QRPp

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From the Editor

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We start year number 4 of the NorCal QRP club with this issue. Time really goes faster as you get older. My father used to tell me that, and I really didn't understand it at the time, but now I do. Those of you over 40 will know what I am talking about, those of you under 40 will in a few years. The reason that I bring it up is that you don't want to put off the things that you have been wanting to do but just haven't found the time for. Take the time to enjoy life, it is the only one that you will have. Build those projects, go out in the field and operate, put that antenna system up, upgrade your license, enter a contest, go on that DX expedition. It doesn't matter what you do to enjoy QRP, just do it.

Jim Cates, WA6GER has asked me to thank all of you who called and wrote him concerning his picture on the cover of the December issue. Jim wants to say thankyou and he is very appreciative of all the friends that he has in ham radio. I must tell you that Jim was very embarrassed when he saw the cover, he did not know that his picture was going to be on the cover. He also was pleased to hear from so many of his friends. I am really proud of the December issue, and especially pleased that I was able to honor such a good friend as Jim.

The December issue got caught in the Christmas mail, and there is nothing that we can do about that. It took over 30 days for some to get their copies of QRPp. We don't want to go to first class postage as that would really drive the cost up of putting out the journal. We just went to $10 last year and we want to hold the cost there as long as possible. Guys, please be patient, we put QRPp in the mail as soon as possible, and the rest is up to the post office. It is just not feasible to do first class mailing.

This issue is exciting in that there are several good construction articles. Derry Spittle, VE7QK has updated the Epiphyte, and now it has the amplifier and the VFO built in. The next thing for the Epiphyte 2 is the digital display. It will be in the June issue.

Wayne Burdick, N6KR is back with another of his special designs. I asked Wayne to design the rig he calls the 49er at Dayton last year. He agreed but said that he did not have time to do the board layout. I agreed to do the board layout, and the result is the neat little rig that is featured in this issue. Be sure to build it and bring it along when you come to Dayton. Enter the building contest and you might become famous. (Or you might just win a 1 year's extension to your QRPp subscription.)

The other project in this issue that is the Regenerative Receiver that was designed by Paul Harden, NA5N. We had a ton of fun building these for a local building contest, and they really work well. I learned a lot by building mine. If you want to build both projects for the contest, be our guest!

You will have noticed by now that I have changed the format of QRPp. The printer has made suggestions, and I have listened. The reason for the double columns is to make it easier to read. When your eyes don't have to travel so far across the page, it is easier and faster to read. The new cover stock is also very attractive and adds to the appeal of the journal.

I would like to thank all of you for the help that you gave NorCal at Pacificon. I would especially like to thank our four presenters at the QRP Forum, Derry Spittle, VE7QK, John Liebenrood, K7RO, Wayne Burdick, N6KR, and Stan Goldstein, N6ULU.

Hope to see you all in Dayton in May. 72, Doug, KI6DS

2nd Annual
Great Dayton Building Contest
Sponsored by NorCal QRP Club

NorCal QRP Club is again sponsoring the Building Contest at this year's Dayton Hamvention. We started it last year with the Pixie 2, and it was a great success. The idea was that we would hand out a schematic at the Hospitality Suite sponsored by the ARCI at the Day's Inn Dayton South, and that the entrants would pick up the needed parts at the flea market on Friday and Saturday, with the contest to be held Saturday night.

It was a lot of fun, but their were some things that needed to be ironed out. One of the problems was that for many the trip to Dayton is a once in a lifetime experience, and they should spend that time meeting people and experiencing Dayton, not searching for parts and building. Hey, we can build and locate parts all year long, but we can't talk with our QRP friends at the Hospitality Suite except for the time we are at Dayton.

So, we decided that for this year's contest, we would announce the project in advance and let you bring the completed entry to Dayton for judging on Saturday night. We have even expanded to two projects this year. They are the 49er 40 Meter CW transceiver designed by Wayne Burdick, N6KR on page 27 or the Regenerative Receiver designed by Paul Harden, NA5N on page 12.

All you have to do is pick your project or build both of them, and bring them to Dayton for judging by K5FO, KI6DS, and WA6GER. The prize? Bragging rights for one year, and a 1 year extension to your subscription to QRPp. We will award 3 prizes for each project, and the only requirement is that the rig actually works. We will hook them up to a 9V battery so make sure that you have a 9V connector or adapter to fit your rig.

You may use any type of construction that you wish. Circuit boards are available for the 49er, and can be obtained from information in the article. But, if you wish to roll your own, by all means feel free to do so. Remember, judging is Saturday night at the Hospitality suite at the ARCI Dayton Headquarters, the Day's Inn, Dayton South.

A LOUD!! LM386 AUDIO AMP

by Bill Hickox, K5BDZ
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After buying a mini-sized Radio Shack FM tuner for $5.00 (nonworking but quickly fixed), I decided to build my own small stereo amp to liven up the test bench with some Good Time Radio. It took me only about two hours to build two of the above amps to drive some small speakers. This little LM386 amp drives cheap 8 ohm 4" speakers loudly enough to go into distortion with an ear splitting volume! It even drives the 8 ohm Realistic Minimus 7 speaker system so loudly it hurts your ears. Yes, it will even allow you to hear in a room full of loud talkers! It's been tested and works on speakers from 4 ohms to 32 ohms. When demonstrated to Fred "Bonacontenshun". W5QJM, he told me to show it to the Austin Group at the Summerfest Convention the next week, and write an article. So here it is.

Many of you will agree that far too many LM386 audio amps in manufacturer's kits don't produce appreciable speaker volume. This design proves that the '386 is getting too many bum raps. I won't bore you with theory. Just build it and try it.

The more I work with IC designs in practical application (vs. theoretical IC ideal performance) and interface with IC manufacturing design engineers, the more I realize that to an IC, "a simple direct external IC ground is not necessarily the best IC ground!" This statement could be the basis of a 2,500 page thesis, but I will let it stand as is.

The circuit in Figure 1 is simple, yet contains a few changes from the "usual" LM386 circuits normally found in current designs. This design is no big secret and is definitely not proprietary. But it really works for me, and I hope it will work as for you, too.

The amps were constructed on perfboard. *Experience: when building an LM386 amp, connect all grounds to the pin 4 IC ground. LM386 amps do not like return grounds that depend on metal enclosures or other meandering paths!* A single amp can be constructed as small as 1 1/2" x 1 1/2" but give yourself room and trim off the extra perfboard later. I power my amp with a 12VDC 800mA wall supply scrounged from my junkbox. No hum or other power supply problems. This little amp will perform with voltages varying from 6VDC to at least 15VDC. Maybe higher. Naturally, the higher the voltage, the greater the output (within reason). Caveat: Watch those capacitor voltages.

The circuit in Figure 2 can be added if you wish to reduce the high frequency response (anti-hiss) and use the amp with communications equipment. The values in Figure 2 allow a roll-off characteristic that starts about 1.5kHz and attenuates the high frequencies at a design rate of about 6dB per octave. Also, for low frequency attenuation you could add a capacitor from ground to the connection between R2 and C1 in Figure 1. Capacitor values can range from .047 uF for "rumble" suppression in stereo amps to .2 uF for low frequency suppression in communications audio.

By adding jumpers across J1 in Figure 1, you can add about 6 dB of gain (depending on the value of R4) to the audio circuit. Even more gain if you delete R4 and use only C3. I did not need this circuit with my FM tuner, but I do often use this added gain in simple receiver circuits. Remember, however, that weak audio output may mean a very weak signal at the input. If you jumper J1 terminals and still have weak output, you might need to include a small 2N3904 preamp circuit at the input.

The anti-hiss circuit in Figure 3 was found in a St. Louis QRP Society **The Peanut Whistle** reprint of *From the pages of Stan's Journal*. It includes an output circuit in which the series resistor and parallel capacitor act as a low pass filter that peaks around 800 Hz., favoring CW, but still allows easy monitoring of SSB. This another "anti-hiss" design that can easily be incorporated in LM380 as well as LM386 amps. According to the article, the 3 dB points are approximately 200 Hz. and 3 kHz. Note capacitor values.

Finally, a bit of experience for trouble shooting audio "motor boating" at high audio levels in any audio amp. Lowering the value of the power supply isolating resistor (R3 in Figure 1 above) should solve the problem. In my original Backpacker II design, I used a 22 ohm resistor in the power lead for the LM380 audio IC. Some units exhibited motorboating at high audio levels and the problem was traced to a high current draw that produced an excessive voltage drop on audio peaks. Replacing the 22 ohm with a 10 ohm resistor did the trick and mods were incorporated in all subsequent kits.

I hope you have fun building your next LM386 amp. I would enjoy hearing of your success and welcome all improvements or suggestions. 72, Bill, K5BDZ

Parts List

R1 100K Pot (Volume Control)
C1 .33uF (.1 to .47uF OK)
R2 10K
C2 100uF/25V Elec.
R3 10 ohm
C3 10uF/25V Elec.
R4 1.5K (1K to 1.5K OK)
C4 .0047uF
R5 10 ohm
C5 .068uF (.047 to .1uF OK)
U1 LM386 Audio IC

All resistors are 1/4 watt. Electrolytics should be 25 volts or higher.

A Loud! LM 386 Audio Amp (make two for stereo)

By Bill Hickox, K5BDZ - *Tejas Kits*

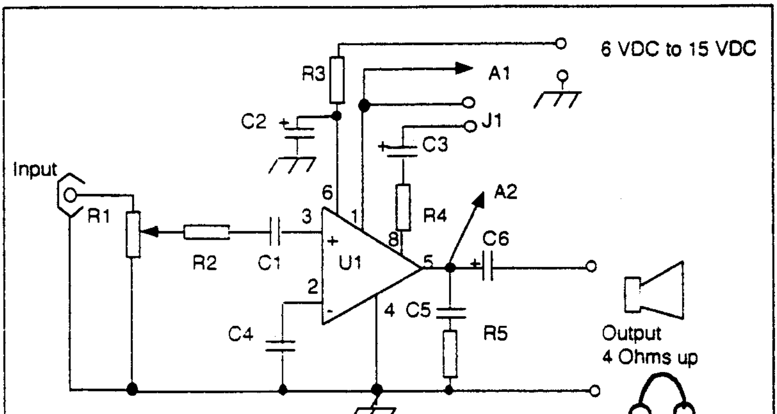

Figure 1

For J1, A1 and A2 connections, see text and Figure 2 below.

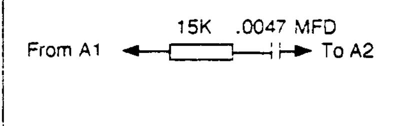

Figure 2

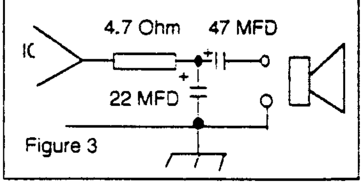

Figure 3

ANOTHER RFI CASE SOLVED (CHAPTER 2)!

by J.C. Smith, KC6EIJ
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I have written previously (June 1995 QRPp) about the RFI problem I located with the aid of a little battery powered "transistor radio" (AM broadcast band). Well, about six months after solving that one another one showed up. This one was even more puzzling, and even louder. We finally eliminated it yesterday, so here is the story.

The problem was on all the HF bands, all frequencies, the same frying sound as the previous case. There was no real pattern to it except that it always went away when it rained and remained off until things dried out thoroughly. Some times it was on 24 hours a day, other times it would tend toward the afternoon and evening, giving me a little relief from sometime early morning (1-3 AM) until about noon. Hot or cold weather didn't seem to matter, and there were a few days it didn't come on at all that didn't fit the wet/dry pattern.

First, of course, I eliminated my own property as a possible source by powering the rig by battery and shutting off the AC mains at the drop. Then, using my old TH-3 ribander I was able to get the general direction from the house. This one was nota as easy to point to as the previous one, probably because it was closer to home and the noise was being transmitted along the power lines down the street. Still, there was noe null (only one this time, the other side of the beam didn't null out) and enough front to back difference to point in one general direction. I went out numberous times with the "transistor beam" (1) and although I could pick up the noise all along the street, and at every pole that had a ground wire coming down, it seemed to peak near one intersection about two blocks away. There were three poles at that intersection, and although one was slightly more suspect than the others (it was a little louder one time) it was hard to say which one was the culprit.

I contacted the utility company and advised them I had another problem. Having been through this once before, I was able to bypass all the administrative front end and go right to the guy in charge of fixing it. If I had located the exact pole, I could have gotten quick service. However, since there were a number of suspects they wanted to get their "locater" out there to pin it down. That took a long time; in fact it never happened. In my service area at least, this guy has to be booked months in advance, and the two times he was supposed to come out here the noise was not present so I called and cancelled (this was much appreciated by the utility, and I think created some good will that helped get a repair crew out in spite of not knowing the exact location of the problem). Finally, they agreed to send out a crew to see what could be done without the specific pole being located.

The crew was supposed to contact me prior to coming to confirm that the noise was present and to get my opinion on where it was coming from. Unfortunately, they didn't do that and when they got out to the location there was no noise. They proceeded to work over towo poles in the area that "looked suspect" but only one of those was on my suspect list, and it turned out not to be the one. After a few more phone calls (polite persistence paid off here) it was agreed that they would phone before coming, and they would stop by to speak with me prior to starting any work. Yesterday that finally happened and I rode over to the intersection to find a bucket truck setting upon another pole, but not one of my prime suspects. I had my "transistor beam" (1) with me and I pointed out the three poles I suspected as well as the one that one time seemed the worst. There were a few others in the vicinity that were equally as loud that day, but based on my numerous observations theyagreed to concentrate on my suspects.

I went back home and turned on the rig to monitor the QRN. In a matter of an hour it stopped. Problem found. It was in fact on my #1 suspect pole. One of the staples used to secure the bonding wire (the heavy, bare solid copper ground wire) to the post had been driven in too tight, and in time the wire broke under the staple crown. This created a spark gap. Apparently when the pole got wet it was sufficient to conduct the current around the break, but when things dried out the sparks would fly.

So, what did I learn this time? Again, the value of the little "transistor" radio as a noise locater, the value of polite persistence in dealing with the understaffed trouble-shooters of a public utility (you can thank the PUC of the Peoles Republic of Calfornia for that), and that it pays to be considerate of the utility companies time. If I hadn't called and cancelled my appointments, saving the "locater" a wasted trip, I might still be waiting for him to find the exact pole. Communicating directly with the crew doing the work also proved valuable. They probably would have found the problem their first trip if they had stopped to ask for my advice. I also learned the value of making numerous observations. It was only on one out of many trips to the noisy intersection that the bad pole was any louder than the others. Don't forget to also go check the suspect problem locations when the noise is NOT present on your rig. You want to be sure the noise is quiet there too. You can go out to almost any utility pole with a ground wire and find some noise any time, but it won't often be severe enough to cause QRN on your rig.

If you are having a noise problem, I wish you good luck in solving it. wehn you do (or if you already have some "solved cases" under your belt), why not write it up and share it so we all can learn from it? 72, JC Smith, KC6EIJ

1. "Transistor Beam": A typical battery powered AM broad cast receiver (transistor radio) has a wire wound ferrite core antenna. These little antennas are quite directional. The gain direction is usually off the front and back of the radio, with sharp nulls off the sides. The nulls usually prove more valuable than the peaks in this type of direction finding. Try it out on a known signal source like a distant broadcast station of known transmitter location.

SKELTON CONE ANTENNA

by Phil Polizzo, AC6LS
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Here is a fine wire antenna that is omni directional and covers 80-10 meters with an antenna tuner. You might even use it on 160 if you connect both ends of the feed line to the long wire input on your tuner.

I don't know what kind of performance it offers over other wire antennas, but I can tell you that it really does work! I have worked barefoot and QRP with this antenna with very good results. Recently I had a QSO with ZL2UW on 40 meters with my Sierra with 2 Watts. I have also worked some VK's and plenty of JA's, not to mention plenty of states. This works as a good antenna to put up at the QTH but you can make one for portable and FD use. It does take a little bit of space to set up.

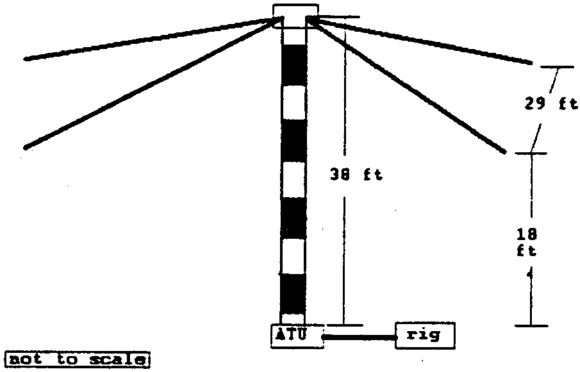
Several fellow QRPers use the Skelton Cone as their main home antenna, including KI6PR, KK6IU and KI6DS. I got the information for the antenna from the following sources: *73*, (Aug. '69, pp. 133) and the *RSGB Handbook* (3rd Ed.. pp. 387).

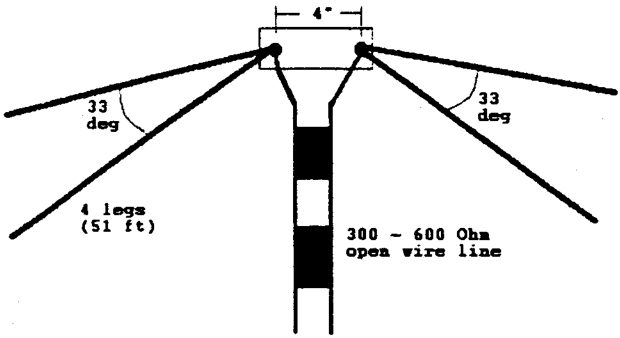
The antenna looks a lot like the G5RV in tandem on the same feedline with the legs spread apart. The feed point should be set around 38-48 feet high, with the legs (4, at 51 feet long each) sloping down at an angle so the ends are about 18 feet high.

The legs should be spread about 33 degrees apart on opposing ends of the feed point, with the feedpoint set 4 inches apart. It should be noted that these measurements are not set in stone, as each installation will be different and is not a problem. Anything close to an "X" configuration when seen from a bird's eye view seems to work.

Be sure to attach the feedline before you put the antenna up. Any twin lead that is 300-600 ohm will work. The 300 ohm twin lead I use (from Radio Shack) tunes a bit narrow compared to 450 ohm ladder line, but it works just fine. The feed line can be 48 or 78 feet, and if you need more, add in increments of 33 feet. NOTE: using coax with an in-line balun is NOT recommended.

I hope you try this out. It is a good antenna and is easy to build and put up. It has worked well for me and seems to work much better than a dipole. One of the reasons may be that there is little or no loss in the feedline (twinlead) as compared to a coax feedline. It is important to get as much signal into the atmosphere as possible when you are operating at QRP power levels. 72, Phil, AC6LS





ABOUT THE ST. LOUIS QRP SOCIETY

by Dave Gauding, NF0R
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The St. Louis QRP Society was organized in 1987 by local amateur radio operators interested in low power communications and homebrewing. Our members are residents of the Metropolitan St. Louis area and Metro East. Monthly meetings are dedicated to the enjoyment of amateur radio. The club does not have a charter or by-laws. business discussions are few and no minutes are taken. We do not elect officers in the traditional sense. Volunteers periodically step forward to moderate meetings, offer direction to the club or take responsibility for special projects. Our monthly newsletter keeps members up to date on club events, local amateur radio activities and happenings within the QRP fraternity. The Peanut Whistle features original articles and commentary by members and contributing authors. We also reprint selected material from other sources on radios, accessories, antennas and construction. The club periodically assembles kits for sale to members only. Among our projects to date are a transmitter, receiver, three-band vfo, two keyers, three audio filters, spectral analyzer, the "St. Louis Tuner" and most recently an audio amplifier. We regularly present educational forums to help members become more familiar with the technical and historical aspects of radio as well as new directions being taken in our hobby. Proud owners routinely display the latest homebrew efforts at meetings as examples and encouragement for others. Novice builders may rely upon fellow members for assistance in completing projects and troubleshooting. The club maintains a modest inventory of donated components and hardware. Members may freely draw upon this reserve for homebrew projects in process. We operate an all homebrew Field Day and schedule portable outings in the spring and fall. The club calendar includes a homebrew competition, tailgate sale, key collector's night and a holiday dinner. We also maintain sub-groups for those specifically interested in the Heathkit HW-8, specialized antennas and coherent CW. Our members periodically staff information tables and present QRP seminars at local hamfests and club meetings. Each year, one member is recognized with a unique service award for significant contributions to the success of our organization. The St. Louis QRP Society gathers on the third Wednesday of each month at Florissant Valley Community College. Meetings begin at 7:30 pm. in the ham shack located on the second floor of the Engineering Building. The club hosts a local net on first Wednesdays, at 8:00 pm on the 145.33 repeater. Annual membership dues are $12.00, prorated monthly for those joining during the year. For additional information contact any member including: W0NVM, Andy (314-997-6473); KC0PP, Keith (314-946-5346); NO0G, Gordon (314-739-7124); WB9FLW, Pete (618-288-5432)

About QRP

[Reprinted with permission from the St. Louis QRP Society]

What is QRP?

This "Q Signal" for reduce power has come to represent the amateur radio tradition of using minimum power to establish and maintain communications. The international standard is 5 Watts output on CW and the digital modes or 10 Watts PEP on SSB. Signing "QRP" after a callsign is not expected though many low power enthusiasts prefer to do so.

Can I Actually Work Stations on 5 Watts or Less?

Yes, and thousands of active QRPer's will be delighted to have you join our ranks. some are absolutely committed to operating QRP. Others run low, medium or full legal power at various times. With reasonable propagation it is possible to work-the-world on QRP. Some hams display a DXCC certificate with a "Milliwatt Endorsement" for achieving this goal with less than one watt output! WAS, WAC and DXCC are earned by low power enthusiasts with simple wire antennas and even indoor antennas. In DX pile-ups or periods of poor propagation, QRPer's substitute skill for power! Adding a rare station to the log after quietly slipping through a wall of KW's can be a satisfying experience for the low power operator. At the same time a QRPer will quickly acknowledge the skills demonstrated by his QRO counterpart in helping to complete a contact.

How Do I Get Started?

One of the most attractive aspects of QRP is simplicity! It is not necessary to purchase new equipment or dedicated QRP gear. Just turn down the drive on your current rig and enjoy the thrill and challenge of making contacts at a minimum power outputs. You may already be running "QRP" without knowing it! The typical low power setting of a 2 meter FM handie-talkie is about 150-300 milliwatts. In the hands of a sharp operator this same output is effective on the HF bands!

What About Commercial QRP Gear?

Major manufacturers have produced HF radios specifically for the low power enthusiast. A dedicated QRP radio is usually in the "calm operator" category with just enough features and controls for good performance. Ten-Tec continues to produce state-of-the-art superhet QRP transceivers and the firm's early Argonaut gear is still in demand. Other manufacturers are actively supporting the commercial market including MFJ with monoband CW and SSB transceivers. Most recently, Index Labs began offering the down sized nine-band "QRP Plus". Icom, Kenwood, and Yaesu provide technical information to adjust their transceivers for optimum performance at reduced outputs.

How About Homebrew QRP Gear?

A basic, solid-state, one watt CW transmitter for the HF bands can be built in a space as small as one square inch, about the size of a postage stamp! It may be used with an existing transceiver or receiver. Proven designs for a wide variety of QRP equipment are described in *Solid State Design for the Radio Amateur, Understanding Amateur Radio*, the *QRP Notebook, W1FB's QRP Notebook, QRP Classics*, the *ARRL Handbook*, and other widely distributed titles. An increasing number of homebrew projects in QST are written specifically for the QRPer. *CQ Magazine, 73 Magazine* and *World Radio* regularly include QRP columns or articles. With this in mind, it is not unusual to find a low power operator running a complete homebrew QRP station! The thrill of the first contact using a hand-built "peanut whistle" is a treasured memory for many hams, ranking with the first QSO as a novice! However, no one is criticized for choosing to run commercial QRP gear or powered down QRO equipment.

Other Comments?

Most QRPer's operate CW but SSB and digital modes are also represented in the low power fraternity. Even at 5 Watts output, 12V batteries are good for long hours of operation. Some QRPer's choose solar panels to charge batteries or power stations. QRP equipment is inherently portable! It is routine procedure to take a station along on vacations, camping, business trips or mobile. a certain camaraderie exists among QRP homebrewers! Creative ideas or improvements in existing designs are willingly shared with others through widelycirculated club newsletters, amateur radio publications and on the Internet. Nationally, a growing number of kit suppliers support the QRPer including Oak Hills Research, Small Wonder Labs, Tejas RF Technology, A & A Engineering, 624 Kits, S & S Engineering, Kanga U.S., and Wilderness Radio. Far Circuits sells printed circuit boards for most popular QRP projects. The New England QRP Club and NorCal QRP Club periodically offer kits to their members. both organizations pioneered inexpensive yet technically sophisticated QRP transceiver projects. The 40-40, NorCal 40 and Sierra designs have been transferred to commercial purveyors and are now available to all amateurs. Kit pricing is competitive when compared to commercial equipment while offering the satisfaction of home construction. For the ham on a limited budget, homebrew QRP gear offers an opportunity to get on the HF bands with a respectable signal at minimum cost. For the seasoned ham bored with "push-button" communications, QRP has the potential to rekindle the excitement and challenge offered by our hobby in earlier days.

Where Can I Find QRPer's?

Locally, the St. Louis QRP Society averages forty to forty-five members. Our club is somewhat unique in that it accepts members only from the immediate metropolitan area. When SLQS organized in 1987, the low power community was already well served by two National QRP clubs. It was not our intention to compete and this initial policy continues today. Active memberships in today's regional and national clubs number from a few hundred into the thousands! ARCI maintains active national HF nets. A good one to monitor for information is the Transcontinental Net (TCN), 14.060 MHz, Sunday at 2300Z. This net offers interested observers an opportunity to assess the reliability of low power signals across the country and occasionally DX. Enthusiasts in the midwest can monitor the Michigan QRP net, 3.535 MHz, Wednesday, 0200Z. All operators are cordially invited to QNI on any low power net. At other times, QRPer's can be found anywhere on the HF bands. However, here are some frequencies where we like to gather to work other low power enthusiasts: CW: 1.810, 3.560, 7.040, 10.106, 14.060, 21.060, 28.060. SSB: 1.810, 3.985, 7.285, 14.285, 21.385, 28.885. Novice or Tech Plus: 3.710, 7.110, 21.110, 28.110.

Are There Many Other QRP Organizations?

About thirty exist world-wide and the number is growing! Among the most active and well-known in the U.S. are the Amateur Radio Club International (ARCI), Michigan QRP Club (MI-QRP), Northern California QRP Club (NorCal), New England QRP Club (NE-QRP), NorthWest QRP Club (NW-QRP) and the Colorado QRP Club (CO-QRP). Many U.S. hams also belong to the G-QRP Club of Great Britain, legendary for on-going efforts to promote homebrewing. All of the above clubs publish excellent quarterly newsletters emphasizing construction projects and reporting operating experiences. Annual membership fees are very reasonable. Each club issues a lifetime membership number to document awards and confirm contest exchanges. The QRP column in the January issue of World Radio is a good one-stop source for specific address and membership information about most major QRP organizations.

What About Contesting?

Many QRP clubs sponsor contests for both CW and SSB enthusiasts. Bonus points are usually available for homebrew gear, battery power or natural power. Some national and international QRO contests offer a low power section. Dedicated QRP contests are typically more relaxed than QRO events. Emphasis is placed on operating skills and good fellowship along with serious competition. CW ops may be pleased to learn that code speeds generallyrange from 10-20 wpm in these events. QRPer's will make a significant effort to stay with a contact until the exchange is completed! There is a growing trend towards "milliwatting" in QRP contesting. Operators accepting this special challenge are eligible for additional bonus points or an option of competing in a separate power classification. "Sprints" with a typical duration of four hours are very popular form of contesting for the QRP community. An on-going "Fox Hunt" contest has recently been organized by QRPer's frequenting the Internet.

What About Awards?

The clubs mentioned earlier offer a selection of wall paper which may include "Worked All Members" and QNI. The standard WAS, WAC and DXCC certificates are available as well. Acknowledging the challenge of attaining awards at low power, several can be earned in stages. Special endorsements are available for awards achieved "2 X QRP" and a "1000-Mile-Per-Watt" certificate is highly prized. The ARRL provides QRP endorsements in some categories.

Is QRP On the Internet?

The QRP-List has been on-line since 1993. To subscribe, send a request to "listserv@lehigh.edu". Type only "subscribe qrp-l" "your first and last name" "your callsign" (omitting quotation marks) in the body of the message and save. Confirmation is sent promptly and messages commence shortly thereafter. This is an active gathering place for new and veteran low power enthusiasts with 800 plus subscribers reported. The GQRP-List and Bikeham forums are also popular. Archives for QRP, homebrew, and related topics may be located through periodic bulletins on the QRP-List.

Dayton Activities?

The ARCI sponsored "Hospitality Suite" at the Days Inn South is a legendary part of the Hamvention for the low power community. Many examples of commercial and homebrew equipment are on display. Portable QRP stations are activated during the evening hours. Several major QRP clubs and low power purveyors maintain sales and information booths in the commercial area. Other related activities include "QRP Forums" (all three days), the "QRP Banquet" with guest speakers (Friday) and "Pizza Night" (Saturday).

Are There Any Surprises When Running QRP?

Yes and no, it really depends upon your outlook and expectations! QRPer's learn the virtue of patience rather quickly. Contacts just don't seem to come as easily as they did before. Operating skills that peaked in earlier days may need to be refreshed and polished. Improvement comes with practice and being there "first with the least" can become very addictive for the low power ragchewer, contester or DXer. The fledgling QRPer may discover an unusual number of hours are again accumulating on the bands making new friends and having fun with our hobby. Time devoted to tweaking an antenna farm to squeeze that last milliwatt out of a fleapower rig is exceeded only by time spent reviewing the latest propagation charts or monitoring WWV reports. A desire to buy the latest commercial transceiver with all the "bells and whistles" seems to diminish just a bit. A few hours must be devoted to brushing-up on radio theory and soldering technique as a decision is made to homebrew that first piece of gear. Consequently, fleamarkets take on a whole new meaning as that odd box or bin is searched with a critical eye for desirable components. The new low power operator learns to graciously acknowledge the abilities of a QRO station pulling out a weak signal or sending a realistic 599/59 report. Finally, in the best traditions of amateur radio the QRP enthusiast accepts good natured needling from QRO friends finding it difficult to understand the challenge and satisfaction of running just enough power to getthe job done. If you can live with these "surprises", come to a St. Louis QRP Society meeting. You'll find lots of sympathy and company! CU SN OM/YL

A REGENERATIVE RECEIVER

by Paul Harden, NA5N
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[Reprinted with permission from "The Peanut Whistle", Journal of the St. Louis QRP Society, November 1995]

I have been fascinated by regenerative receivers since the first one I built in the early 1960's - the receiver that opened the world of short wave to me at a young age, and probably what launched me on a career in electronics and a ham ever since. Even with 1R5 vacuum tubes now long gone, I still find myself building a regen now and again, experimenting with different bipolar and FET transistor circuits. Last year in *Electronic Design News* (EDN), there was a simple regen receiver that caught my eye.... a simple circuit, but implemented slightly different than circuits I've seen before. So, I built one, and it worked as well as the fancier FET versions I've built. Making a few of my own modifications, such as using an LM386 IC for better audio gain, I called it the "PipSqueak". So impressed with the circuit, I called the author at Analog Devices, Charles Kitchin, who turns out to be a ham and an avid low power builder, N1TEV.

I then built another "Kitchin" detector with a front-end preamp for more RF gain and other embellishments. I called this one the "Desert Ratt". This one works so well, I listen to it several times a week... the BBC World News primarily.... from the speaker, while doing other things in the shack. But it's always been a kinda private endeavor -

building regen's just isn't the sort of thing you want to brag about to fellow QRPers.

Then one day on the QRP-L internet group, Dave, NF0R asked about the article and I could not resist but to respond. It was time to come out of the closet and admit, I too, build regens. This started an enjoyable relationship with the SLQS and Dave, mostly through email and regular mail. Dave has since sent me a few goodies from the SLQS parts bin and I offered to build a regen receiver for the St. Louis Club, based on these parts. This includes the famous St. Louis variable caps of the tuner fame, an LM380 audio amplifier board and S-meter. That project has begun and when completed, will be Part II of this series. Prototyping has begun and I'm excited about finishing the "rig". It will be a general coverage short-wave receiver with a switch for the 40M band and coil data for the other popular QRP bands. IT will have sufficient audio to drive a speaker and will even have an "S" meter! all this with 4 transistors and the LM380 audio board. Dave and I have decided to call this SLQS regen receiver the "Howlie Crafters". (If you don't get it ask an old timer.)

In the meantime, warmup your soldering irons and try building either the "PipSqueak" or "Desert Ratt" contained herein. Both are very simple circuits, easy to build, using virtually any construction method from "Ugly" to "Really Ugly", like mine.

WHY BUILD A REGEN?

Regenerative receivers were the first generation of radio receivers used by hams, back to the days of Armstrong. Even though built today with semiconductors, they still have the original "sound" and romance of their turn-of-the-century cousins. They are much different from the ease of a superhet: they take some practice and skill to operate, but once a station is properly tuned in, you'll be amazed at the gain and how well it sounds for a single transistor stage. It will send you back to the old days of radio... is that the SOS from the Titanic? Regens have a charm of their own and can entertain you for hours.

From a project point of view, they are an ideal project. First, they're almost a fail safe circuit, guaranteed to work almost no matter what. All parts (except the variable capacitor) can be bought at Radio Shack for about $10; if you have a junk box of parts, you probably have everything you need. Due to its low parts count, you can build it about any way you choose. Fancy perf board, copper clad board, pretty or ugly. If you've never built anything from scratch before, try a regen circuit. Just figuring out how to solder everything together and build the thing mechanically is fun in itself.

On the practical side, just think of the electronics you'll learn. Even though it's a very simple circuit, over half of the basic circuits used in electronics are there.... tuned circuits, RF amplifiers, oscillators, audio amplifiers, biasing transistors, diode rectification, interstage coupling, dc bypassing, etc. Build one, poke around the circuit with a DVM, change a component to a different value and see what happens. You'll be ready to upgrade in no time -- or your money back! You can learn how this stuff really works and you'll never forget it.

HOW THE CIRCUIT WORKS

Q1 is basically a Hartley oscillator circuit, the kind with the tapped coil. The current through Q1 is controlled by Pot R1. With sufficient current through Q1, enough energy will flow through C3 to sustain oscillation. The objective is to increase R1, the regeneration control, just to the point of oscillation. At this point, Q1 becomes a very high gain, hi-Q amplifier, with gains >100,000 not unusual. Any signal on the antenna, at the resonant frequency determined by L1 and C2, will be amplified by Q1. However, when Q1 breaks into oscillation, it will mask the RF signal. Setting R1 for maximum RF gain without inducing oscillation is critical, but once achieved, tremendous gain occurs. The amplified RF signal is detected by D1 to recover the audio. It is capacitively coupled to Q2, an audio amplifier. Q2 will conduct with a base voltage >0.6V. R4 biases the base at about

1V to ensure constant conduction (the definition of a Class A amplifier). Thus, the small voltage variations on the base from D1 will be amplified. R5 is the collector load, where the amplified signal is developed. It is tapped off by R5, the volume control and capacitively coupled to the LM386. C8 can be any value >1uF; the larger the value, the lower the frequency response. The gain of U1 is determined by C9. With no C9, the gain is 26dB, sufficient to drive earphones; 10uF will produce the maximum gain of 46dB, sufficient to drive a speaker. A value less than 10uF will produce an intermediate gain. The output audio is applied to the speaker (or phones) through C10. Like C8, it can be any value >1uF.

Charles Kitchin uses D2-D4 to establish a very stable voltage for the Q1 regen stage, which makes this circuit very stable compared to others I have built. A 0.6V drop occurs across a diode junction, such that D2-D4, with limiter R3, forms a 1.8V voltage regulator. C6 stores this voltage while C5 keeps the RF out of this dc bias. It provides for a very smooth regeneration action.

WINDING COIL L1

Another beauty of building a regen is winding your own coil and I don't mean a toroid! Good old fashioned coil. Kitchin recommends a 35-mm plastic film case, which works quite well; I use IC shipping tubes with equal success. Here's where you can be real creative. Just don't use anything that's metallic. L1 consists of 15 windings for the RF part and 5 windings for the "tickler" part. With a 200pF variable cap for C2, this produces a frequency range of about 6-16 MHz. Your mileage will vary. Experiment with different number of windings. The rule of thumb is for the tickler winding to be about 1/3 of the RF winding.

SOME CONSTRUCTION HINTS

The circuit can be built almost any conceivable way. Keep the RF components as close to each other as you can, however. It is best to build the circuit on a piece of wood, as a metal chassis causes lots of hand capacity effects. Do not put a metal case over your finished radio.... it can keep L1-C2 from oscillating. The LM386 is carried by Radio Shack for $1. I recommend you also get an 8-pin IC socket. It makes soldering things together much nicer without the chance of overheating the IC.

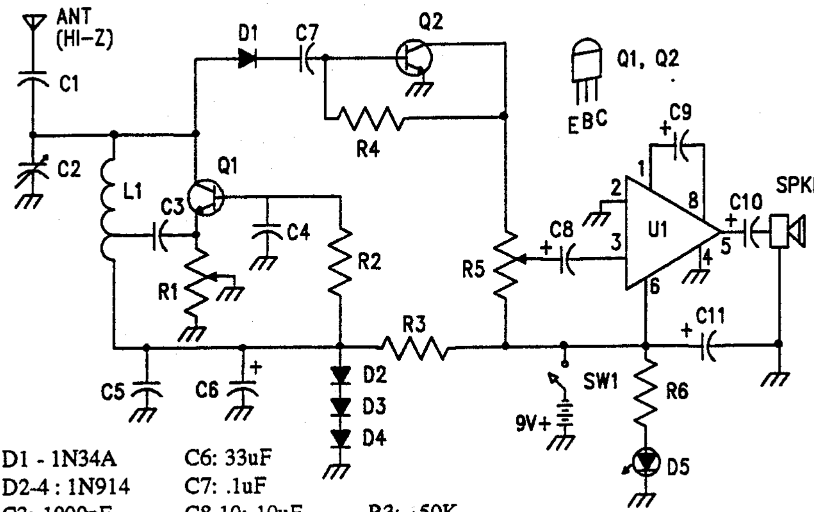
You will find this circuit to be very tolerant of circuit values. If you are using junk box components, just come as close as you can... it will likely work. R1 can be 100K or greater; R5 can be 2K to 10K; C1 any small value. C3 and C4 must be the same value, but can be 700pF to 1500pF (= .0015uF). Q1 and Q2 can be any NPN transistor, although a high Hfe and high FT works best.

If you're a new builder, I recommend you build the audio portion first. Power it up, R5 to maximum and you should hear a slight hiss. A touch of the finger to the base of Q2 should produce a hum. Then build the regen stage. When completed, power it up again and advance R1. Towards maximum, you should hear it start to "squeal". It's working. Attach to a wire antenna (not 50-ohm coax). A 12 foot wire or more works great.

OPERATION

Turn on the receiver and advance the regen control until you hear a squeal. Back off to just before it squeals, or oscillates. As you tune C2, you will hear occasional squeals. These are usually stations. Stop and adjust R1 for proper regeneration. For the international broadcasters, such as the BBC or Radio Nederlands, their powerful signals gives good starting practice on proper tuning. This is aggravated by an effect called "pulling". This is where you advance the regen control for proper amplification and the received frequency will pull downwards a bit. It's a two handed operation jiggling both the tune and regen controls. But you'll quickly learn that regens indeed have a charm and romance of their own. GL es 72, Paul NA5N

"PipSqueak Regen Rcvr"
NA5N



D1 - 1N34A	C6: 33uF	
D2-4 : 1N914	C7: .1uF	
C3: 1000pF	C8-10: 10uF	R3: 150K
C4: 1000pF	C11: 33uF	R4: 470K
C5: .01uF	R2: 100K	R6: 750

TUNE YOUR HAMSTICK THE EASY WAY

by Lloyd Bennett, WA0WOD
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Many hams have taken advantage of the Hamstick mobile antennas. They are cheap, easy to mount, and they work. The only problem with them is their relatively narrow bandwidth, typically 35 to 40 KHz. I was in California this spring visiting Vern, W6MMA and while I was there, Doug, KI6DS came for a weekend of QRP hamming. Saturday we worked the NorCal QRP contest, and then on Sunday we drove to Livermore for the Swap Meet and then followed by going to the monthly NorCal Club meeting at the "California Burger". Doug purchased a 75 meter Hamstick at the swap to go with his mobile setup. He is using the Cascade and the Epiphyte in his Toyota pickup, and wanted a simple mobile antenna system.

When we got back to Vern's house, we decided to set up the 75 meter resonator. It was going to be easy, because Doug has one of the MFJ249 antenna analysers. The MFJ unit is really handy. All that you do is hook the coax from the antenna and then dip the meter for resonance. The unit has a built in frequency counter to read the resonant frequency. When Doug tried his unit, the resonant frequency was at 3.950. That was much too high, as he wanted to operate from 3.760 to 3.800. The instructions that came with the antenna said to add a capacitor to the mount to lower the frequency. Doug did not want to do that as he uses the mount for other bands. He was upset, and not a happy customer.

It was then that I remembered an old trick that someone taught me years ago. It is a simple way to change the resonance of the antenna, and it works. We all know that if you lengthen the antenna, you will go down in resonant frequency. The trick is to do it simply. Doug did not want to add on to the length of the whip. So we used the "trick" of using a short piece of wire attached to an alligator clip and then clipped on to the base of the whip portion of the antenna. We used #14 copper wire that is soldered to the alligator clip, and is quite easily bent.

When we attached the wire to the whip on Doug's antenna, the resonant frequency dropped to 3.575. Then all we had to do was start trimming the short piece of #14 copper wire. As we trimmed, we would measure the resonant frequency with the MFJ unit. We found that we would change by about 20 to 25 kHz with each inch of wire cut off. It was a simple matter to arrive at a resonant point of 3.780, which allowed the antenna to have a SWR of less than 2:1 from 3.760 to 3.800. The wire wound up being about 12" long.

The interesting thing about this method, is that you can have several alligator clips and wires, all cut to different lengths for different portions of the band. Then when you want to change band segments, all that you have to do is simply change the alligator clip! This works much better than changing the length of the whip segment by loosening the set screw, sliding the whip in or out, and then tightening the set screw again. I can never find the right allen wrench when I need it anyway.

Now, Doug has a mobile antenna for 75M that he can use over the entire band by a simple change of an alligator clip and a wire. Remember to set the resonant frequency of the antenna at the highest frequency that you will want to operate. I would suggest that you put it 20 kHz below the top edge of the band, so that when you take the alligator clip off, the antenna will be usable at this point. By using this method you will have use of the antenna over the entire band by having an alligator clip wire for each segment. I hope that you findthis method useful, and it solves the narrow band width problem of the Hamstick antennas. 72, Lloyd, WA0WOD

BRINGING THE WILDERNESS TO MR. WILDERNESS RADIO (aka DOING THE CALIFORNIA QSO PARTY FROM GLENN COUNTY)

by Bil Paul
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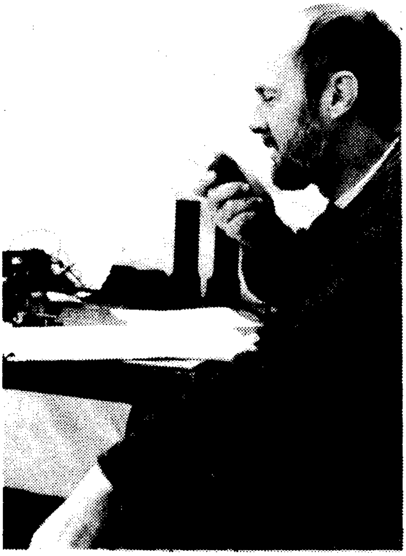
As far as I knew Bob Dyer and I were the only campers at Plaskett Meadows Campground when the wolves started howling at the full moon around midnight.There was a regular chorus of them and they sounded too close for comfort. At least the tent was zippered tightly shut. The next morning Bob said they were coyotes. OK, not so bad— kind of like skinny dogs.

Bob, you see, is a naturalist. Through and through. Specializing in birds. And, being that he runs Wilderness Radio (which is selling theNorCal Sierra, etc.) he thought it a good idea to take a hamming sojurn in the woods. We were at Plaskett Meadows Campground (6,000 feet up) in the coastal mountains about due west of Chico, next to a small lake.

This was in early October and overnight

Bob Dyer Getting the Antenna HIGHER!



Bil Paul at the Mike on 20M

temperatures were near freezing. We had come to represent Glenn County in the California QSO Contest, wherehams try to work every county in the state. I had figured Glenn County had such a meager population it would need some hams.

The start time for the contest arrived on Saturday morning and we had our inverterted V (for 20/30/40 meters) and G5RV antennas up. OK — a confession— we were running 25 watts with a Ten Tec Scout. In a contest with lots of big guns, that's like running QRP. This was my first participation in a contest ever — Bob had some experience.

We had decided to do this for fun,not to try to rack up big scores. We had just started to make contacts on 20 meters ("What county?" "George-Lima-Echo-November-November — Gla-enn County — QSL?") and the day had just started to warm up when Madame Ranger showed up. She was all bustle and business.

"You can't camp here. This is the picnic area. The camping area's across thelake."

"Oh. We must've missed the sign. But look at this big tent and all the antennas up in the trees. Can't we stay here just one more night?"

"Sorry. Stay and I'll cite you."

In the end we compromised. She let us plop our stuff in the back of her pickup for a quick ride around the lake. By this time we were getting very good at setting up the monster tent. Now we had water. And neigh-

Bob Dyer, Mr. Wildernous Radio, at the controls of a Scout!! GASP!

bors.

The inverted V went back up (improved for this trip with a balun and RG8X coax). Bob put up a full-wave delta loop for 40 meters, which eventually brought us Japan.The results: around 70 contacts. Lots of fun. I learned some contesting basics and how to use cut up logs for stools.

Broadcasting at night by candlelight is cozy. I think I'll make this California QSO party trip an annual affair — to a different "rare" county each year. Operating in the field is a major pleasure for me. Next year I won't bring three times more food than needed.

If you ever get the chance, take a walk in the woods with Bob Dyer sometime. He can ID most birds bytheir songs alone. Even his license plate has the name of a bird on it. And now he's put the wilderness in Wilderness Radio. 72, Bil

QSL CARDS: HOW TO INCREASE YOUR RETURN RATE

by ChuckAdams,K5FO
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All hams in amateur radio should know what a QSL card is.The QSL card has been around almost from the very beginningof amateur radio. The ARRL in the latest Handbook defines a QSL card as a postcard that serves as a confirmation of communication between two hams. I consider the card to be both a paper trail for the QSO or contact in the case of a contest and also to be a courtesy extended by oneham to another. Not unlike a handshake between old friends and new friends. It is a thank you note and a record of the contact.

The QSL card comes in many forms and sizes, but there are some things that you must consider when getting your own card with your very own call sign and information on it. The ARRL in the 1995 Handbook says in Chapter 2 that the card must have a minimum of the following information for it to be useful for award qualification for their many awards. The minimum card must have:

1. Your call sign, street address, city, state or province and country
2. The call of the station worked
3. The date and time (in UTC) of the contact
4. The signal report
5. The band and mode used for the contact.

In addition to the required information above most hams will addsome additional information such as

6. County name if in the USA and/or grid location for VHF work
7. Logo(s) for clubs, state seal, etc. as well as member number, e.g. NorCal #40. All the printers have the most popular logos such as ARRL and some even have the QRP ARCI logo available to put on your card. Mine has the ARCI logo occupy the upper left quadrant of the card.
8. List of awards won such as WAS, DXCC, WAC, etc.
9. Rig and antenna(s) used
10. Power output at time of contact (very important IMHO)

Depending upon your budget that you allow just for QSLcards, you can spend just about any amount that you want. I personally buy my cards 1,000 at a time and my cost runs about $36.00, so we are talking about four cents a card. There are a number of advertisers in QST, 73, CQ, and other magazines that can provide you with card samples and will even print up a card using your own design. Shop around and get what you want and what you will be happy with and what you think will get you noticed when the other ham receives it. The number of cards that you get should depend upon how much operating you do or think you will do over a period of time. For some people a thousand cards would be a lifetime's worth. Others may use up that many, or could use that many, just for one contest if they QSL'd one-hundred percent. There is usually a price drop per card as the number of cards ordered at one time from a printer goes up.

Here are some suggestions that I recommend for increasing your returns on QSLs (and I restrict myself here forQSOs between US hams) and others that have experience will tell you some variation of also:

a. Put ALL the information on one side of the card. A lot of hams don't want to have to turn the card over to get other parts of the total information. This can mean the difference between getting a card back or not. Be sure your call is on the card. You can put what you want on the back of the card, such as a photo, etc. or in my case it is blank. It keeps the cost of the card down.

b. Don't go overboard and get too fancy. The KISS principle works here as well as in a lot of other places.

c. Most cards are 3.5"H x 5.5"W (13.9cm x 8.9cm) standard size that you get from printers that advertise in QST and other places. Don't get cute and decide that you can make your card stand out from the rest by making it larger or some off the wall odd shape. Two problems here — you need to find an envelope that'll work or the US PO will charge you extra for being oversize and there is the possibility that automatic sorting machines will pick your card to chew up if you don't put it in an envelope. If the other ham stores cards in a shoebox or card file, your's will not fit and it just might go into the circular file known as the trash basket.You either have to find a design already done and there are many or do one yourself. Here one tends to go overboard with fancy designs. I have gotten all kinds of cards over the years. Some hand drawn, rubber stamped, regular postcard with info filled in and hand written on the back, computer generated dot matrix cards, computer generated laser output, and the list goes on. If you can think of it it has already been done. I think that simple works here as the other ham wants a valid card for possible use for some award.

Here is the typical process from start to finish that works for me and gets me a fairly good return in this day and age.

1. I work a station on the air. I make sure that I get all the information correct — call, name, qth, rst, etc. I carefully put it into the log book. This is the most critical thing of all. If you screwup the call, you are going to QSL to the wrong individual and will not get an answer back or a nasty letter back wondering if you worked a "pirate", another station using someone else's call. This happens a lot in DX work.

2. If you are going to QSL the station and you are not running hot and heavy in a contest such as SS, QRP Afield, QRP ARCI QSO Party, etc. then you should go ahead and fill out the card right then and there. Several reasons for this. The QSO is fresh on your mind and you can note something on the card that will refresh the other persons memory and it makes them feel good that you paid attention to them and it wasn't an ego trip for you. Work on your penmanship if it needs it and do a good job. Do not make an error then scratch through it and rewrite the info on the side. ARRL awards people don't like this. In fact they will accept no cards with modifications or deletions on them. If the band has good propagation and it is not expected to last much longer, then you can and should wait until later to do the QSL paperwork. Work 'em first and QSL later. If the other station was QRP, then indicate so when you place their call in the location on the card with the /QRP after their call sign. They they will appreciate it if they are working on a QRP award. I also will put in a square marked MODE 2-WAY the words QRP CW. On my card I have a place for power output and since I do QRPp only I write it down. It does two things. Reminds other station that I was QRP and sometimes will impress them and they will QSL back. May also get them to remember to put your call followed by / QRP in the call field of their QSL card.

3. Now get the latest address for the station and hopefully they have kept the FCC informed of their current whereabouts. I personally use the internet and use the listserver for the qrp-l group and run the 'calls2dist'

command. This command goes out on the internet and gets the latest FCC information which is usually no more than 24 hours old and the routine also returns the distance from my QTH to that of the other station. This assumes that they are not portable out in the field or traveling. If you have the call wrong, you will immediately spot the wrong QTH or name etc. from the information that you get back. To those new to the internet send email to LISTSERV @LEHIGH.EDU with RUN QRP-L X CALLS2DIST K5FO KI6DS where you substitute your call for K5FO and the other station's call for KI6DS. You will get back their name and address and a calculation of the great circle bearing distance to their QTH from yours. Note: you must be subscriber to QRP-L to do this. I also write on the QSL card the distance that I got. I think that at QRP levels this impresses hams to give them some indication of how far our little signals can go and theirs if they too are QRP.

4. Something that I do and you have to make the call for yourself here. I put the QSL card in an envelope. This just upped the cost from 20 cents to 32 cents to mail it!!! Some can not afford this and I respect that, so do what you have always been doing here. But I do one extra thingy here. I put in the envelope a 3.5"x1.5" peel away label with my mailing address on it done by a rubber stamp. This helps the other person in that they don't have to address their card or envelope by hand. Saves them time and costs me an extra cent or less. I find that I now get a lot of envelopes and cards with that label attached. And I know the address is correct. The reason why I personally put a QSL card in an envelope. I find that about 25 percent or more of the cards that I receive that are not in an envelope have been defaced by some machine within the postal system. I'd like others to let us know how many they get that way.

5. Now with a leap of faith mail the card and place it in the hands of the postal authorities and wait for a reply. Sometimes the other ham will reply immediately, sometimes later, sometimes much later, and sometimes never. It's a gamble here gang.

6. When you do get their card back, mark in your logbook that you received a reply, put it into the computer if you are using some program to keep track, and then put the card into your box. I got a platic shoebox from K-Mart for $2.00 that is clear plastic and has a green lid, but the color was just the color they had and has no special significance. It is 6.5"W by 4.75"H by 12"L on the inside. This box serves two functions at the present time. It holds incoming cards and it holds some of my blank cards and some envelopes. This makes it handy to do outgoing cards and keeps everything in one place. Works for me. It is about to run out of room for my cards pretty quick though. I have a set of cards with tabs A, B, C, through Z, that I use to seperate the cards. Here is the scheme I use. I take the first letter after the number in the call to file under. For instance, K5FO goes under F, KI6DS goes under D, etc. Even for DX calls, the same thing. It pretty much evens out the distribution of the cards after a while. Neato.

As a recent example of how this typically works. During June through August I spent all my time on the air on 30M. This was part of a study of propagation on 30M, since I have been on 40M all my life and 40M is my favorite band. That is, until this and now I work both. I worked 211 stations on 30M during this time period. I have sent out 174 QSLs and will continue to send out more. So we are talking about another $60 in expenses here. I have so far gotten back 97 QSLs. I worked 45 statesand have 42 states confirmed. At the time of this writing I have sent a second card to the 3 stations in the three states that I don't have confirmed. This to test to see if they did not get the first one or are going to bea problem. Next step is to send a SASE.

There are two things that get to me and here they are for your consideration. I have seen someone post on an internet group that they will not QSL unless the other station sends them a SASE. This is inexcusable behavior in my book. Why should I pay foryour postage? I paid for mine and it shouldn't break the bank to return the favor. Ever think about another hobby? Wonder if this is a ham with a $3,000 dollar station and another $2,000 in an antenna system? Now I have had guys send me a card and an SASE. I return the SASE in my envelope. Let 'em use it somewhere else. I can afford this hobby. I appreciate it but the Golden Rule applies here. And number two. If I need your card bad enough, I'll decide what the hell and send the station another card and a SASE.If the guy doesn't return the favor, then I hope the guy doesn't sleep well at night. What is he doing? Collecting stamps for the next rig? I hope not. At least return it with a note to tell me where to go. That I can understand. There might be a Federal Regulation on this from the US PostalService. Wouldn't that be nice?

And now a happier note and something that I don't do enough. Sit down with the box of cards once in a while and go through them one by one. It'll bring back fond memories of nights and days at the rig with electromagnetic energy going from one placeto another with information being exchanged. That's what it is all about in my opinion, and you did ask. I run across cards of friends that I have made and friends that I have lost over the years. Each memory is precious and hopefully you and I will be remembered long after we are gone because of a small card sent to someone somewhere as a momenta of a QSO carried on by the miracle of radio.dit dit es here's hoping for many QSL returns—Chuck Adams (K5FO CP-60) adams@sgi.com

NOTES ON PUTTING THE CASCADE ON 40 AND 17M

by Jim Kortge, NU8N
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Fenton, MI 48430

As promised, here are my notes from building a Cascade using the 40/17 meter option.

General Comments: I did not follow the modification described by John Liebenrood, K7RO, the Cascades designer. The original procedure requires two 20 meter band modules, one for 40 and one for 17 meters. However, when the PC boards were done for the kit, no additional 20 meter band module boards were manufactured. One could use a blank Sierra board, (Jim Cates has some of these) but I wanted to assemble the kit from the boards that were supplied. Therefore, my modifications will allow assembly using the original 75 meter and 20 meter band boards.

Here is the litany! The first thing which must be done before building, is to correct a mistake in the PC board. Failure to correct this error before installing connector J4 will require later modification to the 75 meter band board. The correction requires cutting away the ground traces on the top side of the PC board, where pins 23 of connector J4 will be. Leave the trace connected between the two pins, but cut the traces to the front and rear of the dual pin holes. Nothing has to be done on the bottom of the PC board at this location. It is correct.

After this step, you can also remove the two ground connections on the PC board pad that is to the right of the rearmost pad for component C89. This component location is right and rear of the area where tuning capacitor C18 will mount. The ground modified pad is used later in the VFO assembly. Finally, make sure that you have the addendum sheet for the Cascade, since I am not covering those changes in these notes. Pay particular attention to the need to add a ground from the back panel to the PC board. In my rig, I actually added two ground points. One near the BNC connector, and one just to the right of C67. Finally, use only silver mica or COG (NPO) type capacitors in the band module boards. Anything else will result in decreased output power, especially on 17 meters.

Section 1, DC POWER, 8V REGULA-

TOR:

Build this section as described in the manual. No modifications are required.

Section 2, BFO:

I have assumed that you have obtained 10 or more 12.288 MHz crystals, but these have not been sorted for use in the filter (Y2 - Y6). Build section 1 per the manual except for the following. Replace R22 with a piece of wire (0 ohms). This will provide more mixer drive. Do not assemble and install the inductor pair L3 and L33. Only one of these parts, L3, is needed with the new 12.288 MHz BFO crystal (More on this later). Install like a resistor, standing up on end. Also, do not solder in a crystal. We need to use the BFO oscillator for sorting the crystals. Here is how that step is done.

Set the PC board on a piece of foam, so it doesn't scootch around on the workbench. Connect your counter, which can resolve +/- 10 Hz, to the junction of R22 and R58. Apply power to the rig, and insert a crystal from the batch into the pad holes where it will eventually be soldered and push down into the foam below enough to hold it steady. Note: Touching the crystal with your fingers during measurement will cause errors. Let it set for 60 seconds or so to stabilize, and then read out the frequency. If it is not near 12.288 MHz, adjust trimmer capacitor C90 to "net" it near our target frequency.

Measure the next crystal, but don't touch the trimmer again. If this crystal is higher in frequency than the previous unit, lay it to the right. If it is lower, lay it to the left. Keep a mental note of frequencies as you go. If your crystals are like the set I was working with, frequency groupings will start developing. Select the 5 crystals with the closest frequency grouping and verify they are with 100 Hz from the lowest to the highest. Out of 10 to 12 crystals, you should get at least one useable group. Out of 20 crystals, I got 3 good sets.

Set aside the 5 crystals that are matched, and solder into the BFO circuit, one of the "unmatched" remainders.

Follow the "Initial BFO Alignment" procedure in the manual, except substitute 12.290 MHz for the 9.001 MHz frequency, and 12.286 MHz for 8.998 MHz. I used the counter attached to the junction of R22 and R58 for this initial alignment.

Section 3, VFO: Build the VFO according to the manual except for C22. C22 changes to a 47 pF NPO capacitor instead of a 270 pF. In addition, follow the 40/17 conversion routine regarding re-connecting the J4 pin 23 ground return. (This is where fixing the PC board error at the beginning pays off.)

The easiest place to get to the junction of C22 and C25 is to connect a wire from the rear, right, open lug on tuning capacitor C34 to the PC board pad. The other step which is required is to connect pin 23 to pin 25 on your 75 meter band board. This board will be used on 40 meters and this modification switches in the extra capacitance to lower the VFO frequency.

To get the VFO to cover the required frequency ranges, I had to add the following parts. These were soldered on the bottom of the PC board in parallel with previously installed components. Add a 10 pF NPO capacitor across trimmer C17. Add a 10 pF NPO capacitor across capacitor C22. Add 220 pF and 22 pF NPO capacitors across trimmer C34. With these changes, my VFO had exactly 200 KHz coverage on 40 (7.100 to 7.200 MHz) and 60 KHz coverage on 17 (18.108 to 18.168 MHz).

VFO Alignment:

1. Set capacitors C17 and C34 to be half meshed position.

2. Set capacitor to fully meshed position.

3. Measure the VFO frequency on your receiver or with a counter, by attaching to the junction of R21 and R57. I prefer this method, since you don't have to keep retuning the receiver as alignment proceeds.

4. Install 17 meter (using the 20 meter) band board.

5. Adjust capacitor C17 so that the VFO frequency is 5.820 MHz.

6. Install the 40 meter (using the 75 meter) band board.

7. Confirm that the VFO shifts down in frequency by approximately 0.850 MHz.

8. Adjust capacitor C34 so that the VFO frequency is 4.988 MHz.

9. Repeat steps 4 through 8 until the both band frequencies come in.

10. With the 40 meter band board installed, confirm that moving the tuning capacitor, C18 from fully meshed to fully open results in 200 KHz of frequency movement.

11. With the 17 meter band board installed, confirm that moving C18 from fully meshed to fully open results in 60 KHz of frequency movement.

Section 4, Audio Amplifier:

Build this section according to the Cascade manual. No changes are required.

Section 5, I.F. and Product Detector:

Build this section according to the Cascade manual except for the following. Change resistors R60 and R61 to 2.2K, for more mixer drive. Change resistor R52 to 10K, for more Tx filter drive. Add a 100 K resistor and 0.01 uF ceramic capacitor on the gate of Q11. This will prevent spurious signal pickup on the gate, leading to frequency offset between the transmit and receive. Use the crystals and capacitor values specified for the 40/17 modification. Either silver mica or ceramic with COG or NPO tolerance will work. I used the COG version obtained from DigiKey. Capacitors Cin and Cout were soldered on the underside of the PC board.

Section 6, Plug in Band Modules:

The 17 meter band module is constructed as described in the 40/17 modification part of the manual. Note that for inductors L2 and L3, a yellow torroid (type T37-6) is used instead of a red (type T37-2). This change will require purchasing two extra T37-6 cores from a suitable source.

The 40 meter band module can be built using the 75 meter band module board with the following changes. Build the Tx Low Pass and Rx Pre-selector sections as described in the 40/17 meter modifications. Build the Tx Spur filter section using the following values. These components go on the 75 meter band board in their original locations, but the values are different. Inductors L4 and L5, 9 turns of #26 on original T37-61 core. Capacitors C3 and C11, use 820 pF values. Capacitor C7, is a 1800 pF value. C5 and C9, 68 pF in each location. The bandwidth of the filter is approximately 400 KHz wide like the original and maintains its 50 ohm termination impedance.

Band Module Alignment:

Use the procedures in the manual. As noted, using these modifications allows using the original 20 meter board for the 17 meter band module, and the original 75 meter board for the 40 meter band module.

Section 7:

No changes required in this sections.

Section 8:

Build as described in the manual, then add the following components. On the bottom side of the PC board, solder a 68 pF ceramic or silver mica capacitor across the primary (collector side) of T1. In a similar manner, solder a 180 pF ceramic or silver mica capacitor across the primary (collector side again) of T3. These capacitors help flatten the response of these transformers, providing more output on 17 meters. A 100 ohm, 1/2 watt resistor should be soldered across the primary (collector side) of output transformer T2 for added final stability when operating into reactive loads.

Sections 9 and 10:

No changes required in any of these sections.

Observations and general notes:

I did the carrier balance on 17 meters, since it seems a bit more sensitive than on 40. I also noticed that setting the PA bias did not exactly follow the manual. I set this by putting the rig on a dummy load, whistling into the microphone, and setting the bias potentiometer until the power output peaks. At maximum CW travel of the PA potentiometer, the power output on my rig actually decreases.

Power outputs are as follows: On 17 meters, just a tad over 4 watts, on 40 meters, I am getting approximately 7 watts. Both of these are under a "steady whistle" (now there is a new engineering term) into the microphone. I am using an Alinco speaker -mike, part number EMS-2. It is too small for good audio from the speaker section, but the microphone seems to work well.

My rig is apparently the first of the Cascades built for 40 and 17. I am hopeful others take the challenge, and try this. My advice is to not build the rig on 75 and 20 first, since there are many parts which need to be changed. My concern is the damage that probably will be done to the PC board getting the old parts out. I have changed just a few along the way (mostly stupid mistakes) and found that removing them, even using a solder sucker and solder wick, was not easy. I can't imaging doing a major rework from 75/20 to 40/17 and not lifting several pads and damaging numerous traces.

I will also be quite happy to correspond via e-mail to those who are doing this modification and need help and/or advice. Or you can call (810-629-0378, no collect calls please) and we can try that mode.

That's all....have fun with this really great rig! 72, Jim Kortge, NU8N
jokortge@tir.com
jokortge@detroit.freenet.org

Postmortem:

I have done some additional modifications to the rig since the "initial foray". I'm not recommending these changes necessarily, but am supplying them "for information only". Use at your own risk!

I have changed the output transistor in my Cascade to a 2SC1945, which has a different pinout than the 2SC2312. One of the important differences is the fact that the emitter is on the mounting tab, instead of the collector, thus allowing the emitter to be directly grounded to the back panel. This device also is rated for more output (15 watts) than the 2SC2312. However, its use also requires that the collector and emitter leads be reversed, making for some real butchering of the PC board to get it connected.

I've also changed the output transformer, T2 with the change to the new output transistor. It is wound with a 1 turn primary, made from RG174 braid, with the 2 turn secondary threaded through the "tubes" of the braid. This technique is detailed in one of the Motorola application notes. I mounted the new T2 on the bottom of the PC board, so that a 0.01 uF bypass capacitor could be soldered on the top of the PC board from the cold end of the primary (12 volt feed) to ground. I'm still using the 100 ohm resistor across the primary for stability reasons.

With these changes, I am getting the following output powers. 17 meters, steady whistle, 7 watts, and on 40 meters, same conditions, 11 watts. That's about double of what the rig would do with the 2SC2312 and the other output transformer. The 2SC1945 hardly gets warm at those power levels. And yes, I know it's not QRP anymore, but I have my reasons. Read on.....

One of the things that I know from experience (more than 3 years of bicycle h.f. mobile) is that you need at least 10 watts of steady state output (especially on 40 meters) if you're going to make contacts while on the bike. With the very high antenna losses from minimal ground plane and low antenna height, anything below about 10 watts won't get the job done. It's not much fun running h.f. bicycle mobile, and not be able to make contacts! I know, I've been there; done that! With the current power levels, taking the Cascade on the bike is now a reasonable consideration.

So that's the latest! Have fun with your Cascade. It's a very good design, and works quite well. I constantly get complements on the audio quality, and most stations find it hard to believe that 10 watts can sound so strong. I still have a bit of drift in the VFO, and that's the last challenge before the rig is "perfect".

72....Jim Kortge, NU8N

[Editors Note: NorCal is deeply indebted to Jim. He put countless hundreds of hours into the research and development of the mods that you see here. John, K7RO also worked with Jim and credits him with doing the first Cascade on 40M. Thanks Jim. Doug, KI6DS]

CASCADE TOROIDS AND POWER STATUS

by Bruce Florip, AA7AR
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Hi Fellow QRPers. I wanted to give you the results of the last few daysof playing with the Cascade. A few comments have been made about "remove a couple of turns from your torroids" and it was bothering me to think someone may try that without a sort-of-rational reason for picking which torroid to attack...At least as far as the Cascade (and Sierra) go a good indication of proper tuning and associated resonance is the position of the variable capacitors (trimmer caps).

On the Sierra Wayne went to some lengths to make the initial tuning point on the trimmers the half way point. Don't get me wrong, if you've tuned up your radio and the trimmers aren't exactly half way don't worry. The point to worry is when the best amplitude is when the trimmer is either all the way meshed, or all the way open.

On my Cascade, I found the 75 Meter band module had two trimmers in the fully open position. That means the maximum signal may not be due to resonance, only to the minimum position on the trimmer. In each case (and done one at a time) I removed one turn from the associated torroid and was able to tune for maximum signal at other than the fully open position of the trimmer. In my case L5 was reduced by one turn to get C6 into about the 2/3 meshed position, and L4 was reduced by one turn to get C8 to a nearly meshed position (not fully, about 80%).The bad news is that with 13.8 Volts on the Supply, and the 75 meter module installed, I started with 70 V peak to peak on the scope across 52.4 ohms and ended up with the same value after the changes. Not all bad for an evening of fun, and no loss of performance.

Still on the Cascade topic... After helping a couple of others with the post-build tune-up on their Cascades:When you're installing resistors and capacitors, it makes tracing signals easier if you stand the resistors up so the signal end has the long wire instead of the ground end. That makes it easy to get the scope probe in there...Secondly take the time to carefully remove the insulation from each of the leads on your torroids. It's not too obvious visually that there is enamel on the wire after the plated through hole is full of solder.

And, last but not least, if you've been "rude" to your final output transistor on the Cascade. You know, shorted mica washers, bad probing etc. you may find the output stage has very little gain. In one case this was due to the two one ohm resistors in the emitter lead changing from 1 ohm to around 20 ohms each. This can be checked in circuit (with power off) with theDVM just be sure there is less than 1 ohm resistance for the two resistors in parallel. 73, Bruce Florip, AA7AR/6

REDUCED DRIFT FOR THE CASCADE

by Ed Burke, KI7KW
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Lake Oswego, OR 97035

For me, one of the pleasures of using my new Cascade SSB transceiver is chatting with some of the old-timers who hang out at informal nets on 75 meters. But that requires being tuned to a single frequency for a long time, sometimes as much as an hour, and my Cascade drifts during that time as it apparently warms up. So. since I got tired of receiving gentle hints to "retune", I decided to investigate improving frequency stability, and I got out my lab frequency counter.

It turns out, a very major improvement can be made with a few simple changes. In its original (stock) form, the capacitors in the Cascade VFO have a net positive temperature coefficient. As it warms up, the VFO frequency tends to decrease, so the transceiver frequency (on 75M) increases. What is required, is a negative compensation coefficient from "something".

To make a long story short, after many substitutions, I found that replacing three NPO capacitors in the VFO with polystyrene equivalents helps a lot. I made the following substitutions:

C25,100pf - Mouser 23PS110
C22, 270pf - Mouser 23PS127
C21, 82pf - Mouser 23PS110 (100pf) and Mouser 23PS147 (470pf) in series to get 82pf effective.

These capacitors are the same ones chosen by Wayne Burdick for the Norcal 40 so the improvement should not be too surprising. Mouser's catalog indicates that they have a temperature coefficient of Negative 150ppm/C. The other change I made was to remount the LM383 audio amplifier outside of the box. I used a five-inch length of shielded, four-conductor cable and put the hot audio chip on its own heat sink on the back panel. I drilled a clearance hole through the lower back panel for the cable. This dropped the receive-only power dissapation inside the enclosure from about 1 watt to less than four-tenths of a watt.

When I rechecked my Cascade after making these changes, I found that the VFO drifted less than 30 Hz over 40 minutes with the cover in place. In operation, I am able to tune a frequency and then leave the tuning knob alone; no more retuning every few minutes. Enjoy. Ed Burke, KI7KW

MY RESULTS WITH THE KI7KW CASCADE DRIFT FIX

by Dave Meacham, W6EMD
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Internet: ddm@datatamers.com

Ed (KI7KW) posted a "drift fix" on the QRP-L reflector on January 2. He reported that replacement of C21, C22, & C25 with polystyrene capacitors gave much less drift. I tried the poly fix and got different results initially, but final results are great.

The situation is that the VFO inductor (L1) has a positive temperature coefficient. We are trying to cancel that by putting in negative-TC caps. Well, when I put them in I got OVER-compensation.......75-meter frequency dropped with time (-274Hz in 1hr from a cold start).

I ended up using straight polys for C21 & C22. For C25 I had to use a combination of poly and NP0 caps in parallel.... 82pF poly and the rest NP0 disks under the board.

My Results:

One hour after a cold start the frequency was +4Hz from where it started. This was with a closed case & without relocating the audio chip.

"Your mileage may vary" (Each rig is a little different!) In general, I'd say that you can't go wrong replacing C21 & C22 with polys. You will get a reduction in drift. Beyond that you will need to do some careful testing with a good counter to achieve lower drift.

72, Dave, W6EMD

PEAKING TUNED CIRCUITS WITH A TRIM CAPS

by Ed Burke, KI7KW
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Lake Oswego, OR 97035

With the winter season upon us, you QRP enthusiasts may be planning to build something. So here is a helpful hint. It may have already been communicated, or maybe it is obvious to some of you but here goes....Trimmer capacitors, such as the miniature types used in the Norcal40, Sierra and Cascade, have a capacitance profile that looks approximately like a saw-tooth waveform, with one "tooth" per revolution. That is, if you take a 5pF to 40pF trimmer and set it at its minimum capacitance (5 pF), and then turn the adjusting slot, it will more or less linearly increase to its maximum value (40 pF) at 180 degrees of rotation, and then linearly decrease back to the minimum at 360 degrees.

So why is this important? Well, when you peak up a tuned circuit which is within range for resonance you should see two peaks for every rotation of the trimmer, not one! Counting two peaks is a pretty good indication that things are working properly, and getting only one probably means that the inductor is somehow the wrong value for the frequency involved. Consider a concrete example. Suppose you have correctly wound a toroid for 5 Mhz such that it will resonate with 20 pF. When you rotate the 5 to 40 pF trimmer mentioned above, it will pass through 20 pF twice, so you will get two maxima. Now imagine that you have made a winding mistake and have produced a toroid which needs 50 pF to resonate. When you try to adjust the trimmer cap it cannot yield more than 40 pF, so it will not really resonate, but you may get an relative peak indication at 40; "I'm not at resonance boss, but I'm doing the best I can". Counting peaks is a pretty good technique when aligning tuned circuits. Enjoy, and best 73's, Ed, KI7KW

THE FORTY-9ER: A 9-Volt 40-METER TRANSCEIVER

by Wayne Burdick, N6KR
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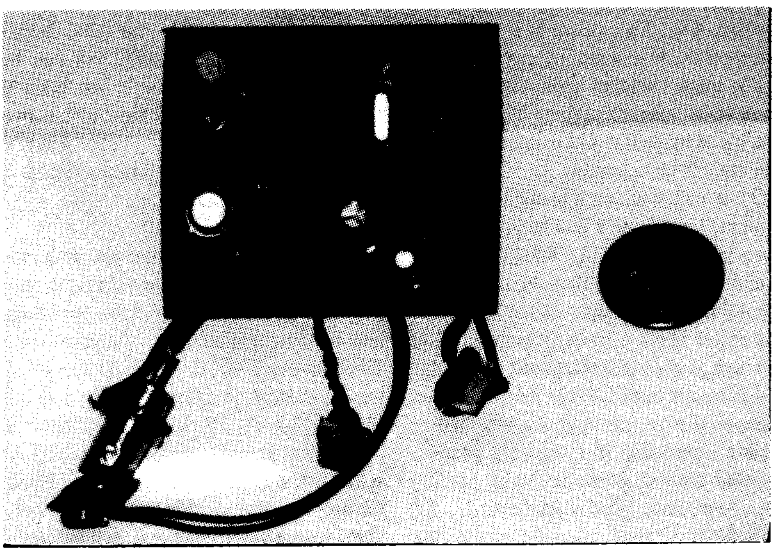
Doug Hendricks found a batch of 7.040MHz crystals, and had no choice but toget someone to design a rig around them. In this article I'll describe a very simple 40m D-C (direct conversion) transceiver that I call the"Forty-9er," because it can run on a 9V battery.

In the spirit of NorCalcollaboration, Doug will do the PC layout, and part with his crystals at some reasonable price. Another motivation for this rig was to improve performance over the D-C transceiver that some of us built at Dayton last year.

The Forty-9er has a few more parts (about 1/3 as many parts as a NorCal 40), but as a resultit is actually usable.



The prototype version of the 49er forty meter CW direct conversion transceiver

Features:

* Runs on any DC voltage from 7 to 12V

* Power output of roughly 250mW at 9 volts, 500mW @ 12V

* VXO covers about 5kHz (7.037 to 7.042 w/7.040MHz crystal)

* Full QSK — really helps when you're using such low power

* Very low current drain: 10mA receive, about 70mA transmit (@9V)

* Only one simple alignment step, and NO toroids

Circuit Details:

Refer to the schematic. U1 is the product detector and VXO. To minimizeAM broadcast and portable phone pickup (both are problems with directconversion receivers), the input tuned circuit has a low L-C ratio. This increases the Q of the tuned circuit, and the small loss in signal is not aproblem.

On transmit, D1 detunes the input tuned circuit and unbalances the mixer, preventing the transmitter from modulating the VXO signal. JFET mute switch Q1 is used to provide full QSK. Q1 must be a low pinch-off voltage type (J309, J310, 2N5484, etc.) because the voltage at pin 4 of U1 is only about 4V. This detail is occasionally overlooked. For example, you'll see MPF102 mute switches used with NE602s running at 6V, even though an MPF102 can have a Vp of up to 8V, and may not be completely cut off on transmit.

Q1 is followed by a passive low-pass filter (RFC2, C10) and a simple, high-gain AF amplifier circuit (U2). RFC2 and C10 are quite large because they must resonate in the AF range (see parts list). The VXO covers about 5kHz. To keep get the VXO output high and consistent, I used two tricks: (1) C4 is bigger than C5; (2) R4 was added to increase the oscillator bias a bit. Don't use these techniques in every'602 project, since they may degrade receiver performance. Also, since good crystal starting and low oscillator current drain are conflicting goals, don't expect to be able to increase the size of RFC6. At somepoint, your transmit power will drop dramatically at one end of the VXO trim cap.

The transmitter has only two stages. The 2N3904 is self-biased for simplicity, and provides enough gain to drive the 2N3866 to around 200mW.

The final operates class C, and is reasonably efficient. I could have used a class A final amp stage instead and possibly eliminated the low-passfilter, but I wanted to minimize current drain. This is a good strategy for operation from a 9V battery, which may provide only a hundred milliamperehours (higher with alkaline or lithium).

Sidetone is not included, since it would have added another five or six parts. You can hear a soft buzz when you key the rig, though, which is acceptable if you're using a push-button key.

Construction:

If you use your own PCB or breadboard layout, here are some things to keepin mind:

(1) in general, keep the RF chokes a good distance apart, or ifyou can't, use toroids;

(2) keep lead lengths short;

(3) use as much groundplane as possible.

There are many ways to improve on the design. You can change the QSK delay by changing C8 (with .002uF, you can hear between dits at 15WPM). If you want better low-pass filtering, add another L-network after C10 (82mH and0.47uF). This will improve rejection of high-pitch signals but will increase insertion loss.

Operation:

To align the rig, all that you do is tweak C2 for the loudest signal and that is it. Hook it up to a power source, antenna, headphones and key and you are ready to get on the air. You can use 7 to 16 volts with this rig, but put a heatsink on Q3 if you use over 12V. **IMPORTANT: Since there is no SWR protection at the output, you MUST use a known, matched antenna (or a 50-ohm dummy load) with this rig.** If you use an antenna tuner, be sure you use an absorptive-type SWR bridge so that the final will see a reasonable load during tune-up. In-line SWR bridges provide no protection for the final.

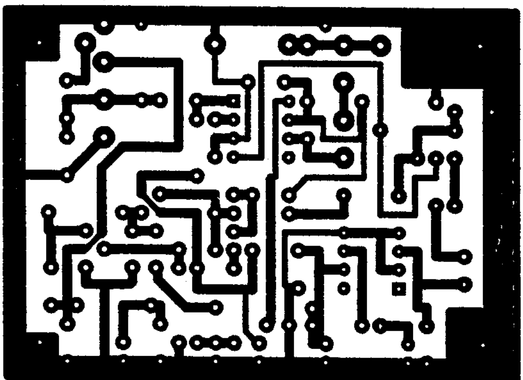
The frequency shift from receive to transmit is very small—typically 100Hz. The shift is in the downward direction, so when you call a station, make sure you're listening on the HIGH frequency side of zero beat. (There are two places you can set the VXO cap to listen to any particular station; use the lower-capacitance setting and you'll be on the high side.)

The rig can be used hand-held with a push-button code key. In the field, you'd just hook up a 33' piece of wire and toss it into a tree, and toss out a ground radial of the same length. Use #22 or larger stranded copperwire and a small, smooth fishing weight. Bring a backup antenna in the event that your tree was hungry.

