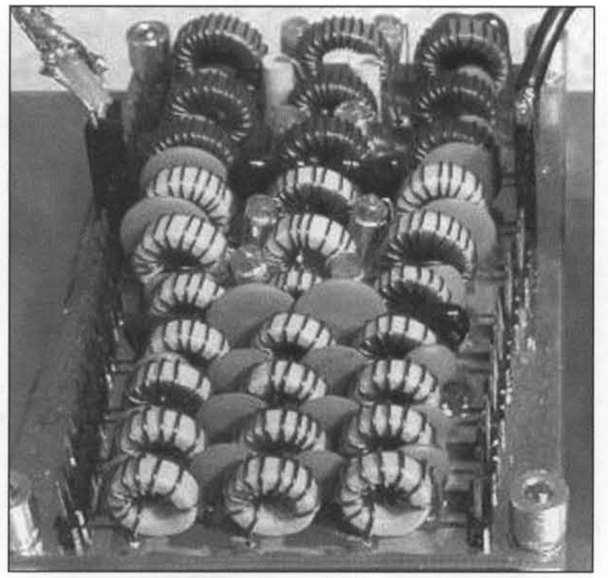

Figure 4—Completed Low Pass Filter board.

need for a heat sink insulator. RF amp efficiency is very high, drawing 700 mA at 5 watts output. (See Figure 6.)

SWR/Power Meter Kit—This board uses two 10 digit LED bargraph devices to display Forward and Reverse power. Analog meters can (optionally) be added. Calibration and range set jumpers are on the PCB. The typical 2 power ranges are 0 to 6 watts and 0 to 600 mW. The output of the SWR meter is 50 ohms balanced. This provides a convenient method to connect directly to a balanced antenna tuner or one side can be grounded for coax connections.

Each PCB is a stand alone unit. The builder can purchase the PLL and use it in another project. I have purchased the transmitter kit and used it to boost my mW rig to 5 watts. The boards are of high quality with plated thru holes. Instructions, schematics and pictures are found on the Kits and Parts web site. This is a unique way to supply documentation. However, I have found it very useful as I always have an e-copy saved on my PC. In addition, as updates and changes are made, you always have a "finished document."

Band switching the MP+ is a manual process. Commercial radios use one button or a switch to change bands. The MP+ changes bands by manually selecting (via jumper cables) the appropriate bandpass and lowpass filters. Also, the PLL/VCO must be manually set to provide the desired frequency range by setting 3 hexadecimal switches and selecting a band jumper to provide the appropriate capacitance to make the PLL lock with the VCO.

Remember, this is an experimenter's rig. Modifications are easier when a complex band switching scheme does not need to be considered.

Detailed operation for the PLL circuit is discussed on the Kits and Parts web site and also at the MP+ email reflector: http://groups.yahoo.com/group/multipigplus.

The instructions for the PCBs are very clear and complete. Kits and Parts also include a very good explanation of the PLL function (see JPEG for PLL board). I built all seven boards. When completed, I tested the PLL and the Frequency Counter/Controller per Kits and Parts instructions to insure proper operation. I then built the receiver, low and band pass filters and the transmitter. With these six boards complete, the boards need to be put into an enclosure and connected together. (The SWR/Power meter is not essential to the MP+).

The Kits and Parts Web page shows a proposed layout for the boards and provides interconnecting instructions. A picture of my MP+ (One Ugly Pig) is shown in Figure 7; notice the jumpers between the boards that are used for changing bands

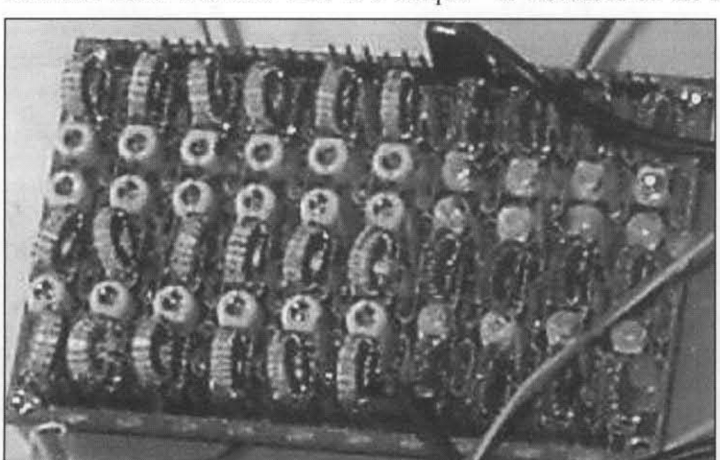

Figure 5—Completed Band Pass Filter board.

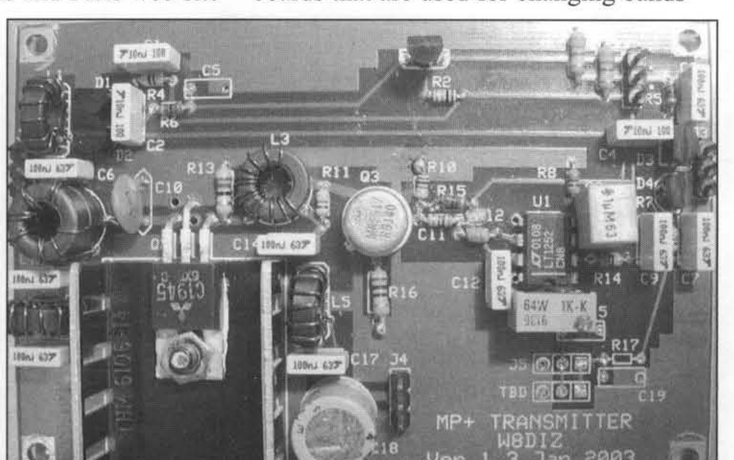

Figure 6—Completed Transmitter board.

Using the MP+

I have been using my MP+ since mid March 2003. My subjective testing indicates that the receiver is exceptional. I have operated it side-by-side with high-end commercial rigs, and found the receiver compares favorably. The variable filter is exceptional and has helped in reducing QRM in contest situations. The AGC performs well, however, I am considering adding a separate RF Gain control and eliminating AGC. (nothing against the AGC in the MP+, it's just that I prefer no AGC when operating CW).

One helpful addition would be a noise blanker. When it rains, I do get line noise and it makes operating difficult. Using a synchronous noise blanker has eliminated the problem. Kits and Parts is working on a noise blanker design as a future enhancement.

Overall, the MP+ is a very good radio. I do not have the equipment to provide the "standard ARRL Lab tests." But, as I stated above, it does compare favorably in side-by-side operation with high-end commercial rigs. It does require the builder to "tie it all together" after completing the individual boards. This process helps to move you from kit builder toward home brewer. The MP+ is available from Kits and Parts dot Com. Price and ordering information is at: http://partsandkits.com/index.asp.

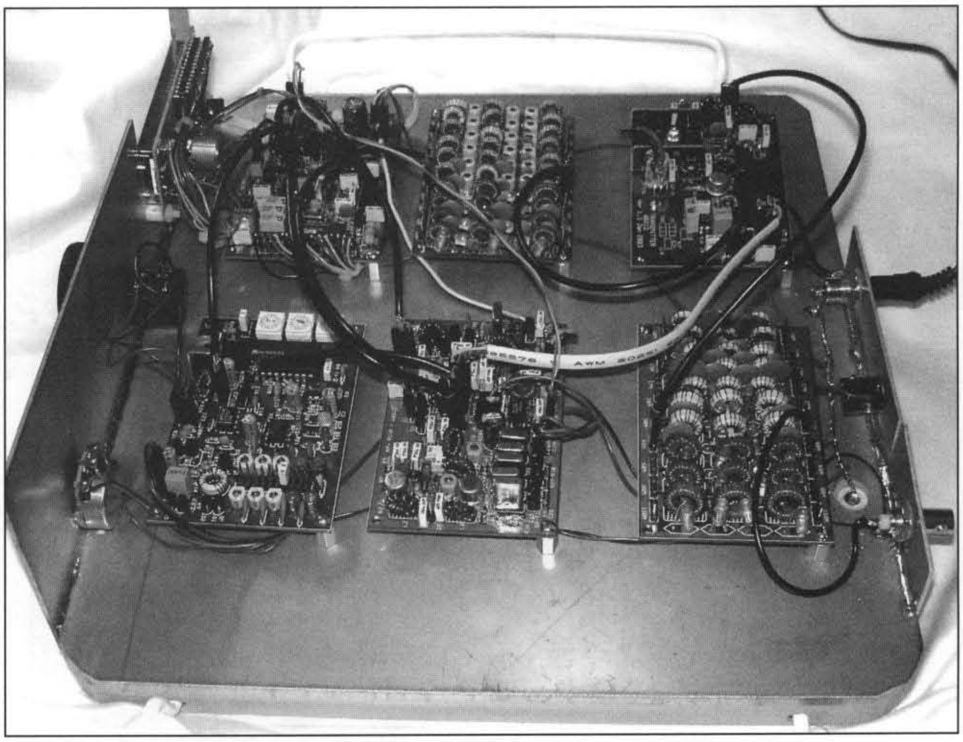

Figure 7—W4DU's "One Ugly Pig" MP+ transceiver.

multiPIG+ SPECIFICATIONS

General Features

- 7 small PCBs (2.5" x 3.8")
- 160- through 10-meter amateur band coverage
- 11.5 - 14 V operation
- CW only
- Back-lit LCD with On/Off switch
- PLL synthesized—low phase noise
- Dual VFOs with RIT on one VFO control
- SWR/power meter with LED readout

Receiver

- Low-noise, single-conversion, superhet receiver
- Double-balanced diode mixers (excellent dynamic range)
- Receive sensitivity: 0.15 µV (pre-amp on, typical)
- Narrow ham-band, triple-tuned bandpass RX/TX filters
- Smooth, fast attack, AF AGC (no "popping")
- Selectable preamp
- Variable-bandwidth I.F. crystal filtering

Transmitter

- Adjustable 0.1 to 5 Watts RF output on all bands
- 7-pole low-pass output filters
- Harmonics and spurious output suppression: Better than 45 dBc
- Full PIN diode switched break-in

K10+ keyer: iambic A and B, adjustable weight
- 8-50 wpm (internal keyer)
- 70+ wpm (external keying)
- Programmable message repeat interval
- Paddle and straight-key inputs

Variable bandwidth crystal filter (approximately 300 - 1000 Hz)

Adjustable RX CW offset with tracking TX side tone.

Typical tune ranges and max power output

Frequency Plan and Power Output

Freq Range	*PLL-freq*	*Watts*
1797- 1817	1810	13
3557- 3582	3560	12
5275- 5305	5300	12
7018- 7053	7040	12
10096-10141	10110	7
14011-14067	14060	7
18064-18103	19096	8
21018-21066	21060	9
24886-24945	24906	5.5
28000-28068	28060	7

Note: The MP+ was designed for 5 watts typical

QRP Contests

Randy Foltz—K7TQ

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Greetings, once again fellow QRP contest enthusiasts. This issue of the QRP Contests contains the results and soapboxes from the Hoot Owl Sprint, the Milliwatt Field Day, and the Summer Homebrew. There are announcements for the Top Band Sprint and the Holiday Spirits contest.

Contest entry forms can be found on the QRP QRCI web site in the "Contests" section. After each contest you can use the High Claimed Scores Form at http://personal.palouse.net/rfoltz/arci/form.htm to send me your contest summary. Then, be sure to send your log separately by either e-mail or regular mail.

Watch the claimed scores change each evening at 9 PM Pacific time for one week after the contest by looking at http://personal.palouse.net/rfoltz/arci/highclm.htm. This web page contains only those results submitted by those who use the web form above. As always, full results appear first in the *QRP Quarterly* then on the web.

For this issue, and perhaps others as well, I've got a "K7TQ's Extra Helpings" column. It contains short items too long for the soapboxes and too short for a full article. We'll give it a try for a few issues.

On to the results and see you on the air.

Mark your Calendars:

Top Band Sprint
December 4, 2003

Holiday Spirits Homebrew Sprint
December 7, 2003

Hoot Owl Sprint

The Hoot Owl Sprint is an exercise in late-night propagation. In 2003 the Hoot Owl Sprint was held on May 25 from 8 pm to midnight local time.

Hoot Owl Sprint Top Three

N9NE	88,970
K9PX	82,656
AA4XX	67,965

The solar flux was 121 with an A-index of 22 so conditions were not as good as in previous years. Most folks used 20 and 40 with a few 80 meter contacts thrown in for good measure, and extra points, too. With the late night times, 80 meters would seem to be more productive, but few folks show any contacts there.

N9NE in WI caught the top honors with a score of 88,970. A mere 6,000 points back in second place was K9PX in IN. Both these operators used the full 5 W for their scores. Rounding out the top three was AA4XX in NC with 67,965 points. Paul took advantage of the 15x multiplier available from using less than 250 mW for his third place finish. Look for AA4XX again in this issue of the *QRP Quarterly* in the "K7TQ's Extra Helpings."

2003 Hoot Owl Soapbox

K8KFJ—Heard no signals on 20m at contest start and 80m had bad storm QRN so ended up doing a single band effort on 40. Thought sigs were generally weaker than usual and struggled being heard (maybe my antenna was down). HI! **N5UW**—My favorite contest, but activity seemed down. Good signals from all I could hear. Loads of QRN on 40. Springtime in OK! **K4UK**—It was fun again to run the K2 at 5 Watts to see what could be worked. Conditions were fair here in Virginia. I had operated in the CQ WPX contest before the Hoot Owl began, so was a bit "drained"...HI! **KD2JC**—Short time spent but still fun! 40M marginal with QRN + QSB. **KK5DJ**—Everyone is very courteous. **K5JHP**—20M had reasonable propagation until near midnight. KØEVZ was worked from TX at 11:20 p.m local time. 40M was very noisy. Only 4 stations were worked and then it was with difficulty due to the very high noise levels. Good contest, however, and looking forward to next year. **KCØPMH**—The standard of operating was, in my humble opinion, excellent and I will most certainly be back next year as a QRP ARCI member as well. **WØUFO**—On late and off early so only a short time. **K4YKI**—Glad to be a part of another fun sprint; it was a hoot! Started 1 hour late. Band wasn't bad at all but could have been better. We weren't under siege by RTTY this time, just SSB. **WB6BWZ**—S8+ steady noise level on 20M and 40M with occasional static crashes next to I-75 in downtown Atlanta (Georgia) industrial area. **KW4JS**—I had loads of fun. See all next time. **AE6GL**—This little contest was a good test of my newly assembled dipole and my new JLog program. Too bad conditions weren't better. **K4WY**—Great challenge! Antennas made the difference. With 700 mW worked roughly 1 of every 5 station called. 40 meters was the most productive. **W5KDJ**—Nice contest and 20 stayed open till almost end of test. 7 mcs QRN and low props. Had good time catching them crafty owls. **WB7AEI**—With only 7 QSOs, actually did better and heard more stations this time than previous sprints! Worked all the strong ones; the rest were weak and reciprocity was once again proven. Nothing east of ID. Conditions? What conditions! Thanks for the fun! **W5TVW**—Things went very well on 20 until activity petered out around 0300Z. Made a few more and then hung it up. Worked 30 states and Panama. No DX heard. I guess the DXers were played out from the CQ contest! See you all next time! **K2EKM**—Inaugurated my newly completed Rock Mite for the Hootowl Sprint. No enclosure yet...just alligator clip connectors. Hope to be active with both R-Ms for the next ARCI event. **NK6A**—I spent the first 45 minutes sorting out a PC logging problem and then the bands were fading here in CA. **AA4XX**—Conditions were good on both 40 and 20. Fellow QRPers displayed excellent listening skills. N7MOB wins the "Golden Ears" award from AA4XX. Thanks for the fun contest! **AA1MY**—Got on an hour late...apologies for first few Qs, computer logging prog. went schizo. Prop. seemed flakey, one hop was all on all bands. NO sigs on 15M, 20M very sparse, 40M OK, and 80M not worth the effort to re-tune. Good ears on lots of you. **W5TA**—This year the cup was half empty and half full. On the empty side 20 meters had poor propagation and ruff QSB. On the half full