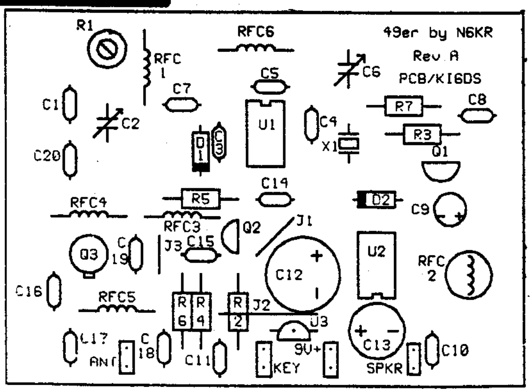
Conclusion:

It's a nice change to build something so simple, and it really seems towork. On the day I built it, I worked Washington state and Michigan, both on the first call! It seemed deceptively easy, so I suspect conditions were good. This is a good rig to take for emergencies or just for fun wherever you're going, since the whole station (including antenna wire and fold-up stereo headphones) will fit in your pocket. The design is still preliminary, so please send me your comments and suggestions if you build one. (I can be reached by e-mail at burdick@interval.com.)

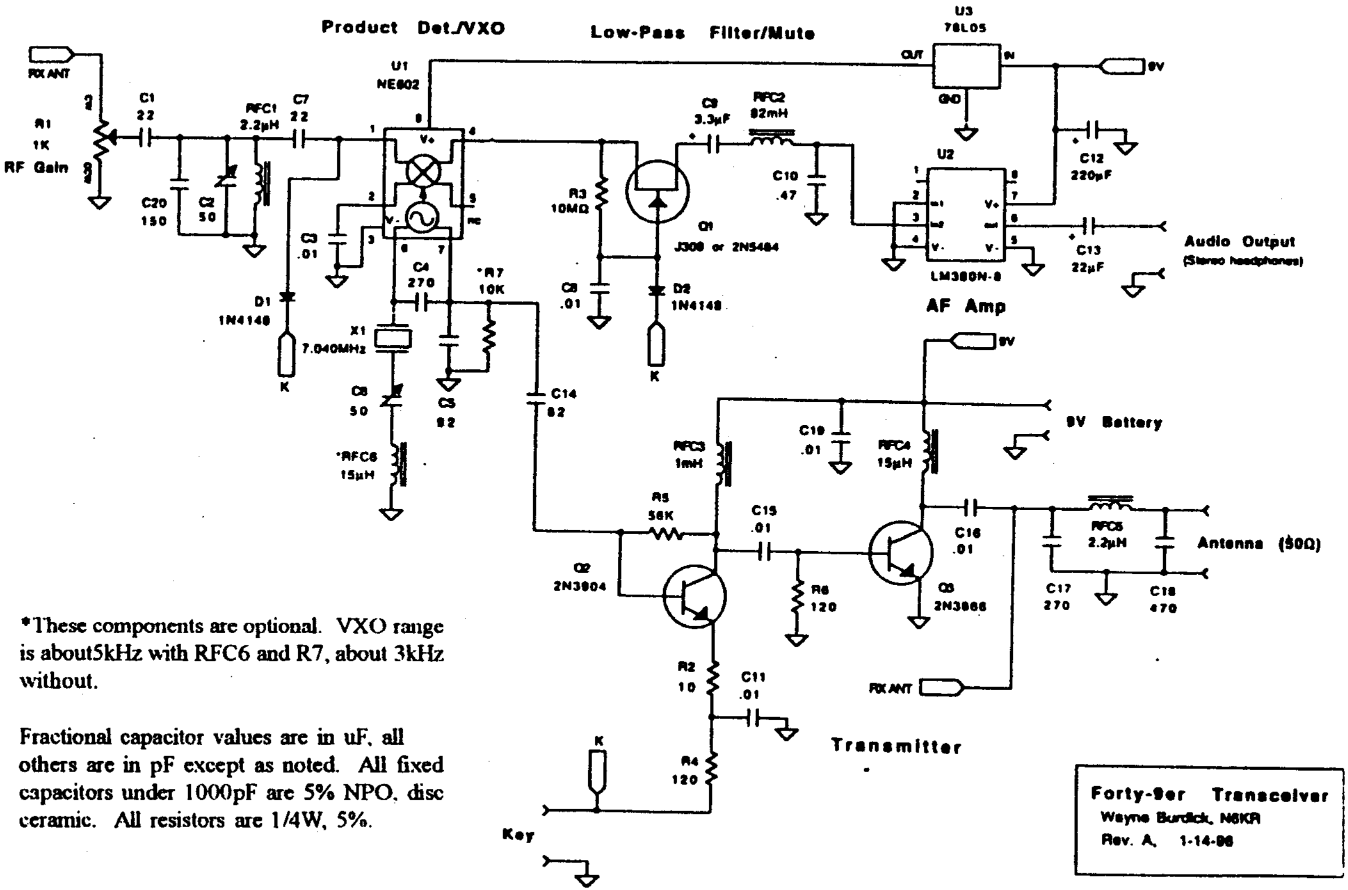
NOTE: Circuit Boards for the 49er are available from NorCal QRP Club. Send $5 to Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Specify that you want the 49er Circuit Board. Make checks or money orders out to Jim Cates and NOT NorCal. Price includes Shipping in the US. Foreign orders add $3 shipping. US Funds only.



49er PC BOARD LAYOUT
XRAY View



49er Parts Placement Guide



*These components are optional. VXO range is about5kHz with RFC6 and R7, about 3kHz without.

Fractional capacitor values are in uF, all others are in pF except as noted. All fixed capacitors under 1000pF are 5% NPO, disc ceramic. All resistors are 1/4W, 5%.

A REVIEW OF THE NORCAL SIERRA (WILDERNESS RADIO VERSION)

by David Yarnes, W5RMZ
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I've had my Sierra up and running for about 10 days now (including band modules for 80,40,30, and 20). Certainly not record time (nor was I trying for such), but pretty good for me—particularly considering a severe case of the flu which I can't seem to completely shake. I am not contemplating a K5FO type report (aren't they great!), but I did want to pass on my brief comments. I had hoped to have some juicy DX QSO reports to throw in, but with the absolutely horrible conditions we have been having lately I don't have that much to offer. I have worked Japan OFTEN on 40 meters with this rig, so it does do DX!

The kit went together very smoothly. No missing parts—no confusion in the instructions. The board is super, just like the 40A's board. The parts are relatively easy to identify, and everything just slips right into place.

There really isn't anything that slows you down or gives you any kind of problem with one small exception. As previously reported, the VFO toroid, L7, appears to require 1 or 2 less turns than called for (2 in my case, 1 in the other reports I saw here on QRP-L). No big deal!!

The band modules are very straight forward—A little dull perhaps due to the number of toroids you have to wind—but easy. Actually, it's not that bad even considering the toroids. Trust me! Winding those things (at least for this kit and for the 40A) is EASY! Each module takes about one and a half hours to complete. Every one of my band modules worked just fine without any problem.

When I first completed the Sierra, and had a band module ready to go, I quickly discovered I had a problem. Fortunately, not a big one as it turned out. I couldn't get anything on receive. I discovered that applying pressure to the top of the band module brought the receiver to life. Obviously I had a bad connection somewhere. I started checking solder connections, and quickly found a bad one. A little reapplication of solder and bingo, I was in business! That is the sum total of the problem list.

I have run side by side comparisons with my Ten Tec Argo 556 and an OHR Classic. The Sierra compares very favorably. My 40A is out on loan or I would have compared it too. Of course the Argo is a different class rig—synthesized, CW and SSB, etc. The Classic is a closer comparison, although it is a duo bander (40/20) while the Sierra is multi band using changeable modules. The Classic does have a big brother that is a 4 bander, which from my observation is very similar otherwise. The Classic is a very solid QRP rig with which I am well pleased, so I felt I was giving the Sierra some stiff competition.

The Sierra hears just about everything the other two transcievers and hear as best as I could tell, and it has a "softness" in the audio quality that allows me to tune across the band without having to ride the gain control. I notice, especially on the Classic, that I have to constantly adjust the gain to keep the audio from becoming too shrill. This is the price you pay for slightly sharper filtering on the Classic. The variable bandwidth feature on the Sierra is a big plus, especially if you move the control to the front panel (which I haven't done yet, but will). Also as previously reported, if you open the variable bandwidth control, it tends to allow reception of the opposite sideband.

The Sierra is rock solid almost immediately. I notice some early drift on the Classic. (The Ten Tec Scout/Argo is supposed to have the shifting problem due to the xtal oven process, but I haven't had much problem in that regard). The sidetone is definitely better on the Sierra than on the Classic.

The real disadvantage to the Sierra (to some people) is that it is only 2 watts more or less (just about 2 in my case). I must admit I wish I had the other 2 or 3 watts sometimes, but the Sierra is a backpack rig while the others definitely don't qualify.

The frosting on the cake is to put a KC1 in this rig. I think it's a crime if you don't! This is such a "neat" add on, and you need a keyer anyway don't you? Having frequency readout in CW and a message memory as extras is just too good to pass up. By the way, the keyer is excellent and substantially programable in case you haven't seen the specs before.

This rig works great. I recommend it highly. I don't get a damn thing for saying this except the possible satisfaction of having some more people with whom to compare notes. I greatly admire the things Wayne Burdick is designing. To a bean counter like me, this guy's a marvel! Fact is though, I think some of you who know a lot more than I do think so too.

If this rig interests you at all, buy it! you won't regret it.
72 de David W5RMZ

[!NOTE: The Sierra, NorCal 40A Rev. B, and the KC-1 Keyer kit can all be purchased from Bob Dyer at Wilderness Radio. His phone number is: 415-494-3806. Please call for current pricing and availability. At the time of publication all kits were in stock and ready for immediate shipment. Wilderness Radio is not connected with NorCal QRP Club, the information provided here is done so as a service to our readers. Doug, KI6DS]

The QRP Lament

by Arvid Hamer, WA6UUT
992 Echo Dr.
Los Altos, CA 94024

[This poem was presented to Bob Dyer, KD6VIO, upon his retirement from being the EMARC Club president at the club's annual banquet in January of 1996. This poem captures the essence of Bob's quest for DXCC/QRP. True to the poem, Bob worked country #125 on 40M CW Jan. 21, 1996.]

The QRP Lament
I'm a little peanut whistle,
And my antennas not so hot.
I can't compete with power
But I try an awful lot.

QRP, QRP. Won't you
Listen, please, for me?

The big guys work the DX
And leave the crumbs for me.
But I'm always in there calling,
Working for DXCC

QRP, QRP. Won't you
Listen, please, for me?

It only takes a minute
To listen to my plea,
And I'll be forever grateful
If you'll stand by just for me.

QRP, QRP, Won't you
Listen, please, for me?

I'm getting old and weary,
and the prop is mighty low.
I'd like to make my hundred,
Before I have to go.

QRP, QRP. Won't you
Listen. please, for me?

But somewhere up in heaven
There's a place, I know for me
Where the DX always says,
"Lets hear the QRP!"

QRP, QRP. Thanks for
Listening just for me!
Arvid E. Hamer. WA6UUT

QRP To The Field, #2

by Bob Farnworth, WU7F
6822 131 AVE SE
Bellevue, WA 98006
USA

SECOND ANNUAL - "QRP TO THE FIELD"

SATURDAY, APRIL 27, 1996

GET READY FOR JUNE FIELD DAY, BY TESTING EQUIPMENT ON THE "QRP TO THE FIELD" - OPEN TO ALL RADIO AMATEURS, AND ALL BANDS AND BOTH MODES (SSB/FM AND CW). SPONSORED BY THE "NORTHERN CALIFORNIA QRP CLUB". SINGLE TRANSMITTER ON THE AIR AT ONE TIME. ONCE STARTED, USE THE SAME POWER OUTPUT AND LOCATION CATEGORIES. CONTEST PERIOD: SATURDAY 1300 UTC TO SUNDAY 0100 UTC - MARK YOUR LOGS TO INDICATE YOUR BEST (8) CONTINUOUS HOURS FOR SCORING.

EXCHANGE: SIGNAL REPORT AND STATE, PROVINCE OR COUNTRY

QSO POINTS:
- 1 WATT OR LESS OUT - 10 POINTS (EITHER MODE)
- 5 WATT OR LESS OUT - 5 POINTS
- OVER 5 WATTS - 2 POINTS

MULTIPLIERS:
- FIELD LOCATION 4 x MULTIPLIER
  - FIELD LOCATION = BATTERY POWER & TEMPORARY ANTENNAS
- HOME LOCATION 2 x MULTIPLIER
  - HOME LOCATION = COMMERCIAL POWER & PERMANENT ANT.S
- HOME BREW EQUIPMENT 3 x MULTIPLIER.
  - HOME BREW = IF YOU BUILT IT, IT IS CONSIDERED HB
- COMMERCIAL EQUIPMENT 2 x MULTIPLIER

FINAL SCORE = BAND/MODE QSO POINTS x LOCATION MULT. x EQUIP. MULT. = BAND/MODE TOTAL. ADD THE BAND/MODE TOTALS FOR THE FINAL SCORE

EXAMPLE:

(20) 20M/SSB QSO'Sx5(5W)x4(FIELD)x2(COMM)= 800 POINTS
(35) 40M/CW QSO'Sx5(5W)x4(FIELD)x3(HB)= 2100 POINTS
FINAL SCORE = 2900 POINTS

AWARDS: TOP TEN SCORES CERTIFICATE (THE TEN STATIONS WITH THE HIGHEST SCORES) PARTICIPANT CERTIFICATE FOR 20 OR MORE CONTACTS (INCLUDE A 9x12 MANILA ENVELOPE WITH 3 UNITS OF POSTAGE) SEND LOGS ALONG WITH A STATION AND LOCATION DESCRIPTION TO:

BOB FARNWORTH, WU7F
6822 131 AVE SE
BELLEVUE, WA
98006-4038 USA

GET IT IN BY MAY 31, 96. ALL CONTEST COMMITTEE DECISIONS ARE FINAL. INCLUDE A #10 SASE IF YOU WANT A COPY OF THE RESULTS. QRPp WILL PRINT RESULTS.

The Epiphyte-2: 75M Portable SSB Transceiver

by Derry Spittle, VE7QK
1241 Mt. Crown Rd.
North Vancouver, BC
V7R 1R9 Canada
jds@freenet.vancouver.bc.ca

[Since my construction article for the EP-2 was published in the December, 1995 issue of SPRAT, I have modified the PA/ Driver section. While this may be made to the original PCB, I have taken the opportunity to revise the text to reflect the changes and redraw the board. Much remains unchanged and is reprinted with kind permission of the G-QRP Club. Wherever parts have been eliminated the numbering of the remainder has not been altered. Derry, VE7QK]

Construction articles for the original Epiphyte were published in Sept.,1994 QRPp and further articles for a 5W amplifier and VFO appeared in the Dec. 1994 issue of QRPp. The EP-2 includes both these features without increasing the size and without compromising the original objectives of simplicity and minimum power consumption.

The Driver Stage is a CA3020A differential amplifier (U5) and replaces the original pair of VN10s to make room for a power amplifier. Operating from a 9V supply, this stage has a power gain of 60dB, an idling dissipation of 200mW and an output of 500mW. It is matched to a 22 ohm resistive load (R23) at the gate of the final amplifier with a broad band transformer (T1).

The Power Amplifier (Q4) is an IRF510 Mosfet with an RF output of 5W PEP. Some instability became noticeable when using the original Tee-match and it has been replaced with a more conventional broadband transformer. Shunt feedback has also been added. The low-pass filter is inserted in the antenna feeder if there is insufficient space within the enclosure.

The VFO is a varactor tuned Vackar circuit and replaces the 4.19MHz ceramic resonator (VXO). The inductor is a Toko 3.3uH variable coil.

The RF BandPass Filter uses the same Toko 4.7uH coils but has been remodelled in a series-tuned configuration using W7ZOI's GPLA program. It has a reasonably flat response over some 200kHz and sharper roll-off on the high frequency side to improve rejection of the image frequency. It has an input impedance of 1500 ohms to match the NE602 mixer and terminates in a 100 ohm resistive load to ensure stability in the driver. Fixed capacitors are "standard" values.

The microphone input is a 2-pin Molex connector (Con 6). R19 provides the polarizing voltage for an electret microphone (2-terminal type) and should be omitted if a dynamic microphone is used. The value of R20 should match the impedance of the microphone. The speech amplifier (U6) gain may be adjusted by changing the value of R17.

Construction:

Assembly is fairly straightforward, but here are a few suggestions. Some fairly large value polystyrene capacitors are specified. Their physical size should be ascertained before ordering if they are to fit comfortably on the board. Ensure that the Toko coils (L3, 5, 6, & 8), filter (F1), ceramic resonator (X1) and trimmer cap (C10) fit the PCB; enlarge the holes if necessary. Install the CA3020A (U5) first; it is easier to align the twelve pins without other components in place. Be sure to solder in the two jumper wires before installing the socket for U1. Remove the center pin before mounting the IRF510 (Q4) and heat sink with a 4-40 machine screw, nut and star washers. Remove unused terminals from the relay socket. Finally, don't bother soldering the three unconnected pins on the Toko coils to the ground plane; you may need to remove the coils one day!

Alignment and Testing:

This must be carried out with the single sided PCB fastened to a ground plane with four metal stand-offs.

1. Remove both metering jumpers. Install the Relay (K1) and PTT switch if not built into the microphone. With all IC's removed connect to a 12-14V **Fused** supply. Verify that VR2 is delivering 5V and that VR1 is delivering 9V on transmit. With an RF probe check that both oscillators are functioning. Set the LFO to 453kHz with the trimmer (C10). Change the padder (C11) if necessary.

2. Adjust L3 and R24 to set the tuning range. Bandspread, with the 10 turn pot (R25), should not exceed 20kHz /turn or tuning will be too critical. Shorten the slug in L3 so that it sits flush with the top of the can and fix with beeswax or sliver from a rubber band.

3. Install all IC's. Connect the antenna, speaker, volume control. Test the receiver and adjust L8.

4. The RF voltage at pin 6 on each of the two mixers should read 140mV +/- 25%. If necessary, change the value of C5 and/or C6.

5. Set the RF drive control (R15) to minimum. Measure the transmit standing current in the driver (U5) at Con7. If this is not 25mA +/- 10%, transformer (T1) or the driver (U5) has probably been incorrectly installed.

6. Adjust R3 to set the transmit idling current in the power amplifier (Q4) to 10mA at Con8. **ONLY AT THIS POINT MAY BOTH METERING JUMPERS BE INSTALLED.**

7. Advance the RF drive (R15) until RF voltage appears across a 50 ohm dummy load while modulating with a tone (whistle!). Adjust the bandpass filter (L5 & L6) to maximize. Continue increasing the drive until it peaks to around 16 volts. The driver current should rise to 60 or 70mA and drop to around 25mA with no modulation. The IRF510 current should rise to 500mA and drop to around 10mA with no modulation. Monitor the signal on a receiver and/or oscilloscope. The "average" current with normal speech modulation will, of course, be considerably less. This completes the alignment.

8. While it isstronly recommendedthat a simple testchassis be used during construction and alignment there is a great deal of flexibility permitted in the final packaging. External connections should be keptas short as possible. The size of the PCB (2.9" x 4.75") was chosen with the TenTec Model TP-20 enclosure (5" x 4" x 2") in mind.

A small simple Digital Display with a frequency resolution of 100Hz has been designed for use wtih the EP-2 and to mount in the upper half of the Ten-Tec enclosure with the display behind the front panel. This will be the subject of an article in the next issue of QRPp.

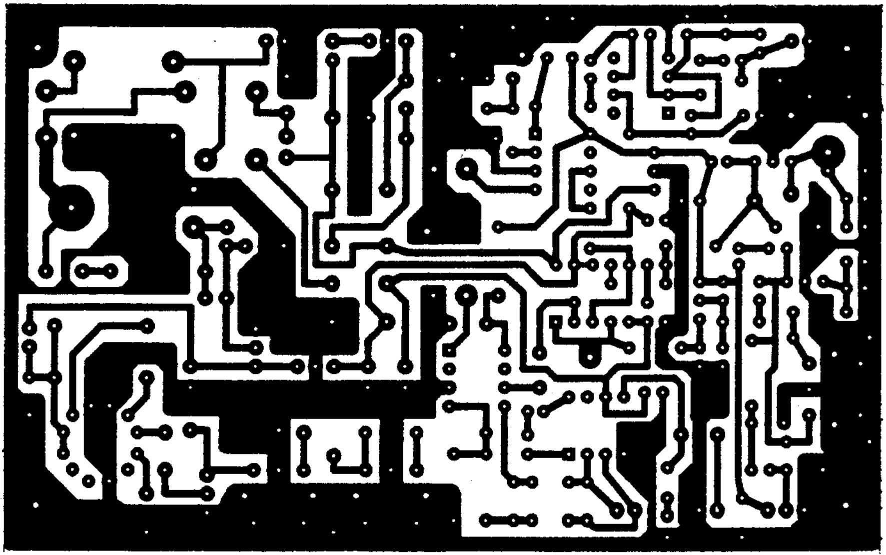
Have fun and feedback is welcome and encouraged. 72, Derry, VE7QK

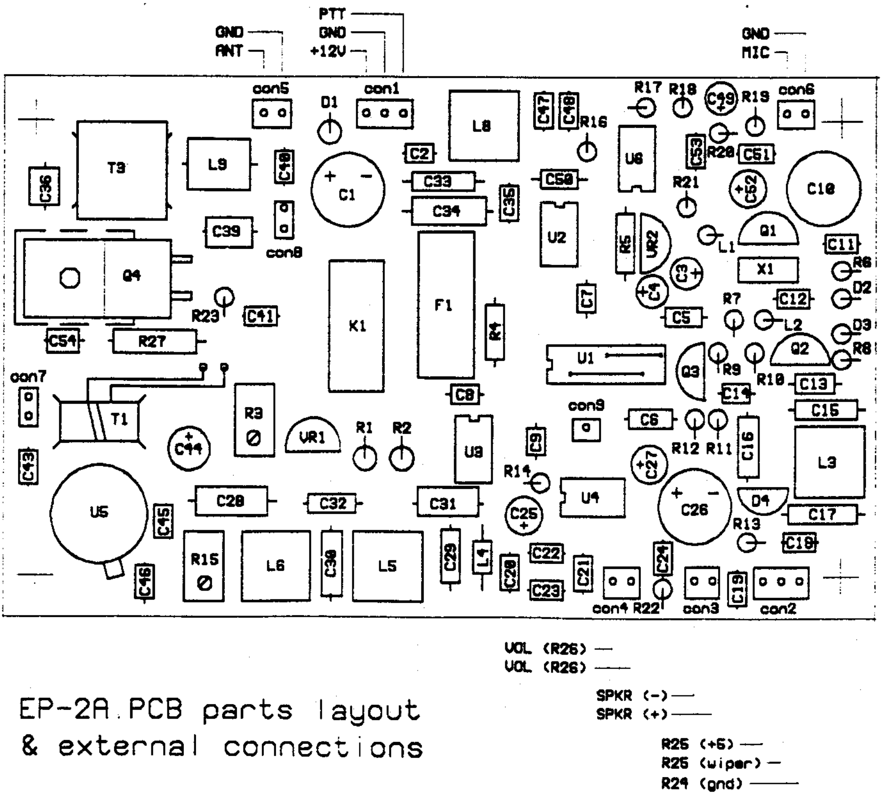
Epiphyte-2 Parts List

C1 100uF elect.
C2 0.1uF mon. cer.
C3 1uF tant.
C4 1uF tant.
C5 24pF NPO
C6 24pF NPO
C7 330pF disc. cer..
C8 0.1uF mon. cer.
C9 330pF disc. cer.
C10 100pF trimmer
C11 50pF NPO
C12 1200pF cer.
C13 100pF NPO
C14 24pF NPO
C15 2200pF axial poly
C16 820pF axial poly
C17 1000pF axial poly
C18 0.1uF mon. cer.
C19 0.1uF mon. cer.
C20 0.1uF mon. cer.
C21 0.1uF mon. cer.
C22 0.1uF mon. cer.
C23 0.1uF mon. cer.
C24 0.1uF mon. cer.
C25 4.7uF elect.
C26 100uF elect.
C27 10uF tant.

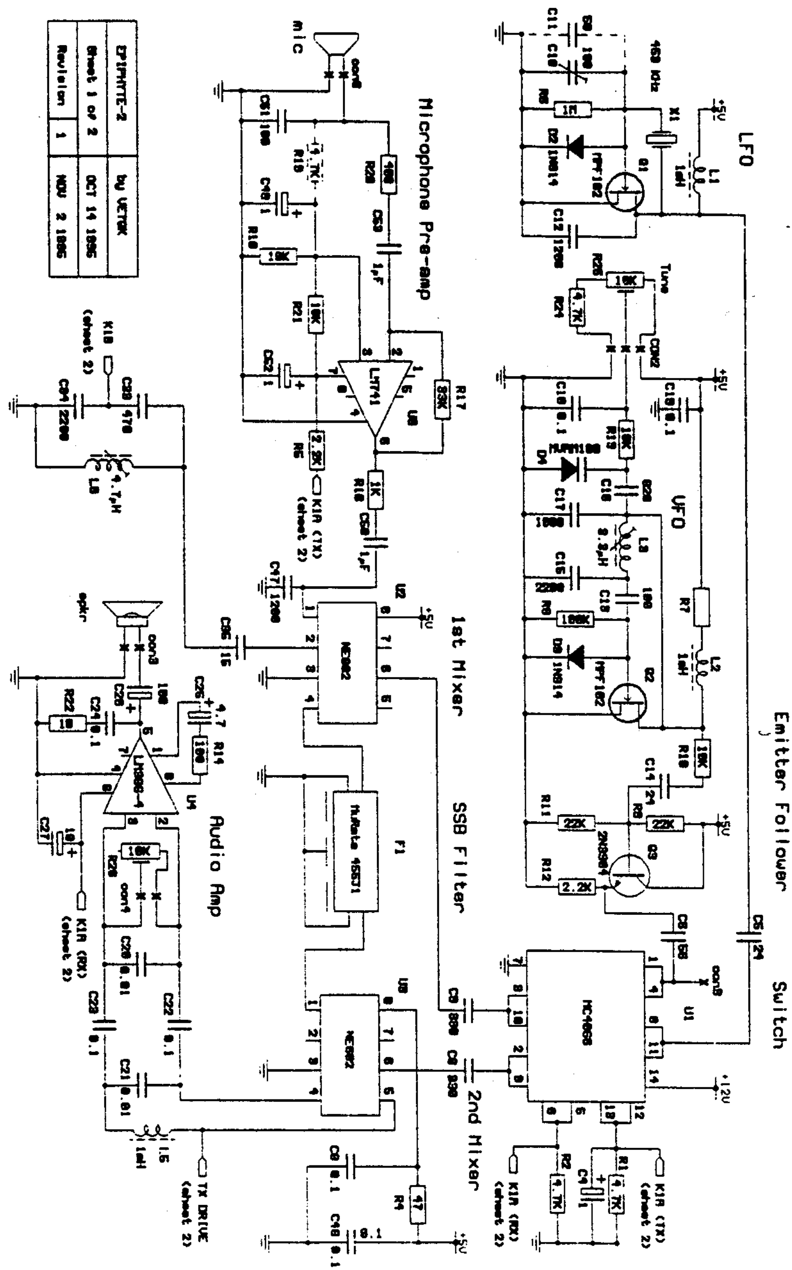
C28 2200pF axial poly.
C29 470pF axial poly.
C30 5600pF axial poly.
C31 2200pF axial poly.
C32 470pF axial poly.
C33 470pF axial poly.
C34 2200pF axial poly.
C35 15pF NPO
C39 0.1uF mon. cer.
C40 0.1uF mon. cer.
C41 0.1uF mon. cer.
C42 0.1uF mon. cer.
C43 0.1uF mon. cer.
C44 1uF tant.
C45 0.01uF mon. cer.
C46 0.01uF mon. cer.
C47 1200pF disc. cer.
C48 0.1uF mon. cer.
C49 1uF tant.
C50 1uF Non Polarized
C51 150pF disc. cer.
C52 1uF tant.
C53 1uF Non Polarized
C54 0.1uF mon. cer.
R1 4.7K
R2 4.7K
R3 10K (10 turn trim pot)
R4 47 ohm
R5 2.2K
R6 1M
R7 100 ohm
R8 100K
R9 22K
R10 10K
R11 22K
R12 2.2K
R13 10K
R14 100 ohm
R15 100 (10 turn trim pot)
R16 1K
R17 33K
R18 10K
R19 4.7K
R20 400
R21 10K
R22 10
R23 22
R24 4.7K
R25 10K, Ten Turn Pot
R26 20K Pot
R27 270 ohm
VR1 78L09
VR2 78L05
U1 MC14066
U2 NE602A
U3 NE602A
U4 LM386-4
U5 CA3020A
U6 MC1741
Q1 MPF102
Q2 MPF102
Q3 2N3904
Q4 IRF510
L1 1mH choke
L2 1mH choke
L3 3.3uH var. coil (Toko BTKANS9445)
L4 1mH choke
L5 4.7uH var. coil (Toko 154AN-T1005)
L6 4.7uH var. coil (Toko 154AN-T1005)
L8 4.7uH var. coil (Toko 154AN-T1005)
L9 RFC (7 sec. T on Amidon FB43-801)
T1 5 bifilar t. on Amidon FB-43-2401 with 2T. output overwound.
T2 2 turns on Amidon FB-43-2401
T3 broadband transformer. 2 t. primary, 5 turn sec. on Amidon BN-43-202
F1 455kHz SSB filter (MuRata 455J1)
K1 Miniature 12V DPDT relay.
X1 455kHz ceramic resonator
2 3 pin Polarized Molex connectors (0.1" spacing)
4 2 pin Polarized Molex connectors (0.1" spacing)
2 2 pin headers (0.1") spacing
2 2 pin jumpers
1 1 pin header (test point)
D1 "Idiot Diode" optional
D2 1N914
D3 1N914
D4 MVAM108 tuning diode
Heat sink (Q4)
4 x 4-40 1/4 inch metal standoffs
1 LED
4 8 pin IC sockets
1 14 pin IC socket
1 16 pin IC socket
1 Epiphyte 2 PC board

Epiphyte-2 PCB Foil Side

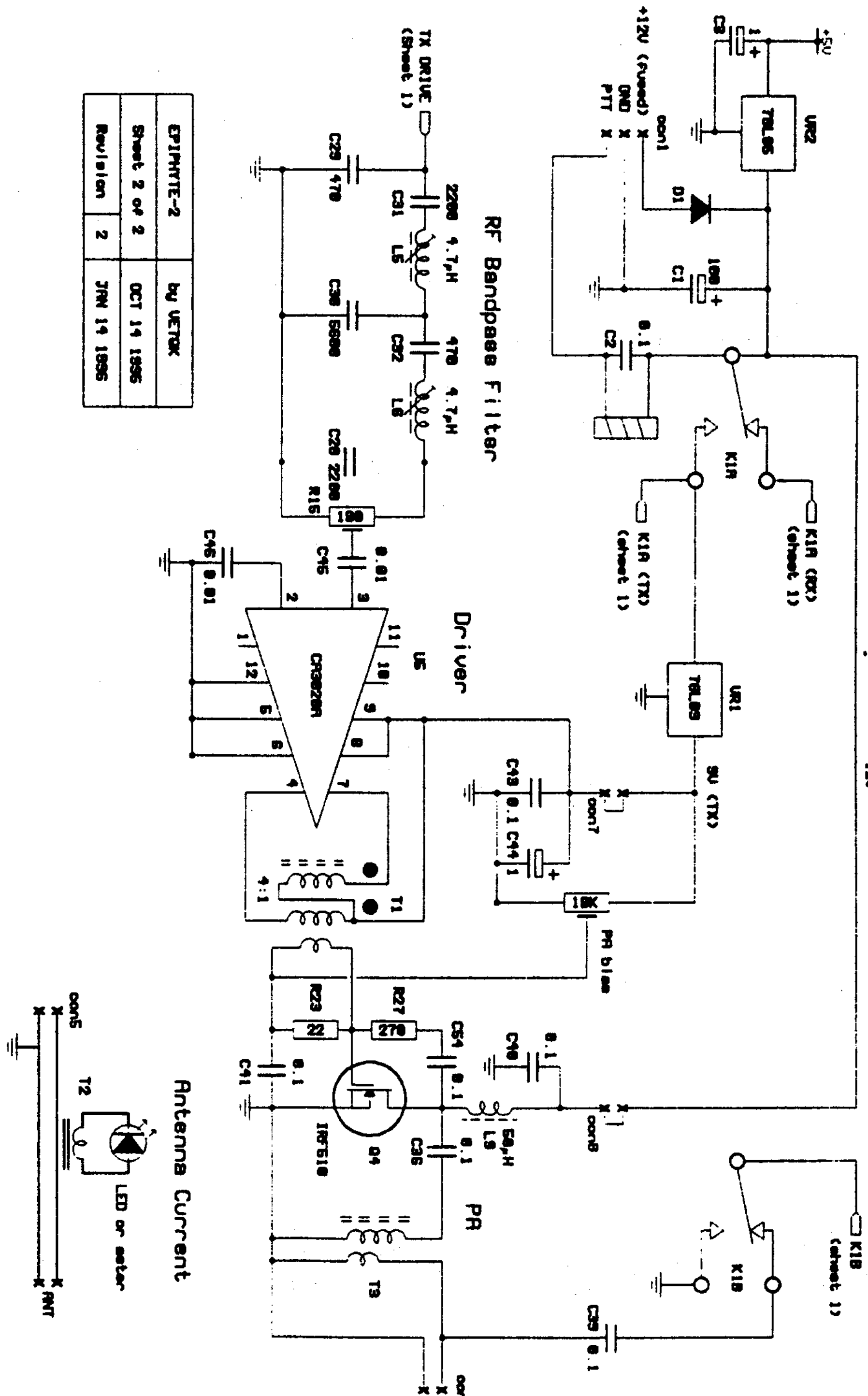




EP-2A.PCB parts layout & external connections



PC Boards for the Epiphyte-2 are available from FAR Circuits. The cost is $7.50 per board, plus $1.50 shipping for up to 4 boards. Order the Epiphyte-2 SSB Transceiver from March 1996 QRPp. Send to FAR Circuits, 18N640 Field Court, Dundee, IL 60118.


12V
+5V
VR2
78L05
C3
1
D1
100
C1
con1
+12V (fused)
GND
PTT
0.1
C2
K1A (RX)
(sheet 1)
K1A
K1A (TX)
(sheet 1)
VR1
78L09
9V (TX)
con7
C43
0.1
C44
1
PA bias
10K
K1B
(sheet 1)
K1B
con8
C39
0.1
C40
0.1
56µH
L9
RF Bandpass Filter
TX DRIVE
(Sheet 1)
2200
C31
4.7µH
L5
470
C32
4.7µH
L6
C29
470
C30
5600
C28
2200
100
R16
0.01
C45
Driver
U5
CA3028A
C46
0.01
T1
4:1
C54
0.1
R27
270
R23
22
Q4
IRF510
0.1
C41
0.1
C36
PA
T3
con5
EPIPHYTE-2
by VE7QK
Sheet 2 of 2
OCT 14 1995
Revision
2
JAN 14 1996
Antenna Current
LED or meter
T2
con5
ANT

The Di-Dah Keyer

by Dave Evison, N6GKC
153 Park Avenue
Palo Alto, CA 94306
(415) 326-7076

Background:

Although I've been a ham for over 40 years, I never really mastered Morse code. So, now that I'm a retired ol'geezer with impaired hearing, I find myself obsessed with mastering Morse both receiving and sending. So as many Amateurs do, I found myself practicing the code while driving about using the "dit dah" method of code practice. It finally dawned on me that I was actually cultivating a skill - Morse by mouth! And the proverbial light bulb lit up in my mind: Why not design and fabricate a circuit that will transform the complex sounds of the dits and dahs into rectangular waves proportional to the dits and dahs, and then drive a relay to key the rig?

Well, that's exactly what I did, and it worked perfectly! I've dubbed it the Di-dah Keyer. I believe the Di-dah Keyer may well find application for not only the handicapped, but by using a boom microphone, hands-free Morse operation is possible. In any case, I've had a wonderful time with this little keyer, and I'm sure you will also.

The Circuit:

The first op-amp provides a gain of 100 to amplify the articulated "di-dahs" sufficiently to drive the second op-amp (also x 1OO) to saturation. This technique eliminates the need for an additional clipper stage. Since articulated Morse has a relatively small duty cycle, the op-amp will tolerate such abuse just fine. The clipped waves are then rectified, filtered and sent to a comparator where proportional rectangular pulses are produced. VRI adjusts the threshold of the comparator. The output of the comparator drives an NPN transistor relay driver.

In the prototype circu¶, a Radio Shack 12V reed relay was used and worked just fine on 9V. 5V versions of this relay are also available and may be used in conjunction with a limiting resistor in series with the relay coil. All parts can be obtained at Radio Shack (including an inexpensive microphone of the type supplied as an accessory for small battery operated cassette tape recorders). And, of course, the average ham junk box can also supply most of the parts. In any case, the total cost of the keyer should not exceed $20.00.

The prototype was built on a Radio Shack Experimenter Printed Circuit Board (RS 276-170). The board has plenty of room and will make construction quick and easy.

Checkout and Adjustment

During checkout and adjustment, it is recommended that you key a code practice oscillator - not your rig!

1) Connect mic, code practice oscillator, and batteries.

2) Adjust VRI while rapidly speaking a series of dits (,di-di-di-di-di ...). The adjustment is quite critical and the set level zone covers just a few degrees of VRI's rotation.

3) It is strongly recommended that you spend some time practicing using the code practice oscillator, before connecting the Di-dah Keyer to your rig. The keyer is quite sensitive and critical of articulated code. You must form your dits and dahs clearly, and character, word spacing and speed are up to you. If you articulate incorrectly or produce extraneous sounds, the keyer will respond acconJingly. It may come as a surprise (at least it did to me) that when I thought I was articulating a series of dits in good form, the Di-dah Keyer soon revealed otherwise.

When speaking into the microphone, it should be held very close to your mouth to insure strong clear input and to minimize response to extraneous sounds. And, yes, if you cough, clear your throat, etc. the Di-dah Keyer will make rectangular pulses out of that also.

An off-the-wall closing thought... The Di-dah Keyer also provides the Novice and Coded Technician with a way to legally use "voice" on HF.

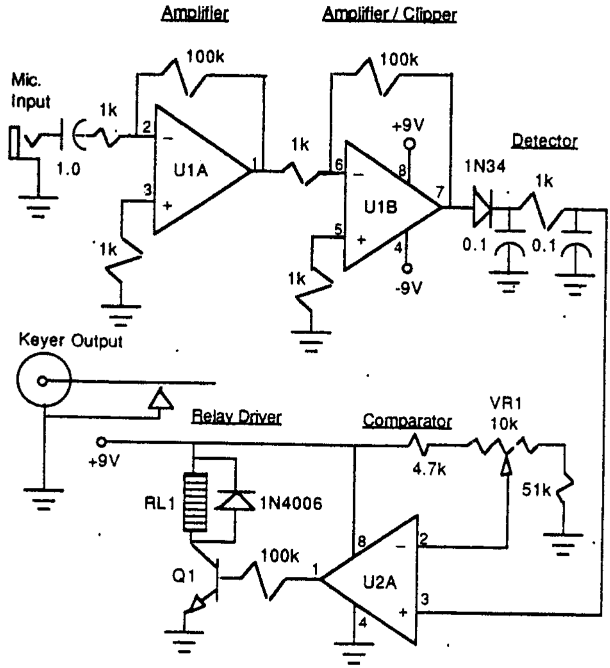
73'S, Dave E

Parts List

UI, U2 1458 Op-Amp(Radio Shack (276-038)
QI Generic NPN switch
All resistors are 1/4 watt 5% or better
RLI Reed Relay (RS 275-233 or 275-232)

Note: The keying relay is a Radio Shack 12V reed relay. In the prototypes It worked fine on 9V. A side benefit of the reduced solenoid voltage appears to be better action (less contact bounce and faster release time). However,'if the 12V version does not work effectively in your circuit a 5V version is available from RS and may be used with suitable current limiting resistor in series with solenoid coil.

Di-Dah Keyer
by N6GKC



U1, U2 1458 Op-Amp (Radio Shack 276-038)
Q1 Generic NPN switch
RL1 Reed Relay (RS 275-233 or 275-232) See Note
All resistors are 1/4 watt 5% or better

Di-dah Keyer
N6GKC

Note: The keying relay is a Radio Shack 12V reed relay. In the prototypes It worked fine on 9V. A side benefit of the reduced solenoid voltage appears to be better action (less contact bounce and faster release time). However, if the 12V version does not work effectively in your circuit, a 5V version is available from RS and may be used with suitable current limiting resistor in series with solenoid coil.

A Simple Portable Antenna for DX

by Frank McCrackin, WB6LMA
180 Calvert Dr.
Grants Pass, OR 97526

I have become very interested in QRP operation on the HF bands with an emphasis on portability and simplicity. Using ELNEC and more recently, EZNEC, I have been exploring quite a few different antennas to find options that have the potential for good DX capabilities. By the latter, I mean low angles of radiation for transmission and rejection of incoming signals at moderate and high angles relative to the horizon. I consider the latter equally important; to me, gain is no more important than the ability to reject unwanted signals. Rejection of high angle signals from both front and back can be more important than high front to back ratios, as usually measured.

So far, the best such antenna I have found that meets the above criteria is a half-square antenna (related to the Bob-Tail Curtain). It consists of a half-wave horizontal element connected to two inverted quarter-wave vertical elements, one hanging at each end. Another way to view it is as two elevated, inverted quarter-wave verticals, with a proper feed system, and comprising a simple two element bi-directional beam.

Using EZNEC, I have modeled half-square antennas for all HF bands from 40 through 10 meters. For this discussion, I have chosen a 40M antenna for the reason that the lower the frequency, the more difficult it is to achieve low angle radiation with relatively low antenna heights.

This 40M antenna has its horizontal element of 68' 5 5/8" located at 50', modeled above poor ground. The two hanging vertical legs are each 35' 7 15/16". the antenna is fed at a corner by 50 ohm coax with the feed-line leaving the antenna at right angles. The calculated SWR is less than 1.1:1 at 7.15MHz.

The results show a bi-directional pattern that has a gain of 3.63 dBi, an azimuth beam-width (-3dB) of 88 degrees, a vertical

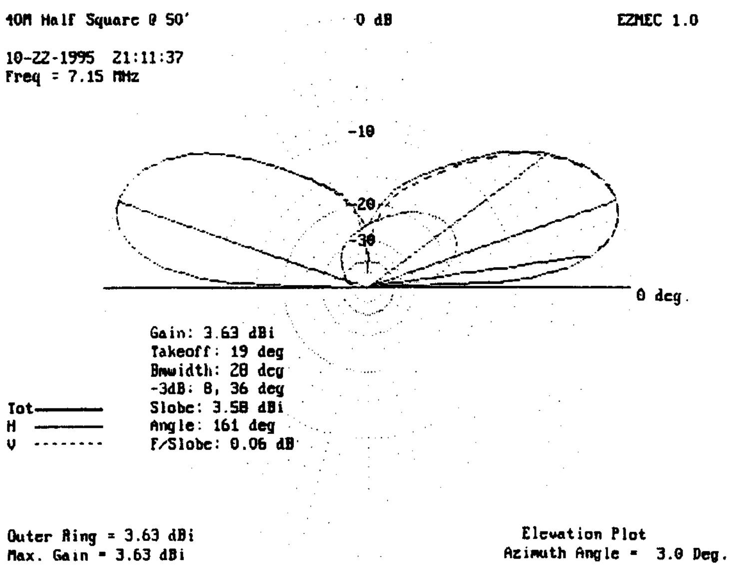


Figure 1

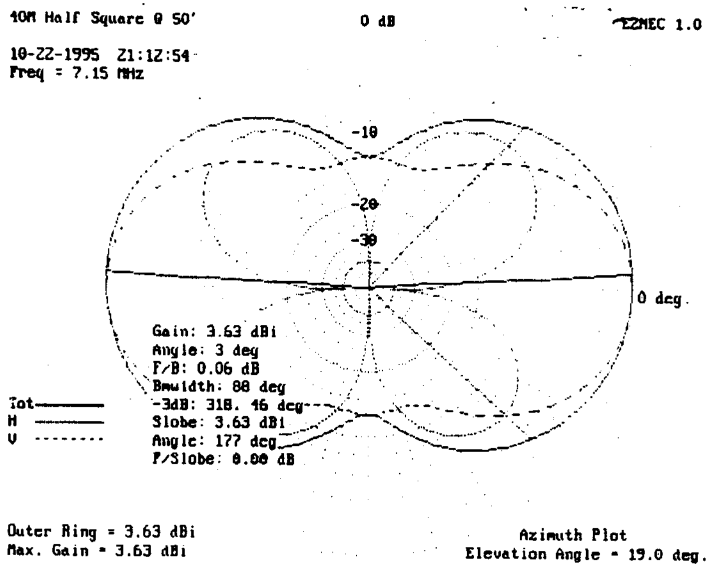


Figure 2

takeoff angle of 19 degrees above the horizon, with -3 dB angles of 8 and 36 degrees above the horizon. The polarization is dominantly vertical as the horizontal element shows little radiation. Both elevation and azimuth plots with horizontal and vertical patterns are shown as figures 1 and 2 respectively.

For comparison, I also modeled a wire Yagi with the second element as a reflector (a director gave a quite different and poorer vertical pattern). Although this two element Yagi is quite a bit more complex and more difficult to erect than the half-square, my model resulted in an antenna also resonant at 7.15 MHz. but with a 27 + j .06 ohm impedance (1.819 SWR at 50 ohms and 1.091 at 30 ohms). Maximum gain was 9.84 dBi at 32 degrees takeoff. The -3 dB angles were 16 and 55 degrees. At 8 degrees above the horizon, the Yagi and the half-square were matched in terms of dBi. This point was -3 dB for the half-square but -9 dB for the Yagi.

As compared to the half-square, the Yagi favors received signals in the elevation range of 15 to 60 degrees by from 4 to 14 dB, resulting in lots of high angle QRM to interfere withreally low angle, long distance signals. I have included elevation and azimuth plots of the Yagi with plots for the half-square superimposed. On these plots, I have also added plots of a 40M half square with the horizontal wire at 66'. IT is interesting to note that this increase to a full 1/2 wave of elevation makes very little improvement. Raising the antenna still further lowers the takeoff angle only slightly but causes a secondary lobe to begin to show increased reception of high angle signals. See figures 3 and 4.

This 40M half-square at 50' is also resonant at 21.225MHz It's impedance is 181.2 -j .463 ohms and the SWR (50) is 3.624. With an antenna tuner, the antenna should be usable on 15M. Gain at 14 degrees is 6.11 dBi and the -3 dB angles are 7 and 24 degrees. There are four major lobes, two slightly larger than the others, tending to favor azimuth angles of 35 to 40 degrees from the plane of the antenna (see figures 5 & 6).

Using a tuner and open-wire feed, the

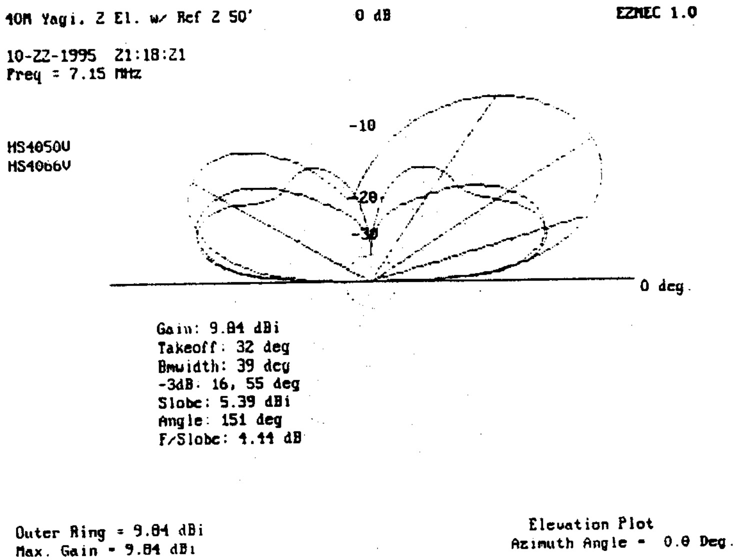


Figure 3

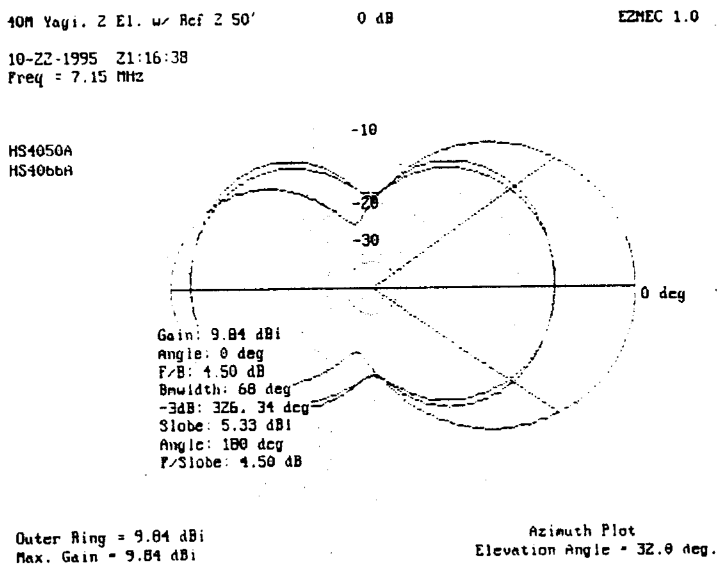


Figure 4

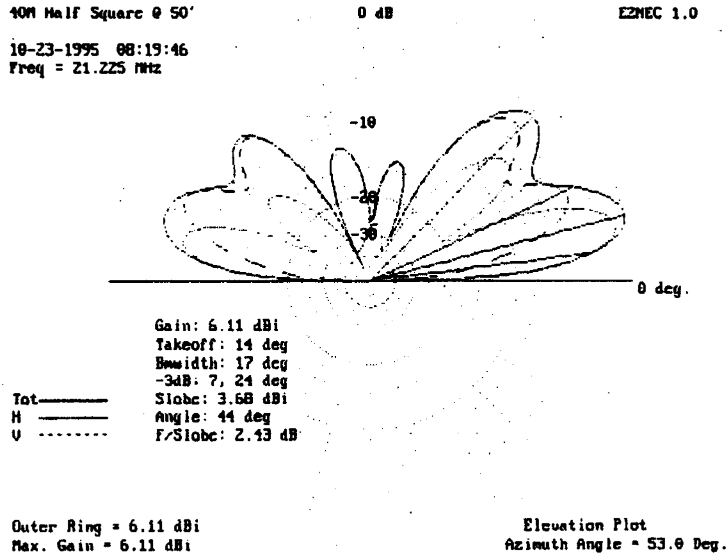


Figure 5

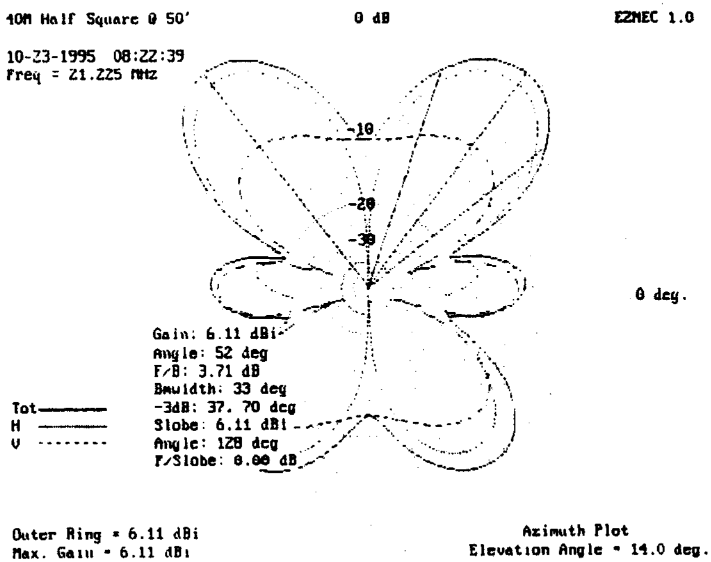


Figure 6

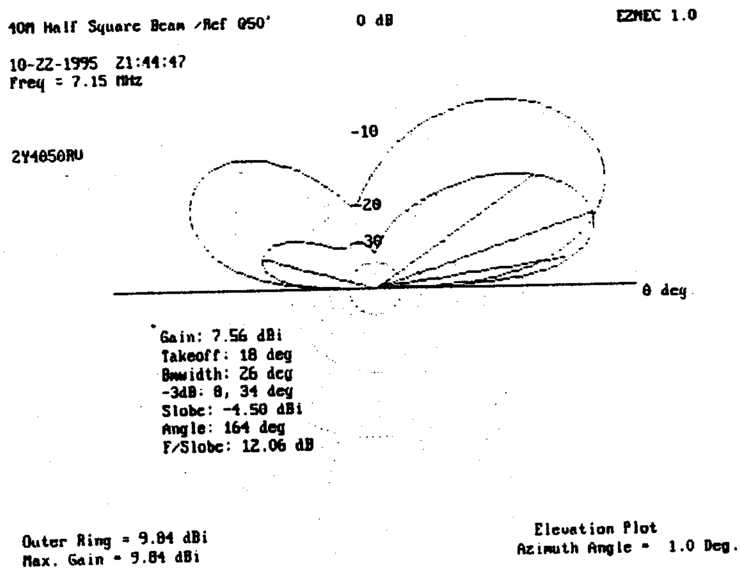


Figure 7

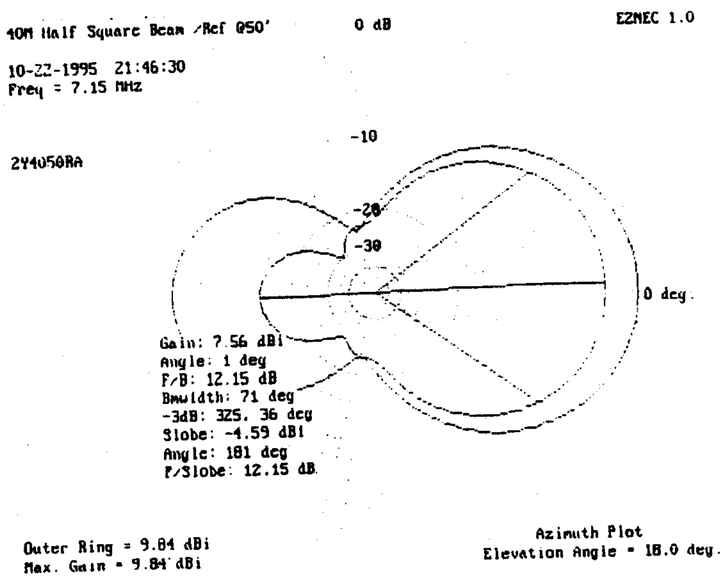


Figure 8

antenna should be usable on all of the HF bands above 40M. Maximum radiation angles decrease in elevation as the frequency goes up, ranging from 20 degrees on 30M to 10 degrees on 10M. Gain improves also, 4 dBi on 30M, rising to 6.82 dBi on 17M and then gradually dropping to 5 dBi on 10M. Multiple lobes on both azimuth and elevation patterns show up beginning with 20M and increasing as the frequency moves to 10M.

If still more gain and directionality is needed, one can make a 2 element half-square beam with the elements spaced about 1/8 wave-length. I modeled one at 50' with only the vertical components of the reflector increased by about 5%. this model showed a gain of 9.84 dBi, with a take off angle of 18 degrees and -3 dB angles of 8 and 34 degrees. The front to back ratio was about 12 dB vs. about 5 dB for the Yagi. I have included a print-out of elevation and azimuth plots for this antenna compared to the Yagi also, see figures 7 & 8. the lower angle of radiation is quite marked.

If one wants a lot of moderate to high angle reception with a simple and easily erected antenna, use a dipole or an inverted vee at a reasonable height. If you really want very low angles, simplicity of design and erection, and a minimum of high angle QRM, use a half-square at an elevation of not more than 1/2 wave length.

I have no vested interest in the half-square concept. If I were operating portable in the field, a dipole (or inverted vee) plus a half-square (or two at right angles) should provide first class flexibility. Working from a fixed station, a dipole and two half-squares at right angles should give the usual 3 element Yagi tribander a fit if they are all mounted at the same height. As I see it, the principle advantage such a Yagi would have would be improved QRM rejection at medium to high incoming angles because of its superior front-to-back ratio at such angles. Cost-wise, the Yagi can't compete. I would welcome any better designs that embrace my criteria. I am still chasing the fantasy(?) that there must be something that is even better. 72, Frank

Reveiw of the Small Wonder Labs Green Mountain-30 CW Transceiver

by Chuck Adams, K5FO
Box 181150
Dallas, TX 75218-8150
adams@sgi.com

MFR: Small Wonder (tm) Labs
Address of MFR: Dave Benson, NN1G
80 East Robbins Ave.
Newington CT 06111
Designer: Dave Benson, NN1G
Model: Green Mountain 30 (GM-30)
Size: 3.5" x 5.0" board
Weight: 3.25 ounces for board and onboard parts
PC board: Double sided, plated-through, solder masked (green), and silk-screened. A beautiful board.
Manual: 18 pages 8.5"x11" double sided
Power : 12 to 15VDC
RX Drain: 37.0mA at 12.7V
TX Drain: about 300mA with 1W out
Modes: CW only
Kit?: Yes. PC board and on board parts.
Bands: 40M, 30M, 17M, 20M and 15M at the present time
LO/VFO: Heterodyne Osc with 18.100-18.165MHz out for 30M.
Drift: 5 Hz first minute, 62Hz after 30 minutes. This is the best frequency stability measured on any of my rigs.
Dial Range: Builder supplies markings
RX: SuperHet
XMT: Yes. 0.050-3.0W output internally adjustable
Filter: Four crystal filter at 8.000MHz
Selectvty: about 700Hz
RIT: Yes
Gain: Audio.

AGC: No
Preamp: No
Atten: No
SPKR: No. Did use with Radio Shack XTS 3 Cube Speaker. Good audio out with the above.
Meter: No
S Tone: No.Signal monitoring
VFO: Yes. Covers 65KHz of 30M band.
Output: 0.05-3.0W adjustable internally Measured 2.1W out max with 12.74V
Internal Keyer: No
QSK: Yes
Price: $72.00 US postage included.
Availability: From NN1G direct to callbook address. See above.
Options: Case and pots. Price not known at time of this writing.
Date of Review: January 25, 1996
Author: Chuck Adams, K5FO
Comments: Another fine rig from NN1G. This puppy will be with me on my travels for the next year. I don't know about you, but after I read about a new rig in one of the newsletters and I decide that it is something that I'd enjoy building and operating and after dropping the money order into the mailbox I'm like a little kid. I clear off the desk and get organized and I get ready for the big day - the day that the package arrives. The first publication to have the Green Mountain rig from Dave Benson, NN1G, was the "72" News letter fromthe NE Club famous for QRP Afield and the NE40 kit. It took the US Postal Service about 7 days to get the plain brown padded envelope from Dave Benson's place to my PO Box using first class mail.

The board and parts are bubble wrapped on top of that and everything arrived in nice shape.The manual is well written and the board is very nice. Dave has done another wonderful job is getting the kit together.

The instructions have you build the Hetrodyne Osc first. Then if you have followed his instructions and you have done everything you power it up and test it. Mine came up the first time and was easily adjusted for maximum output. The frequency was right on and required no additional mods. After getting everything else soldered in and double checking for missed solder points, shorts, etc. and then using the toothbrush(not the one I brush with) with water to remove the solder flux from the 63/37 solder, I install the board into bottom half of the shell case that I typically use as I have a garage full of them. Oh, I use the Kester SN63PB37 with 331 Organic Core.

The kit does not have the case, connectors, and required three pots of 5K, 10K, and 100K (linear) which I got at Radio Shack. I hooked up everything to a 4AHr Gel-Cell and adjusted the receiver. This receiver has much greater sensitivity than the SWL-30 (to be expected due to additional gain with IF amp in the GM-30). First station heard was a KK6 in Santa Cruz CA, then a W2 in Beesleys Point NJ, and the third station heard was ZK1DI.

I also discovered that I now have to turn off the computer on the desk top due to hash RFI from it. Didn't notice this before. So I know that the receiver is extra sensitive. Turned system off for an hour then came back with frequency counter for drift measurements. First minute gave 5 Hz drift and after 30 minutes drift had settled to 62Hz. So it is super stable. Oh, calibrated counter with 3.600000MHz out of GC-1000 Heath clock both before and after to make sure that the counter didn't drift. Sure enough it didn't.

Checked out the transmitter and it's adjustable from 0.05 to about 2W out. When checking the keying I got the scare of my life when I heard a chirp. Turns out the gel-cell was low and I switched to a 20AHr to stabalize the voltage to 12.75V and all was fine. After charging the gel-cell found that it was good too. Got the OHR WM-1 and set the GM-30 for 0.95W output. Since Saturday have worked about 20 stations (not enough time on the air yet) and all have given super reports. Worked a KG4 on 30M this a.m. at 6:15CST (1215Z), so 30M has been open. In fact I've been hearing stuff on at midnight local. I do have a small click in phones on individual elements of keying.

so think that the keying circuit will require an additional cap to soften the make/break. More to follow as time permits.

Doug Hendricks in a phone conversation the other day mentioned the R/S speaker, so I stopped by and picked one up. Rather pricey at $16, but it is nice. The GM-30 had the audio power to drive it to comfortable levels in a 15x18' room and with headphones I do not ever have to run the gain over about a 1/4 to1/3. On the SWL-30 I often had to run at 80% or better. So the new audio circuit that Dave has is super. The additional stage with the IF amplifier makes all the difference in the world on total gain. The speaker used was the XTS 3 Cube Speaker System from your friendly Radio Shack Dealer.

From my previous postings by members of the qrp-l group on the SWL-XX burping when powered off. I figured the audio section was going into oscillation when powered off. I was right. You can get the SWL-30 to go into oscillation when powered on by having a strong signal come on while you have the volume up. I discovered this the hard way when monitoring the keying of the GM-30 next to the SWL-30. Don't do this at home kids...... Also found when I had gone to a NorCal meeting and purchased a gel-cell at Livermore that was at 10.7V the NE40, a.k.a. SWL-40, oscillates like crazy in the audio preamp section due to low voltage and this is what we are hearing when power is removed and the little rig "burps".

I think we are going to see $75 as the price point, what with Roy's NW80/30 series and others, for single band high performance kits without a case. With case and all it looks like $100 is the price. I got the Oak Hills Research Explorer II also for 30M and a comparison of the receivers shows that they are almost identical in sensitivity to my ears on the antenna. There is no comparison on sensitivity with the NorCal 30A since the NC30A does not havean IF section. Same is true of the SWL-30 rig. So Chuck says check it out if you are looking for a small singleboard rig that has a lot of band for the buck [sic]. If you see me at the NorCal meeting I'll have the 30M rig with me. And I'll be at the NorCal meetings about three or four times this year. I save the company about $600 on airfare by coming to CA on Saturday. Killing two birds with one stone, so to speak.

If you are a first time builder or want a step-by-step set ofinstructions, either send me a SASE business envelope or email at the email address at the top of the article and I will see that you get a set. It helped me speed things up.dit dit es see you on the air—Chuck Adams (K5FO CP-60) adams@sgi.comBox 181150, Dallas, TX 75218-8150

Build A QRP Antenna Tuner with Home Brew Roller Inductor

by Floyd E. Carter, K6BSU
2029 Crist Drive
Los Altos, CA 94024

This small QRP antenna tuner is intended for portable or FD operation on 40 meters and higher frequency bands.

What is not expected is that this versatile antenna tuner features a roller inductor! The tuning resolution is infinite within its range, making it possible to match virtually any coax fed resonant antenna for maximum power from your transmitter. It is no longer necessary to compromise for "almost OK" simply because the fixed taps on your commercial QRP tuner are seldom in the correct place for <u>your</u> antenna and <u>your</u> operating frequency.

The purpose of an antenna tuner connected between a transmitter and a transmission line/antenna is sometimes misunderstood. A tuner will not improve the performance of a resonant antenna operating away from its resonant frequency. a tuner will tune out the reactance of an antenna when it is off frequency, so that the transmitter can operate into a purely resistive load, and so deliver maximum power.

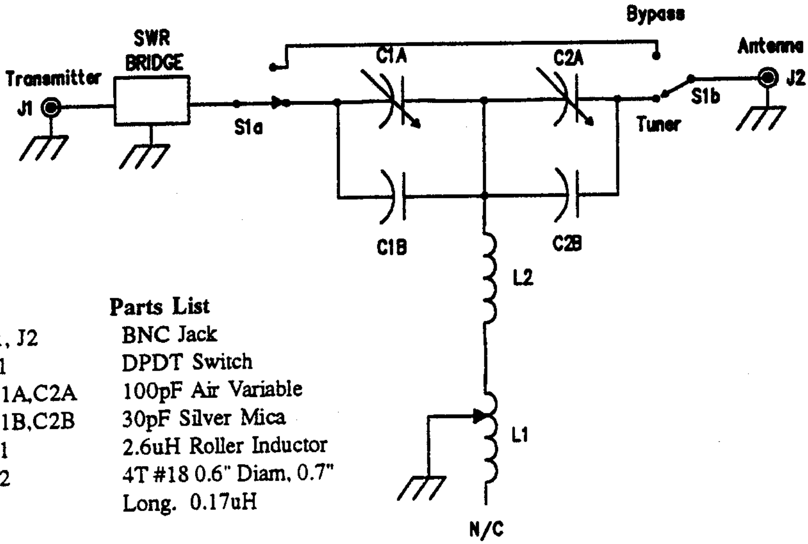
For tuning flexibility, I chose the popular high pass T network. This circuit matches a wide range of complex antenna impedances while using L and C components of reasonable values. The schematic diagram for this antenna tuner is shown in Figure 1.

For the inductor winding, drill and tap two 4-40 screws into the acrylic rod 3 1/2" apart. You will need 5 feet of 18 gauge tinned copper bus wire. Solder one end of the wire to one of the screw heads. Clamp the free end of the wire in a vise and slowly and carefully wind the wire onto the acrylic rod, while keeping constant tension on the wire. Try to maintain about 0.2" between the turns. Do this by eye, as there is not good way to mark an accurate path for the wire (unless you have a lathe and can cut a shallow thread). Think about the direction of the winding and how the slider will move. You want the inductance to increase with clockwise rotation of the tuning shaft.

When the inductor has 18 turns, the wire should pass over the second screw head tapped into the finished end of the acrylic rod. While maintaining wire tension, solder the wire to the second screw. Clip off excess wire and secure all the wire turns to the rod with a very small amount of CYA instant adhesive. 18 turns on a 1" diameter acrylic rod 3 1/2" long will give L = 2.6uH.

The slider is made from two flanged

K6BSU ANTENNA TUNER

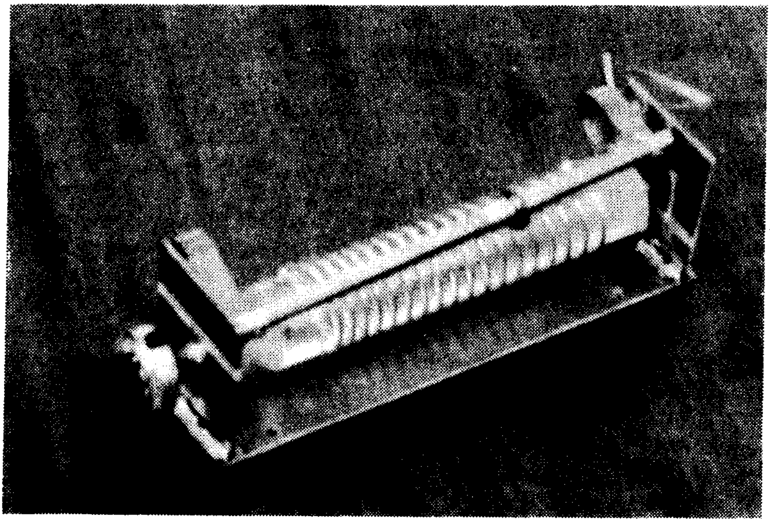


Parts List

J1, J2	BNC Jack
S1	DPDT Switch
C1A,C2A	100pF Air Variable
C1B,C2B	30pF Silver Mica
L1	2.6uH Roller Inductor
L2	4T #18 0.6" Diam, 0.7" Long. 0.17uH

This is not a construction article for some new or revolutionary antenna tuner. Rather, it shows that a homebrew rotary inductor can be built using available materials and with simple hand tools. Here's how to go about it.

Cut a length of 1" diameter acrylic rod 4 3/4" long. Drill a 5/32" diameter hole in each end, as axially as possible. If you have a lathe, the holes will be perfect. In my case, I got the holes as straight as possible by eye. Epoxy a length of K&S brass tubing in each end. (K&S brass tubing is available in nesting sizes from 1/8" to 1/2" at hobby shops). After the epoxy sets, the brass tubing can be bent a little if necessary until the front and rear shafts are aligned.



K6BSU Roller Inductor

brass eyelets, back to back, (ref. 1) and soldered to a short length of 1/4" brass tubing. This, of course, slides along the main rod of brass tubing. (Remember you should already have a supply of nesting K&S brass tubing). Note that the rod for the slider is angled to be perpendicular to the pitch angle of the inductor windings.

For spring tension, I used a couple of beryllium copper flat springs from a desk latch. Flat clock spring could also be pressed into service if you first test the material for solderability.

The inductor frame is made from pieces of 1/16" double-sided PC board material soldered into a "U" shape. The shaft bearings are made from the ubiquitous K&S brass tubing, with axial stops made from brass nuts soldered to the tubing shafts.

One end of the coil is connected to its shaft with a short piece of wire. Of course, that shaft bearing becomes one of the coil contacts. So cut away the copper foil from the PC board end plate to isolate it from chassis ground. The slider bar is grounded through the flat springs and end plates.

Assembly and Operation:

This rotary inductor, along with the C1 and C2 values shown, will have enough range to tune most resonant antenna systems on 40 Meters and higher frequency bands. The T network will also tune a long wire antenna, but not just any random length wire. Experiment with the length of a long wire until it is within the adjustment range of the turner.

The fixed capacitors C1b and C2b raises the minimum value for the variable capacitors. The air variables shown have a minimum C of about 5pF, which is much too small to be useful at HF. The fixed inductance, L2, is needed for the same reason. It prevents a zero inductance condition, which would be possible with the roller inductor at its extreme end.

Putting this tuner to work on 80 or 160 Meters will require larger L and C values. A rotary inductor wound on a 1.5" diameter acrylic rod with 0.15" spacing and 25 turns will give a total inductance of 8.3uH. This size inductor, with maximum values of C1 and C2 at least 250pF, will be more useful in reaching these lower frequency bands.

The T network requires that the rotors and the stators of C1A and C2A be insulated from the chassis. These are both mounted on a bare epoxy glass board. The tuning shafts are made from (what else?)

K&S brass tubing! The tubing is soldered to the capacitor shaft and then cut in half about 1" from the capacitor. A piece of birch dowel is epoxied between the cut off tubing pieces to insulate the rotor from the panel knob.

An antenna tuner needs some form of RF power meter or SWR bridge to assist in tuning. This tuner is fitted with an SWR bridge designed by GM4ZNX (ref. 2). This bridge circuit works very well for QRP, and it requires no balancing. Other popular SWR bridge circuits may be found in the ARRL Handbook.

A DPDT bypass switch is a good thing to include. The SWR bridge remains in the circuit at all times, and this is especially useful if a dummy load is connected to the ANTENNA terminal with the switch in the bypass position. The forward meter then functions as a watt meter indicator into a 50 ohm dummy load.

I installed two meters for simultaneous reading of forward and reflected power without having to switch back and forth. Individual meter potentiometers were installed so that the forward meter could be calibrated for 5 Watts full scale, and the reverse meter calibrated for 2 1/2 Watts full scale.

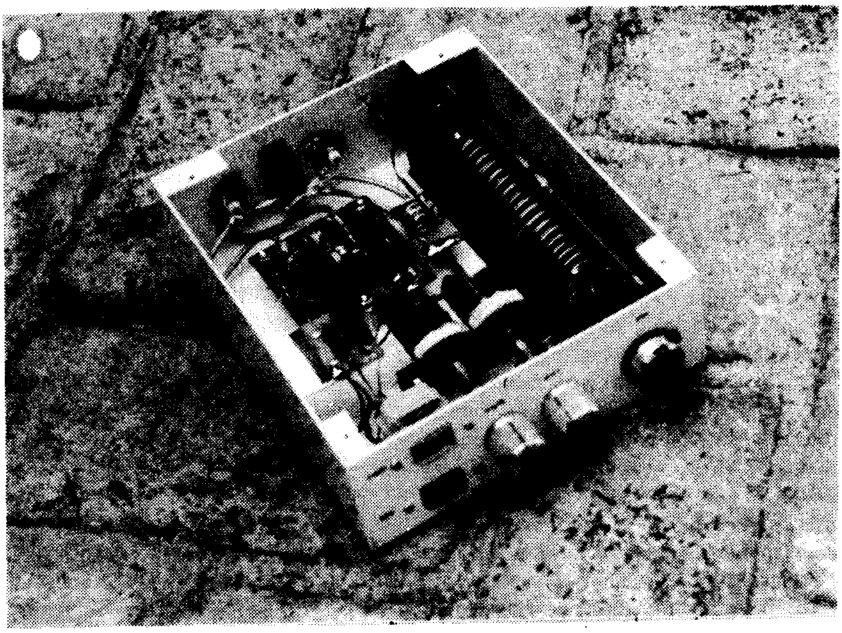
The custom cabinet was made from rectangular panels of 1/16" double sided circuit board material, soldered together into a box. This provides an easy and inexpensive enclosure, with the bonus that it is fully shielded.

The miniature turns counter dial is a Clarostat #316-11. It indicates 15 turns so that the preset values of the roller inductor can be recorded and logged for later use. NestingK&S brass tubing is soldered to the inductor shaft until it is built up to 1/4" for the dial.

Build and enjoy. 72, Floyd, K6BSU

References:

1. Acrylic rod and brass eyelets are available from K6BSU.
2. D. DeMaw "An Easy to Build SWR Bridge". CQ, June 1994, pp. 112-115. (reprint available from K6BSU).



K6BSU Antenna Tuner with SWR Bridge

The Original St. Louis Tuner

by Randy Miller, WA0OUI
12090 Lavida Ave.
St. Louis, MO 63138

[This is a copy of the original manual that came with the St. Louis Tuner that was a club project of the St. Louis QRP Society. It was a project done by several members of the club, and Randy was the author of the manual. NorCal has kitted a version of the tuner and made two small changes, the original tuning caps were replaced with custom air variables and the case was replaced with a custom NorCal style case. Other than that, the kit was as designed. The manual is reprinted her for those of you who were not able to obtain tuner kits or wish to "roll your own". The custom caps are not available as all of them were used in the kits, but circuit boards are available from Jim Cates, 3241 Easwood Rd., Sacramento, CA 95821. Cost is $5 postpaid. $8 DX. US funds only. Make checks and money orders out to Jim Cates and NOT NorCal. KI6DS, Editor.]

Description:

This unit is the combination of a sensitive power meter which reads both forward and reflected power simultaneously, a transmatch for matching transmitter output impedance to antenna feedline input impedance and a dummy load for making transmitter adjustments without producing an interfering signal.

The power meters can read levels from milliwatts to well above the 5 Watt QRP limit. The forward and reflected power scales are independently set with trim Pots inside the it. For example, it is possible to set a forward reading of 0-5 Watts and a reflected reading of 0-100 milliwatts.

The transmatch is a T-match design with switchable parallel variable capacitors and a twelve position tapped inductor for increased flexibility in matching unknown line impedances. A four-to-one output balun is switch selectable for matching low impedance, unbalanced transmitter outputs to high impedance, balanced feedlines.

Four 200 ohm, 2 Watt resistors in parallel provide a 50 ohm Dummy load that will easily handle QRP power levels up to 5 Watts. The dummy load is conveniently switch selectable from the front panel.

Operation:

Front panel controls consist of three switches, (Mode , Inductor and high/low Capacitance) and two variable capacitors for transmitter and antenna adjustment. The mode switch has three settings, OUT, TUNER and DL. OUT means the tuner is not in the circuit; however, the power meters are still active. In the TUNER position, the power meters are used with the tuner to match the transmitter to the antenna. The DL position removes the tuner and connects the Dummy Load following the power meters for transmitter adjustment.

The inductor switch has twelve positions that change the tap point on the tapped inductor (L1) so a match may be obtained over a wide range of frequencies.

The Transmitter and Antenna controls are two-section variable capacitors which are used to obtain a match between the transmitter and antenna. The high/low capacitance switch allows the two sections of the variable capacitors to be paralleled (high) or operated separately (low).

This tuner operates much like those sold by MFJ and Ten Tec. Begin by setting the mode switch to "TUNER", both capacitors approximately mid scale and the paralleling switch in the separate position (Low). Make sure the balun switch is set for the type of feed line you are using. either balanced or unbalanced. Set the inductor switch at either end of its range and apply transmitter power to the unit. Quickly note the reading of the reflected power meter. If not less than full scale, quickly turn off the transmitter, select the next setting of the inductor and again check the reflected power. Continue this procedure until a null in reflected power is observed. Then adjust the "transmitter" and "antenna" capacitors on the transmatch to reduce the reflected power further, hopefully to zero. If unable to find a match with the capacitor switch in the separate setting, try the procedure again using the parallel position. There may be times when a perfect match (zero reflected power) cannot be achieved but some value less than full scale reflected power can. Depending on how critical SWR is to your transmitter, you may decide to operate with some reflected power showing if that is the best match you can obtain.

To use the dummy load, select the "dummy load" position on the mode switch. Remember the maximum power capability of the dummy load is eight (8) Watts. Try to limit continuous transmission at full rated power (8 W) to no more than 60 seconds with a minute or two cooling period in between.

Construction Notes:

Detailed construction steps are not provided. Therefore, even though this kit is close to "Heathkit" quality in materials and manual , it still will qualify as home-brew for contests and bragging rights. A few explanations and suggestions are in order, however.

* Do as much prep work first such as wind toroids, prepare coax cable sections for toroidal transformers, paint case, attach front panel markings, extend capacitor shafts (spacer & screw) and attach capacitors to case (hot glue or epoxy). Then you can sit down and assemble the kit without major interruptions, having already experienced them!

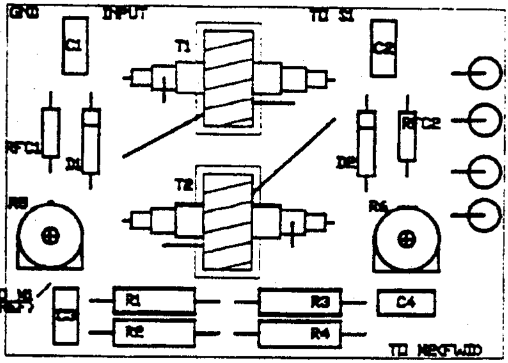
* An important note: The components on the circuit board mount on the same side as the circuit board traces. Murphy was present when the board was laid out but this doesn't present a problem during construction and makes the circuit much easier to trace once the board is mounted in the case. If you want to "sling" some of the components under the board rfc. diode, cap, etc., be creative, but remember to install the trim pot's on the circuit side so they can be adjusted.

* To extend the shafts on the two variable capacitors, included are two 1/4" X 3/8" nylon spacers and corresponding metric threaded screws. Thread the screws through the spacers (a tight fit) and then apply glue (epoxy) to the screw threads before screwing them into the capacitors. This will ensure your knobs don't screw off when you turn them counterclockwise. (Very embarrassing!)

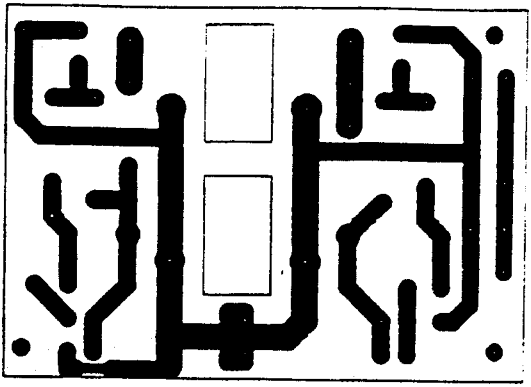
* There are threaded inserts on the front of the variable capacitors which could be used to mount them to the front panel; however, the screws have to be the exact length to clear the front panel but not so long they screw into the capacitor plates (a close tolerance). Therefore, I recommend gluing the capacitors to the front panel with hot glue or epoxy. I've used the hot glue and it does a good job but is a little prone to break loose under mechanical shock. I would recommend epoxy especially some of the newer fast setting varieties. Make sure you have your case painted and the front panel lettered before attaching the capacitors.

To wind the toroids, start by making a "shuttle" for the magnet wire to keep it manageable while passing in and out of the toroid core. The shuttle can be made from cardboard, fiberglass, metal or plastic and should be no more than 3/16" wide by 2.5" long so it can pass easily through the center of the toroid core. Included in the kit is an ordinary plastic straw which makes a nifty wire shuttle. Cut a piece about 2.5" long, cut a 1/4" slit in each end and wind your magnet wire between the two slits.

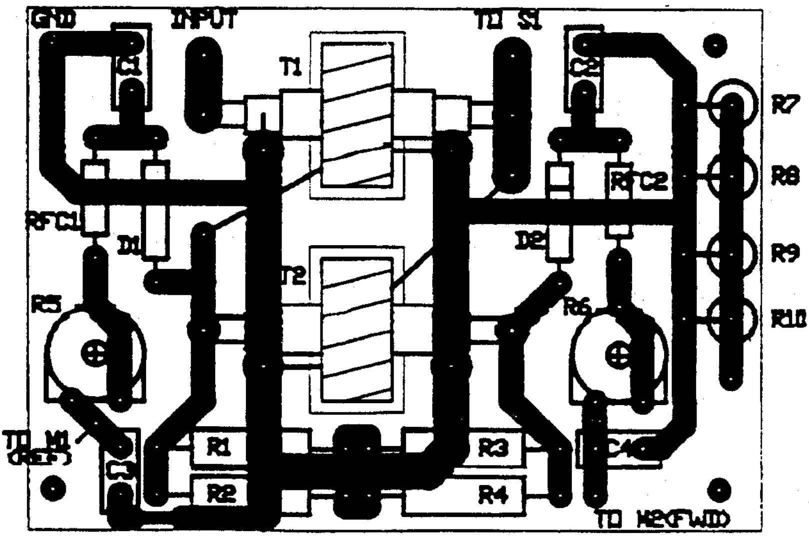
* Enamel can be removed from the magnet wire by several methods. It can be scraped off, sanded off, burned off (?) or dissolved with a chemical like "Strip-X" made by GC Electronics and available at Van Sickle Electronics on South Broadway & 7th St. I prefer and strongly recommend using Strip-X. I scraped the enamel on the first prototype but used Strip-X on the second. What a difference! Just dip the wire in Strip-X and then wipe off the enamel. Someone can buy a jar and share it at your local club meeting. Have a toroid winding night!



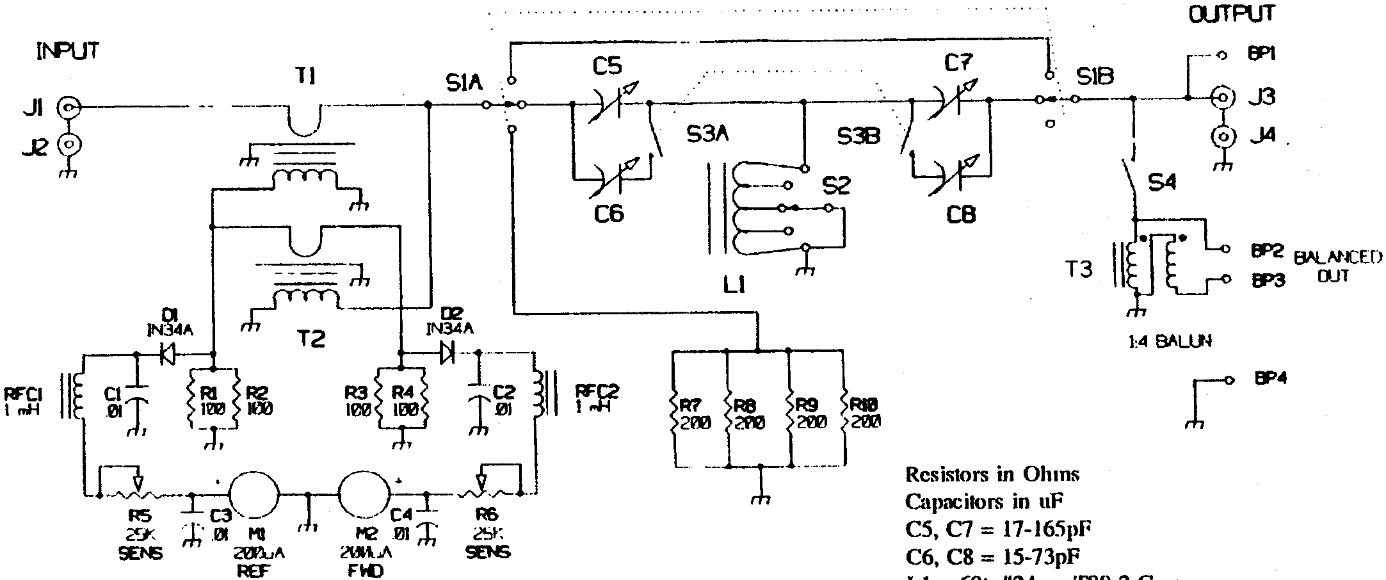
Parts Layout, St. Louis Tuner PC Board



PC Board Layout, St. Louis Tuner



St. Louis Tuner Schematic



Resistors in Ohms
Capacitors in uF
C5, C7 = 17-165pF
C6, C8 = 15-73pF
L1 = 60t. #24 on T80-2 Core
Tap at 3, 6, 10, 15, 20, 25, 30, 37, 44, 52, 60 turns.
T1, T2 = 12T #24, FT50-61 Core
RG58 Coax Primary
T3 = 1:4 Balun, 10T#26, FT50-43 Core, Bifilar Wound

* Remember when winding toroidal coils that the turns are counted inside the core. Every time the wire passes through the core it counts as a turn even if it does not go around the core.

* The inductor for the transmatch is wound on a T80-2 (Red) core, 60 turns of #24 wire. Tap the inductor at turn number 3, 6, 10, 15, 20, 25, 30, 37, 44, 52 and 60. Leave plenty of wire to make your taps. I usually leave a loop about one inch long, secure each loop with a twist or two and wind the whole coil with these one inch loops sticking out. Then I go back and strip each loop, one at a time and then twist the loops into a twisted pair. This method results in much cleaner taps which are easier to solder to the switch lugs than if the wires are twisted together first and then stripped. When twisting the taps together, I try to position the taps so they mate with the switch lugs.

* Coaxial Transformers T I & T2 are wound on a FT50-61 core with a secondary of 12 turns #24 wire and a primary of RG-58 coaxial cable center conductor running through the center of the toroid. The coax shield acts as a Faraday screen preventing TI & T2 from picking up harmonic currents and causing false readings. When connecting the Faraday shield to the circuit board, be sure to only ground them on one end, not both ends!.

* When winding the balun, a bifilar winding is used. Bifilar means that two wires make up the winding instead of a single one. There are several ways to make this winding but the easiest is to twist the two wires together into a twisted pair and then wind them on the toroid core. A small hand drill can be used to twist the pair of wires as well as a small locking clamp (hemostat) or long nose pliers. Six or Seven turns per inch is usually adequate don't get carried away and make the turns too tight. Magnet wire, of two different colors, is included for the balun so you can easily tell which winding is which and then connect them properly. Follow the diagram included in the section on baluns and note the phasing dots which show the two leads which are together at the start of the winding and ensure proper phasing for transformer voltages.

* There are two sections in each variable capacitor, the Antenna and Oscillator section which share a common connection. The connections are identified on the capacitor with an 0, G and A next to the leads corresponding to Oscillator, Ground (Common) and Antenna sections. The approximate values for each section are Oscillator: 15-73 pF and Antenna: 17-165 pF. The prototype tuners were built with the Antenna section (17-165) in line all the time and the Oscillator section (15-73) switched in parallel when more capacitance is needed for a match.

* Also the variable capacitors have small trimmer capacitors across each section. These trimmers are visible from the rear of the case and have a small flat blade screwdriver adjustment. Adjust both trimmers for minimum capacitance (plates unmeshed) to ensure minimum capacitance can be reached with the main capacitor.

* We hope all goes well with your kit building. Attached are some notes from the 1994 handbook and the ARRL data book giving some additional information on winding toroids and baluns. Enjoy!! 72, Dave, NF0R and Randy, WA0OUI

Parts List for ORIGINAL ST. LOUIS TUNER

1		Cabinet
6"	T1,T2	Cable, coaxial, RG-58, 6"
4	C1-C4	Capacitor, .01 mfd, ceramic disk, 50V
2	C5-C8	Capacitor, variable
2	RFC1,2	Choke, RF, 1mH, 5%
3	BP1-3	Connector, binding post, 5 way
2	J1, J3	Connector, coax jack SO-239, single hole

1	BP4	Connector, ground. 5 way
2	J2, J4	Connector, phono jack, (RCA)
2	D1, D2	Diode, 1 N34A
4		Feet, rubber
2	M1, M2	Meter, 200 uA
1		Printed Circuit Board
4	R1-R4	Resistor, 100 ohm, I watt, 5%
2	R7,R8	Resistor. 200 ohm, 2 watt, 5%
2	R5,R6	Resistor, variable,'trim pot, 25K ohm (PC
4		Screws, 4-40 x 1/4 & Nuts
3		Screws, 4-40 x 3/4 & Nuts
3		Spacers, Nylon, 3/32 x7/16
2		Spacers, nylon, 1/4 x 3/8
2		Screws, metric
1	S2	Switch, rotary, 1P12Pos
1	S1	Switch, rotary, 2P3Pos
1	S3	Switch, toggle, DPDT
1	S4	Switch, toggle, SPST
1	T3	Toroid, ferrite, FT50-43 (balun)
2	T1, T2	Toroid, ferrite, FT50-61 (bridge)
1	L1	Toroid, powdered iron, T80-2 (inductor)
		Wire, hook-up, stranded
L1, T1, T2		Wire, Magnet, #24 (bridge, inductor)
	T3	Wire, Magnet, #26 (balun)

[Note: The following information isfrom the1994 edition of the ARRL Handbook and the ARRL Data Book.]

How to Wind Toroids

The effective inductance of a toroid coil or a transformer winding depends in part distributed capacitance between the coil turns and between the ends of the winding. When a large number of turns are used (for example, 500 or 1000), the distributed capacitance can be as grert as 100 pF. Ideally, there would be no distributed or parasitic capacitance, but this is not possible. Therefore, the unwanted capacitance must be kept as low as possible in order to take proper advantage of the AL factors discussed earlier in this section. The greater the distributed capacitance. the more restrictive the transformer or inductor becomes when applied in a broadband circuit. In the case of a narrow-band application. the Q can be affected by the distributed capacitance.

The pictorial illustration at Fig. 1B shows the inductor turns distributed unifomly around the toroid core. but a gap of approximately 30° is maintained between the ends of the winding. This method is recommended to reduce the distributed capacitance of the winding. The closer the ends of the winding are to one another, the greater the unwanted capacitance. Also, in order to closely approximate the desired toroid inductance when using the AL formula, the winding should be spread over the core as shown. When the turns of the winding are not close wound, they can be spread apart to decrease the effective inductance (this lowers the distributed C). Conversely, as the turns are pushed closer together, the effective inductance is increased by virtue of the greater distributed capacitance. This phenomenon can be used to advantage during final adjustment of narrow-band circuits in which toroids are used.

The proper method for counting the turns on a toroidal core is shown in Fig. 1C. The core is shown as it would appear when stood on its edge with the narrow dimension toward the viewer. In this example a four-turn winding has been placed on the

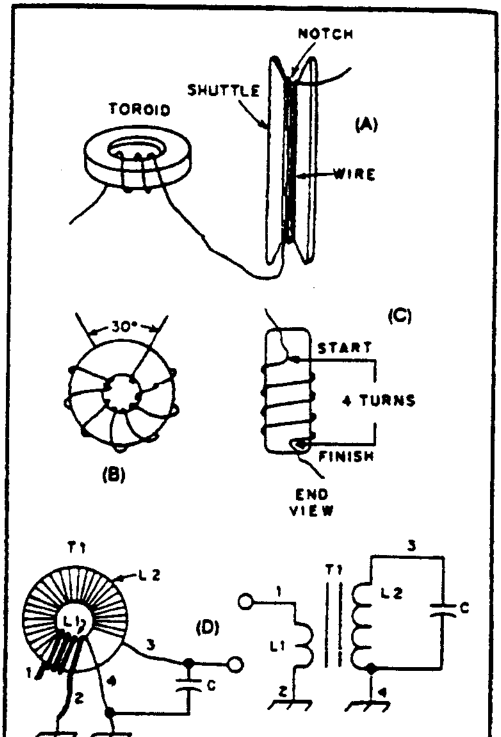


Figure 1

winding method is to discourage unwanted capacitive coupling between the windings, which aids in the reduction of spurious energy (harmonics, and so on) that might be present in the circuit where the transformer is used.

In circuits that have a substantial amount of voltage present in the transformer windings, it is good practice to use a layer of insulating material between the toroid core and the first winding. Alternatively, the wire itself can have high dielectric insulation, such as Teflon. This procedure prevents arcing between the winding and the core. Similarly, a layer of insulating tape (3-M glass tape, Mylar or Teflon) can be placed between the primary and secondary windings of the toroidal transformer (Fig. 1D). Normally, these precautions are not necessary at impedance levels under a few hundred ohms for RF power levels below 100 watts.

core.

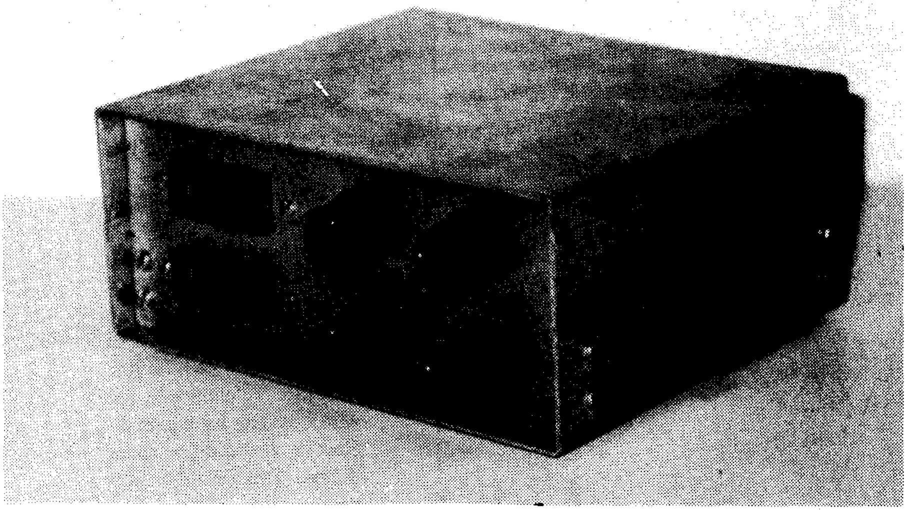
Some manufacturers of toroids recommend that the windingson toroidal transformers be spread around all of the core in the manner shown in Fig. 1B. That is the primary and secondary windings should each be spread around most of the core. This is a proper method when winding conventional broadband transformers. However, it is not recommended when narrow-band transformers are being built. It is better to place the low-impedance winding (L1 of Fig. 1D) at the cold or grounded end of L2 on the core.

This is shown in pictorial and schematic form at Fig. 1D. The windings are placed on the core in the same rotational sense, and L1 is wound over L2 at the grounded end of L2. The purpose of this

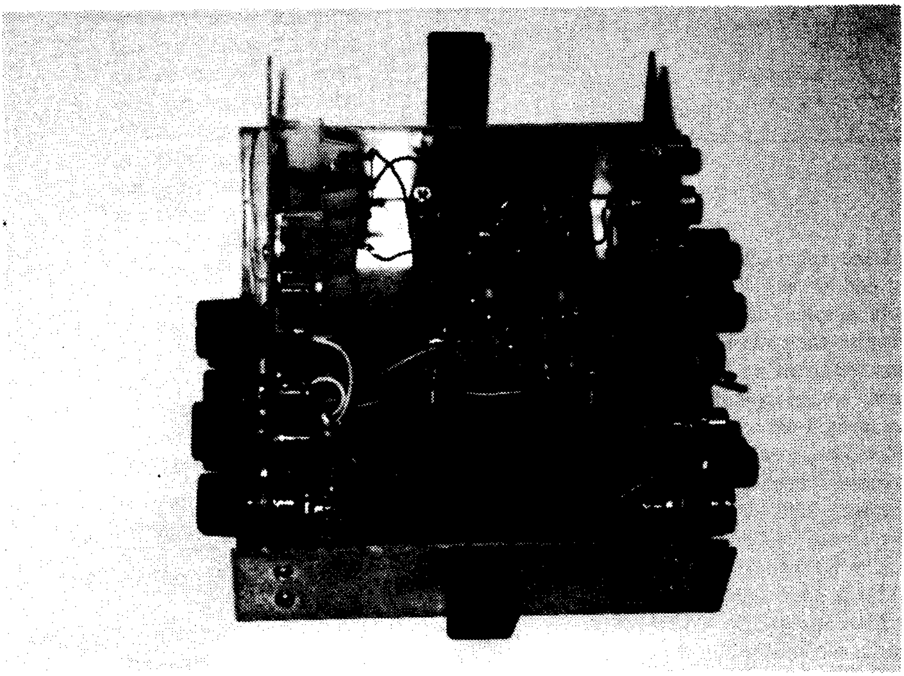
Once the inductor or transformer is wound and tested for proper performance, a coating or two of high-dielectric cement should be applied to the winding(s) of the toroid. This protects the wire insulation from abrasion, holds the turns in place and seals the assembly against moisture and dirt. Polystyrene Q Dope is excellent for the purpose.

The general guidelines given for toroidal components can be applied to pot cores and rods when they are used as foundations for inductors or transformers. The important thing to remember is that all ofthe powdered-iron and ferrite core materials are brittle. They break easily under stress.

Balun Transformers

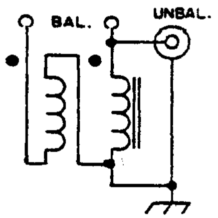


St. Louis Tuner, Interior View



St. Louis Tuner, Exterior View

It is important to keep in mind that a balun transformer is designed for a specific integer of impedance transformation- 1:1, 4:1 and 9:1, for example. This is a broadband transformer that will operate from, say 1.8 through 30 MHz. Baluns that contain magnetic cores, such as ferrite rods or toroids, provide the best broadband characteristics. The Figure below shows the wiring scheme for 4:1 balun transformers. Correct



4:1 BALUN

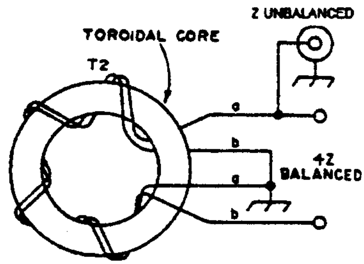
● PHASING

operation will occur only when the polarity of the windings (marked with a black-dot) is observed.

In an ideal situation the balun should be used between two known resistive conditions 50 ohms to 50 ohms or 50 ohms to 200 ohms, for example. A reactive load will cause the balun to function improperly; if the mismatch is great enough, the balun can become hot (saturated). In a worst-case situation the core may change mu permanently, or the core may break. Core saturation can cause TVI by virtue of square-wave generation (rich in harmonics). Therefore, the core cross-sectional area must be chosen for the RF power level anticipated.

Baluns and other broadband RF transformers are intended for relatively low impedance values. Ohmic termination values greater than 500-600 ohms are not recommended. This is because the higher the load impedance, the greater the developed voltage within the transfofrmer. This will cause rapid core saturation and voltage arcing between the windings and the transformer core.

Although some commercial Transmatches contain built-in 1:1 baluns for feeding balanced transmission lines, the line impedance should not exceed the proper secondary-load impedance of the transformer (50 ohms for a 1:1 balun and 200 ohms for a 4:1 balun). Some manufacturers imply (through text omission) that the Transmatch will work witli any balanced load. This may be true to some extent when using 100 watts or less. In this case tlie balun may not overheat, but it is definitely not in its proper impedance environment, and true balanced feed is in question. In other words, a balun transformer is not a cure-all for a variety of unknown load im-



4:1 BALANCED TO UNBALANCED VOLTAGE BALUN

pedances.

Ferrite-core baluns can provide a high impedance over the entire HF range. They may be wound either with two conductors in bifilar fashion, or witli a single coaxial cable. Rod or toroidal cores may be used. Current through a choke balun winding is the "antenna current" on the line; ifthe balun is effective, tliis current is small. Baluns used for high-power operation should be tested by checrng for temperature rise before being put into full service. If the core overheats, tums must be added or a larger or lower-loss core must be used. It also would be wise to investigate the cause of such high line antenna currents. Type 72, 73 or 77 ferrite will give the greatest impedance over the HF range. Type 43 ferrite has lower loss, but somewhat less impedance. Core saturation is not a problem with these ferrites at HF; they will overheat due to loss at flux levels well below saturation. Eight to ten turns on a toroidal core or 10-15 turns on a rod are typical values for the HF range. Winding impedance increases approximately as the square of the number of turns.

Add RIT to the Pixie 2

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I was browsing QRP-L late in December, 1995, when I encountered the messages of Nick Franco, KF2PH. He described his experiences with the Pixie 2 QRP transciever. I had built one of these, too.

What interested me was Nick's struggle with RIT. The usual problem with direct conversion transcievers without RIT is they receive on one frequency, and transmit on a different frequency. The transmit frequency is, of course, the oscillator frequency, but the receive frequency is actually determined by your preferred beat note frequency. The receive frequency is either (really, both) above or/and below the transmit frequency by your favorite pitch. For example: If my oscillator generates 7.110 MHz, and I like 1 kHz pitch, then I will be transmitting on 7.110 MHz, but receiving on 7.111 and 7.109 MHz without the benefit of RIT. Two transcievers operating like this can't use the identical transmitting frequency, but they must transmit on frequencies separated by the beat note. Some guys like low tones, while other like higher, but, both sides must hear the same pitch without RIT.

Example: I transmit on 7.110 MHz, receive on both 7.111 MHz and 7.109 MHz. You must then transmit on either 7.111 MHz (which means you receive 7.110 and 7.112 MHz) or 7.109 MHz (then you receive on 7.108 and 7.110 MHz). Notice that each of us is listening to a different unwanted sideband. QRM misery can visit us in these extra sidebands.

Now, RIT can't solve the double sideband problem of direct conversion receivers, but the frequency offset of the two transmitters can be fixed. What RIT does is offset the oscillator between receive and transmit by the desired beat note. Now my oscillator transmits on 7.110 MHz, as always, but the RIT shifts the oscillator by my favorite 1 kHz when I receive. So, during receive, my RIT circuit shifts my oscillator down 1 kHz to 7.109 MHz, and I am receiving 7.110 MHz and 7.108 MHz. Now I can receive the same frequency I transmit, yet I can adjust the beat note to my satisfaction independent of the other station. Note in this RIT example, I could have shifted my oscillator up by 1 kHz instead, receiving on ??? (the quiz part) frequencies.

I think that's enough of the what and why of RIT, so, on to the important HOW of RIT. Now back to Nick. Nick used a series inductor capacitor network for pulling the crystal. This is well established technique. For example, August 1995 QST has a construction article using this. The QST article suggested mysterious (to me) series inductors instead of a single inductor. The circuit subtleties for optimizing the pulling range are unnecessary for the limited range of RIT. Nick first used a variable capacitor, then he tried two capacitors in parallel, with one of them switched in/out of the circuit for RIT.

When I read about his using a manual rx/tx switch for RIT, I immediately knew how to solve the switch problem. The problem was how to somehow change the capacitance of the crystal pulling network from transmit to receive. My short answer is to use the voltage across the key to operate a varicap that shunts the capacitor in the pulling network. With the key up, receiving, there's voltage across the key, relatively constant (I'll ignore the audio signal that's there). Key down, it's zero volts. By some stroke of luck, a resistor is across the key. I changed this to a pot of the same value (the ends of the pot go where the 10K ohm resistor was.) Now, when the key is up, in receive, the pot wiper may be adjusted to control the RIT offset. Key down, both ends of the pot at ground, wiper voltage is zero, for fixed transmit frequency. What's still needed is the connection between the pot wiper and the varicap. This is a largish resistance (100k ohms or higher), it dissipates no power, so 1/4W, 1/8W etc. is okay. Since it has no steady current through it (the varicap changes its capacitance by varying the reverse bias across the junction) the value isn't too critical, however extremely large values (I'll guess greater than 1 meg ohm) might start to cause hearable chirp.

To summarize, start with the original Pixie 2 circuit, replace the 10K resistor across the key by the two ends of the RIT adjustment 10K pot. Lift up the ground end of the crystal and connect it to one end of an 18 microhenry choke (another like the one in the collector of the final/mixer.) The other end of this choke connects to one side of a 82 picofarad capacitor (another like the coupling cap between the osc. and final/mixer.) Also at this connection is the CATHODE end of a varicap (I used a Motorola MVAM 109, but I'm advised that a common rectifier diode such as 1N4001 to 1N4007 might also work as a varicap), and that largish dc coupling/rf isolating resistor (I had 150K ohms.) Ground the free end of the 82pF. cap and the ANODE of the diode or varicap; finally the free end of the new resistor connects to the wiper of the 10K ohm RIT adjustment pot.

I guess that's five parts (can you get a trade in allowance for the old 10K resistor?) This circuit pulls my 7.125 MHz crystal down to about 7.110 MHz in transmit, with a few kHz adjustment in receive. I didn't use a counter, so that's a guess. I bet you could replace that fixed 82pF capacitor with a variable (no, it doesn't have to be 82pF.—probably a 50, or a 150, or even a 365 pF variable would work) to move the transmit frequency, too. The RIT will interact with the adjustment of this cap, however.

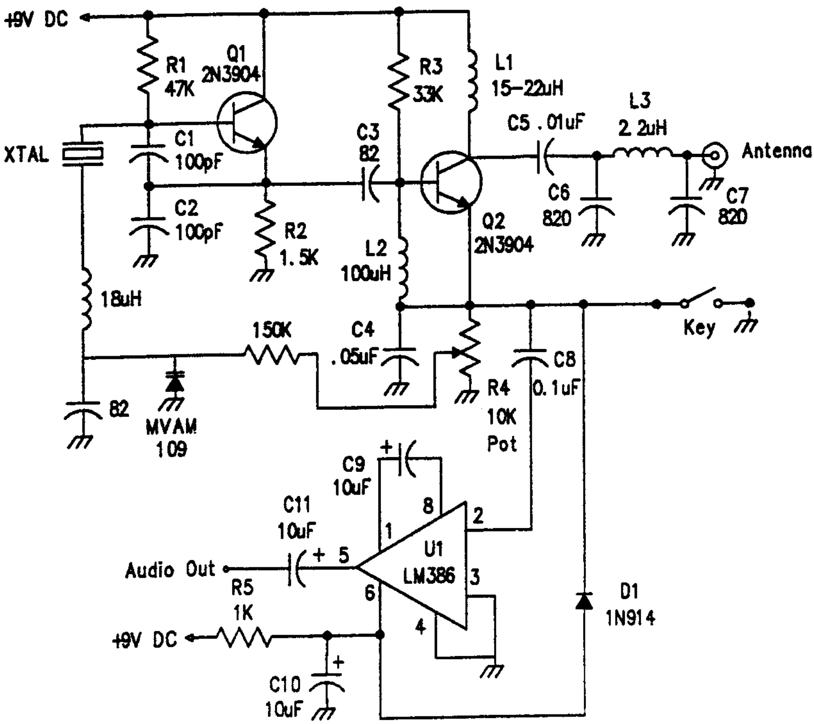
I adjusted the RIT using my Sierra. I had to wrestle it out of my son's hands to use it. First, I vaguely recall that the Sierra has no tx/rx offset when the received beatnote is the same pitch as the sidetone and its RIT is off. Okay. Pixie key down driving dummy load, etc. tune Sierra for same received pitch as Sierra sidetone. Now Pixie key up, (whew, that tiny plastic final in the Pixie can overheat) Sierra transmitting (NOT into the Pixie directly) adjust Pixie RIT for desired beatnote (don't change Sierra tuning here.) That's how I did it.

Now some caveats and observations. I confess, I did not use an LM386. I designed my own two transistor audio amp. I did it because I was dipping into a small plastic bag with cheap two cent plastic transistors in it, and I would have to excavate my junk box to find some (rarer and dearer) LM386's. Plus it was fun to design and build it. The basic design is in "Solid State Design for the Radio Amateur" ARRL, 1986 by W. Hayward and D DeMaw. I recommend it. Yes, you, too, can fill an 8-1/2 x 11 sheet of paper with mile long algebraic expressions (of course, just for fun.) Seriously, I consider it a practical exposure to the arts and sciences of solid state circuits.

Back to the Pixie. A main feature of this amp is that it has gain of about 2000 or so, maybe ten times the maximum LM386 gain; but it needs hi-z headphones. I use Trimm Featherweights. I don't shut it down the way the original Pixie 2 shuts down the LM386. This means that the voltage across the key in my Pixie is probably lower in receive than with the LM386 circuit. Your RIT adjustment may have a greater range than mine, or it may be more (or too) sensitive an adjustment. Your mileage may vary. The specific values I used for the various parts were what spares I had left from building the plain Pixie. A look at the QST article suggested that I was in the ballpark, and the proof of the pudding...I spent no effort to temperature compensate the varicap. Be my guest.

I only briefly imagined what the varicap does to the oscillator's waveform or harmonic content. Especially around zero bias, the capacitance varies (nonlinearly, even) with voltage. Watch out for the back wave. I noticed sufficient output in receive to drive an amplifi@ed resistive reflection coefficient bridge very well. Of course, it's at least an order of magnitude (10 dB) or more down, but that's still a second signal. (how about FSK for RTTY?)

Now for the interesting part. I am working on a scheme to add sidetone to the Pixie. My secret weapon is that discrete amplifier. All the nodes of that circuit are exposed to my whims... I need to add a switch transistor, however. Either stage may be shunted by an R-C phase shift network to make that stage oscillate at an audio frequency, with the switch transistor, driven by the good ol' voltage across the key, shorting out the middle of that network in receive, to allow oscillation only with key down (sidetone!!) I suspect that something could be done with the LM386 as well; I notice an uncommitted input, some gain adjust nodes are assessable..... who knows? SSB next? 72, Jeff, KD6MNP



Pixie 2 With RIT

Crystal Calibrator

by Elmer Harger, KM6FG
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At the January NORCAL club meeting, I brought along my crystal calibrator and several members were interested in it including Doug KI6DS. Doug suggested that I write up an article for QRPp.

A crystal calibrator or marker generator is a very handy accessory especially for a QRP station. I built one described in the ARRL handbook 1991 - 1996. This generator provides markers at 25, 50 and 100 kHz intervals and has enough harmonic content to be useable through 30 Mhz and beyond. The purpose of a crystal calibrator is to verify or calibrate your receiver dial reading. The NORCAL Sierra, for instance, does not have a digital readout but does have markings at 0, 50, 100, 150 and marks at 5 kHz intervals. These markings are meaningless unless they are calibrated. A good way to calibrate the Sierra is to build the band module for 30 meters and then calibrate the dial at 0 to WWV on 10.000 MHz.

That is fine except for one thing, the receiver is calibrated at one point on the dial and on only one frequency. The marker generator however allows us to calibrate the receiver across the entire dial on all bands and allows us to verify the dial calibration each time we use the receiver. This is important if we don't want to operate outside of the band, an FCC requirement. To use a marker generator, it must first be set against a standard frequency source. The frequency standard is the National Institute of Standards and Technology radio stations WWV and WWVH at 2.5, 5, 10, 15 and 20 Mhz. These stations can be used to zero beat the marker generator. To do this you can use a receiver that will tune to any one of these frequencies, turn on the marker generator and you should here a beat note from the speaker or earphones. The marker generator has a trimmer capacitor that can be adjusted (C1 in the handbook diagram) so that the beat can be zeroed (the beat eliminated). When this is done the marker generator is set and can now be used to calibrate your Sierra, NORCAL 40, etc.

Calibrating the Sierra is easy using this generator. With the Sierra turned-on and a short piece of wire connected to the Sierra antenna jack (about 2-3 feet of wire will do), turn-on the calibrator and also connect a short wire to its output. This will provide enough signal to make the calibration. Tune the Sierra dial to 0, you might have to rock the dial back and forth about 5 to 10 kHz either side of zero to get a beat note like you did when calibrating the marker generator on WWV. When you find the beat note, adjust the Pre-Mix trimmer C70 on the Sierra band module. Make this adjustment until you can set the zero beat point right on 0 of the Sierra dial. When this is done, tune the dial to 150. Check and see if this point also zero beats, it probably won't. This is normal, and will probably require some adjustment of the VFO master oscillator per the NORCAL Sierra tune-up procedures in your instruction manual. Ounce you have been able to get a zero beat at 150 on the dial, then go back to 0 and again check for zero beat condition. You may have to go back and forth several times on your first try when doing the first band module alignment. However after doing one band module and checking at 0 and 150 on the dial, the other band modules will fall into place once you set them to 0 on the dial.

Now that you have calibrated the 0 and 150 points on the dial, it is time to check the rest of the dial for linearity. The dial may not necessarily be linear or it might be right on throughout the dial. I found that I was able to get my VFO to be linear across the dial almost without exception, except for an error of only a few hundred Hz at 150. Now check using the calibrator at 25 kHz intervals. It can be used daily to check your frequency and can be used each time you change band modules to verify dial accuracy and band edges. At this point you can see the nice advantage of having a calibrator.

The marker generator was made by obtaining the circuit board from FAR Circuits in Illinois. The circuit can be made using several options. The crystal Y1 in the circuit can be 1,2 or 4 MHz, I elected to use a 4 MHz crystal as they are easy to obtain locally. Most of the parts were obtained at Anchor Electronics or Halted Specialties in the Sunnyvale-Santa Clara CA area or can be ordered from Mouser Electronics.

The marker generator uses digital technology and consists of four IC TTL 74xx series chips. The master oscillator is a quad nand gate 74ALS00, the first two sections serving as the oscillator, a third section acting as a buffer and the last section is not used. A 74ALS74 dual flip-flop is used to divide by 2 or 4 as required. If a 1 MHz crystal is used, then the dual flip-flop is not needed, however if a 2 or 4 MHz crystal is used then a divide by 2 or 4 respectively is required to get a 1 MHz reference frequency. Following this we need to divide by 10 and use a 74LS90 decade divider chip. That now gives us a 100 kHz calibrator frequency. One more chip is needed for our marker generator, another 74ALS74 is used to divide by 2 and by 2 again. This gives us outputs at 50 and 25 kHz. We now have all the required outputs. A two pole four position switch is the only control needed to operate the calibrator, the 4 positions are OFF-25-50-100 kHz.

The entire calibrator was built into a Ten-Tec aluminum cabinet measuring 3.75 x 3 x 1.5 inches. It also includes a 9 volt transistor radio battery, a 5 volt regulator IC (78L05) and a BNC RF connector. Have fun and keep on building. 73, Elmer

Optimized Band Module Values for the Cascade

by Dave Meacham, W6EMD
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Here are the optimized values that I have found to work best with the Cascade band modules. I am getting 9 Watts on 75M and 7W on 20M. All caps Silver Mica 300Volts/5%

75M Band Module:

Low Pass Filter Values

L2, L3	23T #26 or #28 Wire, T37-2 Core, 2.1uH
C12	680pF
C13,14	150pF
C15	1200pF
C16	560pF

TX Filter Values

L4,5	12T #26 or #28 Wire, T37-61 Core, 7.96uH
C3,11	820pF
C5,9	240pF
C7	1500pF

RX Filter

No Changes

20 Meter Band Module:

Low Pass Filter:

L2,3	12T #26 or #28 wire on T37-2 Core. 0.58uH
C12	220pF
C15	430pF
C16	200pF

TX Filter:

L4,5	14T #26 or #28 wire on T37-2 Core. 0.78uH
C3,11	39pF
C4,10	47pF
C5,9	82pF
C7	9pF (Critical. a selected very-low 10pF ok)

RX Filter:

L1	27T #28 or #26 wire on T37-2 Core. 2.9uH
T1	3T Primary #24, 29T Secondary #28 on T37-2 Core.

Back Issues of QRPp

Back issues of QRPp are available in bound issues only. volume 1 contains the 3 issues from 1993. Volume II contains the 4 issues from 1994, and Volume III has the 4 issues from 1995. Volume I is 140 pages and is $10 plus $2 shipping for US addresses, $5 DX. Volume II is 296 pages and is $15 plus $2 shipping for US addresses, $5 DX. Volume III is 276 pages and is $15 plus $2 shipping for US addresses, $5 DX. If you order all 3 voumes the cost is $40 plus $3 shipping for US addresses, $10 DX. To order send your money to Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620. Make all checks and money orders out to Doug Hendricks and NOT to NorCal or QRPp. All prices are for US Funds only.

Curtis 8044ABMKeyer Chip and Far Circuits Board Combo

NorCal has made a bulk purchase of the Curtis 8044ABM Keyer Chip and is offering it with the Far Circuits Board and the Info Sheet for $17.00 Postpaid. DX orders add $5 shipping. US Funds ONLY!! Make Checks or Money Orders out to Jim Cates, NOT NorCal! Send your orders to: Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821.

7.040 Crystals

We have located a supply of 7.040 crystals in the small HC49 holders. These are on the QRP calling frequency for 40 meter CW. The price is $3 each postage paid. Make Checks or money orders out to Doug Hendricks, NOT NorCal. Send to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620.

NorCal QRP Club

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From the Editor

by Doug Hendricks, KI6DS
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Did you notice the great drawing on the front cover of this month's issue? It was done by one of the Riley QRP Expeditioners, Jason Miller, who is a 17 year old senior in high school. His effort really captured the essence of the trip.

It has been a very busy 3 months for me, what with kitting the St. Louis Tuner, then the 49er kits, and writing this issue. But, I am sitting here typing this with a gleam in my eye, as I am getting ready to go to Dayton for the 4th time. What an adventure!

This issue is the biggest ever for QRPp, and it is a special one, as we start our 4th year. We now have over 1700 members in all 50 states and over 60 foreign countries. This issue has over 20 pages of mods for the 49er, a rig that was designed by Wayne Burdick to encourage experimentation, and did he ever succeed. We decided to offer kits after the last issue went to press, and we had to put inserts in the issue to announce it. We are still offering kits, and if you are interested, turn to the inside back cover for information. We now are offering crystals for 30 meters, plus the novice band on 40 meters. Thanks to Chuck Adams, K5FO for locating the source for us.

This issue also has several pages of pictures from QRP to the Field, which was very successful this year. I just did not have time nor space for writeups this issue, and will have them in the next edition. Thanks to everyone who participated.

Jerry Parker, WA6OWR has come forward in true NorCal fashion and has started the NorCal Web Page. If you have World Wide Web capabilities, check it out at: **http://www.fix.net/~jparker/norcal.html** It is absolutely the best QRP web page on the net. Thanks to Jerry's hard work. 72, Doug, KI6DS

Mods for the 49er

The 49er 40 meter direct conversion transceiver was designed by Wayne Burdick, N6KR as a platform or framework for the building contest at the ARCI Annual Meeting at Dayton. It was never intended to be a finished product, but was designed as a starting point for experimentation and learning. It was successful beyond our wildest dreams. Here is a collection of mods that were sent to me by the various authors. They are presented here so that you may share in the information discovered by our members.

Debugging the 49er Receiver

by Ori Mizrahi, AC6AN
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The 49er is simple enough to write almost a complete test procedure, so here it is:

Debugging the 49er Receiver:

The debug procedure for the receiver involves going through the schematic and checking the RX signal path from the inputs of the LM380 backwards. Listen to it and touch the appropriate pins with some wire - a resistor lead works just fine. If you can hear some "scratching" - the signal path is most likely OK from this point to the headphones. Before running this test, let's check the obvious first:

* Are the headphones OK?
* Are they compatible with the socket in use?

If this is fine, proceed with the electrical debug. First check all the supply voltages:

* LM380 pin 7 = 9V (depends on battery or supply in use)
* NE602 pin 8 = 4.7-5.3V

Check the ground connections with an ohmmeter to the supply ground, no more than a fraction of an ohm is acceptable:

* LM380 pins 2,4,5
* NE602 pin 3

If you have another receiver then this is an easy step: NE602 Oscillator: oscillator circuit defective? "Sniff" the oscillator with another receiver: tune between 7.035-7.045 with a short wire as an antenna for the other receiver very close to the (powered) 40-9er board. If nothing is heard - debug the oscillator circuit.

Next follow the receive signal path, using the procedure described above, in this exact order:

* **Test point** What to do if no sound

1. LM380 pin 3 Check the LM380 supply, pin connections, etc. Possible cause: bad LM380?

2. RFC2-C9 Check across RFC2 with an ohmmeter, a few hundred ohms is acceptable - Possible cause: bad RFC2?

3. Q1(drain)-C9 Possible cause: bad C9?

4. NE602 pin 4 Check pins of Q1, check voltage on gate of Q1 in RX

5. NE602 pins 6,7 Oscillator circuit defective? Skip this step if you already verified the oscillator is working.

6. NE602 pin 1 Check D1 for short, some short between ANT and pin 1, if all OK - bad NE602?

7. ANT RX ANT not connected to this point? Bad R1?

If all the above looks fine, you have to deal with the worst problems:

* NE602 oscillates at VHF frequencies
* Some intermittent (Good Luck!)
* Bad solder joint - hope you didn't build it tight and "ugly" like me (it took some time to find those fine shorts.) 73 DE ORI AC6AN

LM380 Audio Boost Mod

Paul Harden, NA5N
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This is an easy mod to boost the audio out of the LM380 signicantly. Just breadboarded it up and it works great. 3 parts, and I know you can fit them in your Sucrets box. I would really recommend making it a permanent addition to the 49er. Well worth the extra 2-3 components.

Here is the positive feedback modification for the 40-9er to boost the audio output from the LM380. It works, and works great. Measurements based on my 14-pin LM380, but should be virtually identical to the 8-pin LM380.

MODIFICATION STEPS FOR THE 49er:

1. Remove power. (Hey, all instructions always start with that one. You don't wanna get knocked on your butt from that 9V battery!)
2. Cut trace on LM380 to isolate pin 2 (+IN) from ground.
3. Solder 15K resistor on LM380 from pin 2 to pin 4 or 5 (ground).
4. Solder 1Meg resistor from (-) side of C13 to LM380 pin 2.
5. Solder .001 cap across the 15K resistor, or from pin 2 to ground.
6. Apply power; there should be a very noticeable increase in audio gain. I did not try different values for the feedback resistors. If you roll your own, make the resistor from pin 2 to ground to be .015 times the feedback resistor ... or, the same ratio as above.

The cap from pin 2 to ground prevents audio oscillation and can be .001 to .1 range. Frankly, my sloppy breadboard of the above didn't need the cap, but it should be added as a precaution anyway.

WITHOUT adding the 200 gain positive feedback mod, here's what I got on the LM380, wired similar to the 40-9er:

GAIN PROFILE with a 9V battery

Where Vin=input sine wave, p-p
Vout=LM380 output, p-p with 8-ohm speaker as load
Av=voltage gain
Gain(dB)=20logAv

Vin	Vout	Av	Gain (dB)
10mv	400mv	40	32
20	850	42	32
30	1500mv	50	34
40	1800	45	33
50mv	2200mv	44	33
60	2100	35	31
Gain compression starts here			
70	2000	29	29
80	2000	25	28
100mv	2000	20	26

FREQUENCY RESPONSE

Frequency response measured with test Vin=22mV(p-p) in for Vout=1000mV at 1 KHz for reference.

Freq.	Av	Gain(dB)
10Hz	31.8	30dB
20Hz	38.6	32
100Hz	45.5	33
300Hz	45.5	33
500Hz	45.5	33
Test signal applied to -INPUT,+INPUT grounded (40-9er configuration)		
1KHz	45.5	33
3KHz	54.5	35
5KHz	52.0	34
10KHz	50.0	34
20KHz	50.0	34
100KHz	50.0	34dB

Pretty darn flat from 20Hz to 100KHz DC Current draw on the LM380 (14-pin version) at 9v was 8.5mA.

Note that with a 9v battery, the stated Voltage gain of 50 is actually quite close. I was at first afraid that was acheivable only at +12v.

SUMMARY:

On both headphones and speaker, kicking in the feedback circuit makes the audio sound 2-3 times louder. I could hear audio in the earphones with Vin down to 4mV. If it were CW, I could have copied it. It is a 3 component modification, which can be added on the circuit side of the board, takes no extra board space, and pretty easy to do.

Try it, have fun, work somebody with it, and let us know how it went. And, I think we QRPers are the first human beings to actually employ the positive feedback design from the LM380 application notes AN-69. 72, Paul NA5N

40-9er history and Comments

by Wayne Burdick, N6KR
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Hi folks, the history of the 40-9er is approximately this:

Early 1995: I saw/heard some of the Pixie transceivers that people had built last year, and thought much better performance would be possible with just a few more parts.
Late 1995: Doug found some 7.040 crystals at the swap meet. He needed a rig designed to help use them up.

These events left me no choice but to do the 40-9er. Since there were so few parts (about 1/4 as many as a NorCal 40A, for example), I figured it was a good opportunity to design the rig around a 9V supply voltage. Then you could put it into a very small box. Doug did a nice PCB layout to achieve this. Some things to keep in mind if you build one:

* The limited VXO range has to do with how far you can pull an NE602 oscillator without having it stop. I used an RF choke, but you can increase the pull with a large toroid (like 60 turns or more on a T68-2 or T68-6). But be careful at the low end of your VXO trimmer cap: if the capacitance nears zero, it may stop oscillating (especially when you transmit, which loads the crystal further).
* That 1/2-watt output will drain a regular 9V battery pretty fast, so consider using an alkaline or better yet a lithium battery (availble from Mouser). A lithium battery costs twice as much as an alkaline, but you'll get something like 60 hours of operation!
* To keep parts count low, I used an LM380, and only a single-ended connection between that and the product detector (an NE602). You could increase the audio output quite a bit by adding a second JFET and going to differential coupling between the 602 and 386. As it stands there is enough audio to drive headphones to a reasonable volume in a quiet space.
* I'm running everything except the final amplifier off of 5V so that receiver performance and frequency stability will be good down to 6.5V or so. To save a few more milliamps and allow the rig to run all the way to 5.1V, you could substitute an LP2950-5.0 low-dropout regulator for the 78L05.

I worked Michigan (2000 miles) on mine. Have fun! 73, Wayne N6KR

Sub the LM386 for the LM380 in the 49er

by Wayne Burdick, N6KR
burdick@interval.com

The 40-9er uses an LM380N-8 to minimize parts count, but if you can't find one, you can easily modify the PC board to use an LM386 instead.

1. Cut all of the traces running to pins 5, 6, and 7. You can use an exact-o knife for this.
2. Reconnect the trace(s) that went to pin 7 to pin 6. Use a very short piece of bare copper wire.
3. Similarly, reconnect the trace(s) that went to pin 6 to pin 5.
4. Obtain a 100 to 180 ohm resitor and a 2 to 10uF capacitor.
5. Connect the (-) lead of the capacitor to one lead of the resistor (keep this and other leads short). Connect the (+) lead of the capacitor to the pin 1 pad of the IC. Connect the free end of the resistor to pin 8.

That's it. The reason step 5 is necessary is that the 386 has only 26dB gain with no external components, while the 380 has 34dB gain (fixed). By adding the R and C in series between pins 1 and 8, you'll make up the difference. In fact, you can make the R smaller or larger to change the gain as needed. Making R a short will result in a gain of 46dB, which would be too much for the 40-9er board and cause instability.

Also keep in mind that you can convert the single-ended connection from the '602 to the '386 into a balanced configuration to improve gain and stability, and possibly improve the muting characteristics. If you want to do this, look at the NorCal 40 schematic. The main difference is that the NorCal 40 doesn't use the 82mH inductor. You should use two of the inductors, one in each leg, to retain the low-pass filtering feature of the 40-9er.

Looking at the 40-9er schematic, it occurs to me that a bypass cap might be helpful from pin 8 to ground on the LM380 (or pin 7 to ground if you're using an LM386 instead). The cap can be anything from 2 to 100uF. Negative end goes to ground, naturally. The audio output isn't high enough to make the bypass cap a necessity, but you may want to try it if you think the audio is distorted on loud signals.

Also, I forgot to mention that the LM386 has one limitation: the supply voltage should be 12V or less for the standard LM386N-1. You can of course use the LM386N-4 instead, which allows for up to 22V. But voltages above 12V are not recommended for the 40-9er anyway unless you heatsink the final amp adequately.
72, Wayne, N6KR

Putting the 49er in an Altoids Case

by Stan Wilson, AK0B

Yes it can be done. Use a RS type RCA phone plug for the antenna, Use the RS 2.5 mm jacks for audio and key. Close the case and layout the holes. Then remove the lid for drilling. When you close the lid it will just touch the jack hardware whisker close.

Use 1/32 plastic sheet (I cut mine to the same size as the PC board) for an insulator under the assembled board. I installed the jacks on the ends. RF on left and other two on right. I installed a 0.1 molex terminal for the battery on the pc board. The jacks will have to go toward the rear of the box.

Space the two (audio and key) jacks about 3/8" apart. I did 1/4" and that is too close for most RS type 2.5 plgs. You will have about 1/32 spacing above the componets on the PC board when closed.

Back up the thin case when you drill it out. The thin metal can tear if you do not. I played with it about a week before I drilled any holes. de Stan AK0B

My Mods to the 49er

by Larry East, W1HUE/7

I increased the size of the bypass caps in the emitter circuit of the driver transistor and on the +V side of the decoupling choke to the final transistor from 0.01 to 0.1 uF. At 7 MHz, the impedance of a 0.01 cap is about 2.3 Ohms — seems to me that 0.1 uF (0.23 Ohms) is a better choice for a bypass.

I found that changing the choke in the final collector from 15 uH to 22 uH will increase the output by 30%. With 15 uH, output is 0.70W; with 22 uH, it is 1.0W. I tried an 18 uH choke and that also gave about 0.7W. These measurements were made with 13.2V on the collector of the 2N4427 final and 6V (rather than 5V) to the NE602.

I found the source of the low audio — a bad solder connection! I'm using small two-pin "strip sockets" for the antenna, etc. connections on the board, and the one for the speaker (? get serious; this thing won't drive a speaker!) output had a bad ground connection — it finally opened entirely, which is how I found it! Much better now, but still not ear-splitting.

I changed the order of the choke and trimmer cap in the VXO so that the side of the trimmer connected to the "tweak screw" is grounded. Much better — a metal tipped alignment tool can now be used to change the VXO frequency without screwing up the oscillator. This seemed like an obvious oversight in the original design, and according to a recent post from Wayne it was.

An interesting side effect: after this change, the VXO range decreased from 5.1 kHz to 4.8 kHz. The same choke and trimmer cap (and crystal, of course) were used in both cases — change in stray circuit capacity perhaps?

The simple mod involving feedback around the LM380 suggested by Paul, NA5N, sounds like it might be worth while — I'll check it out. I have the applications handbook he mentioned at home, so I'll look it up. By the way — the potential problem mentioned by Paul concerning no load on the audio amp output can be circumvented by connecting a 150 to 270 Ohm resistor from the audio output decoupling cap to ground (i.e., across the phone jack). This also eliminates the loud "pop" that occurs (with the unmodified circuit) when headphones are connected after power is applied to the rig (due to the output cap discharging thru the headphones). I routinely do this on all my rigs.

I am a firm believer in the "KISS Principle" (Keep It Simple, Stupid!), so it is not my intent to turn this little rig into a "Monster". There are a lot of additions one could make, like a series resonant circuit at the receiver input to reduce shortwave broadcast feed-thru (I'm picking up some religious station at times — don't know what frequency it's on), balanced input to the audio amp, etc., but I don't intend to do all this since this is REALLY a "toy rig" as far as I am concerned and it is interesting to see what CAN be done with a minimum number of parts. Component changes to optimize performance, on the other hand, I just can't resist doing. 72 and happy tinkering — Larry W1HUE/7

Improved Audio Filtering for the 40-9er

by Ori Mizrahi, AC6AN
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I followed the LM-380 positive feedback scheme for the 40-9er and it does work. The one thing I wasn't happy with was the poor audio filtering. The setup resulted in a stronger audio, i.e. amplified QRM...

Of course this was never intended to be anything more than an easy-to-build radio, and no complaints - like most anybody else - I love it!

Once I started tweaking the audio amp it dawned on me that we can revert to the LM-386 and with roughly the same circuit complexity achieve better filtering and lower power too.

No major development, just copied from the NC40A, sort of. I don't have the Norcal PCB, so can't advise on that, but it should be easily done on that PCB too. N6KR described most of the basic mod earlier, I added the bypass cap from pin 7 and the RC between pins 1 and 5.

The full LM-386 circuit goes like this:

* Pins 2,4 to Ground.
* Pin 6 to +Vcc (similar to LM-380 pin 7)
* Pin 3 is the input, connected to RFC2/C10 (same as LM-380)
* Pin 5 is the output, connected to C13(+), same as LM-380 pin 6

The additional circuitry:

* 10 microfarad cap between pin 1 (+ side) and pin 8 (- side)
* 0.1 microfarad (or bigger) from pin 7 to Ground
* 1800 ohm resistor in series with 0.022 microfarad cap between pins 1 and 5

This is audio circuitry, so somewhat longer wires can be used, although it's always a good idea to keep them short due to the high gain.

The result:

Calculated about -8dB for 3KHz vs. 500 Hz, sounds pretty much as predicted. It's absolutely an improvement, but -8dB are not exactly a "brick wall", especially if your tiny earphones favor the squeaky part of the audio spectrum. So, next we'll try a low-power dual-opamp active filter with some gain to cut some parts from the LM-386 circuit. Now that we saved a few mA at the audio stage, can afford some extra current somewhere else! 73 DE ORI AC6AN

Power "Switch" for the 49er

by Ori Mizrahi, AC6AN
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I put the 49er in a box and had to worry about the inconvinience of disconnecting the battery. I talked with a Jeff, KD6MNP and he was "surprised" I don't use what he considers a natural power switch.

This is taking advantage of a STEREO 1/8" socket and the fact that a MONO plug shorts the middle contact to the ground (not the tip). Wire the earphone socket in the following manner:

* TIP - Audio out (from C13)
* MIDDLE - Battery (-) Side
* GROUND - PCB Ground

Jeff also warned to plug in the earphones BEFORE they're in your ears. I would appreciate it if someone lets me know what happens otherwise!!! 73 DE ORI AC6AN

Simple Power Supply Instability Fix

by Ori Mizrahi, AC6AN

One potential *giant* source of instability is the battery! You eliminate this problem with a bypass cap across the supply.

I added a 0.1 cap in parallel to C12, probably a good thing to do in general. So far the radio is totally imune to supply noise. I tried NiCad, Alkaline, a regulated linear supply and a laptop switcher, all with the same good results. Mine is built on a proto board with a ground plane, so ground loops are not an issue. 73 DE ORI AC6AN

40-9er Correction: Receiver Input Tuned Circuit

by Wayne Burdick, N6KR
(burdick@interval.com)

If you think your 40-9er's receiver is too weak, it may be that C20 is too small. (I considered changing it from 150 to 180 pF but missed the publication deadline.) Rob Capon sent me the message below, confirming that on some 40-9er's, an extra cap paralleled across C20 may get the tuned circuit into the proper range. Which brings up the following question:

Q: Why does the 40-9er need so much capacitance in that tuned circuit, when the NorCal 40 and some other designs use the trimmer by itself, with a much larger inductor?

A: The reason is that the 40-9er is direct conversion, making it much more likely that hum and A.M. broadcast stations picked up at pin 1 of the NE602 will make it to the AF amp. By using a much larger capacitance here, the Q of the circuit is improved, and the NE602 "hears" less interference. I haven't quantified the effect, but I noticed that with the usual small amount of capacitance, things get much worse. The tradeoff is that with C2 being a smaller part of the total capacitance, the value of C20 becomes more critical.

Another way to acheive the same thing is to tap down on the inductor on the '602 side—but hey, that requires a toroid and the 40-9er was supposed to be torroid-less. 73, Wayne, N6KR

Case for the 49er

Robert Capon,
RobCap@aol.com

I have built my 49er, which I'm enjoying very much. Clearly it is not a rig that's going to see lots of air time, but definitely worth having some novelty QSO's.

Radio Shack sells a very nice beige plastic case for $5.25 that works great. The 49'er board fits neatly into the main compartment (after I notched the two lower corners, that-is), and there is a small compartment designed to house a 9-volt battery. The case comes with a 9-volt battery clip as well.

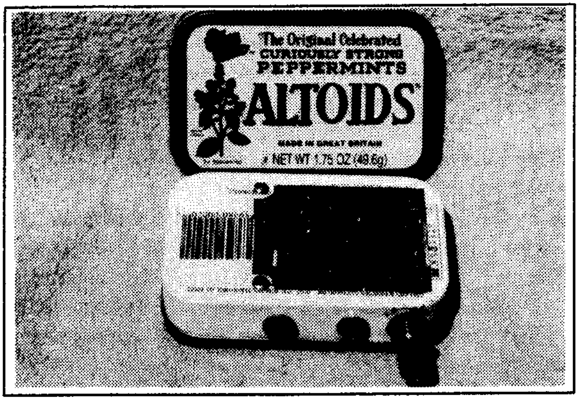
The box has a removable side panel, which is where I attached four components: antenna jack, key jack, phones jack, and on/off switch. Because the little panel slips out, wiring is a breeze.

So, if you don't mind the total radio cost escalating from $25 to $30, you might want to take a look at this case. (By the way, I had looked at a Sucrets case, but the battery would have to be external. Decided the Sucrets case was too spartan.) 73, Rob

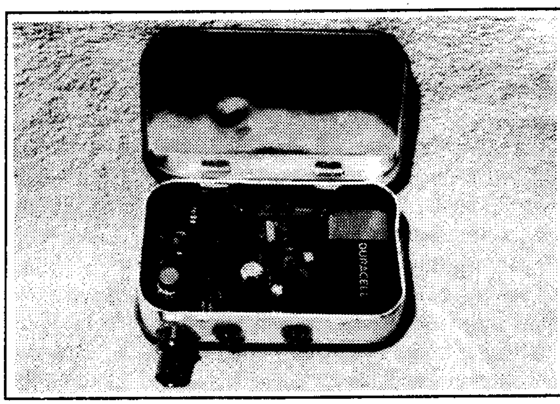
The Altoid Oreo 40-9er

by Floyd Smithberg, NQ7X

I call my 49er the Altoid-Oreo 40-9er.....Battery wouldn't fit in case so cut about 1/8" off the right end of pcb at and



Bottom View of Floyd Smithberg's "Oreo 49er"



Interior View of the "Oreo 49er"

rounded corners on opposite end. Battery now lies flat nicely in case. I used the usual snap connector with loose plastic cover removed and the terminals covered with non-corrosive RTV and unplug the battery and put it back in the case reversed (disconnected) when not in use. I put a piece of plastic tape inside the case to prevent the terminals shorting to the case when the battery is not in use.

Then, while working on mods I got tired of having to unsolder and disconnect jacks etc. to remove from the case so I cut out bottom of Altoid box only under pcb, leaving the part under the battery and about 1/4 inch around the other 3 sides. Used hand nibbler, scissors, files etc. Used only one 4-40 to hold the board and single sided tape to space the board from the bottom of the case on the end opposite the battery.

Now, how to cover the bottom? Just take another Altoid box lid and snap it on...voila, an Altoid Oreo. Now you have a typical NorCal rig....both sides available for service or show and tell! 72, Floyd NQ7X

40-9er Alignment and Output Power

by Ori Mizrahi, AC6AN
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The instructions with the kit tell you to peak C2 for maximum signal on receive. I found that there is quite a wide range where the reception is satisfactory. I also found that C2 has a major impact on the output stage loading, when R1 is at maximum resistance (where I suspect most people will leave it). It also tunes very sharply in this regard. The alignment procedure should include output power peaking, not only receive signal peaking. If you wonder why nobody hears you, check this first!!!

When the RF GAIN is set to a max signal, R1 is at max resistance of 1K or 2K, depending on what was supplied with the kit, and can be ignored for this analysis. If the paralel L/C circuit is NOT resonant, it presents a low impedance to ground at any frequency OFF resonance, possibly lower than the 50 ohms at the antenna terminals. The RF then favors this path to ground through C20, C2, RFC1 or C7-D1.

Notice the differences between receive and transmit. On receive, D1 is floating and C7 is terminated at the high impedance input of the NE602, thus it is not a factor in the resonance of that circuit on receive.

On transmit, D1 shorts C7 to ground, making it a part of this circuit. That is the exact detail that needs more attention. Tuning the circuit for max receive signal makes it resonate at the operating frequency with C7 essentially NOT in the circuit. That same circuit is NOT resonant on transmit, when C7 becomes a part of it, and it forms a low impedance path for the transmit signal to go to ground.

Fortunately, the receive peaking is fairly wide range. If you align C2 for max transmit output, the reception is acceptable, but not necessarily the other way around.

The alignment step should be:

* Connect a 50 ohm dummy load to your antenna terminal through a power meter. An SWR meter in the FORWARD position can do the job too, as it shows the peak relative power.
* Key the tranmitter and change C2 until peak power is observed. JOB COMPLETE!

73 DE ORI AC6AN

Choke Your 40-9er, Now!

by Wayne Burdick, N6KR

Based on a couple of messages I received I now can say with some confidence that the rev. B 40-9er board, at least, must have the driver and PA RF chokes in too close proximity. This is what's probably causing the reported "Squeal" (oscillation) on transmit.

There are two cures, either of which seems to work. I recommend that everyone make mod 1 or 2, even if you don't know that your unit is oscillating, and even if you have a rev. A board. This may also improve 2nd harmonic attenuation that was discussed earlier on the list.

1. Put a 1K resistor across each choke (the chokes in the collector leads of the driver and final transistors). If 1K doesn't do it, try 470 ohms on the PA choke.

— OR —

2. Replace the PA choke with 8 to 10 turns enamel wire (nearly any size will do) on a high-permeability toroid core, such as an FT37-43 or FT37-50. If necessary, do the same for the driver choke (shouldn't be necessary).

Here's what I think is happening, although I've never seen in person the rev. B board or a unit with oscillation. The two chokes are fairly close together on the PC board, so it's almost like they're two halves of a bad transformer. With enough coupling between the two, bingo—you've got an oscillator.

Either the 1K resistor or the toroid will drastically reduce the Q of these chokes, so that they can't "talk" so effectively at the frequency of oscillation.

Neither choke is critical. The idea is to suppress RF while passing DC. The rule of thumb is usually that the choke's inductive reactance should be at least 10 times the intended collector impedance, but it can be much more than that as long as there are no undesirable resonances or DC voltage drop or inter-winding capacitance. This is why the FT37-43 core is so useful here: it won't resonate at 7MHz no matter what you do, and the permeability is so high that you only need a few turns, hence the low DC resistance of the winding and the low inter-winding capacitance.

42uH (10 turns on an FT37-43) is plenty for both driver and final. I used 1mH at the driver to—hopefully—make it less likely to have any unwanted self-resonances. But I couldn't use 1mH at the PA because that particular choke has so much internal resistance that it would have a significant DC voltage drop. The idea was to use no toroids, but in hindsight I should have put swamping resistors on the board just to be safe since I wasn't the one laying out the PC board. 73, Wayne, N6KR

40-9er Self Oscillation Fix

by James L. Jendro, K8WVG
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I now have my Rev. B 40-9er up and running without self-oscillations on xmit at 9v. I don't have a clean way to measure power output at home, will have to wait till I can use a 'scope at work. Anyway, this is the "cure" for my rig...

1) Bypassed the 5v regulator with .01 uf on input and output side as well as a 10uf tantalum the output side. => Self oscillations still there.

2) Changed .01 uf V+ bypass on driver and final to .1 uf. => Self oscillations still there.

3) Added 1K resistor in parallel with the final's choke. => Bingo! Reducing the Q seems to have done the trick. If I notice any more self-oscillation I'll try the same thing on the driver's choke. Now, for that first QSO... Thanks to Wayne and Doug for the info/help/design. 73, Les K8WVG

40-9er "Tweaks" and Tips

by Larry East, W1HUE/7
LVE1@inel.gov

1. Change C11 and C19 to 0.1 uF for better RF bypassing (original schematic shows these as 0.01 uF).

2. A 78L06 can be used in place of a 78L05 for a little more "oomph" from the NE602 and still allow operation from a (reasonably fresh) 9V battery.

3. Add a 0.1 to 1.0 uF cap between the output of the 78L05 (or 06) regulator to ground; these critters will sometimes oscillate when their output is not bypassed.

4. If you plan to use an AC power supply, add a 1 to 10 uF cap from pin 8 of the LM380 to ground to reduce power supply hum and noise. (4.7 uF or so should completely eliminate any power supply hum unless the supply is very poorly filtered.)

5. A 2N4427 or a 2N3053 (available from Radio Shack) can be used for Q3 (the final amplifier) in place of a 2N3866. A 2N3553 or 2SC799 will probably give a little more output, however.

6. I found an easy way to keep the oscillator output from dropping off drastically at the high-end of the tuning range: add a 4-6pF cap from the "bottom" of the xtal directly to ground. In other words, shunt the L/C series network that is connected from the xtal to ground with a 4-6pF cap (small ceramic type is OK). This keeps the oscillator output from dropping at the low capacitance end of the tuning cap without significantly reducing the tuning range. It does reduce the high-end of the range by 0.2 - 0.3 kHz, but this is less than the reduction that would occur (about 1kHz) if the same size cap is shunted directly across the tuning trimmer (assumed to have the recommend 9-50pF range) — and it seems to have a greater effect on oscillator output. Its only one more part...

Your results may vary, but 5pF worked for me (3pF did not keep the oscillator output from dropping). If the low-end of your tuning cap is less than 8-10pF, then a larger capacitor may be required. 72, Larry W1HUE/7

40-9er success!

by Mike Hagale, AC6JA
AC6JA@aol.com

I just finished building the 40-9er and packaging it with the KC-1 keyer. I have made three contacts already, Turlock, Death Valley, and San Jose, Ca. from my QTH in Foster City, Ca. The rig seems to put out almost 1 Watt when running off my Radio Shack 2.5 amp regulated power supply at close to 15 volts. It sure takes some getting used to listening to a direct conversion receiver after being used to the Wilderness 40A, Sierra, and new Qrp Plus.

I put the 40-9er and KC-1 in a small metal case with lithium battery, and put two small momentary push button switches on either side of the case to act as my iambic paddle. It sure works out great. Now that everything works, it's time to start modifying the rig. The antenna used is a 40m hamstick dipole mounted on a telescoping painter's pole on the balcony of the townhome at 16ft! 72 Mike

49er Battery Mod

by John, N5INZ

I spoke with Alan, of the Famous SoCal Gang, about a mod for you folks who insist on the Mint Boxes. I got a handfull of 3.6v @ 60 mAh ni-cad batteries that are used for maintaining the BIOS in computers. They are about .75 x .5 inches. 3 in series would give you 10.8v. The bonus is that all three are smaller then a 9v rectangular and re-chargable. 2 sets and you have a change while the other charges.

Another idea would be to build a charger that plugs into the cigarette lighter. 72, John-N5INZ

Solving Two 40-9'er Problems with One Mod!

by Alan Kaul, W6RCL
kaul@netcom.com

I had one of the original boards and built one of the original designs (C20 = 150 pf). I had two complaints — the rig had a strong SW broadcast station (WEWN, Birmingham, AL) overloading the receiver, AND the receiver input circuit (C20, C2, RFC1) didn't really tune the same frequency that the crystal VXO did. Larry, W1HUE and Wayne, N6KR reported the circuit tuned higher in frequency than it should and the easy fix was to replace C20 with a 180 pf cap. Last night I soldered into place an even better fix!

On the theory that the SW station was there because the input circuit was not resonant, I thought I might try eliminating it by replacing RFC1 with a torroid (remember Wayne reported over the weekend that even thought the rig was to be "torroid-less" that the best fix for a squeal in the version B board was to replace a couple of chokes in the transmitter stage with FT-37-43 handwound coils). So with the torroid-lamp-clearly-lit by the designer himself — I plunged ahead.

Using the traditional formula for Xc=1/(2 x pi x freq x C), I found that a capacitance of about 180 pf (C20 + approx midrange of C2) would resonate using a coil size of approx 2.8 uH. Then I used the torroid winding formula of Turns = 100 * SQR (L{uH} / AL value). The charts indicated the AL value of a T-50-2 torroid was 49, and the coil worked out to be about 24 turns. I used #24 wire, threw it together and soldered it in place of RFC1.

WOW, what a difference! In one single step I was able to get rid of the SW crud and to find true 40M resonance in the receiver input circuit. While I was making modifications, I swapped C6 and RFC6, so C6 now connects to ground and RFC6 is isolated between the crystal and the input side of C6. Incidentally, I drilled a new hole for C6 in the large ground plane area (where the silkscreen says '49er by N6KR)!

I thought briefly about making another mod at the same time — using the 2.2 uH choke I removed (soldering RFC1 in series choke with RFC6—the VXO choke) which might increase the swing of the VXO, but I saved it for another day.

One more thing — if you have a parts kit for board B, or have already replaced the capacitor C20 with a 180 pf cap, you can make a 2.2 uH torroid by winding a theoretical 21.189 turns on a T-50-2 (winding 21-turns ought to work!).

The 40-9'er is a terrific little rig. This mod makes it even better! GL and 73/72 de Alan, W6RCL

49er Measurements

by John, WB4OFT

Bob Kellogg AE4IC let me borrow his newly assembled 40-9er and make a few measurements. We thought the rest of the 40-9er owners would like to see the results.

I measured the transmitter performance and got the following results.

Supply voltage = 9volts

* Power output = 235mW
* Second harmonic = -27.8dB below the fundamental
* Supply current = 85mA TX / *18mA RX

Supply voltage = 12volts

* Power output = 480mW
* Second harmonic = -24.3dB below the fundamental
* Supply current = 125mA TX / 20mA RX

NOTE: This rig had some modifications to boost audio gain.

I used an HP8595E spectrum analyzer for the harmonic measurement and a Rhode & Schwarz NRVD power meter for the power measurement.

I was amazed how well such a simple receiver can work. Also, I listened to the transmitter operated into a 50 ohm load and my inverted vee. The 40-9er sounds as good as any commercial rig.

With all the 40-9ers out there, maybe we should have a 40-9er hunt. That would give the rigs a good work out. Hope this information is useful. 72 John, WB4OFT

40-9er Harmonics

by Alan Kaul, W6RCL

Using my 40-9er (Board A) I measured 15 dB of second harmonic suppression the first time I tested it, and 16 dB the second time I tried it. Both times, the analysis was performed on a Motorola R-2000 Communications Analyzer. My results varied by some 10 dB with John's post reported today on the list. I hope my measurements were wrong — because I'd like to think that the rig has better suppression than I was able to find. It is possible the analyzer I used was not working properly, OR that I inaccurately made my measurements OR that the parts I installed were off tolerance (listed values: C17=270pf, RFC5=2.2uH, C18=470pf), etc.

Has anyone else measured the output on their 40-9er's? Theoretically, we should all be getting approximately the same results. 72, Alan W6RCL

Alan,

I looked at the output of my 40-9er (also a Version A board) on an IFR communications analyzer and found about the same thing you did, the harmonic is only about 16 dB down on the fundamental.

72/73, Al Moyle N3KFL

Measuring 49-er Performance

by Alan Kaul, W6RCL

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One of the perks of working in the broadcast business is occasionally getting into the shop to play with the toys. This morning, I was able to do just that with the 49-er (aka 40-9er) designed by N6KR and offered by the Norcal QRP club.

All of the tests were made using a Motorola Communications System Analyzer — model series R-2000 (no label on this one, it might have been an R-2001 for example). Performance was measured using various power supply voltage levels, at 7.040 kHz.

OUTPUT POWER AS A FUNCTION OF INPUT VOLTAGE

Voltage (under load)	Power output (sum of all emissions)*
7.0 (AC supply)	0.26
8.26 (used 9v bat)	0.32
8.52 (used 9v bat)	0.33
8.94 (new 9v bat)	0.39
9.0 (AC supply)	0.42
12.0 (AC supply)	0.70
12.5 (AC supply)	0.74
13.4 (AC supply)	0.80

* The test gear is absorptive, the power measured = the sum total of the power on the primary frequency plus the 1st harmonic, plus the 2nd harmonic, etc.

RELATIVE POWER OUTPUT BASED ON FREQUENCY ** (see below)

Supply voltage = 12V (AC supply)

Frequency (mHz)	Power output (W)
7.038	0.65
7.040	0.70

7.0459	0.53

** In my rig, the VXO variable capacitor is not the one specified: it has a slightly larger tuning range (8-60pf)

HARMONIC CONTENT

(using 12V power supply, at 7.040 mHz, 0.70 watts)

	F1	F2	F3
Freq	7.040	14.080	21.120
Signal	0 dB	-16 dB	-38 dB

Here are the 2nd day measurements — same test gear just 24 hours later and with slightly different results.

I went back to the Motorola Communications Analyzer this morning, and put a few more variables into the equation.

First, using a 12-inch clip lead (as opposed to soldering jumpers and unsoldering parts) I measured harmonics at the input to the pi-output filter.

Obviously my method was NOT perfect, I'm sure I introduced stray capacitance and stray inductance. But it's what I had in the time that was available.

Measurements with no harmonic attenuating filter.

Power Supply Voltage	Power Output (Watts)*	F1 (dB)	F2 (dB)	F3 (dB)	F4 (dB)
9.0	0.47	0	-5	-13	-25
13.0	0.64	0	-5	-15	-25

* POWER OUTPUT is the sum of all emissions (i.e F1+F2+F3+...etc) The output of the rig was then measured at the coax connector:

V	Power	F1	F2	F3	F4
7.0	0.25	0	-17	-37	-39
8.0	0.34	0	-16	-37	-38
9.0	0.42	0	-16	-37	-38
10.0	0.52	0	-15	-36	-38
11.0	0.60	0	-14	-36	-37
12.0	0.67	0	-15	-37	-38
13.0	0.75	0	-15	-37	-38

NOTE: Some of today's measures might differ slightly from measurements made with the same equipment with the same power source, with the same transmitter, etc., yesterday(!)

All merasurements were made at a nominal frequency of 7.040 (I didn't calibrate for each measurement, and only occasionally looked at the frequency counter, but the VXO was not changed between tests, and on those few occasions when I looked at the counter, it was not more than 200-250 cycles off frequency).

NOTE: The key-down for 13.4V was approximately 2-minutes. I did not have a heat sink installed on the 2N3866 and it ran quite hot. I'd recommended not running it at that power level without a heat sink. I make no claims for the output of any 49-er other than my own — yours may or may not perform similarly.

The 49-er is a great little rig. Wayne has done a terrific job — he's been able to get a lot of out of a tiny Altoids' box!

72, Alan Kaul, W6RCL kaul@netcom.com

40-9er Power Drop W/1K Resistors

by Wayne Burdick, N6KR (burdick@interval.com)

Paul, WB8ZJL wrote:

I finished the 49er and it had the (typical) intermittent self-oscillation problem. The problem went away when I added the 1K ohm resistors across the RF chokes but the RF power dropped about in half. Looks like 100mw output (+/- 100mw)

Is this "normal?" Would toroids fix it? Any way to get a sidetone out of the thing? Boy it's COOL... thanks again Wayne and NorCal!!! 73 Paul WB8ZJL

Paul, try resistors > 1K across the driver choke to find one that kills the oscillation but not the power.

For a better solution than resistors, use FT37-43 toroid cores for both the driver and final chokes. Anything from 8 to 12 turns on each ought to do it—it isn't real critical. The rule of thumb is that the inductive reactance of the choke should be 10 times the collector impedance of the stage. By this logic, the driver choke should have more turns, but my guess is that it won't make much difference.

Experiment!

I finally received a rev. B 40-9er board myself, and Doug Hendricks did an excellent job. He and I both learned a few things about placement of RF chokes, though! The close proximity of the driver and final chokes may be the cause of the oscillation, and would explain why switching to toroids would cure it.

One thing I haven't looked at is whether you could keep the chokes as they are, but simply relocate them as far apart as possible on the PC board. In other words, tack solder them on—don't use the existing holes. Anyone try this? 73, Wayne N6KR

An 80-9er: Putting the Norcal 40-9er on 80 Meters

by Ralph Irons, AA6UL/4
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On 80m, there are plenty of QRP CW nets (where guys will listen for puny signals). As soon as I built and operated Norcal's fine 40-9er kit, I wanted an 80m version.

Whoa! WAKE UP! The sum total of my electronic knowledge could be inscribed on the head of a pin ("It already is", my wife says.)

Well, I reached REAL DEEP into that limited storehouse — consisting of SOME of the answers I memorized years ago for my exams — and pulled out the idea that maybe I could: (1) calculate the reactances of the various capacitors and inductors in the receiver input, the VXO, and the driver/PA/output filter circuits at 7 Mhz; (2) calculate the values of components which would have the same reactances at 3.5 Mhz; and (3) leave everything else the same!

This seemed too easy, so I sent email to Wayne Burdick, N6KR, (isn't QRP-L great?) asking his advice. Wayne said it should work, noting that this just means DOUBLING the L and C values in the RF circuits. DUH!

That is (approximately) what I did, and Lo! the result works. Actually, I used the values in my junk box CLOSEST to double the 40m values. I built the 80-9er using ugly construction, on a single-clad PCB (about 4" by 4"), with the semiconductors lying upside down ("dead bug" style), gently bending down every other pin on the ICs, and trying to keep the leads to ground short.

I built the oscillator circuit first (the NE602 and all the components connecting to pins 2, 3, 6, 8, and the components hooked to pin 7 up to C14). I wired C6 (the variable in series with the crystal) to ground, and in place of RFC6 (or a single choke double its value), I used three 33 uh chokes in series. (This is in the spirit of the QRP-L thread on increasing the swing of a VXO. I look forward to playing with this more!) The oscillator worked right away. It had a surprising swing of 4 khz — plenty to make sure I'd be able to zero beat the net!

Next, I completed the transmit circuit by continuing from C14 on out to the antenna connector! (No need to connect the diodes yet, though — there's no receiver to mute yet!) I didn't have a 2N3904, so I decided to try a 2N4401.

Unwanted oscillation occurred as soon as I hooked up the transmit circuit to the antenna. I had used 33 uH chokes in the collector circuits of the driver and power amplifier. There was no way I could wind a 1 mH choke (let alone DOUBLE that) on any of the toroids in my junk box. But a QRP-L posting by N6KR suggested that I could get away with alot less!

So, I just selected the core with the highest AL value I could find in the box (an FT-50-61) and wound as many windings as I could — about 30. This SHOULD have yielded about 60 uH, but actually netted me only 24 uH (as measured with my Autek RF-1). Well, the core was not from Amidon...

Having only one such core, I tacked a 1K swamping resistor across the choke in the power amlifier collector circuit. The unwanted oscillation was gone.

Finally, the receive circuit (everything else). The junk box contained an LM386 (no LM380), so I dug around in old QRPp issues and found a circuit using an LM386. I just copied it. Also, I didn't have any 1N4148 diodes, so I used 1N914s.

In testing the receiver, I learned the folly of another substitution I had made. I used a 78L06 (supplying a regulated 6v) instead of the 78L05 (5v) in the schematic. (Just because that's what I had!) Turns out that while the oscillator in the NE602 doesn't seem to mind the 6v, the mixer part of the chip doesn't like much more than 5v, and before long it just folded its arms and turned its back on me. So I added a 47K pot as a voltage divider between the NE602 and the 78L06, to give the little chip the 5v it likes.

Finally, I did not have anything like the 82 uh choke used in the audio low pass filter, so I don't have a low pass filter installed yet. That gives me something to look for at hamfests!

I had a lot of fun dusting off the old ideas from the exams and actually using them to try to build a radio! Thanks to N6KR's rugged design, which survived both my limited knowledge and junkbox, the resulting 80-9er works.

Here are the actual values of components used in a working 80-9er. These are far from "ideal" or "optimized" — but the resulting transceiver does work!
(Only the component values which differ from those in the 40-9er are listed):

C1, C7	47 pf
C3,C11,	.02uF
C15,C16,	.02uF
C19	.02uF
C4	560 pf
C5	150 pf
C14	150 pf
C17	560 pf
C18	910 pf
RFC1, RFC5	4.7 uh (30 turns on a T50-2)
RFC3	2 mh (30 turns on an FT50-61)
RFC4	33 uh (used a 1K resistor in parallel with this choke)
RFC6	I used three 33uh chokes in series and got a 4 khz swing in the VXO.

Other substitutions made (not recommended, but they DO work!):
1N914s for the 1N4148s
2N4401 for the 2N3904
LM386 for the LM380 — the pin-out is different, so don't hook it up the same way!
78L06 for the 78L05 — But be sure to use a voltage divider to drop the output to 5v for the NE602!

It feels great to have a homebrew rig! The want-to-work design of Norcal's 40-9er makes this possible. 72, Ralph AA6UL/4

40-9er Success
byRichard Schneider, KB0SRY
(74602.3317@compuserve.com)

My first 40-9er QSO was logged Saturday (4/13) during the ARCI contest. I heard fellow CQC member and ace contester K0FRP calling CQ and figured if anyone could hear me he could — and he did.

On Sunday, no QSO's but I experimented with the OHR SCAF filter kit I purchased from Marshell Emm/AA0XI and found that the filter really separates the signals on the 40-9er. I'd urge anyone interested, to contact Marshall pronto — it's a great unit.

Last—anyone have a mod to filter out religious SW stations? I had two tonight (Sun.) on the 40-9er. One station — the one always begging for money — is a regular. The other, which just showed up for the first time, ran me thru a hundred or so Hail Mary's while I was experimenting with the SCAF filter and the 40-9er Rx. 72/73 Dick/KB0SRY

Harmonics and Spectrum Analyzers
by John Mckee, WB4OFT
(jmckee@rfmd.com)

I've been reading on the internet about the differences between harmonic measurements made on a Motorola radio test set and a spectrum analyzer. One mistake I've made several times with the spectrum analyzer was over driving the front end mixer and getting erroneous results that looked worse than they really were.