QTH	Call	Score	Pts	SPC	Power	Bands	Time	Rig	Antenna
						2003 Hoot Owl Sprint			
QTH	**Call**	**Score**	**Pts**	**SPC**	**Power**	**Bands**	**Time**	**Rig**	**Antenna**
AZ	AA7EQ	1470	35	6	LT5	40,20	1.75	K2	40M doublet, GAP Titan
CA	WA7SPY	5964	71	12	LT5	40,20	2.25	K2	Carolina Windom 40
	NK6A	2961	47	9	LT5	40,20	3	K2	C4
	AE6GL	1512	36	6	LT5	40	2.5	K1	Low dipole
	W6EMD	476	17	4	LT5	20	1	Sierra	Tribander @ 30'
GA	K6JSS (W4QO op)	10829	91	17	LT5	40,20	2	K1	80M loop
	WB6BWZ	7245	69	15	LT5	40,20	2.2	FT817	5 Mhz OCF wire @ 40'
ID	K7TQ	37260	162	23	LT1	40,20	2.75	K2	C4S
IN	K9PX	82656	369	32	LT5	40	4	K2	80 m loop
	K9UT	7840	70	16	LT5	40	1.25	K2	Sloper
	WD9EYB	532	19	4	LT5	40	1		
KS	KCØPMH	875	25	5	LT5	40	1	QRP+	60' doublet @ 20'
KY	K4YKI	13923	117	17	LT5	40	3	K1	CF Zepp
LA	W5TVW	48825	225	31	LT5	40,20,15		K1	135' Zepp
ME	AA1MY	48280	234	32	LT5		2.7	IC706 IIG	175' CF @ 55'
MN	WØUFO	5698	74	11	LT5	40,20	1	K1	
MO	KGØTW	49532	244	29	LT5	40			
MT	KL7FDQ	4914	78	9	LT5	20	1.5	FT817	dipole
NC	AA4XX	67965	197	23	LT250	40,20	4	Sierra	40M phase deltas, 20M yagi
NH	W1PID	8008	88	13	LT5	80,40,20		IC706	Windom OCF dipole
NJ	W2AGN	34776	216	23	LT5	80,40,20	3	K2	KT34, dipole
	KD2JC	10080	96	15	LT5	40	1.5	K1	40M loop
	W2JEK	8008	88	13	LT5	80,40,20	2	FT840	20M gnd plane, 40M dipole
OK	N5UW	24864	148	24	LT5	40,20	2.1	Omni 6+	TA33 @ 50'
	K5DP	1800	30	6	LT1	40,20	1	HW9	40M horiz loop
PA	K3HX	40404	222	26	LT5	80,40,20	3.5	TS870	Dipole @ 42'
TN	KW4JS	16240	116	20	LT5	40,20	4	K2	Wire loop
TX	W5TA	59780	244	35	LT5	40,20	4	TS430S	Verts
	W5KDJ	32890	143	23	LT1		3.75	K1	PRO57B, long wire
	K5ZTY	25725	147	25	LT5	40,20	1.5	K2	C4S
	KK5DJ	9744	87	16	LT5	40,20	1.5	K2	Outbacker
	K5JHP	7462	82	13	LT5	40,20	1.5	K2	TA33jr
VA	K4WY	61200	360	17	LT1		3.5	Rockmites	PRO57B & 40M 4 square
	K4UK	47740	220	31	LT5	80,40,20	4	K2	
	WA4CMI	13622	139	14	LT5	40,20	2.25	IC703	D4
	K3SS	2744	49	8	LT5	40	1	FT1000MP Mk V	Inv vee @ 35'
	K2EKM	400	20	2	LT1	40	1	Rockmite	HFp portable vert
WA	WB7AEI	896	32	4	LT5	40	1	40M HB superhet	40M loop @ 17'
WI	N9NE	88970	310	41	LT5	80,40,20	4	K2	88' doublet @ 30'
WV	K8KFJ	12096	96	18	LT5	40	4	K1	14AVQ

side, 20M stayed open untill about 0400Z here in Texas, and after 0400Z the QRN on 40 died down and the signals were up. **WA4CMI**—This is only the second contest for me in 28 years of hamming. I have a lot to learn about operating skills, strategy, and optimizing the station for these events. Had to sit out 1 hour and 45 minutes of test due to heavy thunderstorms overhead. **N9NE**—Operated portable at cottage on battery power and a 88' doublet up 30' in the pines. Highs: working QRP ARCI #1 K6JSS, and AA1MY (ME) on 20, 40, and 80 meters. **W2AGN**—As always, fun, in spite of poor conditions. Good try out for the new K2 DSP. **K9UT**—Not sure about the scoring but had fun anyway. First Hoot Owl! **K6JSS**—Shocked a few folks with the QRP ARCI Club Call K6JSS and ARCI #1! Everyone thought it was my power. QSL to W4QO (op.), 11395 West Road, Roswell, GA 30075. **K3HX**—Another FB contest. Hootowl Sprint started just after a short, but intense 6M short-skip opening ran out of (ionized) gas. Noted many new numbers.

2003 Milliwatt Field Day

This is a piggy-back contest held at the same time as the ARRL Field Day. June 28 and 29 were the dates in 2003. Seventeen groups or individuals sent in reports about their efforts. The classes included 1, 2, and 3 station club groups, 1 station individual operations both with and without battery power, and single operators from home using emergency power.

N4BP was the call used by the Guano Reef Bashful Perverts who made 1,032 CW contacts from the south Florida sec-

Group Name	Class	Call	Section	2003 Milliwatt Field Day Score w/o bonus	CW Qs	Dig. Qs	Ph. Qs	Nr. Ops	Rig	Antennas
Guano Reef Bashful Perverts	1A	N4BP	SFL	10320	1032	0	0		K2	4BTV, 40M dipole
WNY QRP Society	1A	K2WNY	WNY	2270	200	0	54	3		
Hawaii QRP Club & Hilo ARC	1A	KH6IN	PAC	1600	160	0	0		K2, TenTec Scout	3 el beam, 40M vert
	1B	W3TS	EPA	3890	389	0	0		K2	130' doublet
	1B	AA5CK	OK	2540	254	0	0	1		
	1B	KIØII	NE	1560	156	0	0			
	1B	K4JSI	MDC	1180	118	0	0	1	OHR20, OHR40, TT1340	
	1B-Bat	N4DD	VA	6330	633	0	0		Omni VI	500' random loop
	1B-Bat	K5AAR	OK	3970	397	0	0			
	1B-Bat	W2AGN	SNJ	2160	430	0	2		K2	100 ' Zepp
	1B-Bat	K3SS/7	UT	1495	132	0	35			
	1E	W8UE	MI	3310	331	0	0		TT 544	Carolina Windom
	1E	KW3F	EPA	1130	113	0	0	1	K1	Short windom
	1E	K6TV	LAX	510	51	0	0	1	HW8	GAP Titan
	1E	W2TI	NNJ	50	5	0	0	1	Rockmite40	Dipole
Minnesota QRP Society	2A	WQØRP	MN	8930	831	0	124			
Keno ARC	3A	K7ENO	OR	865	0	2	169	15		

tion in the single transmitter, club class. Bob and his group (K4PG and N4GM) operated from Fiesta Key which is 70 miles from Key West. For an antenna they used a 4BTV vertical mounted on a seawall with water around it for 270 degrees.

A fine showing was turned in by the Minnesota QRP Club, WQØRP, in the two transmitter club class. They made 831 CW and 124 SSB contacts.

Fifteen operators from the Keno Amateur Club made 2 digital and 169 SSB contacts from Oregon in the three transmitter, club class.

W3TS in Eastern Pennsylvania lead the entries in the single transmitter, non-club class with 389 CW QSOs. The top single transmitter, non-club class, battery powered operation was by N4DD in Virginia with 633 CW QSOs. Top honors in the home station, emergency power class went to W8UE in Michigan with 331 CW QSOs.

2003 Milliwatt Field Day Soapbox

K4JSI—The weather here in the Maryland DC section was perfect, and I enjoyed it thoroughly as I have most years since my first one as a Novice from Western New York in 1955. **K6TV**—Took my HW-8 out on the patio and hooked up to my GAP Titan. After the sun was setting low moved into the house and pretended to have no electrical power. It was fun. **W3TS**—Static and conditions very poor. It was hard work for every QSO. **W2AGN** — Casual operation from back yard this year. Conditions better than expected. **K5YC**— Between work, birthday parties, honey-dos and other issues I finally got to work 3-1/2 hrs of the contest Saturday night. I worked 27 states and a few countries on 20 SSB running 5 watts into a sloping dipole antenna. **KH6B**—Nice Milliwatt FD. A few on 15, many on 20 and 40. This was a CW-only effort this time.

2003 Summer Homebrew Sprint

N4BP, Bob, took top honors in the 2003 Summer Homebrew Sprint held July 13 with a score of 130,290 points. He told me that he was a bit tired from the IARU contest where he hit a high of 122 QSO in a single hour. Yup, I'd be tired too, if I could have a rate like that!

In second place was N9NE at 116,712 points. Todd had been the Summer Homebrew Sprint winner the previous two outings, but couldn't pull off the three-peat. Rounding out the top three was KØZK, Arn, with a score of 108,400. Bob and Todd used 5 W while Arn used less than 1 W. (See K7TQ's Extra Helpings for more about Arn's outing.)

Solar flux for the contest was 126 and the A-index was 14, but had been in the mid 40s the previous two days. Last year those values were 144 and 6. As is usually the case, 20 and 40M were the workhorse bands, although some folks reported summer thunderstorms made 40M difficult.

Summer Homebrew Sprint Top Three

N4BP	130,290
N9NE	116,712
KØZK	108,400

Category Winners

Less than 50 mW:	AA4XX	73,020
Less than 250 mW:	W5KDJ	32,500
20M:	WB8RTJ	48,216
40M:	K9PX	31,082
All bands (160-10):	KH6B	33,430

2003 Summer Homebrew Sprint Soapbox

AA4XX—Condx were noisy on both 20 and 40M. I spent most of my time On 20M and was quite impressed with the listening skills displayed by many operators. Running 50 mW, each contact was a joy, especially on 40M where the QRN levels were pretty stiff. The high point of the con-

2003 Summer Homebrew Sprint

QTH	Call	Score	Pts	SPC	Bonus	Power	Bands	Time	Rig	Antenna
AZ	K6RXL	5476	17	4	5000	LT5	20	4	K1	GAP Challenger
	AA7EQ	1134	27	6	0	LT5	20	3	K2	GAP Titan
CO	NØTK	20376	64	12	15000	LT5	40,20,15	3	K1	Attic dipoles
	KIØG	9860	54	9	5000	LT1	20	2	AT Sprint	Long wire
	NØIBT	1813	37	7	0	LT5	20,15	1.5	TS870	Dipoles
FL	N4BP	130290	366	45	15000	LT5	20,15,10	2.6	K2	TH7DXX @ 65'
GA	K4BAI	81900	300	39	0	LT5	40,20,15	4	FT1000MP	TH6DXX
	W4JHR	18927	51	11	15000	LT5	40,20,15	3	K2	
	K4GT	11160	56	11	5000	LT1	20	2.75	K2	C3S @ 38'
	K4IR	9774	62	11	5000	LT5	20	1.5	K1	Butternut vert
	WB6BWZ	1715	35	7	0	LT5	20	1.7	FT817	5 MHz OCF stealth wire
HI	KH6B	33430	49	10	30000	LT5	160,80,40, 20,15,10	2	K2	284' sloping loop
	W6ORS	30	30	1	0	GT5	160, 80,40, 20,15,10	0.2		
ID	K7TQ	53402	211	26	15000	LT5	40,20,15	4	K2	C4S @ 50'
IL	N9RY	13150	50	9	10000	LT5	40,20	1	K2	Inv Vee & mobile whip in attic
IN	K9PX	31082	162	23	5000	LT5	40	2.75	K2	80M loop
KS	WBØSMZ	5770	22	5	5000	LT5	20	1	Norcal 20	Butternut vert
KY	K4YKI	15864	97	16	5000	LT5	40,20	3	K1, TS570DG	
MA	K1GDH	16461	71	13	10000	LT5	40,20	2	HW9	G5RV
ME	KØZK	108400	246	40	10000	LT1	40,20	4		
MI	N8NM	24460	139	20	5000	LT5	20	3	TT 1320	R5RB @ 30'
	K8DDB	18465	55	9	15000	LT5	40,20,15	1.1	Sierra	G5RV
	K8CV						40,20,15			
MO	KØLWV	5124	61	12	0	LT5	20	1	TS520	N4GG vert array
NC	AA4XX	73020	137	23	10000	LT55	40,20	4	Sierra	20M monobander, 40M phased delta array
NH	K1HJ	23580	66	13	15000	LT1	80,40,20	4	K1	Random wire
	W1PID	8295	79	15	0	LT5	40,20	3.5		
NJ	W2AGN	38184	144	23	15000	LT5		4	DSW-II, GQ40, TAC-1	
OH	WB8RTJ	48216	246	28	0	LT5	20	3.5	K1	C4SXL
	AB8FJ	11800	30	6	10000	LT1	40,20	1	SW40, SW20+	Random wire
OK	N5UW	35975	177	25	5000	LT5	20	2.5	OHR400	TA33 @ 50'
PA	W3TS	15920	37	8	10000	LT55	40,20	1	HB superhet	Inv vee, 2 el yagi @ 52'
	NA3V	9555	91	15	0	LT5	40,20	1.5	IC756	130' doublet @ 65'
SD	K7RE	66637	261	31	10000	LT5	40,20	4		
TX	W5TA	35625	175	25	5000	LT5	20	2	Red Hot 20	130' center fed zepp
	W5KDJ	32500	100	15	10000	LT250	20,15	3	K1, Sierra	PRO57B @ 50'
	K5FX	720	12	3	0	LT55	20	1	Argosy	20M dipole
VA	K4UK	13965	105	19	0	LT5	40,20	2.75		
	K2EKM	10450	15	3	10000	LT1	40,20	0.75	RM/20, RM40	Indoor loop
	KK4R	5050	5	1	5000	LT1		0.25	NC 40A	Doublet
WI	N9NE	116712	314	44	20000	LT5	40,20,15,10	4	K2	Beam, 40M dipole, 136' doublet
WV	K8KFJ	24257	131	21	5000	LT5	20	3.75	K1	TH6DXX
DX	PA3ELD	98	7	2	0	LT5				

test was completing an exchange with KØZK (ME) on 40M, at which point I shouted out loud! K7RE gets the big sig award for a consistently bodacious presence on 20M. K9PX gets the 40M big sig award, along with the golden ears award. **AA7EQ**—Crummy band conditions. **AB8FJ**—A bit slow running just search and pounce at 900 mW but a fun time as usual. **K1HJ**—I thought the antenna I was using wasn't doing such a good job but after reading the comments from others I'm not so sure. Conditions seemed pretty sketchy overall. **K2EKM**—First time using both R-Ms (20 & 40) in a contest. My less-than-optimal antennas (indoor loop up 6' and portable vertical) make contacts with these little critters even more amazing to me! **K4BAI**—In this one, there was reasonable activity for maybe the first 90 minutes and it was very hard to find new contacts after that. **K4IR**—Fun contest! I really need to get an ARCI number. **K4UK**—I had to quit at 2315 UTC because we had a BIG thunderstorm complete with lightning. So I disconnected all the antennas and grabbed a beer and sat back and relaxed. **K4YKI**—I will say that 40 was a lot better than during the FISTS Sprint the day before. Wouldn't have missed this sprint. Great to run with the fine QRP crowd again. **K6RXL**—20M was miserable! High QRN and noise levels! **K7RE**—Conditions were sub par, lots of QSB made copying the very low power stations most difficult, and I know that I missed a few. Tried many times to get some action going on 15M, but only worked 4 stations there. **K8DDB**—Only had one hour to spend, but had a good time. **K8KFJ**—Murphy = rotator decided to quit. Yagi stuck pointing south. **K9PX**—Pickings were kinda slim on 40M. **KH6B**—W60RS/KH6 agreed to band hop giving me action on all bands. **KK4R**—I missed the beginning of the contest doing chores. Then the thunder storms came. I worked 1 station in spite of it and then shut down. Thank goodness for bonus points! **NØTK**—Selective propagation. Worked most stations I could hear. **N4BP**—Thunderstorm static was so bad on the high bands that there was no point in even trying 40M. After 2 1/2 hours, could not hear anyone new so quit. Still no one tries 10M. **N5UW**—I got sleepy, so took a 1-1/2 hour nap in the middle of the contest! Too old for late Saturday nights!!! **N8NM**—Little contest... Big fun! **N9NE**—Interesting and challenging contest this year. I think well over half of the stations on 40 meters I worked elected to run 50 mW or less! **N9RY**—Only about 1 hour in contest, but had great time with newly finished K2. **NA3V**—Threw in the towel after several short stints on the radio. QRN and weak signals on 40M in particular. **W2AGN**—Lousy Conditions! DSW-II worked great on 20M, old GQ40 on 40, and even pulled out an 80M QSO from the QRN with the old TAC-1. **W3TS**—Eight very good operators pulled my 50 mW signal out of the QRN and poor band conditions! I tried hard to raise someone on 80M and 15M but no one could hear my CQ-ing. I called a few others on 40 & 20 but they could not hear me. **W5KDJ**—Good time by all, nice to QSO the regulars again. **W5TA**—Vertical wasn't loading too good. Stations not coming back. Found the top 8 feet of vertical was horizontal! Had to resort to all band long wire. **W6ORS**— Worked Dean KH6B at a remote location in Hawaii on all bands from my QTH in Hilo, Hawaii. **WB6BWZ**—28-gauge insulated wire stealth antenna up 40 feet in heavy-foliage trees next to I-75 in downtown Atlanta industrial area. **WD9EYB**— Monday morning I found out I had connected the Pixie to the wrong connector on the transmatch and all my power was going into the transmatch, not the antenna. I had a good time even though I didn't work anyone.