I don't how the Motorola set works but I assume it has a built in dummy antenna and somehow couples RF into the spectrum analyzer part. Is there some kind of input level control?

The spectrum analyzer input however goes straight in (there is a warning on the front panel not to exceed 1 watt or +30dBm). One thing I always do especially when measuring a device capable of outputs high enough to damage the analyzer is use an attenuator pad, usually 20dB, at the analyzer input. Even an RF level not quite high enough to damage the instrument can over drive the it and show up as nasty IM products.

Before I made the 40-9er measurements, I ran the self calibration routine and then added a 20dB amplitude offset to make the analyzer think it was looking at the actual power level coming from the transmitter output. This let me measure actual power level and the difference between fundamental and second harmonic with a high degree of accuracy. However, for power the power measurement I used a power meter.

I am pretty sure the harmonic levels are accurate. I would like to check another 40-9er or two just to be sure. Bob Kellogg AE4IC and I are planning to experiment some more and see what kind of results we get.

I really think if you want to operate a 40-9er from 12v, you need to redesign the output network. One option for 12V operation might be to remove the existing pi network then replace it with half of a half-wave filter (5 element) and put the other half off board.

The 49-9er is a good inexpensive test bed for experimentation. That's what makes QRP fun. 73 John WB4OFT

40-9'er Measurements
by Rich Kellner, W5RXP
kellner@usa.acsys.com

I have the Rev B board, and I first measured: ~250mw out at 9V, ~500mw out at 12V, 2nd harmonic 30db down.

I had taken those measurements with a digital scope with FFT, and I rounded the 30db figure from an actual 28db measured at 9V. After the discussions on QRP-L, I went back and took more careful measurements.

With a spectrum analyzer. I got:

F0		2nd harmonic
9V	.27W	-24db
12V	.50W	-22db

72, Rich W5RXP

40-9er Mod, Barber's Shaver and Carbon Stones
by Ori Mizrahi, AC6AN
mizrahi@svlhp8.scs.philips.com

Some time back I posted a message regarding the impact of the parallel L/C circuit in the receiver front-end on the transmit power.

I went back to investigate this problem yesterday. The parallel L/C should have, in theory, a very high impedance at resonance. The 22pF capacitor coupling to that circuit has about a 1 KOhm reactance. The theory I had before just didn't seem to hold.

I decided to simulate the pi network and the parallel L/C circuit interaction when fed by a generator (simulated transmit mode). There it was, a huge dip of the output at the antenna terminals coinciding with the resonance frequency of the parallel L/C!!!

After some discussions with Jeff KD6MNP we ended up with the conclusion that what we have here are two loosely coupled resonant circuits. The parallel L/C behaves in this case as an harmonic dampener, absorbing energy from the pi network and the load (there's very little in the literature, but

try Terman if you have it). So now, if you didn't know it already, your 40-9er shares something with a barber's shaver and your common car's mechanicals!

Why didn't this show up in other QRP designs? I think this is due to the receiver muting method. The 40-9er uses a diode to mute the incoming RF signal, but that diode is at the NE602 chip, relying on it for DC bias. This saves parts, but leaves the parallel L/C connected to the pi network during transmit!

Reviewing the Norcal 40 schematics you'll find that the mute circuit is before the peaking circuit in the receiver. The NN1G uses a diode isolation circuit, also ahead of the receiver circuitry. So what's the cure?

I was ready to insert a PIN diode circuit before I started my simulations, in order to isolate the receiver circuitry during transmit - lots of parts... but given the nature of the problem, I figured that lowering the Q of the L/C circuit can do some good, and indeed the simulation confirmed it. I chose to go with an 8 Ohm resistor in series with the inductor RFC1. The fix works like a charm.

But then - a big surprise! I used to have a real problem with a BC station at 7.425 MHz booming in at night - it's gone now! I shorted the extra resistor, and there it was again. Maybe that signal was picked up not through the antenna but rather in the receiver front-end circuit. Whatever the theory is, sure seems like I killed lots of birds here with one carbon stone...

The tuning of the transmitter becomes unnecessary after this mod, so I truly recommend to try it. I don't have the boards from Norcal, but all it takes is to unsolder one side of RFC1, solder the 8 Ohm resistor to it and then solder the other side of the 8 Ohm resistor to where the RFC1 lead was previously connected. 73 DE ORI, AC6AN

Re: 40-9er Mod, Barber's Shaver and Carbon Stones

Alan Kaul, W6RCL
kaul@netcom.com

Same results, different mod. I swapped out RFC1 in my rig with a torroid of approx 2.8 uH value which 1) enabled me to get a nice peak using the variable capacitor, and 2) enabled me to lose the SW station in Alabama that was crudding up my front end. I presume my switch to a torroid coil had about the same effect as your lowering the Q of the circuit with an 8 ohm series resistor. NOW THE REAL QUESTION: Does changing the Q of the parallel input circuit also have an impact on harmonic output? I'm still waiting to get into the lab to retest the 40-9er, now that I have replaced the fixed inductance choke at RFC1 with a torroid.

The Q has changed, but has the 2nd harmonic radiation? Could that help explain how various 40-9er models built and tested by different people are reported to vary by as much as 10dB in 14mHz energy measurements?

Also BTW - I have done the audio mods and the gain is quite improved. I replaced RFC4 with 10T on a FT-37-43 as suggested by Wayne, N6KR, and there does not seem to be a noticeable difference on my rig. Also, I installed the electrolytic on the downstream side of the voltage regulator and bypassed both the input and output of the 7805 close to the chip with no perceptible difference. I'm ordering parts for the 80M version (using a color burst crystal) and I'm planning to make the C/L ratio significantly higher in the receiver input stage (I'll use about 900 pf of total capacitance and around 2.4 uH of inductance at the input circuit and as Larry, W1HUE, mentioned, I think I'm going to use link (transformer) input from R1 instead of C1).

I'm also planning on not putting the 80M version in a Sucrets/Altoids box, so I can use a 'real' variable capacitor (and a vernier dial!) at C6. Just by tack-soldering added C in parallel with C6 on the 40M version, I have been able to significant change the frequency by another 4-5 kHz downward. So, I'll probably make C6 about 80-to-100 pf in the 80M version, and make RFC6 a torroid coil also. And may switch in additional capacitance. I have the 'version A' board, and when Doug laid it out, he left a "few" extra holes in the C6-RFC6 bus which will make an outboard variable cap easy. Also, I'll reverse the position of RFC6 and C6, so the inductance is between the crystal and the cap, and the cap will connect directly to ground.

Also, FYI, I'm using the audio monitor from my Curtis Keyer (using a double-jack to single plug for the headphones) which is easier to install than building in a monitor circuit.

Has anyone figured out a way to pull the transmit frequency 500-700kHz lower? 73/72 de Alan

Eliminating Hum from the 49er

by Larry East, W1HUE/7

My original post assumed the 8-pin version of the LM380 (LM380-8) if you are using the 14 pin version, then it is a different pin that needs to be bypassed (don't have the pinouts here at work). The +V line (which connects to pin 7) should be bypassed with a large cap — at least 100uF. The original 40-9er schematic showed 220uF, which is what I believe I am using. If you do NOT have such a bypass installed, then you will probably be getting some power supply hum even with a 10uF cap bypassing pin 8 (but it should be worse with no bypass on pin 8). If you do have +V bypassed with 200 to 300uF and are still getting hum, try a larger cap on pin 8 — and/or look for ground loops. (Ground loops are a big problem with "DC" receivers — for example, when I connect my external keyer to my 40-9er, I get some hum that is not otherwise there.)

Pin 8 (of the LM380-8) is intended solely for a bypass cap to decouple the high gain input stage of the IC from the power supply. My National IC data book makes some mention of this, but it is not stressed; in one place it shows a 4.7uF cap connected from this pin to ground, but in most of the other examples it shows it floating, or with a "dotted line" cap with no value indicated. I have seen many designs (in various kits and even my QRP+) in which this (or the equivalent pin for the LM380-14 and LM386) pin is not bypassed (or too small a cap is used), and in every case properly bypassing it decreased power supply hum (and/or noise) sensitivity.

Increasing the gain of the LM380 will indeed increase the 40-9er's sensitivity to power supply hum and ground loop induced noise/hum problems. 72, Larry W1HUE

Pulling the 40-9er 600 kHz Lower on Transmit!

Alan Kaul, W6RCL

kaul@netcom.com

I posted the following message to the internet qrp-l group.

> Has anyone figured out a way to pull the transmit frequency 500-700kHz lower?

Ori, AC6AN, sent the following reply:

I tried something but it needs more work. The simplest approach is to first relocate the capacitor as you suggested and then connect the following circuit:

(1) 8pF (?) cap from the RFC6/C6 junction to a 1N914 or 1N4148 diode D3, which is connected to the K line (similar to diodes D1 and D2)

(2) 22K resistor from the D3/Cx junction to +12V. Hopefully there's enough isolation but you can replace the resistor with a 1mH choke + 12K resistor if needed..

I'd love to experiment with the component values of this circuit, maybe you have the time to start this work...

Let's make good things better! ORI AC6AN

Well 40-9er fans, I tried it and it works! But unfortunately, it's a good news, bad news story!!!!

First of all, I modified the frequency determining LC in the crystal VXO so the inductor is above ground and the cap goes to ground. Then I connected a 5-26 pf variable cap to the junction of RFC6 and C6 and connected the other end of it to a 1N914.... the cold end of which goes to the K bus at D2 (which grounds during keying of the transmitter). For voltage, I connected one end of a 22k resistor to pin 8 (V+) of the NE602 and attached the other end to the junction between the new variable and the diode. At about half mesh of the trimmer — I get approximately 600 hz lower carrier frequency: just about right for a CW offset.

The good news part is above. The bad news is that I now have some SW broadcaster audible in the front end of the receiver. I formerly had SW crud, and got rid of it by changing RFC1 to a Torroid. Now it's back, but it is much weaker. After another trip to the parts store and the purchase of a nominal 10-15pf 1% cap to replace the trimmer, I'll see if I can get rid of some of the intermod by eliminating the variable.

The mods continue—I also changed the pi output filter to 470pf-1.5uH-470pf based on another bit of modelling Ori did. I hope to test it tomorrow or Friday on the spectrum analyzer. The old setup (270pf-2.2uH-470pf) measured about 16 db down at the second harmonic when I tested it a month ago. We'll see what the new filter does (Ori suggested the harmonic suppression might be the same, but the power output will increase slightly).

Details on that to follow. In the meantime, keep the solder irons hot. 73/72 de Alan, W6RCL

More 49er Measurements & 600 kHz Offset Mod Report

by Alan Kaul, W6RCL
kaul@netcom.com

I got back into the field shop/testing lab this morning and was able to run a few tests on the 40-9er, in an attempt to measure the effectiveness of some of the mods described here on the list.

The most recent mod on my rig involves changing the 3-element pi output filter from a 270pf-2.2uH-470pf combination to a 470pf-1.5uH-470pf (as suggested by Ori who thought one could get more power out of a different output filter). In fact, I found that he's right — I get more output power AND I get slightly better attenuation of second harmonic energy (though it is still not legal by FCC standards!).

Then I tried an outboard 5 element Chebyshev "T" filter (the dimensions of which I can't specifically remember (ARRL 1988 Handbook— approximately this: 1.4uH-470pf-1.8uH-470pf-1.4uH). It REALLY CHOPPED THE HARMONICS but as I found out when I looked at the primary frequency, it cost me a couple of dB there, too.

My charts are below. The measurements were made on only one rig (my own). You may or may not get similar results. But if you do have access to test gear, I would hope this would prompt you to measure your equipment and to post the results here so all of us can share in the knowledge of your experiments. Remember: QRP ARE US!

Note: All measurements are made with a Motorola Communications Analyzer, model R-2000, which includes a built in spectrum analyzer, frequency counter, power measuring scope, etc.

My 40-9er is built on a type REV A circuit board, ordered from Jim Cates. My rig uses a 2N3866 in the final. Tests conducted on various dates, with various voltage input levels (as specified). The "power output figure" is the total amount of measure output power (F1 + F2 + F3 + F4 ... etc).

Table I (March 21, 1996) Power Output and Harmonics (note: rig using "stock" pi output filter 270-2.2-470)

Voltage	Power Out	F1	F2	F3	F4
7.0	0.25	0	-17	-37	-39
9.0	0.42	0	-16	-37	-38
12.0	0.67	0	-15	-37	-38

Table II (April 18, 1996) Power Output and Harmonics (note: rig using modified pi output filter 470-1.5-470)

Voltage	Power Out	F1	F2	F3	F4
9.0	0.60	0	-20	-34	n/a
12.0	0.95	0	-21	-36	n/a

LOOK AT THE OUTPUT POWER DIFFERENCES BETWEEN THE TWO FIL-

TERS!!!)

TABLE III (April 18, 1996) Power Output and Harmonics (note: rig using modified pi output filter 470-1.5-470 and an additional 5-element Chebyshev added outboard)

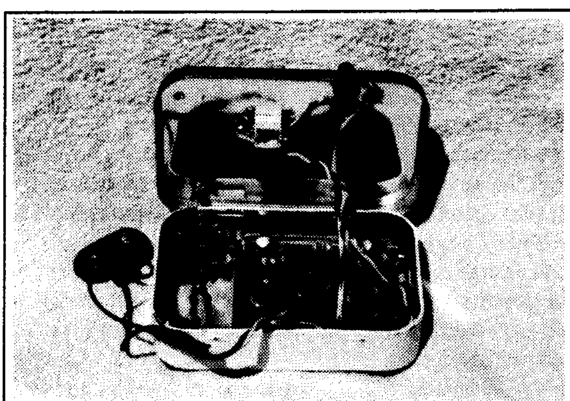
Voltage	Power Out	F1	F2	F3	F4
9.0	0.46	0	-49	n/a	n/a
12.0	0.60	0	-49	n/a	n/a

LOOK AT HOW MUCH POWER THE 5-EL FILTER APPARENTLY CONSUMES, WHEN COMPARED TO THE OUTPUT POWER OF THE RIG WITH ONLY THE MODIFIED PI OUTPUT FILTER.

I am proud to report that this morning I worked WA7BZL in Bend, Oregon, using the 40-9er with my 600 Hz transmit-offset mod. I tuned thru zero beat, and found a comfortable-to-listen-to-note on the high side and answered his CQ — his call twice plusmy call twice and then K. HE CAME RIGHT BACK TO ME WITHOUT ANY QSY!

I'm beginning to believe the transmit offset mod suggested by Ori really works! Keep those mods-a-coming. And best 73/72 de Alan

Bert Davidson, W2GOB did the excellent packaging of this 49er



Interior View of W2GOB's 49er

EPIPHYTE 2 Is On the Air!

by Ed Burke, KI7KW
28 Del Prado
Lake Oswego, OR 97035

I attended the March Norcal meeting at the California Burger Restaurant. Took a plane from Portland to Oakland for the day, and had a good time meeting many of the people I had previously only talked to, or corresponded with.

At the meeting, Vern Wright, W6MMA showed me his Epiphyte transceiver with a built-in frequency counter. The dynasty of Epiphytes has been designed by Derry Spittle, VE7QK and is a part of a tradition of QRP SSB rigs developed by amateurs in British Columbia, and as you will see, developed to a surprising degree of sophistication.

Anyway, Vern was gracious enough to give me a blank circuit board and a 12 volt relay for the newest version of the Epiphyte series, the Epiphyte 2. So there went my spare time during the months of March and April!!

If you belong either to GQRP club or to Norcal, you have probably seen descriptions of the EP 2, since they have been published both in Sprat and in QRPp. The version in the latest issue of QRPp has a number of late changes; the output coupling was changed from a T network to a binocular toroid transformer to limit instability. But the instructions in the text of the articles are almost verbatim.

Here is a thumbnail description of the rig. First of all, it is tiny. It is an (almost) complete 75M SSB transceiver with in excess of five Watts output in a circuit board only 4.5" long and 2.8" wide, needing only a low-pass filter to be functional. It uses an IRF510 MOS power transistor driven by a CA3020 pre-driver. The circuit cleverly uses the same set of two NE602's as first and second mixers, but demonstrating that a SSB transmitter can be a superhet receiver in reverse, uses a CMOS 4066 switch to route the LFO and VFO signals to the appropriate mixer:

	1st Mixer	2nd Mixer
Receiver	VFO	LFO
Transmitter	LFO	VFO

The IF frequency choice takes advantage of the fact that that there are a lot of components already developed and available in diminutive sizes for 455 KHz. And 75 Meters is a low enough operating frequency that 455 KHz is an effective choice. The IF filter is a very compact Murata unit which does a good job. I found the receiver to be excellent for its class; it performs on a par with my Norcal Cascade, and that rig can hear anything that it might possibly talk to. Have not (as yet) had a chance to measure the sensitivity, but it "feels" like a fraction of a microvolt.

I have operated my EP 2 for about two weeks now (thanks to Doug Hendricks, who helped me get some scarce parts) and a logical question is "how does it work". My response is that it works wonderfully well, as long as three details are dealt with.

The first is a ground loop in the power output stage. When I first tried my EP 2 during the evening QRP net on 3760 KHz, I was told that it sounded pretty terrible, and indeed, when I looked at the output with my oscilloscope, the waveform was pretty rough. Derry, VE7QK, the designer, indicated that a ground loop in the board (as published in QRPp) was preventing the power stage from working properly. I started experimenting, and while my investigations were not exhaustive, developed a set of fixes which include three cuts and a ground strap (or maybe a ground wire) which seem to fix the problem. Derry and Dave Meacham, W6EMD have both tried the fixes, and as far as I know, both have been sucessful.

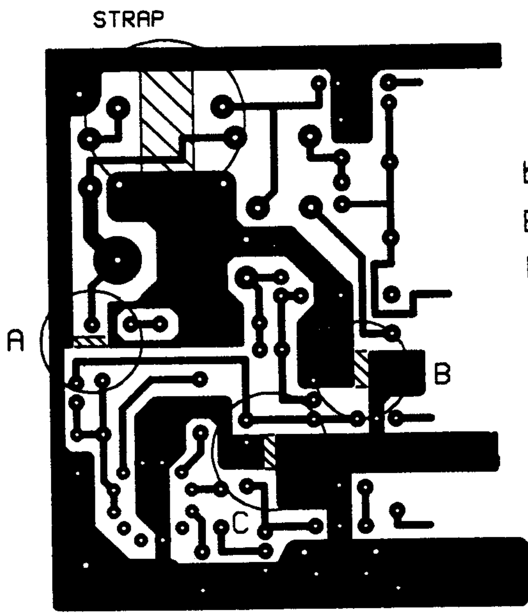
I get about seven Watts output on peaks now, and signal reports have been mostly excellent except when I have not tuned my rig to the proper frequency.

I have sent a sketch of the (ground loop) changes to Doug Hendricks so that he might consider including it in the next QRPp. The cuts can easily be made with an Xacto knife (but you might practice a bit, if you have never done it before on a section of scrap circuit board). The jumper I used is a small piece of

EPIPHYTE-2 PC BOARD

Modifications to eliminate ground loops

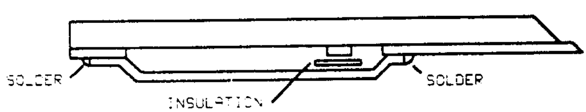
Phantom view (component side)



by
Ed Burke
KI7KW

Cut at A, B and C.

DETAILS OF STRAP



0.25 in wide strip of brass shim
or copper stripped from PC board

CORRECTIONS

C-20 & C-21 (p.36) should read 0.01MF

The PCB layout (p.37) is as viewed from the COMPONENT (not foil) side brass shim stock (maybe .005" thick or so) soldered to the traces. It must be bent in a gentle arc so that it does not short out the 12 Volt line beneath it. Probably a heavy piece of insulated wire would do as well.

The second issue is the relationship of choke L9 and transformer T3. As the board was layed out they are both close and aligned for interaction. I got improved results from turning L9 90 degrees and moving it as far as possible from T3. A little adhesive will attach the choke to the board in that orientation.

The third issue is a minor error in the parts list as published by QRPp (the list in Sprat does not have the error). C20 and C21 are shown as 0.1 microFarad capacitors in QRPp; they should be 0.01 microFarad, or Derry claims that the receiver will not function properly.

By the way, don't even consider operating this little rig without running the output through a suitable low-pass filter. The wave form looks terrible without it but nice and sinusoidal after it is added. I used a duplicate of the 75M filter that Dave Meacham designed for the Cascade. Seems to work fine.

Finally, a matter of personal taste. I chose to add an RF gain control to my Epiphyte 2 receiver. It is easy to do. Just cut the trace from relay contact K1B to the junction of C33 and C34. Patch in a 1000 Ohm potentiometer as follows. One side of the element goes to relay contact K1B, the other side of the element goes to a convenient ground, and the wiper of the pot goes to the junction of C33 and C34. Indispensible when a strong signal overloads your NE602!

The Epiphyte is an amazingly capable little SSB rig. I have used it nightly for the last week with excellent results over much of the western part of the U.S.A. Next, I am considering adding an AGC circuit to the receiver section.

More on that later. Enjoy. Ed Burke, KI7KW

10 WATTS FROM YOUR EP-2

by Dave Meacham, W6EMD
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Internet: ddm@datatamers.com

I got interested in Derry Spittle's Epiphyte-2 when I saw Vern Wright's handywork. He had squeezed it into a box 1.85 by 3.20 by 5.16 inches! Derry, VE7QK, wrote up the EP-2 in QRPp for March, 1996, and earlier in SPRAT #85. Vern, W6MMA, built one of the early prototypes. I decided to go for 10 Watts in my EP-2 because every Watt counts on 75 meters.

I used the same box as Vern, No. 3008H-5B made by Context Engineering, Inc., Santa Clara, CA. The cost was $12.70 at Metro in Sacramento, CA. It is black-anodized aluminum and very well made.

Ten Watts of RF output instead of five causes higher RF voltages and currents on the PC board. Because of the small size the board was already short on ground plane. Being single-sided increased the chances of grounding problems. Ed Burke, KI7KW, came up with the ground-loop fixes detailed elsewhere in this issue. I used his, plus two more (with 10 Watts in mind). I made a number of other changes to get more power, enhance stability at 10W, and keep spurious emissions below FCC requirements (-40dB). My changes are listed below:

C2 - Substitute a 1N4004, under the board, across the relay coil, cathode (band) to +12V line.

C5 - 5pF NPO ceramic (also added a 12pF NPO cap at U3 pin 6 to pin 3, under the board). This cap divider sets the drive to the '602.

C6 - 5pF NPO ceramic (also added a 12pF

NP0 cap at U2 pin 6 to pin 3, under the board). (Another drive-setting divider.)
C7 on the board should be C9 (330pF).
C9 on the board (C8 on the schematic) should be C7 (330pF) per the parts list.
C10 - I used an 80pF trimmer. 453kHz is at about half mesh.
C11 - I used 100pF mica.
C12 - I used a Polystyrene cap.
C14 - 47pF NP0 (for full response at 3.7MHz).
C20, C21 - 0.01uF mono.
C26 - 470uF, 16V electrolytic.
C36 - Omit. Use a wire jumper instead (part of series feed).
C39 - Substitute a jumper wire.
C42 - Delete.
C44 - 22uF, 35V electrolytic.
C47 - 0.022uF disk ceramic.
C50 - mono.
C51 - Schematic says 100pF. Parts list says 150pF. Used 150pF.
C53 - mono. Interchange this cap with R20.
C54 - Delete.
C55, C56 - (new numbers!) Add a 0.1uF mono cap under the board on U6 from pin 7 to pin 4. Add another under the board across C1.
R3 - PA bias pot (not labeled on schematic).
R4 - Change to 220uH choke (Mouser #43HH224).
R5 - Same as R4.
R15 - Drive gain.
R17 - 10k with a 0.005uF ceramic cap in parallel.
R20 - 1k.
R23 - 51 Ohms.
R24 - (off the board) 4.7k in parallel with 33k.
R26 - (AF Gain) 50k.
R27 - Delete.
R28 - (New number!) 1k RF gain control per Ed Burke's article.
VR1 - (78LO9) A substitute is NTE-1902.
Q1, Q2 - PN4416.
L1 - (1mH RFC) Mouser #43LS103.
L2, L4 - 220uH (Mouser #43HH224). L4 is mis-labeled in the schematic as L5. It is near C21.
L3 - Slug should tune at a rather deep position. (Tip from KI7KW)
L9 - Stand up with hole vertical.
T1 - 10T #28 Bifilar on FT50-43 with 6T #26 secondary overwound.
T2 - Slip core over "hot" antenna lead. 2T secondary goes to LED. LED then indicates relative RF current in antenna line.
T3 - 3T #22 primary, 8T #24 secondary overwound.
D1 - 1N5158.
mic - I used a Radio Shack #270-092. The red lead goes to the pad for R19 that is closest to the edge of the board. Omit R19.

The board leads to pins 4 & 5 of U3 are criss-crossed compared to the schematic (not significant, but confusing).

My #1 ground-loop fix is to cut an L-shaped gap in the ground plane (under the board) around the right-hand grounding hole for T3, making an isolated solder pad. This hole is for the secondary "low" terminal of T3. Solder the wire into the pad. Then solder a copper or brass strap 1/4-inch wide from that pad directly to the pad where the antenna connector is grounded. Make the strap go up and over other traces by 1/8-inch or so.

My #2 fix is to series feed the IRF-510 drain instead of the original shunt feed. Isolate the lower left-hand hole for T3 by cutting an L-shaped gap in the ground plane (under the board) around the hole, making a solder pad. Solder the wire from T3 into the pad. Cut the narrow Z-shaped trace where it joins the pad for C36 that goes to the mounting hole for Q4. Solder a short wire from the Z-shaped trace to the new pad. Solder a 0.1uF mono cap from that pad to the ground plane under Q4.

The new schematic for the PA consists of a direct connection from the drain of Q4 to the "high" side of the T3 primary. The "low" side of the primary is bypassed to ground by a 0.1uF capacitor. It is also connected to the "high" end of L9. Thus L9 series feeds the drain through T3, providing good decoupling.

The EP-2 needs a good low-pass filter between the "antenna" connector and the antenna jack on the rear panel. Use mica capacitors in the filter. The one shown below is an improved version of the one used in the NorCal Cascade. Core permeability varies widely, so measure your inductors to make sure they are 1.9uH! 20 to 22 turns of #28 on a T37-2 core should do the job. Just build the filter on a piece of perf board about 1 by 1-1/4 inches and mount it with #16 buss wire to the Molex plug for the "antenna" connector on the board. The output end is connected via RG-174/U coax to the rear panel Antenna jack.

L1 = L2 = 1.9uH
C1 = C5 = 620pF
C2 = C4 = 150pF
C3 = 1200pF

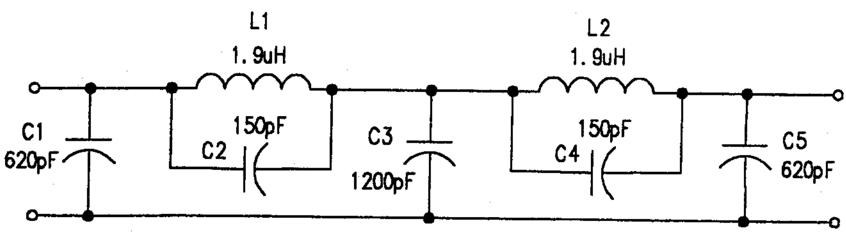
The electret microphone is mounted on the front panel in a grommet.

To provide temperature compensation for the MVAM-108, connect a 1N4148 diode in series with R24 to ground, cathode (band) to ground.

This rig covers 3.75MHz to 3.95MHz with constant output-power level. (At ten Watts the drive control is all the way up.) As Derry says, 20kHz per turn on the ten-turn tuning pot is about the maximum you want to have. The coverage is great, but if you want only 100kHz of range just change R24 to about 15.5k. The Epiphyte-2 is a nifty little rig. I hope you enjoy my ten-Watt modifications!

72, Dave, W6EMD

Elliptical Low-Pass Filter For 75-Meter SSB



The DFD-5: A Simple Digital Frequency Display

by Derry Spittle, VE7QK
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North Vancouver, BC, Canada V7R 1R9
e-mail: jds@vcn.bc.ca

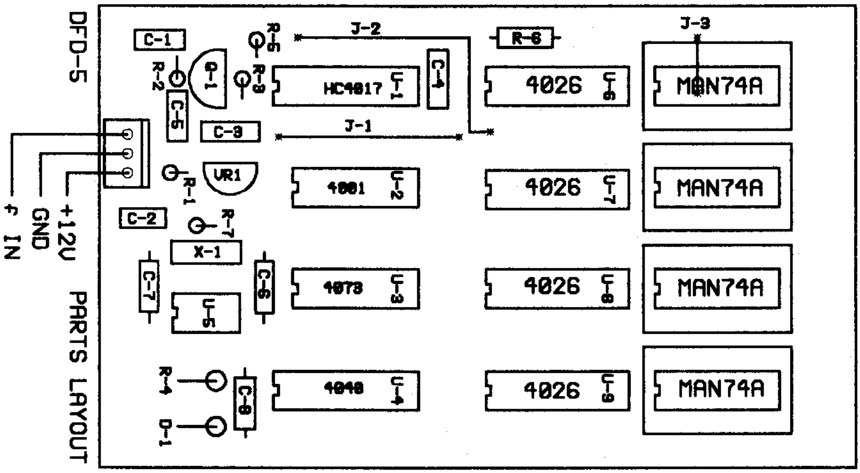
Although my article in the Match 1995 issue of QRPp was intended for those of you who like to tinker with simple digital counter and logic circuits on solderless breadboard, I have since received a number of requests for a PCB. The late Herb Clark, VE7GE, developed a neat layout which included the displays on the PCB thereby eliminating the onerous task of individually hardwiring 28 segments. I have incorporated much of his layout into the board presented here. To minimize component count the clock is a M706BI 50Hz time base. A source for these has been found in Europe (see below). A somewhat larger board could easily be designed using the "alternative" clock circuit described in the original article.

Assembly is straightforward. Unused terminals must be removed from IC sockets before mounting (see diagram). Since the resolution is +/- 500Hz no trimmer cap has been included on the clock. The values C-6 and C-7 may be changed if necessary. Total power consumption is less than 50mA.

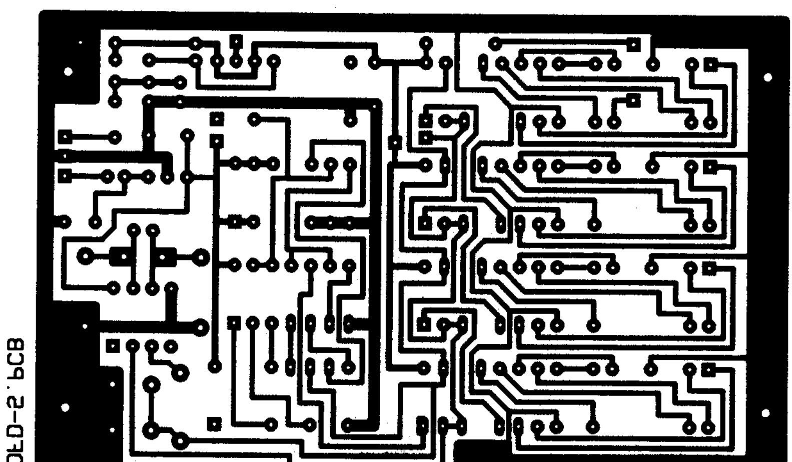
The DFD-5 is intended for mounting alongside an Epiphyte-2 in a "slim" enclosure with all controls on the top surface. This makes more sense ergonomically when taken camping. IC sockets are "stacked" to raise the height of the display.

Joe Stipec, M.D., VE7TX, has developed a novel method of placing the display in a vertical plane. With surgical precision he carefully cuts a narrow slot across the PCB below the display penetrating 90% of the thickness. The display is then bent down at a right angle allowing the traces to remain intact. The break is filled on the outside with epoxy. When the assembly is inverted the display then reads correctly. 72, Derry, VE7QK

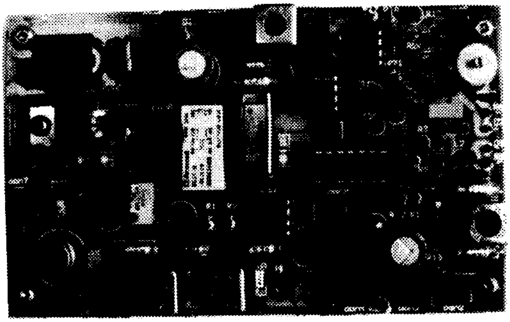
NOTE: The clock IC, M706BI, is available from ELECTROME S.A., 20 Rue Pierre Baour, Cidex 23, 33083 BORDEAUX, CEDEX, FRANCE. (tel: 56.39.69.18 and fax: 56.50.67.39) and priced at 29FF (c. US$5.) in single lots + p&p. The remainder of the components are listed in MOUSER catalogue.



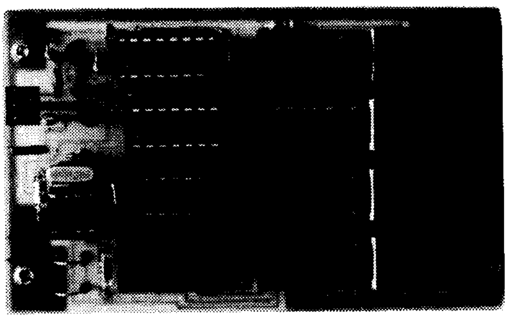
DFD-5 Parts Layout



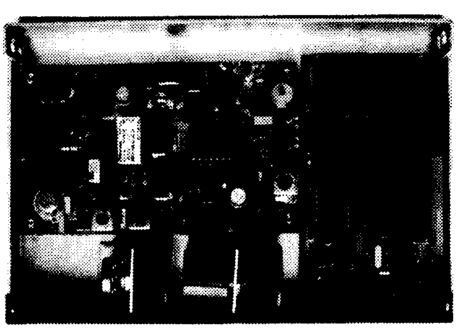
DFD-5 PCB Pattern



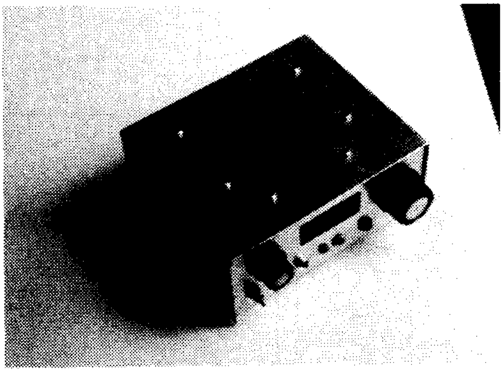
Epiphyte II with New PA in upper left corner



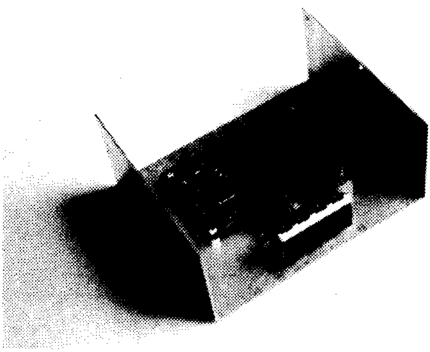
DFD-5 Board



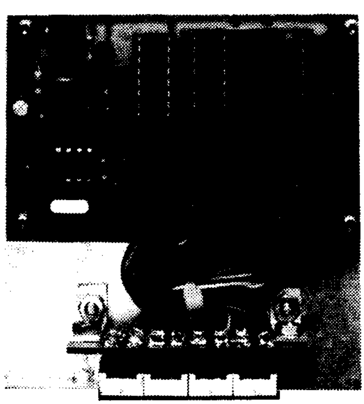
Epiphyte 2 Mounted in "Camper Special Case with DFD-5 Counter



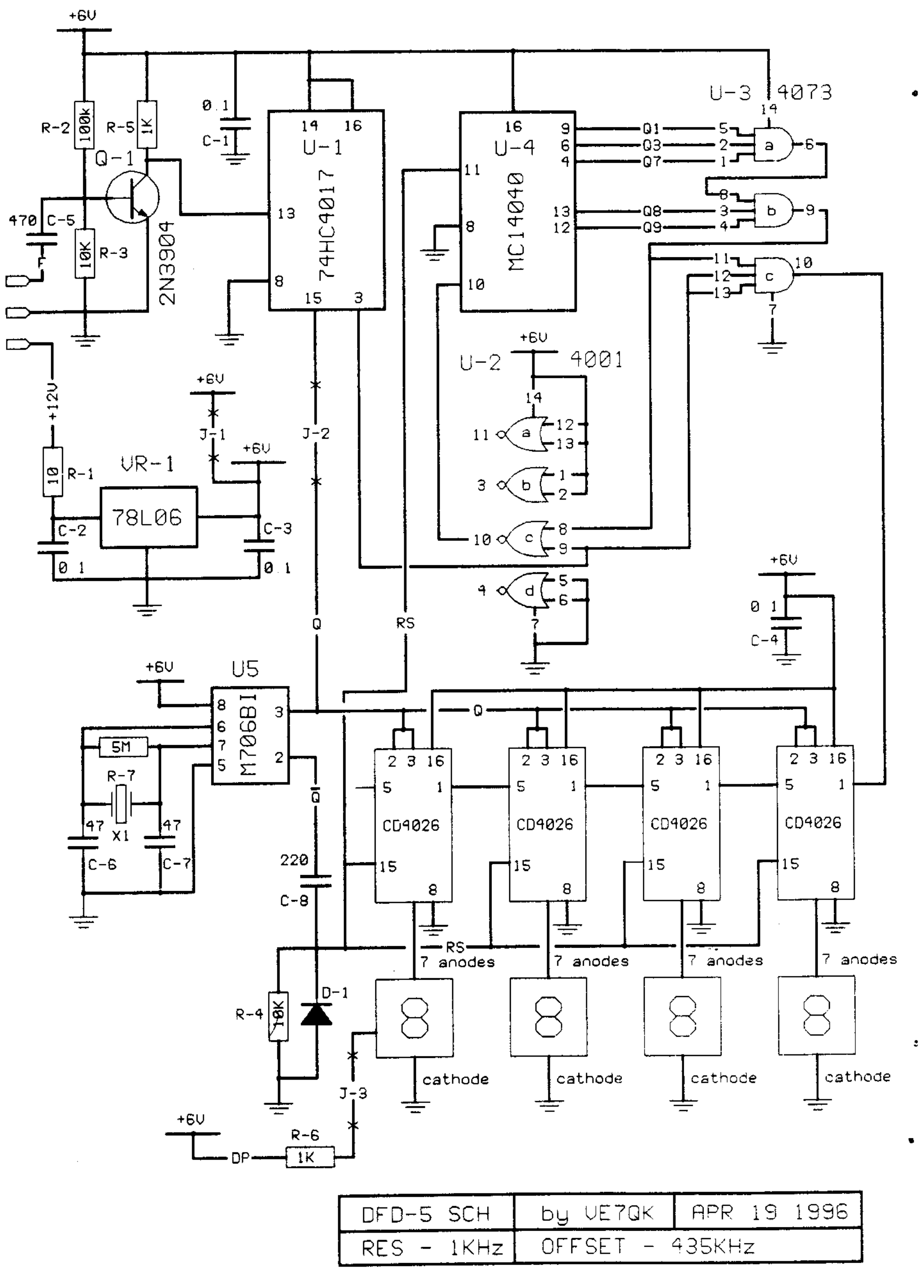
Epiphyte 2 Mounted in TenTec Case



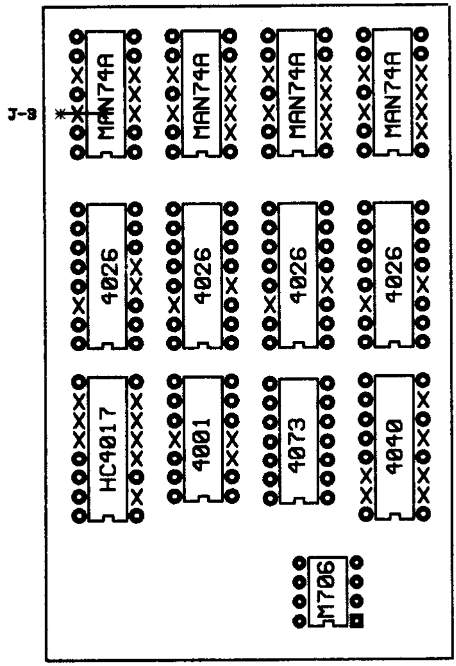
DFD-5 Counter Mounted in Top of TenTec Case



Close-up of Counter Mounting


+6V
R-2 100k
R-5 1K
Q-1
2N3904
470 C-5
10K R-3
0.1 C-1
U-1 74HC4017
14 16 13 8 15 3
U-4 MC14040
16 9 6 4 11 8 13 12 10
Q1 Q3 Q7 Q8 Q9
U-3 4073
U-2 4001
+12V
10 R-1
VR-1 78L06
C-2 0.1
C-3 0.1
J-1
J-2
Q
RS
0.1 C-4
U5 M706BI
5M
R-7
X1
47 C-6
47 C-7
220 C-8
R-4 10K
D-1
J-3
DP
R-6 1K
CD4026
7 anodes
cathode
DFD-5 SCH
by VE7QK
APR 19 1996
RES - 1KHz
OFFSET - 435KHz

DFD-5 MODIFICATION TO IC SOCKETS BEFORE INSTALLATION



(a) remove pins marked X

(b) install jumper J-3. File groove in underside of IC socket to clear

DFD-5 PARTS LIST

C-1,3,3,4	0.1 uF cer
C-5	560 pF cer
C-6,7	47 pF poly
C-8	220 pF poly
R-1	10
R-2	100K
R-3,4	10K
R-5,6	1K
R-7	5M
VR-1	78L06
X-1	3.2768MHz clock crystal

Q-1	2N3904
U-1	74HC4017
U-2	4001 quad 2-input NOR gate
U-3	4073 triple 3-input AND gate
U-4	4040 12-bit binary counter
U-5	M706BI 50Hz time base
U-6,7,8,9	CA4026 decade counter/de coder
1 - 4	MAN74A 7-segment LED displays
3-pin molex connector	

Results: 1995-96 QRP-L Fox Hunt

by Chuck Adams, K5FO
Box 181150, Dallas, TX 75218-8150
adams@chuck.dallas.sgi.com

Here are the final results of the 1995-96 Fox Hunt on QRP-L. First three places:
NA5K, Smitty with 81 contacts as Fox wins an MXM Transceiver.
N6ULU Stan with 23 contacts with a fox wins a GM-xx Transceiver.
WA9PWP Paul with 23 contacts with a fox wins a GM-30 Transceive. Paul came from a long way back in the pack and got real serious.

The following deserve mention for a fine effort.

W6ZH Pete with 21 contacts with a fox [one year QRPp sub/extension]

K5UP Glen with 20 contacts with a fox [one year WorldRadio sub]

AK5B Bob with 20 contacts with a fox [one year ARCI membership]

W5HNS Henry with 18 contacts with a fox [one year ARCI membership]

AB5OU Tim with 18 contacts with a fox [one year QRPp sub/extension]

WO0Q Marty with 16 contacts with a fox [a MI-QRP mug]

W3PM Gene with 15 contacts with a fox [an ARCI mug]

K2NF Norm with 15 contacts with a fox [a MI-QRP mug]

My heartfelt thanks to the prize contributors. What makes this work is the participation by the group. The small prizes for such hard work is minor compared to the joy of working fellow members on the air. It's more personal than email.

Prize Contributors

MXM Transceiver - Bruce Williams, WA6IVC
2 GM-xx Transceivers - Chuck Adams, K5FO
QRPp Subscriptions - Doug Hendricks, KI6DS, and Jim Cates, WA6GER
WorldRadio sub - Richard Fisher, KI6SN
ARCI Membership - Mike Dooley, KE4PC
ARCI Membership - the missing 7-call
2 MI-QRP mugs - Paul Valko, WB8ZJL
ARCI mug - Paul Valko, WB8ZJL
Certificates to all - Chuck Adams, K5FO

If you are not a subscriber to qrp-l on the internet, here is a summary of what the Fox Hunt is all about.

It is not the usual foxhunt, a station gets on the air (40M only) (usually two per week) around 7.040MHz for a two hour period preannounced and works as many stations a possible.

It's not a hide the transmitter type activity as DF foxhunts go. We don't do weekends 'cuz that's not the purpose of the activity and weekends usually have some other contest going anyway.

This was the second year and this madness started by Chuck Adams, K5FO, to generate activity and "friendly" competition. Has cost some time and money, but is darn well worth it. Wait until October and we'll do it again. Big Winners from previous sessions will not be allowed prizes in following contests in order to spread the wealth around. This is a new rule, as N6ULU wong two years running. The winners proved their antennas, rigs and operating skills, so we'll let the next guy have a chance.

I have had numerous requests for other bands and weekends, but we just can't do it. 40M is the most popular during winter and where the rigs like the NorCal 40's, etc. are popular. High bands are dead at night most of the winter.

Totals		Fox
81	39+42	NA5K Smitty
75	35+40	NA5N Paul
57	36+21	AA4XX Paul
52	27+25	N6ULU Stan
45	28+17	AB5OU Tim
43	14+29	WW7Y Steve
43	23+20	K5FO Chuck
40	20+20	WA3NNA Pete
35	26+9	AA0XZ Greg

34	14+20	WO3B	Bob
31	25+ 6	WA4NID	Dave
28	18+10	WB8ZJL	Paul
27	15+12	WB3GCK	Craig
26	5+21	WJ2V	Preston
26	5+21	VE7CQK	Paul
23	10+13	N4AOX	Clay
22	20+ 2	N2CX	Joe
18	12+ 6	KV2X	Tom
17	9+ 8	NN9K	Pete
9	6+3	N9UXU	Dave
36	36	KK6MC	Duffey
18	18	KJ4XR	Ken
15	15	WB4ZKA	Mike
7	7	NQ7K	Mike

Number of times a fox was worked in parenthesis if more than 1.

0's — WO0Q(16) AA0XZ(8) KB0WZ(7) KB0LMQ(3) NG0N(3) AA0XI(3) AA0YU(3) N0OCT WI0W NF0R KB0PBQ KI0G AA0QU AA0VF W0KQC N0UVR KC0OS N0TFI N0WM WB0WQS AB0AE

1's — W1HUE(9) KC1FB(5) AA1IK(5) KC1GS(3) AA1OC(2) WA1GUV(2) KC1DI NO1E N1QPR WA1LNP N1RXT WA1KPB

2's — K2NF(15) KC2DU(10) AA2WJ(7) AA2PF(6) N2MNN(5) N2CX(3) N2KPY(2) KV2X(4) N2KPY N2CX WB2SXN WJ2V N2VPK(2) KF2PH WZ2T KE2WB(2) KF2ON N2VPK N2GO(2) N2WLQ N2YRJ K2VNM WA2BMQ K2SJB

3's — W3PM(15) N3KFL(12) WA3NNA(5) WA3YON AA3AV WO3B(3) K3TKS(3) KA3EAJ(2) N3PM WA3JPG KA3WMJ K3ETS(3) K3VOA AA3EJ WB3GCK WA3BHM

4's — NZ4I(11) N4AOX(5) K4JPN(2) KC4EWT(6) KE4PC WB4TPW(6) WA4KAC(2) KM4LT AB4EL(2) WB4BDS(2) WB4TBW KD4HZ WD4MPS(4) AC4HF AA4YZ KF4DNL WB4ZKA AE4IC(8) WJ4P(4) WA4FTM KJ4XR N4XXR NR4N(2) N4EUK AD4ZE(3) KT4HB WB4TWE KC4URI K4CGY(2) N4UCM KE4HNS AA4YZ KS4XS N4EKP

5's — K5UP(20) AK5B(20) W5HNS(18) AB5OU(18) KC5EQC(14) KK5KX(6) KA5T(11) KK5RO(12) K5FO(2) NA5K(5) KA5DVS AB5DG AB5EU WD5GNW(2) KI5EZ KK5NA(2) WA5WHN K5ERJ(3) AB5TZ(5) AB5QE(3) KB5AA KC5FGE W5XE(2) W5RMZ WB5QMP(6) N5SS AB5WB WB5IRI(3) AB5UA(9) WA5YFY WA5ZTP WB5LXA WB5FKC KF5IU N5OCD(2) KF5IV W5TEH(2) N5GW AB5B AC5BC KC5RAS KB5YIX KC5GTQ AA5EA KC5EQK NA5N W5TTE AB5AA(2) KB5OB(2) KK5RD KK5HA

6's — N6ULU(23) W6ZH(21) NU6U(5) AB6DG(11) KK6MC(8) WA6HHQ(2) WA6MOK(2) KE6YAR WB6HQK(2) WA6HUE(2) AC6IY(5) WB6Q N6SSQ WI6I N6GA N6WG(4) KC6EIJ N6MM(6) AC6KW K6VNX(7) KO6KA(4) AA6XZ KQ6AG(3) WB6TJF K6CA K6QQ W6BAB(2) WA6NAE(2) K6UNO AC6PI(2) W6DVO K6VNK KO6CL

7's — WW7Y(12) N7MFB(2) AA7QU(5) AL7GQ NQ7K(5) AA7QY(8) AB7JX(4) WA7FCU(8) KD7S AB7HI(2) KB7SOK KC7AKW N7RMQ KC7NEV(3) NQ7X(10) KG7WS NQ7B AA7TQ(3) WT7F(4) KJ7DN W7WC

8's — N8ET(2) WB8ZJL(7) K8DD(6) WB8AJD N8VAR(5) KF8EE(2) WB8RUQ KF8SG WA8ALX WB8E(2) WA8ZOF WK8S KB8LFQ W8BE WB8APR

9's — WA9PWP(23) KB9IUA(4) K9DZE(7) W9LTL N9DD AE9K(2) WA9YLB NN9K(5) WB9LKC(7) AE9F(2) KA9NSA WB9QDL N9XVZ WD9EYB N9SAI AB9W NN9H KC9RH

DX —VA3TAR(2) VE3DNL(6) VE7CQK(5) VO1CRB VE5VA(2) VA3TAR VE7CTN VE7FJE

Swap Meet Fun!

Doug Hendricks, KI6DS
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My wife and I attended the Foothill Swap Meet in Los Altos in April. While there I saw something that absolutely had me laughing so hard I had tears in my eyes. This is how it went.

A certain QRPer, who shall remain nameless to protect the guilty, was getting married the next week. He had to clean out his ham shack to get it presentable to the new bride. So he and a friend, who also shall remain nameless, cart all of his excess "treasures" to Foothill.

Their goal was to unload "everything", nothing was to go back to the house. They set up and business was brisk for about 2 hours, then it slowed. But our two heroes were not to be denied. By golly they came to get rid of gear, and it was going to go. Rumor has it that the following is true.

A gentleman, with pocket protector, 12 pens, tennis shoes, thick glasses with tape at the bridge of the nose, plaid shirt, striped bermuda shorts, black knee length socks, 3 handie-talkies on a chest holster, (you got the picture) walks up to the table and starts to look over the offerings. The soon-to-be groom, saw his chance. While the victim was occupied perusing the offerings, the perp grabbed a couple of "large unchoice items" and placed them on the pull cart that the victim was pulling along, loaded with his treasures of the day. The guy never knew it. He left, didn't buy anything, but he did have extra "baggage" on his cart.

This was repeated many times during the morning. Kind of reverse shop lifting if you will. I thought of the "hams" going home and this is what might have transpired:

"Wilbur, what did you buy today"

"Not too much, Mildred. The prices were too high. But I did get a couple of good buys."

"Well, this certainly looks expensive. How much did you pay for it? You probably spent the house payment again."

"Gosh, I didn't buy that. Where did it come from?"

"Sure Wilbur, sure. Try another one. You can't fool me." And they probably are still arguing about the "treasure" that our QRP friend dumped on his unsuspecting victim.

But that isn't all that our wiley friend did. His next trick was even better. He picked up a huge transformer, walked over a couple of aisles, set it down in front of an unsuspecting vendor's display, and acted like he was looking to purchase. Then, when the vendor turned his head, our friend, calmly stood up, and then walked away, empty handed, but with a devious grin on his face and a twinkle in his eye. This unsavory act was repeated many times during the rest of the swap. I will not reveal the identities of our two NorCal members, but they are well known at swap meets. You are hereby forewarned to be extremely careful when you approach a vendor booth at a swap manned by a NorCal member. Also, if you have a booth and NorCal member approaches, watch him, especially if he is carrying boat anchor type of gear. YOU could be the next victim!!

Picture the above in your mind. It was really fun to see. My wife and I laughed for miles on the way home. Have a good week.
72, Doug KI6DS

Wanted to buy: QRP paraphenalia of all kinds. Books, rigs, keys, paddles, accessories. If it is related to QRP, I am interested. Send description of item to:

Jim Cates
3241 Eastwood Rd.
Sacramento, CA 95841
916-487-3580

My Rip Van Winkle Ham Radio Career

by Bob Mix, KF6ABC
916-635-7680

Last August a friend persuaded me to teach a basic electronics course to junior high kids, beginning in September and continuing one hour per week, plus one evening a month, until June. I knew what I was getting into, since we ran a chess club last year with the same kids.

Immediately after accepting, I began reminiscing about my boyhood experiments in electronics. I built Heath and Knight kits, learned to read schematics and constructed many circuits from book and magazine articles. I combined sections from one circuit with portions of another to see if I really understood what did what. I made my own batteries from raw materials, powered little radios from solar cells and learned how the new devices (transistors) worked.

Shortwave radio looked fun; it was: I built a Heath All-Band Communications Receiver and eventually bought a Hallicrafters SX-99 (own it still). I thought ham radio might be interesting, so I bought the 1959 Radio Amateur's Handbook. I studied the ARRL's "How to Become a Radio Amateur" and learned the code with a couple of code practice oscillators I built. I learned all the theory to pass the General. I bought and constructed a Heath DX-40 Phone and CW Transmitter with a 7153 KHz crystal. It passed the smoke test and lit a light bulb, but I never got a license so I never put it on the air. Being a shy kid I couldn't picture myself calling CQ and talking to adult strangers. I had no Elmer, I was just a kid with dreams and no one to talk to.

About 1960 I dropped electronics and began studying cars and girls. So in August of 1995 some 35 years had passed and I was faced with a steep learning curve. I want these modern kids to experience the thrill I had listening to radios I built myself. Thrill? These kids spend hours a day with multimedia computer games. I was their age in a much simpler world. Parents still controlled access to television, a controversial medium. Innocence has been lost; who will be its champion?

I checked books out of the library, bought books and magazines. I compiled a binder of circuits and wrote an outline for the course. Then I went shopping for parts: Radio Shack, HSC, Zack, Marvac and Quad-A. I began breadboarding circuits. By October I found The Radio Place. I bought the Ramsey SR-1 kit, built it, and decided to become a ham 35 years late. In November I took the Tech test and passed. In the first week of December I took on the alias of KF6ABC. I studied two-meter transceivers and decided if I were to take the fast path to the ether, I would buy a Kenwood TH-28A.

Yeah, but that ain't me. I want to understand how it all works. Operating is not the best part of the hobby for me. To get really enthused, I must do homebrew, like I did with computers.

I ordered every catalog I could, and only one of them (Antique Electronic Supply) had 365 micromicrofarad (now picofarad!) air variable capacitors (for $7.30!). This was a shock to me; first, this makes me an antique and second, what do people use now? The answer, I believe, is varactor diodes and phase-locked loops. So I bought an NTE618 440 pf varactor diode from Quad-A.

Sure enough! You can junk the variable capacitor and use the diode with a pot to tune a frequency if you have an old inductor. The circuits I tried worked fine.

Okay, where do I buy an antenna coil or a ferrite rod to wind my own coil? Antique Radio Supply has antenna coils for $3.15. My total budget for each kid was $15, so $10.45 (plus tax and shipping) for the tank circuit (coil and cap) was too high. Within the $15, I wanted the kids to build motors, telegraphs, telephones, receivers, transmitters, metal detectors, sirens and intercoms. To meet the budget, I had the kids wind coils on 35mm film cartridges and tune by using a paper clip as a wiper. Too late, the money is spent. Next time I will use varactors and toroids.

At the December ARCS meeting I met Roy Campbell and Terry Seeno. They told me about something called QRP and the NorCal 40A. They urged me to attend the Northern California QRP Club meeting in Livermore on the first Sunday of the month. So on Jan. 7th I drove down with Rod Laas. At the meeting at California Burger I met Jim Cates (WA6GER) and Doug Hendricks (KI6DS), fathers of the QRP club and both fine gentlemen. I subscribed to the wonderful QRPp Journal and have now read 6 issues totalling hundreds of pages; when I wasn't running around Monterrey the weekend of January 13th in T-shirts under blue skies and sunshine, I was reading the Journal.

Before the meeting Rod directed me to the swap meet at Las Positas College where I bought one of those NorCal 40A 40-meter CW transceivers. Two days later it arrived in the mail. I assembled it slowly (about 12 hours, twice as long as it should take), then bought a multimeter to test current draw. Current was right so I plugged in a longwire and tried listening for a signal to no avail. I have no test equipment to align or debug, so I called Jim Cates. He said to bring it over and he would get it running. He reheated a few solder joints and rewound a couple of coils.

Bless him, it now breathes radio waves! He also set it up for the Novice band and made sure I could hear the code station. Maybe next month I will write about the NorCal 40A. For now, 72.Bob Mix, KF6ABC

The Further Adventures of Rip Van Winkle:
A Review of the NorCal 40A 40-Meter CW QRP Transceiver

What Do I Know? I am new to ham radio, having taken the Tech test in November. In December when I received my call sign I almost bought a 2-meter HT. What stopped me was the knowledge that the most fun for me is derived from kits, homebrew and experimentation. I also want to DX.

These decisions meant that I must learn code to earn HF privileges. So I got to work with the W5YI tapes and their Morse Academy computer program. In February I took the Novice code and General written tests. I am now studying for the 13-WPM code and Advanced tests. So what sort of radio should I buy? I wanted it to be small enough to master, from its antenna jack to its headphone and key jacks. I want to understand its circuits, not just use them. A cowboy is close to his horse; a ham should be intimate with his circuits.

On the advice of Terry Seeno (N6YQD) and Roy Campbell (KN6QS) I bought the Wilderness Radio (WR) NorCal 40A January 7th at the Livermore Swap on the way to my first meeting of the NorCal QRP Club. I paid WR $144, $129 plus shipping and tax; I received the kit by mail in two days. **Specifications:** The receiver is a single-conversion superhet that is sensitive (better than 0.5 uV for 10dB S+N/N), and selective (400 Khz @ -6dB, 1.5khz @ -30dB). It has linear varactor tuning, RIT (receiver incremental tuning, +/- 2KHz at center VFO tuning range) and AGC (automatic gain control protects the ears). The IF (intermediate frequency) is 4.915 MHz, featuring a 4-pole Cohn crystal filter, which was chosen for low-cost and so that no special test equipment is needed. QRP means low-power: current drain is only 15mA. It was designed for battery operation (10-15 VDC); I use a 500mA wall adapter I bought at HSC for $4. There is no 60Hz noise pickup. I use Radio Shack Nova-42 lightweight stereo headphones (#33-1115) with volume control.

The transceiver's best quality is its stability. The stable, low-frequency (about 2Mhz) Colpitts VFO (variable frequency oscillator) drifts by about 100Hz from cold start to 65 degrees F. The PA (power amplifier) doesn't oscillate. The radio has smooth transmit-receive switching (T-R delay 200 msec). There is no sidetone oscillator; you hear the actual keyed tone. Normal power output is adjustable up to 2 watts drawing 225mA; a few changes, documented in the QRPp Journal, will boost output to 5 watts. Final amplifier efficiency is 70%. Tuning range is 35-45 KHz. Transmit offset is 400-800 Hz (adjustable). Any "key-to-ground" keyer works. Keying is QSK (you can listen for incoming signals between key presses as well as hear your actual transmitted signal) with nice shaping.

The circuits include 5 IC's, 7 toroids, 8 transistors, 12 diodes, 6 crystals, 6 trimmer caps and 6 pots.

The Vendor

The 40A was originally a club project; members built a couple of hundred before the radio was turned over to Wilderness Radio (WR), basically Bob Dyer (KD6VIO). Bob demonstrates WR products at the Livermore Swap the first Sunday of each month. WR has a 30-day warranty; you may return an unbuilt kit for a refund of what you paid less a 15% restocking fee.

Missing or defective parts will be promptly replaced (none missing for me). If you can't get it working, WR will repair it for a flat fee of $55 including shipping. Tech support is available Monday through Friday from 10AM to 5PM. WR also sells the Sierra; see the 1996 ARRL Handbook for an article devoted to the Sierra by the same genius who designed the 40A, Wayne Burdick (N6KR).

The Kit

The Rev B kit is a quality piece of work. The compact case (2.2" x 4.6" x 4.5") is painted and silk-screened. Remove the top by flipping two long-lasting latches. The bottom is held on with two screws. Front panel controls are RF Gain, RIT on-off, RIT tuning and the main tuning knob. The rear panel has jacks for headphone or speaker, morse key, power, 50-ohm antenna BNC, and a power on/off switch. The parts are very high quality and the circuit board is silk-screened with plated-through holes. There is room on the front and rear panels as well as inside the case for accessories. WR offers the microcontroller-based $44.50 KC-1 Keyer/ Frequency Counter that features a speed-adjustable iambic keyer with searchable message memory and frequency reporting in Morse code.

Assembly

The circuit was designed for ease of assembly, minimum parts and low cost. There is one board with no chassis wiring. The manual has checkoff boxes.

I put the parts in a muffin pan and did a parts inventory; none were missing. I made the mistake of using silver bearing solder from Radio Shack. Use a 20-watt iron and Radio Shack solder (#64-009) as stated in the manual.

For the toroids, buy a BIC lighter and 400 grit sandpaper. When winding the toroids, spread the turns evenly, close together and with no overlaps. Every pass of a wire through a toroid is counted as a turn. Ground the crystals; Roy Campbell said this is important. The Novice band requires fewer turns on the VFO toroid. An experienced person can comfortably assemble the kit in 6 hours, but I took 12 (old guys daydream). Alignment is simple, using only a receiver, signal generator or frequency counter.

The 40A has been field-tested by hundreds of hams. The QRPp Journal and a section in the manual document many possible modifications, such as operation on 80, 20 and 30 meters.

I assembled my kit in January; it didn't work right away. But I called Jim Cates, one of the fathers of the NorCal QRP club, and he offered to "look at it". Reheating a couple of solder joints brought forth feeble sounds of life; it sputtered like Frankenstein's monster. A frequency counter showed that the VFO was working perfectly.

A bit more tracing pointed the finger at the toroids; I wasn't surprised, since I was feeling a bit guilty about the toroids. I wasn't sure I had used the right sized wire in all cases, and I hadn't bought a BIC lighter to burn off the enamel from the ends. I used paper matches and rubbed the ends with emery. But when I tinned the ends, the solder didn't take well. When Jim had more time, he cleaned up my toroid ends and rewound a couple of them. He even aligned the radio for the Novice band and made sure the code practice station was within range.

What I Believe

I learned several things from this experience. The least important was that I must solder better and be meticulous with my toroids. When I was younger, my pride would have forced me to solve my own problems; I wouldn't have been able to let Jim "look at it". I became very self-reliant and eventually became a self-employed computer consultant with a depth and breadth of knowledge and problem-solving skills that few people achieve. The dark side is that it took too long, I had little time for friendship and I probably missed out on the better solutions that the merging of minds makes possible. Jim and I are now friends who talk regularly. This isn't a side benefit; making friends in ham radio is more important than getting a radio working. Jim wants to buy a computer; it will be my great pleasure to return his favors and show my gratitude. I want to elmer him onto the Internet so he can email with his son Jack in Scotland.

Wrapup

This radio is fun to operate. I am biased but this little radiowave sucker sounds sweet. It is solid and the tone has a purity to it. Stan Goldstein (N6ULU) worked 113 countries with it. If you aren't into building your own equipment, you are missing out on the greatest fun the ham hobby has to offer, in my opinion. We QRPers are very active and enthusiastic. As Will Rogers might have said, "I haven't met a QRPer I didn't like". I have attached a frequency counter to my 40A so that I have a digital display of my callsign and frequency. Next I will write about that project.

Contact Wilderness Radio at P.O. Box 734, Los Altos, CA 94023-0734; phone is 415-494-3806 (10AM-5PM). Call and ask for a copy of the 13-page manual. 72, Bob Mix, KF6ABC 916-635-7680

Wilderness Wireless at its Best: A Story of Adventure on the High Seas

by Peter Talbot, VE7CVJ
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It all started way back in '79 when my good friend Gordon bothered me enough into getting my ham licence. You see, I had this unique job at the time, one that had me working in the remote wilds of British Columbia as a park ranger, far from human contact and even farther from any form of communication. So I would stay up late studying the theory book by the light of a small hydro powered generator I had built, wondering why we still had to know all about valves. In any case I guess it stuck, so Gordon got his way, and I got my ticket and started building radios.

The first model was a classic, and provided me with as much or more thrill than anything since. Funny isn't it, how a few bits and pieces soldered into a tin can turns out to be a favorite, and often sets a precedent which charts our future course. That first rig, a rock-bound CW transmitter running off a 9 volt battery was such an unlikely looking thing that even old Gord didn't give it much hope when I headed off into the hinterland on a canoe expedition. He was more surprised than I when he picked up my faint message, "At Hobitan lake, all is well", for you see, that first rig had no receiver and I had no idea he had picked it up till I got home days later.

Several versions of CW rigs followed before I could get onto phone. Things were pretty crude at the time, drifting oscillators and a distorted double sideband output running class A, thereby chewing up lots of battery power. Still, there were not too many hackers out in the bush doing this so it felt kind of novel and provided reasonable communication to the outside world.

At the time, the famous SBX 11 ssb transceiver manufactured by a local Vancouver company was considered to be the standard for wilderness communication, and we would pour over the schematics to see what we could adapt for our rigs. The design was good but the thing was very complex and weighed a ton. We could not hope to make something as good ourselves so we just 'borrowed' what we could.

While pursuing the matter on the air, I had the good fortune to encounter Derry, VE7QK. He was actively building rigs at the time and had years of previous experience with tube equipment. A master at construction, Derry could come out with a new design every week, and every one would rival commercial equipment in appearance.

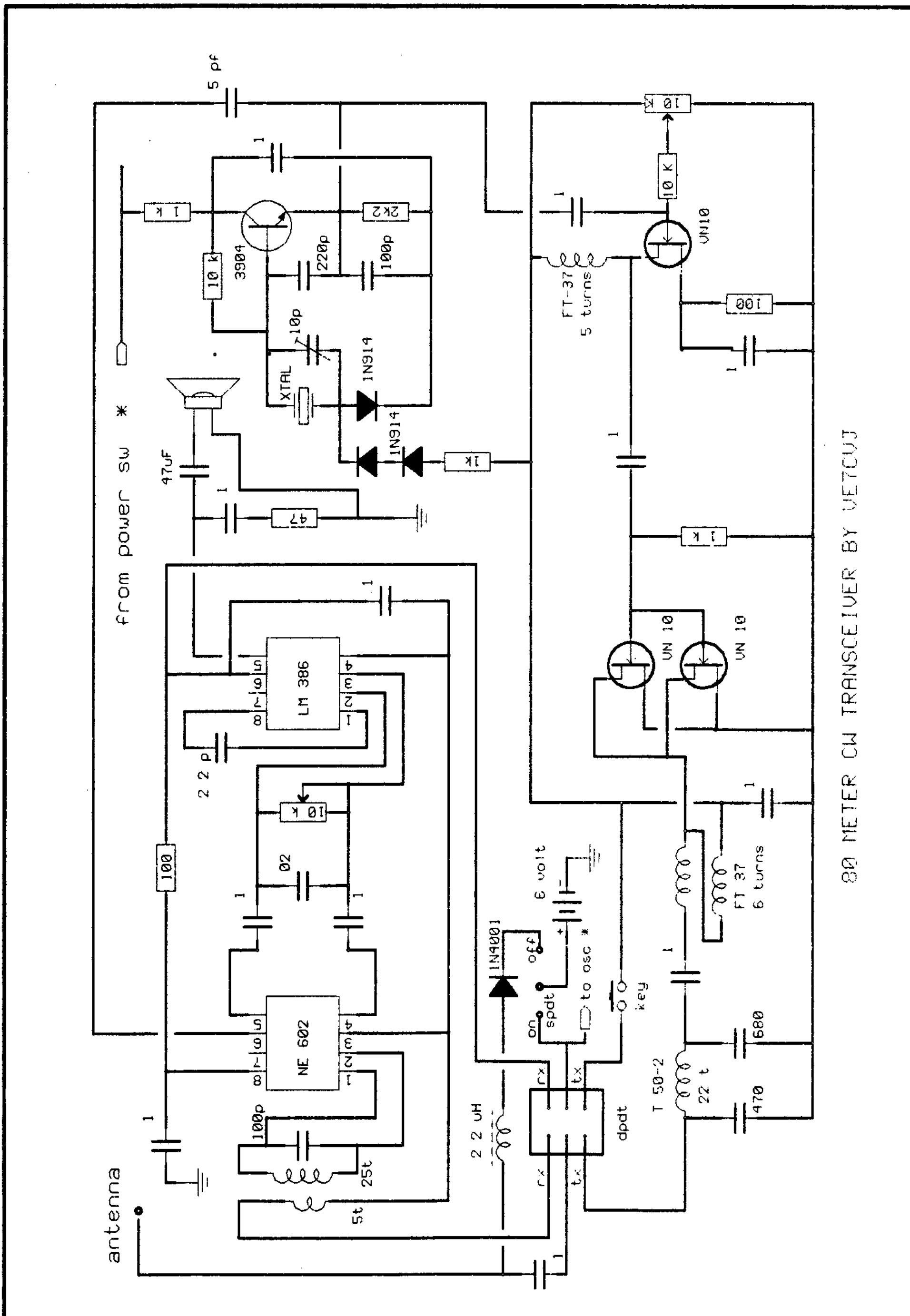
The race was on to develop the ultimate rig designed primarily for wilderness operation. While Derry spent his time tramping the bush in search of historic relics and testing his designs, I enjoyed backpacking into some remote corner and hanging from a mountain on the end of a climbing rope. Therefore the goal was to combine practicality with reasonable quality and light weight together with the best chance of getting out. To this end I favoured including optional CW transmit in my rigs, as my experience showed it to be far superior to DSB or even SSB under marginal conditions. Derry didn't share this view, stating that static crashes favored cw signals and always took me out on some key word!

Nonetheless, my goal was to build a fully self-contained rig that would easily fit in a shirt pocket and be as light and reliable as practical, designed primarily for emergency use on wilderness expeditions. The problem we had always encountered was the battery voltage required to give an acceptable signal out. On sideband the amplifier performance fell sharply at less than 12 volts and led to distortion on the transmit audio. On cw, the power fell off using the conventional designs.

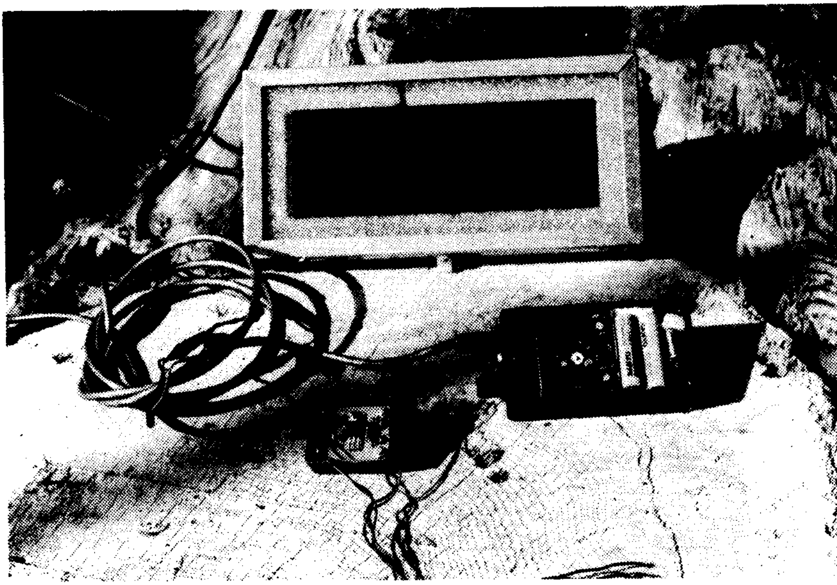
Given these constraints I set out to design a rig that would give satisfactory performance with minimal battery voltage. In order to reduce weight and bulk I limited the available power to four AA nicad batteries which give a nominal 5.5 volts after charging. The final amplifier consisted of paralleled VN 10 FETs running class C and driving a 50 ohm load. That required transformers that would match the very low impedance of the output stage to my usual antenna, an inverted V thrown over a near-by tree.

The receive section was built with a direct conversion, double sideband mixer and integrated audio amp. While ssb is much better for listening in noisy band conditions, it does nothing for a CW transmitter, so I opted to go the simplest way and put up with a little noise. So far the wider bandwidth has not caused much problem. The 5 volt supply drives an NE 602 mixer, oscillator and audio stage. The separate oscillator feeds the receiver and transmitter and therefore is powered at all times.

Diode switching provides an offset for CW transmission by changing the capacitance across the oscillator when the key is pressed. Antenna change over is accomplished manually with a small toggle switch. While this is a little crude, it does simplify things and has never been a hindrance, since the push button key is located beside the switch.



80 METER CW TRANSCEIVER BY VE7CVJ



Peter, VE7CUI's CWRig and Solar Charging Setup

The Compact Packaging of VE7CUI's CW Rig. Note Battery Pack on Left.

With the power switch in the off position the antenna jack becomes the input for charging the battery. An inductor and diode in series isolates the power switch from the rf signal and prevents accidental shorting of the battery. The 50 mA solar panel I carry plugs directly in the antenna jack, or I can use my constant current minimal loss charger for direct connection to any power source from 6 to 24 volts. This is how I charge equipment while traveling by car.

Well, once again I was off on a solo kayak trip to visit the west coast of Vancouver Island. This time the ultimate destination would be to the northern tip, to a place called Brooks Peninsula. This is just about as far as one can go on the island, 400 miles from home and three days paddle from road's end. It's the kind of place that demands decent weather to visit, and that you keep your wits about you. One can never guarantee if there will be other people in such a remote location so I consider the ham gear essential, and probably wouldn't go to such a place if I didn't have it or couldn't rely on it working when required.

The hardest part of any trip for me is getting my grub together and figuring how to fit it in a small slim kayak. The camping gear is easy to plan as is the radio equipment and other high tech hardware. One other item I include is a small solar panel which I made up specifically for charging AA nicads at a 50 mA rate. The panel is encased in foam and is protected by an aluminum shell making it waterproof and buoyant. It rides on the bow of the boat and has seen the inside of many a wave. Facing directly up, it averages 40 mA throughout the middle of the day, and I can leave it connected to any of the electronics packages I carry on board.

The small CW rig was designed with this in mind, and when powered down the antenna connection which is an RCA socket, becomes the charging input. This design has proved to be extremely convenient and reliable.

It takes all day to reach the launch point and much of the afternoon is spent driving over rough logging roads. If I have planned well I can get the boat loaded and be under way within half an hour. The concern then turns to navigation along the rocky coastline, watching for bad weather and finding a suitable site to set up camp. Often this takes place in the gathering gloom or by candle light. This time I was able to reach a tiny rocky island and find a spot just big enough for the tent.

I generally try to make contact each night on the B.C. QRP Net to let the folks back home know of my progress and although there were some low bushes, none were high enough to support the antenna. Also, the island was nowhere near long enough to string the 135 feet of wire I use for the inverted 'vee' antenna. One interesting point on ocean camping is that the available real estate varies remarkably throughout the day. Had I arrived earlier, the tide would have been out and the island would be twice the size! I've often had an antenna set up with the ends tied to poles jammed in the rocks and the whole works surrounded by water. Sure makes for a good ground plane!

Many miles later I was finally close to landing on the long sought-after beaches of the Brooks peninsula. Throughout the day I passed by some of the finest coastal scenery on the planet, had encountered no-one else, and was now about to walk on the oldest landform on the west coast of Canada. Due to its unusual positioning, this peninsula was not affected by the latest ice age, and as a result it contains some unique fauna and ancient landforms.

I found a small sheltered lagoon with a smooth sandy beach, surrounded by dense forest making it the perfect place to establish a camp. This time I had arrived early enough to get all the gear set up, so before long I had the BC Net tuned in and was receiving signals from all over the west coast.

One of the nicest features of the small CW rig is that it is entirely self contained. Other than the antenna connection, there are no other wires to get caught underfoot when moving about. It's one thing to be sitting at the operating bench at home with everything in front of you, the cables all out of the way, and quite another to be stooped over a sandy log, fighting off rain or mosquitoes with your big feet ripping the battery connection out of the rig or stepping on a microphone! With a good audio amplifier and enhanced low frequency response, the sound does not get swallowed up by the great outdoors or nearby surf. This had always been a problem on my earlier rigs especially with the tiny speakers needed to fit a small enclosure.

I was so pre-occupied with matters at hand that I scarcely noticed the approaching water. At this time of year the tides peak in the evening and rise right to the top of the beach which is where I was set up. Before long my campfire floated away and the tent was about to get flooded! I grabbed the SSB rig and fired it up, cursing the external battery pack, microphone, antenna and speaker. I had heard another marine mobile check the net and I figured I'd try to raise him on phone to see if he had a tide table. If it was close to high slack I just might make it without pulling camp. The word came back from a sail boat 50 miles south of my position that it was just about to turn at Brooks, so I anxiously waited and sure enough, in 5 minutes the water started to recede.

There is nothing like actual wilderness experience to really test out a new design. What I find most essential on these rigs is simple and reliable operation. I don't want to be tuning a drifting VFO or worrying about rain or sand getting into the works. On the CW unit, its small size and freedom from external connections other than the antenna make it a breeze to operate in difficult conditions. Its internal battery is rated 600 mA and will power the rig for many hours. On one charge of the nicads I can easily go a week using it for several hours a night. Add to this the ability of CW to cut through a noisy band, and it is my rig of choice. On the negative side is its single frequency oscillator, which while great for nets or skeds, does not permit searching the band. The time it takes me to communicate via CW is another drawback as often there is so much to describe on these trips. I do not find the built in pushbutton key to be a problem but those used to a regular key might.

As for the SSB rig, I had made up one of Derry's designs and borrowed one of his 5 watt amplifiers. I put the radio pcb in one of my old double sideband boxes and hung the amp off the side. It had a tuning range of about 100 Khz but could be set for other sections of the band. The 5 watt signal was a big improvement over the old 1 watt DSB rigs of days gone by, and on a decent night I was an easy copy to all I contacted. I was powering it from an 8 amp hour gel cell although it would be fine on one much smaller. It does have to be a 12 volt supply however. Putting it all in one box would be my next step, and I would strive to have the controls top-mounted for convenience, as most often the rig is on the beach or low drift log. I would say a digital readout or synthesized tuner would also be essential, although they do suck back the juice.

In addition to field testing radio equipment, my days on the west coast involved exploring every cove, sea cave, island and wild beach I could find. At a tidal lake I encountered, there were scores of large brightly colored jelly fish. They measured at least two feet in diameter and were trailing long tentacles while riding the current in and out of the lagoon. Ancient Indian villages are said to lurk in the dense forest, although I never saw any. More common are the sea otters which populate the islands in this region. I could trick them into getting very close by paddling slowly backwards, then they would follow the kayak, not knowing I was watching them. Large patches of kelp serve as protection for otters allowing them an afternoon snooze while lying on their backs, gazing up at the sky.

For me the pleasure of wilderness wireless comes alive on an adventure like this one, and it still amazes me that these simple and inexpensive home-brew rigs can provide communication to the outside world that is so reliable - and so valuable! 72/73 Peter

Improved Audio Amplifier Performance for the Sierra

by Cam Hartford, N6GA
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Claremont, CA 91711
and
Walt Thomas, WA4KAC
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Laurel, MD 20707

The Wilderness Radio Sierra instruction manual suggests changing the LM386N-1 audio amplifier to an LM386N-4 IC run from the transceiver's supply line (Vs) to get more audio output [1]. In addition to increasing the audio output, this modification also significantly reduces distortion in the audio amplifier on strong signals. Some of this distortion comes from the audio IC actually pulling down the regulated +8 volt line on very strong signals, especially when driving a speaker.

WA4KAC was the first to modify his Sierra (Wilderness Radio version) and he noticed a reduction in audio distortion; e.g., when running with the AGC "Off" signals which distorted at 12 V (Vs) became clean when the supply voltage was raised to 14 V. N6GA modified his NorCal Sierra and performed oscilloscope measurements on the audio output waveforms. He noted a nice sine wave output until the gain was increased to a certain point, above which both the tops and bottoms of the waveform began flattening out. The audio began to sound distorted as soon as the waveform started "flat-topping." This distortion in the audio amplifier is caused, in part, by the high gain of the Sierra's receiver section. When U3 (the audio amplifier) is run from the +8 V line, the stock configuration, the output transistors have a more limited swing available before they begin "clipping." Assuming the receiver is set for the same gain, running U3 from a higher Vs (e.g., 12 - 14 V) allows more output swing before flat-topping occurs, hence less distortion. Because the LM386N-1 is rated at 12 V maximum operating supply voltage, the 18 V - rated LM386N-4 is needed if U3 is to be run at the higher supply voltages [3]. Note: This distortion has NOT been observed on the NC40 and NC40A, because these transceivers are designed with no IF amplifiers and their LM386N audio amplifier receives less input signal at pins 2 and 3.

The modification to an LM386N-4 audio amplifier can be easily accomplished on both the Wilderness Radio (PWB marked "Sierra (c) 1995 N6KR Rev. C") and NorCal (PWB marked "Sierra N6KR Rev. B 6/94") versions of the Sierra. For either version, the existing LM386N-1 must be removed and replaced with an LM386N-4 (available from Digikey). We recommend simply clipping the leads on U3 which already is soldered on the board and then using a "solder sucker" and "solder wick" to carefully remove the leads and solder from the eight U3 pads. Be careful not to use too much heat or you might lift a pad or trace from the board. Solder in the LM386N-4; it is positioned identically to the -1 device. (NOTE: If you're building the radio "new," you might want to go ahead and install the -4; it will save having to remove the IC from the board later.)

For the WR version, the wide trace on the bottom of the board between U3 pin 6 and C75 is cut near C75 (+) and four components are added: one 1/4 W 10 to 22 Ohm resistor, a 220 uF/25 V radial-leaded electrolytic capacitor and a 0.1 uF ceramic disk to the bottom of the board and a 10 uF radial-leaded tantalum capacitor to the top of the board. The 220 and 0.1uF capacitors go between U3 pin 6 and pin 4 (ground) and the 10 to 22 Ohm resistor is in series between the U3 pin 6 trace and the Vs rail. Pick up Vs near S2 using a 7 1/4 in. insulated wire routed under the board from near

S2, along the rear panel over to the left corner, to near the left edge of the PWB and over to the resistor tack-soldered to the U3 pin 6 trace. The 10 uF Ta capacitor was added on TOP of the board between U3 pin 7 and the PWB's ground plane. The drawings show where these components are added on the WR version. [A detailed set of instructions for the WR version modification is available by sending an SASE to Bob Dyer at Wilderness Radio, P. O. Box 734, Los Altos, CA 94023-0734.]

For the NorCal version the same four components are added AND the AGC circuit needs three additional parts. (The AGC amplifier was changed from DC to AC coupling and an AGC threshold trimmer added for the WR Sierra/Rev. C. If the NorCal AGC is not changed, the MC1350's gain will be reduced by the LM386N-4's DC output which is centered at 6 volts.) Cut the wide trace from C75 to pin 6 of the LM386 (which is on the TOP of the NorCal board) near C75, scrape off about 1/4 inch of the solder mask coating, tin it and solder on the 10 to 22 Ohm resistor, as described above. Route the insulated wire from this resistor back past the PA to the rear panel, then across toward S2 to pick up the Vs line (12 V nominal). All three capacitors (220, 0.1 and 10 uf) can be tack-soldered on the bottom side of the board. Then modify the AGC circuit to resemble that of the WR version by adding a 0.1 uF ceramic disk, a 5.6 K-Ohm (or thereabouts) resistor, and a 10 K-Ohm trimpot, per the partial schematic, below. Unsolder and lift the anode end of D1, the AGC rectifier diode, and solder one end of the 0.1 uF disk cap in the hole vacated by the diode. Then connect the free ends of the

diode and the 0.1 capacitor together. There is a conveniently placed and marked +8 volt supply point included on the NorCal board as a reference source for the S-meter: use this pad to mount one pin of a vertically-oriented 10 K-Ohm trim pot. This provides a good place to anchor the pot which, coincidentally, needs +8 volts on its high side. Bend the other two pins on the pot up so that they clear the board. Solder one end of the 5.6 K-Ohm resistor to the wiper of the trimpot. Then connect the other end of the resistor to the diode-0.1 uF capacitor connection and solder it. The remaining end of the pot goes to ground. Use a clipped resistor lead, run from the pot around to the bottom side of the board, a distance of about 3/8ths of an inch. You now have an AC-coupled AGC with a threshold adjustment control, which you can set to your own preference.

After making the above component changes and additions, inspect the board to make sure all solder joints are secure and there are no shorts. Then apply power and measure the current draw; we noted only about a 1 mA increase when using headphones. You may want to reset the AGC trimmer; when run from the higher voltage provided by the Vs line, the AGC pot could be run a bit more CCW (for the WR version) than before the modification was performed. Enjoy your improved Sierra!

Acknowledgement: The author's thank Wayne Burdick/N6KR for his assistance and encouragement in tweaking the Sierra design to even better performance.

References:

[1] Sierra Multi-band CW Transceiver Assembly and Operating Manual, Wilderness Radio, Los Altos, CA, 1995, p. 33.

[2] Special Purposes Linear Devices Databook TL/2613P, National Semiconductor Corporation, Santa Clara, CA, 1989, pp. 1-28 to 1-32.

PARTS NEEDED:

For both WR and NC versions:

(1) 220 uF/25 V radial electrolytic capacitor

(1) 10 uF/20 V Ta capacitor (electrolyic OK if it fits)

(1) 0.1 uF ceramic disk capacitor

(1) 10 to 22 Ohm 1/4 W resistor

For NC version AGC modification: (1)
0.1 uF ceramic disk capacitor
(1) 5,6 K-Ohm 1/4 W resistor
(1) 10 K-Ohm trimpot, to fit board per above.
73 Walt & Cam

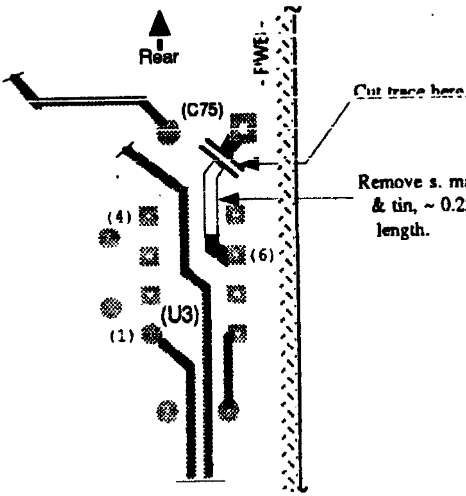


FIGURE 1. U3, Bottom of PWB

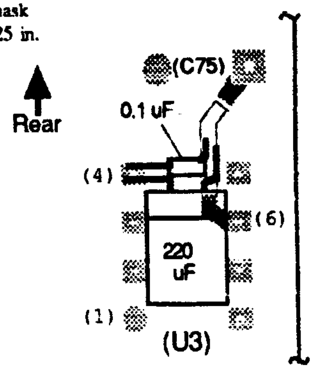
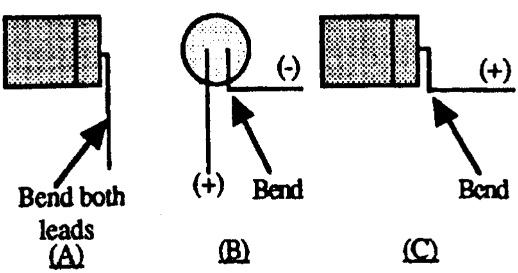


FIGURE 3. U3, Bottom of PWB, after 220 uF and 0.1 uF are installed.



After bending, cut "feet" to 3/32 in. length

FIGURE 2. 220 uF Electrolyic Capacitor

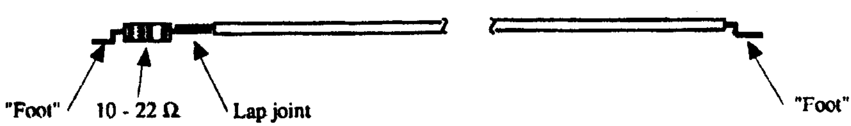


FIGURE 4. 7 1/4 in. (184 mm) wire - U3 to Vs.

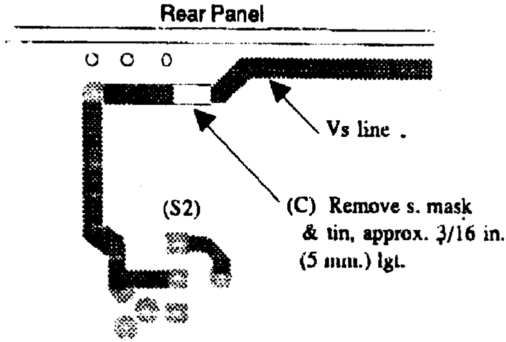


FIGURE 5. S2 - Vs Area: Attach non-resistor end of wire to bared, tinned trace.

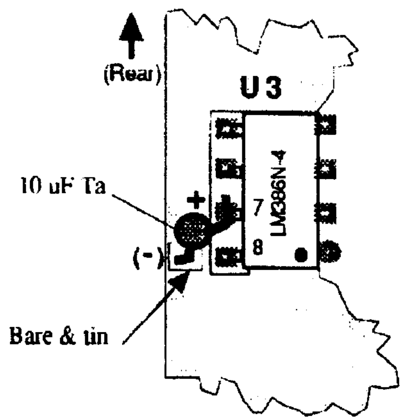
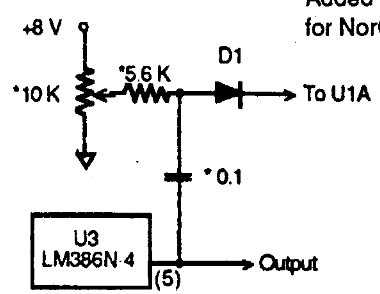


FIGURE 6. Adding 10 uF to U3 on TOP of board.

Added AGC components for NorCal Sierra (*):



The Tuna Tin 2 Revisited

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I remember 1976 well. It was the 200th anniversary of our country, and there were celebrations everywhere. I also remember it as the year that I was first licensed as a Ham, with the call WB0YVK in Kansas. One of the other things that I remember about 1976 was a very famous article that appeared in QST. It was Doug DeMaw's "Tuna Tin 2" QRP transmitter construction article in the May issue.

This was my first exposure to QRP. I remember reading and rereading the article, trying to decipher how to build this thing. I started to gather parts, and it took three months to do it, but I finally had all the capacitors and transistors and coils together. It then took another month of futile effort trying to make a circuit board before I finally succeeded with the fingernail polish resist method (not suggested). I did get the circuit to work, and I wish that I still had it, but it did not survive the move from Kansas.

Last year, Zack Lau found the original "Tuna Tin 2" that somehow disappeared from the ARRL. Mike Czahajewski had an article in QQ about it. Zack was walking through a flea market and saw it on a table. I think he paid $2 for it.

We featured the 49er in the last issue of QRPp, and the response to it was astounding. This indicates to me that our readers want simple, easy-to-build, projects. I decided to reprint the "Tuna Tin 2" article, as there are many of our members who have never seen it, and it is a classic.

The first thing that I decided to do was to update the circuit so that it could be reproduced with today's parts sources. Dave Meacham, W6EMD, is the technical advisor to the club, and I contacted him for his help in translating the information. Dave very graciously provided me with the information on how to change the coils to components available today. Next, I decided to redo the board layout so that it would fit my favorite container, an Altoids candy tin. I built the circuit, it works great, and this article is the result. The original article is reprinted here in its entirity, and the only changes that need to be made are:

L1 = Mouser 43HH225 (22uH)
L2 = 21T #28 on T37-6 core (1.36uH)
T1 = 14T #28 on FT37-43 core with 7T Sec. wound over Pri.
Q1 = 2N2222A
Q2 = 2N2222A

My thanks to Dave Meacham, W6EMD for his help in the modern translation of parts, the ARRL for permission to reprint the article, and Doug DeMaw, W1FB, for writing the article. Enjoy. Doug, KI6DS

The following is a reprint of the original "Tuna Tin 2" construction article from the May 1976 issue of QST. Reprinted with permission from ARRL.

Build A Tuna-Tin 2

by Doug DeMaw, W1FB

Ham Radio lost its kick? Go QRP with this weekend project transmitter! WAS with a 40Meter half-watter? You betcha!

Workshop weekenders, take heart. Not all building projects are complex, time consuming and costly. The Tuna-Tin 2 is meant as a short-term, go-together-easy assembly for the ham with a yen to tinker. Inspiration for this item came during a food shopping assignment. While staring at all of the metal food containers, recollections of those days when amateurs prided themselves for utilizing cake and bread tins as chassis came to the fore. Lots of good equipment was built on make-do foundations, and it didn't look ugly. But during recent years a trend has developed toward commercial gear with its status appeal, and the workshop activities of many have become the lesser part of amateur radio. While the 1-
KW rigs keep the watt-hour meters recording at high speed, the soldering irons grow

colder and more corroded.

A tuna fish can for a chassis? Why not? This inspiration led the writer to a nearby Radio Shack store, where most of the parts for a two-transistor 40 Meter CW transmitter were gleaned. A few hours later 350 milliwatts of rf were being directed toward the antenna, and QSOs were taking place.

Maybe you've developed a jaded appetite for operating (but not for tuna). The workshop offers a trail to adventure and achievement, and perhaps that's the elixir you've been needing. Well, Merlin the Magician and Charlie the Tuna would probably commend you if they could, for they'd know you were back to the part of amateur radio that once this whole game was about - creativity and learning!

Parts Rundown

Of course, a tunafish can is not essential as a foundation unit for this QRP rig. Any 6-1/2 ounce food container will be ok. For that matter, a sardine can may be used by those who prefer a rectangular format. Anyone for a Sardine-2? Or, how about a "Pineapple Pair?" Most 6-1/2 ounce cans measure 3-1/4 inches in OD, so that's the mark to shoot for. Be sure to eat, or at least *remove* the contents before starting your project!

One object of this venture was to obtain as many of the parts as possible from Radio Shack. A bargain pack of disk ceramic capacitors was acquired for this and other jobs in the future. All of the capacitors needed were found in the pile of mixed value types. Coils, L1 and L2 of Fig. 1, were fashioned from ferrite-core rf chokes found in the store. A scan of the transistor types available led to the purchase of a packet of eight substitutes for the popular 2N2222A device. That left six spares for the rig or for use in other projects. The important characteristics for the transistors are (should you want to try substitutes) a maximum collector voltage of 30 or more, a gain (Hfe) of at least 100, and a maximum frequency (f_T) of 100 MHz or higher. Also, the transistors should have a dissipation rating of 500 mW or more.

Resistors for the circuit were already on hand, but new ones could have been purchased singly or in an assortment. Circuit board material is also in supply at Radio Shack, so a sheet was added to the shopping bag. The tiny send-receive toggle switch is a mite expensive. The builder may want to substitute a low cost miniature slide switch in its place. A small bag of phono jacks was purchased also, as those connectors are entirely adequate for low power rf work.

Finding a crystal socket may be a problem of minor proportion. The type used will depend on the style of crystals the operator has on hand. International Crystal Co. has a variety of sockets for sale at low prices (see QAT ads for their address). a Millen steatite crystal socket was used in the model shown. It is designed to handle HC-6/U crystals withthe small diameter pins. Fundamental crystals are used in the transmitter - the general purpose (GP) type sold by International Crystal, 30 pF load capacitance. Surplus FT-243 crystals will work fine, too, provided the appropriate socket is used. If only one operating frequency will be used, the crystal can be soldered to the circuit board permanently. Estimated maximum cost for this project, exclusive of the crystal, power supply and tunafish, is based on brand new components throughout, inclusive of the left over parts from the assortments. Depending on how shrewd he is at the bargaining game, a flea market denizen can probably put this unit together for two or three bucks.

Circuit Details

A look at Fig. 1 will indicate that there's nobody at home, so to speak, in the two-stage circuit. A pierce type of crystal oscillator is used at Q1. Its output tickles the base of Q2 (lightly) with a few milliwatts of drive power, causing Q2 to develop approximately 450 milliwatts of dc input power as it is driven into the Class C mode. Power output was measured at 350 milliwatts (1/3 W), indicting an amplifier efficiency of 70 percent.

The collector circuit of Q1 is not tuned to resonance at 40 meters. L1 acts as a rf choke, and the 100 pF capacitor from the collector to ground is for feedback purposes only. Resonance is actually just below the 80 Meter band. The choke value is not critical and could be as high in inductance as 1 mH, although the lower values will aid stability.

The collector impedance of Q2 is approximately 250 ohms at the power level specified. Therefore, T1 is used to step the value down to around 60 ohms (4:1 transformation) so that the pi network will contain practical values of L and C. The pi network is designed for low Q (loaded Q of 1) to assure ample bandwidth on 40 meters. this will eliminate the need for tuning controls. Since a pi network is a low-pass filter, harmonic energy is low at the transmitter output. The pi network is designed to transform 60 to 50 ohms.

L1 is made by unwinding a 10 uH Radio Shack choke (No. 273-101) and filling the form with No. 28 or 30 enamel covered wire. this provides an inductor of 24 uH. In a like manner, unwind another 273-101 so that only 11 turns remain (1.36 uH). The 11 turns are spaced one wire thickness apart. Final adjustment of this coil (L2) is done with the transmitter operating into a 50 ohm load. The coil turns are moved closer together or farther apart until maximum output is noted. The wire is then cemented in place by means of hobby glue or Q-dope. Indications are that the core material is the Q1 variety (permeability of 125), which makes it suitable for use up to at least 14 MHz.

T1 is built by removing all but 50 turns from a Radio Shack No. 273-102 rf choke (100 uH). The ferrite core in this choke seems to be on the order of 950, in terms of permeability. This is good material for making broad band transformers, as very few wire turns are required for a specified amount of inductance, and the Q of the winding will be low (desirable). A secondary winding is added to the 50-turn inductor by placing 25 turns over it, using No. 22 or 24 enameled wire. The secondary is wound in the same rotation sense as the primary, then glued into position on the form. Tests with an RX meter show this to be a very good transformer at 7 MHz. There was no capacitive or inductive reactance evident. The primary winding has an inductance value of 80uH after modification.

Increased power can be had by making the emitter resistor of Q2 smaller in value. However, the collector current will rise if the resistor is decreased in value, and the transistor just might "go out for lunch," permanently, if too much collector current is allowed to flow. The current can be increased to 50 mA without need to worry, and this will elevate thepower output to roughly 400 mW.

Construction Notes

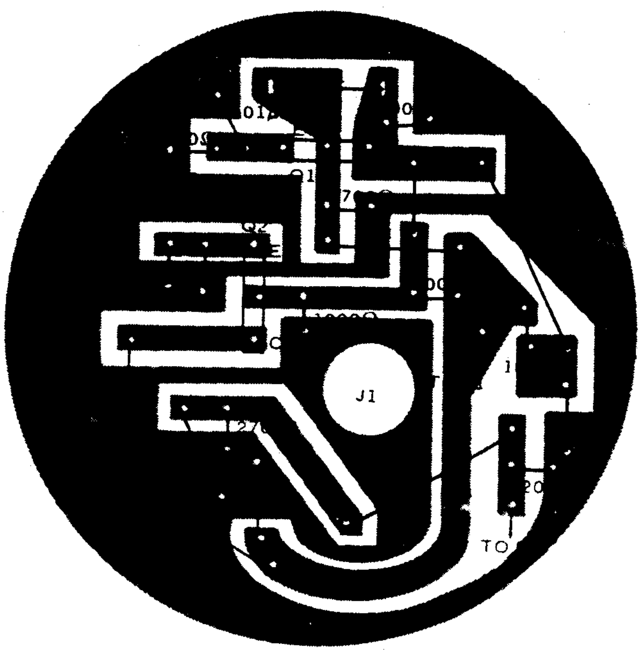
The pc board can be cut to circular form by means of a nibbling tool or coping saw. It should be made so it just clears the inner diameter of the lip which crowns the container. the can is prepared by cutting the closed end so that 1/8 inch of metal remains all the way around the rim. this will provide a shelf for the circuit board to rest on. After checkout is completed, the board can be soldered to the shelf at four points to hold it in place. The opposite end of the can is open. The container can be mounted on a metal plate if the builder wishes. a base plate will help keep the transmitter in one spot on the operating table, especially if adhesive backed plastic feet are used on the bottom of the plate.

Those with art in their souls may choose to paint the tuna can some favorite color. Alternatively, decorative contact paper may be used to hide the ugliness of the bare metal.

Summary Comments

Skeptics may chortle with scorn and amusement at the pioneer outlook of QRP enthusiasts. Their lack of familiarity with low-power operating may be the basis for their disdain. Those who have worked at

PCB Pattern for Tuna Tin 2



Parts Placement for Tuna Tin 2

micropower levels know that WAS is possible on 40 meters with less than a watt of rf energy. Of course, the odds are a bit greater against a speedy WAS achievement when crystal controlled QRP rigs are use, but it can be done. From the writer's location in Connecticut, all call areas of the USA have been worked at the 1/4 W power plateau. It was done with only a 40 meter coax fed dipole, sloping to ground at approximately 45 degrees from a steel tower. Signal reports ranged from RST 449 to RST 589, depending on conditions. Of course, there were many RST 599 reports too, but they were the exception rather than the rule. The first QSO with this rig came when Al, K4DAS, of Miami answered the writer's "CQ" at 2320 UTC on 7014 kHz. An RST 569 was received, and a 20 minute ragchew ensued. The copy at K4DAS was "solid."

Keying quality with this rig was good with several kinds of crystals tried. There was no sign of chirp. Without shaping, the keying is fairly hard (good for weak signal work), but there were no objectionable clicks heard in the station receiver.

There is a temptation among some QRP experimenters to settle for a one transistor oscillator type of rig. For academic purposes, that kind of circuit is great. But, for on-the-air use, it's better to have at least two transistors. This isolates the oscillator from the antenna. thereby reducing harmonic radiation. Furthermore, the efficiency of oscillators is considerably lower than that of an amplifier. Many of the "yoopy" QRP cw signals on our bands are products of one-transistor crystal oscillators. signal quality should be good, regardless of the power level used.

The voltages shown in Fig. 1 will be helpful in troubleshooting this rig. All dc measurements were made with a VTVM. The rf voltages were measured with an rf probe and a VTVM. The values may vary somewhat depending on the exact characteristics of the transistors chosen. the points marked 1 and 2 in circles can be opened to permit insertion of a dc milliammeter. This will be useful in determining the dc input power level for each stage. Power output can be checked by means of an rf probe from J2 to ground. Measurements should be made with a 51 or 56 ohm resistor as a dummy load. For 350mW of output, there should be 4.4 rms voltage across the 56 ohm resistor.

Operating voltage fro the transmitter can be obtained from nine Penlite cells connected in series (13.5 volts). For greater power reserve one can use size C or D cells wired in series. A small ac operated 12 or 13 volt regulated dc supply is suitable also, especially forhome station work.

A fellow staff member, WA1LNQ, was inspired by the size of this transmitter. He vowed to build a mating receiver for it. I think I heard him refer to his upcoming project as the "Clam Can 5."

The Recipe VFO

by John Koenig, NB7W
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With the recent popularity of home built SSB transceivers in the Ham community, we need a stable VFO formula more than ever. Single sideband operation demands more of VFO performance than CW. VFO drift on SSB is annoying, especially in round table QSOs. The higher power often used in SSB transceivers can introduce VFO pulling and instability called FMing. These problems are difficult to locate and resolve and can ruin a project. The design of the Recipe VFO avoids many of the problems encountered in the past.

I build VFOs based on the Hartley oscillator circuit described by Wes Hayward in **Solid State Design for the Radio Amateur.** p. 37, and the buffer offered by Roy Lewallen in his classic An Optimized QRP Transceiver for 7 MHz recently reprinted in the 1993

ARRL Handbook and **QRP Classics**. A successful VFO is a stable VFO. The combination of component stability, thermal stability, mechanical stability, and power supply stability add up to make a VFO that changes frequency only when the operator turns the knob.

CIRCUIT TUTORIAL

Examine Circuit 1, the very basic Hartley Oscillator. The resonator consists of one inductor, L, and several capacitors that behave as one, C(T). A resonator is an electronic pendulum, it sets the speed or frequency of the oscillator

The resonator components determine the frequency of the oscillator. One or more of the capacitors in C(T) is an air variable to change the frequency of the VFO. C 1 is a very small capacitor that couples energy to the Amplifier Q1; the smaller C1 the better the resonator isolation from the amplifier. The isolation this small capacitor provides is one secret to the Hartley oscillator's superior stability. A portion of the amplified energy goes from the source of Q1 to the resonator through the tap in the coil. This feedback keeps the electronic pendulum swinging. The rest of the amplified signal goes from the source of Q1 to the buffer.

A buffer is a specialized amplifier that has a high input impedance, and therefore takes very little oscillator energy to operate. The buffer isolates the oscillator from the circuitry that follows. This keeps outside circuitry from affecting the oscillator, and allows the oscillator to generate a minimum of heat. Both are important to stable operation. The buffer presented is exactly as W7EL designed it for his Optimized QRP Transceiver for 7 MHz. It is efficient, and uses readily available parts.

A voltage regulator provides a stable power supply and isolates the oscillator and buffer from other circuitry. I use a 6 to 9 volt low power regulator. This same voltage regulator easily supplies a crystal controlled BFO if you are using an IF receiver.

INGREDIENTS

Through experimentation, observation of other builders, and luck I found that certain parts work best in building a stable VFO. Before building the recipe VFO, you must acquire a few recommended parts.

Variable Capacitors: The best air variable caps have solid or soldered connections between the plates of the rotor and stator plates and their supports. I prefer variable caps with a shaft bearing at both ends, silver or gold plated; these are nice but optional. I generally choose values in the range of 50 to 100 pF, other values work fine. Variable capacitor size determines the frequency span of the VFO. The smallest sizes may not be desirable for the main tuning, but smaller caps work great for a band spread.

Air trimmer capacitors and glass or quartz piston trimmers work well as band stop capacitors, or to adjust the VFO slightly to calibrate a mechanical frequency readout.

I don't know where to buy quality air variable capacitors new. I find air variables at ham swap meets, surplus dealers, and in the junk boxes of ham radio friends.

Avoid variable capacitors with aluminum plates, or plates that are not solid or soldered. Film trimmers, and compression trimmers are also not stable enough to use in the Recipe VFO.

Fixed Capacitors: Modern technology provides us with NPO capacitors that remain the same value despite temperature changes. These capacitors exactly fit our needs in a stable VFO. NPO is the electronic industry abbreviation for Negative Positive Zero. A dab of black paint often marks NPO caps, or they are marked with the letters NPO.

Not all NPO capacitors are as stable as I like. Recently manufactured NPO capacitors are superior to those made years ago. The builder that invests in a supply of new quality NPO capacitors takes a giant step toward a stable VFO.

Order ten each of a full set of values of the Panasonic RS series NPO capacitors. They are listed as part numbers P4444A to P4461A in the Digikey catalog; the values range from 10 to 270 pF. This provides parts for many stable VFOs, and a variety of values needed for minor adjustments in frequency and span for your Recipe VFO. If the cost seems great, go together with a friend. These capacitors are very stable, and the extra capacitors will come in handy for all sorts of projects.

Avoid all non NPO capacitors in the frequency determining circuitry.

Inductors: I have found that the T-68-6 Amidon toroid is the basis for a stable inductor. Optimally, use the largest possible wire size to wind the inductor. Larger wire adds mechanical stability.

Theoretically, the most stable inductors are wound with an air core. Air core inductors are larger than the Recipe VFO toroidal inductor. This is an area worth experimentation. Avoid slug tuned inductors.

Transistor: The recipe calls for a NTE452. This is a JFET, N- channel, UHF VHF amplifier widely available at NTE dealers. I use this FET because it is available at my local electronics emporium. I never found a source for the 2N4416 specified in the original design. Other VHF JFETs work, some are more stable than others.

The MPF102 usually works in the Hartley oscillator, but the I(DSS) or saturation current, varies in different samples of the MPF102; this variation manifests itself as unpredictable oscillator output amplitude or instability problems.

STEP BY STEP RECIPE:

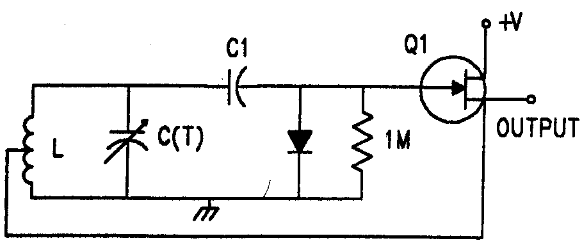
I use a nomograph in estimating the resonator component values. The nomograph is a graph of precalculated values of inductance, reactance, capacitance and frequency. See Figure 1. Nomographs are found in many electronics data books, including the ARRL Electronics Data Book. To use a nomograph I lay a ruler across the page aligning the frequency, capacitance, and inductance for the resonant circuit. I like this approach because it allows me to estimate visually the effects of component changes on the other components or frequency of the oscillator.

I can also calculate the values using the formulas for resonance. A computer using a spreadsheet program is ideal for these calculations. Once you get the hang of the nomograph a computer or calculator is not necessary.

Besides the usual hand and soldering tools, the builder needs an accurate way to determine the frequency of the signal generated. A frequency counter is an ideal tool for getting your VFO to work on the frequency you want. A calibrated general coverage receiver also works. The counter saves time and guesswork.

The recipe VFO target frequency is 5 to 5.35MHz. I also plan on using an inductor of about 3uH. A convenient value based on the T-68-6 toroidal core and the inductance available when winding this core with a single layer of number 22 enamel insulated wire.

CIRCUIT *1



Using these values on the nomograph, or computer, see that the value for C(T) varies between 250 and 300 pF. The air variable capacitor provides the 50 pF. difference between 250 and 300 pF. and NPO fixed value capacitors provide the 250 pF.

These values of components are estimates and relative. The exact values of the inductor and variable capacitor are not critical. I set the operating frequency of the Recipe VFO by experimenting with different values of capacitance in the resonator and measuring the frequency. The nomograph gets us in the ballpark with a minimum of fuss.

WINDING THE INDUCTOR:

I used a T-68-6 (yellow) toroidal core with 24 turns of #22 wire wound tightly around the core. The recipe inductor value is about 3uH. I tap the coil 6 turns, or 25%, above the grounded end. Boil the completed inductor in water for two minutes and let it cool slowly to room temperature. This process anneals the inductor making less it susceptible to changes in temperature.

Read more information on toroidal inductors in chapter 2 of any recent **ARRL Handbook**

PREPARING THE AIR VARIABLE CAPACITOR:

Clean the air variable by boiling in water for several minutes. A small amount of TSP in the boiling water really cleans up grimy old capacitors. After the capacitor gradually cools to room temperature replace the bearing lubrication with a high quality conductive lubricant. TV tuner lubricant, Caig PreservIT, or Pentrox (beam goop) works.

CONSTRUCTION:

Refer to Circuit 2, schematic of the Recipe VFO.

I build my VFOs on unetched copper clad circuit board, ugly style. I make a box of the circuit board material and solder the joints to create a mechanically stable RF tight enclosure. I use metal foil tape to secure the lid to make access for repair or adjustment easy. Size your box to accommodate the main air variable capacitor and leave room for the circuitry. I build the VFO in two compartments, separating the oscillator from the buffer and voltage regulator with a partition. I add a third compartment for the crystal controlled BFO for an IF receiver.

I used a 2 inch by 4 inch copper clad board as the base in the example Recipe VFO, and I built the surrounding box from copper clad circuit board as circuitry was completed.

Mount the air variable capacitor securely to the front panel. The rotor side of the air variable connects to ground; this minimizes frequency jumping when the knob is touched. Always ground the air variable at the same point as the inductor. This may seem unimportant considering the ground plane is a solid copper sheet, but this keeps unwanted circulating RF currents from the transmitter chain out of the resonator. Build the rest of the oscillator keeping the ground leads short, and all grounds as close to the resonator ground point as possible. The NTE452 has a fourth lead connected to the case; solder this lead to the ground plane, but stick the other wires straight up for easy connections. Secure other types of transistors to the ground plane using a dab of hot melt glue. My starting C(T) in the recipe VFO is a 220 pF NPO in parallel with my air variable.

C1is a 3 to 5 pF. NPO capacitor. The smallest capacitor in the Panasonic selection is 10 pF. Place two of these 10 pF. capacitors in series to create a 5 pF. value. A small piston or air trimmer also may serve here.

I build the buffer stage by gluing two 2N3904 transistors together front to back, with the leads sticking up. Make connections by gently bending the transistor leads in the correct direction and tack soldering the other components in place. I solder the emitter resistors and cap to the ground plane to secure the circuit.

Wind the broad band toroidal transformer on a FT-37-43 core. The primary is 15 turns of #22 enameled wire, and the secondary is 3 turns of #22 enameled wire. I hot glue the broadband transformer to the ground plane next to the transistors and make connections where indicated. Connect the buffer to the oscillator through a small hole in the partition.

Build the voltage regulator circuit in a similar manner.

INITIAL TESTING:

With power applied, and connecting the output of the buffer to my counter I measured the oscillator frequency at 4.830 MHz. with the air variable capacitor fully meshed, maximum capacitance. If you are using a receiver, connect a 12" wire to the buffer output. This wire serves as an antenna. You will find the VFO output as a strong CW signal not far from 5 MHz, or wherever you expect it. Wiggling your finger near the oscillator moves the frequency slightly, or moving the air variable back and forth helps you to find the oscillator's signal. Measure the highest and lowest frequency the VFO produces.

ADJUSTING THE SPAN:

The recipe VFO ranged from 4.830 to 5.800 MHz, or 970 KHz. Use the nomograph. Align 3uH at one end of the ruler and move the other between 4.830 and 5.800MHz. Note the difference read on the capacitance line, 250 and 350 pF. This is the approximate range of the air variable, 100 pF.

I want the frequency span of my VFO to cover 350 KHz., 5.0 MHz to about 5.35 MHz., or about one third of the current span. Connecting a capacitor in series with the air variable decreases the frequency span of the VFO. The inverse relationship for capacitors in series is illustrated in the formula:

$$\frac{1}{C(Total)} = \frac{1}{C(air)} + \frac{1}{C(series)}$$

to:

$$C(Series) = \frac{1}{\frac{1}{C(Total)} - \frac{1}{C(Air)}}$$

I use the nomograph to estimate the value of my air variable and call this C(Air) 100pF. I wish to reduce the VFO span to one third of the measured span. Therefore, I want to reduce the effective value of my air variable, C(Air) to one third, or 33pF. I call this C(Total).

$$C(Series) = \frac{1}{\frac{1}{33} - \frac{1}{100}}$$

$$C(Series) = 49pF$$

I tacked a 47 pF. NPO in series with the air variable and found the span reduced too much. I finally permanently added a 56 pF. NPO capacitor in series with the air variable. This reduces the span to 365 KHz.

You may wish to review capacitors in series and in parallel in the Capacitance section of chapter 2 in a recent **ARRL Handbook**. With a real world application, this section may take on a whole new significance.

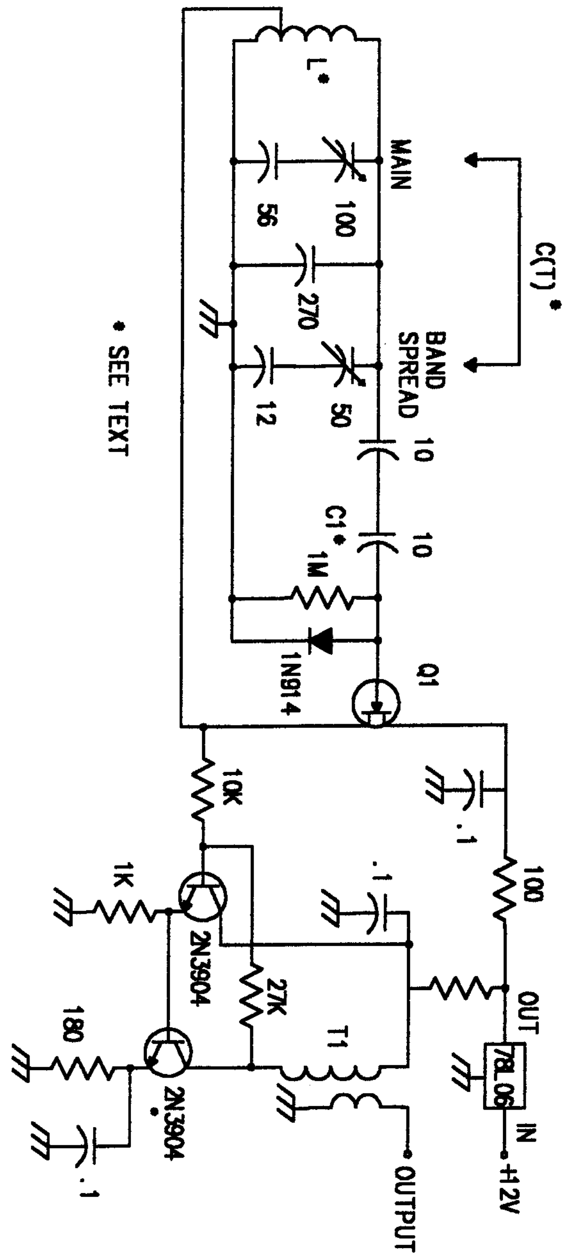
ADJUSTING THE FREQUENCY:

After adjusting the span of the recipe VFO, the lowest frequency is 5.435 MHz. To estimate the approximate capacitor value change needed to lower the frequency to 5 MHz., refer to the nomograph again. Locate one end of the ruler at 3 Moving the other end of the ruler from 5.435 MHz to 5.00 MHz. Read the difference on the capacitance line of about 300pF. to about 350pF; we need to add an additional 50 pF to C(T). I tack solder in a 47 pF. NPO capacitor across the original 220 pF. capacitor. The oscillator moves down to 5.060. This is perfect as I plan to add a stop band trimmer.

If the frequency moves to low you can substitute a slightly smaller capacitor. If it is not low enough, substitute a slightly larger capacitor, or add another small capacitor.

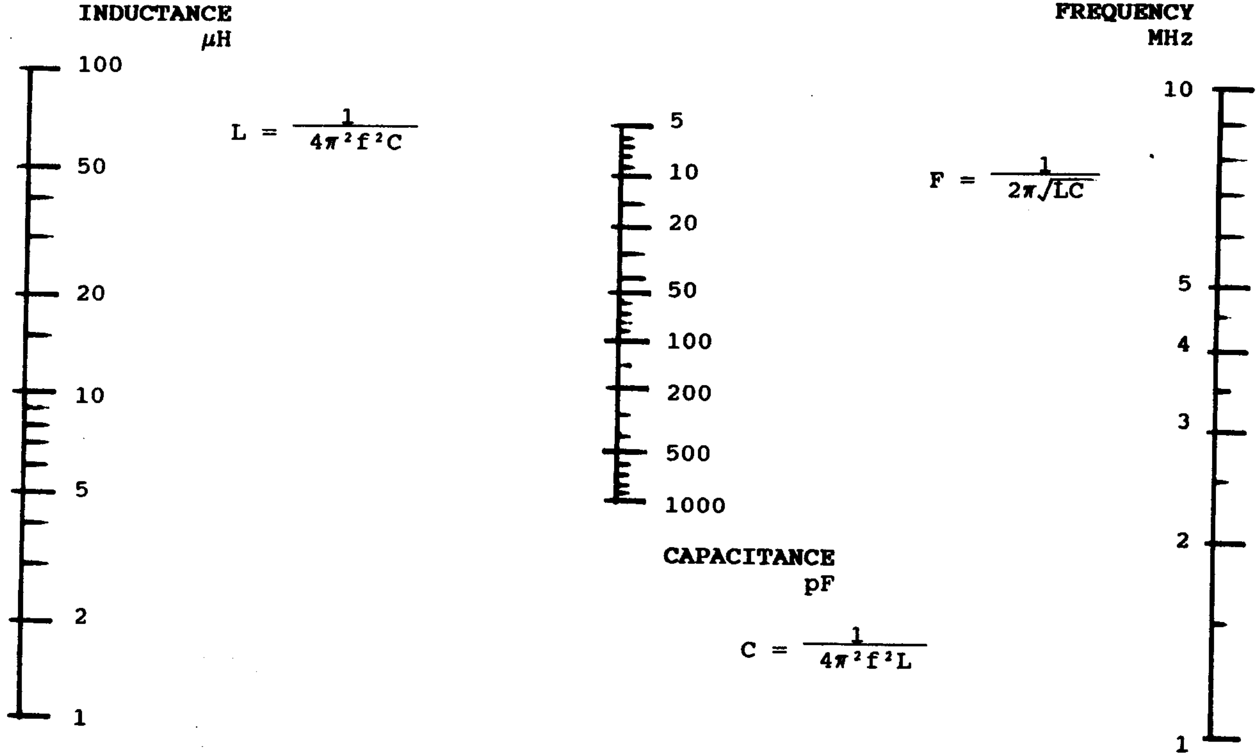
After adjusting the oscillator, I apply a drop of hot melt glue to secure the inductor to the ground plane. A hot soldering iron warms the ground plane and melts the glue if you ever wish to remove it.

ADDING A BAND SPREAD OR BAND STOP ADJUSTMENT (OPTIONAL):


C(T)*
MAIN
BAND SPREAD
L*
100
56
270
50
12
10
10
C1*
1M
1N914
Q1
.1
100
OUT
78L06
IN
+12V
.1
10K
1K
2N3904
27K
T1
180
2N3904
.1
OUTPUT
* SEE TEXT

CIRCUIT 2

figure 1 **VFO ESTIMATING NOMOGRAPH**



A band spread is a separate control capacitor that tunes the VFO at a much slower tuning rate than the main air variable. A band spread capacitor is useful in tuning SSB signals if you don't have a good mechanical turns reduction method. I use an air variable capacitor with a small NPO fixed capacitor in series. These series capacitors are connected in parallel with the main frequency determining capacitors and become a small variable part of C(T). See Circuit 2. In the Recipe VFO, I used a small air variable, about 50 pF., mounted at the front of the VFO box. A few capacitor substitutions in series produced a span of 6 KHz using a 12 pF. NPO. This makes precise tuning of SSB signals easy. This arrangement is superior to many planetary mechanical reduction knobs.

Connect the optional band stop capacitor in parallel with the C(T) capacitors. Use a 10pF air variable or piston trimmer. Mount the band stop capacitor so that you can adjust it through a small hole without opening the VFO box. Adjust the band stop capacitor so you can't tune the VFO below your legal band.

The band stop capacitor is a lifesaver when adjusting a mechanical frequency readout if the VFO frequency shifts slightly. This happens when you finally close the cover or install the VFO in your radio, after you spent hours calibrating the mechanical readout.

Be sure to ground these additional capacitors at the same point as all the other resonator parts.

OSCILLATOR FINAL ADJUSTMENT:

After all the adjusting and experimenting, the recipe VFO is not exactly at 5.00 MHz. I experimented and ended up adding a 15 pF NPO capacitor to C(T).

CONCLUSION:

I tested the example Recipe VFO using a remote reading thermometer and a Tektronix DC 503 universal counter. A small power resistor, connected to a variable power supply, placed in the oscillator compartment provides a controlled source of heat. In this way I am able to measure the oscillator frequency change with changing temperature. During warmup, without any power supplied to the heater, the temperature rose from 20 degrees C to 21 degrees C in 20 minutes. The frequency changed -73 Hz. or -14 PPM/

I applied power to the power resistor heater. The frequency changed from 5.003236 MHz at 23 degrees C to 5.002841 MHz at 33 degrees C. A change of -395 Hz, or -7.9 PPM/degree C. Repeated testing confirmed these numbers. In normal use, after a 30 minute warmup the example Recipe VFO varied 3 Hz. over the next half hour.

VFO TIPS AND TWEAKS:

Amidon sells a Toroid mix 7, white, more thermally stable than the mix 6 toroids. Substitution for the T-68-6 would be T-68-7.

Don't pass up bargain air variables with an odd shaft diameter. I adapt odd shaft sizes to match the standard 1/4" shaft size using telescoping brass tubing found at well stocked hardware stores and hobby shops.

Lubricating the air variable bearings with conductive grease often eliminates receiver crackles or hisses while tuning, backlash, and frequency jumping.

The NE602 does not like a VFO input over 0.5 volts peak to peak. A two resistor voltage divider will match the output of the Recipe VFO to an NE602. The output of the example Recipe VFO is 3.5 volts peak to peak. A 300 ohm resistor in series with a 50 ohm resistor does it.

Zack Lau, KH6CP, in April 1989 **QST**, p 38, suggests that FETS with lower I(DSS) will be more stable. FETS such as the 2N5484 (I(DSS) to 5 mA) and 2N5485 (I(DSS) to 10 mA) are worth experimentation. These lower output FETS may match to circuits using the NE602.

If size is not an issue the WWII surplus air variables with the 100:1 worm gear reduction drive are excellent air variable capacitors. These units have a taper that gives a more linear mechanical readout plus a neat mechanical setup for a frequency readout. These capacitors also work well for a VFO with a larger span. Their huge thermal mass also stabilizes the temperature in any VFO. Not recommended for backpackers.

A phasing SSB transmitter power amplifier is on the same frequency as the VFO. This complicates the VFO pulling and FM distortion problem. CW chirp can be a related problem. One solution is to run the VFO at half frequency and use a frequency doubler buffer stage. Single point grounding and isolating the transmitter and transmitter chain filters reduce the circulating RF currents that create the problem.

Property Line Special Antenna

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Selecting the correct antenna is important for all radio amateurs, but particularly for QRP'ers. We have to make sure that every last watt (or for some, every last milliwatt) is radiated most effectively. Here's one solution.

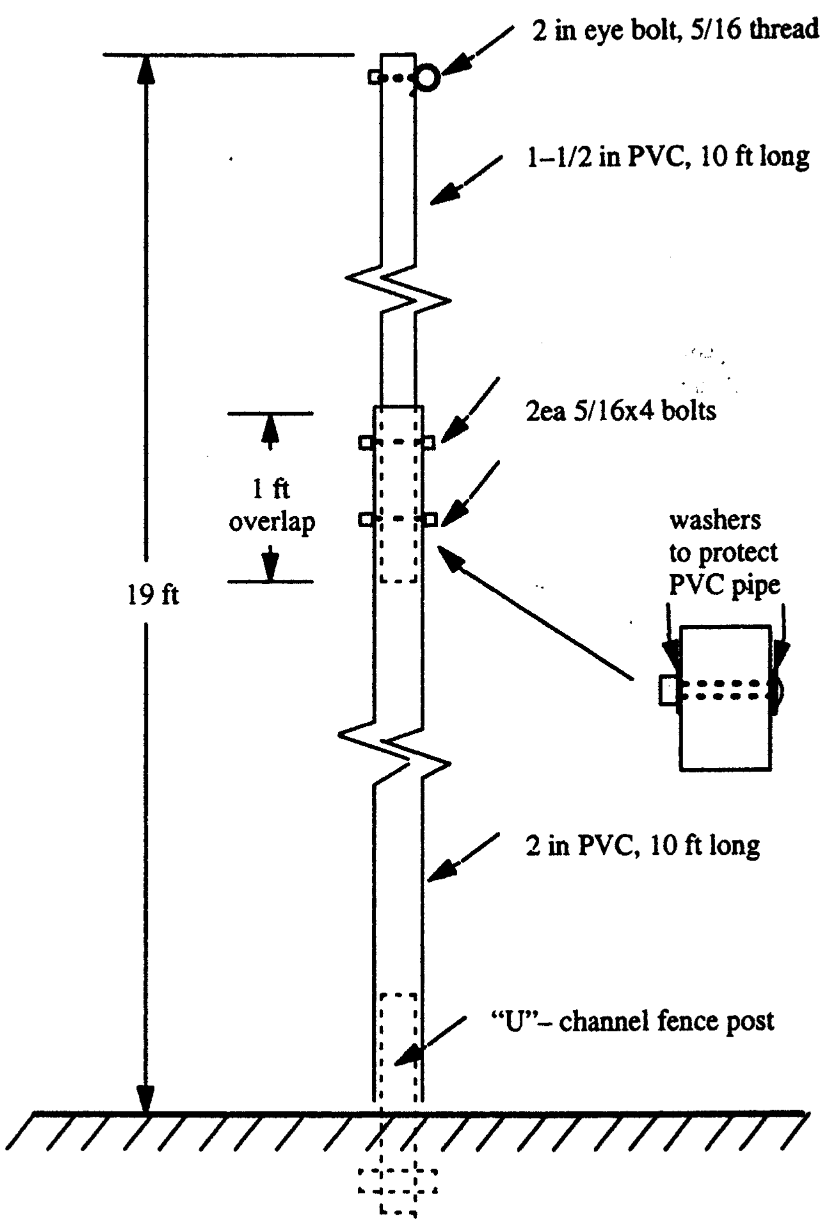
I have an antenna problem that I suspect may familiar to many urban and suburban hams. The primary space I have for antennas is my back yard, but it is not practical to use! My house is situated at one end of a 30 x 100 foot lot with a garage at the other end, BUT the "airspace" is taken up by power lines, telephone lines and cable tv lines.

My first solution to the antenna problem was to erect a Butternut HF6-VX vertical antenna in one corner of the side yard. It works well for 30 through 10 meters where I want low angle radiation. Unfortunately, though, its low angle propagation means that it skips over stations closer than a few hundred miles on 40 and 80 meters. Most of the time this is ok, but for contests or nets, close-in stations are hard to work . What I needed to fill in the gap was a high angle radiator like a low dipole.

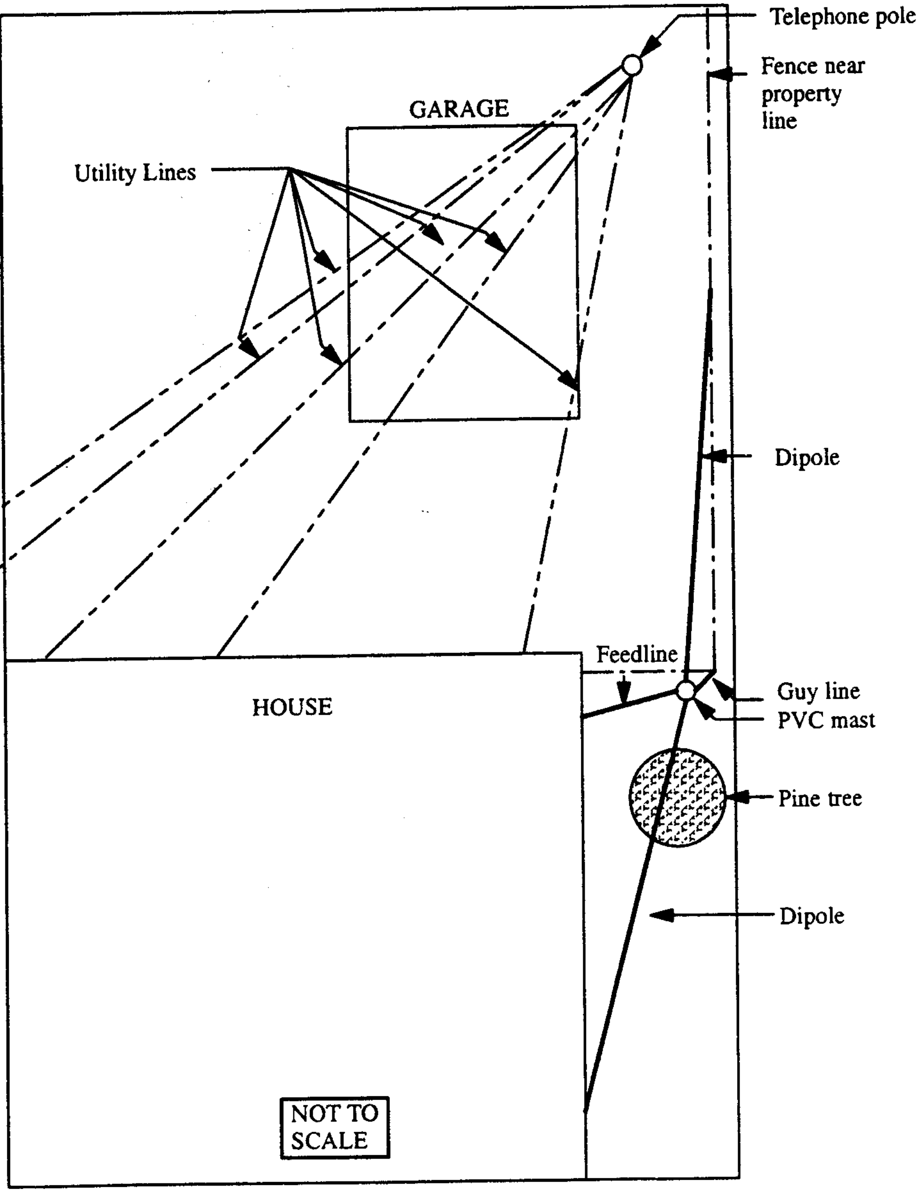
My garden gave me the solution. I grow quite a few vegetables and flowers in small beds that don't take up a lot of room. Following some ideas from "Square Foot Gardening," popularized in a book of the same name by Mel Bartholemew, several of the beds are along the fences at the edges of my yard. I realized that a horizontal antenna along the fenceline would be as far from the utility wire jungle over the back yard as it could get. And just as important, I could erect an antenna that wouldn't have to cross under or over those wires, adhering to an mandatory safety rule.

There are no good antenna end supports, so I decided on an inverted vee dipole. A 40 meter dipole fits nicely. Half of the dipole runs toward the back of the property and is tied off to a fence that runs along the property line. The fence height is three feet, so the insulated support line runs far enough back that the end of the antenna itself is about seven feet above ground level. The other half of the dipole runs forward and is attached near the front of my house, again arranged so that the end is at least seven feet above ground. A 15 foot pine tree in the side yard does a good job of screening most of the support pole, so the antenna is only barely visible form the street. Having a friendly neighbor helps, though, since it is clearly visible from her side!

I wanted the center support to be simple, cheap and invisible. The final result meets all of these criteria to one degree or another. The idea comes from a book by Ed Noll, entitled "Easy Up Antennas." It consists of two PVC pipes telescoped about a foot and bolted together. I started out with relatively small diameter pipe but ended up with one 2 inch section and another one with 1-1/2 inch diameter (both i.d.). Each section is 10 feet in length, so with the 1 foot overlap, the resulting height is about 19 feet. To bolt them together, I used two four inch long, 1/4 inch dia bolts. The pipes were laid on their sides, telescoped the appro-



PVC Pipe mast for Property Line Special Antenna



N2CX Property Line Special Antenna Installation

priate amount and 5/16 holes were drilled through both pipes simultaneously. to protect the pipes from being crushed at these joints, I used large flat washers between each bolt head and the pipe and between the nut and the pipe on each bolt. It was probably overkill, but I used some Loctite thread sealant to keep the hardware from working loose over time. The attachment point for the antenna and a guy line at the top is a large eye bolt mounted about three inches from the top of the mast.

The base of the antenna is secured very simply. Drawing again on an idea from Ed Noll's book, I used a three foot "U-channel" fence post. This was driven into the ground about four feet in from the fence line. The PVC pipe mast was then put over the top. The two inch pipe does not make a tight fit, but that doesn't matter much because the main function of the fence post is to keep the antenna base relatively stable. Physical stability is important because the structure is so close to my neighbor's fence. Front and back stability results from the guying action of the dipole itself. Side to side stability are provided by the coaxial feedline on one side and a 1/8 inch nylon line tied from the top eye bolt to the nearby fence. With this relatively stiff large-diameter PVC pipe, little swaying is noticed even in 40 to 50 mph winds. I could have probably gotten away with smaller pipe if I were not concerned about a flimsy structure so close to my neighbor's property!

The dipole I have up now is a 40 meter inverted vee. Being as low as it is, it works very well for close-in contacts (up to several hundred miles away). In recent QRP operating events, I've worked as far away as Texas and Minnesota during the day with my NC-40A at 1 watt with good success. And just as importantly, I managed to snag WB3GCK who is only 30 miles away. With the vertical, Craig reported that I was two S-units weaker than with the dipole! That's not too surprising but it's nice when reality confirms theory. This summer I intend to tack on some trapped end sections so that I can use the antenna of 80 meters, too during the upcoming long winter nights.

This isn't the optimum antenna, but, like most things in life, I think I've found a good compromise. It works well enough to make QRP'ing fun and doesn't jeopardize safety. Thanks to a cooperative neighbor it is practical and relatively unobtrusive. And finally, at an estimated cost of under $20 for the support materials, it fits nicely into my budget.
72, Joe, N2CX

50-Ohm Dipoles - - Cheap

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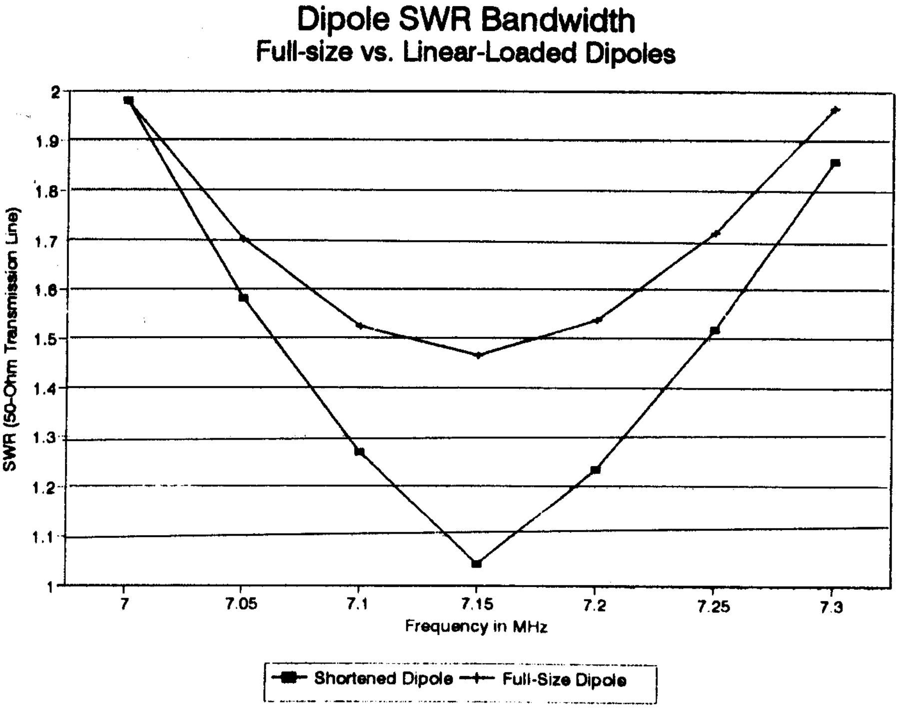
Every newcomer learns that the feedpoint impedance of a resonant half-wavelength dipole is approximately 70 Ohms resistive. Some have insightfully asked, "What do you mean by 'approximately'?" The impedance of a dipole will tend to vary from 69 to 73 Ohms, depending on the type and diameter of the antenna wire. Too, it will vary more widely depending on the height above ground in fractions of a wavelength up to about 2 wavelengths elevation, at which point it remains stable and close to its free space value.

Some operators worry about feeding a 70-Ohm antenna with 50-Ohm coaxial cable, since the minimum obtainable SWR under these conditions is 1.4:1. Many articles have been devoted to the relative harmlessness of this procedure in the HF bands, since with SWRs below 2:1, matching schemes may eat as much or more power than is lost in this very minor mismatch condition.

However, the concern persists for a variety of reasons. Some few solid state rigs reduce drive levels even at low SWRs to protect the transistor finals. Additionally, some operators are perfectionists. Since SWR is almost universally measured, it is a target for perfection. One way to achieve a (more nearly) perfect match with a resonant dipole is to use a transmission-line transformer with a ratio of 1.4:1 between the antenna and coax. Jerry Sevick, W2FMI, has designed numerous efficient transformers of this type, and versions are available through Amidon. However, they are by no means cheap. There are

The first step is to shorten the main element by about 10%. This will reduce the feedpoint impedance to about 50 Ohms, but it will add considerable capacitive reactance: something between 200 and 220 Ohms of reactance. The second step is to compensate for the reactance with an inductive center load (at the feedpoint). A split coil of the proper size (about 4.7 ìH at 7.15 MHz) would provide suitable compensation. However, coils in the weather, although sometimes necessary,



other means to effect the near-perfect match. A quarter-wavelength section of 60-Ohm transmission line between the antenna and 50-Ohm Coax would also do the job, but this line is hard to find.

Perhaps the cheapest way to a nearly perfect match is by shortening the antenna and adding a linear-load at the feedpoint. **Figure 1** compares a full-size 40-meter dipole and its 50-
Ohm revision.

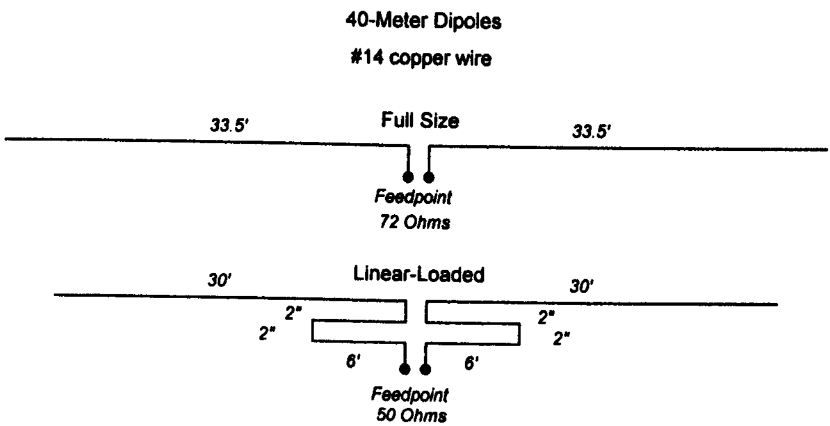
are fairly lossy devices, as the chemical soup of our atmosphere changes the shiny copper skin for RF currents into something else.

Linear-loading is less lossy, even if not lossless. The wires in Figure 1 beneath the main element are the linear load. Linear loads are fairly simple to understand once you orient yourself to them. Note that each side of the load looks like a shorted length of parallel transmission line. And what it looks like, it is--almost.

If both wires were equally spaced from the main element, then the currents in them induced by the main element would be equal and opposite. Under those conditions, the wire segments would act just like shorted transmission lines. Shorted transmission lines less than a quarter wavelength long act like inductors and provide inductive reactance--just what we need to cancel the capacitive reactance of the shortened main element.

The portion of the linear load on each side of the feedpoint acts as an independent inductance. Hence, each side cancels half the capacitive reactance and needs a corresponding inductive reactance. Transmission line formulas for constructing home made short lengths of line for purposes like this are readily available. For example, VE3ERP's collection of programs called HAMCALC, contains all you need to calculate the lines for each side. With #14 wire spaced 2" apart, a length of 4.85' will provide an inductive reactance of about 110 Ohms at 7.15 MHz. Since 110 Ohms is half the reactance to be canceled, a pair of these lines extending in opposite directions will provide the total compensation needed.

The lines shown in Figure 1 are about 6' long, and for a good reason: they are not equally spaced from the main element. Therefore, their currents are not equal and opposite, although close. Hence, they act mostly as shorted transmission lines and a little as part of the radiating antenna element. The net effect is to require more wire for the same task. However, the in-line arrangement does not harm antenna performance and is usually easier to build.



The dimensions shown in Figure 1 are derived from MININEC models, which are accurate to about 2-3%. Close-spaced wires, with their short right-angle segments, push modeling programs to the edges of accuracy, so some field adjustment must be expected. (NEC has an even harder time with modeling linear loads of this design.) However, for most cases, you can fix the size of the linear load, feedpoint, and center of the main element in one length of wire. #14 copper was used for all modeling because it is so common for wire antennas. Adjust the outer ends for a good match with coax. The numbers in Figure 1 are for free-space models, and height above ground will have a significant effect upon the feedpoint reactance for a given length of wire, just as it would have for a full-size dipole.

Nothing is absolutely free. The performance of the slightly shortened dipole will be about 0.2 dB down from the performance of a full size dipole in the same setting. This difference is unlikely to be measurable by any test equipment readily available to hams.

The real cost of the 50-Ohm dipole with its small linear load is in the SWR bandwidth. **Figure 2** shows the comparative SWR bandwidth for the shortened dipole and for a full size dipole, both cut for about 7.15 MHz. Although the linear-loaded dipole provides a nearly perfect match to 50-Ohm coax at the center frequency, the center loading steepens the rate of SWR change away from center frequency. At the band edges, the is nothing to choose between the two antennas.

So the big question: should I go to the trouble of making my dipole more complex mechanically for this small improvement in design-frequency SWR? For most operators, the answer is likely to be "no." However, if a perfect match bugs you and if your operation is over only part of a ham band (or across 30, 17, or 12 meters, where the entire bands are narrow), then the linear-loaded shortened dipole is the cheapest way to achieve perfection. For nearly 150 kHz of 40 meters, the SWR is below 1.4:1, the best SWR obtainable in theory by connecting 50-Ohm coax directly to a full-size resonant dipole.

Would I go to this trouble? Probably not, if my only aim was to eliminate a vestige of SWR that is not creating significant losses. However, presenting the idea in this context is a useful device for removing some of the mystery that has surrounded linear loading. For further details on linear loading when an antenna needs significant shortening, see *Communications Quarterly* for Spring, 1996. Look for the article on linear-loaded Yagis.

Freedom From Tyranny

by Joe Everhart, N2CX

(Some blue-sky thoughts about the future of homebrew QRP rigs) The story begins...

Wayne Burdick, N6KR, set the stage for a new direction in QRP homebrewing in a presentation at the 1995 QRP banquet in Dayton. His talk was a discussion of ergonomics as applied to QRP rigs. Wayne, the talented designer of the famous NORCAL NC-40 and Sierra really believes in practicing what he preaches! His latest creation is the KC1, a microcontroller combined iambic memory keyer and frequency counter. This small, low power add-on accessory takes a bold step forward in human-machine interface with ham rigs.

Ergonomics? Human-machine interface? What the heck is that all about? Well, they're just high-falutin terms to describe how you use something. A human-machine interface just means the way a rig (or whatever else) supplies information to and is operated by a human being. And ergonomics is the study of how to make the human-machine interface as good as it can be. For example, the usual interface with a ham rig is via the front panel indicators, knobs and switches and the morse key or microphone. Ergonomics as applied to ham rigs is all about making the rig more convenient to use.

I won't go any farther into Wayne's speech, except to say that he discussed making more use of tactile (touch) and audible means of controlling and using our ham rigs. His recently-released KC1 is a giant leap in that direction. I hope to show just what an advance his innovation is and to brainstorm a little bit on paper to present a few ideas of my own.

The plot thickens...

The front panel is the focus of most rigs. And the front panel is dominated by the tuning controls and frequency display, no matter whether the rig is analog, digital or whatever. Some information about the rigs operating state is gained through touch by the feel of rotary controls or the position of switches, but mostly the information is gotten visually. With increasing miniaturization of handheld radios, some use is made of beeps and other crude aural clues however they are often awkward and subject to misinterpretation.

Enter the hero...

Wayne's KC1 is a new simpler means of simplifying front panels. It is operated entirely by touch, through pushbutton switches and a morse keyer paddle and the feedback to the operator is entirely by sound! By depressing appropriate switches you can activate the digital dial feature which counts the rig's frequency which is then sent through the rig's audio channel as a three digit morse value, corresponding to the lowest three digits of the rigs tuning frequency. For example 7.123 MHz is sent as "123," with the MHz being understood.

Other pushbutton depressions put the KC1 into a memory keyer storage mode, where you can store up to 50 characters in a non-volatile memory. The message is played back with a different set of button pushes.

What's so revolutionary about this? It frees you from what I call the tyranny of the front panel. No longer are you locked into wasting lots of front panel space just for the tuning dial and its associated markings and the need to linearize the tuning control. Frequency counter dials and frequency synthesizer oscillators, of course, don't have this problem, but they do add lots of complexity in themselves. Using the KC1's frequency counter and audible readout completely sidesteps the problem with either analog or digital tuning.

Off the beaten path...

Recent simple rigs like those designed by Gary Breed, KA9AY, Dave Benson, NN1G, and Wayne Burdick, N6KR, have featured voltage variable diode tuning. This eliminates the need (with some compromises) to have all the mechanical complication that goes along with mechanical tuning capacitors and their associated mounting bracketry and dial reduction drives. In combination with the KC1, there is no longer any need for even putting the tuning knob on a rig's front panel!

The radio itself can be any shape you want it, not just a rectangular box as it has been since Marconi's days. Using audio eliminates the need to see the front panel. And since the tuning control doesn't have to be mounted close to the radio circuitry, you can completely divorce the rig's controls from the radio itself. Kinda like the separate control heads used with commercial two-way radios. Using the varicap tuned radios can also help to simplify mounting the controls apart from the rig. Of course since all that is needed to tune the radio is a variable dc voltage, the tuning potentiometer can be mounted remotely in the "control head." But we can completely do away with even the potentiometer! A dc level can be controlled by a simple, cheap digital to analog converter connected to an up/down converter. Making the counter count upward increases the voltage and making it count down decreases it. 256 discrete tuning levels can be gotten from an 8-bit counter-D/A combination. Pushbuttons or "touch pads" could be used to gate counting pulses into the up/down counter to make it count in either direction. Thus with only tow buttons tuning could be achieved remotely. A similar up/down counter could be used to feed a "digital potentiometer" which is a digitally programmed attenuator to provide a remote volume control. Thus control of the rig remotely could be done entirely with pushbutton switches!

Off we go into the wild blue yonder...

Let me propose three different ideas along those lines. First, picture a futuristic control head built into a glove, like the ones being used these days for video games and virtual reality simulators. Switches could be built into fingertips of the small finger, the ring finger and thumb to control the KC1 functions, and into the joints to control tuning and into the joints for volume and tuning. Press with fingertips for controls and flex the fingers back and forth to adjust tuning or volume. The index and middle finger would be reserved for "dit" and "dah" keyer switches. Picture somebody operating in a contest with one of those! Of course he'd have to do his logging left-handed....

Or the control panel could be a simple set of pushbuttons mounted alongside a keyer paddle. To configure or tune, you use the buttons and to key the rig, you use the paddle. More conventional, but still something that you could use to operate singlehandedly (pun intended).

Or for another thing I've wanted to do for years, you could have a rig remotely controlled by a touchtone phone. The phone supplies the pushbuttons for control and tuning and two of the buttons could be used for "dit" and "dah" paddles. A touchtone decoder chip at the rig end decodes the pushbuttons for connection to the rig. And the telephone audio sends the received audio back to the ham operating the rig.

An attractive feature of removing the front panel dial is completely eliminating the need to look at the radio. This is particularly attractive for several groups as disparate as the visually impaired and the tent camper! Wow, I can imagine a guy laying in his tent, operating his NC-40A in the dark with a glove mounted controller and his tentmate dimly sees him groping in the air!

The rig itself becomes merely an appendage to the control head. It can be mounted any way you want. In a mobile operation, it can be just a black box mounted under the seat or in the trunk (like the two-way radios mentioned earlier.) the operator then can concentrate on watching the road instead of the radio. For home use, the radio can be built into the power supply and tucked away in a closet somewhere. Or a control head could be switched between different radios and the radios themselves hidden out of site.

Finally, since the controls and indicators often dictate cabinet size, the radio itself can now really shrunken down. WA8MCQ and Mike's Maryland Midget Manufacturers can build a rig so small that you can tape it on the back of your 9-volt battery and build the controls right into your keyer paddles. 72, Joe

St Louis Tuner Manual Errata

by Bob Follett, WA7FCU
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I finished the St. Louis Tuner, and it works great! The case is a piece of art. Everything fits perfectly! Thanks Doug, an outstanding effort. Now, My Revised, Final Manual Changes, with input from Doug, Chuck and Bob Kellogg, separated into Errors, Omissions, and Hints:

ERRORS:

1. Page 5, fifth line: D1 and D2 banded ends are towards C1 & C2, NOT the resistors.

>From Chuck:

2. S4 is not correct. It is used to switch between the Balun OR the BP1,J3-6 outputs. Both can not be active as wired.

3. From Doug Hendricks: "Dave Gauding, NF0R, who was on the design team for the St. Louis Tuner has discovered an error in the St. Louis Tuner Manual. The balun on the back panel should be wound with 12 turns, not 10 as specified in the manual. That was my error

and I apologize for any inconvenience and all that stuff. Dave says it makes a big difference, so don't forget to change it..."

4. The schematic is missing the two ground connections on S2. The center position of the switch and the bottom of the inductor (lug 12) are both grounded (in the original St Louis Tuner design) . Mark your schematic, because the step-by-step procedures are wrong, in my opinion.

5. Page 7, 2nd column, third paragraph: "Cut a piece of wire that is 8" long" —Don't waste wire, 6" is more than enough.

5. Same as 4, end of paragraph: "solder a #18 tinned bus wire 4" long to the first lug (the one that has the 1st tap on it). ALSO ADD:, solder a 4" long bus wire to the 12th lug, then connect and solder the other end to a convenient point on the previously installed 6" (Ground) wire coming off the center lug of the same switch. Reference # 3 above, why we are doing this.

6. Page 8, Step 2: This is in error, in my opinion. If you expect the tuner to work/look the same on the front panel as a commerical tuner, You want the inductor switch to start at the 9:00 o'clock position (tap 1, NO inductance) with small changes in inductance, ie., three turn taps, and end up with larger degrees of change, as you turn the knob CW, at the final switch positions at maximum inductance. This means lug 1, not lug 12, is connected to the capacitor frames. The 4" bus wire is ALREADY soldered to Lug one, so just shape it right, and connect & solder to the wire between the two caps. you just installed in Step 1. (You already fixed lug 12 in # 5, above).

OMISSIONS:

1. As Chuck pointed out, the K binding post (Red), is missing from figure 3, page 5.

2. Note that the F binding post (blk), needs a ground lug. Use one that came with the BNC connectors, and position the solder point at 12 o'clock.

3. Add the missing Step 19 to the manual: "Connect the bus wire from Switch 1, lug B to the center position of S-4, the Balanced/Unbalanced selection switch on the rear panel."

HINTS:

1. LABELING: Page 6 bottom diagram shows labeling for the 3-way Out, Tuner, Dummy Load spread across about 160 degrees. This switch only has a range of about 30 degrees. Therefore, I suggest you place all three labels on the left side of the knob, relatively close together, one over the next (Vertical alignment). The supplied knobs are so big, there is little room for calibration marks for the inductor and two vari-caps, so I left them all blank. You could use smaller knobs and then put numbers and alphabet on the panel. (If anyone wants, I'll e-mail my front and rear layouts in either native Coreldrw format, or .GIF. However, your e-mail must support MIME attachments!)

2. I mounted my PC board on the Left side with the dummy load resistors facing the front panel. That is one of many positions you could use, but it worked for me, and left a large area on the right side for ten big battery cells, should I feel the urge.

3. When soldering the bus wire to the rear panel connectors, use a high wattage iron! These are big heat sinks.

4. As Bob Kellogg pointed out, when winding the Main Coil, L1, page 4, make sure you wind it in a clockwise direction, as viewed from the 12 position s/w it will be eventually mounted to. The idea is to make sure that what becomes position 1 on the switch is the 1, 3, 6 turn/tap end, and position 12 is the 60 turn end. That way, the switch will function in a normal clockwise direction from no inductance to maximum inductance. Don't twist the tap loops too tight, or they may break after you untwist, strip, re-twist and solder. (I didn't try to insert the taps into the switch lugs. It was much easier to keep them straight and lay them along side the length of the lugs, and solder)

5. Quoted from Chuck:

"Helpful hint on installation of the two caps and the nylon washers and screws. Place a cap on the desk with the shaft up. Place the three nylon washers over each of the three threaded holes. Now with all the eye-hand coordination you can muster lower the front panel over the cap and align the holes before the panel contacts the washers. Then with a free hand install each of the three nylon screws. If things shift a little, a small screwdriver gently can be used to align the washers back to where they belong."

"After you GENTLY tighten the screws you'll find, as Doug mentions, that the screws coming out of the bracket of the cap will obstruct the rotation of the plates."

"Here is what I did. I hate putting any sharp object between rotating plates and the front panel. The potential for me to mess something up is too great. So, note how much of the screw extends into the cap area. Remove ONE screw and using either an Exacto Knife (my favorite) or a single edged razor blade (kids and razor blades and sometimes adults don't mix) remove just a little bit of the screw and put it back in. Check your work. Now do another one..

Don't get in a hurry and do only one at a time. Make sure that the washer does not move or drop out during this procedure. Worked for me, and worked well, if I do say so myself..." (Test your final work with an ohmmeter. The cap frames sh/be isolated from the front panel... Bob)

6. I ran out of # 18 bus wire using the suggested lengths in the manual. I then substituted #18 stranded/insulated wire, and found it was superior to use for connections to the front switches from the PC since, as Doug pointed out, it is difficult to make the two switch connections when both the front panel and PC board are in place. (It helps if you don't screw in the front panel, but rather, put it into the case and tilt it forward while soldering).

7. Quoted from Chuck Adams: "Now, this is just my idea and all you antenna wizards, and ATU (antenna tuning unit) gurus can tell me if I'm wrong. C5,C6,C7, and C8 are the four sections of the two dual-gang variable caps. C6 and C8 being the 15-73pF small sections and C5 and C7 being the 17-165pF caps. As marked in the schematic on page 10 of the manual.

My preference would be to have the smaller sections in all the time and the larger sections switched out. My logic behind this is that with only the smaller sections in I have a greater control over small variations with larger angular movement in the dials and the smallest value would be 15pF. With the smaller sections in place of (now labeled C5 and C7) the inline at all times sections then I can have 15-73pF on the single section inline vs.17-165pF with having the larger sections inline and the smaller sections switched in/out".

(I, Bob, have used the tuner on a balanced 1/8th wave DCTL loop, a end-fed random, and unbalanced 40M horz. loop, and find the "normal" switched arrangement works well for what I have encountered so far—We will have to wait for a report from Chuck or someone else who tries his suggested arrangement).

8. Note that while the manual only refers to 4 lugs on the two vari-caps, there are really eight. The important thing to remember on page 8, steps 3 to 6, is that A & B(the larger variable plates) are the lower/closest to the front panel lugs, and there are also two more lugs under the one's labeled C & D in Fig. 7. You can connect the switch wires to either set. The same goes for the upper (away from the front panel) four lugs labeled C & D.

If the above seems confusing, look closely at one of the vari. caps, and you will see that the fixed plates have insulated lugs at each end of the frame. (the frame is connected to the rotating plates) There are two sets of fixed plates, one with fewer plates than the other. The larger set is, when mounted to the front panel, closest to the front panel.

9. Note that in step 13, you are connecting BOTH Point A and Lug 12 of Switch 2 to the ground lug on the rear panel. (Big wattage iron again). Yes, the tuner will work without grounding either/both, but "normal tuner convention" is to ground both to keep RF under control. According to our qrp-l tuner authority, LB Cebik, at QRO levels, arcing can occur if both points are not grounded.

A New Project is Born: The Atomic Keyer

A New Project is Born: The Atomic Keyer

by Brad S. Mitchell WB8YGG
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Like so many projects, this one began with some initial discussion of whatcould be done: a microcontroller could be used as a base for an iambic keyer, something functionally equivalent with the Curtis Keyer chip. The functions would be simplified: only allow mode B keying, support 3:1 weighting, and have the speed adjustable via the paddles. In addition, message memory would be supported. Messages would be stored in both microcontroller ROM (Read Only Memory) and RAM (Random Access Memory). The RAM based messages would be entered dynamically by the user, thus allowing customization of the messages. With these requirements in mind, a keyer design was started.

The following functions were necessary to meet our goals for the project:

*Mode B Iambic Keying
*Easy Speed Adjust via Paddles
*Message Memory, Customizable by the User
*Low Current Requirements
*Simple User Interface
*Low Parts Count\Quick Assembly
*Built-in Tune Function
*Built-in Audio Feedback Mechanism
*CW Practice Mode

Background

The decision to base the design around the Microchip line of PIC micro-controllers was made early on in the project. The Microchip PICs are RISC (Reduced Instruction Set Computer) based, and as such are able to execute one instruction per clock cycle (with the exception of a couple instructions). The chips are available in low current versions, making them ideal for portable operations or where battery life is important. All that is needed for development of programs for the PIC are a PC capable of running DOS, and a PIC programmer. Once we picked the particular PIC for the project, it was agreed we would work within the constraints of it.

There are several methods for developing a project. One way is to build all the features in at once. We took a phased approach to developing the features, completing a series of which involved mini-milestones on the way toward the goal of completing the project.

Phase I

The first feature to be implemented was the mode B iambic keying. Part of this feature included using a default weighting of 3:1. Weighting is defined as the ratio of the amount of keydown time allotted to a DAH as compared with the time allotted a DIT. How is iambic mode B implemented? First of all, iambic mode B means that when the DIT paddle is pressed during the keying of a DAH, that the DIT will automatically be sent after the DAH. Likewise, when the DAH paddle is pressed during the keying of a DIT, the DAH will automatically be sent after the DIT. In order to implement this feature, the keyer needs to poll the DIT input line during the output of a DAH (and the DAH input line during the output of a DIT). Upon completion of the DIT (DAH), a DAH (DIT) would then be sent.