K7TQ's Extra Helpings

I get one or two long stories from each contest that are too good to cut down to the soapbox level. For this issue I've chosen two. The first is by KØZK, Arn, who tells us about his Summer Homebrew adventures. If you look at the results of this contest, you will find that Arn turned in a third place with 108,400 points.

Summer Homebrew Sprint From the Beach

This year I was plagued once again by low battery voltage. I guess I will have to correct that problem. I traveled to the coast of Maine. Parson's Beach is located in Wells, Maine just south of Kennebunk. It is a preserved nature reserve next to NOAA Oceanographic site Laudholm Farm and the Rachel Carson Federal Preservation area. Parson's Beach is private property with a very limited amount of public parking. This keeps the beach and adjacent areas from being crowded. I have set up on numerous occasions right over a small bridge. A vertical works wonders when there is salt water under you and the ocean a matter of 100 yards away to the east. I used a military telescoping aluminum tubing guyed with nylon parachute cord. The antenna was set on a Merlot bottle as an insulator. I have found Merlot bottles give better results than Chablis or Champagne bottles here.

The rig was basically my home setup, Elecraft K2, dragged down to the beach. The battery used was a 12 volt battery pack which I had used the previous weekend without remembering to recharge it. I found starting out that the battery was a low 11.2 volts, and I was forced to operate at the one watt level. Everything was alright, however, as the location evened out the power deficiency.

I was late getting started because an interested bystander kept asking questions. I took the time to tell him about amateur radio and QRP and did not mind getting on 15 minutes late if I had gained a new ham to the amateur radio ranks. I hope we can snag this gentleman who did code back in his Navy days.

Conditions were noisy on 40 so I did not spend much time there. Twenty was better and I managed to work some DX. Working UT7IF at the end of the contest was a thrill as the battery voltage was down to 9.4 volts.

It is fun to operate QRP contests from such a great location. I should be given a handicap for having to operate while being distracted by cute girls in skimpy bikinis, however.

—KØZK, Arnold Olean

The second extra is by AA4XX, Paul. At his request, a new power multiplier for less than 50 mW was initiated in the Summer Homebrew Sprint. He and two other operators, W3TS and K5FX gave it a try. For Paul it was good enough for fifth place from a total of 31 QSOs.

So What's It Like to Run 50 mW During an ARCI Contest?

As a brand new novice back in 1968, I can remember filling in page after page of logbook entries where I called CQ and nobody answered me.

My first FD experience was similar. The novice FD station was well equipped with a good antenna, but the contacts were few and far between.

Upon sensing my frustration, my mentor sat down to the key and explained that a major factor in getting responses was "timing." My humble mentor then sat down at the key and worked three or four stations in a row, and we novices felt a little light turn on.

About ten years ago, I was chasing DX on the low end of 80M, running 500W. I heard a rather weak station calling CQ. It turned out to be a QRPer in CA, who was running an HW-8. He was answered by another W6 QRPer. Intrigued that I could readily copy both stations, I called them and let them know that they were being copied on the East Coast. I asked them to QRX a minute so I could turn off the amplifier, and they could still copy me at 80W. This was an epiphany for me. I went to 10W and they could still copy. Wow! I was hooked. For the next few weeks, I made lots of QSOs at the 10 watt level. It took several more weeks before I developed the courage to turn the wick down to 5 watts. Amazingly to me, stations were still copying, and all of a sudden ham radio had become exciting again, much like those days as a novice.

As time went by, it was natural to try even lower power, and new lessons were learned. I guess the most important lesson is that it is indeed possible to make yourself heard while running QRPp power levels.

Success at 100 mW and below is hugely dependent on using the appropriate antenna for the location and occasion. At the beach it is hard to beat a vertical antenna, but at my home a dipole performs so much better. After learning how to use EZNEC, it became apparent that the height and orientation of the dipole were also important. Lessons learned from EZNEC were quite valuable, especially when it came to evaluating multi-element wire-beams.

Recently I decided to see if it would be possible to actually compete at the 50 mW level during the ARCI Summer HB Sprint The station consisted of a Wilderness Sierra (A FB performing QRP contest rig), a 20M beam, and a 2 element 40M phased delta loop beam. To be honest, I was nervous going into this event, never having tried a contest at this power level. I knew consistent contacts could be made at 250 mW, but 50 mW seemed a little crazy for a serious contest effort. I knew N4BP, N9NE, K7RE and the rest of the Big Boys would be making lots of contacts, so unless my QSO rate could be sustained it would be impossible to compete with the higher power guys.

So what was it like? In a word, Exhilarating! The QSO rate was not stellar, but most of the folks I heard were also hearing me. From previous contests I had learned that Search and Pounce was the most effective approach while running below 100 mW, so I simply timed my calls to snag each station as the opportunity presented itself. Needless to say, at this power level you've got to grab your next victimer, station-while nobody else is calling him and while he isn't transmitting. For this reason, I prefer fast QSK. As expected, the most productive band was 20M (25 QSOs) followed by 40M (6 QSOs).

Surprisingly, my average received signal report was 559, so few stations had any difficulty copying at 50 mW. Only two stations asked for repeats, and only three stations gave a report less than 559. Six stations (W4RYW, K7ZYV, K3HX, KØFM, WB6BWZ, and K4IR) actually answered my CQs, which added much needed multipliers. Thanks, Guys! There wasn't much activity on 40M, but the stations on that band displayed exceptional listening skills. The 50 mW station did not receive any reports below 559 on 40M, which was surprising to me. It was especially exciting to work Arn, KØZK in ME on 40M. Arn's vertical over salt water was literally blasting into NC, and he could hear a pin drop.

If anybody asked me if I'd run 50 mW again during a contest, I'd say, "Absolutely." As a matter of fact, I'll be kayaking out to Swash Inlet on Portsmouth Island for the ARCI Fall QSO Party. If you hear the 50 mW peanut whistle from NC, I'd be pleased to make your acquaintance. The antenna system for that trip will be a homebrew dual band 40/20M phased vertical array, along with a top loaded 80M vertical.

For those who might be interested in getting into QRPp, my advice is to take it in steps. This allows you to get your confidence level up before turning the wick down still lower. I still remember those days when I was hesitant to operate below 10 watts, as if that were some invisible power barrier. With the right combination of patience, timing, and station, you can also be successful with QRPp.

Fellow milliwatter W5KDJ is a good example. You'll hear Wayne's 250mW signal during most ARCI contests.

—AA4XX, Paul Stroud

Those are the two "extras"" for this issue. If you've got an interesting tale, good pictures, or anything else that doesn't quite fit into the standard reporting form that is related to one of our contests, please let me know and we'll get it in K7TQ's Extra Helpings.

Contest Announcements

2003 Holiday Spirits Homebrew Sprint

Date/Time:

December 7, 2003, 2000Z through 2400Z, CW only.

Exchange:

Member—RST, State/Province/Country, ARCI number

Non-member—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 more than one band for QSO points and SPC credit.

Power Multiplier:

0 - 50 mW = x20
>50 mW to 250 mW = x15
>250 mW to 1 W = x10
>1 W to 5 W = x7
Over 5 W = x1

Bonus Points for Homebrew Gear:

(Per band) Add 2,000 points for using HB transmitter, 3,000 for using HB receiver, or 5,000 for using HB transceiver. If you built it, it is homebrew!

Suggested Frequencies:

160M	1810 kHz
80M	3560 kHz
40M	7040 kHz
20M	14060 kHz
15M	21060 kHz
10M	28060 kHz

Score:

Total score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Entry may be All-band, Single-, High-, or Low-band. Entry includes a copy of logs and summary sheet. Include legible name, call, address, and ARCI number, if any. Entry must be received within 30 days of contest date. Highest power used will determine the power multiplier.

The final decision on all matters concerning the contest rests with the contest manager.

Entries are welcome via e-mail to rfoltz@turbonet.com or by mail to

Randy Foltz
809 Leith St.
Moscow, ID 83843

After the contest send your Claimed Score by visiting http://personal.palouse.net/rfoltz/arci/form.htm. You must still submit your logs by either e-mail or regular mail if you use the High Claimed Score form. Check the web page for a week after the contest to see what others have said and claimed as their scores.

2003 Top Band CW & SSB Sprint

Date/Time:
December 4, 2003 0000Z to 1200Z.

Exchange:
Member—RS(T), State/Province/Country, ARCI number
Non-member—RS(T), State/Province/Country, Power out

QSO Points:
Member = 5 points; Non-member, different continent = 4 points; Non-member, same continent = 2 points. You may contact the same station only once regardless of mode.

Multiplier:
SPC (State/Province/Country) total for both modes.

Power Multiplier for CW:
0 - 50 mW = x20
>50 mW to 250 mW = x15
>250 mW to 1 W = x10
>1 W to 5 W = x7
Over 5 W = x1

Power Multiplier for SSB (PEP):
0 - 100 mW = x20
>100 mW to 500 mW = x15
>500 mW to 2 W = x10
>2 W to 10 W = x7
Over 10 W = x1

Mixed Mode:
Use the smaller multiplier

Suggested Frequencies:

CW	1810 kHz
SSB	1910 kHz

Score:
Total score = Points (total for both modes) x SPCs (total for both modes) x Power Multiplier.

Entry may be CW, SSB, or mixed mode. Entry includes a copy of logs and summary sheet. Include legible name, call, address, and ARCI number, if any. Entry must be received within 30 days of contest date. Highest power used will determine the power multiplier.

The final decision on all matters concerning the contest rest with the contest manager.

Entries are welcome via e-mail to rfoltz@turbonet.com or by mail to

Randy Foltz
809 Leith St.
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After the contest send your Claimed Score by visiting http://personal.palouse.net/rfoltz/arci/form.htm. You must still submit your logs by either e-mail or regular mail if you use the High Claimed Score form. Check the web page for a week after the contest to see what others have said and claimed as their scores. ●●

– QRP ARCI Contests are FUN ! –

How to Operate the Contest:
2003 Holiday Spirits CW Sprint

Date: December 7, 2003 from 2000Z to 2400Z

How to participate: Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies of 3560, 7040, 14060, 21060 and 28060 kHz. Work as many stations calling "CQ QRP" or "CQ TST" as possible, or call "CQ QRP" or "CQ TST" yourself. You can work a station again on a different band.

What to send: Give a signal report and your state (for Americans), province (for Canadians), or country (for everyone else), and QRP ARCI member number if you have one, or your power if you don't have one.

Best reason to participate: You can pickup needed states for 2x QRP WAS in one afternoon.

Relative challenge: Easy for all. (Slower code speeds, short duration, good number of participants, QRP only contest).

Scoring: Standard QRP ARCI method for CW contests

Web link: http://personal.palouse.net/rfoltz/holspr.htm

How to Operate the Contest:
2003 Top Band Sprint

Date: December 4, 2003 0000Z to 1200Z.

How to participate: Get on 160M around 1.810 for CW or around 1.910 for SSB. Avoid 1.830 to 1.835 which is the DX window. You can work a station using either CW or SSB, but not both.

What to say: Give a signal report and your state (for Americans), province (for Canadians), or country (for everyone else), and QRP ARCI member number if you have one, or your power if you don't have one.

Best reason to participate: A good warm-up for the ARRL 160M contest the following weekend. Learn more about 160M activity and propagation. The only mixed mode QRP ARCI contest.

Relative challenge: Moderate (160M not an easy band).

Scoring: Mix of standard QRP ARCI method for CW contests and SSB contests.

Web link: http://personal.palouse.net/rfoltz/top.htm

Just Tall; That's All

Some Principles of Portable Antennas to Strive for

L.B. Cebik—W4RNL cebik@cebik.com

W4RNL first presented this material at the 2003 FDIM in Dayton, Ohio. We are pleased to make it available to all QQ readers. —ed.

2003 marks the 8th FDIM symposium to which I have tried to make a contribution to our array of antenna ideas. This year, I want to present some principles that apply to portable antennas. We may not be able to achieve them all, but the more of them that we can implement, the greater success we are likely to have in our portable and field operations.

Unfortunately, I have seen too many operations (many documented with published photos) showing folks using the finest QRP equipment with some of the worst antennas imaginable. Sometimes, circumstances force us to load up the proverbial bedsprings, and we can make contacts—at least a few. However, when you have only five watts of power—or less—you owe it to yourself to develop the finest field antenna you can imagine--and then carry. Of course, that last qualification is the limiting factor. You must be able to get the antenna to the site, erect it, and then take it down and home again. Before we are done, I shall pass along a few techniques to help make that possible—at least in some circumstances.

Since this is not a mystery story, I shall list the basic principles that I have in mind right here—and then expand upon them.

1. Look before you leap
2. The higher, the better
3. The bigger, the better--up to a point
4. As the guy said, safety above all else
5. Avoid nuts (and bolts)

My 6th principle is simply that no presentation should have more than five principles.

Look Before You Leap

The first principle simply says to reconnoiter the territory that you will be using before you go there to operate. Find out what is there that may be useful, what is there that may get in the way, and what is not there that you will need. I knew an operator who carefully prepared a doublet and an end-fed wire for his vacation, which sent him into the New Mexican wastelands, where there was not a tree or shrub more than 4 feet high to tie off the ends.

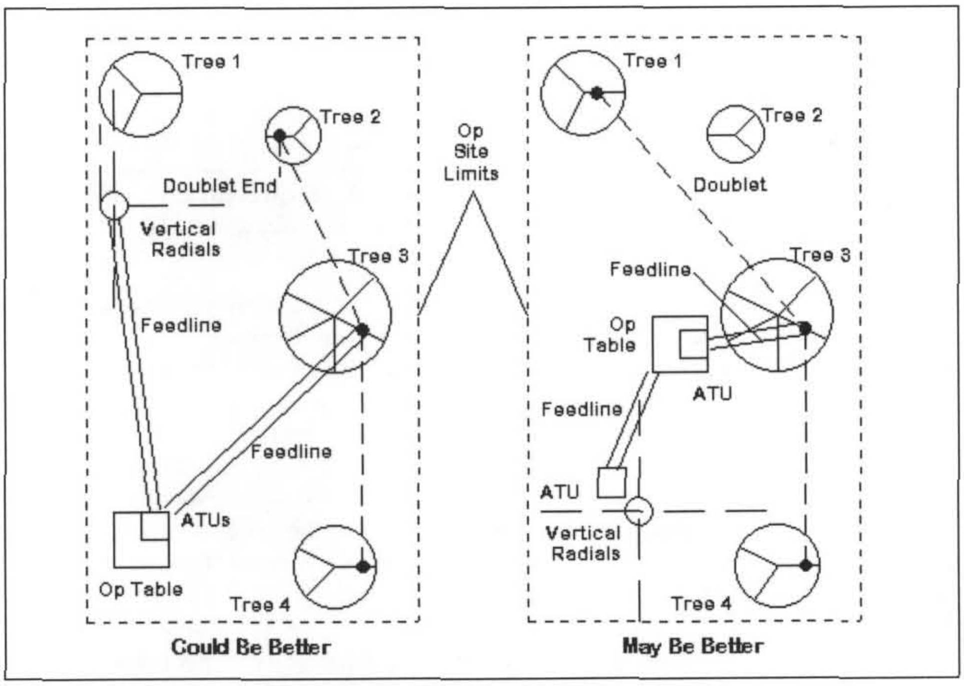


Figure 1—Site surveying and planning.