The next feature needed was a method of speed adjust. With the advent of the speed adjust function, it was clear some form of audio feedback was required. A number of approaches were discussed: using a sidetone circuit, installing a speaker, and utilizing a piezo audio transducer. In the end, a piezo transducer and software were used to implement the audio feedback function. The other approaches were deemed unusable due to cost and increased parts count. By pressing a button, the speed adjust loop is entered and the user can choose to decrease or increase the keyer speed via the paddles. By pressing the DIT paddle, the speed decreases to a minimum, then wraps around to the maximum speed, whereupon the speed decreases again. When the user stops pressing the DIT paddle, the speed is set, and the user returns to keyer mode. Using the DAH paddle, the speed increases to a maximum, then wraps to the minimum speed, whereupon the speed increases again. With iambic keying and speed adjust, we had our first version of an operational keyer!

Phase II

The next feature added was the ability to store messages in the PIC's ROM. These messages were actually programmed in the assembly language program, and stored in the ROM on the PIC. By pressing a button, the user could automatically send a any string of characters, for example "CQ TEST CQ TEST K". This added a handy feature, but did not allow the user to customize the message, for example by adding his/her own callsign.

At this point we decided to add dynamic message input. This allows the user to enter a string of DITs and DAHs using the paddles, and the message is stored in RAM on the PIC. The RAM on the PIC is volatile, which means that as long as the PIC is powered on, the message in RAM is preserved. Message memory turns out to be a very useful feature, as it allows the user to enter his/her own callsign, as well as use messages specific to a given event or contest. The final version of the keyer allows the user to enter two separate messages into memory, each consisting of approximately twenty characters (the actual amount will be more or less depending on their length). The keyer allows the user to press a button and output Dynamic Message #1, Dynamic Message #2, or Dynamic Messages 1 and 2 concatenated together into 1 longer message.

The AK-1 dynamic message input is WYKIWYG - What You Key Is What You Get. That is, spacing between elements, characters, and words is controlled by the user. The keyer only enforces spacing between elements, in that there is always at least one space between elements.

Phase III

At this point we considered auxilliary functions and the user interface. In addition to speed adjust, the keyer needed to support a tune function and practice mode. The tune function is realized by pressing two buttons simultaneously, the keyer will activate the keyline, until a button or the paddle is pressed. Practice mode is realized by pressing two buttons simultaneously, directing all output from the keyline to the piezo audio transducer. This allows the user to practice CW sending on the keyer without actually being on the air.

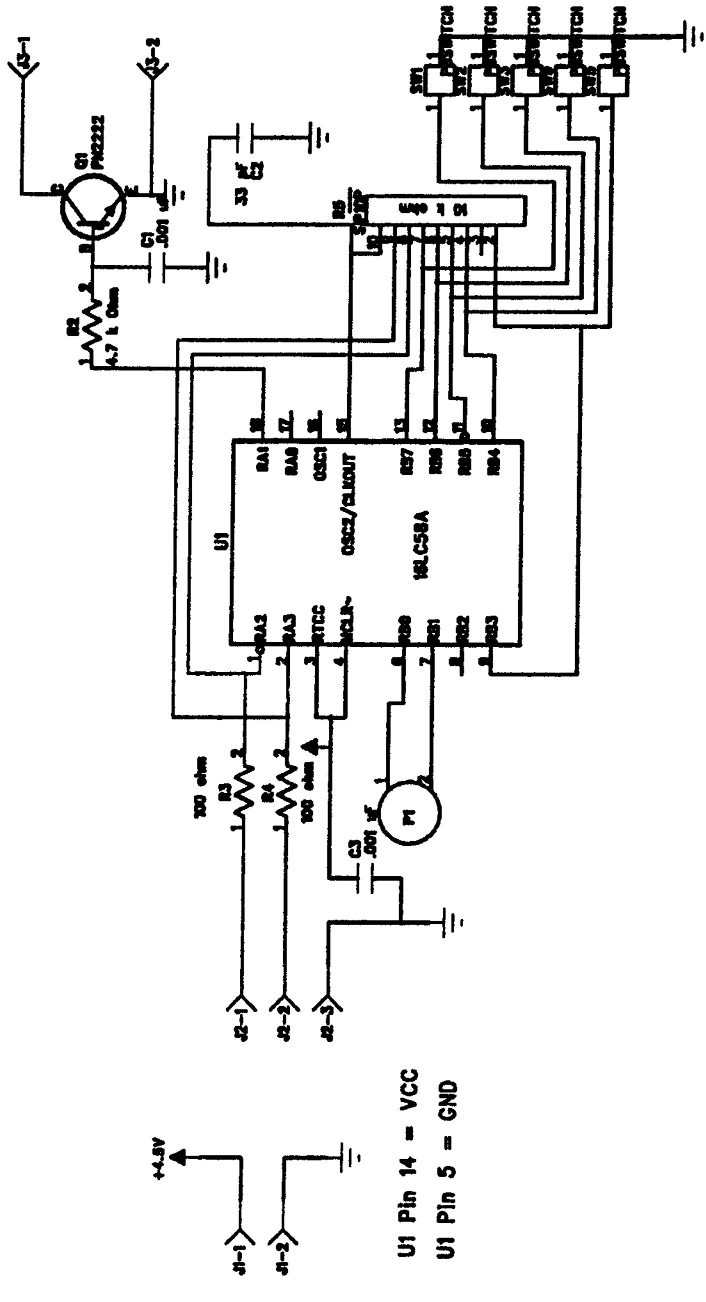
The Fine Points

After the functions were completely implemented, many hours of testing were invested. The goal was to make the functions easier to use. For example, we found that it was important to have the ability to increase or decrease the keying speed quickly. To support this ability, we inplemented a speed adjust "acceleration" function. Once the DIT key is pressed and the keyer begins decreasing the speed, by simultaneously pressing the DAH paddle, the user can accelerate the speed adjustment by half the time.

In order to accommodate the functions with a straightforward user interface, five buttons were designed into the circuit. To support the five buttons, the chip needs to have at least that many input pins. In the case of the particular PIC used for the keyer, the number of input pins needed by the 5 buttons and the paddles was covered.

The Name

Early in the development of the AK-1, we were talking to several people, looking for inputs on the feature list. One person we talked to was Bob Gobrick (VO1DRB) and he was curious what our project was all about. In an Email he asked "What are you guys



Atomic Keyer Schematic

working on, an atomic keyer or something?". Well the name stuck, and now you know "the rest of the story".

Atomic Keyer AK-1 Feature Summary

- Mode B Iambic Keying
- 3:1 weighting
- Piezo Audio Feedback for Functions
- Speed Adjust via Paddles
- One Static Message "CQ CQ CQ DE DM#1 DM#1 DM#1 K"
- Three Dynamic Messages:
    - DM#1 - Can contain approx. 20 chars (depending on char size)
    - DM#2 - same spec as DM#1
    - DM#3 - The concatenation of DM#1 and DM#2 into one longer message
    - Dynamic Messages are WYKIWYG (What You Key Is What You Get)
- Tune Function
- On-Air/Practice Mode (via Piezo Audio Device)
- Low Current Consumption (~300 uA @ 3v)
- Low parts count: 15 board mounted parts; Easy and fast to build
- Simple User Interface: 5 buttons handle 9 functions
- Kit contains all board mounted parts, PC board, paddle & keyline jacks

User Interface

Button 1 - Static Msg: "CQ CQ CQ DE DM#1 DM#1 DM#1 K"
Button 2 - Dynamic Message #1 + Dynamic Message #2
Button 3 - Dynamic Message #1
Button 4 - Dynamic Message #2
Button 5 - Speed Adjust
Buttons 1/3 - Dynamic Message #1 Input
Buttons 3/5 - Dynamic Message #2 Input
Buttons 2/4 - Toggle Practice / On-Air Mode
Buttons 1/4 - Tune Mode

Building the AK-1

The Atomic Keyer was designed to be simple to build! It should take about an hour to build the kit, so far as the board mounted components are concerned. Before building the keyer, you'll want to consider the enclosure the keyer will eventually go into. The AK-1 was designed to be built in a couple different ways, in order to accomodate the needs of as many users as possible. If you're going to build the keyer for something like an Altoids box (i.e. thin material), then all the parts can be mounted on the silk screen side of the board. Depending on the thickness of the enclosure, you may elect to solder the PIC directly into the board and NOT use the supplied 18 pin socket. If you are using a box with thick walls (i.e. 1/8" or more), then you may elect to surface mount the switches on the copper side of the board. This will necessitate the remote mounting of the piezo audio transducer. This means you may want to drill a 1/8" hole in the enclosure, and use epoxy to affix the piezo to the inside of the enclosure, and run two wires from the piezo back to the board. In any case, the kit comes with a drilling template, to make the board mounting hardware and switch button holes easy to get straight.

The AK-1 can be powered with a DC source of 3 to 5 volts. Two AA or AAA batteries will work fine and give long life, due to the PIC's low current consumption.

AK-1 Kits are available for $29.95 + $3.95 shipping from:
Embedded Research
Box 92492
Rochester, NY 14692
(NYS Residents please add appropriate sales tax)

Building the 49er

by Brian Miloshosky, N5ZGT
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I received my first NorCal Forty-9er QRP transceiver during the NorCal QRP To The Field contest on April 27th from Doug Hendricks, KI6DS. When I opened the little package, I was greeted with a small circuit board, instructions and 42 components. I have never really built a piece of radio gear before except for a Ramsey 40 meter transmitter about a year and a half ago. I was excited to receive it!

The NorCal Forty-9er is a very simple direct conversion transceiver which runs from 7 to 12 volts DC. Power output is 250 mW at 9 volts and 500 mW at 12 volts. The supplied crystal for the transceiver is tuned to 7.040 MHz, although you can use a different crystal for the 40 meter CW band. One of the very nice things I like about the Forty-9er is its full QSK, which I really enjoy while operating CW.

The day after I received the kit, I started building! Before assembling the kit I separated each part into piles of similar parts (resistors with resistors, etc.) and identified them. From there I followed the instructions and the whole transceiver was put together in less than an hour. The kit includes well-written instructions that are very easy to follow, even to the beginner (Like me!).

I found the Forty-9er to be a fine QRP transceiver that is easy to build and enjoy! I have not had a chance to put it on the air yet however. I will plan on writing a follow-up to this article with the Forty-9er's performance! My next little project is to install the Forty-9er into an Altoids box, including the 9 volt battery, switch, and jacks for CW key and audio. Becuase of the Forty-9er's size (2 X 2.5 inches) it will be a perfect QRP radio to take camping and backpacking!

I would like to thank Doug, KI6DS for the NorCal Forty-9er, Chuck Adams K5FO, Jay Miller WA5WHN, and Paul Harden NA5N for their great advice and of course the NorCal QRP club for putting out such a fine piece of equipment! If you are looking for a small and easy to build QRP transceiver, the NorCal Forty-9er is the kit for you!

Best of 72/73, Brian, N5ZGT

[Editor's note: Brian is a 16 year old ham that I met at Riley, NM when I went there to participate in QRP to the Field. I had taken a couple of 49er kits with me, and he seemed to me to be the perfect candidate to build a rig. Brian is a member of an Explorer post that is sponored by a Ham Radio Club in Albuquerque, and NorCal will be supplying more 49er kits to the scouts in order to interest them in QRP and homebrewing. If you here Brian on the air, be sure to give him a call. 72, Doug, KI6DS]

The User Friendly 49ER

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My interest in QRP operations is a relatively new "addiction" in my amateur career. Since being stricken with QRP fever I have spent more and more time using my Oak Hills rigs and leaving my Yaesu FT-990 and kilowatt amp dormant. One evening while browsing the daily e-mail postings on QRP-L I noticed information on Wayne Burdick's latest design - the Forty-9er. I must admit that while I am always casting about for a new construction project the fact that the little rig could be packaged into an Altoids tin cinched the deal. I have long been an Altoids "freak" and have a goodly supply of empty boxes just waiting for something other than parts storage.

After building my first Forty-9er (although mine says 49ER) and making several contacts I started thinking of modifications. I concentrated on three areas. First I felt that the rig needed sidetone and using the forementioned FT-990 or OHR-400 seemed a bit overkill and was not in keeping with the KISS (Keep It Simple Stupid) principle. Also, it would certainly be nice to be able to easily tune several Khz with a minimum of fuss. Lastly, an internal keyer would be a nice touch since I had just purchased an Envirotronic paddle for use camping and on my little sailboat.

What follows are brief descriptions of the changes and additions that I have made to Wayne's little wonder rig.

Additon Number One: Sidetone

To make the addition of sidetone interesting as well as practical, and since the local computer emporium started stocking some surface mount components I decided to utilize them in construction. The circuit (Figure 1) uses a LM-358 for the oscilator and about a half dozen other components. The sidetone oscillator is keyed using the Forty-9er's key line. I found that the output fed through a 2.2 meg resistor to pin 8 of the LM-380 set a comfortable level. The sidetone board measures about one inch square and will fit nicely in the Altoids box.

Incidently, there is no magic in using the surface mount components and you might wish to try them on a small project such as this. I used a wooden toothpick to maneuver the components into positon for soldering with my trusty Weller equipped with a small tip.

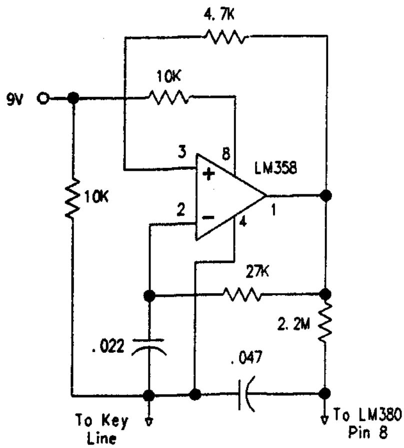


Fig. 1

Addition Number Two: VXO Tuning

To keep this mod simple I began to search the catalogs for a suitable tuning capacitor with a maximum capacitance of about 50 pf. In the Mouser catalog I spotted item number 24TR222 (Poly Film RF Tuner Capacitor). This capacitor measures .8" x .8" x .5" and has an oscillator section with a range of 5 pf to 59.2 pf. The only problem was that the capacitor only has a stub shaft that is threaded internally. To remedy this shortcoming required a trip to the local hobby shop for some brass tubing. (See Figure 2.) I cut a short section of 1/4 tubing and soldered a small washer to the end. From the inside of the "shaft" I used a screw to attach the extension onto the end of the existing stub. Incidently, make sure that when you order the cap you also order the mounting screws (Mouser

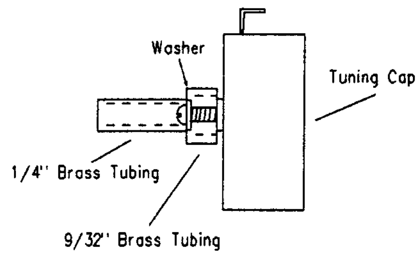


Fig. 2

48SS003 size M2.5 x 0.45 x 4 mm) when you order the tuning cap since they were difficult to find locally. To make the shaft more secure I also cut about a quarter inch piece of 9/32 tubing to overlap the joint. When I assembled the shaft extension I placed a small dab of epoxy on the shaft stub. The tuning range of the Forty-9er with this is about 3 khz. I found that I also needed to add a 5 pf capacitor from the crystal to ground (on the bottom of the board) to keep the output of the oscillator constant throughout the tuning range.

Addition Number Three: Keyer

Since I had just purchased a KC-1 Frequency counter/Keyer for one of my Oak Hills rigs I had a spare OHR Curtis based keyer board "spare". I discovered that the Oak Hills board would stack very neatly on top of the Forty-9er circuit board.

Repackaging

The last step was to repackage the little rig. It had ooutgrown the Altoids box, but I still wanted a minimum sized rig and also wanted to have a self contained battery. The solution was one of Ten Tec's enclosures. At the back of their T-Kit catalog is a partial list-ing of their aluminum boxes. I chose the TP-15 which measures h 1 1/2" x w 3 3/4" x d 3". As can be seen from the photograph everything can be coaxed into the case without too much difficulty.

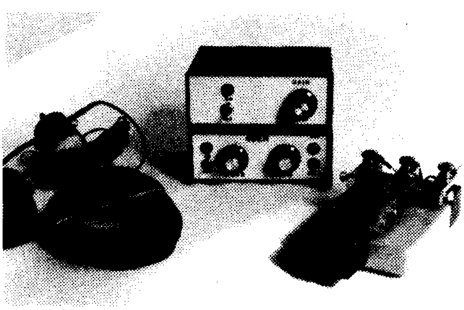
Never-the-less a few notes are in order. I used a small piece of plastic cut from a coffee can lid as well as small spacers to make sure that the bottom of the Forty-9er board did not make contact with the chassis. The spacers that separate the T/R board and the keyer board are 5/8 long. The small sidetone board is fastened by one corner. On the rear panel is a handkey jack, audio output (for external amp), external power jack, and antenna connector.

I'm still tinkering with the rig and have replaced RFC-1 with a toroid (T-50-2 with 24 turns of #24 wire). This mod was suggested by Alan Kaul, W6RCL and solved the shortwave broadcast reception problem. I also replaced RFC-4 with a toroid (FT-37-43 with 9 turns of #24 wire) as suggested by Wayne, N6KR to prevent the possibility of oscillation. Additionally, I swapped the location of RFC-6 and C-6 to place the shaft of the tuning capacitor at ground.

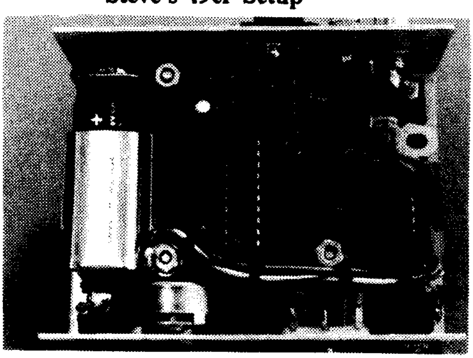
With a nine volt power supply my Forty-9er put out about 200 mw as measured on an Oak Hills WM-1 wattmeter. Using a twelve volt supply poweris about 600 mw. I regularly work the East Coast and have worked Texas to the south. The antenna I use on 40 meters is a center fed Zepp fed with ladder line with it's center at about 50 feet and the ends at about 25 feet. The tuner I use is an MFJ-986.

The photo also shows the external audio amplifier I use with the Forty-9er. It is also in a Ten-Tec TP-15 case and uses a 2 1/4 inch speaker from Radio Shack driven by a LM-386. It also contains it's own nine volt battery.

Many thanks are owed to Wayne Burdick from the QRP community for this splended little design. It's simplicity and impressive performance are remarkable.



Steve's 49er Setup

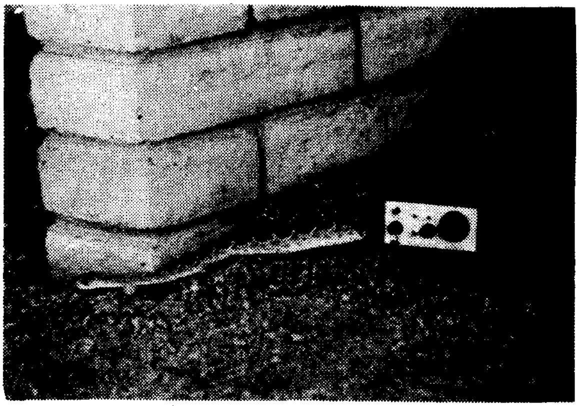


Interior View of Steve's Rig

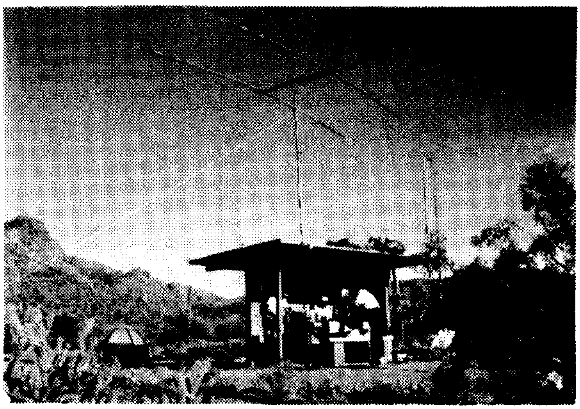
Chuck, Tom, and Gary Raising the Antenna at Riley

Tim Pettibone, AB5OU & Doug Hendricks, KI6DS Check Out the Altoids 40 Prototype Transceiver

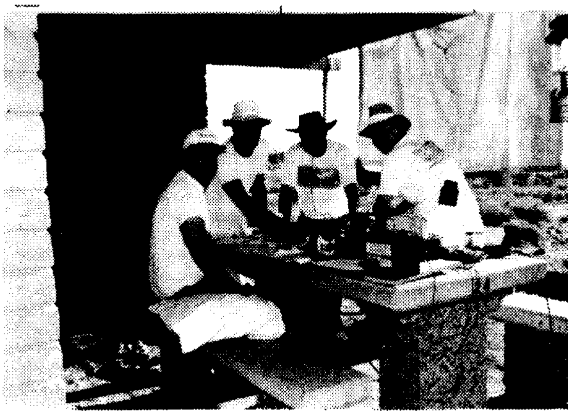
Chuck Adams, K5FO with his new friends from New Mexico



The Arizona Scorpions QRP Club had a deadly visitor. Yes, that is a rattlesnake.



The Arizona Scorpions Main Station

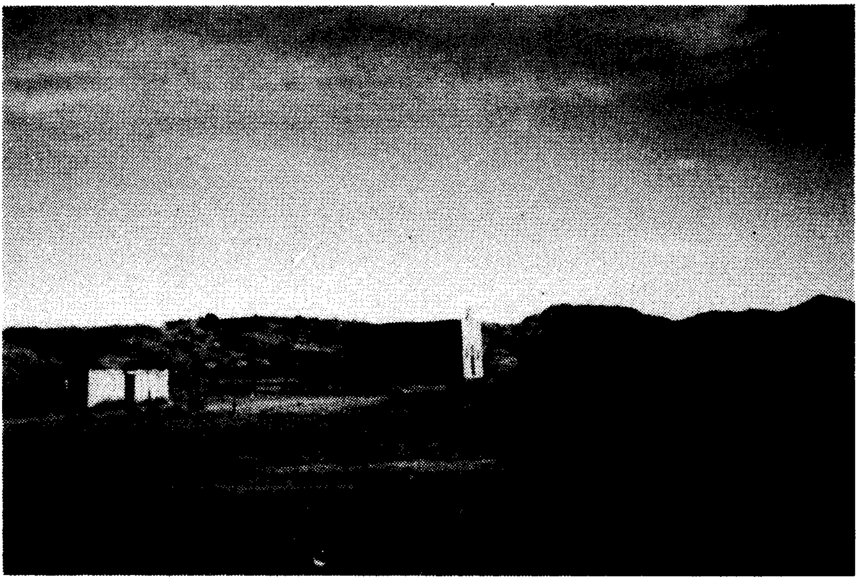


Rich KB7YEB, Brian W5VBO, Dave AAF5U, & Joe KC7NEV of the Scorpions

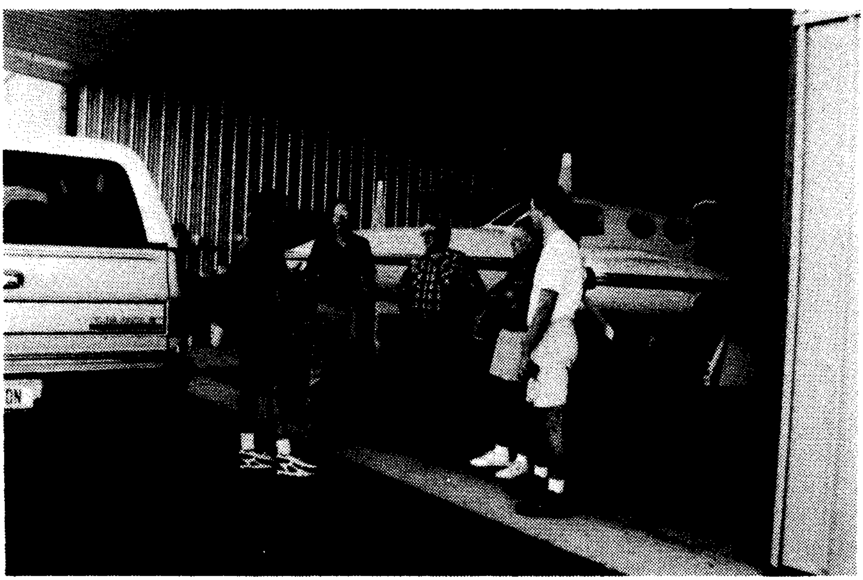
Mike W9VQB, Mike NQ7K, Rich KB7YEB & Dave AF5U

Brian W5VBO, Floyd NQ7X & Dave AF5U

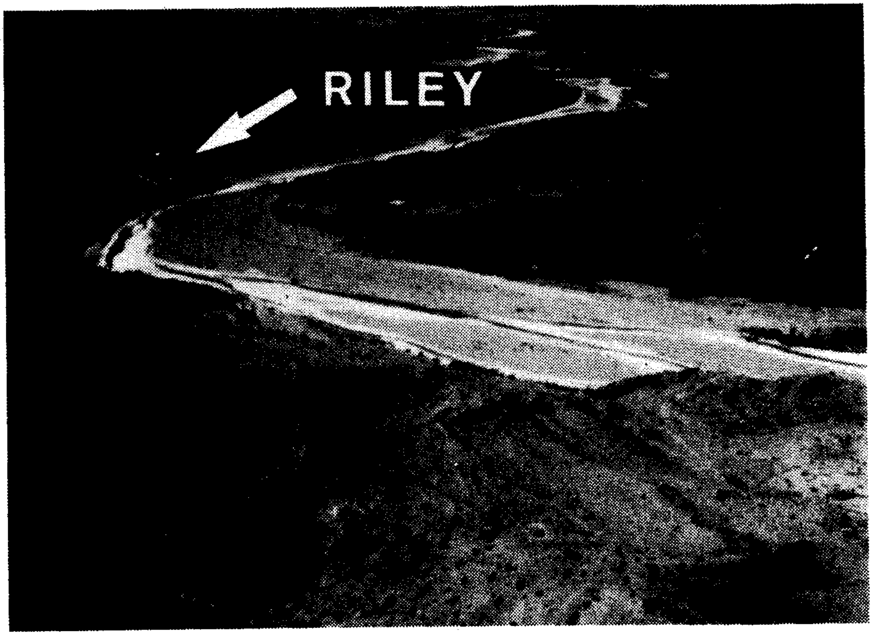
The Riley Setup



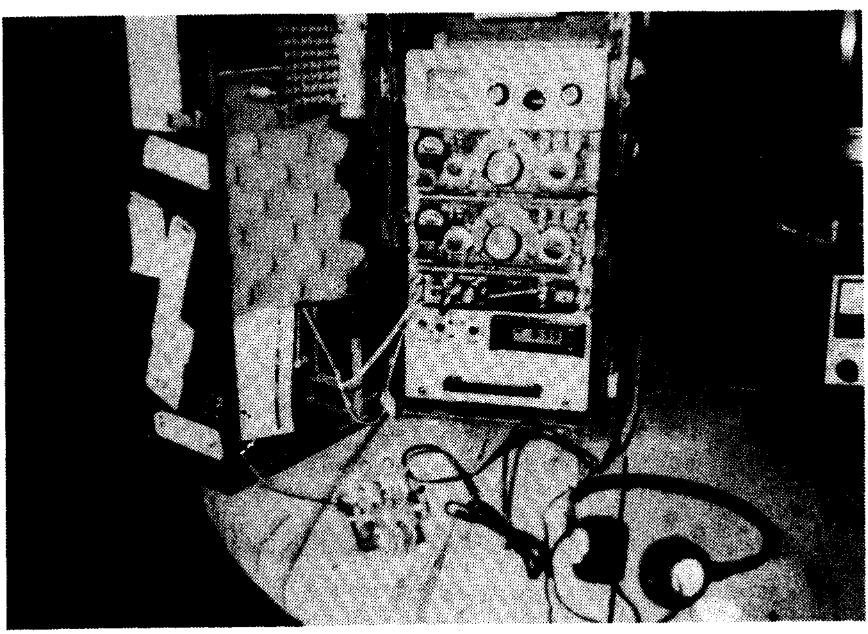
Downtown Riley, New Mexico, Population 0



The AB7PF/AM Crew:Steve Thompson, AB7PF, Kent Torell, AB7OR, Doug Pelley, WB7TUJ, Ron Thompson, AB7LL, and Stephen Marvin, KC7OMT



Riley, New Mexico as seen from the operating position of AB7PF/AM



Paul Harden, NA5N's Portable QRP Setup

Back Issues of QRPp

Back issues of *QRPp* are available in bound issues only. Volume I contains the 3 issues from 1993. Volume II contains the 4 issues from 1994, and Volume III has the 4 issues from 1995.

Volume I is 140 pages and is $10 plus $2 shipping for US addresses, $5 shipping for DX. *Volume II* is 296 pages and is $15 plus $2 shipping for US address, $5 shipping for DX. *Volume III* is 276 pages and is $15 plus $2 shipping for US address, $5 shipping for DX.

If you order all 3 volumes, the cost is $40 plus $3 shipping for US addresses, $10 for DX. To order, send your money order to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620. Make all checks and money orders out to Doug Hendricks and NOT to NorCal or QRPp. All prices are for US Funds only.

NorCal Keyer Kits

NorCal has made a bulk purchase of the Curtis 8044ABM Keyer Chip and is offering it with the Far Circuits Board and the Info Sheet for $17.00 postpaid. DX orders add $5 shipping. US Funds ONLY!! Make checks or money orders out to Jim Cates, NOT NorCal! Send your orders to: Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821.

Crystals

NorCal has made a bulk order of crystals. We now have the following frequencies available: 7.040 MHz, 7.122 MHz (Novice Band), and 10.116 MHz for 30 Meters. The price is $3 each, postage paid. Make checks or money order out to: Doug Hendricks, KI6DS, 862 Frank Ave., Dos Palos, CA 93620.

40-9er Kits

We have a kit for the 40-9er transceiver that was featured in the March (1996) issue of *QRPp* It was designed by Wayne Burdick and has had over 20 pages of mods and improvements developed by QRPers all over the world. All board components, PC Board (plate and silkscreened), 6 page manual, and a crystal of your choice, either 7.040 or 7.122 MHz, is $25.00 for US, $30 for DX. US Funds only. Please specify which frequency you desire. Extra crystals are $3.00 each. See the June 1996 issue of *QRPp* for mods and improvements. This design was the basis of the 1996 ARCI Dayton Building Contest and is an excellent learning kit. Send your orders to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Please make checks and money orders out to Jim Cates, NOT NorCal.

NorCal QRP Club

QRPp is published at Dos Palos, California 4 times per year: March, June, September and December. Subscription fee is $10 per year for US residents, $15 per year for Canada, and $20 per year for DX. To join the NorCal QRP Club send your name, call and address to Jim Cates. There is no charge for membership to NorCal QRP Club. To receive *QRPp,* you must subscribe and pay the fees. Send your money (US Funds ONLY) to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Please make checks and money orders out to Jim Cates, NOT NorCal.

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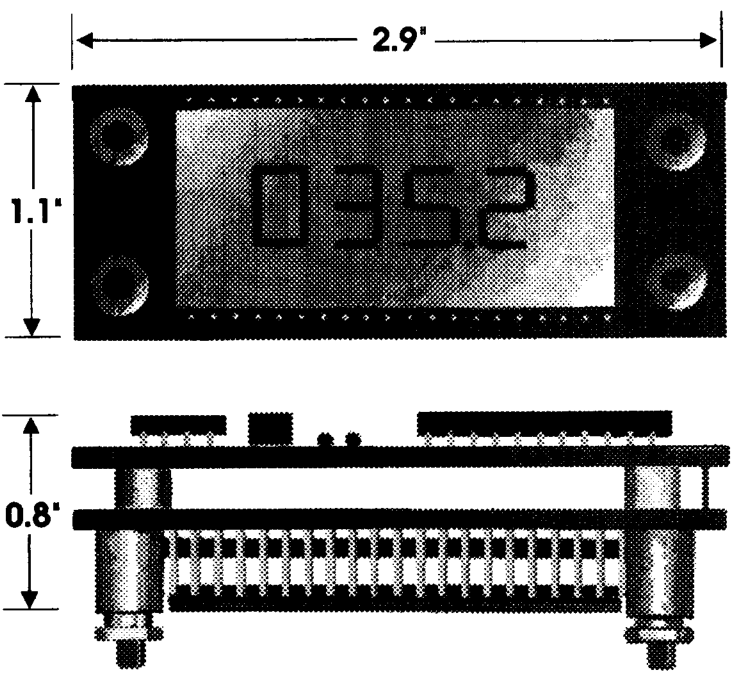
Volume IV, Number [illegible]

The KC-2

A Multi-function QRP Accessory: Keyer, Counter, S-Meter and Wattmeter

by Wayne Burdick, N6KR



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From the Editor

by Doug Hendricks, KI6DS
ki6ds@telis.org Phone: 209-392-3522

The summer has flown by, and the fall contest season is fast approaching. Don't forget to enter the QRP Afield contest sponsored by the New England QRP Club. You will notice a new feature this month, QRP Hints and Kinks, which will be an ongoing column conducted by Paul Harden, NA5N. If you have a hint or kink, send it along with a rough sketch to Paul.

I would also draw your attention to the first annual West Coast QRP Symposium to be held in conjunction with the ARRL Pacific Division Convention, Pacificon in Concord, California on the 19-20th of October. Please refer to the announcement on page 66 of this issue.

There are lots of good articles in this issue. Please keep them coming. QRPp is what it is because of those who contribute. Thank you for your efforts. NorCal has a couple of exciting projects coming, and look for an announcement in the December issue of another kit. Can't tell you what yet, but it will be an accessory that every QRP station needs. 72, Doug, KI6DS

The KC2: A Multi-function Accessory for QRP Transceivers

by Wayne Burdick, N6KR

Like many NorCal projects, the KC2 began as a discussion between club members at a NorCal meeting. (I think there's something special in the fries at the California Burger.)

Doug Hendricks and I were looking over a homebrew rig that had a built-in digital display. The unit worked OK, but had three characteristics that I felt thought could be improved upon.

First, it drew a lot of current, due to the use of LEDs. Next, it was around 3 by 4 inches—too big to fit on the front panel of the Sierra and most other rigs. Finally, it put out considerable RF noise because of the high-speed logic circuits and a system clock in the megahertz range.

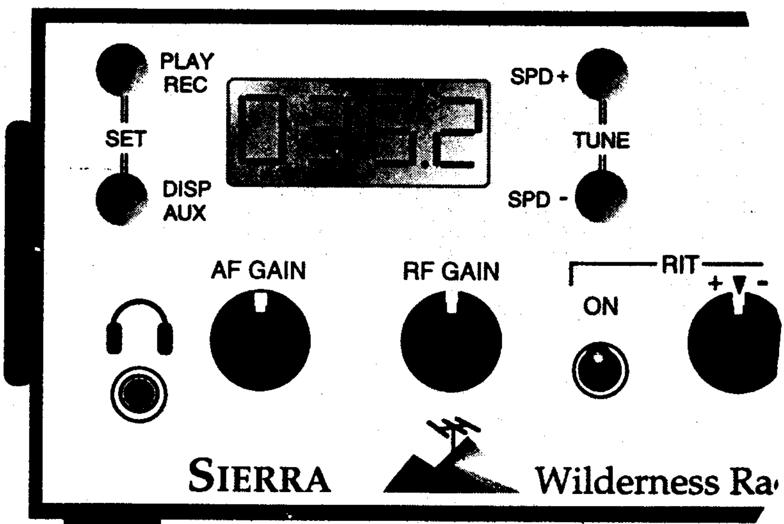
"Doug," I said, doing some mathematically- questionable shooting from the hip, "I bet I can make that thing 1 by 3 inches, draw only 4mA, and put out zero RF noise."

"DO IT!" he said, in his typical way. We brainstormed a bit and agreed that, if it could be done, it would make a nice club project. (Once you get Doug started you can't stop—you gotta finish the project. He'd make a great VP of engineering.)

A few weeks later, subconsciously forcing the issue, I put a three-position VFO range switch into my Sierra. The two upper ranges didn't match the dial. "Ooops. Now for some fancy thinking," I recall mumbling to my cat, Purry Mason. I started work immediately, and had the KC2 working just in time to demo for the QRP gang at Dayton.

Many of you are familiar with the Wilderness Radio KC1 keyer/counter, which uses Morse-code report of the operating frequency to eliminate the display and keep size to a minimum (0.8" by 2.5"). The KC2 is slightly larger, intended for rigs like the Sierra and Cascade that have a bit more panel space available.

Here's the really fun part: the KC2 also includes not just a frequency counter



The KC2 shown installed in a Sierra transceiver.

and keyer, but a bar-graph S-meter and digital wattmeter, too! For me, these features really spice up QRP operation. The drawing below shows how the KC2 looks installed in a Sierra.

Meeting the Challenge

To get the KC2 down to around 1 by 3 inches, I had to resort to a custom, 1"-tall LCD. I also had to use a stack of two boards, as shown in the illustration on the cover of this issue of QRPp.

Current drain became a non-issue with the use of an LCD. The LCD driver and LCD itself draw nearly zero current, and the rest of the circuitry adds only about 4 mA.

To eliminate nearly all digital noise, I used a 100kHz clock for the microcontroller, rather than the typical frequency of 1 to 4MHz. With the prototype KC2 mounted in my Sierra, I found that harmonics of the 100kHz signal could just barely be heard at the band edges, and only if I had the receiver's RF gain control turned all the way down. With normal background noise coming from the antenna you can't hear the KC2 at all!

This is a significant improvement over every other unshielded digital display I've encountered. The reason that it works is twofold: first, harmonics from the 100kHz clock roll off significantly in amplitude by the time they get into the HF range. Second, with the controller running at such low current drain, there is less energy in the edges to begin with. Rise and fall times are a bit slower. You could enhance this effect further by running the controller at 2 or 3V, but that would compromise other parts of the circuit.

The hardest part of the KC2 design was actually the firmware. Picture me with two days' growth of beard, red-eyed, hunched over a tiny 386 laptop. Fortunately, my wife was out of town and there were plenty of carrots in the refrigerator. I lived.

With only 1K of program memory available, I needed every optimization trick in the book. Also, with the processor running at only 100kHz, it's a challenge to keep display update and math routines from perceptibly slowing down other operations, such as keyer paddle input. Because the PIC has only one timer/counter, there are times when I/O must be polled rather interrupt-driven.

Here's the complete list of features for the KC2. Of course, the design continues to evolve and some features may change a bit by the time you read this.

* Size: about 1.1" tall by 2.9" wide
* Four-digit custom LCD with large, easy-to-read digits
* 100Hz counter resolution, with four programmable counter offsets to handle multi-band rigs (Sierra, Cascade); works with VFOs up to 6.4MHz
* Frequency counter calibration works just like setting a digital clock—no need to calculate offsets or enter data with the keyer paddle; each offset can be programmed for count-up or count-down
* Same keyer features as the KC1, except with push-button-access to speed, weight, and Iambic mode
* Bar-graph S-meter using the bottom row of 8 LCD segments; sensitivity control included
* Direct-reading digital wattmeter; reads up to 9.9W
* All configuration is done with switches, not via the keyer paddle, for compatibility with SSB rigs (e.g., the Cascade)
* Nonvolatile storage for CW messages and configuration parameters
* Auxiliary TTL-level output controlled by one of the panel switches

Circuit Details

The schematic for the KC2 can be found at the center of this issue of QRPp. One side of the page is the display board, the other the CPU board.

The display board is made up of the LCD, LCD driver (U1), and four switches.

The resistors in series with the switches are needed because the corresponding inputs to the CPU are also used as display-control outputs. When the I/O pins are used as outputs, the resistors protect the CPU should you happen to be holding down a switch while the display is being updated.

U2 on the CPU board is a Microchip PIC16C84 microcontroller, the same device I used on the KC1. This 18-pin DIP includes 13 I/O lines, a timer/counter, 1K of EEPROM program memory, 64 bytes of EEPROM for nonvolatile data, and 36 bytes of RAM.

The PIC is a RISC (reduced-instruction-set) computer with "pipelining," which means that internal fetch, execute, and other operations occur in parallel. The result is that the PIC is quite fast for a microcontroller, executing all instructions in one clock cycle. Even so, at 100kHz each instruction takes a whopping 40 microseconds! The device has extremely low current drain—a small fraction of a milliamp—when operated at this speed.

Q1 and Q2 form a VFO buffer. A simple amplifier is all that's required because, with a 100kHz CPU clock, the maximum allowable count frequency into U2 is only 6.4MHz. Two pins of U2 are used up by the frequency counter. RA4 is the counter input; RA3 is used as an external clock to manually extract the LSB of the count from the PIC's 8-bit prescaler. The prescaler can't be read directly.

Op-amp U5, R7, D1, R5 and C5 form an amplifier/detector for the S-meter. R7 sets the gain of the amplifier, while C5*R5 sets the detector filter's decay time.

The rest of the circuitry is a little tricky, allowing U2 to read four logic signals (DOT, DASH, B1, and B2) and two DC voltages (S, RF) using only three inputs (RB3, 4, and 5). Comparator U4 is used as a pair of one-shots for measuring the S and RF DC voltages appearing on pins 6 and 2, respectively. The S3 and S4 lines (RB0 and RB1) are used to enable the one-shots, one at a time. (Remember that there are resistors in series with switches S3 and S4 to allow these pins of U2 to be used as outputs as well as inputs.) In a similar fashion, the DOT and DASH lines are made outputs to enable reading of the B1 and B2 band-select lines. In this case, Q3 and Q4 function as the enable gates.

Construction

In order to make all of the circuitry fit in the given amount of panel space, I had to mount the LCD directly on top of the LCD driver chip. Both are soldered in—no sockets!—to keep the LCD at exactly the shoulder height of the push-button switches. This left no room for other components under the display, necessitating a second board for the CPU. The two boards are sandwiched together, then held in place with nylon screws and standoffs.

To make the electrical connection between the two PC boards (J1 and J2), I invented a primitive sort of "flex connector": seven short wires in parallel on the right-hand end of the stack (viewed from the front). As a bonus, these wires form a hinge that allows you to spread the two boards apart for testing or rework. At first I was skeptical about this assembly technique, but having spread the two boards apart more times than I want to admit, I have to say that I'm sold on it! To be safe, use of the hinge should be minimized.

Transceiver Interface

How many wires you'll need to bring out of the I/O connector, J3, depends on which functions you use. If you're using the KC2 only as a frequency counter, you'll need just three wires: power, ground, and the VFO input. If it's a multi-band rig with different band edges, add the B1 and B2 lines, which can then be grounded in combination to select one of the four VFO offsets.

To use the keyer, a few additional wires are needed: DOT, DASH, and KEYLINE. Unlike the KC1, the KC2 does not generate a sidetone, so there's no AF output or MUTE line. This seemed like a reasonable tradeoff since nearly all rigs that will be used with the KC2 have their own sidetone generator.

The KEYLINE output is active all the time—even when you're entering messages with the paddle. For that reason the KC2 includes a MSGREC output that can be used to optionally disable the transmitter's output when messages are being recorded. The manual will include suggested ways to use the MSGREC output.

The S and wattmeter functions each require one additional connection. The S-meter runs from the rig's S-meter amplifier—NOT from the AGC line—and an S-meter detector is provided on the KC2. This allows you to use the S-meter feature with any rig, regardless of how it derives its own AGC voltage.

The wattmeter input on the KC2, on the other hand, requires a DC voltage from an external RF detector circuit. The Sierra provides such a circuit. The RF detector should be located close to the final amplifier in all cases. Further interfacing details will be provided in the kit.

Operation

On power-up, the display shows the operating frequency, assuming you've programmed it correctly (described later). There are also special display modes for the S-meter (bargraph), wattmeter, message record/play, and configuration settings.

I tried to keep the complexity of the user interface to a minimum, hence the large number of switches. If I had tried to use only two switches, access to some functions would be complex and easy to forget.

Referring to the Sierra/KC2 drawing, note that the two switches on the right are used one at a time to vary the speed. If you press these two switches and hold them for one second, TUNE mode is entered, in which the rig is keyed and the display shows the rig's power in watts, up to a maximum of 9.9. For example, at 2.5 watts you'd see "P=2.5".

My early tests show that the reading is accurate to within 10 or 15% when the rig is operated into a 50ç load. The wattmeter reading updates continuously, so you can use it to align the transmitter. Unfortunately, there was no way to provide transmit power display during use of the keyer—that's just too many instructions at this processor speed to avoid perceptible delays. Instead, the display continues to show the S-meter reading or operating frequency, updating at each keying pause.

The switch at the upper left operates identically to the MSG switch on the KC1: press it one or more times quickly to play stored messages, and hold it in to re-record message memory. The display shows "PLY1," "PLY2" etc. during playback, and "REC1," "REC2," etc. during record.

The switch at the lower-left toggles between frequency and S-meter display with each short press. A long press toggles the AUX output on and off.

When you hold the two left-most switches in together, you enter SET mode, in which the keying weight, Iambic mode, and frequency offsets can be set. Complete details for setting VFO offsets, etc., will be provided in the manual.

Conclusion

The KC2 was a real challenge, combining a dense physical package and triple-somersault-with-two-twists firmware. But Doug and I both think it was worth the effort: this multi-function module is right in tune with the compact, low-current philosophy of the Sierra and other portable rigs.

If you build one, please send Doug or me your comments and suggestions. As with past club projects, I'll gather the input and refine the design as needed. I'm indebted to NorCal members for their continuing efforts in field testing these designs, which amounts to a learning experience for all.

I'd like to also acknowledge the help and support of Bob Dyer at Wilderness Radio. Bob purchased all of the parts for the KC2 and helped get them into kit form. After the field test run has been snapped up, look for the KC2 as a Wilderness kit.

Note to current and future Sierra owners: Wilderness Radio will be offering a replacement Sierra front panel that matches the KC2. The panel will work with the club version of the Sierra, too, although it is painted light blue, silkscreened, and has stiffening brackets on each side. Price has not been set as of this writing. Call Bob Dyer at 415-494-3806 for more details.

A Homebrew Spectrum Wavemeter

by Tony Fishpool, G4WIF

[Published with permission from Sprat 86, G-QRP Club]

I imagine, that many constructors cherished wish, is one day to own a spectrum analyzer. Unfortunately (though not if you are selling), even second hand they hold their price well.

So we tend to fall back on the humble absorption wave meter for spotting rogue emissions from our transmitter. Unfortunately this often takes much knob twiddling and waving(!) around to find the signal and it can only "display" one frequency at a time.

This project is basically a posh absorption wave meter (which in its most simple form is shown in Fig.1

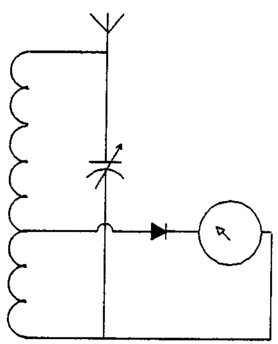


Fig. 1

It uses the same principles i.e. a tuned circuit which is adjusted to the same resonant frequency as the circuit or signal source under test. Instead of using a conventional variable capacitor, a varicap diode is employed.

While this is not a new idea and I have seen at least one article previously that used this principle (1). What I believe is novel, is the use of a timebase independent of that contained within the oscilloscope and the wide frequency coverage of the design.

What is needed to tune the varicap, is a steadily rising voltage, the higher it goes the lower the capacitance, and consequently the higher the resonant frequency of the tuned circuit.

If that rising voltage is also taken to the X axis of an oscilloscope that had its internal timebase disabled, the dot will travel from left to right, (i.e from low frequency to high). The diode D3 will rectify any voltage that has developed across the coil and if connected to the Y input of the oscilloscope, it will produce a "bump" somewhere along the trace. The magnitude of the bump will depend on the degree of coupling between the signal source and the coil.

One of my oscilloscopes does not have an external output from its timebase and the other presents a waveform that I found unsuitable and so I designed my own waveform generator. It is based around the ever popular 555 timer chip, often found at rallies for pennies. I needed two, so to keep the chip count down, I used a 556 which contains two 555's in one package.

Describing the many applications for the 555 would be a series of articles in itself, so I will concentrate on the principal aspects of the design.

The first timer (see Fig 2) provides a continuous square wave output the frequency of which is given by:-

$$\frac{1}{0.5 \times R2 \times C1}$$

Which in practice worked out to 135 Hz with the components chosen.

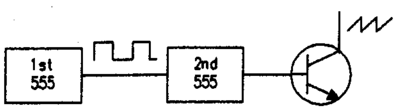


Fig. 2

This wave form would be enough to move the spot from the left to right on the oscilloscope but it would not spend very much time at all, between the two extremes which is where we want our "bump" to appear. So the second timer is used to produce a ramp or sawtooth waveform.

Each time a pulse from the squarewave generator arrives it triggers the timer, and capacitor C5 is charged via TR1 in a linear manner. It is the sawtooth waveform that is fed to both the varicap diode and the X axis of the scope.

The circuit Fig 3 shows the ramp generator on the left side of the diagram with the wave meter circuit on the right.

The coil (L1) was constructed using a 35mm plastic film canister as a former and close wound with 44 turns of 26 SWG enamelled copper wire and tapped as shown in fig 4. If your junk box doesn't contain one they are usually obtainable from film processing shops free, and are very useful for all sorts of things.

I also have dabbled over the years with printed circuit boards and given it up as a time consuming messy job. While a boon for the kit constructor, I feel that for one off production there are better, quicker methods. I generally use single sided copper clad board and mount the components with the copper side up. Leads that have to be grounded are simply soldered to the board, while other components are linked underneath, either by their own leads or short pieces of wire. Of course it is necessary to ensure that components are not inadvertently grounded on their way through the board to the other side and this is accomplished by removing the copper around the hole, I use a veroboard cutter (but a small drill would do).

I use a small piece of perf board to provide a template for drilling the holes for I.C.'s which are then cleared with the vero cutter. A small blob of glue holds the I.C. socket in place.

Whenever possible, I lay out the components in the same position as they appear in the circuit diagram and on more complex circuits I use a computer PCB design package to work out the layout that produces the least amount of leads that cross underneath the board. The layout diagram (Fig 5) shows this in practice, The dotted lines show the connections underneath the board. Of course this could be used as a basis for a PCB if you should wish. This method has been successful with R.F. circuits as well.

Where components need to be soldered to a non-grounded point on the copper side, a pad may be easily cut using a modified wood drill, see sketch, the principle of which originated from an article by G4FQQ (2) thanks Roy! (see Fig 6)

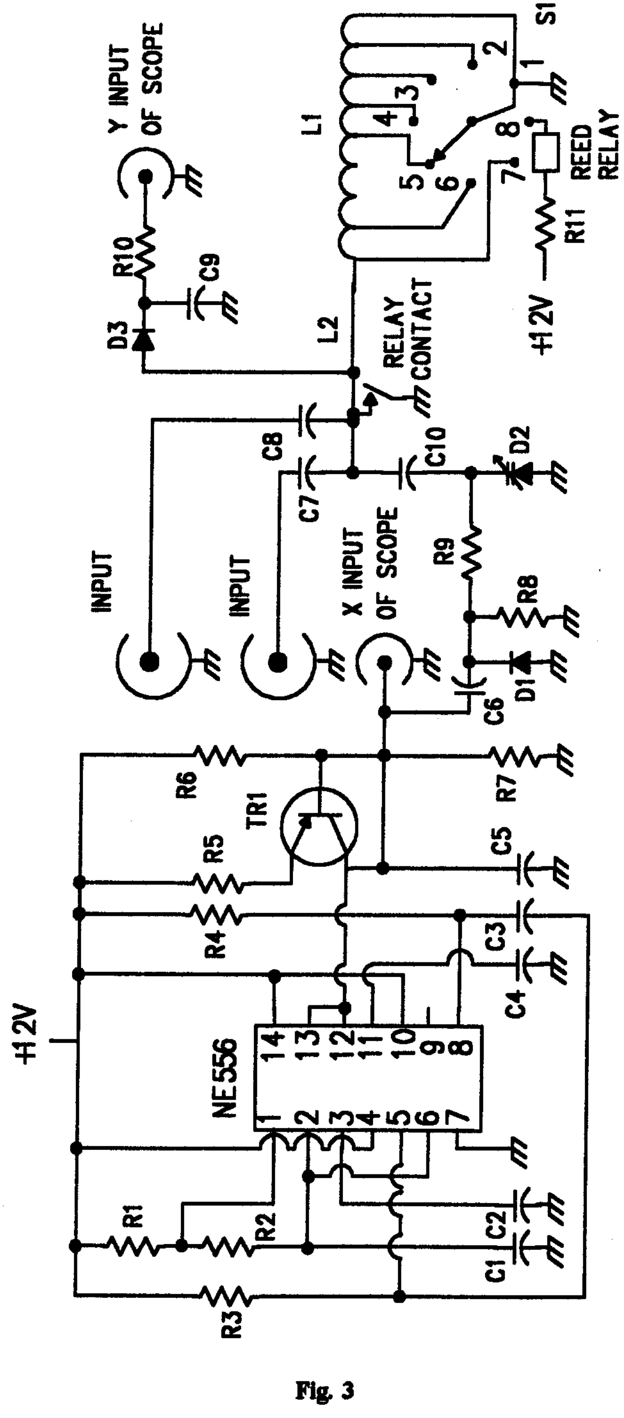

Y INPUT OF SCOPE
S1
L1
R10
C9
D3
L2
RELAY CONTACT
+12V
R11
REED RELAY
INPUT
INPUT
X INPUT OF SCOPE
C8
C7
C10
D2
R9
R8
D1
C6
R6
TR1
R7
R5
C5
R4
C3
C4
+12V
NE556
R1
R2
C1
C2
R3

Fig. 3

Using a grindstone I removed one of the outer cutting edges of the drill bit. Now by drilling a small pilot hole in the copper board and then (by hand) twirling the modified bit around in the hole, an island is formed onto which components may be fixed or a pin soldered so that components or leads may be attached. I buy the pins that are used to make up RS232 plugs, they are available quite cheaply in packets of 100 and provide convenient test points in circuits.

The varicap used was a BB212 and was chosen solely because I had one in the junkbox, others may be tried, and will no doubt work providing they have a similar capacitance swing. The BB212 is a double varicap, half of which is not used and the lead bent away or cut (see Fig 6). The cathode is connected via C10 to the end of inductor L2 which is actually just a piece of wire that becomes a significant part of the tuned circuit at high frequencies. The cathode is also fed with the sawtooth wave which is coupled to the oscilloscope Y axis, the anode is taken to ground. While in circuit, L1 allows the coverage of approximately 1.75 MHz to 66.3 MHz. With L1 virtually out of circuit (by being grounded by SW1 in position 7), L2 allows the analyzer to cover roughly 41 MHz to 82.5 MHz. If higher coverage is required, a means of grounding L2 further along is needed, and this is accomplished by soldering a small reed relay between a tap on L2 and ground. (see Fig 6.)

When SW1 is in position 8 it operates the relay and coverage of 64Mhz to 150Mhz may be achievable.

There is considerable overlap on each of the band positions. This is not a bad thing as the frequency response is not linear across the trace and neither is the Q which is better at the high end where there is a higher L/C ratio, affording a narrower bandwidth.

So we have a classic spectrum analyzer trace on the oscilloscope. But how do we know what frequency we are seeing? For owners of a signal generator this is not a problem. If the signal source is presented at socket SK1 and the signal generator is connected to SK2 it can be tuned until the generator signal overlays that of the unknown source. At that point the two signals beat together and the frequency can then be read off the generator scale. Alternatively, perhaps the station transmitter (and a dummy load) could be pressed into use instead. If the oscilloscope's controls were always returned to the same setting, a removable scale could provide calibration marks.

The capacitors C7 & C8 provide enough coupling to inject a signal into the analyzer without damping the tuned circuit too much. The table shown below indicates the approximate frequencies covered by each range as component variances will inevitably have an affect.

Ranges Covered

Range	From	To
1	1.75	3.5
2	3.5	6.9
3	6.2	10.6
4	10.5	20.1
5	18.1	33.5
6	32	68
7	55	90.5
8	90	155

Measuring amplitude and bandwidth of a signal is the job of a real spectrum analyzer but for a construction cost of around fifteen pounds is surprisingly effective.

Components List

R1	1K	C4	47nF
R2	27K	C5	0.1uF
R3	4K7	C6	0.1uF
R4	10K	C7	3pF
R5	10K	C8	3pF
R6	10K	C9	270 pF

R7	33K	D1	1N4148
R8	3M3	D2	BB212
R9	220K	D3	OA91
R10	10K	R11	470R
Small Reed Relay			
C1	0.2uF	TR1	BC214
C2	0.022uF	IC1	NE556

C3 10nF
SW1 1 pole 8 way rotary switch

References
(1) G4JST - Ham Radio Today - July 1983
(2) A PCB Pad Cutter by G4FQQ - Sprat Issue 74. Spring 1993

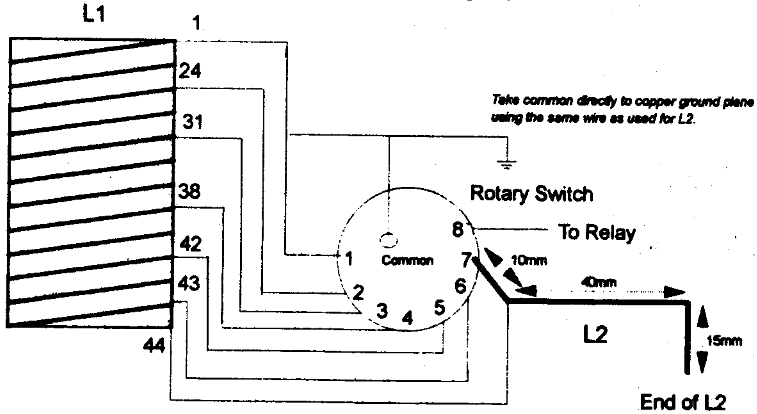
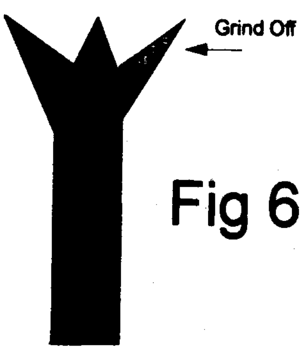


Fig. 4

Inductor / Switch Details

G4WIF SPECTRUM WAVEMETER



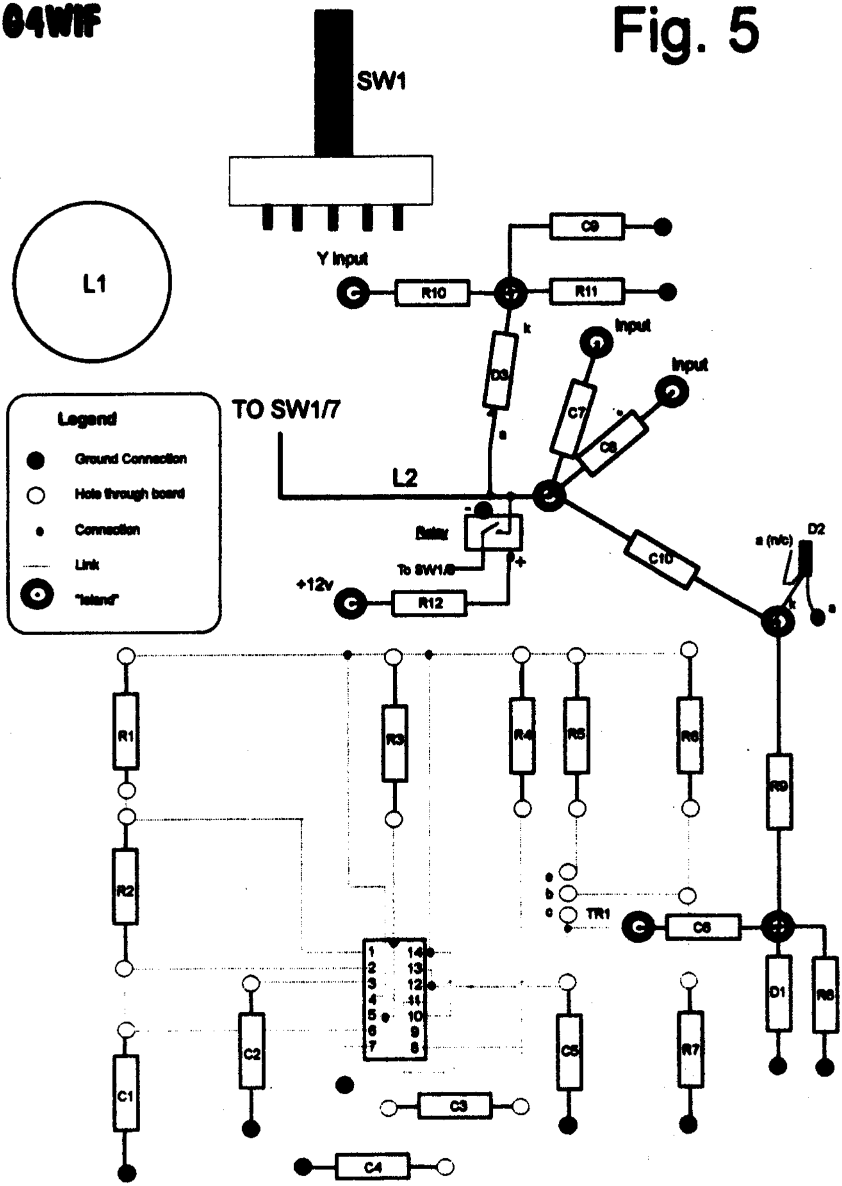
Modified Wood Drill

Fig 6

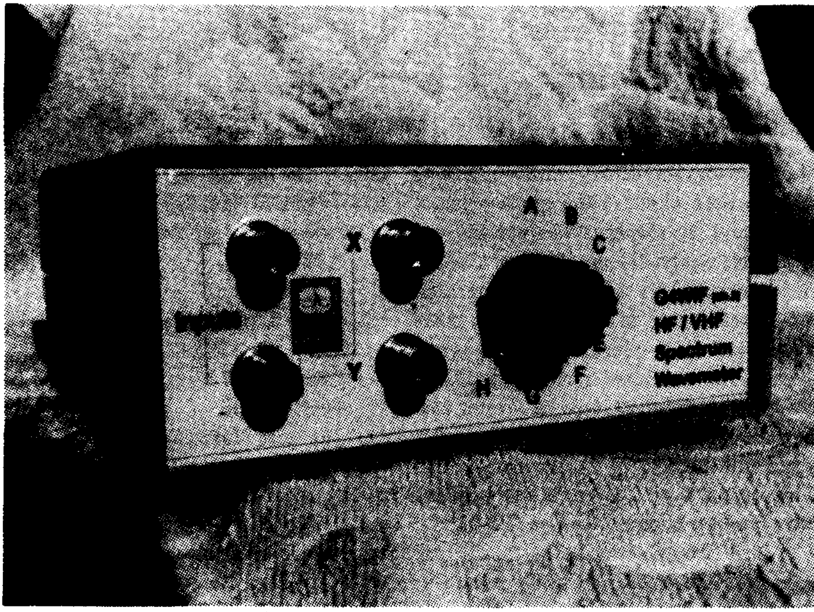
G4WIF

G4WIF

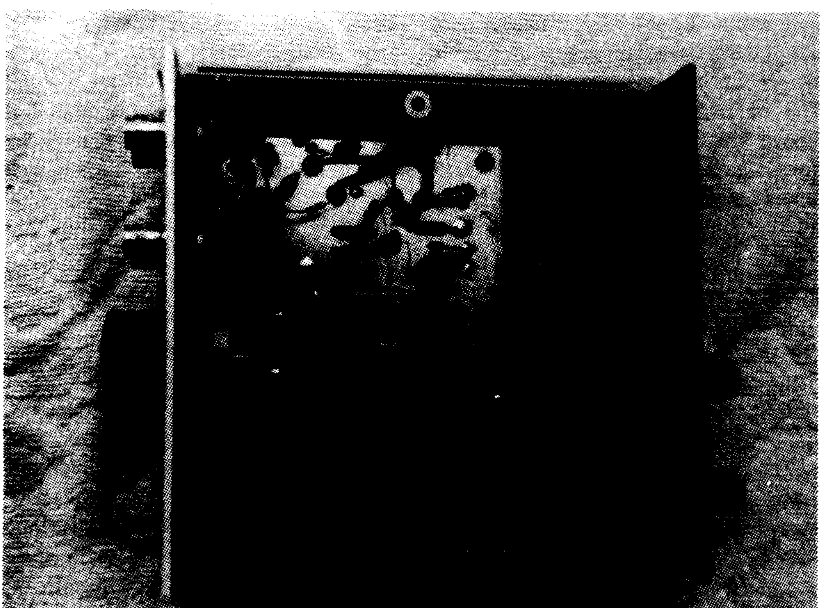
Fig. 5



SW1
L1
Y Input
C9
R10
R11
Input
Input
D3
C7
C8
Legend
Ground Connection
Hole through board
Connection
Link
"Island"
TO SW1/7
L2
Relay
To SW1/8
+12v
R12
C10
a (n/c)
D2
R1
R2
R3
R4
R5
R6
R9
TR1
C6
D1
R8
C1
C2
C3
C4
C5
R7



External View of G4WIF HF/VHF Spectrum Wavemeter



Internal View of G4WIF HF/VHF Spectrum Wavemeter

IMPROVED CASCADE CRYSTAL FILTER

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After building my Cascade I found that the crystal-filter bandwidth was greater than 4kHz at the quarter-power points and the response was not smooth. The filter design for the kits was the one used successfully in the prototype rigs. The crystals used in the prototypes, however, were not available in quantity when parts were purchased for the kits. So, a similar, but different, type of crystal was purchased for the first kit run (a similar problem happened on the second kit run). This crystal type had sufficiently-different characteristics to degrade the filter.

Not being satisfied with the response, I re-designed the filter using the same circuit, but with added shunt capacitors at each end. I used Wes Hayward's "G87" program which comes with his book "Introduction to RF Design". In the new design the crystals are not changed, nor is C89, but all other capacitor values change and one has to add the end caps. The resulting response is excellent...a very smooth passband of 300Hz to 2750Hz at quarter-power points, with steeper skirts. A table of new values follows:

CAUTION: These values are correct ONLY for the Cascade crystals having ALUMINUM CANS!

(all capacitors silver mica)

C77 - 82pF
C78 - 82pF
C80 - 82pF
C81 - 82pF
C82 - 120pF
C83 - 120pF
(do NOT change C79)

Add a 13pF (12pF will work) capacitor to ground from the mixer side of Y6, and another of the same value to ground from the mixer side of Y2.

Now, re-adjust the BFO trimmers, C19 and C90, for the narrower passband. I use 8.997395MHz for 20 meters and 9.000475MHz for 75 meters (measured at pin 6 of U1 with a 13pF 'scope probe). Using the modified filter I continue to receive glowing reports on my audio quality and my signal seems to cut through the noise and QRM better than before. It requires patience and care to remove the old capacitors, but the end result is well worth the effort!

72, Dave, W6EMD

Finer Resolution for the W6QIF Counter

by Ed Burke, KI7KW

In June of 1994, the design of a frequency counter developed by Jim Pepper, W6QIF, was described. The counter was usable for general applications, though it was targeted for the Norcal 40. It displayed operating frequency with 1000 Hz resolution and became available as a Far Circuits board.

I built two of them about nine months ago, and eventually put one in my Cascade transceiver, where I discovered that 1 KHz resolution was pretty much useless for SSB; I really needed 100Hz.

The changes described below will convert a W6QIF counter to 100 Hz, and the only part which needs to be changed is a fixed capacitor which is replaced by a trimmer. Other than that, you need an X-Acto knife to make the cuts, and a small amount of wire to make the jumpers.

The counter remains a four digit device. In its original form, it would display (for instance) 5,623,241 Hz as 5623. After it is modified to a 100 Hz device it will display the same frequency as 6232. The digit depicting MHz simply overflows so you will need to either mentally add it or, add a mark to the panel like the Ten Tec Scout.

Here are the changes:

1) Replace the 22pF cap which connects to pin 11 of U1 with a 10-40 pF trimmer.
2) Connect the trace which formerly went to pin 14 of U2 to pin 12 of U2.
3) Connect the trace which formerly went to pin 7 of U3 to pin 12 of U3.
4) Connect the trace which formerly went to pin 3 of U3 to pin 6 of U3.
5) Connect the trace which formerly went to pin 2 of U3 to pin 9 of U3.
6) Connect the trace which formerly went to pin 10 of U3 to pin 1 of U3.

About a one-half hour job for somebody who has done cuts and jumpers before.

Next, turn on the power, get an accurate lab frequency counter and adjust your new trimmer cap so that the waveform at pin 14 of U3 is precisely 100 Hz. Then you need to deal with wiring up the preset diodes. I can't give you wiring instructions; it depends on the specific frequency offset you are correcting. But you should be able to figure it out from the Norcal 40 example built into the Far Circuits board. It is fun to experiment with, too.

As to the theory behind the change, the original counter design divided the input frequency by 10 and counted for a gate time of 10 msec. With some paper and pencil work you can show that the result is (therefore) 1000 Hz resolution. The revised design divides the input frequency by 5 but counts for a gate time of 50 msec. You can show that the MHz digit overflows and 100Hz resolution is produced. Enjoy! Ed, KI7KW

ONE MAN'S 40-9er

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When I saw the announcement about the NorCal sponsored Dayton building contest earlier this year, I knew I had to compete. Furthermore, because this would be my first trip to Dayton, I wanted to make a good first impression.

Because the competition would be stiff, my version of N6KR's 40-9er would have to be unique. To complicate matters, I chose to build the rig using whatever parts I had in my junk box. I simply couldn't justify ordering all new components from the Mouser catalog as my Dayton budget was already seriously strained to the limit.

The first step toward creating my 40-9er was to sit down at my computer and make a rough drawing of the cabinet. Figure 1 shows the general layout I followed during construction. Everyone who saw the rig at Dayton commented on my homebrew dial mechanism and wanted more information Figure 2 is another computer drawing showing the parts that went into the dial. It's not nearly as com-

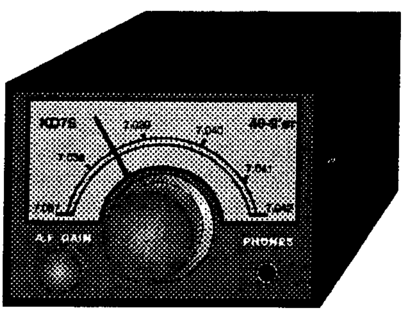


Fig. 1

plicated as it looks and I can rough one out in about an hour using common hand tools. The front and rear panels are made from double-sided PC board stock. The center panel is cut from a scrap piece of 1/8" ABS plastic sheet and the clear plastic window came from an ordinary sheet protector. The dial pointer was formed from a large paper clip. I used a small vernier drive mechanism (hamfest special) to turn the main tuning capacitor. The dial pointer was attached to a tiny flange on the drive. A temporary paper scale was taped to the rear panel and calibration marks were penciled in. A final scale was drawn using CorelDraw and glued to the rear panel. Then, the various parts were glued together using epoxy resin to complete the assembly. I have to laugh when I think that I used a 6:1 vernier drive to spread the 8 kHz VXO tuning range out over an 180 degree arc. Is this overkill or what?

Because I didn't have many of the electronic components specified in the original 40-9er design, I had to alter the layout somewhat. For example, I had some very nice little Toko, slug-tuned, shielded inductors in the junk box. I wanted to use one for the receiver front-end tuned circuit instead of the r.f. choke arrangement. The nominal inductance of the coil was slightly low so I rewound it. At the same time I added a 2-turn link for the antenna. This increased the out-of-band signal rejection and all but eliminated the foreign broadcast signals. Of course, it also meant I had to redesign the receiver PC board. Along the same lines, nowhere in my junk box could I find an 82 mH inductor for the audio filter. However, I did have several dynamic earplugs originally intended to be used with pre-Walkman style transistor radios. I measured the inductance and found them to be around 72 mH. I stripped one from it's pink plastic housing, soldered two pieces of solid hookup wire to the terminals and stuffed it into the receiver board. It worked just fine. I didn't have an LM380 audio amplifier IC on hand so I used the faithful LM386 instead. Finally, I couldn't find a suitable FET for use in the receiver muting circuit. However, I discovered a couple well used 40673 dual-gate MOS-FETs in a drawer. I connected both gate leads together and substituted it for the J310 device Wayne used. It

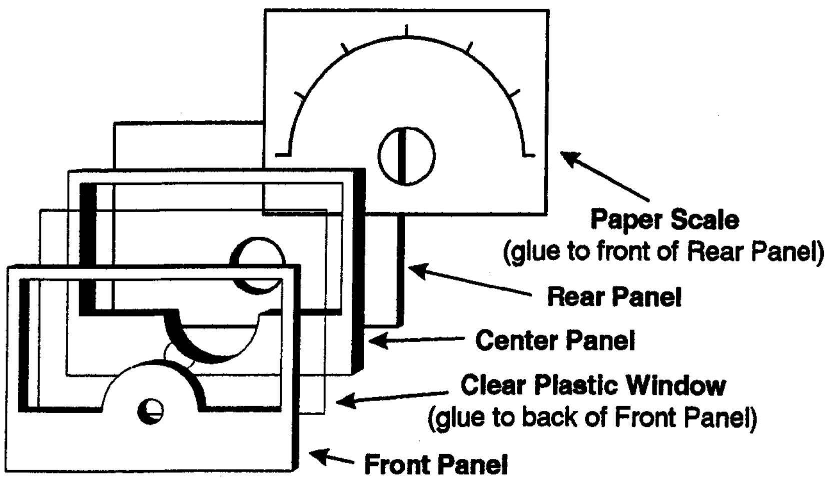
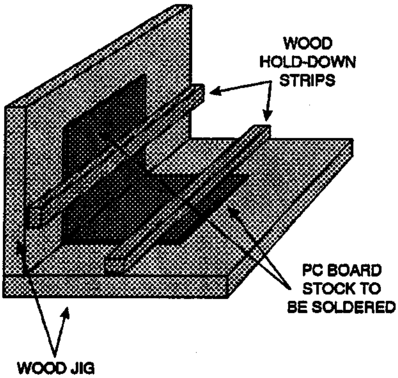


Fig. 2



worked very well and the QSK is smooth and silent.

Due to the unusual size and shape of the cabinet, I chose to build it from scratch using more double-sided PC board stock. Having built many boxes and cabinets over the years, I have discovered an almost foolproof method for getting everything lined up and square. Here's how.

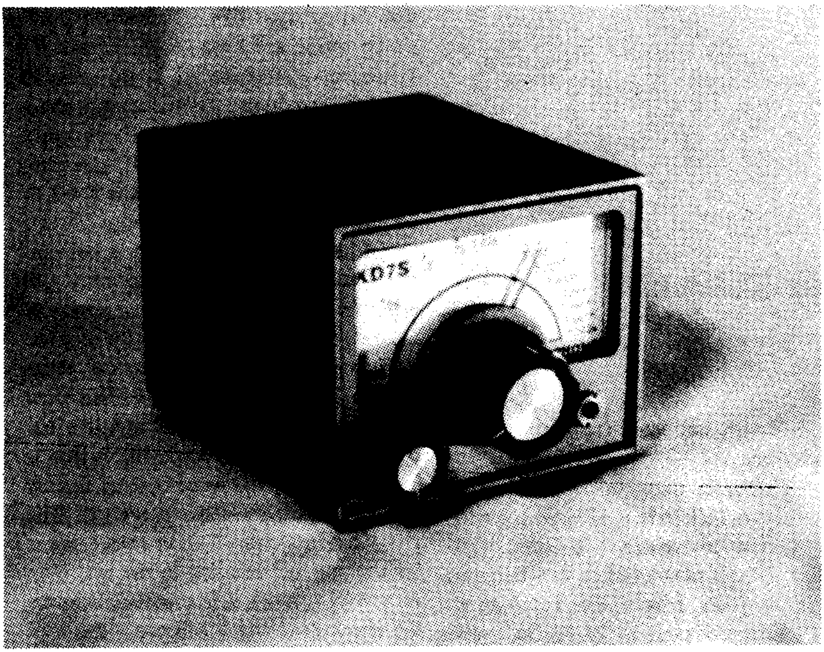
Figure 3 shows a home made jig I use during assembly. The wood hold-down strips are held in place with C-clamps and keep the PC board material from shifting during the soldering process.

The copper must be thoroughly cleaned and a liberal amount of high quality soldering flux applied to the areas to be joined just before soldering.

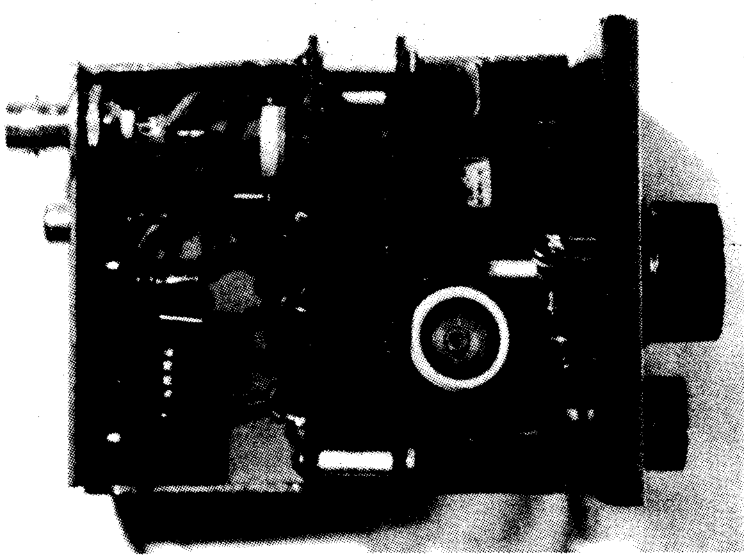
I have found that neither a conventional soldering iron nor a soldering gun can generate enough heat to do a good job. Instead, I use a small, hand-held propane torch with a pencil tip. I heat the entire area to be joined, all at once, and flow the solder as uniformly as possible between them. Then, while the solder is still molten, I tip the wood base up slightly to allow the excess solder to run off. The end result is a clean fillet of solder that is both strong and pleasing to the eye.

With a torch it is possible to apply too much heat which can cause the copper to wrinkle or separate from the fiberglass base. It is best to practice on some

Bill Jones, KD7S with his "Collins 49er", winner of the 1996 Dayton Building Contest. Steve Hideg Photo.



Exterior View, Bill Jones, KD7S Collins 49er, Steve Hideg Photo.



Interior View, Bill Jones, KD7S Collins 49er, Steve Hideg Photo.

scrap material before tackling the real thing.

Finish the cabinet with a coat of primer followed by a two or more applications of spray paint in the color of your choice. I painted my 40-9er Machine Grey. Doug Hendricks, KI6DS, referred to it as Collins grey.

In case you're wondering whether my little rig is nothing more than just another pretty face, rest assured, it is not. The first time I put it on the air, I snagged a station in Idaho, some 700 miles from my home QTH in central California. Since then I have worked stations from coast to coast with my best DX being well over 2,000 miles away. The power output is around 400 mW at 9-volts and just under one Watt with a 12-volt pack of "AA" cells. To say the least, it's a fun rig to operate.

When I returned home from Dayton, my wife asked if I made a good first impression at the QRP gathering at Days Inn South. I don't know whether I did or not, but my 40-9er sure did. It won first place in the building contest.

"TCF" Sideband/CW Transceiver for 40M

by Drew Diamond, VK3XU
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[Reprinted from **"Radio Projects for the Amateur"** by Drew Diamond, VK3XU, and published by the G-QRP Club with permision by the author.]

Here are details of a 40M version of the TCF transceiver. Transmitter and receiver sections have individual circuit boards, so these may be built as separate items (with small adaptions), or in stages, as desired. The prototype has the following measured characteristics:

Receiver:

Frequency Range: Nominally 7.0 to 7.250MHz.
Sensitivity: 0.5uV for 10 dB S+N:N
Reception Modes: SSB, CW, DSB and AM (as SSB)
Image Rejection: 70 dB
IF (4 MHz) Rejection: 60 dB
Incremental Tune: Nominally +/- 3 kHz.
Frequency Stability: Less than 100 Hz in any hour after warmup
Spurious Signals: One sub-microvolt spur at 6.998 MHz.

Transmitter:

Frequency Range: Same as receiver
Power Output: At least 2W, typically 3 W into 50 Ohms
Modes: SSB (LSB) & CW
Carrier Suppression: 35 dB
USB Suppression: 35 dB
Harmonics & Spurs: At least -55 dB at full output
Frequency Stability: Same as receiver
Load Tolerance: Withstands any load SWR without damage
Power Supply: +12 to +13.8 Vdc at up to 1 A.

Circuit:

The receiver section is in the lower half of the schematic. VFO and crystal oscillator, which are common to both the receiver and transmitter, and are shown in the centre. Transmitter is in the top portion.

An IF of 4 MHz was found by experiment to produce the cleanest transmit signal, and most spur free reception using cheap computer crystals. Complexity is greatly reduced by having identical Twin Crystal Filters (TCF), one each for transmit and receive functions.

Receiving:

Signals in th 7.0 to 7.25 MHz range are admitted via the top-coupled band pass filter, and applied to one of the NE602 inputs of the receive mixer. The VFO is adjustable from 1.0 to about 11.25 MHz, and is injected int the oscillator port at pin 6. The wanted product; IF at 4 MHz must negotiate the 4-crystal ladder filter, whose bandwidth is determined by the value of the five coupling capacitors: 33pF yields a BW of about 1.8 kHz. The filtered 4 MHz signal is again presented to an NE602 as product detector. Crystal derived oscillator (BFO) signal at about 3.9995 MHz is applied to the osc. port at pin 6. The 4.0 MHzoscillator crystal is pulled about 500 Hz low with a 0 uH coil to place it on the lower edge of the crystal filter bandpass, thus providing reception of LSB signals on SSB (the polarity of the sideband is reversed by the VFO mixing process), and single-
signal reception of CW signals. The low level audio product is applied to a conventional '741/'386 audio amplifier to pwer speaker or earphones.

The NE602 was designed originally by Signetics for mobile radio applications, and has a 500 MHz input bandwidth. To keep unwanted VHF signals out of the set, the receive signal is routed via the transmitter's low-pass filter.

For CW operation, and to allow for small netting errors on SSB, incremental tuning is provided on receive with a diode and capacitor at the source tap of the VFO tank coil. The effective value of capacitance is altered by varying the forward current through the diode. A 470 ohm resistor sources the diode on transmit from the regulated +6V which powers the balanced modulator, and thereby biases the diode to the same nominal current level as at the mid point of the 1K offset pot, which is sourced on receive from a separate +6V regulator (the 7806 chips provide a very stable 6V supply at these low current levels).

Transmitting: Microphone audio is amplified and applied to pin of an NE602 wired as a balanced modulator (input pins 1 and 2 are interchangeable, as are the output pins 4 and 5). "Carrier", at about 3.9995 MHz is applied to pin 6. The normally good balance is upset at audio rate, thereby producing double sideband (DSB) at the output of the balanced modulator. Static dc conditions of the NE602 may be altered with high value resistors and trimpot connected between pins 1 and 2, thus allowing for accurate carrier balance adjustment. For CW operation, the LM741 mike amplifier is unpowered, and balance is upset by inclining one side of the NE602 input to ground. Rise/fall time constant is determined by the value of C at pin 1; 1 uF, and series R, 22K, resulting in click free CW keying. Back-wave on CW is about the same as carrier suppression; -35 dB.

The DSB or CW signal emerging at pins 4 and 5 is applied to a second crystal filter which passes the USB only, the LSB being greatly attenuated. Another NE602 doing transmit mixing duty has VFO applied at the oscillator port where our 4 MHz SSB or CW signal is heterodyned as follows; 11.0 - 4 = 7.0 MHz, 11.25 - 4 = 7.25 MHz. Once again, the VFO mixing process inverts the sideband polarity from USB to LSB, the convention for 40 M SSB.

The resulting SSB or CW signal is raised in discrete increments through a three stage linear amplifier to about 2 W. A seven pole low pass cleans up any harmonics which may be (and probably are) present at the drain of the output power MOSFET.

CONSTRUCTION:

Equipment required: The usual electronics hand tools, drill-press (not essential, but handy), multimeter (preferably digital), power meter/load (or lamp), 40 M receiver, frequency counter and/or general coverage receiver.

The set must be housed in a metal box, so that external RF fields cannot enter and cause instability problems. My aluminummade "shoebox" measures 285 x 163 x 85 mm. Good rigidity and compactness is obtained by using three internal sub-chassis panels as shown. Most components are accommodated upon three home-made circuit boards, which are receiver, VFO and transmitter. The patterns are the same as for the TCF-80. If only the receiver, or transmitter sections of this project are rered, then i is only necessary to build that part, plus VFO and crystal oscillatqr (the crystal oscillator is located on the receiver board). As a transceiver project, it is suggested that items should be constructed in the order of; VFO, power supply (if required), receiver, then transmitter.

Constructgors generally agree that a home-made VFO should be housed in a metal box, preferably die-cast. In addition to RF shielding, the thermal time constant of the box is so long that the oscillator components are effectively buffered from any short term temperature excursions. A further useful degree of isolation may be had by mounting the assembly upon insulating material, or insulated spacers.

The VFO tank coil is wound on a standard 7.5 or 8mm (5/16") former, the kind with four or six tags is ideal. Drill a 1 mm. hole across the diameter of the former, 23 mm from the base. Uncoil about 1 m of #22 B&S wire from your spool, then fix the spool in a vice. Solder the wire to the tag corresponding to the ground end of the coil (check the circuit board layout). While maintaining tension on the wre, walk towards the vice and wind on five turns, then pull out sufficient wire to twist up a little pig-tail loop, which is the source tap. Now wind on the remaining 20-1/2 turns, making sure that each turn lies right next to the last, maintaining tension all the way. Cut the wre with about 50 mm spare, then carefully (this is the tricky part) poke the wire through the 1 mm hole, then pull through to keep tension on the coil. Solder teh "hot" end of the coil to the appropriate tag. The coil should be coated with Q-Dope (TM), Estapol (TM) or shellac.

Variable capacitors of any kind are hard to buy new, although the resourceful builder can generally locate something to suit (in my opinion, without great care, varactor diodes do not offer the high Q and stability required, whereas a good variable capacitor is the best and simplest part for the bariable element in a VFO). The capacitor shown is one of those well-made ceramic insulated screwdriver adjust 8 pF units with a homemade 1/4" adaptor fitted to the ferrule. If greater than 250 kHz range is required,, employ say a 10 or 12 pF. Now this is important; for a quality VFO, use the best construted variable capacitor that you can find, NPO, polystyrene, or silver mica capacitors in the VFO tank (do not use cheapo "mystery" ceramics, and avoid the tiny little NPO's - physically larger caps have more thermal mass), and an air delectric "beehive" trimmer. Improved stability is generally obtained if the fixed C part for the tank is made up of more than one capacitor. The prototype required 22 pF worth of N750 (negative 750 parts per million) C for very acceptable stability. See Reference 7 for further VFO notes. The components associated with RIT may be located on a small 4 tag strip soldered to the feedthru capacitor which carries RIT current into the VFO box.

The frequency dial consists of a disc of 3 mm opaque perspex, machined in a drill press using a tank-cutter. A hole saw would also serve. Temporarily fix a bolt and nut throught the resulting center hole, and reduce the disc diameter by mounting it in the chuck and applying a flat file to the outer edge of the rotating disc. The clear perspex "window" has slightly larger diameter than the dial disc, and is fitted into the front panel. By the same method, but with the file tilted, put a sight taper on the outer diamer of the window disc so that it is a nice friction fit into the front panel. The planetary drive is mounted upon a right angle fromed in a sub chassis. To take up any small mis alignment, the drive should be connected to the variable capacitor with an insulated flexible coupler. A short length of 6.35 mm (1/4") i.d. rubber fuel hose clamped between drive and capacitor is a workable second best. The dial disc may be illuminated with a 12V/100 mA dial lamp laced so that light is radiated through a 10 mm hole from behind. A cursor line is formed by positioning a length of wire between lamp and dial, thus projecting a line onto the dial.

With care, there is just room behind the VFO for an intenal power supply, although an external supply is recommended. If accidental wrong polarity is possible, (e.g. battery), connect a 1 A diode in reverse accross the power input terminals, and series connect a 2 A fuse between battery supply and the set.

Bifilar broadband transformers T1, T2 and T3 are made as follows; take two 300 mm lengths of #24 B & S (magnet) wire. Twist together at one end, and clamp that end in a vice. Twist the free ends together and clamp in the chuck of a hand drill. While maintaining tension, turn the drill until you have about three twists per cm., then pull the drill to set the pair. Now carefully loop the pair onto an Amidon FT50-43 core. About 11 loops should fit comfortably. Snip the ends leaving about 2 cm free. Remove about 1 cm of enamel from each wire, and with a meter on ohms, identify the "windings". For T2 and T3, connect the end of one winding to the start of the other as shwon on the circuit. Most toroidal transformers and coils are self-supporting. However, if additional support is required, they may bew fixed to the board with a small blob of non acid silicon glue.

Several different brands of c rystals were tried for the crystal filters and oscillator. Cheapest price (in lots of ten, we need nine - a spare would be handy) and satifactory performance was obtained with units branded Vigor from Tecs Computers (see Parts). For best chance of success, it is suggested that you use these also. In any event, try to not mix different makes of crystal in any one filter.

The IRF511 output amplifier must have an effective heatsink. A rectangular hole is cut in the circuit board so that the MOSFET may sink excess heat directly into the chassis. Remember to fit insulating hardware at the device/chassis interface. A solder tag under the mounting nut provides the drain connection. The source pin is soldered direct to the foil, then drain and gate pins are bent up at right angles to clear the board.

Although it may be useful to have an in-built ammetewr to monitor the PA drain current, meters are rather expensive, and once the standing current bias has been set up, there is rarely need to touch it again. The current drawn by the remaining circuitry (excluding dial lamp) is small. So if the power supply is external, and has its own meter, then none is required for the transceiver. In the absence of a metered supply, a 0.1 ohm resistor (or two paralleled 0.2's) in series with the drain supply line allows us to connect a multimeter across it and check the current. 100 mA will therefore cause 0.01V to dropped, 800 mA drops 0.08V, and so on. A 3 or 4 digit DMM will read these values.

ALIGNMENT:

Receiver: VFO range must first be

ferified. If a conter is available, simply connect the VFO to the counter input and measure the frequency. (Note; if checking the VFO as a "stand-alone" assembly, in order to fully test the unit we should hay-wire the RIT components and 7806 regulators into the circuit and replace the cover). Adjust the 25 pF VFO trim capacitor so that a range of a little less than 11.0 to 11.25 MHz is generated. Check that the RIT pot gives a smooth receive frequency adjustment of about 3 kHz each side of mid pot travel. Under normal conditions, ten minutes of warm up operation should have the device generating a satisfacgtorily stable signal. If for some reason, the correct VFO range cannot be obtained, change one of the fixed tank capacitors, larger or smaller as required.

No counter? Listen for the VFO signal on a general cov erage receiver and adjust as describ ed above. A short clip lead inserted in the VFO output connector should radiate a detectable signal. With the perspec window removed, the dial may be calibrated by applying rubon numbers onto the opaque disc at (say) 50 kHz increments.

Connect an antenna to the input. Peak the two 55 pF trim capacitors at the receiver input filter for best sensitivity/ flatness across the band. The receiver should be responsive. At moderate loudness, SSB and CW signals should sound clean, without perceptible distortion or hum.

TRANSMITTER:

Set the MOSFET bias pot for minimum voltage, the balanced modulator pot to mid-range, and the VFO to 11.1 MHz (to produce 7.1 MHz). Connect the output to a 50 ohm dummy load (a 12V/250 mA lamp will do). Disconnect any dial lamp if you are doing your current measurement with a power supply ammeter. Selectg CW mode, and switch to send. Adjust the MOSFET bias voltage so that something less than about 100 mA of standing (no signal, or "idling") drain current fllows i.e., class B operation. Close the Morse key. Current should increase. Adjust the 55 pF trim capacitors at Tx Mix. and the collecgtor tank of the 2N2222 amplifier for maximum RF output. Current should now be about 800 mA, giving about 2 to 3 W RF output across the band. Open the key. While listening to the signal on another receiver, adjust the balanced modulator pot for carrier null. You should obtain a clearly defined null as the carrier is balanced out. The signal at the test receiver must not bew so strong that the null is masked. Keyed CW should have a pure note, with no cliocks, chirps or ripple.

Switch to SSB mode. Plug in a radio type PTT dynamic microphone. While talking, increase the mike gain pot until the drain current flicks up to about 800 or 900 mA on voice peaks. Listen to the SSB signal on another receiver (don headphones to avoid feedback). It should sound clean, and be free of splatter, clicks, hum or other unpleasant noises. If an oscilloscope is available, view the RF waveform. It should have nicely rounded peaks, without bright spots anywhere on the envelope, and no significant "carrier" with mike gain at minimum.

Set the RIT pot to mid travel. On transmit, measure, as precisely as you can (preferably with a DMM), the voltage at the junction of the two 1N914's. Now switch to receive. Adjust the RIT pot to read exactly the same voltage, then slacken off the RIT knob grub screw and position the pointer to a caibration mark at 12 o'clock. Transmit and receive frequencies will now be the same at the nominal midpoint of the RIT pot.

In actual use, when contact has been established with another station, any necessary receive frequency adjustments must be made with the RIT pot. Leave the main VFO control untouched. When operating CW, about 1 kHz offset will be necessary to obtain a pleasing "beat note".

AN AFTER BURNER

Two watts into a dipole antenna should yield good interstate (and possibly NZ) SSB and CW contacts, although the going may sometimes be rough under poor conditions. As a follow-up project, the output power may be raised with a linear amplifier. One similar to the 25 W job described in Ref. 6 is suggested, with the addition of a relay with two sets of change over contacts to bypass the amplifier during recieve.

PARTS

All conventional components are available from the usual electronics suppliers. The crystals were purchased from Tecs Computers (03) 562 9501. In addition, radio type components, including Amidon cores and trim caps may be be ordered from Stewart Electgronics (03) 543 3733, Daycom (03) 543 6444, Truscotts Electronic World (03) 723 3860 and Electronic Disposals (03) 723 2699. Some perspex vendors will supply small off-cuts, look up perspex in your local yellow pages. Dick Smith can supply a planetary reduction drive for the dial (but check for adequate shaft length).

TROUBLESHOOTING:

Some relevant dc and RF voltages are shown on the circuit to aid in any necessary troubleshooting. Voltages which differ greatly should indicate the problem area. If, after earnest efforts, you cannot get your project to work satisfactorily, please write, and all reasonable assistance will be gladly returned. An appropriately sized SASE would be appreciated.

REFERENCES AND FURTHER READING:

1. NE602 Primer - Carr, Elektor Electronics, Jan. 1992.
2. Sideband Can Be Simple! - Price, G4BWE, Rad Com, Sept. 1991.
3. A Miniature SSB Transceiver - Greierson, G3TSO, Rad Com, June/July 1991.
4. QRP SSB/CW Transceiver for 14 MHz - Hayward, W7ZOI, QST, Jan. 1990.
5. Designing and Building Simple Crystal Filters - Hayward, QST, July 1987.
6. 25 W MOSFET Linear Amplifier - Diamond, VK3XU, AR, Jan. 1991
7. Some Practical Tips on VFO Construction - Diamond, AR Jan. 88.
8. "TCF" SSB/CW Transceiver for 80M, AR Oct. 1993.
9. Multi-band Phasing Transciever - Hey, Rad Com July-Aug. 1993.
10. The "Tiny-Tim" 3.5 MHz SSB Transceiver - Walford, Practical Wireless July-Aug, 1993.

PARTS:

Capacitors: All 16V or better

2	3.3 pF NPO
2	10pF NPO
1	8 pF Variable (see text)
1	22pF N750
1	25pF "beehive" air trimmer
1	27pF NPO
2	33pF NPO
10	68pF NPO
4	55 pF compression trimmer
1	120 pF poly or ceramic
7	220 pF poly or ceramic
1	330 pF ceramic
1	390 pF ceramic
1	560 pF ceramic
2	820 pF poly or ceramic
2	1000pF feedthrough
1	3300 ceramic
1	0.01 uF ceramic
29	0.1 uF ceramic
2	1uF electrolytic
1	1uF tantalum
5	10uF electrolytic
1	33uF tantalum
4	100 uF electrolytic
1	680 uF electrolytic

Resistors: all 1/4 W

1	0.1 ohm
1	1 ohm
2	4.7 ohm
7	10 ohm
1	47 ohm
1	56 ohm
4	100 ohm
3	470 ohm
1	680 ohm
1	1K
1	1K Linear Pot
2	2.2K
1	4.7K
2	5K flat mount trimpots
1	5.6K
1	10K
4	33K
1	47K
2	50K Audio Taper Pot
2	56K
3	100K
1	220K

Semiconductors

2	MPF102, 2N5457, etc.
2	2N2222, 2N3904, etc.
1	2N3053, BFY50, etc.
1	IRF510, IRF511, MTP4N08, etc.
4	NE602AN
2	LM741
1	LM386
2	7806/1A Voltage Regulators
2	6.2V/400mW Zener Diodes
3	1N4148 or 1N914 Diodes

Miscellaneous:

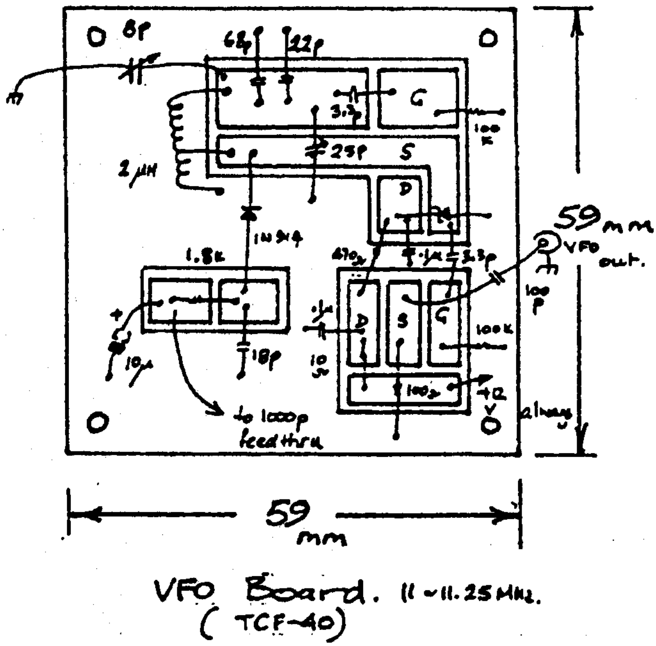
Case to suit, or sheet aluminum to make, die cast box approx. 122 x 41 x 66 mm., Amidon T50-2 cores (8), FT50-43 cores (3), Vigor 4.0 MHz crystal (9 all identical), 6 or 4-pin 8 mm. bakelite coil former, dial drive, coupler, perspex, 12V lamp or holder, 8-pin DIL wire wrap sockets (7), single or doubles sided circuit board material, speaker, mike socket, antenna coax connector, phones socket, key socket, RCA plug and socket for VFO, power supply terminals, knowbs, 12V relay with two sets of c/o contacts, miniature SPST and DPDT switches (one each), miniature 50 ohm coax, #22, #24, #26 B&S enamelled wire, chassis items including IRF511 mounting hardware, screws, nuts, washers, and VFO spacers.

[The schematics, pcboard pattens and parts placement diagrams can be found in the center of this issue. If you would like to order the complete book by Drew Diamond, contact George Dobbs, G-QRP Club. The cost of the book was $15 dollars at Dayton, but I don't know what the shipping costs would be. Please contact George at the following address:

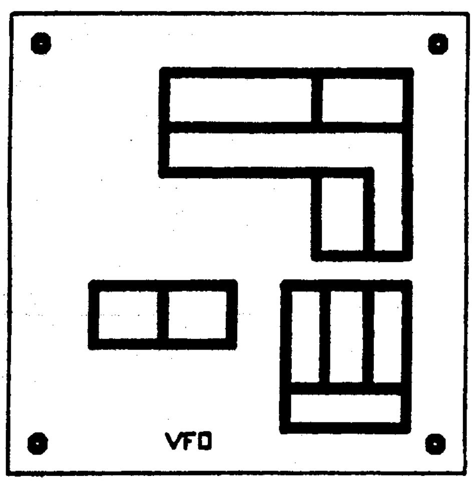
G-QRP Club
St. Aidan's Vicarage
498 Manchester Road
Rochdale, Lancaster
0L11 3HE England
Telephone and Fax: 01706-31812
Overseas: +44 1706 31812
Internet: g3rjv@gqrp.demon.co.uk

While you are at it, you should subscribe to the excellent QRP Journal, SPRAT, which George edits, and was the inspiration for QRPp. It is in my opinion the very best QRP journal in the world. Subscription rates are available from George.

I would like to thank Drew Diamond for being so very gracious as to allow QRPp to reprint his excellent work. The book that it came from is an excellent addition to your library. It is filled with projects that I can't wait to build. VK3XU is a very well known QRPer in England, Canada, Australia and New Zealand, but a very well kept secret in the US. Hopefully this article and his book will change that. Thank you Mr. Diamond. Doug, KI6DS]



TCF VFO Parts Placement



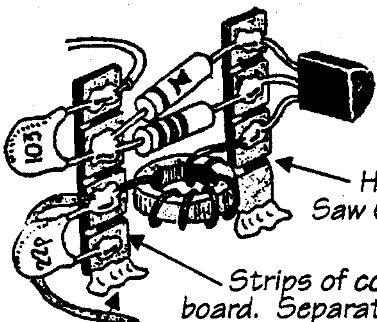
TCF VFO PCB Pattern

QRP Hints & Kinks

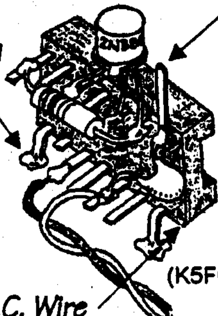
#1

Contributors this issue:
Chuck Adams, K5FO
Paul Harden, NA5N
Doug Hendricks, KI6DS

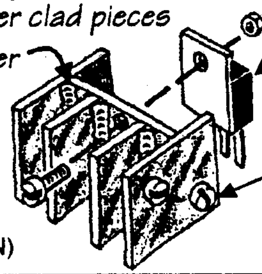
Some "Ugly Construction" Ideas



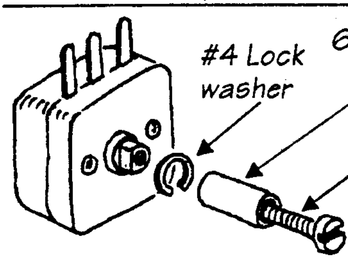
(NA5N)



(K5FO)

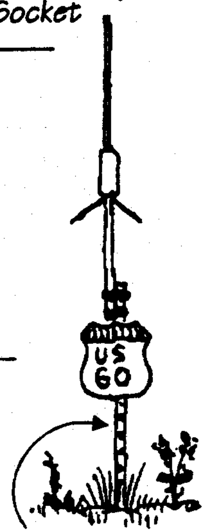


(NA5N)



(KI6DS)

Making a ¼" shaft for poly-film variable caps with metric threads

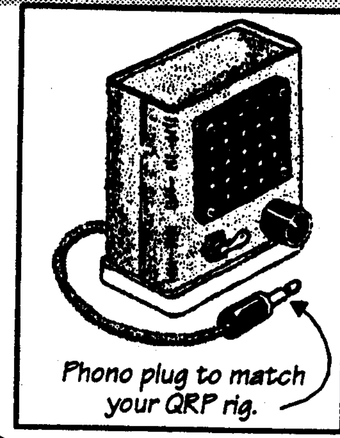


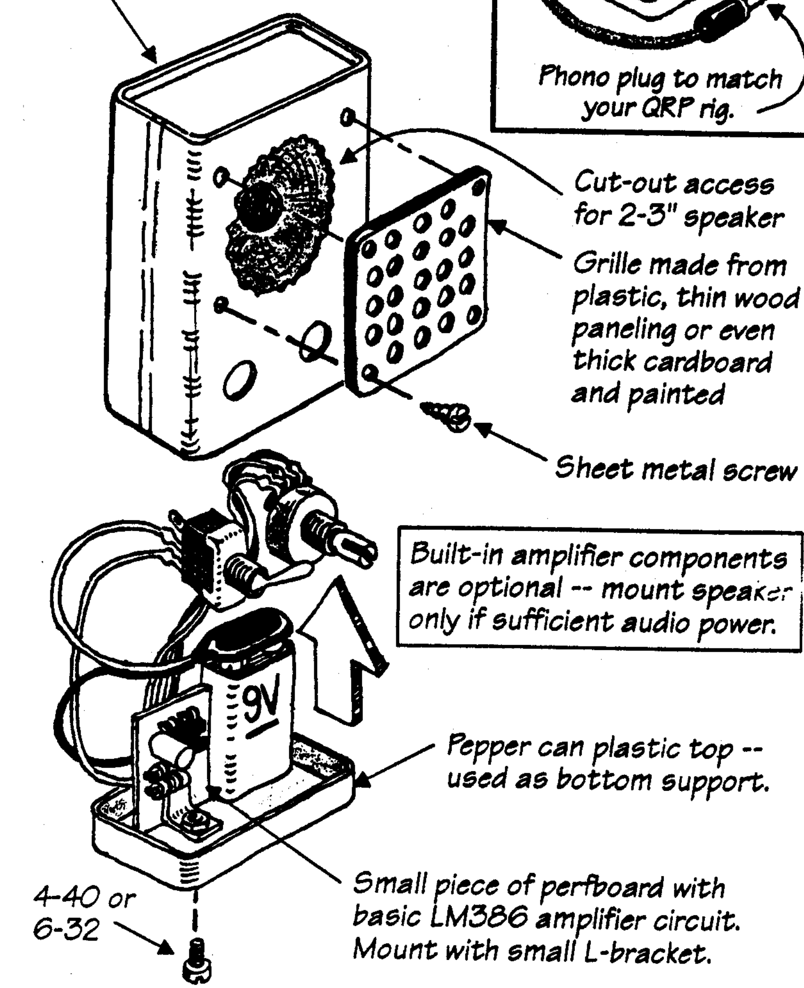
Highway markers make GREAT supports for trap verticals

(Anonymous)

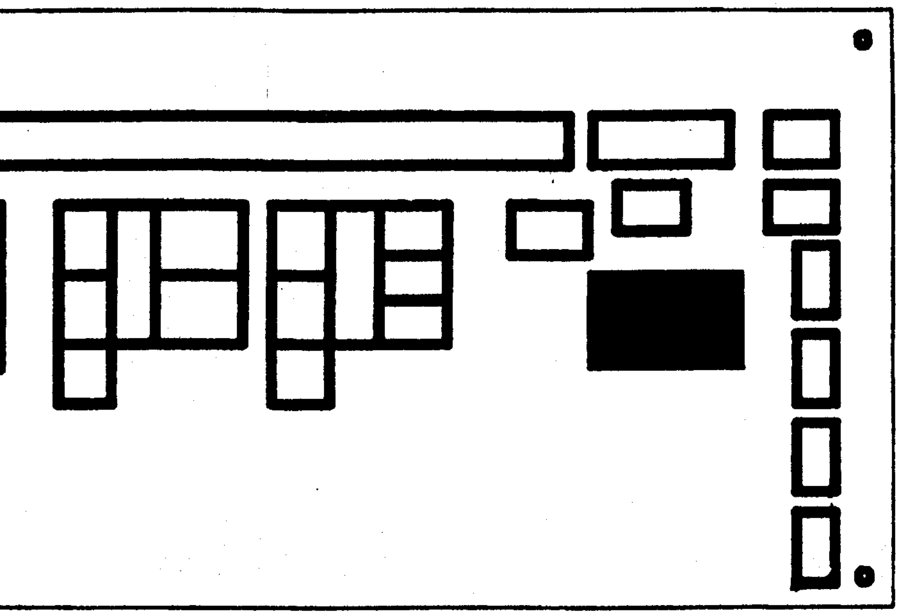
More QRP Hints & Kinks

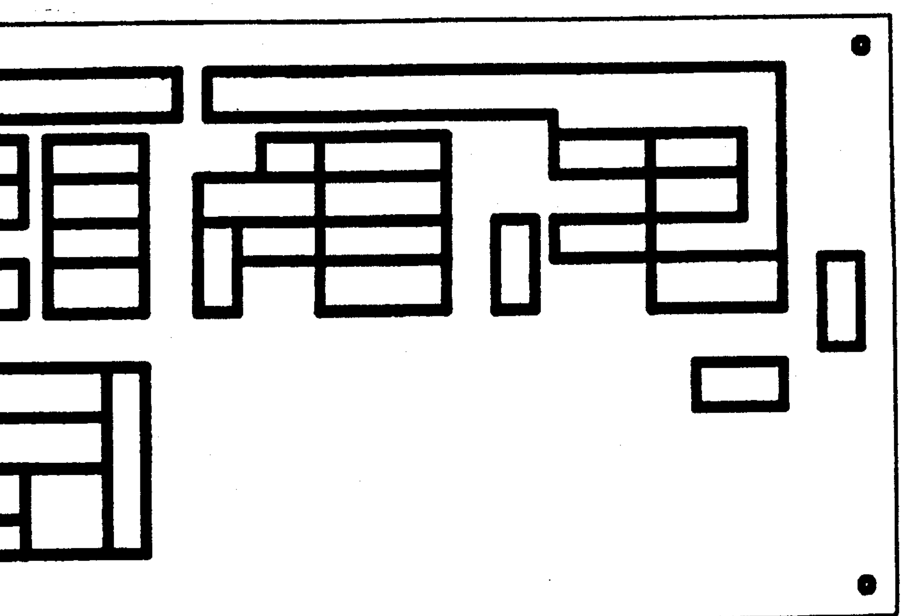
WEEKENDER PROJECT -- Build a Mini-External Speaker

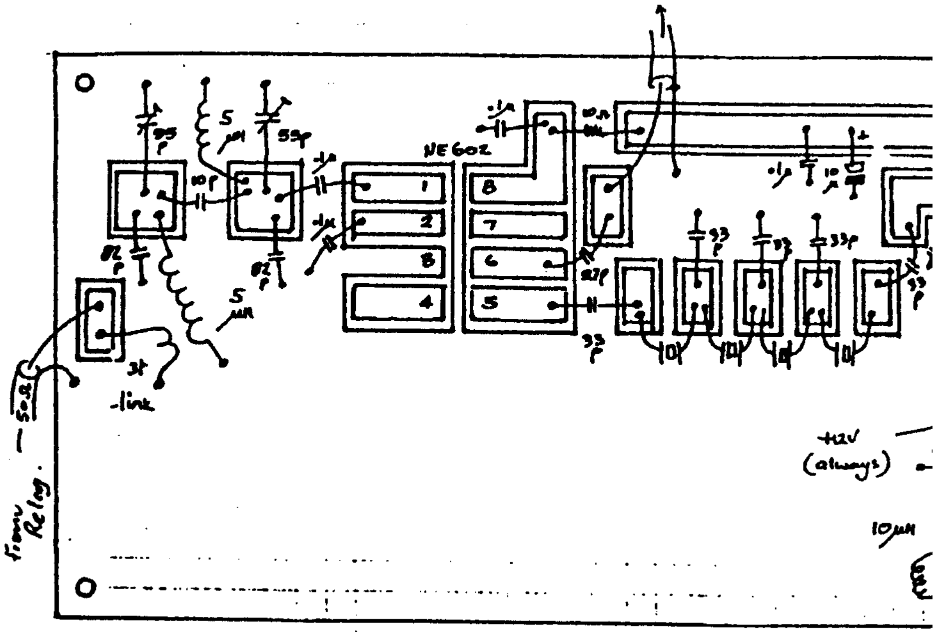


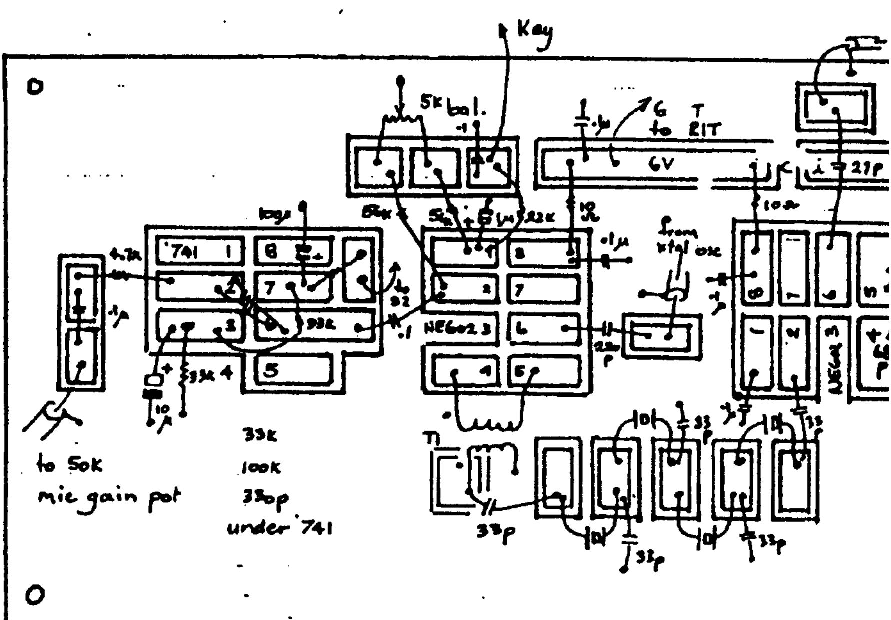


Send your ideas to:
Paul Harden, NA5N • POB 757 • Socorro, NM 87801 or Doug Hendricks, KI6DS

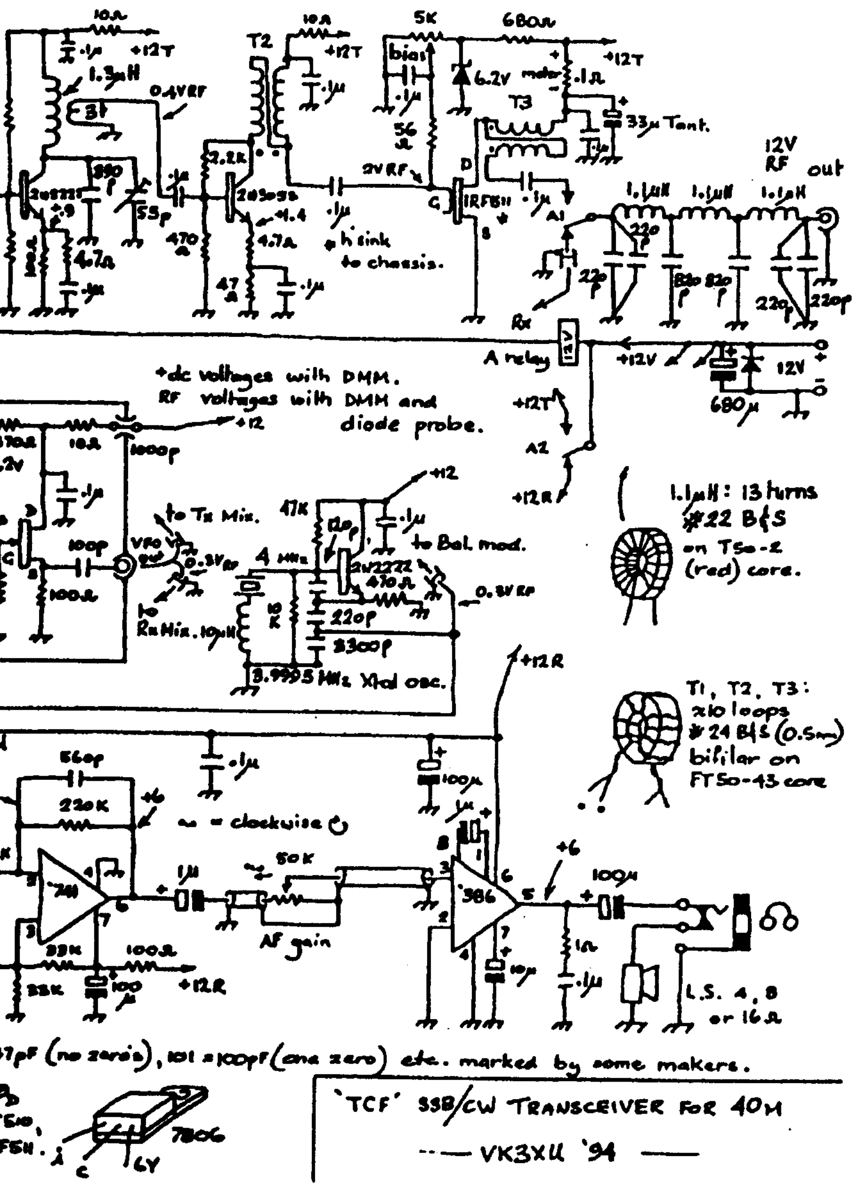


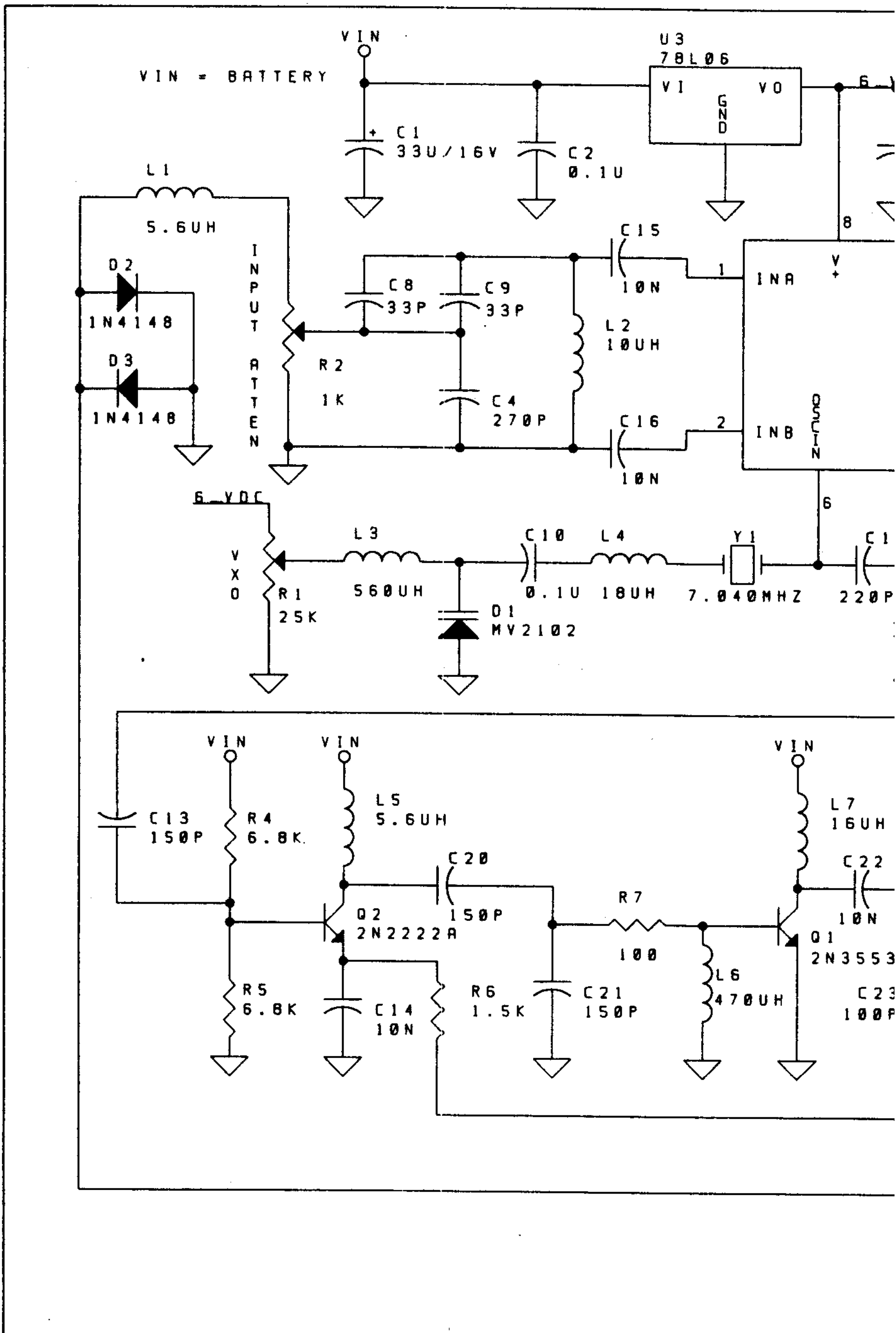



NE602
5 µH
55p
10p
82 p
3t
-link
50Ω
from Relay
+12V
(always)
10µH
33 p
10Ω


Key
5K bal.
6 to RIT
6V
741
NE602
from xtal osc
T1
33p
to 50K
mic gain pot
33K
100K
330p
under 741

Transceiver Schematic




VIN = BATTERY
VIN
U3
78L06
VI
VO
GND
C1
33U/16V
C2
0.1U
L1
5.6UH
D2
1N4148
D3
1N4148
INPUT ATTEN
R2
1K
C8
33P
C9
33P
C4
270P
L2
10UH
C15
10N
C16
10N
INA
INB
OSCIN
6 VDC
VXO
R1
25K
L3
560UH
D1
MV2102
C10
0.1U
L4
18UH
Y1
7.040MHZ
220P
C13
150P
R4
6.8K
R5
6.8K
L5
5.6UH
Q2
2N2222A
C14
10N
C20
150P
R6
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C21
150P
R7
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L6
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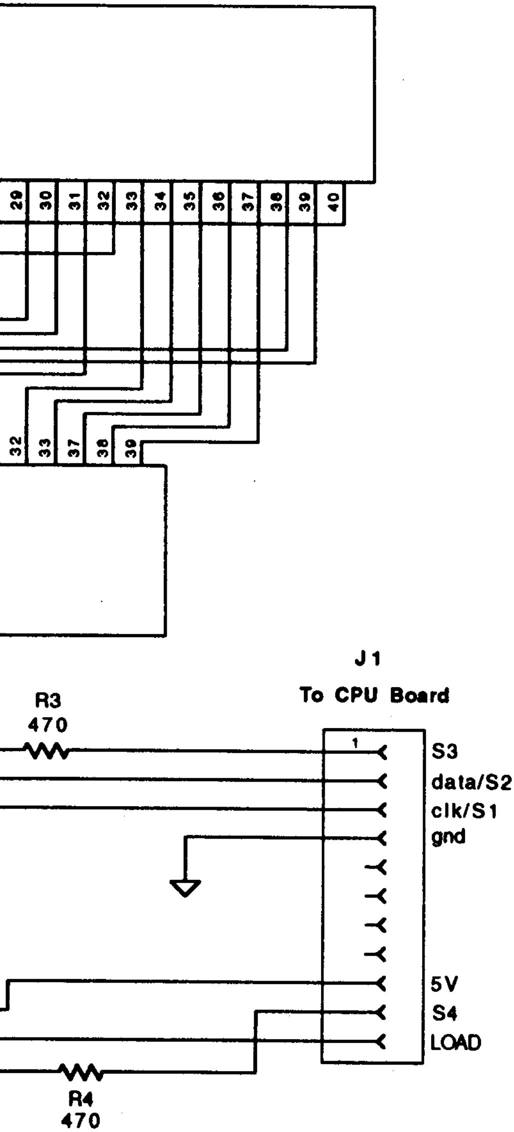
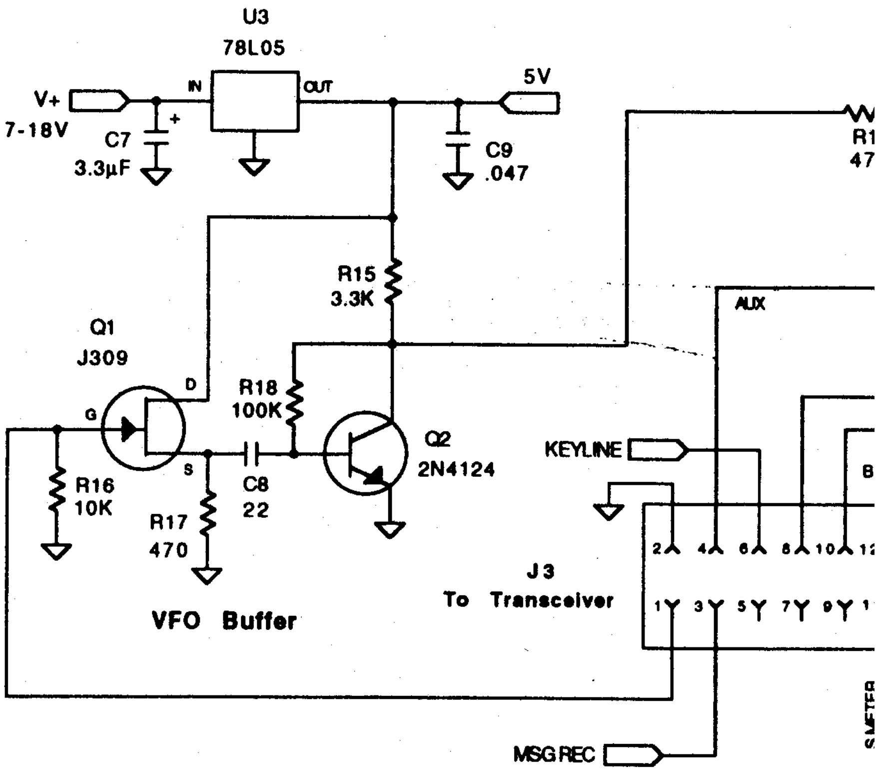
L7
16UH
C22
10N
Q1
2N3553



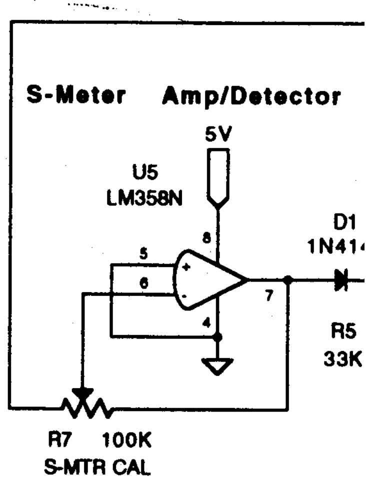
Appendix B
Schematic, KC2 Display Board
Wayne Burdick Rev. A, 6-26-96

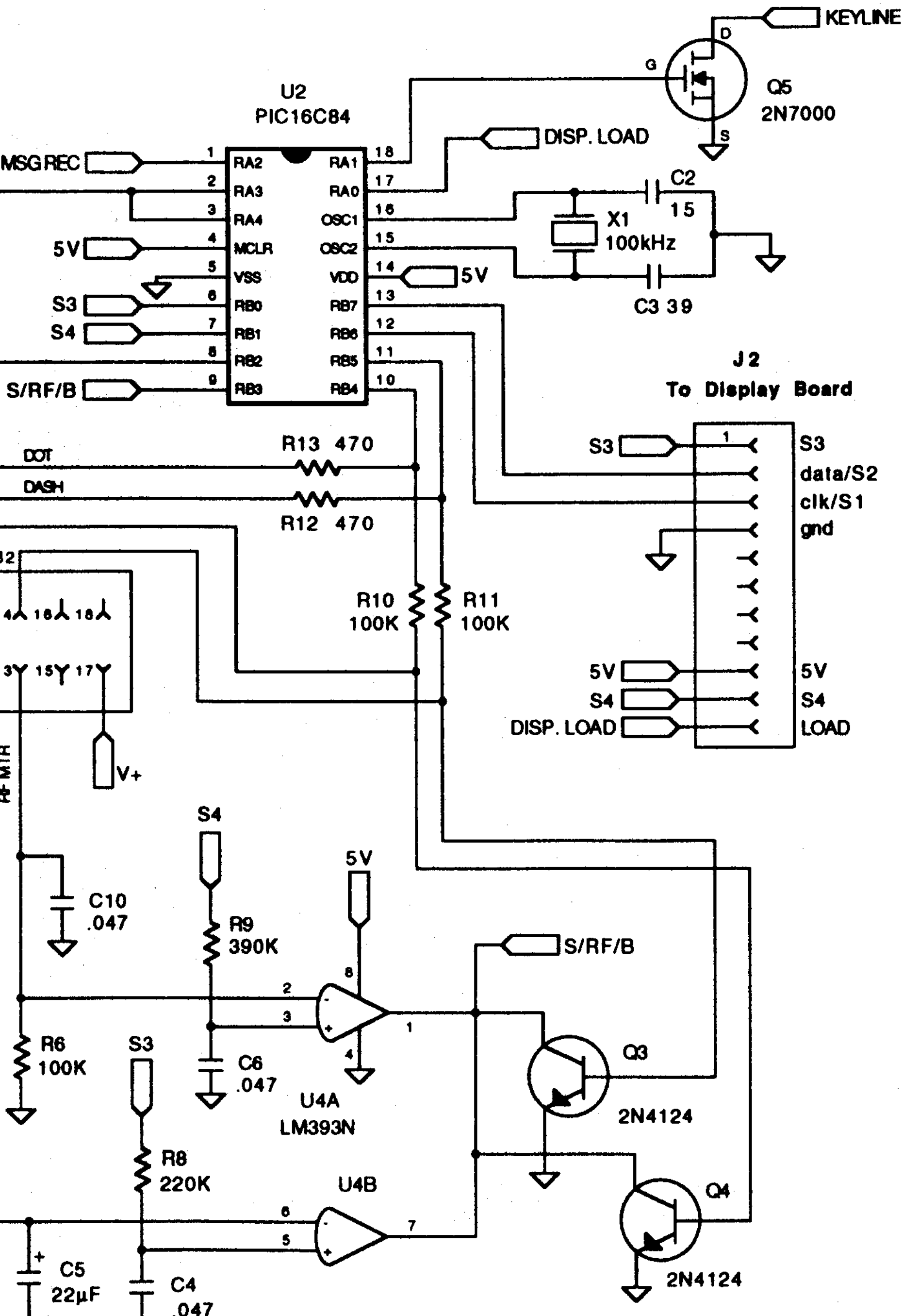


J3 Connections

Note: Pins marked "Reserved" are not used by the KC2 and should be left unconnected.

1 VFO	2 GND
3 MSG REC	4 AUX OUT
5 Reserved	6 KEYLINE
7 Reserved	8 DOT
9 Reserved	10 DASH
11 AGC AMP IN	12 BAND 1
13 RF DET. IN	14 BAND 2
15 Reserved	16 Reserved
17 V+	18 Reserved

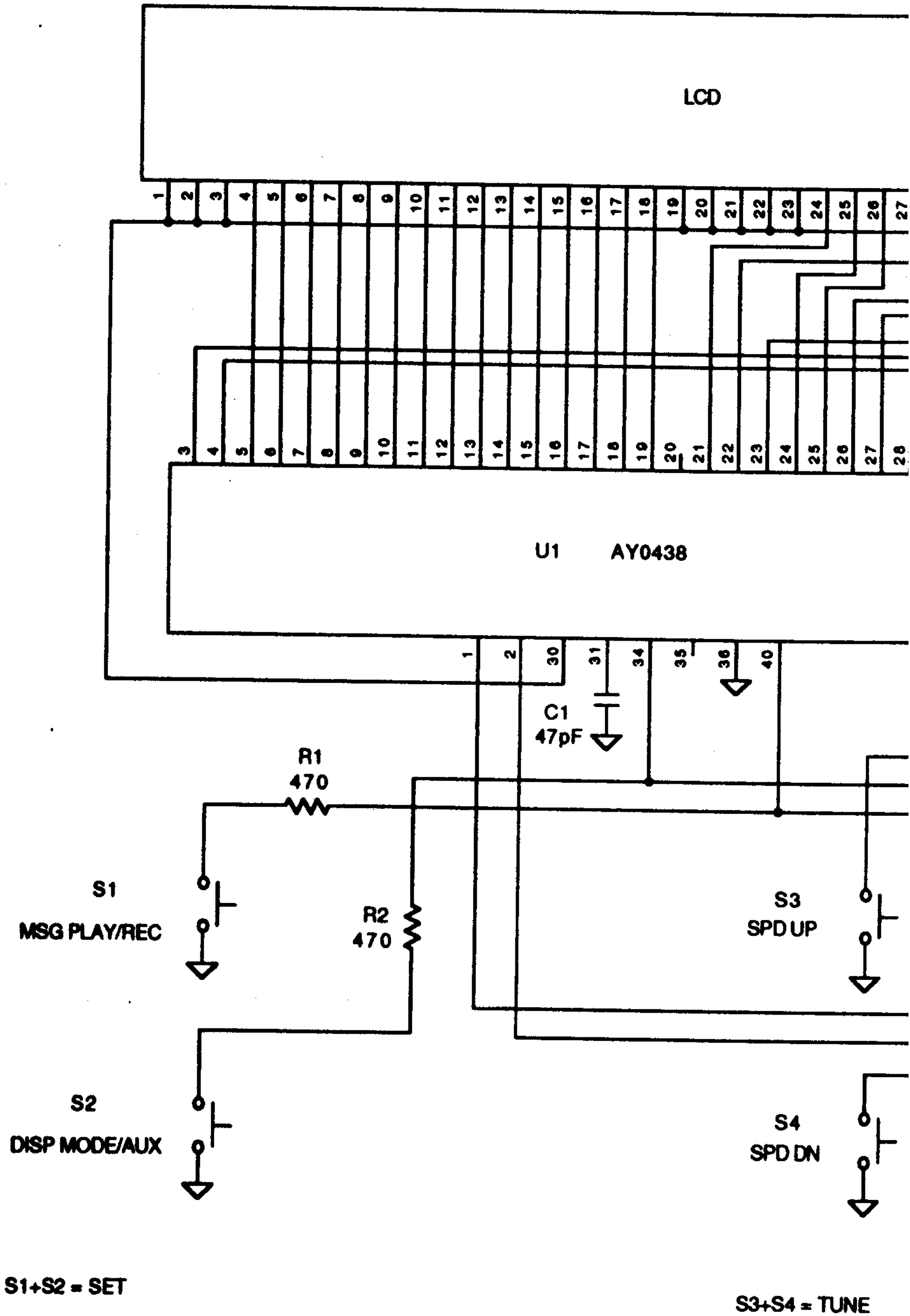


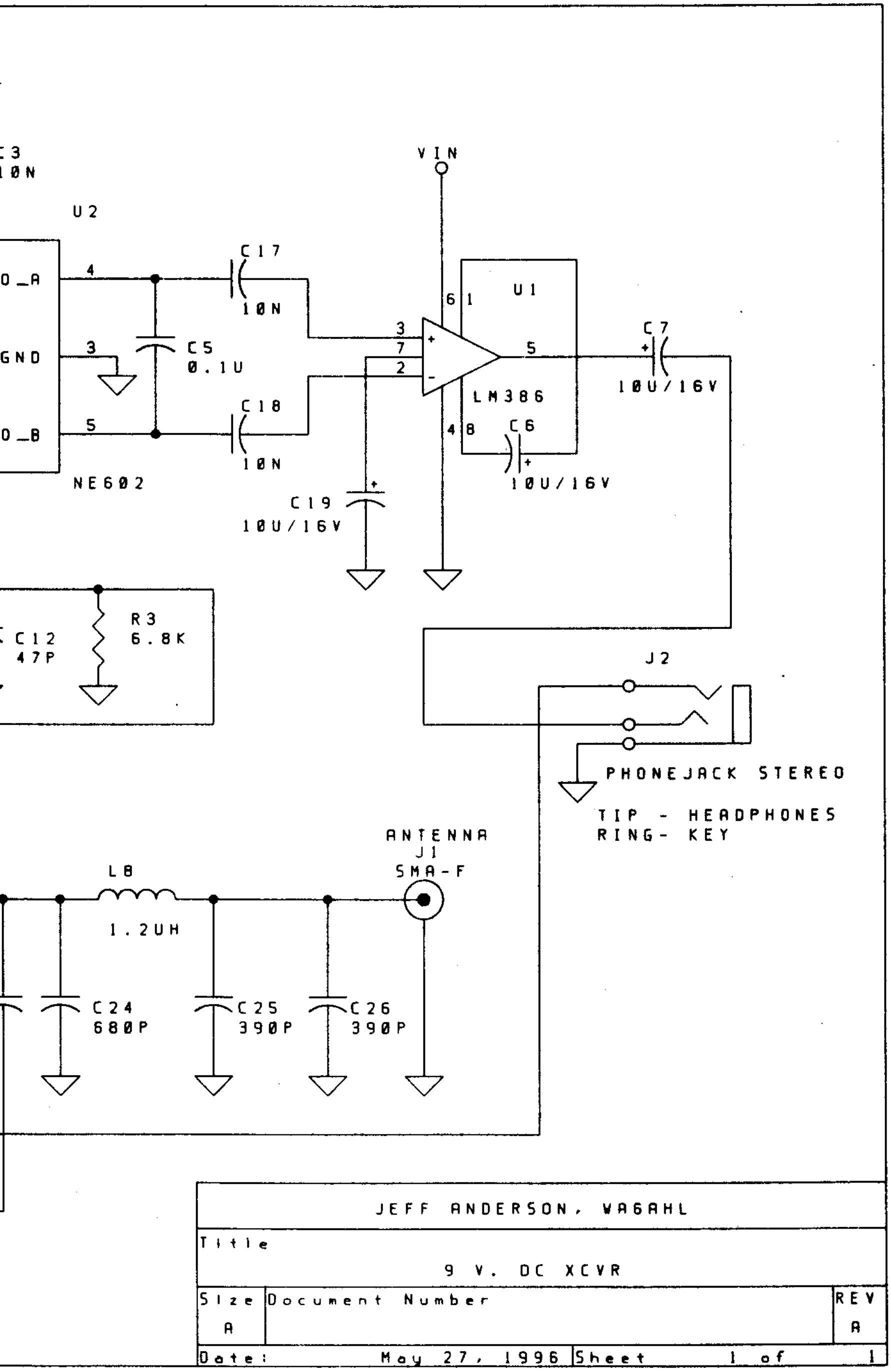


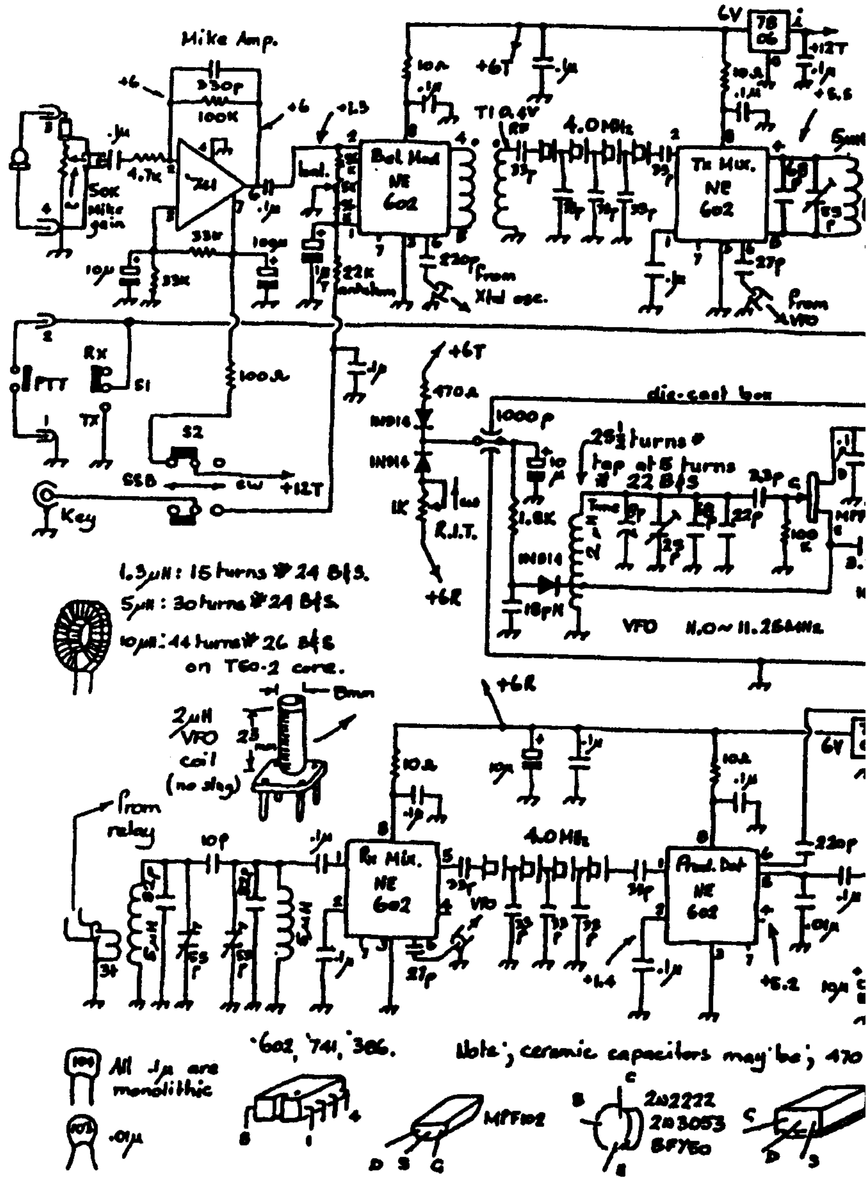
Appendix B

Schematic, KC2 CPU Board

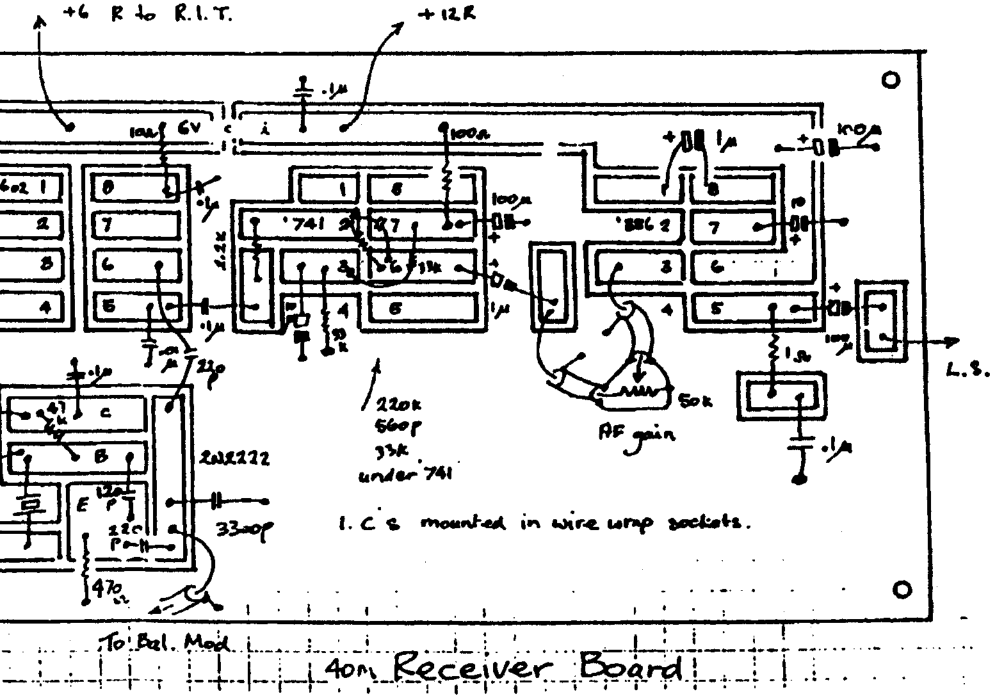
Wayne Burdick Rev. A, 6-26-96

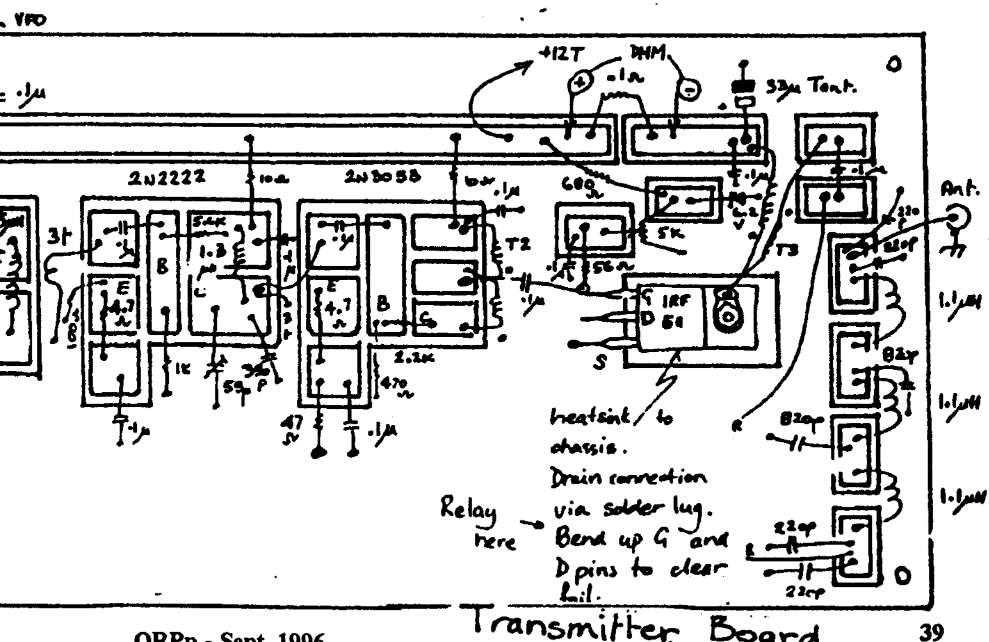

LCD
U1 AY0438
C1 47pF
R1 470
R2 470
S1
MSG PLAY/REC
S2
DISP MODE/AUX
S3
SPD UP
S4
SPD DN
S1+S2 = SET
S3+S4 = TUNE

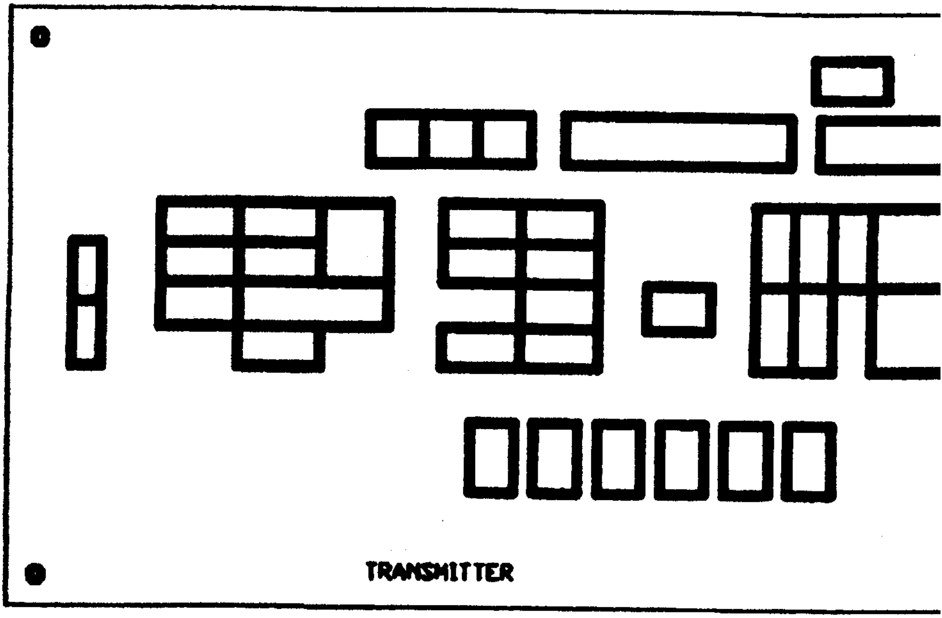

C3
10N
U2
0_A
GND
0_B
NE602
C17
10N
C5
0.1U
C18
10N
VIN
U1
LM386
C7
10U/16V
C6
10U/16V
C19
10U/16V
C12
47P
R3
6.8K
J2
PHONEJACK STEREO
TIP - HEADPHONES
RING- KEY
ANTENNA
J1
SMA-F
L8
1.2UH
C24
680P
C25
390P
C26
390P
JEFF ANDERSON, WA6AHL
Title
9 V. DC XCVR
Size A
Document Number
REV A
Date: May 27, 1996
Sheet 1 of 1

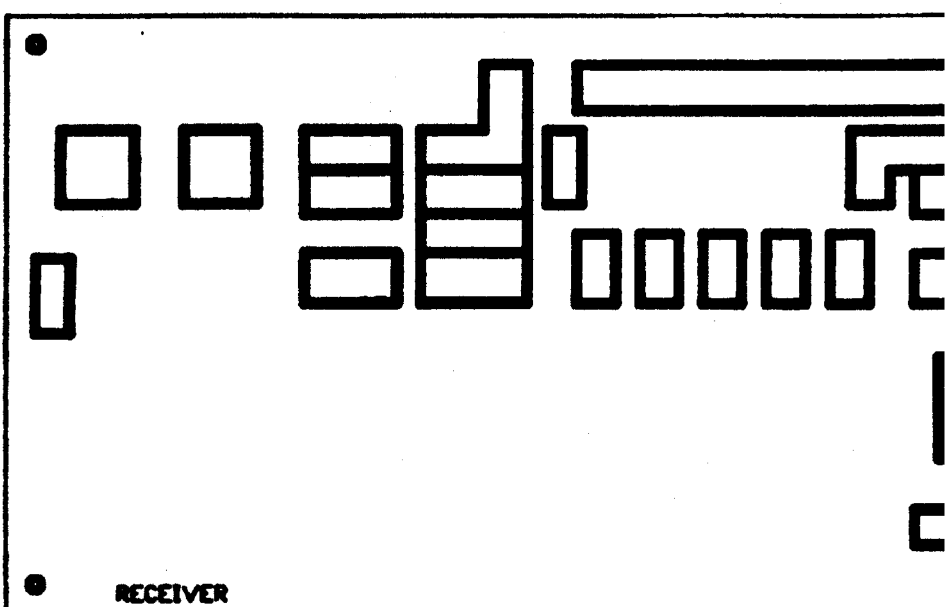

Mike Amp.
330p
100K
4.7k
741
50K Mike gain
33K
10µ
100µ
Bal. Mod. NE 602
Bal.
22K
220p from Xtal osc.
4.0MHz
33p
Tx Mix. NE 602
27p from VFO
78 06
6V
+12T
PTT
RX
S1
TX
100Ω
S2
SSB
CW
+12T
Key
+6T
470Ω
1N914
1000p
1K
R.I.T.
+6R
die-cast box
25½ turns # tap at 5 turns #22 B&S
VFO 11.0~11.26MHz
18pN
1.8K
1.3µH : 15 turns #24 B&S.
5µH : 30 turns #24 B&S.
10µH : 44 turns #26 B&S on T60-2 core.
2µH VFO coil (no slug)
8mm
+6R
from relay
10p
Rx Mix. NE 602
21p
4.0MHz
33p
Prod. Det NE 602
220p
+5.2
6V
·602, 741, 386.
Note; ceramic capacitors may be; 470
All .1µ are monolithic
.01µ
MPF102
2N2222
2N3053
BFY50
D S G

er Transceiver Parts Layout






TRANSMITTER


RECEIVER

IMAGES ON 30M

by Wayne Burdick, N6KR

Tim, WA5VQK, posed the following question on QRP-L: I'm receiving some type of broadcast images throughout the 30m band. These are among the 'normal' things heard there (cw, rtty, etc). Any ideas?

My guess is that the images you're hearing on 30m are a result of secondary mixer products, OR harmonics from strong nearby AM-band stations. There's little that can be done about the latter: a local station on 1450kHz might have a strong 7th harmonic at 10.150MHz! To take the optimistic view, let's assume your problem is due to images that result from the receiver mixing scheme.

As you can tell from the schematic, the Sierra I.F. is 4.915MHz—a fairly low frequency chosen to provide good CW filtering with standard microprocessor crystals. The only way to completely elimintate second-order or higher image responses in a receiver is to use up-conversion to a high I.F. or use direct conversion with no VFO multiplication. Both methods are incompatible with the performance goals of the Sierra, so a different approach to image rejection is needed. I haven't measured the actual level of 30m image responses, but from tuning around above and below the 30m band I found that there were many loud signals just a few hundred kHz away from our band segment. Their amplitude will vary greatly depending on your QTH and propagation. There may be a way to reduce the images, but first you need to know the cause, e.g, what the actual image frequency is and how the mixing scheme is producing a local oscillator product that lets it get through. Then you can use traps or other simple mods to the filtering scheme to get rid of them (in some cases). I'll get to these techniques later.

Types of Image Responses

There are "first-order" and higher-order image responses produced by a receiver's mixing scheme. The first-order images are due to the fundamental of the local oscillator that's actually injected at the receive mixer. In the case of the Sierra, this is the pre-mixer output or "PMO" signal. The higher-order ones are those that result from harmonics of the BFO, VFO, HFO, and/or PMO.

You can tell a second-order image response that is a result of a harmonic of the VFO by listening to the tuning rate as you sweep by the image signal. A faster-than-normal tuning rate indicates that a harmonic of the VFO is involved. Signals that appear to be unaffected by the crystal filter may actually be at the 3rd overtone of the BFO. Signals that tune backwards give you additional clues.

In addition to first- and higher-order image responses, there is a different kind for which I haven't heard a name: those that are first-order (fundamental) but result from unexpected pre-mix output products. Let's call these "pre-mix leakage" image responses.

Note that in a non-synthesized rig with a pre-mix arrangement, like the Sierra, there are typically three oscillators: BFO, VFO, and HFO or crystal oscillator. This provides many possible combinations that can lead to second-order and pre-mix leakage images! Combinations of the two are even more likely, i.e. sum and difference freuqencies of *harmonics* that make it through the mixer output filters.

In addition to image responses, you can also have "birdies," signals that are caused by the oscillators themselves. In the case of the Sierra, I was successful at choosing a mixing scheme that resulted in nearly zero birdies on all 9 bands—no simple trick. The strange I.F. frequency helps (4.915MHz) because it tends to elminate band-edge birdies.

First-order Images

Your image response are unlikely to be first-order. For example, at 10.100, the PMO needs to be 10.100+4.915 or 15.015MHz. The first-order image is then 15.015+4.915, or 23.930MHz. But the input tuned circuits and low-pass filter do a great job of getting rid of this frequency.

Second-order Images

So, how about harmonics of the PMO? Again using 10.100, the 2nd harmonic of the PMO is 30.030. The images produced by this harmonic would be at around 25 and 35MHz, again not likely to be heard.

Pre-mix Leakage Images

The Sierra pre-mix arrangement at 10.100 on your dial looks like this:

I.F. = 4.915 VFO = 2.985
HFO = 18.000
PMO = HFO - VFO = 15.015
RF = PMO - I.F. = 10.100
IMAGE = PMO + I.F. = 23.930 (not likely)

This is the normal case. But what happens if the *sum* output from the premixer gets by the PMO filter? This is always a possibility with a low-frequency VFO:

PMO(sum) = HFO + VFO = 20.985
IMAGE = PMO(sum) - I.F. = 16.070

This image has a better chance of getting through than 23.930, but I still don't think this is your problem. (Higher-order harmonics of the PMO will be even less of an issue.)

Harmonics of the VFO getting around the pre-mixer are more likely. For example, the 6th harmonic of 2.985MHz is 17.910MHz. This makes for an image response of 17.910 - 4.915 = 12.995MHz. This is getting close to the desired band, so a strong signal might get through.

MoreLikely Scenarios

The images that are most likely to get through are those right near the 30m band. But to get images here, you'd have to have more than one premix output near 15.015, OR have one near what would be the low-side injection frequency, i.e.: 10.100 - 4.915 = 5.185. How in the world could the Sierra premixer produce such signals? Here are some possibilities:

PMO(1) = HFO - VFO*4 = 18.000 - 2.985*4 = 6.060

IMAGE = 6.060 + 4.915 = 10.975

NOW we're getting somewhere. 10.975MHz is only 875kHz away from the desired 10.100MHz signal. If the low-pass filter passes it (likely) and the input filter attenuates it by 40dB (just a guess) then a very strong signal could still get through. This might happen despite the fact that the fourth harmonic of the VFO is of low amplitude.

You could probably kill this image response in one of two ways: (1) with a high-Q series trap from the antenna input to ground; (2) with a stiffer low-pass filter at the VFO output (currently, it's an LC low-pass filter). By the way, you'd know if you were getting this image response because the VFO tuning rate would be four times normal!

How to Hunt for Problem Frequencies

Now that you've got an idea of some ways that images can happen, the best approach is to simulate the problem using a signal generator:

1. Connect a 1Mhz to 20MHz signal generator to the antenna input
2. Set the output amplitude to 1mV or less (use an attenuator if necessary)
3. Sweep slowly over the range of 1MHz to 20MHz while listening to the audio output.
4. Note all frequencies that produce an audible response (as accurately as possible), along with some indication of the strength of the response (S units, AGC voltage, etc.).

If you're getting way too many strong signals (dozens), back down the signal generator level to 100uV or less.

Now look at your list. Some of the frequencies will be harmonics of the fundamental of the signal generator (e.g., 10.100/2 = 5.050MHz). These can be ignored for the most part because they're caused by harmonic distortion in the generator's output.

The signals that remain are the important ones. If you've measured them down to the nearest kHz, there's a good chance that you can do a small amount of math to see where they came from, based on the VFO, HFO, and I.F. and harmonics thereof.

As you can imagine, it took me a while to find a combination of I.F., VFO, and HFO frequencies that minimize images while meeting my other constraints—low current drain and simplicity. But I may be able to design-in a trap for a specific problem-causing mixer product. If you find the source of your 30m images, please let me know!

73, Wayne N6KR

The "EverReady": A 9 Volt Direct Conversion Transceiver

by Jeff Anderson, WA6AHL
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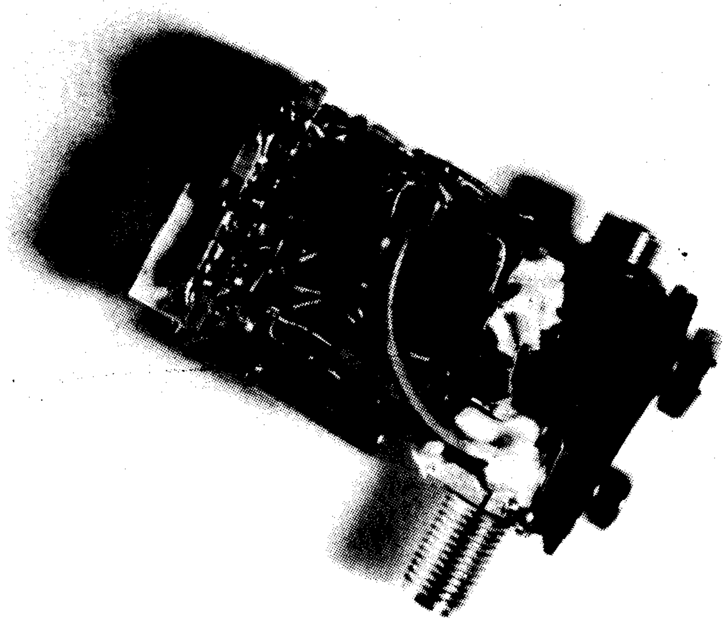
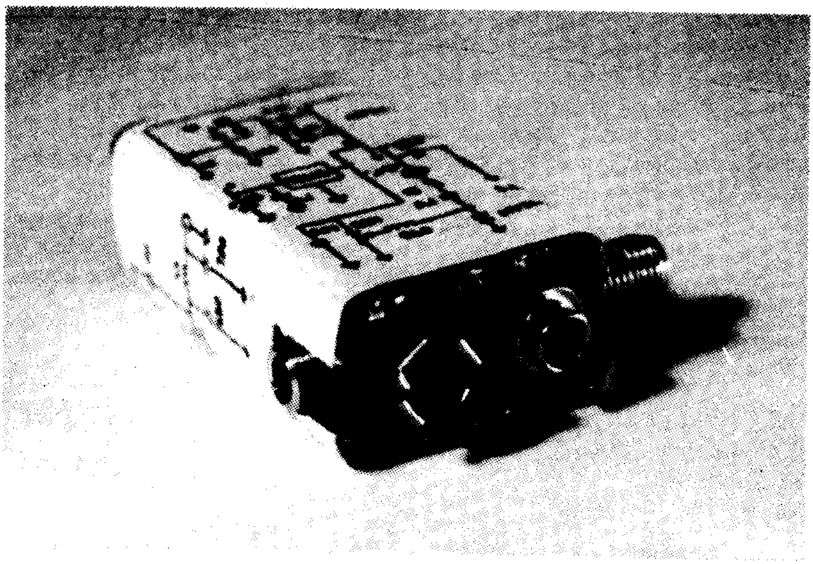
The "EverReady" is a 40 meter transceiver with VXO frequency control built into a 9 volt battery case. Tiny radios have always fascinated me, and the idea of building a transceiver into a 9 volt battery has tempted me for several years, ever since I read David Joseph's (WA6BOY) "The Pixie 2" article in the December



Interior View of the WA6AHL "EverReady" Transceiver
Steve Hideg Photo



Extern[illegible] [illegible]ing the Power Connectors of the "EverReady"
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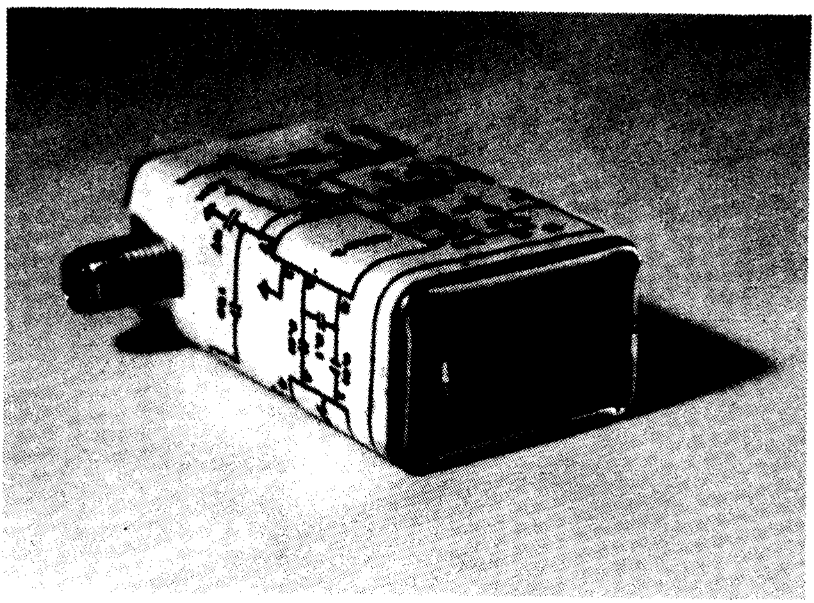

External View Showing the SMA Antenna Connector and the "Holes" for adjustments with a screwdriver
Steve Hideg Photo

1993 issue of QRPp, in which he built a Pixie transceiver into a 35mm film cannister. I thought that a 9 volt battery case might be the ideal package for a rig - it's small, yet not too small, and best of all, it already has its power connector built-in! I played around with the idea for a few days in August of '94, then shelved the project as other responsibilities (such as work) took priority. It wasn't until I heard about Wayne Burdick's (N6KR) "Forty-Niner" design through the internet that I decided to resurrect the idea and set about designing my own radio in a battery.