My example is extreme, but not so far fetched as it sounds. If you will use a horizontal wire or even an inverted-L, you need at least a pair of tall supports and a way to reach them to tie off the ends. If you will use a vertical, you should know that you can set it up reliably. A base pipe that works well in clay and loam is not necessarily adequate in sand or rock. Even a guy-wire/rope needs soil that will handle the anchor.

The more complex the field operation, the more important it becomes to do advanced planning. Too often, even in seemingly well-planned Field Day operations, the first person to arrive with an antenna selects the best spot for his/her antenna and all others arriving later must squeeze themselves into any remaining space. Little wonder why scores are not higher.

The planning process is mostly a thinking and paper operation, which is not very exciting compared to the actual effort to make contacts. However, it can make actual operation even more exciting by improving the chances for more successful contacts. The process is very straightforward:

- Catalog the antennas that will go on the expedition.
- Visit the site and records all details, including trees (and limbs eligible as supports); relative heights of areas within the site; unusable places due to water, ant colonies, etc.; and any other feature that might affect the operation or its layout.
- Make many sketches of potential site layouts before deciding on the one to use.
- After deciding on the layout, accumulate all of the pieces needed to make that layout become an operating reality.

Figure 1 sketches the very same area twice. It has 4 trees, each with a pattern of eligible limbs. I have omitted some potential details to keep the sketch from getting too crowded. I shall assume that the most convenient place from which to approach the site is the lower left corner. It may be nearest to a trail or a parking area. As you can see from the left version of the sketch, the initial plan is to dump all of the heavy gear as near to the approach as possible. Then the antenna field can take shape using the spaces left over. The operative principle behind the antenna arrangement is to keep the antennas as far from the equipment as feasible within the limits of the site.

It seems reasonable to use the nearly aligned trees on the right edge of the site to support the doublet, even if one end must hang down. To give the vertical antenna clearance from the doublet, the plan calls for placing it near the left edge of the site, even if that means reducing the radial field to only 3 effective radials stretched out on the grass. The ATUs, one for each antenna, go on the operating table, with feedlines to the individual antennas.

Now let's re-plan the site. Let's move the operating table to a more central location. Yes, it is nearer the doublet, but we shall let height provide separation and take advantage of the shorter feedline run that goes upward from the ATU with less chance of encountering objects that might disrupt balance. Our next move is to run the doublet between trees 1 and 4. This arrangement allows the doublet to be horizontal throughout, with no vertical end to couple into the vertical antenna. The increased angle will have little effect on patterns. We shall also move the vertical to the open area that formerly held the operating table. It has no immediately nearby tree to absorb its energy. The radials extend for their full length in each direction. Note that the ATU is at the base of the vertical, a better position if there will be significant SWR levels at any operating frequency. The cable to the table is a length of matched coax.

I only label the right-side plan as possibly better, because the sketches lack significant details that you would enter into your real planning drawings. A boulder where you want to place the operating table could ruin everything. As well, high and low spots in the area might dictate some right and wrong places to set the vertical antenna. A hornet's nest on the limb from which you wish to hang the doublet might call for last minute revisions. Nevertheless, the right-hand sketch does widely separate the antennas and, to the degree possible, account for the most efficient transfer of power—both incoming and outgoing—from the antennas to the operating position, while minimizing the potential for unwanted interactions.

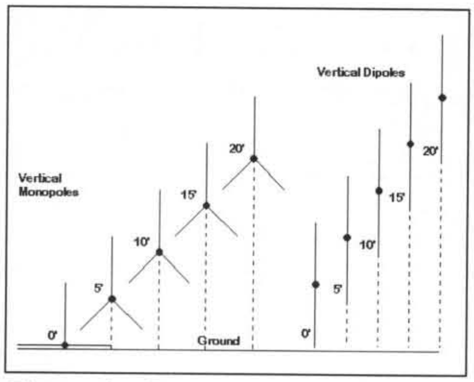


Figure 2—Representative effects of height on vertical antennas.

Once you have reconnoitered the site and planned its layout, your next task is to gather all of the materials needed to make it a reality. Everyone thinks of the equipment, the antennas, and the feedlines. However, have you thought about the materials necessary to get the antennas in place and to keep them there throughout the event? It usually pays to have at least two means of getting lines over limbs, because trees have a habit of coming in odd shapes. As well, it also pays to not let the antenna wire contact a limb, but to suspend it below the limb with a rope and ring. A vertical antenna may require guying, even if the maker declares that no guying is necessary. Loose soil and careless wanderers can defeat such claims in a flash. Do not forget the equipment anchors. QRP gear tends to be small and light. Hence, it crawls off operating tables and finds it way to the ground when no one is looking. In general, plan on having as much (or more) weight devoted to set-up and maintenance materials as to the operating equipment, antennas, and feedlines.

The bottom line is a modification to the basic principle: Look—and think and plan—before you leap.

The Higher, the Better

When it comes to antennas, this principle is as old as radio itself. We often think of the principle as applicable to horizontal antennas, like dipoles and multi-band doublets. However, it also applies to many types of vertical antennas. Let's look at what happens when we take a few representative vertical antennas that you might carry to the field and elevate them. We shall compare antenna base heights of 0, 5, 10, 15, and 20 feet—the last height likely only being available to those with significant equipment. Our samples will consist of a vertical monopole with radials and a vertical dipole without radials. Figure 2 shows the general outlines of what we shall do with a few models. Although the samples will be full-size, while the vertical antennas that you carry to the field may be

Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
Band: 10 Meters (28.4 MHz)				
0	---	–0.17	27	42 + j 38
5	0.14	0.73	22	54 + j 3
10	0.29	1.32	17	52 + j 6
15	0.43	1.50	14	46 – j 1
20	0.58	1.63	45	49 + j 0
Band: 20 Meters (14.1 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
0	---	–0.32	26	44 + j 35
5	0.07	0.20	24	46 + j 4
10	0.14	0.49	22	56 + j 4
15	0.22	0.80	19	50 + j 1
20	0.29	0.97	17	41 + j 4
Band: 40 Meters (7.1 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
0	---	–0.43	25	46 + j 35
5	0.04	–0.15	24	45 + j 3
10	0.07	0.06	23	50 + j 5
15	0.11	0.21	22	54 + j 1
20	0.14	0.32	21	59 – j 0

Table 1—4-radial vertical monopoles over average ground.

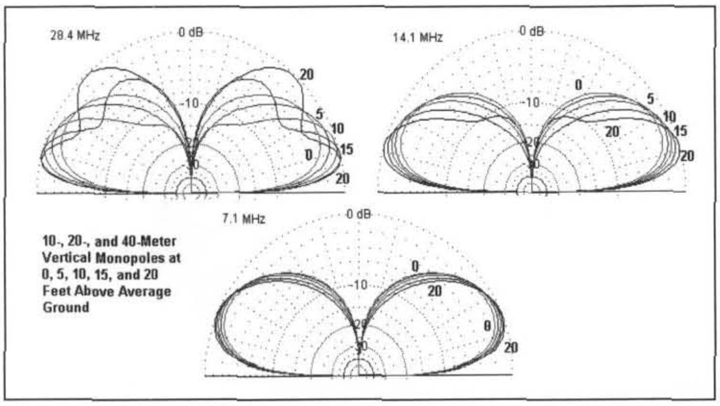


Figure 3—4-radial ground-plane with radials that slope toward ground up to 45 degrees.

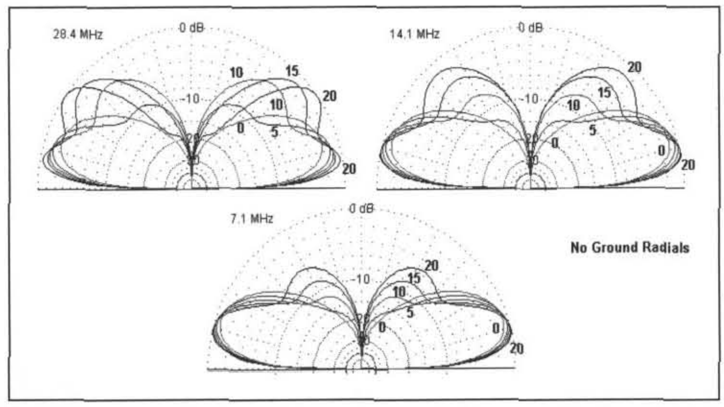


Figure 4—Vertical dipole with no radials.

shortened and loaded, the general patterns of the analysis will apply.

The variations in patterns created by elevating a vertical antenna may seem subtle, but they can become important under certain operating assumptions. For our small sample, we shall take vertical monopoles using 4 radials—about the average size radial field used for most field expeditions. As we elevate the antenna base from ground level past 5, 10, 15, and up to 20 feet above average ground, we shall droop the radials back toward the ground. In part, this move reflects using the radials also as part of the guying system. The drooping radials also let us set the impedance close to 50 ohms for a direct match with coax. Let's look at the information in tabular form and as a series of overlaid elevation patterns. The abbreviation 'wl' means wavelength.

Clearly, the greatest change in pattern shape (Figure 3) and performance occurs on 10 meters, because each 5' of height is twice the change on 20 and 4 times the change on 40 in terms of wavelengths. On 40 meters, we acquire about a dB of gain and a lower elevation angle of maximum radiation, also called the take-off or TO angle. On 20, the gain increment is greater, as is the lowering of the elevation angle. On 10 meters, we see more radical changes in the elevation pattern, most notably the emergence of the higher lobe until it becomes also the strongest lobe.

Whether the 10-meter pattern at 20' is useful depends upon the operating goals. On DXpeditions, the pattern only brings in noise to a remote island. However, for landlocked field operations looking for shorter- and longer-range contacts, the higher-angle radiation may be beneficial. The double entry for 20' on 10 meters indicates the angle and strength of both the lobes of the pattern.

We may perform a similar analysis for vertical monopoles, which will be twice as long above the base height as the monopoles. Still, they are usable and generally require no radials. So let's see what happens. Remember that the feedpoint of a vertical dipole with the same base height as a corresponding monopole is about where the tip of the monopole falls. Therefore, we should expect to find lower TO angles. As well, the vertical dipole, when sufficiently above the ground, will show a typical dipole feedpoint impedance of about 70 ohms. The feedline should come away from a dipole at right angles for as far as may be feasible. However, I have heard of successful vertical dipoles that run the coax inside the lower end (assuming the use of a tube), with a 1:1 choke/balun at the point of exit. As with all field antennas, you should test all assembly, disassembly, and operating details long in advance of carrying the antenna to the field.

Once more, we find the greatest variation in operation on 10 meters, with lesser changes on 20 and 40 meters. The gain of the dipoles is slightly higher than that of the monopoles, except at the highest altitude. Indeed, we can see a diminishing gain advantage as we raise each dipole higher. That phenomenon occurs because each of the monopoles is becoming a dipole the higher that we raise it. The drooping radials are no longer a symmetri-

Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
Band: 10 Meters (28.4 MHz)				
0	---	0.40	19	96 + j 49
5	0.14	1.23	16	71 – j 4
10	0.29	1.42	13	70 + j 2
15	0.43	1.59	12	73 + j 2
20	0.58	2.38	35	74 + j 5
Band: 20 Meters (14.1 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
0	---	0.03	19	100 + j14
5	0.07	0.56	17	80 - j 2
10	0.14	0.84	15	72 - j 0
15	0.22	0.93	14	70 + j 4
20	0.29	0.94	13	71 + j 7
Band: 40 Meters (7.1 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
0	---	-0.24	19	111 + j 22
5	0.04	0.08	17	90 + j 3
10	0.07	0.24	16	81 + j 0
15	0.11	0.32	15	76 + j 1
20	0.14	0.35	14	72 + j 3

Table 2—Vertical dipoles over average ground.

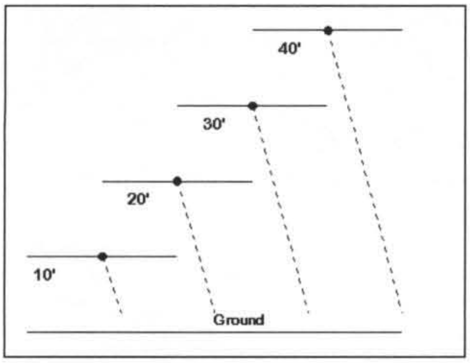


Figure 5—Representative effects of heights on dipoles and doublets.

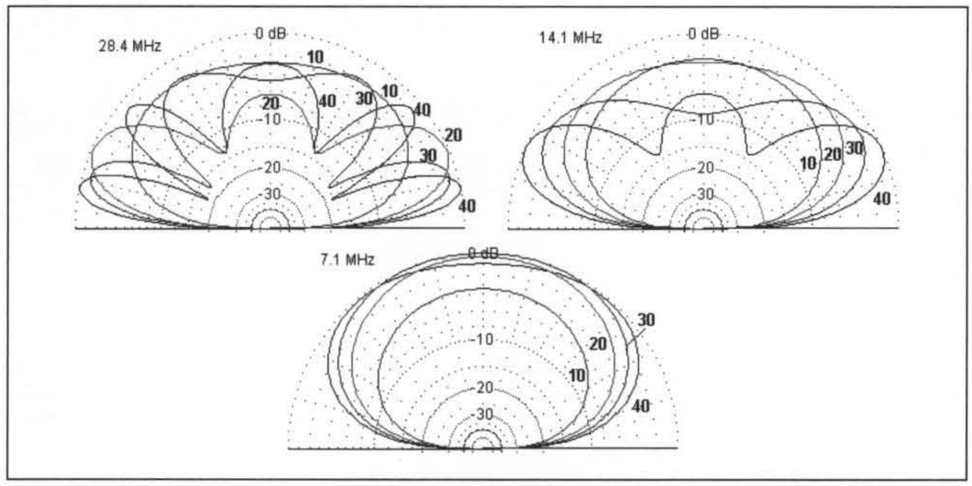


Figure 6—10/20/40M horizontal dipoles 10/20/30/40 feet above average ground.

cal horizontal affair that cancels out its own radiation. To the degree that the radials have a vertical component to their slope, they also contribute to the vertically polarized radiation of the entire antenna. The VHF Ringo Ranger, with its conical lower section, is actually a form of a vertical dipole.

The patterns in Figure 4 show that the vertical dipole's greater overall height and higher feedpoint create pattern variations more quickly than do the corresponding monopoles. Even the 10-meter dominant lobe at a base-height of 20' has a lower TO angle than the corresponding lobe of the monopole. As usual, the changes are less severe on 20 and 40 meters.

Even with a base near ground level, the vertical dipole has one more advantage over a monopole with the same base height, especially where the operating field is not a completely clear plane. There is a widely reported phenomenon that goes under many names. I tend to call it "RF-eating shrubbery," based on my own experience of moving an old Hy-Gain 14AVQ from ground level to the rooftop of a one-story home. With only 4 radials per band, performance improved dramatically, far more than the tables would suggest. A vertical dipole tends to avoid the RF absorbers by having its feedpoint elevated to begin with. Hence, commercial antennas that are vertical dipoles or simulate them by having the high current area of the antenna elevated for each band, have become very popular.

Although the effects of height on verticals may seem somewhat subtle, they become dramatic applied to horizontal dipoles and doublets. Figure 5 shows a small sample of dipoles at heights of 10, 20, 30, and 40 feet above average ground. We shall sample near-resonant dipoles at 10, 20, and 40 meters at each of these heights, and then show the corresponding elevation patterns. In this case, however, the patterns are taken along the axis of maximum gain, since a dipole pattern at field heights may range from a broad oval to, at best, a bi-directional peanut at the maximum height.

As the tables and Figure 6 show, height is a necessary ingredient in maximizing the performance of a dipole or any other horizontally oriented antenna. The higher the antenna in terms of wavelengths above ground, the lower the TO angle of the lowest lobe and the more complex the lobe structure. The 10-meter patterns clearly show this phenomenon. In fact, a horizontal antenna does not become truly competitive with a good vertical until it is at least 3/8 wavelength above ground. In addition, if you examine the tables, you will discover that the feedpoint impedance of a dipole does not begin to stabilize until we reach the 3/8-wavelength or greater height. For heights below about 1 wavelength, there are heights less favored. If you examine the 10-meter patterns, you will discover that the 20' height shows a higher maximum gain than the 30' height. The 30' height is close to 7/8 of a wavelength, where so much energy goes upward that the lowest lobe suffers a bit.

We have performed our rudimentary examination of the effects of height on antenna performance using full-size dipoles and monopoles. However, for the sake of weight and convenient assembly,

Band: 10 Meters (28.4 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/- jX ohms)
10	0.29	5.68	51	85 +j 6
20	0.58	7.67	24	64 –j 5
30	0.87	7.09	16	78 –j 4
40	1.15	7.84	12	69 –j 0
Band: 20 Meters (14.1 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/-jX ohms)
10	0.14	5.33	87	61 +j 11
20	0.29	5.72	50	86 +j 1
30	0.43	6.59	32	77 –j 17
40	0.57	7.33	24	63 –j 9
Band: 40 Meters (7.1 MHz)				
Height (ft)	Height (wl)	Gain (dBi)	TO Angle (deg)	Feed Z (R +/-jX ohms)
10	0.07	2.55	88	53 +j 1
20	0.14	5.71	87	61 +j 10
30	0.22	6.02	75	78 +j 9
40	0.29	5.86	50	88 –j 4

Table 3—Horizontal dipoles over average ground.

Antenna	Length (ft)	Load: L (uH)	R (Ohms)	X (Ohms)	Gain (dBi)	TO Angle (deg.)	Feed Z (R +/- jX Ohms)
Full-Size	17.5	---	---	---	-0.56	27	42 + j 2
3/4, Base	13.125	1.422	0.42	126	-0.78	28	19 - j 0
3/4, Mid-El	13.125	2.427	0.72	215	-0.78	27	29 + j 0
1/2, Base	8.75	3.240	0.96	287	-1.59	29	9 + j 0
1/2, Mid-El	8.75	5.395	1.59	478	-1.31	29	17 - j 0

All antennas use 1" diameter verticals with 15' long, 0.2" diameter radials. Length refers to the vertical element. All loading coils have a Q of 300.

Table 4—Monopole size tests at 14.1 MHz.

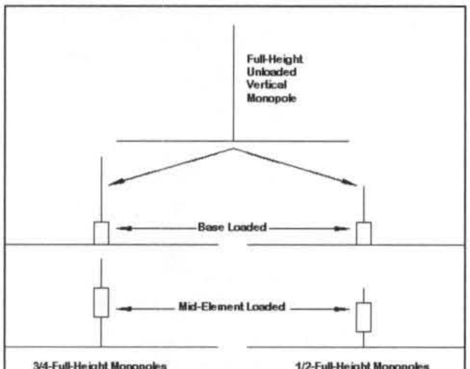


Figure 7—The effects of size (or loading) on the performance of ground-mounted vertical monopoles.

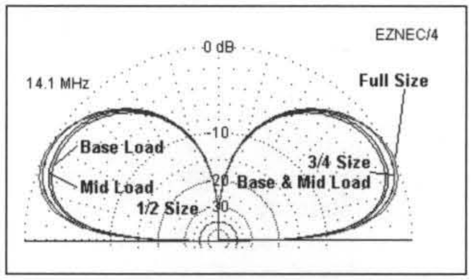


Figure 8—Elevation patterns: 20-meter vertical ground plane, ground level with average soil, full-size, 3/4 and 1/2 size with base and mid-element loading.

many field operators have obtained multi-band, shortened antennas. So our next question is whether size makes a significant difference, that is, significant enough for us to rethink our field antennas.

The Bigger, the Better—Up to a Point

In fact, size can make a sizable difference. As we did for our look at height, we shall explore the effects of size for both vertical and horizontal antennas. The vertical will be a 20-meter vertical monopole at ground level. We shall use the full-size antenna as our baseline data and then shorten the antenna in two steps to 3/4 full size and to 1/2 full size. For each of these two cases, we shall place the load both at the base and about halfway up the vertical element, using full-length radials throughout. Then we shall do the same for a horizontal 20-meter dipole at a height of 20'. We shall use center and mid-element loading for lengths that are 3/4 and 1/2 of the full-size antenna.

Normally, we use inductors (coils) to shorten an antenna, and coils have some losses that are a function of the Q or ratio of series reactance to series resistance. Most loading coils have a Q of 20 to 250, but I shall use a Q of 300 for our test models. Since the required loading will differ for the vertical and horizontal antennas, let's take them one at a time. Figure 7 shows in sketch form the vertical tests.

The Table 4 summarizes the results of the test models, using the full-size monopole as a basic reference and then proceeding to the 3/4 and 1/2 size versions with base and mid-element loading coils. The mid-element coils were placed exactly half-way up the monopole, although a practical antenna may vary this position considerably. The coil reactances were varied until re-establishing resonance within +/-j1 ohm.

The move from full size to 3/4 size results in a gain reduction of about 0.2 dB. However, a further reduction to half-size increases the loss of gain to around a full dB. The rate of gain reduction increases more rapidly as we get still shorter than half-size. You can estimate the effects of these losses from the patterns in Figure 8. The advantage of using mid-element coils is less a matter of gain than it is a matter of having a higher, easier-to-match feedpoint impedance than we get with base loading coils. However, to obtain that advantage, we normally encounter greater mechanical complexity, which often translates in the field to a greater tendency to break in the middle of an operating session.

Reduced size vertical monopoles are certainly usable, but full-size versions are somewhat better and have a broader bandwidth. In fact, the operating bandwidth--using the usual 2:1 SWR standard--decreases according to the loaded element length. However, since we assume the use of an ATU at the base of the antenna, SWR will not normally be a problem, and added losses will be only those inherent to the particular type of network used in the tuner. (If you simply use coax to the antenna base and place tuner at the operating table, you will have a small additional loss due to the SWR level on the cable, and the

Antenna	Length (ft)	Load: L (uH)	R (Ohms)	X (Ohms)	Gain (dBi)	TO Angle (deg.)	Feed Z (R +/- jX Ohms)
Full-Size	33.88	---	---	---	5.74	50	85 + j 0
3/4, Center	25.41	4.309	1.26	379	5.42	51	40 + j 0
3/4, Mid-El	25.41	3.968	1.16	349	5.45	51	59 + j 0
1/2, Center	16.94	9.947	2.92	875	4.66	50	18 - j 1
1/2, Mid-El	16.94	9.095	2.67	800	4.76	52	34 + j 1

All antennas use AWG #12 wire. All loading coils have a Q of 300. Center loading coils are single units.
However, mid-element loading uses 2 coils each of the size listed. Hence, the total loading is twice the values shown.

Table 5—Dipole size tests at 14.0 MHz.

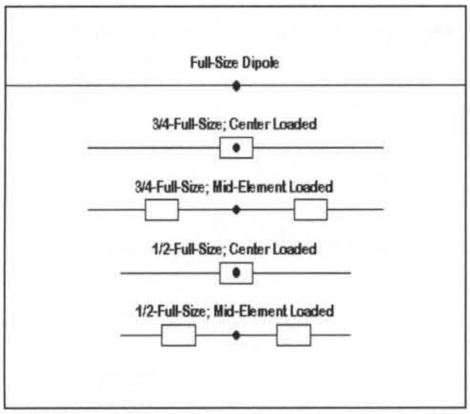


Figure 9—The effect of size (or loading) on horizontal dipoles.

total loss from this source will be a function of the cable length. Such cable losses will vary with the frequency of operation, increasing as one increases frequency.)

The dipole tests all used AWG #12 (0.0808" diameter) copper wire at a test height of 20' above average soil. The antennas were level, something that may not be completely feasible in most field situations if we tie off the ends of the antenna using available structures. Figure 9 shows the layout of the tests, and Table 5 tabulates the results.

We see the same pattern in the loaded, shortened dipole that we saw in the monopole. Total mid-element loading requirements are nearly twice the center-loading requirement in terms of coil size and losses. Hence, for any given level of shortening, mid-element loads to not significantly increase gain, although they do set the feedpoint impedance at a more usable value if we do not use a tuner. Both center-loading and mid-element loading coils present mechanical challenges by adding to the complexity and weight of the antenna structure. The more complex the mechanical structure of a field antenna, the greater the likelihood of difficulties during an extended field operation.

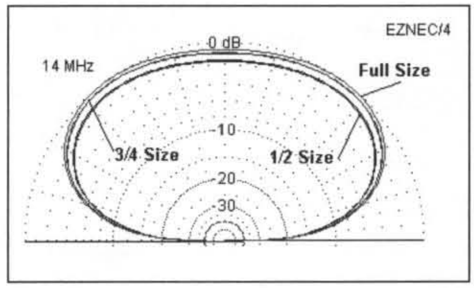


Figure 10—Elevation patterns: 20-meter dipole 20' above average soil, full-size, 3/4 and 1/2 size with center and mid-element loading

Nevertheless, as the patterns in Figure 10 show, we do not lose much by way of pattern. The worst-case gain is about 1 dB lower than the gain for a full-size dipole, about the same drop that we encountered with the vertical monopole. Do not try to directly compare the patterns for the monopoles with those for the dipole, since the outer ring in each case refers to a different gain level. However, you may wish to estimate the dipole gain at an angle of 25 degrees and compare that estimate to the maximum gain of the monopoles at their TO angles. The dipoles are down by about 2 dB or so and thus have more strength along the axis of maximum bi-directional gain than the monopoles have in their omni-directional patterns.

We can effect considerable simplicity in compact dipole design by eliminating the loading coils. Instead, let's complete the antenna simply by dropping the elements downward once we have created a half-length dipole. The arrangement, which we can call an inverted-U, looks like the outline sketch in Figure 11.

The general dimensions shown for a 20-meter inverted-U are for AWG #12 wire, although they tend not to change much for any size elements. A single mast would support a tubular horizontal element with drooping end wires. Perhaps the one disadvantage of this design is that it requires a 20' mast to keep the ends of the elements well above the level that people can reach. Even at QRP power levels, the voltage on the ends of a dipole can reach uncomfortable, if not dangerous, levels.

The inverted-U performs a little better than a half-size dipole at the same height when that dipole uses loading coils. The performance is a little less robust than a 3/4-size or a full-size dipole. The elevation pattern shown in Figure 12 provides the relevant data. It also shows the –3 dB or half-power points for the antenna. You may generally apply these angle values to any of the dipoles that we have examined.

The azimuth pattern shows that the inverted-U has significant, but not overriding vertically polarized radiation from the drooping ends. Hence, for any given height, its azimuth pattern—to the right in Figure 12—will be a bit more oval than corresponding patterns for loaded dipoles.

The design frequency for the inverted-U modeled here is 14.175 MHz, the center of the band. The reason that I used this frequency rather than some frequency closer to the CW end of the band is simple. Using linear elements rather than loading coils provides a very broad SWR curve, while the drooping elements reduce the feedpoint impedance from the 70 ohms that we asso-

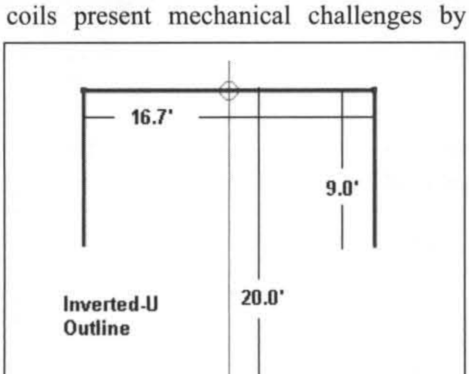


Figure 11—Inverted-U outline.

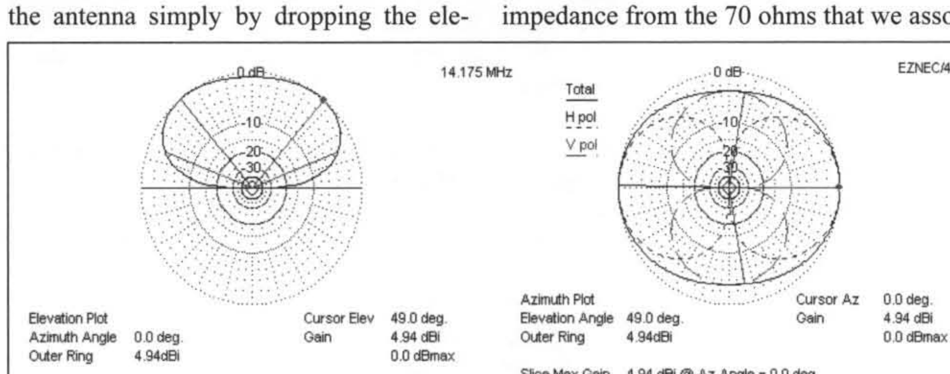


Figure 12—20-meter inverted-U at 20' top height: elevation and azimuth patterns and data.

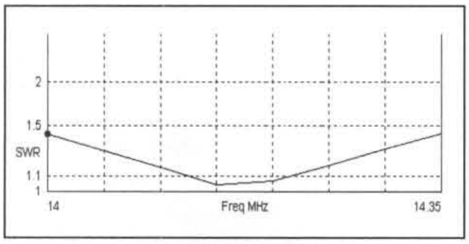


Figure 13—20-meter inverted-U 20' top height 50-ohm SWR curve.

ciate with a full-size linear dipole down to just about 50 ohms. Figure 13 shows the modeled SWR curve for the inverted-U.

Before we close the book on our five principles of field antennas, we shall return to the inverted-U to show you how to build a 5-band version, suitable for 20 through 10 meters, an antenna that will be about 36" long for carrying. And the cost will be well under $50, even if you buy all of the parts (excluding the mast) new. However, before we go there—and perhaps to create a mood of suspense—let's return to the general issue that surrounds my note to keep the ends of the inverted-U element well above the hands of even the tallest person at the field operation site.

As the Guy Said, Safety Above All Else

Safety is often a remote thought at remote field operations. However, it is much easier to plan safety into a field operation than it is to transport an injured person from the remote site back to civilized territory that has medical care. Hence, it must be an integral part of every planned field operation.

Figure 14 sums up some of the most overlooked safety matters in a field set-up. The safety principle that we have mentioned is illustrated by the stick figure and the antenna end: a safe spacing between the furthest reach of a person and the end of an antenna. Antenna ends are normally high-voltage points and must not be touchable, even accidentally, during operation.

The figure also points to a few other safety features. The simple word "guys" signals the need to make sure that everything you erect in the field should be mechanically secure from any anticipated breeze. The proper location of an antenna is sufficiently remote from the operating site so that if the antenna falls, it cannot fall on anyone—or on any expensive equipment. Having taken that precaution, you should also brace the installation so that it has the least chance to fall. In most cases, 3 or 4 guy ropes will adequately stabilize anything tall, including masts and vertical antennas. If the vertical structure is more than 20' tall, then use two sets of guys, one every 10' upward. 3/16" nylon rope is light enough for you to carry extra in the field pack to replace worn guys. Also carry a cigarette lighter to seal the rope ends to prevent fraying.

No guy rope or wire is any better than its tie-down. Do not depend upon finding rocks or limbs at the field site to use as tie-down weights. Bring long stakes that you can drive into the ground. The longer—within carrying limitations—the better. As well, learn one or two good knots that do not slip, and apply those knots to the rope-to-stake junctions.

Figure 14 also shows several pennant-shaped items called flags. It does not require the dark of night or a morning fog to make the visible invisible. There is a fog caused by the excitement of the venture that blinds every participant at one time or another. Murphy's Law says that the fog will strike when an individual is nearest to something that will stop the field operation in its tracks. You may not be able to totally defeat Murphy, but you can make his task more difficult. Place flags on the guys at the most visible level. An added flag on the tie-down stake is not a bad idea to prevent a trip that will bring down the antenna.

Add flags on short stakes along any cable run to forewarn wanderers of its presence. A snagged cable can break—usually at the connectors. As well, it can drag down the antenna. On the other end of the line, it can drag the equipment off the operating table. The figure only shows a ground-level coax run. You should add flags to any twinlead rising from an ATU up to a doublet overhead. Indeed, make a general rule for yourself that anything that you may encounter from toes up to outstretched hands gets a flag.

Flags need not be formal pennants. At a fabric store, look for remnants of the brightest, most iridescent cloth that you can find. A yard of this material will be light to carry and allow you to rip strips for flags that only the absolutely color-blind person can miss.

Our focus on making the site elements safe from accidental encounters should not exclude the other safety factors that we normally think about. All equipment must be electrically safe, with no exposed electrical contacts. If a power supply or battery has such contacts, invent a cover for them to prevent accidental contact—either by a person's fingers or the wandering screwdriver shaft. A shorted battery means a short field trip, not to mention damage to your favorite screwdriver.

Do not overlook the mechanical security of your equipment. Much low-power equipment is also very light. Add a power and RF cable, and you have situation that we can call a drag—right off the operating table to the ground. You may use any number of techniques to prevent gravity from making your equipment disappear. Some field operators develop compartmentalized cases to hold all of the gear in place during use. You may also create a base-plate and use L-brackets to hold down the gear. You may also create a table-top with shallow bins into which each item fits. The exact system that you create will vary with the type of operation and the amount of equipment to be anchored.

Anchoring equipment requires pre-trip planning. In fact, every facet of making a field operation safe and secure demands as much time devoted to thought in advance of the trip as will be taken by the trip itself. These brief notes are only designed to alert you to the possible issues and a few ways of handling them. The actual number of ways of making a field operation safe and

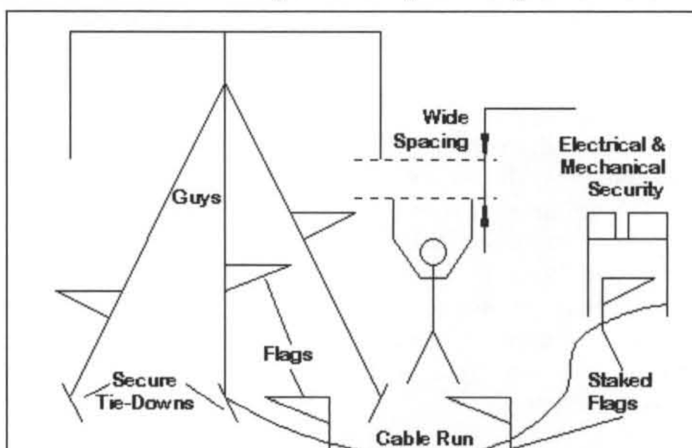


Figure 14—Some safety thoughts.

secure are as many and varied as the creative minds of field operators.

Pre-planning should include two important steps. The first is to clean everything that will go on the trip. This activity should focus on anything in the set-up that will make metal-to-metal contact, including connectors and joints in any antenna structure. The second step follows onto the first: test everything at home to ensure that it has the highest probability of working at the site.

Nothing blunts a safety principle like too many words. As incomplete as this listing may be, I shall bring it to an end here, hoping that I have said just enough for you to carry on from this point. Forethought is your greatest weapon against Murphy's Law that reads "If it can happen and it ain't good, then it will."

Avoid nuts (and bolts)

Accidents are not the only events that bring field operations to a screeching halt. One of the most trivial but effective ways to stop an operation is to lose a nut or bolt in the grass or dirt and never find it again. So invent ways of preventing that loss. I use two rules.

1. Any nut or bolt used in the field set-up must be permanently tightened and never loosened.
2. Every field connection must use something other than a nut and bolt.

There are a few wing-nut connections for ground wires and the like that may be unavoidable. For these, I add a dab of Plasti-Dip to the end of the threaded contact to prevent the wing nut from coming off completely.

However, let's use this final principle to do two things. First, I shall introduce you to two of my favorite field connectors. They are not the last word in connections for field antennas, but they may inspire you to more closely examine the available hardware to develop even better ones for your type of field operations.

Second, to give you an idea of how we can apply at least one of these field connection-makers, we shall return to the inverted-U antenna and see what it may have to offer. Again, it is not the last word in field dipoles, but it has some features well worth considering, including its light weight, common materials, and low cost.

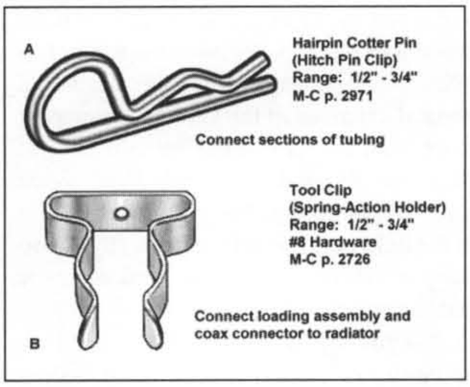


Figure 15—Key hardware for a no-bolts field antenna.

Figure 15 shows two of my favorite hardware items for any type of field antenna using aluminum tubing. The data includes a reference to the McMasters-Carr catalog (http://www.macmasters.com). However, many sizes may be available in the specialty hardware section of home centers. The catalog will present you with a quandary. The hardware is available in both stainless steel and plated versions. Stainless steel offers a rust-proof finish, but plated hardware has more sizes and is half the cost.

Suppose that we are constructing an antenna using aluminum tubes and need to bridge a gap with a component, such as a coax connector or a loading coil. Of course, we mechanically plug the electrical gap by using a short length of fiberglass rod or tube, or a CPVC tube. The tool clip, sometimes sold as a "broom-handle" clip, solves our bridging problem, as shown in Figure 16.

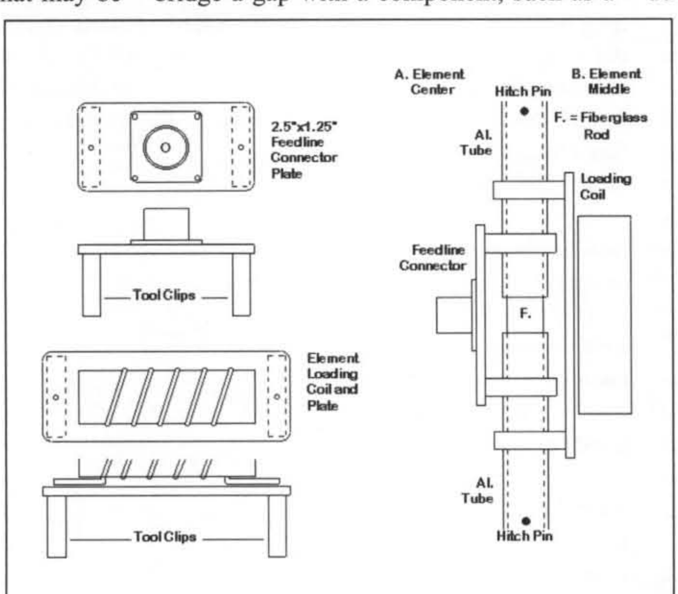


Figure 16—Tool clip applications.

With a small piece of Plexiglas, we can create a plate to hold a connector or coil. The clips form the mechanical connection to the tubing and the component terminals. Use 3/16" to 1/4" thick Plexiglas, because the flat end of the clip is not really flat. In fact, it is curved and springy, so that when you (permanently) nut and bolt it to the plate, it exerts considerable bending pressure on thinner plastics. Flattening the mounting portion presses the clip portion together so that it makes excellent mechanical and electrical contact with the tubing.

My preference for home-made antennas is already showing, and wherever possible, I like to use aluminum tubing. However, I long ago learned not to use just any tubing, just as I learned to build my own antennas to be as good or better than anything on the commercial market. So I use 6063-T832 tubing for almost every antenna project, except when I need aluminum rods, which are available in 6061-T6. The aluminum stock is available, if not locally, from mail order houses such as Texas Towers, and comes in 6' lengths. 6063-T832 tubes have 0.58" walls, which means that you can nest the tubes in 1/8" diameter increments. Figure 17 shows a typical nest of tubes from 0.75" diameter down to 0.375" diameter, with a quarter-

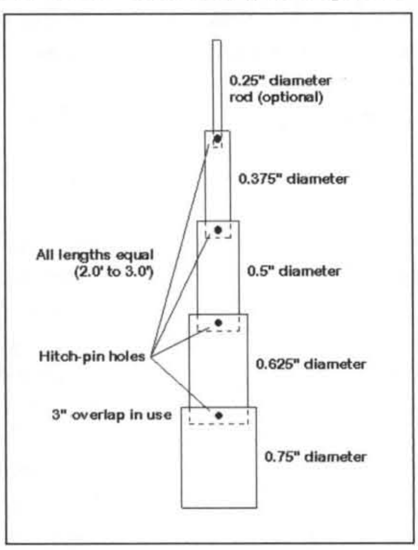


Figure 17—Nesting lengths of 6063-T832 aluminum tubing for easy storage and transportation.

6063-T832 Tubing		6061-T6 Rods	
Diameter	**lb/ft**	**Diameter**	**lb/ft**
0.375"	0.044	0.1875"	0.032
0.5"	0.095	0.25"	0.058
0.625"	0.104		
0.75"	0.127		
0.875"	0.150		
1.0"	0.202		
1.125"	0.229		
1.25"	0.255		
1.375"	0.283		
1.5"	0.309		

Table 6—Aluminum tubing weight per linear foot.

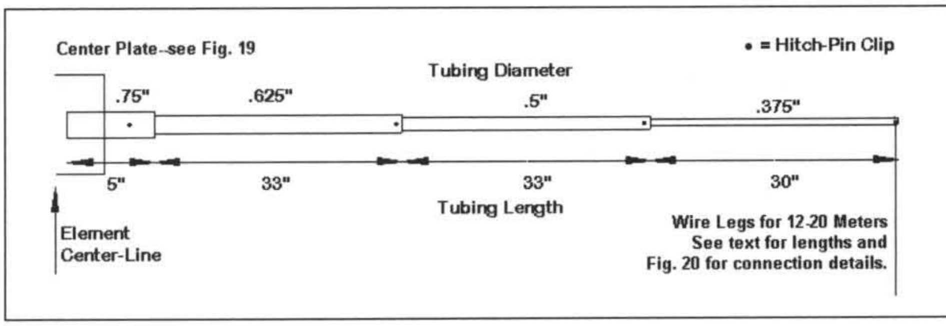


Figure 18—Inverted-U half-element structure.

inch rod thrown in for good measure.

If we carefully de-burr and clean both the inside and outside of the tubes, they will slide together when not in use to make a compact single item to carry for a monopole—or a pair of transportable items for a dipole. Do not file the cut tube edges. Instead, sand them smooth with fine aluminum oxide sandpaper to avoid leaving particles of another metal on them. Periodically clean the outsides with a plastic pad and clean the insides with a long-handle bottle-brush. Do not use a lubricant to facilitate nesting, since we shall depend on the metal-to-metal contact of clean aluminum for electrical contact between sections of an element.

Some folks who have only used heavier aluminum conduit for antenna elements do not realize how light a 6063-T832 element can be. Table 6 lists the weight per foot of each size of tubing, along with the weight of some aluminum rods. From the table, you can estimate the weight of almost any kind of element you may wish to make and then add in the weight of any loading or center-structure that you add.

I included some larger tubing sizes, because someone might wish to design a nested mast composed of tubing sections. However, such a mast can hold only the lightest dipole assembly and requires guying at least every 10' above ground.

To form the basic element for our inverted-U, let's create a full-size 10-meter dipole. Figure 18 shows the basic structure.

The 3/4" section to the far left will be part of the center-plate assembly that we shall show separately. We only need to note here the hole for the hitch-pin clip that we shall use at each junction to fasten the sections together. Nested, each half-element is only 36" long, using a 3" overlap at each junction. Open, we use hitch-pin clips to mechanically fasten the sections. Each hole requires that we carefully drill through both section of tubing on one operation to ensure a tight-fitting hole and accurate alignment. You may wish to mark each hole on the joining tubes in a way that does not interfere with nesting. A jig made from scrap wood and some form of drill press makes the drilling of perfectly aligned holes much easier.

The element—composed of 2 half-elements and the center plate—will cover the first MHz of 10 meters with less than 2:1 SWR using the tubing sizes and lengths shown. For each of the bands from 12 through 20 meters, we need to add wire extensions that hang down and that we can readily change. However, let's first complete the dipole with a center plate assembly that is permanently assembled and hence, has a few nuts and bolts.

I used a scrap of 1/4" thick polycarbonate that I happened to have as a based for the center assembly, as shown in Figure 19. I also had stainless steel U-bolts, so I pressed them into service to fasten the plate to the mast. However, you may substitute a short mast section—either metal or PVC—and use single bolts and self-locking nuts to fasten the mast and plate together. In fact, you may develop an entirely different dipole center assembly, so long as it has a means of connecting the cable to the antenna and a way of connecting the element halves to the center gap and junction.

1/2" nominal CPVC fits inside the short lengths of scrap 0.75" tubing. The tubing keeps the element halves aligned and minimizes the necessary hardware to fasten the element to the plate. I used a short section of 1" by 1" by 1/16" aluminum L-stock to hold the female coax connector. The entire assembly weighs under 1 lb, including U-bolts. The entire remainder of the element, including hitch-pin clips weighs less than 2 lb. So we have a 3-lb 10-meter dipole.

Before going any further, let me note

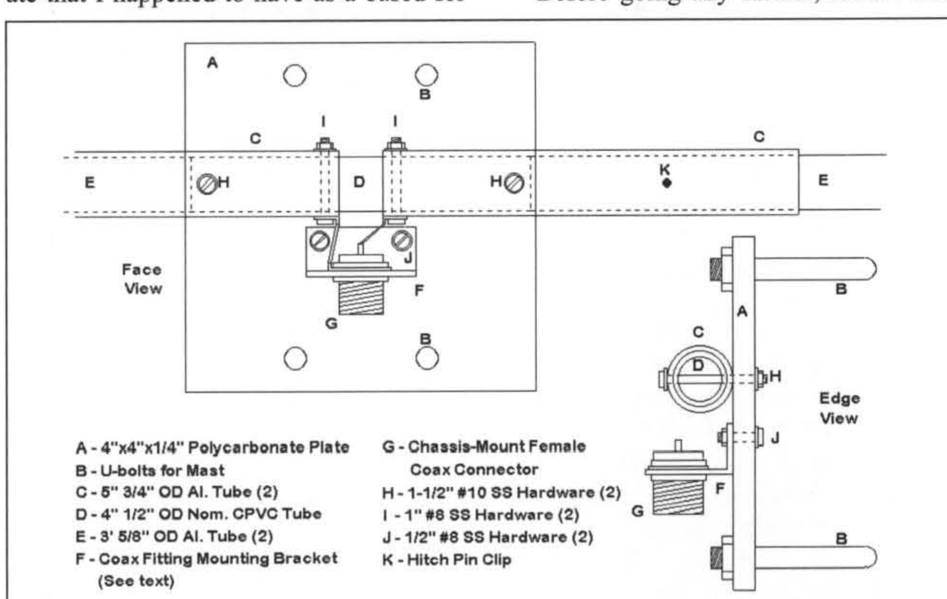


Figure 19—Element and feedpoint mounting detail.

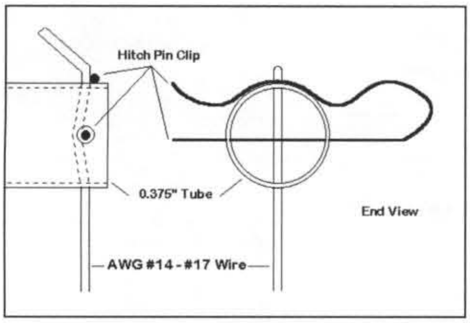


Figure 20—Simple vertical-wire-to-tube clamping scheme.

Band	Wire Length (inches)	Modeled Performance at 20' Above Avg Gnd:	Gain (dBi)	Elevation Angle (deg)	Impedance R +/– jX (ohms)
10	-----		7.6	24	65 –j 2
12	16		7.2	27	67 –j 8
15	38		6.4	32	69 –j 8
17	62		5.7	38	65 –j 4
20	108		4.9	49	52 +j 4

Table 7—End-wire lengths need for the inverted-U.

an additional advantage of hitch-pin clips as a mechanical fastener. They are considerably larger than any screw or nut or bolt that you might use to join element sections. As a result, they do not get lost on the ground quite so easily. However, let's go one step further in the hardware preservation plan. You can add brightly colored tape flags to the loop of each pin. With that added precaution, you will have to dig a hole and bury a clip before you can lose it!

However, the clips provide mechanical fastening of the sections. Electrical contact is a matter of clean aluminum meeting clean aluminum. If you clean the element sections before each field adventure, you will have no problems at all. However, do NOT use this technique for a home antenna that will stay in the weather for months and years. The oxide build-up will gradually increase the resistance between tube sections and degrade antenna performance.

Now we are ready to expand the coverage of the antenna for all bands from 10 through 20 meters. For 12-20 meters, you can add vertical wires to the ends of the 3/8" diameter end pieces of tubing. Almost any wire from AWG #18 up to AWG #14 will do. A convenient wire to use is AWG #17 fence wire, which is cheap, plentiful, and very adequate to the task. Figure 20 shows how I attached my wires to the end of the 10-meter element, once more using a hitch-pin clip.

I drilled a pair of holes through the tube at right angles to each other. One through-hole is the size of the straight section of the hitch-pin clip. The other is just large enough to pass the end wire. With the wire in place and bent over slightly, I install a hitch-pin clip, pressing the wire to one side as the clip goes through its holes. The combined bends make a very secure mount and good electrical contact. However, when I remove the clip, the end wire pulls right out.

I have pairs of end wires for each band wound on empty plastic ribbon spools. I tug them straight before installation, but slight curves remaining in the wires have no affect on the antenna performance. The wires are remarkable consistent in length, whatever the wire size, since the tubing sections dominate the high-current section of the antenna. The following table provides the length needed for each band, using the dimensions set for the 10-meter basic dipole. I have added the modeled performance on each band for reference, assuming a height of 20' above average soil. Remember that the 20' height is necessary on 20 meters as a safety measure.

A spool of aluminum fence wire contains an endless supply of replacement end wires, in case you break one, step on another, and inadvertently use a third as a tie-down. I recommend a non-conductive mast, if you have one, to prevent an accidental resonance on one or another band. With a 20' mast, 15-meters is the band most likely to show some SWR anomalies due to coupling between the end wires and the mast. As noted in the safety section, use guys on whatever mast you take to the field. Do not rely on tripod bases if you plan to have the antenna up more than a few minutes.

The inverted-U will perform as well as any commercial field dipole on the market. The big difference is that you will have a difficult time spending $50 on the inverted-U, even if you have to buy a double pocket full of hitch-pin clips to meet the minimum order requirement for a mail-order house.

I present the invert-U as only one of many possible light-weight field antennas that you can build yourself. Using the same techniques, you can build vertical monopoles, including loaded versions for 80, 40, and 30 meters. Tool clips can hold separate loading coils for each band. You can construct base supports from PVC. (See recent issues of *QRP Quarterly* for the application of these techniques to vertical monopoles. *QST* will eventually publish a complete background and construction article on the inverted-U. The basic idea is not new, but the use of hitch-pin clips to make it work is relatively recent.)

I respect the major commercial portable/field antennas on the market—and I have systematically modeled some of them. Still, there is no reason why the budget-minded QRP field operator cannot have a first-rate set of antennas to use on his trips and still have a few dollars left over to pay for the gas and some food for the adventure. At the same time, there is also no good reason why those antennas must depend on field assembly using easily lost nuts and bolts when there is so much hardware available that is both secure and hard to lose.

I have come to the end of my list of principles. They are all ideals, and the real circumstances of a portable or field operations may dictate that you have to violate one or more of them. With respect to performance, you at least will know what to expect by the amount that you violate principles like being high and large. If there is one principle that you should not violate under any but the most dire emergency circumstances, it is the principle of safety. We can replace good equipment, but not good operators and friends.

The Spartan Sprint Special 40M Transceiver

Steve Kavanagh—VE3SMA sjkavanagh1@yahoo.ca

This transceiver developed out of an earlier transceiver that itself began as an experiment to see if I could build a direct conversion receiver using only CMOS digital ICs. The answer to that question was yes, but the CMOS chips were too noisy as audio amps to permit hearing weak signals. After adding a single bipolar transistor audio preamp the performance was good enough that I added some more CMOS chips to turn it into a transceiver.

At 150 mW output, it seemed ideal for running off small batteries so I started using it for Spartan Sprints. Well, that was fun, but I have been a keen contester for years and the desire to place better took hold. The CMOS rig had not really been designed for minimum weight, so out came the data sheets, the calculator, etc. and the idea for the rig described here was hatched.

It was about this time that AA4XX's amazingly lightweight transceiver started winning the Sprints and was described in the Sojourner. However, I decided I wanted a "real" rig, in the sense that it had a case, knobs and connectors and did not require a screwdriver to operate. I also didn't want the extra pleasure of listening to shortwave broadcast stations at the same time, as AA4XX noted with his ultra-simple receiver.

I spent a couple of summers working at Radio Canada International, operating transmitters with more than a million times the output power of this rig! These short wave broadcast signals are really strong, so a more sophisticated design was called for. I started with the direct conversion design of the earlier CMOS transceiver and thoroughly revamped it to give smaller size, lower weight and lower receive current drain. It also has somewhat better receive performance as a result of not being limited to CMOS digital chips.

The Result

The transceiver that resulted has about 200 mW output, VFO-tunable over 15 kHz of 40M around the QRP calling frequency. It is sensitive enough to copy other milliwatters. Despite a lot of audio filtering, the selectivity still does not compare very well with most superhets, but is certainly usable. It weighs about 73g (0.16 lb) including the case. It draws about 14 mA on receive (no signal), a little more with a loud signal, and about 125 mA key down on transmit. The case (Figure 1) is 2.4"W x 1.5"H x 2.3"D, excluding knobs and connectors. It will easily run for a full Spartan Sprint on four AAA alkaline cells. Features include fast semi-break-in and sidetone.

And, in conjunction with a 26 foot vertical antenna, it achieved the goal of getting a respectable score in the Sprint with a fourth place finish in June, 2001.

Construction Approach

The following table summarizes the active devices used in each stage shown in the block diagram (Figure 2) and the construction technique used for each board. Each board holds only one or a few stages of the transceiver so I could design, build and test the rig in sections. The techniques varied from board to board depending on what styles of parts were available in my junkbox or from local electronics outlets.

All the surface mount (SMT) boards were cut with a knife (under a large magnifying glass) rather than etched, using 1/32 inch single-sided PC-board in most cases. The audio filter and PA board is the ultimate in this kind of board making, with a 16-pin small outline IC (.025" traces and spaces) as its centerpiece. This board took forever to make; I don't really recommend this technique for complex boards except to those of you who enjoy inscribing sacred verses on the heads of pins or similar exercises. I was off work due to an injury for several weeks and had time to spare when I did mine!

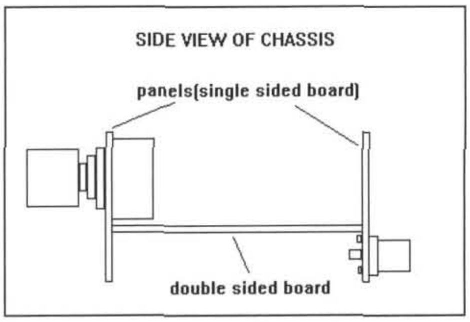


Figure 1. The chassis is made from printed circuit board material.

Not all the components on the surface mount boards are proper surface mount parts, but they were used when available to save space. For those of you who have a hard time finding SMT parts, you will be glad to learn that nearly all the ones I used were removed from junked cordless phones, cellphones, etc. found at surplus stores or ham fleamarkets.

All these small boards were mounted to the PC-board chassis by soldering components or small wire jumpers from the boards to the chassis. The chassis itself is made from a horizontal piece of 1/32" double sided board soldered to front- and rear panels made of single-sided 1/32" PC-board, with enough room for attaching the individual circuit boards both above and below the horizontal part of the chassis. Some circuits are also attached to the panels.

The tuning and volume pots are mounted to the front panel and the connectors are

Circuit	Active Devices	Construction
VFO/Buffers	74HC04(U9)	SMT/Manhattan/Live-Bug, double sided
Mixer	74HC4053(U1)	(opposite side of VFO board)
Audio Preamp	2n3904	SMT
Audio Amp	TL072(U2)+TL062(U3)	Veroboard + SMT parts on foil side
Muting Switch	4053B(U6)	SMT
Audio Filter	MC33174(U4)	SMT
Audio Power Amp	2N3904+2N3906	(same board as Audio Filter)
Transmit Driver	74HC02(U8)	Manhattan/Live-Bug combo
TX Power Amp	2N4400	(same board as Driver)
Keying Circuit	74C04(U7)	(same board as Driver)
Sidetone Oscillator	2 x 2N3904	SMT
Voltage Regulator	LM2931C(U5)	SMT

Table 1. Active devices and construction technique by stage.

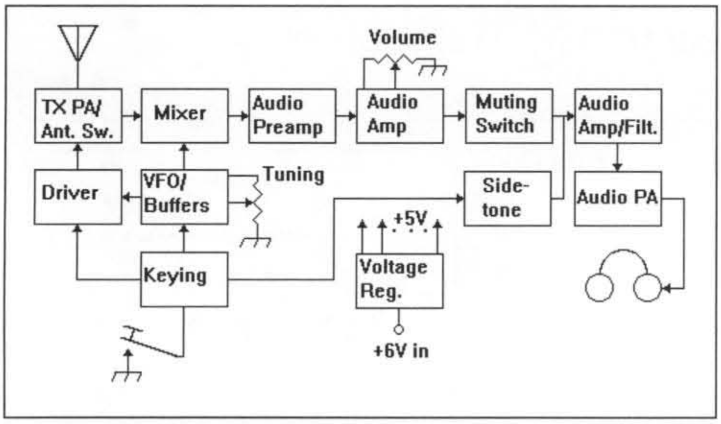


Figure 2. Block diagram of the Spartan Sprint transceiver.

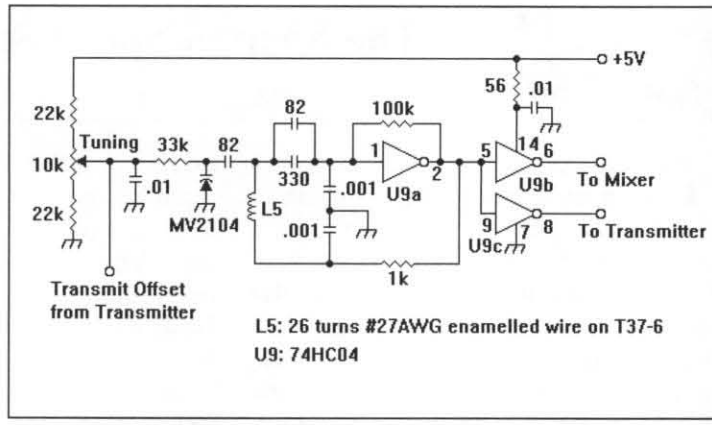


Figure 3. A CMOS inverter chip is used for the VFO.

mounted to the rear panel. I used an SMA PC-board mount jack for the antenna connector and 0.1 inch spacing headers for the power, key and headphones. There is a shield over the VFO made from a piece of tin-plated sheet metal obtained from a hobby store. It is soldered in place, which helps to make the chassis more rigid.

The case is made from balsa wood sheet. Three pieces of sheet are made into a U-shape, into which the chassis is dropped. A fourth sheet drops in on top as a lid. Both the U and the lid have small pieces of balsa glued to the inside which engage the rear panel to stop the chassis from sliding back and forth. This lid is held on simply by wrapping a couple of elastic bands around the whole rig; it's not very elegant but I haven't thought of a better way.

Circuit Details

It turned out that the schematics were more practical to generate if I didn't stick strictly to one schematic per board. I doubt if anyone will try to replicate this rig exactly so this should not result in too much confusion. One general note to keep in mind: all the unused inputs to CMOS chips are grounded, which is not shown on the schematics in all cases. Otherwise, IC pins not shown are left unconnected.

Let's start with the VFO (Figure 3). This is pretty unconventional, using a high speed CMOS inverter chip for both the oscillator and buffers for the receive and transmit chains. It is varactor tuned, with a single turn potentiometer used for control. To give a comfortable tuning speed with a small lightweight knob, the tuning range is limited to about 15 kHz, which is plenty for QRP contests. Note, however, that the component tolerances will easily move the VFO several kHz from where you think it will be so you will need to juggle the tuned circuit components to hit the desired part of the band. It is surprisingly stable, given that it uses a device which was never intended for RF use. I measured a turn-on drift at room temperature of about 130 Hz in 40 minutes after which it stayed within a 30 Hz range.

Now, on to the receive chain, starting with the mixer, shown in Figure 4. This is a CMOS switch balanced mixer, basically the same as many of the 74HC4066 designs that have been published. The 74HC4053 has the advantage of not needing two out-of-phase VFO inputs. The 6.8k resistor at pin 14 biases the output to about 2.5V. I didn't bother with proper wideband termination of the mixer; rather, everything above a couple of kHz is shorted to ground by capacitors.

The rejection of shortwave broadcast stations is reasonably good, though there is occasionally some breakthrough. The mixer is followed by a 2N3904 common-base audio preamp, biased to about 0.5 mA to give a 50 ohm input resistance. In an effort to get maximum gain the preamp biasing ended up not very stable, so a regulated supply is essential.

Next is the main high-gain audio amplifier, Figure 5, which uses a TL072, for reasonably low noise, followed by half a TL062, for low current consumption. Each stage is configured as a bandpass filter (actually combined low-pass and high pass filters. These op-amps are not really specified for 5V single-ended operation but seem to have no problems.

Figure 6 shows the muting switch; it uses a similar IC to that used in the mixer, but the lower speed version [without the 74HC in the part number]. The 470k resistor and 1 μF capacitor set the semi-break-in delay time. You can change these to set the timing you prefer, or perhaps use a 1 meg pot for variable delay. This circuit turned out to give nice quiet switching.

The sidetone oscillator, also in Figure 6, is a classic multivibrator using two NPN transistors but with keying applied to one

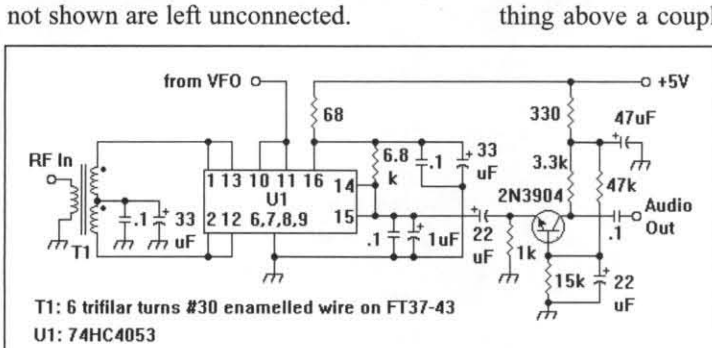


Figure 4. A 74HC4053 CMOS chip is used for the mixer.

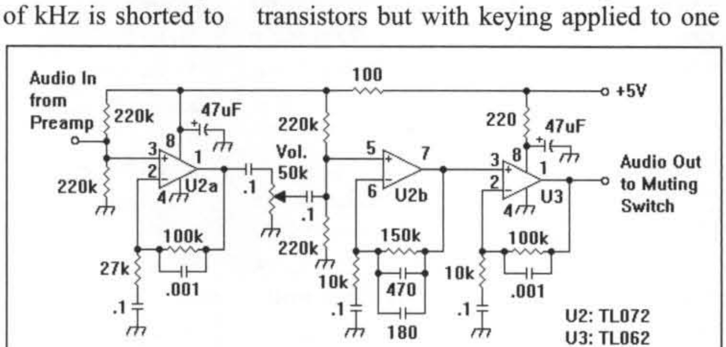


Figure 5. The main audio amplifier also provides filtering.

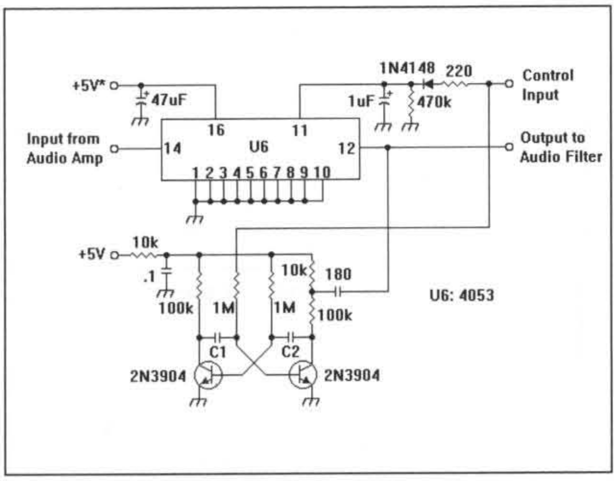


Figure 6. A regular, normal speed 4053 chip is used for a muting switch, and a pair of transistors provide sidetone.

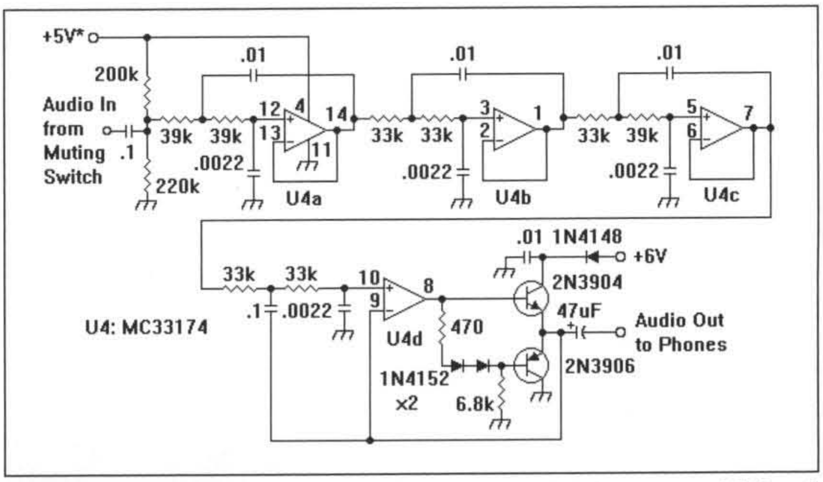


Figure 7. The audio power amplifier is preceded by some additional audio filtering.

of the bases, rather than the supply line, in order to minimize the current required from the control line. The two capacitors, C1 and C2, are around .001 µF, but can be changed to set the desired pitch.

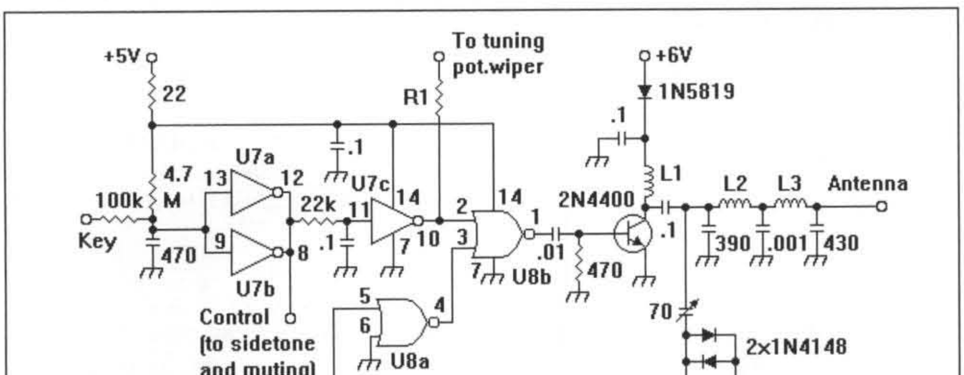
Following this is a quad op amp, Figure 7, set up for four more stages of audio filtering. The MC33174 was selected mostly because I had some, in surface mount packages, but it has the advantage of quite low power supply current drain and is specified for 5V operation. The last stage is the driver for a complementary-symmetry audio power amplifier. The output transistors are inside the filter feedback loop to keep the distortion down. Building the output stage from discrete components allows a significant reduction in the no-signal current compared to the classic LM386.

The current, and the distortion level, can be changed by playing with the biasing resistors and diodes for the output stage, but from my experiments there seems no need for more than 1 mA quiescent collector current if only headphone operation is intended. Much less is often sufficient for Walkman-style phones with both sides in parallel. The output stage is run directly from the battery (through a reverse-polarity protection diode) so the varying current of this stage will not pull the VFO supply voltage.

All the transmit circuitry is shown in Figure 8. The 74C04 provides various control functions driven by closing the key. It turns off the audio muting switch, turns on the sidetone, offsets the VFO by a few hundred hertz, and keys the transmitter. The input resistors and capacitors shown are for a touch key with no moving parts, which was slightly lighter weight than my smallest microswitch. For a normal key or keyer, the resistors should be reduced (perhaps by a factor of as much as 100) so they don't affect the length of dots and dashes.

Resistor R1 sets the transmit/receive offset frequency and will probably need to be selected to give the offset you want. A good starting value is 4.7 megohms. Two sections of a 74HC02 provide an extra VFO buffer and a keyed driver stage. The final is a 2N4400 in a pretty standard circuit. This transistor is run from the battery through a Schottky (low voltage-drop) reverse-polarity protection diode, so the varying current won't pull the regulated supply to the VFO. I tried both a 2N3904 and a 2N2222 in the final but the 2N4400 seemed best. I have no idea why, and the final still isn't very efficient so I recommend further experiments.

The voltage regulator selected was an LM2931C which is a low dropout voltage, low quiescent current type with built-in reverse voltage protection. (Figure 9.) As with most low-dropout regulators, it requires a high quality capacitor across the output for stability. I used a 47 µF tantalum electrolytic. Using a low dropout regulator allows the use of 5V regulated circuits with a 6V battery. The nominal 5V rail is actually at 4.8V, so with a dropout voltage on the order of 0.2V, the battery voltage can fall to 5V before regulator problems appear.



U7: 74C04 U8: 74HC02
All inductors #30 AWG enamelled wire. L1: 26 turns on FT23-43, L2 & L3: 18 turns on T37-6, L4: 50 turns on T37-2.

Figure 8. Two more chips and a discrete transistor make up the transmitter.

Summary

This rig showed that it was possible to build a fairly complicated direct-conversion transceiver with case, knobs and connectors that weighs less than 0.2 lb without using any etched circuit boards. The key weight saving techniques included:

- Using .032" board instead of .062" board for the chassis and boards
- Using surface mount components where possible
- Using lightweight connectors and other small components (small toroids, 6.3V electrolytics, etc.)
- eliminating all controls except tuning and volume
- using small homemade wooden knobs
- keeping the overall size as small as possible (less chassis weight).

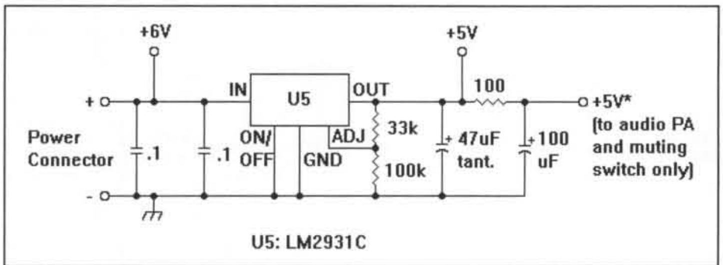


Figure 9. A low dropout regulator provides power to part of the circuitry.

The following additional techniques reduced the weight of the batteries required:

- designing every stage for low current consumption
- employing a 6V supply voltage (most stages don't benefit from any higher supply voltage)
- running only 200 mW output.

Notes from the Assistant Editor:

Backpacking and other types of portable operation are greatly enjoyed by quite a few QRPers. The Adventure Radio Society was formed in 1998 by some people who wanted to actively promote this enjoyable pastime and share notes and experiences. As the opening page of their web site says, they are "a great group of men and women who combine amateur radio with their love of the outdoors."

In addition to publishing an excellent monthly online journal called *The Sojourner*, edited by Rich Fisher, KI6SN, they also sponsor a number of popular operating events such as Top of the World, Flight of the Bumblebees, and Spartan Sprints. (The latter is what inspired this article.) Those who frequent the QRP-L mail reflector hear about these events in real-time on a regular basis.

Another stated goal of the ARS is supporting "the development of imaginative radio equipment and antennas." A good example of the former is the Trail Friendly Radio design event they had some time ago, where people shared their ideas on building small radios that were specifically tailored for ease of use and portability in the wild.

Their URL changed a while back, and you can now find the ARS web page at http://www.arsqrp.com/ In addition to the current issue of *The Sojourner* and other info, you can find all of the back issues going back to the first one in May 1998. When they first announced the formation of the group I signed up almost immediately even though I have never taken a rig to the trail and probably never will. I figured I'd still enjoy whatever they had to present, and I haven't regretted it yet. If you have even a passing interest in portable operation, I highly recommend checking them out.

Used with permission, this article originally appeared in the June 2002 edition of *The Sojourner*. The tag line at the end of the online version says, "Steve Kavanagh, VE3SMA, is an enthusiastic low power contester and remarkably gifted QRP designer." No one can argue with that.

—de WA8MCQ, Assistant Editor

A Two-Antenna Switch for Open-Wire Line

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I have always had an interest in latching relays. The capability to produce almost-no-power switching seems like a great idea for all sorts of applications. In this article, I will describe their use in building a low power to open wire line-fed antenna switch.

General Description

The total cost for this switch is less than $10 (plus the cost of whatever you choose for connectors and a cabinet). It requires only a momentary 400 mW when switching with the antenna (ANT) LED(s) set to OFF. The nominal continuous current drain, with the ANT indicator LED switch set to ON, is only the value of the LED-typically 40 mW. It also incorporates an innovation that requires only one extra SPDT switch to have the antenna LEDs indicate which antenna is in use (either continuously, or only when the ANT push-button is enabled). The power cost is never more than approximately 400 mW—even with the ANT indicator switched to NORMAL (continuous). Set for LOW POWER, the only power drain occurs during the brief switching period.

The relay used for this project is a two coil, latching, four-pole, double throw (4PDT) unit capable of switching 60W/125 VA. It has gold-on-silver contacts capable of switching up to 250V at 2A, AC or DC. It can safely carry up to 3A. However, keep in mind the total power capacity ratings (60W or 125 VA) always apply. With this rating, a 20W RF source would have no trouble at all, and the relay performs superbly at QRP levels.

Theory of Operation

The principle by which a 2-coil latching relay works is simple: one coil (and associated sets of contacts) is called the SET coil (see Figure 1). The other coil (and contact sets) is the RESET coil. These are only labels used to differentiate between coil-contact sets, and could just as easily be "Side A" and "Side B." If one of the coils is pulsed (meaning you pressed SW 1), its contacts close and latch. To switch to

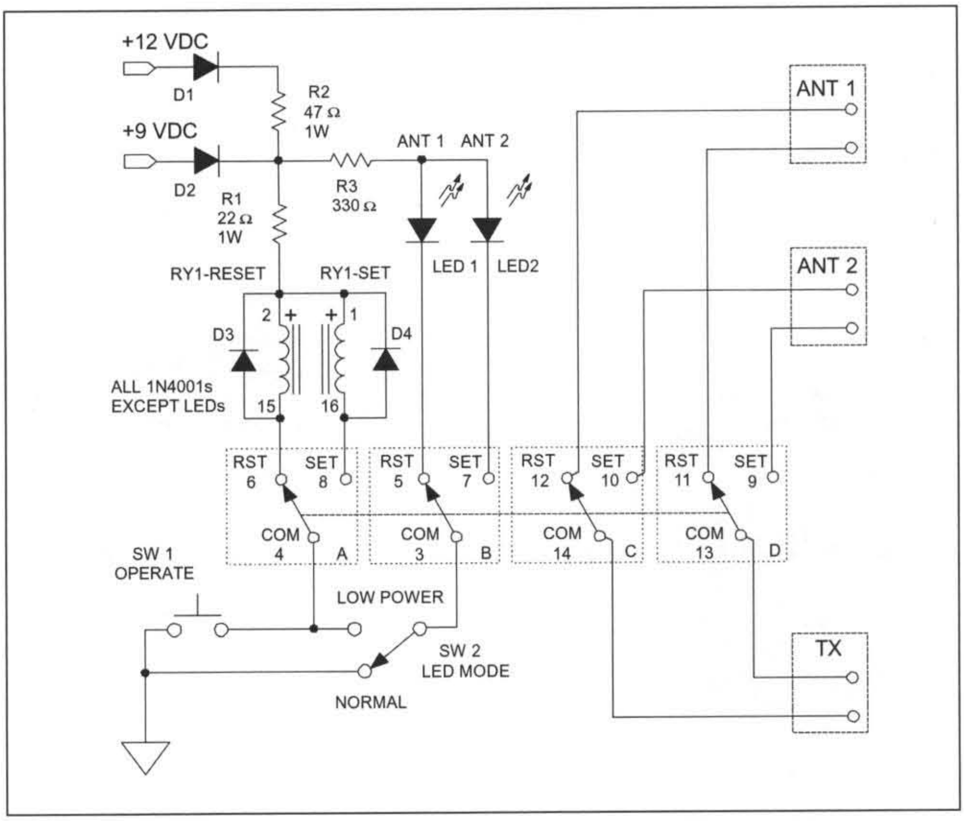

Figure 1—Schematic diagram of the latching relay open-wire line switch.

the other antenna, the other coil must be pulsed. The simplest way to achieve this is to use one single-pole, double-throw (SPDT) contact set (out of the four SPDT contacts available) to determine which coil will get the next pulse. With this approach for control, there are three remaining SPDT contact-sets.

The next contact set is used for an antenna-in-use indicator. It is very helpful to know which antenna is selected. This SPDT contact set switches between one of two LEDs, corresponding to the antenna-in-use. If an SPDT toggle switch is inserted connecting the LED switch "common" contact, it can be used to switch between either: 1) one side of the pushbutton; or 2) ground. This allows selection between keeping one of the two ANT indicator

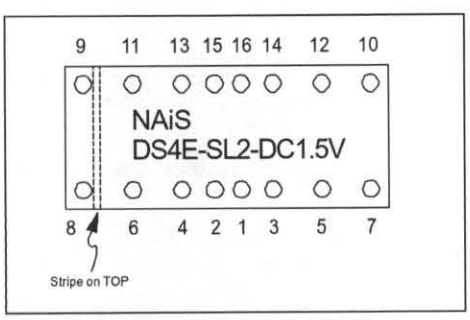

Figure 2—Pinout diagram of the relay.

LED's on continuously or only when the pushbutton switch is closed for an ANT change.

The last two sets of SPDT contacts are used for the RF switch. They switch between two open-wire line antennas.

Summary

So there you have it: a two-antenna selector for open-wire line that uses only minimal components; and optionally, no current at all after switching.

Construction Notes

The relay has 16 widely spaced pins on the bottom (see Figure 2). Note that they are NOT consecutively numbered. However, the numbers are molded into the bottom. The relay would fit into a pair of end-to-end 14 pin IC sockets, although I suggest that the relay be mounted on its back, "dead-bug" style, and carefully soldered to the pins.

You may use either epoxy or non-corrosive RTV sealant to attach the relay to the board. For my project, I used #30 silver-plated Kynar (wirewrap) wire. No formal wirewrap techniques were used, just a turn or three of the stripped wire end around the relay pin, then carefully and quickly soldered, trimming the excess wire-ends when finished.

A new, military surplus, 2 x 3 inch 10 staked-fiberglass terminal board was selected for the base of the switch. Epoxy was used to attach the relay, on its side, to the board. It is recommended that the wired-connections to the relay be completed, (but not connected at the other end) before mounting the relay to the board-just in case you get a bit too heavy-handed with the soldering.

The connectors are a matter of personal preference. For my project, I used female banana jacks for all six connections. I then added a standard 2.5 mm coaxial power jack, with (NOTE!) the center pin "hot." Additionally, I added a series diode for polarity protection. The half-volt loss this causes, is not significant, and the small loss provides protection against reversing the power, so it is simply a good practice to follow when feasible and appropriate. It's not essential to the design, and you may leave it out if you're not concerned about that. Finally, the "standard" reverse-connected diode for relay coil reverse-pulse suppression is added to both of the relay coils.

The OPERATE switch can be any momentary-contact switch. In my project, I used a simple SPST normally open pushbutton. The NORMAL/LOW POWER switch (that causes the ANT position LEDs to be lit all the time, or only when a relay coil is pulsed) can be any SPDT switch that is not momentary.

The LED and relay coil resistors have been calculated based on a 12 VDC power source. There is no reason you couldn't use a built-in 9 VDC battery. I have included an extra resistor and diode so that either power source can be used by isolating the 9 VDC battery with a diode, and using a resistor for each source. The diode in series with the 9 VDC input may only conduct if there's no 12 VDC input. Best of both worlds in that case.

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