This transceiver is very similar in form to Wayne's "Forty-niner," yet it's quite different in detail. My inspiration was Wayne's design, yet at the time I hadn't seen a schematic - only a parts list that was published on the Internet. In fact, it was the low number of parts in this list that convinced me that I might be able to squeeze a similar design into a 9 volt battery. I'd never designed a radio before, but I thought it would be fun to design my own using Wayne's parts list as a starting point. The IC's on the list dictated the form the radio would take, but I was on my own filling in the details!

As the schematics reveal, the design itself is straightforward. The direct conversion receiver consists of an NE602 mixer/oscillator that feeds an LM386 audio amp. The antenna is coupled to the NE602 input circuit through C23 (part of the transmitter's output network), whose reactance is canceled by L1. Diodes D2 and D3 provide a clamp to near-ground for this capacitor during transmit. The 50 ohm antenna impedance is matched to the NE602's 1.5K input impedance with the resonant circuit consisting of L2, C4, C8 and C9. This resonant circuit also acts as a 40 meter band -pass filter.

The NE602's output is fed differentially to the LM386. C5 acts as a simple lowpass filter in conjunction with the output resistance of the NE602. The LM386 gain is set to 200 with C6, and the amplifier's output is coupled to the headphones through C7. Interestingly, C7 is much smaller than values one normally sees in this application. 10 uF was chosen because it fits nicely into the battery package without taking up too much space, and also, in comparing 10 uF and 100 uF values, I couldn't detect any difference in response with my headphones. C19 improves the amplifier's Power Supply Rejection Ratio specification.

The oscillator is a variable crystal-controlled oscillator using a varactor diode to control the frequency. The MV2102 provides a 3 Khz span (7.039 - 7.042 MHz). Capacitor C10 isn't really needed (as Wayne Burdick helpfully pointed out to me), since the crystal itself provides DC blocking.

The NE602 and the VXO operate from 6 volts supplied by U3. Power supply input bypass C1 was added to prevent receiver "howling" when keyed. Even when I reduced the DC input from 9 volts to 7 volts I could detect little, if any, difference in receiver performance, although the minimum voltage used should be in the 9 volt range.

The transmitter section consists of a 2N2222A amplifier buffering the NE602's oscillator, and a 2N3553 final amplifier. The buffer amp is keyed at its emitter, and its collector output is coupled through a parallel LC resonant circuit (L5, C20, C21) to the base of the 2N3553. Interestingly, when the buffer is keyed there is a frequency shift downwards of several hundred hertz - a built -in transmit offset. I'm not sure if this shift is due to an extra phase-shift introduced into the oscillator loop each time the buffer is keyed, or if it's generated internally within the NE602 when it's overdriven by the transmitted signal.

The final power amplifier's output network is designed as a Chebyshev low pass filter with 0.5 dB ripple and a cut-off frequency of 8.0 MHz. Chebyshev filters have a steeper roll-off than Butterworth filters, but with a trade-off of ripple in the passband. The filter's Source and Load resistances were assumed to be 50 ohms (in this case, this means that the filter's input, when its output is terminated with 50 ohms, will present 50 ohms to the PA's collector). The values shown in the schematic aren't exactly those derived from the calculations, but are close (the values were limited by the parts that I had on hand). An excellent resource, by the way, for filter tables and design is "RF Circuit Design," by Chris Bowick; a book I strongly recommend!

When the transmitter is keyed there is no receiver sidetone or muting (it's a very simple receiver!). During transmit I hear a distinct "click" in my headphones at each key transition, but that's it.

Most of the capacitors and all of the resistors are surface-mount, as is the 2N2222A. All other parts are standard through-hole components. Even with the surface mount parts, fitting everything within the case was a challenge. I had decided that an SMA connector was the way to go for my antenna (it's small, and I already had an SMA to BNC adapter). To minimize connectors, I used a single stereo mini-phone jack for both the headphones and the key, and then made a separate "Y" cable to break out these signals to two external jacks. The battery terminals remained as they were, and I placed the two pots at the other end of the case opposite the battery terminals. With holes through the original cardboard backing to allow screw-driver adjustment.

I first prototyped the transceiver "dead-bug" style on a large piece of copper clad board, then cut a piece of perfboard down to a size that would bit within the battery case and started mounting components on it. The big parts went on first (NE602, LM386, 2N3553, the pots, the SMA RF connector, and the stereo jack), and around these I squeezed the other components, using all three dimensions. I don't normally recommend layering parts - repairing something in the bottom layer can be quite frustrating. Unfortunately, it was the only way to fit everything into the package. Finally, when the soldering was complete, I wrapped the board and parts with a layer of Kapton tape to prevent shorting, and slid the assembly into the battery case.

Ideally, all of the resonant circuits should be tuned with either variable inductors or capacitors to allow peaking for maximum gain at 7.040 MHz. Unfortunately, there was no room for these components within the battery case. So, although close in resonant frequency, the resonant circuits may not be "spot-on" due to component values and tolerances.

In receiver performance, there is about a 6 dB receive loss between this unit and the one I prototyped on copper clad, which I attribute to the resonant circuits' inability to be adjusted to 7.040 MHz. Nevertheless, the transceiver performs well, given that there are no tuned-circuits that can be peaked in the receiver front-end. My first two contacts were with local hams, and my third with Portland, Oregon.

Power output is about 300 milliwatts when powered with a 9 volt battery, and about 900 milliwatts with 12 volts. Second and third harmonics measured 37 and 41 dB down from the fundamental, respectively. With a 12 volt power source, current draw is 17 mA on receive, and 155 mA transmit.

I would appreciate hearing form anyone who duplicates my efforts. If you have questions please send a self addressed stamped envelope for a reply.

Enjoy, 72, Jeff, WA6AHL

[The schematic can be found in the center of this issue.]

UNDERSTANDING RECEIVER SPECIFICATIONS
(And How They Are Measured)

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Industry standard tests are employed to profile overall performance, and for the transmitter portion, ensure FCC emission compliance. These measurements, such as S/N ratio and dynamic range, are discussed below.

RECEIVER SENSITIVITY

"Sensitivity" is not, in itself, a measurement, but a description of the overall ability of a receiver to "hear" weak signals. This includes with the presence of internally generated noise and nearby stronger signals.

Signal-to-Noise Ratio (SNR) is the level of the input signal to the receiver compared to the noise level. However, this is difficult to measure, since the exact contribution due to noise can not be easily isolated. A more useful term is **signal plus noise to noise (S+N/N)**, the actual relationship that is measured. S+N/N is defined as the input level to the receiver required that exceeds the noise level by 10dB. It is measured with a signal generator connected to the receiver antenna input and measuring changes in the audio output, as shown in Fig. 1. Since most signal generators do not provide very small outputs, an attenuator is placed in line to develop the desired levels, usually in the -100 to -140dBm range. S+N/N (and MDS) is measured with full RF gain and the AGC disabled, if possible. First, the audio output voltage is measured and recorded with the signal generator "off" to represent only the noise level. Then, the signal generator output is increased until the audio output voltage increases by 10dB (3.16 times the first reading). For example, say with the signal generator off, the audio output is measured at 200mV rms; the signal generator output is then increased until the audio voltage reaches 632mV (200 x 3.16). The output level of the signal generator is recorded; say it is .16µV. The 10dB S+N/N is thus .16µV or -123dBm.

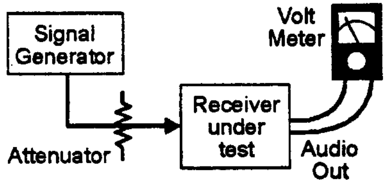


Fig. 1: Basic test setup for measuring S/N ratio, MDS and dynamic range

Minimum Discernable Signal (MDS) is measured virtually identical to S+N/N except it is defined as the input signal level that equals the noise level. The audio output voltage is first recorded at the noise level only (signal generator off); the signal generator is then increased until the audio voltage increases by 3dB (original reading x 1.4). The signal generator output is measured, which is the MDS. For example, the noise only audio voltage is measured at 200mV rms; the signal generator is .07µV that produces an audio output voltage of 284mV (200mV x 1.4). The MDS is thus .07µV or -130dBm (see Fig. 2 for conversions). Without access to an accurate AC voltmeter, the signal generator can be increased until the test signal is just heard; this will be accurate within 2-3dB.

However, MDS must be interpretted carefully, as it is noise bandwidth dependent, as shown by:

MDS(dBm)=-174dBm+10logBWn+NF

dBm	µV	dBm	µV
-115	.400	-125	.128
-116	.355	-126	.117
-117	.325	-127	.100
-118	.285	-128	.090
-119	.251	-129	.080
-120	.255	-130	.071
-121	.200	-131	.061
-122	.180	-132	.058
-123	.160	-133	.050
-124	.141	-134	.045

0dBm = 1mW = .225v (at 50Ω)

Fig. 2: dBm and µV conversions for common receiver sensitivity levels

-174dBm is the "perfect" noise level of a system at room temperature (290°K) and infinitely small bandwidth (1Hz). It is used as the starting point in noise and power calculations in electronics. If your receiver has a 1-Hz bandwidth and absolutely no noise, it would be capable of receiving -174dBm signals (a few *femto-watts*). But back to the real world ... your receiver *does* generate noise (the noise figure or *NF* term) and the effectiveness of your IF filtering throttles how much noise gets through (the *10logBWn* term). These two factors play a major role in the minimum signal your receiver can detect.

Filter BW	10logBWn
3.0KHz	34.8dB
2.0KHz	33.0dB
1.5KHz	31.8dB
1.0KHz	30.0dB
500Hz	27.0dB
300Hz	24.8dB
100Hz	20.0dB

Fig. 3 Approximate Noise Power vs. Filter BW

MDS can be somewhat meaningless unless you know the bandwidth under which it was measured. No real standard exists for communications receivers, although 500Hz is often used, as this is the typical bandwidth of a good 4-pole IF crystal filter, such as found in most QRP rigs. The effects of the filter bandwidth are shown in Fig. 3. For example, say your IF filter bandwidth is 1.5KHz and you determine the MDS to be -120dBm. If you improve your filter (select better crystals or fine tune the capacitive shunts) to 300Hz BW, the noise improves by 7dB (31.8-24.8dB). You can expect your MDS to now be 7dB better, or -127dBm. This also demonstrates why the variable bandwidth IF crystal filters, now found on many QRP rigs, have such a profind effect ... not only are you limiting adjacent channel interference, but you are actually improving your MDS.

There is little one can do about the noise contribution due to the receiver circuitry itself - it remains virtually constant. By measuring the MDS and knowing your filter BW, you can determine your NF by rearranging the MDS equation to:

$$NF(db)=-174dBm+MDS+10logBWn$$

Comparing S/N Ratio to MDS. Since S+N/N is 10dB above noise, and MDS is 3dB above noise, the two can be roughly compared by subtracting 7dB from the SNR value to obtain the equivalent MDS. Fig. 3 can be used to adjust the values if different bandwidths are used.

Icom lists for its new IC-706:
Sensitivity: @10dB S+N/N = .16uV
or -123dBm for 2.3KHz BW SSB reception. To compare to the MDS of your QRP rig, first adjust for, say, a 500Hz CW BW. From Fig. 3 this would be ~6dB improvement at 500Hz S+N/N for -129dBm. Subtract another 7dB for -136dBm as the equivalent CW MDS.

The MDS for NE602 based QRP rigs fall in the range of -118 to -130dBm.

Gain Compression.
In any amplifier or mixer, a point is reached where an increase in the input signal no longer produces a linear output that follows the stated gain. This is shown in Fig. 4, and is defined as the point where the output varies from the linear gain by 1dB, and hence the name *1dB gain compression*. Further increase in input signal will eventually saturate the output, where no further output power is produced. This is also referred to as the "overload" point.

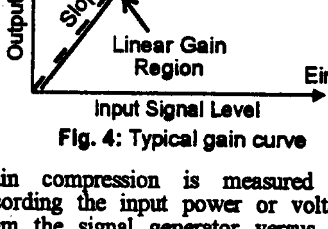


Fig. 4: Typical gain curve

Gain compression is measured by recording the input power or voltage from the signal generator versus the output, then calculating the gain from *Gain=Eout/Ein*. The signal generator output is increased until the determined gain drops by 1dB. This is the 1dB compression point. Other methods are used to measure the gain compression, including using two signal generators, differential power meters, an oscilloscope in the "invert and add" mode, or a spectrum analyzer.

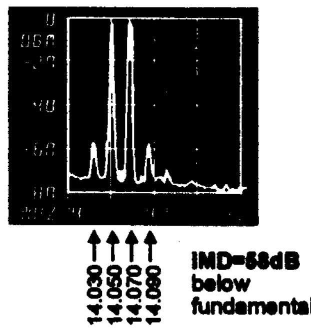
Desensitization. A variation of the gain compression test is to use two signal generators, one as the receive frequency (f1) and the second set at 10-20KHz away (f2). The second signal generator output (f2) is increased until 1dB gain compression occurs on the receive signal (f1). This is a measure of at what point a strong nearby signal will saturate the mixer, which in turn *desensitizes* the receiver against weak signals. In NE602 based QRP rigs, this is a noted limitation and a serious problem.

DYNAMIC RANGE

No radio receiver can effectively handle and process an infinite range of input signal strengths. Below a certain point, the signal will not be heard; above a certain point, gain compression occurs, and at a higher level yet, the mixer can go into complete saturation. Obviously, a good receiver should be able to handle a wide range of input signal levels. The range of input signal strengths the receiver can handle is called its *dynamic range*. We have already measured dynamic range in this article ... the difference between the minimum discernable signal (MDS) and the 1dB gain compression points is called the *blocking dynamic range (BDR)*. If gain compression occurs at -20dBm signal input and the MDS was measured at -122dBm, then the BDR=102dB, about typical for most QRP rigs. Only a few years ago, a dynamic range of 80dB was considered good; however, 100dB or better is now easily achieved by the active mixer IC's currently available. This is why QRP rigs, inspite their relatively simple designs, often outperform commercial ham equipment only a few years old.

Passive mixers, such as the MiniCircuits SBL and SRA series, have a larger dynamic range over active mixers. This is because they can handle 50-70mW (~+18dBm) of input power, and their lower noise figure lends to a lower MDS ... the difference yielding a larger overall dynamic range.

Intermodulation Distortion (IMD) is another term often seen on specification sheets. The effect of IMD is having a strong incoming signal appear at two or more places in the receiver tuning range. The IMD figure should be as low as possible, 50dB or better. It is measured with two signal generators separated by 20KHz, for example, at 14.050 and 14.070MHz, as shown in Fig. 5. The 3rd order IMD products would then appear at ± the 20KHz spacing, that is, at 14.030 and 14.090. How far below the level of the signal generator signals as viewed on a spectrum analyzer is the IMD measure, or by tuning the receiver to the IMD products and calculating the power in dBm from the audio voltages.



14.050, 14.070 Signal generators
14.030, 14.090 IMD Products

Fig. 5: Spectrum analyzer display showing 2-tone test for IMD products

Third Order Intercept (3IP) is another IMD measure more commonly seen with the advent of active mixers, and seems to cause much confusion. First, 3IP is a *theoretical value* and can not, in itself, be directly measured. As a real world QRP example, say you are in QSO with a station on 7.040MHz and another QSO is ongoing at 7.050MHz. Assuming both stations are equally strong, this would produce an IMD product in your receiver about 60dB down at 7.030 and 7.060 as described above. However, due to the square law behavior of a detector, if the station at 7.050 gets 10dB louder, the resultant IMD products will get *30dB louder* to be only 30dB below the signal of interest at 7.040. If the 7.050 station gets another 10dB louder, the IMD product gets another 30dB louder, which is now *0dB below*, or exactly the same level as the station you are trying to work at 7.040. The 3rd order IMD product has *intercepted* the primary signal of interest, and hence the name, *3rd Order Intercept*. In reality, this can not occur, since the receiver will go into gain compression well before this point. However, it can be measured at several points before gain compression and plotted graphically to determine the 3IP point, as shown in Fig. 6. While it is not a direct measurement, it is a figure of merit used to describe the expected dynamic range. By knowing the MDS and 3IP of the system, the dynamic range is approximated by:

$$DR=2/3(3IP-MDS)$$

As a rule-of-thumb, the 3IP is about 10 to 15dB above the gain compression.

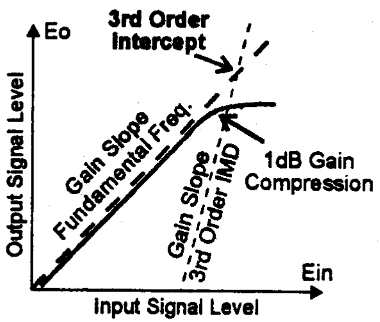


Fig. 6: Typical gain curves for the fundamental and 3rd Order IMD.

SELECTIVITY

Selectivity is the receivers ability to differentiate between the desired signal and all other (unwanted) signals. If you are able to "tune out" a signal only 200Hz away, your receiver has excellent selectivity. In most QRP rigs, receiver selectivity is developed by: 1) the front-end filters, before the mixer, 2) the IF filters, and 3) audio filtering. The IF crystal filters develop the majority of the selectivity by "shaping" a narrow IF passband. The selectivity is thus characterized by measuring the passband (at -6dB points) and the shape factor (at -6 and -60dB points).

Using the Fig. 1 setup, the receiver is tuned to the signal generator frequency by noting peak audio output voltage. Now tune the signal generator above and below for *one-half* the peak audio reading to determine the -6dB bandwidth. It is important to find *both* 6dB points, as IF crystal filters are not symetrical (greater attenuation on USB side). Repeat for the -60dB points (Peak reading x .001). Say the measured bandwidth is 1.2KHz at -6dB and 3.5KHz at -60dB points. The filter *bandwidth* is 1.2KHz and the *shape factor* is 3.5KHz/1.2KHz = 2.9:1 for moderate selectivity. A shape factor closer to 2:1 makes for good CW selectivity. It is important to use a signal generator that can resolve at least 50Hz tuning steps to properly measure these bandwidths. Repeat above with the CW audio filter on and off to judge its contribution to the overall selectivity.

SUMMARY

The most important receiver characteristic is dynamic range, since it defines the minimum to the maximum signal the receiver can handle, followed by receiver selectivity. It is important to realize that MDS, compression point and 3IP is established *primarily by the mixer*, while selectivity is developed by the IF filters. The IF amplifiers and product detector play virtually no role in these overall specifications. This is why QRP rigs with an NE602 receive mixer and a 4-pole IF crystal filter will always have very similar performance characteristics within a narrow range, limited primarily by the care in which the rig was built. Fig. 7 summarizes the measurements and concepts just discussed and the levels typical to most QRP rigs.

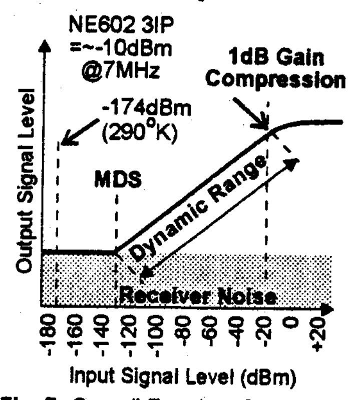


Fig. 7: Overall Receiver Sensitivity

1996 QRP TO THE FIELD CONTEST RESULTS

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What a response, over 80 logs were submitted and 70% of those were from field operations. If you checked WWV for the propagation conditions during the contest, you would have been discouraged but then N6MM, WU0L, K5LG and AA7QU logged over (100) contacts, each. Does the solar flux really have any bearing?? The QRP contingent was out in force, no entries over 5 watts. Articles in Worldradio and CQ VHF and announcements sent to all the QRP clubs, on the QRP-L net and QST, helped in introducing and gaining interest from last years contest to this years. Some of the unique entries were AB7PF/ Air Mobile, with a four hour operation in the air from Phoenix to Riley and back, the ghost town stations in Camp X, ON, Riley, NM, Deary, ID, and Rossville, TX. VE6ZAA operated both in the field and from his home station, giving out more contacts after the field conditions turned winter like. Some stations had a little trouble with the new "Best (8) continuous hours rule", but it was straightened out in the log compiling. I would say that this years contest was an success, with so many saying that they had enjoyed it. Good luck in Field Day and remember the NE QRP ClubÆs QRPAfield in September. 72 & 73 de WU7F.

SOAPBOX - 1996 QRP TO THE FIELD

I set up near an old mica mine north of Deary, ID. A typical spring day in Northern Idaho, sunshine, snow and sleet with temps. in the low 50's. Just as the band was getting better, thunder and lightening chased me off the mountain. WB5QMP; Location-Licton Springs Park, Seattle, under wooden shelter. Light sprinkles, 40 to 60 degrees. Visitors: adults walking dogs, kids hanging out, a man getting drunk, and a teen reading a book. KV9X (+ KC7MCW); Winning last year's event was a tough act to follow. I only made half as many QSO's as last year. Still had lots of fun. WB3GCK; Thanks for some fun from the house (still cold in Newfoundland - HI) VO1DRB; Location was Cumby, TX . Cumby, formerly known as Black Jack Grove, was named for a Confederate General, Robert Cumby. Thanks for a great operating event. WD5ABC; Great WX and location on Silver Lake with a great bunch of guys (NJ QRP Club). When's the next one? N2CQ; Not a world beater, but fun, lots of fun. KI7MN; The rig was HB and a HB tuner. I put up 66' end-fed wire, with another 66' ground wire dangling in the fish pond. The antenna didn't work out very well, bet the goldfish got an unexpected surprise. K6BSU; I wish to tell you I had a good time. I was in a picnic area near a local lake in Madison, MS. I will look forward to next year. K5HQV; Could not operate continuously...shared band with KI7MN and AA7TQ. Tough going at 950mW, but worth it. AA7QY; Set up in a field near my house, used existing antenna masts. (Turned in score based on home location - B.F.) AA8LF; Due to family commitments, I wasn't able to get out to the field. I made 66 contacts and had a ball. KB2JE; 40M dipole strung between two trees. I lowered the dipole mid-day and cut half of each end for a 20M dipole. Couple of hikers with dogs came by and my dogs got in a fight with them right on the blanket during a QSO. KE6PTM (+KE6PPM & VE6DK/ W6); Operated QRP-TTF from a overlook on Highway 35 in the Santa Cruz Mountains, edge of Palo Alto. Very high noise level. WA2CRQ; I was chafing at the bit for 9: am, we have to stay ahead of EU BC QRM at 2: PM. KB2SWI; I went by small boat to an uninhabited Island on Beaver Lake, AR. What a blast. KJ5TF; I couldn't get "..to the Field..". Conditions not very good, but fun never the less. W6ZH; Station located at Cherry Creek State Park, CO. Great FD primer. KB0UCQ (KF7MD) ; Operated from back yard, but had a great time! AE4IC; North Texas QRP Club set up field location at Point North Park, Richardson, TX. WX was warm but winds were 15 to 25 MPH during contest. NA5K (+ AC5GT, KC5RAS, K5JHP, AC5GY, KE4PC, N5OSG and K3ETS); I missed the first 10 hours! The last 2 were fantastic. KB7BEJ; AZ ScQRPions Site - White Tanks Regional Park, plenty of Saguaro cactus, mesquite, wildlife, etc. Goal - get out in the open desert, have fun and keep an eye out for rattlesnakes. and make CONTACTS. NQ7X; My first try at a contest. AA0OL; First QRP field contest for Brockport AR Klub. Forecast "near 40 degrees" with 50% chance rain or snow, We got SNOW. Auxiliary equipment - GLOVES while using a straight key. KB2UFY (KE2DI); Location - Glyndon Park, Vienna, VA K4XY; Portable on Blue Ridge, Angeles National Forest, west of Wrightwood, CA. N6MM; Set up in a pop up camper in my yard. Glad contest was only 8 hours because I forgot to charge the battery. K5LG; I had every intention of operating from the field, kite antenna packed for the trip to the park, the trouble was NO WIND. Went home. WA0RPI; Location - Ghost Town of Rossville, TX. N5JWL; Set up in Chabot Park in the hills on the east side of SF Bay. Clear blue sky, hills green, shade trees. Neat site. 95% QSO's on half square ant. N6WG (+WA6NAE, W/ N6LIT & KF6BKR); Beautiful camp setup in the foothills of the Rockies at about 7500 ft. Forecast was for high winds and heavy snow. Had my 8 hours in at 21Z, headed home. WX forecast was right. WU0L; G5RV antenna mounted with center near ground, one leg up to tree, other leg - counterpoise running E-W @ 3'. KC1FB; Antenna - last years FD Zepp set as a inverted vee. AE4CA; QRP TTF proved to be a great opportunity to tune up our clubs efforts in Field Day. K8FF (+ N8LBI, N8KBF, W3MMM & W8CBR); Location - Ghost Town Riley, NM. K5FO; Location - Martin's Ridge, west slope of Cascade Mountains in OR. AA7QU; Location - east of Calgary. Low temps. (35 F) and high winds, we only operated part of the time, but it was great fun. VE6EY; I think I had more fun than is legal. Location - remote part of county park, twenty miles from home. Here comes some wags from my local club who don't believe QRP works. Worked Cam, HP1AC, got some of their attention, think QRP bug bit two of them. K5ZTY; A beautiful spring day. The eyeball QSO's kept getting in the way of the QRP Afield(?) QSO's. N0JFZ (+WA0OUI, N0MFC, KY0U & WB0MHU); I operate "pure" QRP (& CW only) with an radiated power of 5 W using the following: homebrew tube with a 6Y6 final. K3WWP; No big score but it was lot of fun. I wonder what kind of ant. farm those CO big sig were using? W0LK; Location: Dead Horse Point, Canyonlands, UT. WA7FCU; Ant.- HB indoor loop, located on the third floor at apartment window. N3CZB; My first QRP TTF. 6 AM temp 32 F. Was on at 8 AM, windy cold day, about 11 AM the band dropped, I was cooled for 3 hours. Packed up and went home, operated from there. (only OP who had two separate entries-B.F.) VE6ZAA; Location near WM8W QTH, OH. Kite was launched, at the 1000 ft. mark on line, cut wire and attached it to ATU. Wire approx. 535' long, high end 350 to 400 ft. in air. We made 20, 40, 80 SSB Q's at 5 W or less. Went to 40 CW, called CQ on 7.040 and had 10 Q's in the log. The main spar on the kite failed, signals on ground mounted long wire much weaker. N8ET

(+WM8W, WS8T); Tried for 20 Q's, using 0.95 W made it difficult. N2MNN; Location: Hueco Club, East El Paso, TX. The contest was a blast. We are already looking forward to next year. AB5WB (+KC5GKW); Location: Camp Far West, east of Sheridan, CA. My first contest in 15 years, enjoyed it. WA9WAC (+WB6RUU); Enjoyed it, but didn't hear any activity on 15M. K3SS; A old newcomer at contesting. Enjoyed it very much. WA8TIM; Location: Pacific Crest Trail, east of Ridgecrest, CA. WA6ARA (+N6VGW & SPARKY); Durham Region QRP Club location - Camp X, Oshawa, Ont. (site of W.W.II spy training school). We nearly froze to death, can't wait until next year. VE3QDR; Location - Colorado Springs. Hard to send CW with gloves on and teeth chattering. KD0SU; It was great even with 1 watt and DC receivers. Hope to work the entire contest next year. AG5P; Location - 15 miles west of Laramie, WY, in the Medicine Bow Nat'l. Forest, at 8200 FT. Operated in snow and a blizzard from popup camper on my Blazer. AE0Q/7; Location - Christopher Creek, AZ. Nothing beats a Saturday with friends and family sitting beside the creek, enjoying sunny, cool WX, making QRP contacts. WB4ZKA (+ KG7WS); Location - Chilao Flats Campground, CA, 5300' Elevation, edge of San Bernadino Forest. KB5OB; I've been a ham for 35 years and this is the first contest I've entered. I had a lot of fun, put in about four hours. KE7IT; Location - Branch Memorial Park, Edwards AFB, CA. KG6VI; I had the perfect location, neighbor took some of my gear up on horseback. Power supply wouldn't work. I ended up taking everything back to my house. AC6NT; Location - Ghost Town, Riley, NM. The wind whipped up toward the end of the day, but a good time was had by all. AB5OU; Location - Strouds Run State Park, Athens, OH. The WX was cool and windy, not surprising as QRP TTF occurred on the date that used to belong to Dayton. The three OP's had a good time. WD8RIF (+AA8EB, W8MHV); Location - between 1,000 FT to 16,000 FT and from Phoenix to Riley, NM and return. AB7PF / AIR MOBILE

COMMENTS FROM DOUG, KI6DS

I would like to thank Bob Farnworth, WU7F, for all of his very hard work running this contest. It was successful beyond our wildest dreams, and goes to show that QRPers really know how to have fun. I would also like to thank Paul Harden, NA5N, and Jay Miller, WA5WHN for all of their great work helping Bob get the word out on the contest. Bob contacted all of the QRP Clubs and the Major Magazines for publicity. Paul and Jay came up with the great idea of operating from historical places. Both of their efforts helped to make this a fun event. And, thank you to all of the QRPers who participated.

Next year, plan on the fourth weekend in April again. Bob will get the announcements out again, and Jay and Paul have come up with another great "theme idea", **Places where strange things have happened.** Socorro, NM, Area 51, Quartzite, AZ, the whole state of California, etc. You get the idea. Find a neat place to operate, take your qrp gear out into the field and have fun.

Special thanks also go to Jim Fitton, W1FMR and the New England QRP Gang for thinking up the idea of a QRP contest in the field. They sponsor the Fall contest, QRP AFIELD, and they suggested that NorCal sponsor the Spring contest. Thank you Jim and the group for sharing with the QRP community.

I had a blast operating from the ghost town of Riley, NM with Chuck, Jay, Paul, Tom, Tim, Gary, Brian, Jason, Howard and all the rest of the New Mexico gang. See you next year in the contest. 72, Doug, KI6DS

CALL	QTH	SCORE	Q'S	40cw	20cw	OTHER	TIME	RIG	ANTENNA
N6MM	F,CA	6480	108	74	34		6:32	OHR 400 5W	20M VERT&40M DIPOLE @30'
WU0L	F,CO	6060	101	46	55		7:55	HB WU0L (3)BD. 5W	G5RV @40'
N6WG	F,CA	5880	49	49			7:57	NC40A 1W	HALF SQUARE & EXT'D.ZEPP
(+WA6NAE)									
K5LG	F,AR	5000	125	61	64		7:44	IC725 5W	TA33 YAGI & 40M LOOP @35'
KI6SN	F,CA	4680	39	39			7:23	NC 40A - 800mW	INV-VEE @22'
WB4ZKA	F,AZ	4620	94	43	51		7:53	NE40/40 1.5W/MFJ9020 5W	CAROLINA WINDOM @60
(+KG7WS)									
AA7QU	F,OR	4240	106	67	39		7:15	ARGO II 5W	INV-VEE
WT7F	F,CA	4080	34	21	13		4:39	WILD.SIERRA 1W	40M DELTA LOOP @85'
(+KQ6AG)									
K8FF (+4)	F,OH	3960	33		33		4:53	GM20 1W	?
AE0Q	F,WY	3880	97	17	80		7:59	TS-450S/AT 5W	HALF SIZE G5RV @30'
(+N0TBM)									
KB0UCQ	F,CO	3840	64	22	42		7:06	HB (5) BAND 4W	40M INV-VEE & 20M DELTA LP
(COLO QRP-KF7MD)									
K5ZTY	F,TX	3780	63		63		7:59	HW-8 3W	20M LAZY H
AE4CA	F,GA	3720	31	19	12		5:44	NN1G-20/40M 1W	INV-VEE @50'
K0FRP	F,CO	3620	64	17	47		5:57	OHR CLASSIC 4.5W-TS850	40M LOOP @ 35'
NQ7X	F,AZ	3200	60	19	40	1	7:53	NW20/QRP+ /2m HT - 5W	?
(AZ ScQRPions)									
KB5OB	F,CA	3200	80	47	30	3	7:55	IC730 4.8W	20M&40M DIPOLE,1500'LOOP
WB3GCK	F,PA	3000	25	25			4:49	SW40 950mW	INV-VEE @25'
NA5K	F,TX	2940	49	15	34		6:40	OHR CLASSIC 5W	140' LONG WIRE
(NORTH TX QRP CLUB)									
K5HQV	F,MS	2880	48	47		1	7:23	NN1G 40M & 30M 5W	?

CALL	QTH	SCORE	Q'S	40cw	20cw	OTHER	TIME	RIG	ANTENNA
KE6PTM	F,CA	2760	46	32	14		7:38	NC40A, SIERRA 2W	40M DIPOLE/20M DIPOLE
(+ VE6DK/W6)									
AB5OU	F,NM	2680	67	26	39	2	7:52	QRP+ 5W & 2M HT	180'ZEPP, 20M&40M HAMSTK
KG6VI	F,CA	2640	66	37	23	6	7:07	QRP+ 5W	HF9V VERTICAL
WA9WAC	F,CA	2460	41	41			7:13	NC40A 2W	DIPOLE
(+ WB6RUU)									
AA7QY	F,AZ	2280	19	19			7:41	NC40A 950mW	?
AA8LF	H,MI	2220	74	50	23	1	6:29	OHR400 5W	INV-V 20M, PHASED INV-V'S 40
N5BTH	FIELD,TX	2120	53	1	52		7:59	TS-50S 5W	40M LOOP @30' & 6'
(+WD5ABC, AB5KN)									
AE4IC	F,NC	2040	34	19	15		5:30	NW40 & NW20 5W	85' WIRE W/17' RADIAL
K4XY	F,VA	1920	48	48			6:06	IC706 5W	DIPOLE
W0LK	F,AR	1800	30	12	18		4:46	OHR CLASSIC 5W	50' LONG WIRE
WA2CRQ	F,CA	1800	30	29	1		4:19	NC40A & HW-8 2W	20M & 40M HAMSTICKS
AB5WB	F,TX	1800	45		45		4:53	QRP+ 5W	20M ROTATE. DIPOLE @16'
(+KC5GKW & STEVE)									
AB7PF	FIELD	1760	44	14		30	4:11	?	?
(AIR MOBILE AZ TO NM)									
WA0RPI	H,MN	1760	88	41	47		7:42	IC735 5W	DELTA LOOP & DIPOLE
K9PV	F,NM	1680	42	3	39		7:05	IC706 >5W	40M DISCONE @25'
WT6P	F,CA	1560	26	14	12		7:26	HW-9 >5W	DIPOLE & MILITARY VERT.
K6BSU	F,CA	1560	26	26			7:45	HB 73 SPECIAL 3W	66' END FED W/66' GRD WIRE
K5FO	F,NM	1520	38	23	15		6:53	Icom 706 3W	VERTICAL (IN THE WIND)
N4EO	F,TN	1520	38	26	12		5:15	QRP+ 5W	?
KE7IT	H,WA	1520	76	6	70		7:24	QRP+ 5W	140' DIPOLE @60'
VE3QDR	F,ON	1480	37	23	14		4:23	ARGO II 5W	?
(DURHAM QRP CLUB)									

CALL	QTH	SCORE	Q'S	40cw	20cw	OTHER	TIME	RIG	ANTENNA
WA6ARA	F,CA	1440	24	18		6	3:25	NC40-2W & CASCADE-4W	DIPOLE @20'
(+N6VGW)									
KV9X	F,WA	1440	36	12	19	5	7:33	QRP+ 5W	80M DIPOLE W/TWINLD @30'
(+KC7MCW)									
W6ZH	H,CA	1440	72	19	53		6:34	OMNI 6 5W	KT34XA@75'- 40-2CD@60'
N2MNN	F,NJ	1320	11	7	4		4:15	W..SIERRA 950 mW	40M VERT. LOOP
N6XG	H,CA	1320	66	5	61		7:59	QRP++ 5W	YAGI & VERTICAL
WA8TIM	H,MI	1320	22	22			6:30	SW40 1W	HG DX88 VERT
KB2JE	H,NJ	1320	66	34	27	5	7:43	IC706 3.5W	G5RV @25'
N2JGU (+3)	F,NY	1280	32	32			2:11	ARGOSY 5W	75M DIPOLE @40'
W7AGJ	H,WA	1260	21	21			7:18	NC 40A >1W	80M DIPOLE
KC1FB	F,CT	1200	10	10			7:50	NE40-40 >1W	G5RV-L FED NR. GRD
AG5P	F,MO	1200	10	9		1	2:04	OHR SPRINT II 1W	40M & 160M HORIZ.LOOPS
WA7FCU	F,UT	1200	30	22	8		7:37	QRP+ 5W	R7 VERTICAL
KC8BIK	H,MI	1140	38	37	1		4:10	HB ?? 5W	?
WD8RIF	F,OH	1120	28	28			2:19	QRP+ 5W	40M DIPOLE
(+AA8EB, W8MHV)									
AC6NT	H,CA	1120	56		56		7:34	MFJ 9020 5W	3 EL. BEAM
KI7MN	F,AZ	1080	18	10	8		6:05	OHR CLASSIC 5W	G5RV
N2CQ	F,NJ	1080	25	4	21		7:31	NC49er & MFJ9020 >5W	FOLDED DIPOLES
VE6GK	H,AB	1080	18		18		3:14	SIERRA 1W	?
KC7NEV	F,AZ	1000	25	22	3		5:48	QRP+ 5W	INV-VEE
KD0SU	F,CO	1000	25	21	4		6:09	IC725 5W	?
VE6ZAA	F,AB	880	22	22			3:17	IC725 4W	40M DIPOLE
WB5QMP	F,ID	840	14	14			5:47	NC40A 2W	40M DIPOLE @20'
W6RCL	H,CA	720	24	24			7:13	NC40 2W	HF-2V ON ROOF

CALL	QTH	SCORE	Q'S	40cw	20cw	OTHER	TIME	RIG	ANTENNA
N8ET	F,OH	680	17	15		2	1:26	FT-707 5W	535' L.WIRE - KITE SUPP'D.
(+WM8W, WS8T)									
HP1AC	H,PAN	660	33	33			3:19	TS430S 5W	TA33JR YAGI
KJ5TF	F,AR	640	16		16		2:25	QRP+ 5W	WALKING STICK
N0JFZ (+ 5)	F,MO	600	15	5	10		6:25	?	?
K3SS	H,VA	600	30	16	14		6:50	FT757GX 5W	G5RV ENDS@45' & 20'
K3WWP	H,PA	570	19	12		7	0:37	HB TUBE 5W	RANDOM WIRE @30'
VE6DN	FIELD,AB	560	14		14		5:57	IC725 5W	3 EL TRIBANDER
(CALGARY QRP CLUB)									
KO6KA	H,CA	500	25	14	11		4:43	ARGO 509 4W	?
VO1DRB	H,NF	450	15		15		7:46	GM20 & OHR 400 5W	MFJ SUPER HI-Q LOOP
N0IZZ	H,MO	440	22	8	14		6:23	TS520 5W	40M EXT'D. DBL ZEPP @20'
AA0OL	H,MN	420	7	7			4:39	WILD.SIERRA >1W	ROTATABLE DIPOLE @60'
KB2SWI	H,NY	400	20	20			5:25	MFJ 9040 5W	?
AA1PB	H,VT	360	12	10	2		4:34	? 5W	?
VE6ZAA	H,AB	300	15		15		1:52	IC725 4W	GAP TITAN VERT
KB7BEJ	H,AZ	280	14	10	4		2:02	SCOUT 5W	5BTV
KB2UFY	F,NY	240	6	4		2	0:47	DX70T 4W	80/40 DIPOLES @15'
(BARK - KE2DI)									
W2JEK	H,NJ	210	7	1	6		1:41	NN1G 2.25W & OHR40 2W	20M VERT. & 40M DIPOLE
N5JWL	F,TX	200	5		5		0:16	FT-7 5W	20M WIRE BEAM
N3CZB	H,PA	140	7		7		8:00	CENTURY 21 5W	2 TURN LOOP - 36" DIA - HB
VC3JFF	H,ON	80	4	3	1		6:08	TS-140S-4W	C/C VERT / 20M INV-VEE
KE6AMY	CA	CK.LOG							
N7ANT	VA	CK.LOG							
KB2TEO	NY	CK.LOG							
TOTAL Q'S		3234	1669		1493	72			

Quick, Inexpensive and Effective: A Simple Satellite Mobile QRP Station for the Beginner

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This article describes how the author's AO-27 satellite station evolved from its simple beginnings. The author has used this station to make contacts with fifteen states and over twenty grid squares while operating satellite QRP mobile.

Introduction

AO-27, also known as EYESAT, was one of several amateur radio low-earth orbit satellites that hitched rides as secondary payloads on an Ariane V-59 rocket launched in September 1993. AO-27 is a small microsat class satellite that performs commercial functions and also acts as a part-time mode J FM repeater within the amateur radio bands. At present (July 1996), the satellite is configured to turn on its FM transponder for a fixed amount of time starting several minutes after it emerges from the Earth's shadow. AO-27 has a very sensitive receiver that will detect even a few watts from an HT.

The Satellite Station

My original satellite station was a Tempo S1 two meter HT, a 5/8 wavelength magmount, a homebrew quagi and a handheld scanner. I have improved upon the original quagi and replaced the scanner with a preamp, a downconverter and a Uniden HR2600 10 meter transceiver. My whole station fits neatly into the trunk of the car, and easily sets up in less than five minutes. When necessary, everything except the quagi boom and 5/8 wavelength antenna can collapse down into a backpack or carrying case.

In March, I demonstrated satellite communications, with help from Joe (N2CX), during a New Jersey QRP meeting and then again at the NE QRP meeting at ARRL Headquarters, where the portable QRP satellite station generated considerable interest. Among those in the audience was Bill Acito, KC1GS, who is now also active on AO-27 and has managed to work European stations through AO-27 by using a pair of stacked eleven element yagis on the downlink!

AO-27 : The QRP satellite

While AO-27's uplink receiver is very sensitive, the downlink is usually at the 600 milliwatt level. This means that a good low noise preamp with 15-20 db gain, or at least a five element beam, is needed. I originally started with a homemade five element quagi built from an article in the December 1987 "QST".

My first quagi was just thrown together. The boom was a wooden dowel. The reflector and driven element were #12 solid copper wire supported by wooden dowel spreaders held in place with hot-melt glue. The directors were one-eight inch welding rods secured with rubber bands. The quagi was pointed manually and fed a few feet of RG-8 connected to my Radio Shack Pro-38 scanner.

For an uplink signal, I used my HT and a 5/8-wave antenna magmounted on my car. The HT put out about one and a half watts. Using the quagi, scanner, two meter ht, and 5/8-wave, I worked six states in my first month of QRP mobile satellite operations.

Downlink Improvements :

The Receiver After the first few contacts, I found that the scanner didn't receive very well except during the highest elevation passes. I also observed that there were times when the downlink would doppler between two channels, and neither one was copyable. My first solution was to use a 435 Mhz downconverter with the scanner set at 29 Mhz. The scanner tuned in 15 Khz steps at 435 Mhz but 5 Khz steps at 29 Mhz. This reduced, but didn't eliminate, the problem of the downlink being between channels on the scanner. However, it also added a few new problems because there were now three times as many channels, and the scanner could only scan in one direction. If I scanned too far I had to go all the way to the end and start over.

The current solution uses my Uniden HR2600 10m HF rig with the 435 Mhz downconverter, effectively turning it into a 435 Mhz all mode receiver. This provides several advantages over the handheld scanner. The combined preamp/downconverter/HR2600 receiver has finer tuning (100 Hz) and copies the downlink at low elevations better than the scanner. The only disadvantage of the HR2600 is the higher current that it requires. This is easily overcome with a 7 amp-hour "brick" gel cell.

Downlink Improvements: The Quagi

Soon after I finished the first quagi, I started thinking about improvements. While it fit in the trunk of my car, it seemed to occupy more volume than it should. Since I wanted it to be portable, it had to be collapsable, light weight and easy to hold and point. In addition, I didn't want something which was overly complicated or required tools for assembly and disassembly. With these goals in mind, I redesigned the quagi.

To solve the pointing and holding problem, I took an angled handle from an old garden tool and attached it to one end of the boom. It allows my hand to grip the handle at a natural angle. I also used a smaller diameter dowel as the boom to make the whole antenna lighter. These two improvements made the antenna aiming much easier and reduced the arm strain.

Next, I connected four short wooden dowels to each of the loops with some creatively cut plastic tubing. The other ends of the dowels are plugged into wooden spools attached to the boom. This allows the loops to be removed from the boom if necessary. The directors are held in place with cord locks from the local camping supply store. Two cord locks, one above the boom and one below, effectively hold the directors in place while providing an extremely quick assembly and disassembly. The preamp was configured to run off of a 9-volt battery and mounted on the boom. The construction of the improved quagi could easily be another article itself!

Working AO-27

In order to access AO-27's transponder, it's necessary to be able to track its orbit around the Earth. These days the way to track satellites is to use a computer with a satellite tracking program. Several tracking programs for various computers are available from AMSAT at http://www.amsat.org. Any of the tracking programs will give all of the details necessary to access the bird: the exact time that AO-27 will be visible above the horizon, the direction to point the antenna (the azimuth) and how far above the horizon to tilt it (the elevation). Don't think that a fast Pentium is required for satellite tracking. The author used to track satellites on his 2 Mhz 8085 computer with 16 kilobytes of RAM.

Once I started working stations on AO-27, I noticed some of the nice characteristics of its orbit. Most of the passes are in the morning or around lunch time. Also, the bird will almost always rise from the north and set towards the south. It is relatively easy to follow its path across the sky once the signal is found: just move the quagi back and forth for the best resulting signal.

All satellite passes are not created equally. When I was using my original station, I only tried to work AO-27 on those passes that would reach a maximum elevation of at least forty-five degrees. Lower elevation passes will place the satellite at a greater distance exceeding the capability of both the HT and the scanner.

Remember that it will take one hand to point the quagi, one to key the mike, one to log the contacts, and one to adjust the downlink frequency. This will take practice, but it can be done.

As the satellite travels overhead, its signal will appear to change frequency. This phenomenon is known as the Doppler shift. In order to compensate for doppler, lower the receiver's frequency gradually as needed. Set the two meter HT to the satellite's uplink (145.850 Mhz) and leave it on that frequency. The satellite will compensate for the doppler on the uplink.

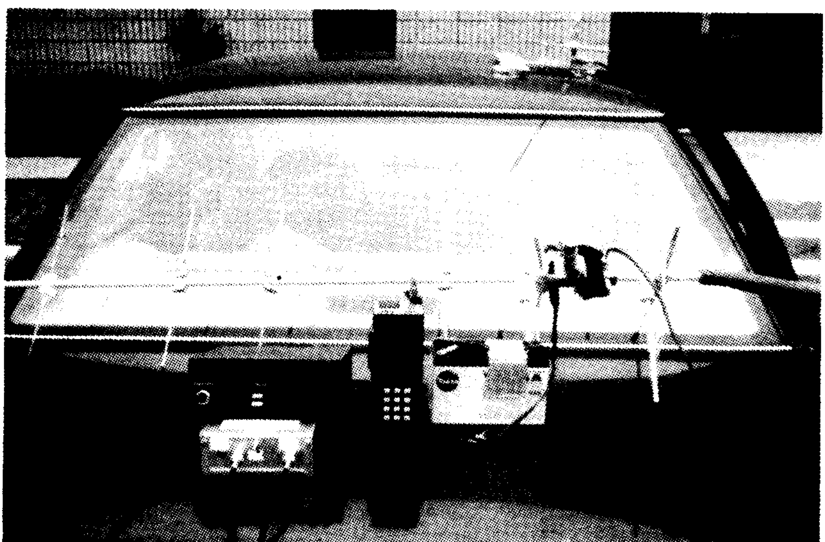
Now w[illegible] DON'T TRANSMIT UNTIL THE DOWNLINK FROM THE SATELLITE CAN BE HEARD! The satellite *will* retransmit any signals it hears. Some people can't hear the downlink and only succeed in disrupting the pass for everyone else who can. You should hear your own voice on the downlink. This is normal, but might take some operators by surprise. Satellite contacts on low Earth orbit birds like AO-27 are usually short and contest style.

What's Next?

Some of the future improvements include collapsable tripod with a crossboom and a two meter beam for the uplink. RS-10 and RS-12 could both be worked by QRP mobile stations, and I haven't even started to talk about the digital birds!

Conclusion

That's all folks! And of course, thanks to my wife/editor who assisted in the preparation of this work. If you have questions, feel free to contact me at dquagliana@aol.com. See you on the birds. 72, Doug, KA2UPW



The KA2UPW satellite QRP mobile station: 7 Ah gel cell, Uniden HR2600 and headphones, homebuilt 435 downconverter, and Tempo S1 2M HT. Behind the radios is the 435 quagi with the preamp. Magmount 2M Antenna on roof of car

The St. Louis Vertical

by Dave Gauding, NF0R
nf)r@slacc.com

[Reprinted with permission from Aug. 1996 Peanut Whistle, Journal of the St. Louis QRP Society.]

The St. Louis Vertical (SLV) offers portable enthusiasts an easy-to-build, easy-to-use antenna which:

* Covers 10-40M via a balanced line tuner. (Lots of bands for the bucks!)
* Installs independently of external supports. (Trees are not required)
* Is inexpensive. (About $40)
* Is lightweight. (45 oz. for antenna, mount and radials)
* Is really portable. (Car, canoe, backpack, bike, etc)
* Installs pronto. (5 minutes or so)

Materials:

20' collapsible fiberglass fishing pole (South Bend Model SD-20 or equivalent)
12" of 1.25" hardwood dowel
4" heavy-duty nail or spike
vinyl plastic electrical tape
5 small alligator clips
1 small solder lug
1 small hollow rubber ball
1 medium fishing swivel
light monofilament fishing line
10" bare copper wire
300 ohm in-line plug & socket set (Radio Shack 15-1198)
130' of 300 ohm twinlead (Radio Shack 15-004)

How It Works:

About 51' of twinlead is coiled on the 4' bottom section of a 20' collapsible fiberglass fishing pole. An additional 16' of twin lead in the clear serves as a vertical radiator.

The pole is socketed on a wood dowel tipped with a pointed spike. It can be pressed into firm ground by hand in practically any location. Due to the lightweight construction and minimal sail area the installed antenna is very stable.

Shortened twinlead radials are used in this design. The smaller footprint can be helpful at some locations. Three radials work okay for casual operations. The number of radials can be increased or otherwise modified to meet builder preferences.

The ground bus is a circle of bare copper wire. The antenna radials and feedline are attached with alligator clips.

The SLV's tuned feedline provides a seven band capability. Chose any balanced line such as twinlead, window line, zipcord, twinax, etc. Impedance and length are noncritical. Selecting a St. Louis Tuner is politically correct but similar transmatches work just fine, of course.

Construction:

1. Terminate a balanced feedline in alligator clips and solder.
2. Cut three 20' lengths of twinlead for the radials. Short and solder each radial at one end. Then short and solder both conductors to a single alligator clip at the opposite end. Measure out 6.5' from the alligator clip. Remove a 1" section on one side of the conductor only. Protect the cut with tape. This creates a continuous 33.5' folded ground wire and a 6.5 ground wire in a 20' span. The long dimension acknowledges the lowest design frequency (40M).
3. Form the bare copper wire into a circle to create the ground bus wire and solder.
4. Using twinlead for the loading coil, strip and short the wires and terminate in the solder lug. The opposite end will be finished later. The twinlead can be spliced and soldered if a continuous length is not available.
5. Position the solder lug end of the twinlead at the top edge of the pole's protective base. Tape in place leaving two inches of the twinlead free for the solder lug to flex. If right-handed start the coil

by rolling the pole away with the right hand. Feed the twinlead onto the pole with the left hand. Butt each turn neatly against the preceding turn. The rolling action establishes a fairly shallow placement angle. Positioning the far end of the pole at table level between two heavy objects (i.e. gell-cell batteries) helps control the assembly while winding progresses.

6. This is surprisingly strenuous hand work when executed properly. Proceed slowly and take occasional breaks. The twinlead needs to be wrapped firmly but not too tightly. The Radio Shack product was selected because the brown rubber jacket and #24 stranded conductors are very pliable. In addition to being relatively light this twinlead does not easily take a set if bent.

7. With the South Bend pole and Radio Shack twinlead in combination there will be about 142 turns on the base section when the loading coil is finished..

8. Tape the top end of the completed coil in place leaving two inches free for connections. Reinforce both the top and bottom turns with additional tape. The entire coil can be wrapped in tape for complete protection.

9. Strip the wire and install the 300 ohm in-line socket at the top end of the loading coil. For durability the wire conductors should be folded back upon themselves several times and twisted before tinning. Miniature solder cups are another alternative. Fix the terminal screws in place with Loctite or clear nail polish. Note that an unbroken twinlead coil and radiator may by an option for some builders.

10. Fully extend the pole along the ground. From the tip of the pole to the top of the loading coil will measure about 16'. Cut a matching length of twinlead for the radiator.

11. Install the 300 ohm in-line plug on the lower end of the radiator. Plug into the previously installed coil jack. Trim the radiator to about 4" below the top, short the wires and solder. Add 5" of monofilament to the tip section and finish with the fishing swivel. This system is preferable to direct attachment where the angle tends to bed the pole over at the tip.

12. Tape or shrink wrap each soldered joint on the loading coil, radiator, radials and feedline.

13. Cut the head off the nail. Drill out the dowel to accept it and tap firmly into place. Make a slit in the rubber ball and install on the spike for safety. Each fiberglass pole is laid up by hand and internal diameters will vary. Some light sanding on the dowel may be necessary to insure a good fit or add a tape wrap if undersized.

Installation:

1. Push the spiked dowel into firm earth by hand. Drop the ground wire bus over the dowel. For now extend only the smallest diameter pole section and twist into position.

2. Unscrew the pole's bottom cover plate while holding the individual sections inside. Carefully slip the entire nested assembly over the dowel.

3. Attach the radiator to the tip section with the swivel. Star extending sections sequentially to 20' locking firmly into place at each level. Plug the radiator into the coil.

4. Attach the radials to the ground bus. Attach the feedline to the radiator and to any point on the ground bus.

Comments:

Tuning is very sharp. Depending on the tuner expect to spend some time in locating resonant points for each band. On the plus side the bandwidth is surprisingly generous including 40M. With a quarter wave of electrical length available the SLV will load on 80M but has not been used seriously on that band.

The dimensions were truly created

at random but appear to fit this 10-40M application. Shorting the twinlead probably offers some electrical benefits but is done mainly for mechanical reasons.

Builders will be able to get by with as little as 20-25' in the coil if necessary. A simple 16' stranded wire can replace the twinlead radiator. There is plenty of room for experimentation such as single band verticals using a coax feedline. The SLV has handled 50W with no coil heating detected.

The specified Radio Shack twinlead is a light-duty product. If weight is not a problem users may want to upgrade to a heavy-duty twinlead.

The wood dowel should fit snugly in the base section to provide rigidity for the installation. However, the dowel may swell if exposed to moisture. Waterproofing with a coat of varnish is suggested for wet climates.

Initial reaction to the pole's light fiberglass construction and flexibility is predictably skeptical. For the record the South Bend SD-20 pole in the SLV prototype has been used as a portable antenna support for eight years.

Backpackers and hikers can rig a simple leather sling for a SLV and shoulder it like a rifle. It is marginal as a walking stick. The nested fiberglass tubes tend to rattle and the plastic screw cap on the base is prone to damage on rocky ground.

This design eliminates dependence on trees or other supports to get a horizontal antenna up where it can do some good. Quick installation and breakdown translates very simply to more time on the bands when running portable.

The SLV is useful for clandestine operating around condos or apartments. The tapered profile and black finish are understandably difficult to detect at night. The antenna can practically be erected by feel in a pinch.

This little antenna follows little QRP rigs almost anywhere. Once there, a SLV offers an opportunity to get our low power transceivers on the air with a respectable signal. Finally, a not unexpected reminder that if the bands are dead the fish might be biting. Either way a SLV operator is properly equipped. Good luck and be sure to pass along any modifications to the original design. 72, Dave, NF0R

Sidetone for the 49er and the Pixie

by Jeff Furman, KD6MNP

I have added sidetine to the 49er. A similar method may work for the PIXIE2 also. The LM380 audio amplifier in the unmodified 49er has an unused input. This input has been used to boost the amplifier's gain by using controlled positive feedback. I used this input to make a classical Wien bridge oscillator circuit for sidetone. The "sinusoidal" waveform produced by a linear type oscillator sounds better than the harsh, raspy squarewaves or pulses generated by typical multivibrators or unijunction oscillators. The design of a feedback oscillator such as this is guided by principles that date back to steam engine speed regulators, and more recently by the work of Barkhausen and Nyquist. Barkhausen showed the condition for oscillation is the net gain around the loop must have magnitude of one and zero phase shift at the frequency of oscillation and different magnitude and/or phase shift at all other frequencies. Our LM380 unused input is non inverting; this means the phase shift from input to output is zero degrees. The gain magnitude of the amplifier is about 50. The Wien feedback network as used here has zero degrees phase shift at only one frequency, and its gain magnitude is a maximum of 1/3 at that frequency. These two elements combined into a loop give the required phase shift, but the gain is too great for oscillation(!!). What is needed is an attenuator of about 3/50 to give the required unity magnitude. This is easily added as a tap, forming a voltage divider, in the resistor of the shunt branch of the Wien network. This is the basic idea for the oscillator. In the sidetone application, the oscillator must be keyed as the transmitter is keyed. A garden variety switching diode is used a switch: when it's forward biased, its resistance is relatively low, compared to the rest of the circuit it controls. When it's reverse biased, its high resistance disconnects the two parts of the circuit. The LM380 output pin is quiescent at half of the supply voltage, so, if the the keyline in the key up condition has a higher voltage than this, the diode will be reverse biased and the feedback loop will be broken, as desired. Next, key down pulls current through the diode, which enables the feedback and allows the desired oscillation to start. The back to back diodes are intended to limit the amplitude of oscillation. It is a feeble attempt to provide oscillator agc, common in linear oscillators. As the amplitude increases, the diodes start to conduct, and thus change the attenuation through the feedback network away from the Barkhausen condition.

Here is the mod in words:

1. At the output of the LM380 (pin 6), connect the anode of an ordinary switching diode such as 1N914, 1N4148, etc. A rectifier such as 1N4001 may work, but I haven't tried it.
2. Connect a 10k (not critical value) resistor between the cathode of this diode and the keyline.
3. At the junction of the diode and the 10k resistor, connect a 160k ohm resistor.
4. At the free end of the 160k ohm resistor, connect a 0.001uf (same as a 1 nf) capacitor. I recommend any film type as opposed to any ceramic type.
5. Connect a second capacitor of the same value and type between the the free end of the first capacitor and ground.
6. Where the two capacitors connect together, connect one end of a 150k ohm resistor.
7. At the free end of the 150k ohm resistor, connect a 10k ohm resistor to ground.
8. Connect two more switching diodes back to back ie. anode of each one connected to the cathode of the other, and connect this pair between ground and the junction of the two capacitors and the 150k ohm resistor.
9. On the printed circuit board, cut the trace that grounds the unused input pin on the LM380 (pin 2) and connect this input to the junction of the 150k ohm and 10k ohm resistors.

These are all standard 5% values; the resistor in step 2 is a nominal value but the remaining resistors and capacitors determine the oscillation frequency and the attenuation, so departures from resistor RATIOS and capacitor RATIOS will cause problems. The key here is the capacitors have the same value (ratio = 1) and the single series resistor equals the sum of the voltage divider resistors. Notice that 10k/(150k + 10k) = 1/16 = 3/48 (almost=) 3/50. The error toward slightly less attenuation than estimated helps the oscillator start up and stabilize before the dit is done. Thus, the 10k ohm resistor added in step 7 may need to be different depending on ?? variables: standard values are 8.2k, 9.1k, 10k, 11k, 12k, 13k, etc, I used 5.1k + a 10k, one turn trimmer. The correct value allows oscillation to build up over the supply, temperature, etc. extremes, but not exceed the limits of the agc. You can notice the raspy, blaring quality of the note when it's too much, and a slow, droopy startup with barely sufficient gain.

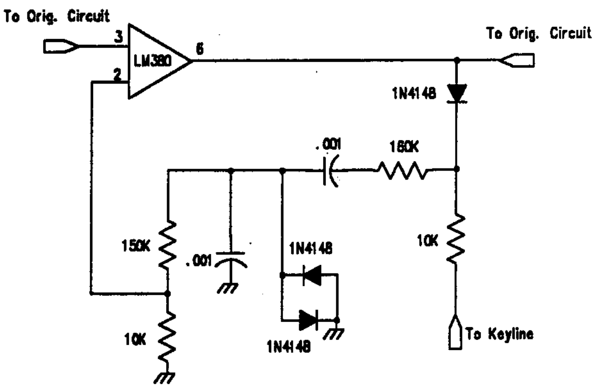
The sidetone frequency is about 1khz. Doubling the resistors (or the capacitors) halves the frequency, so, as an example, for about 700hz, the 160k ohm resistor becomes 220k ohms, the 150k ohm resistor becomes 200k ohms, and the 10k ohm resistor in step 7 becomes about 13k ohms.

PIXIE2 modification:

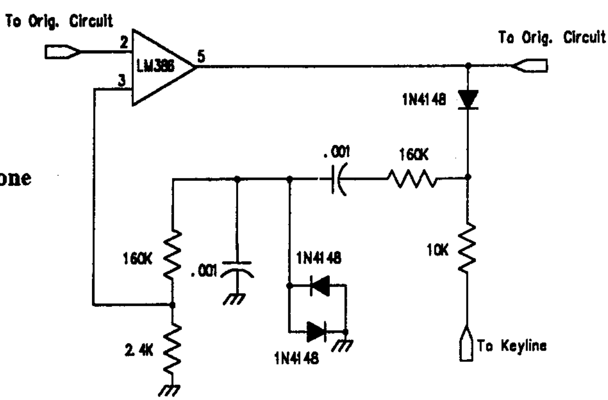
Three major differences are:

1. the pin numbers are different on the LM386 than the LM380 (LM386 output is pin 5; LM386 noninverting input is pin 3),
2. the LM386 gain is about 200 instead of the LM380's 50. Just changing the voltage divider attenuation from 3/50 to about 3/200 should do it, so, for 1khz, the 150k ohm resistor becomes 160k ohms, and the 10k ohm resistor in step 7 looks like about 2400 ohms,
3. The PIXIE2 shuts down the LM386 during transmit; this needs to be changed by disconnecting the anode of D1 from the junction of R5, C10, and pin 6 of the LM386, and connecting it to its own 1k ohm resistor to +9v. and another 10uf cap. This accounts for the bias current through D1 during receive, if D1 has some effect in receive. If it happens that D1 is not necessary, then a resistor from the keyline to +9v. (guessing here, 1k to 10k ohms) could replace D1. I have a PIXIE2 that uses a homemade discrete audio amp without D1, so I need to investigate its function further.

I invite comments on the functioning of the PIXIE2 in receive to clarify this. Experimenter's License and author's caveat: Since I haven't tried this PIXIE2 modification, this is more speculative. As before, the value of the 2.4k ohm resistor may need tweaking. Exact science, huh? 72, Jeff, KD6MNP



49er Sidetone Circuit



Pixie Sidetone Circuit

1st Annual NorCal QRP Club West Coast

QRP Symposium

Oct. 19-20, 1996
In Conjuntion with Pacificon 96
Concord Hilton Hotel
Concord, CA.

The NorCal QRP Club is sponsoring the first annual West Coast QRP Symposium. We have lined up 6 exciting speakers and it promises to be an entertaining weekend filled with QRP Fun and Fellowship. The best part is that there is no charge to attend the symposium, other than the registration for the Pacificon Pacific Division Convention which is $3 in advance and $4 at the door.

The first session will be at 9:00 AM, then we will take a break until 1:00 when we will have 4 speakers at 1, 2, 3 and 4PM. We will come back at 7:00 PM for a QRP Open House, featuring show and tell and Vendor Tables from the various QRP suppliers. The Vendor Tables are free. If you are a QRP Vendor, contact Doug Hendricks at 209392-3522 to reserve your space.

Room Reservations: Contact the Concord Hilton and ask for the Pacificon Pacific Division Convention Rate.

Tentative Speakers:
Saturday, Oct. 19, 1996

Paul Harden NA5N "How QRP Rigs Work, A discussion of the NorCal 40A, NW8020, OHR Explorer, SWL Green Mountain, and the Hands GQ Transceivers."

Dave Meacham, W6EMD, "QRP Antenna Systems"

Ed Burke, KI7KW, "Operating QRP SSB"

Chuck Adams, K5FO, "QRP and the Internet"

Eric Swartz, WA6HHQ, Stan Goldstein, N6ULU, Chuck Adams, K5FO "Working QRP Contests and DX"

Bob Tellefson, N6WG, "QRP Field Day Operating"

Sunday, Oct. 20, 1996

Doug Hendricks, KI6DS, "QRP, Advice for the beginner."

Back Issues of QRPp

Back issues of QRPp are available in bound issues only. Volume I contains the 3 issues from 1993. Volume II contains the 4 issues from 1994 and Volume III has the 4 issues from 1995.

Volume I is 140 pages and is $10 plus $2 shipping for US addresses, $5 shipping for DX. Volume II is 296 pages and is $15 plus $2 shipping for US addresses, $5 shipping for DX Volume III is 276 pages and is $15 plus $2 shipping for US addresses, $5 for DX.

If you order all three volumes the cost is $40 plus $3 shipping for US addresses, $10 DX. To order, send your money order or check to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620. Make all checks and money orders out to Doug Hendricks and NOT to NorCal or QRPp. All prices are for US funds only.

Crystals: NorCal has made a bulk order of crystals. We now have the following frequencies available: 7.040 MHz. 7.122 MHz (Novice Band), and 10.116 MHz for 30 Meters. The price is $3 each, postage paid. Make checks or money order out to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620.

40-9er Kits: We have a kit for the 40-9er transceiver that was featured in the March (1996) issue of QRPp. It was designed by Wayne Burdick, N6KRE and has had over 20 pages of mods and imporvements developed by QRPers all over the world. All board components, PC Board (plated and silkscreened), 6 page manual, and a crystal of your choice 7.040 or 7.122MHz. is $25.00 for US, $30 for DX. US Funds only. Please specify which frequency you desire. Extra crystals are $3.00 each. See the June 1996 issue of QRPp for mods and improvements. This design was the basis of the 1996 QRP ARCI Dayton Building Contest and ia an excellent learning kit for the first time builder. Send your orders to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Please make checks and money orders out to Jim Cates, NOT NorCal.

QRPp is published at Dos Palos, California 4 times per year: March, June, September and December. Subscripiton fee is $10 for US residents, $15 for Canada and $20 DX per year. To join the NorCal QRP Club, send your name, call sign, and address to: Jim Cates. There is no charge for membership to NorCal QRP Club. To receive QRPp, you must subscribe and pay the fees. Send your money (US FUNDS ONLY) to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Please make checks and money orders out to Jim Cates, NOT NorCal. The articles in this journal have not been tested nor is there any warranty as to the feasibility of the items described. The articles have been published with the consent of the authors, and no article may be reprinted or reproduced in any form without the expressed written consent of the author. All authors retain all copyrights to their materials, and all articles in this publication are copyrighted. Publishers of other club newsletters may reprint articles as long as they are NOT for profit and not a commercial venture of any kind, and credit is given to the author and to QRPp.

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Volume IV, Number 4, December 1996

From the Editor

by Doug Hendricks, KI6DS
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Greetings again from the editor. This is the end of the 1996 QRP year, and what an exciting year it has been. We saw the 49er, KC-2, St. Louis Tuner, St. Louis Vertical, and with this issue, the "38 Special", all NorCal kits.

This issue also features an article with lots of pictures from the West Coast QRP Symposium that was sponsored by NorCal and held in conjunction with Pacificon 96 at Concord, California. We had a wonderful time and hope that you can join us next year for the second annual event. Plan on keeping the third weekend of October open, as we plan on meeting in Concord once again.

This year also was a sad one for Jim and I. Jim lost his lovely wife Electra, to cancer in June. He received many, many messages and cards of condolence from his friends and wishes to say thank you. My wife's father died in late October from Alzheimer's Disease, and again I want to echo Jim's thank you to all of you who sent messages and cards. They were appreciated very much by both Jim and my wife JoAnne and me.

This issue features the "38 Special" and the Rainbow Tuner, the two co-winners of the NorCal sponsored Dayton Building Contest Design Contest. The purpose of the design contest was to encourage the development of cheap, easy to build projects, and boy do we have two great winners. Joe Everhart, N2CX, from the New Jersey QRP Club and a long time NorCal QRP Club member, has an outstanding project with his Rainbow Tuner. This one will be kitted by the guys from the New Jersey QRP Club. It was not possible for NorCal to kit both projects, and the New Jersey QRP Club stepped forward to offer their services which we appreciate very much. It is nice to have another club producing a kit for QRPers to build. I strongly encourage you to support their efforts.

Ori Mizrahi-Shalom, AC6AN did a lot of the work with the 49er mods that appeared in the June issue. He loves the idea of a simple radio, that is cheap to build, and encourages experimentation. So, he has designed the "38 Special", which will be kitted by NorCal. The "38 Special" has a superhet receiver, sidetone, offset, and a tuning range of 25 kHz. Plus, the circuit board has been designed to allow for adding an RIT, improved IF filter, a simple mod to increase the power to 3 Watts, and there will even be space for the new TiCK keyer that has been introduced by Embedded Research. Complete details for the mods are in the kit manual. Congratulations to Ori and Joe for their wonderful work.

Wayne Burdick is busy working out the final details on his new design, the SST, which stands for the "Super Simple Transceiver". NorCal will kit this rig, which will be available in late February. Complete details will be in the next issue. Wayne had hoped to have it ready by this issue, but just could not get it finished in time. We did not want to rush the project, and want it to be right, the first time. The SST will be available in two forms, as a bare bones kit, with PC Board and parts only, and as a full kit with case, connectors and controls. Pricing details are not firm at this time.

Finally, starting with this issue, we will have a Winter, Spring, Summer and Fall issue We will try to publish on the same schedule as before. 72, Doug, KI6DS

The "38 Special" Transceiver

by Ori Mizrahi-Shalom, AC6AN
2841 Burdick Way
San Jose, CA 95148
e-mail: ori@juno.com

What radio??

1) is a superhet with only two NE602s
2) has no discrete transistors
3) sells for $25

Can't guess? The answer is the "38 Special". The "38 Special" is an exercise in minimization. We feel that it is "special" because of the following:

*It works on the under-utilized 30M band

*Runs of f a 8V supply (due to limitations of some components)

*Special in its architecture

*Excellent price/performance ratio

*Last, but certainly not least, the fact that it offers a great platform for another year of hacking...

The "38 Special" is the result of an effort which started with hacking the 40-9er transceiver. A novelty radio, the direct-conversion 40-9er was quite limited, especially for weak signal work. The "38 Special" rectifies most of these problems and even adds a few nice features. It came to life due to the design contest challenge and the never ending enthusiasm and encouragement by Doug, KI6DS, who also came up with the great name.

GENERAL DESCRIPTION

The "38 Special" is a superhet transceiver for the 30M band. The first thing you'll notice looking at the schematics is the lack of discrete transistors. I have been playing with this concept for some time and the 38 Special was the right vehicle. The transmit section relies on a TTL buffer. I extended this concept to utilize the same TTL chip for other tasks. Although it's an NE602-based superhet transceiver, the "38 Special" incorporates only two NE602s. I reuse the product-detector as the transmit mixer by channeling different signals to that chip on receive and transmit. Also, the traditional LM380/386 is gone in favor of a more versatile dual op-amp circuit for the audio section.

RECEIVER FRONT-END

The receiver front-end starts with a back-to-back diode switch. The "38 Special" utilizes 1N4007 diodes for the switch. This diode has a PIN structure and provides low insertion loss, although it suffers from poor zero bias isolation and does not offer a strong IMD performance like an RF-rated PIN diode. (1) It is superior to the 1N914 or similar diodes in this type of design. Next is a toroidal impedance transformer with a 10.1 MHz tuned circuit at its output, providing additional front-end selectivity to that offered by the transmit output network. Provisions were made to include a 10 KOhm pot for RF-GAIN control. The 10.1 MHz RF signal is fed to the input of the NE602 receive mixer, where it is mixed with the 22.1 MHz VXO to generate the 12.0 MHz IF frequency.

THE VXO

The superhet circuit enabled me to use standard crystals and avoid the high price of custom ham-band crystals. Many crystal combinations work for most HF bands. I chose a high frequency first crystal to achieve a high frequency swing. (2) This required a relatively high IF in the simple receiver. The NE602 Collpits oscillator required a high DC bias for a large swing, provided by a 3.9 KOhm resistor at pin 7. Although well below the value recommended, this resistor provides for stable operation of the NE602. "Rubbering" the crystal with a varicap allows relocating the tuning pot away from the oscillator, if desired. A 1N4000-family diode works here nicely as a varicap. (3)

A little assist from a molded inductor yields a tuning range of 25 KHz. A little hint here for the experimenters, do not replace this inductor with a toroid. The low Q helps to increase the pulling range. The VXO signal is mixed inside the NE602 with the received signal to produce an IF output of 12.0 MHz, which is the difference between the VXO and the RF frequency. During transmit, a 22.1 MHz signal is taken from the Collpits oscillator and injected into the input of the transmit mixer.

IF FILTER

The IF filter is implemented with a single crystal. It is a few KHz wide, due to budget constraints. Provisions for a better IF filter are included in the board layout. The main selectivity is achieved at the audio stage and the wide IF filter greatly simplifies the alignment of the receiver. The wide IF filter provides very little "wrong" sideband attenuation. Due to this, the "38 Special" in the stock form cannot be classified as a single-signal receiver. It will take a much sharper IF filter to achieve that. Although you will hear the same signal twice, the sharp audio filter totally eliminates the "off" signal.

PRODUCT DETECTOR

In the cost cutting tradition I left out the "traditional" third NE602 for the transmit mixing. Instead, the 38 SPECIAL reuses the product-detector for the same function. On receive, an oscillator (IF frequency) is mixed with the IF signal and it results in a low-level audio signal. On transmit, a signal from the VXO is mixed with the IF frequency oscillator in the second NE602. The selection of the input signal to the second NE602 is done by means of a 4066 analog multiplexer. Other than the switching of signals with the 4066, the receiver is similar in concept to most NE602-based superhet rigs.

RECEIVE OFFSET

Sharing the product-detector and transmit mixer required a "trick" to achieve a receive offset. The 38 SPECIAL "pulls" the IF frequency oscillator about 500 Hz up on receive with a 100 pF capacitor in series with the 12.0 MHz oscillator crystal. During transmit, this capacitor is shunted to ground with a parallel forward-conducting diode, so the crystal oscillates right on its fundamental frequency, resulting in a zero-beat transmit signal. The down-conversion at the first mixer and this oscillator pulling up on receive combine to yield the "right" receive sideband at a lower frequency. So, although the IF filter allows either sideband through, it is easy to identify the "right" one. This is not an issue when you call a CQ. The answering station is on the right frequency, if it zero-beats with your transmit signal.

AUDIO AMP/FILTER

The audio is filtered and amplified by an NE5532A dual op-amp, instead of the "traditional" LM380 or LM386 chips. (4) The 5532 requires more external components, but it gives a higher gain, and more important, the circuit also forms a sharp band-pass filter. From that point of view, the "38 Special" is superior to most NE602-based radios. This amp delivers about 60 dB of gain while driving a walkman-style headphones. The filter offers a 50 Hz -6 dB bandwidth and about 400 Hz at -30 dB. This circuit uses a dozen more components than an LM386. But they are probably the most cost-effective components in the whole radio!

TRANSMIT CHAIN

As mentioned before, the product-detector doubles as a transmit mixer. The signal on the output is filtered by a tuned circuit, and the 10.1 MHz output of 100 mV is used to drive the two-stage transmit amplifier. A few examples in the literature describe the use of TTL chips (and other logic devices) for a low-power transmitter. (5)

The most interesting article on the subject was written by Len Smith and appeared in QST. Len used an octal inverting buffer with eight individual active devices, but really utilized only five of them. This circuit gave me the idea of using the leftover devices for sidetone generation and other tasks.

One of the inverters is biased as a high gain linear amplifier. The 100 mV at its input comes out as a few volts on swing at the output. The single inverter is strong enough to drive the final circuit, which is made of four parallel inverters. Depending on the output matching, this circuit can deliver well over half a watt of output power. I chose to leave it at 400 mW for the sake of cool and safe operation of the final. The board supports additional circuitry (not supplied with the kit) for a higher output of up to 5W.

THE OUTPUT NETWORK

The use of only 8V supply required very low impedance for the final to give any appreciable output power. The matching is easily done by an L-C-L-C type network. [6]

SIDETONE

Two inverters combine in a simple oscillator circuit, as described in the ARRL handbook. The oscillator is clamped to ground during receive but is free-running during key-down. The output is attenuated by means of a large series resistor. There was no need to filter the square waveform, as the audio bandpass circuit does that anyway.

ADDITIONAL LOGIC

One inverter of the octal buffer chip forms the receive/transmit logic. It inverts the logic state of the "key" line, so when key is down, this signal is at full Vcc and when key is open, this signal is at 0V. The availability of the T and R signals simplifies the implementation of the T/R circuitry.

ALIGNMENT

The "38 Special" was designed with a novice builder in mind. There are only two alignment steps, although more parameters could be tweaked by the experienced builder. The receiver alignment consists of peaking the front-end trimcap for the highest receive audio.

The transmitter alignment is a bit more tricky. The radio transmits 10.1 MHz signal, when it has a 12.0 MHz IF signal in the output of the transmit mixer. This requires care when tuning the transmit filter trimcap. One way of doing that is by listening to your signal on another receiver. Tune close to your center frequency and look for the adjustment that results in an output with the least close-in spurs. The two alignment steps do not require any test equipment, although having such equipment can improve the alignment.

THE NEXT STEP

The final design reflects cost-cutting and other changes to simplify the alignment and kitting of the design. It is a superhet with offset and sidetone at a 40-9er price! As such, it has limitations, of course. I look at it as a product and a development platform. There will be many that will assemble the basic unit and have lots of fun with it in the stock form. But there will be those who want to do things their way. This radio was designed for both.

I will not continue its development. I leave that to the hackers and tinkerers out there. The "38 Special" was designed to continue the tradition that started with the 40-9er - mods by the dozen. There are many possibilities. In fact, some mods are being developed as we speak. I certainly encourage people to do just that. All I ask is that you share with the QRP community and let us all know of your adventures...

For those that build it stock or custom, plain or modified, hot or low key - have fun. I can't wait to see the entries for Dayton and Pacificon next year. I also hope to get more activity on the 30M band. Maybe we will finally know what the propagation properties really are on 30...

ACKNOWLEDGEMENTS

Again, many thanks to Doug Hendricks for the encouragement. Special thanks to Dave Fifield, KQ6FR, who built the second prototype and beat me to the first QSO - 549 on 200 mW from San Jose

to Spokane! Dave is a master builder, both of circuits and enclosures. He came up with many additions and suggestions that made this radio nicer and more robust. Special thanks to the XYL, who became a "radio-widow" during the last month...

NOTES:

(1) QST, Dec 1994 pp. 25-27.

(2) A similar concept is used in the Mizuho MX7S radio.

(3) See Jim Pepper's Deluxe QRP station, although not for rubbering a crystal.

(4) One designed by NN1G uses the 5532A for an audio amp but the filter seems to be not as sharp (that radio has a sharp IF filter)

(5) QRPp Mar. 1994 p. 58 and W1FB's Design Notebook p. 156.

(6) Solid State Design p. 53.

"38 SPECIAL" Parts List

C1,C2,C4,C6,C18,C23,	0.01 uF
C3,C10	150
C5,C12,C22,C27,C28, C29,C30,C33, 36 C37,C38,C40,C43	0.1 uF
C35	0.001uF
C7,C8,C9,C11,C13,C14	47
C15,C19	100
C16,C34,C39	22uF/16V Elect.
C17,C20,C31	5
C21,C24	220
C25	1300 SM 5%
C26	560 SM 5%
C32	220uF/ 16V Elect.
D1,D2	1N4007
D3	1N4004
D4,D5	1N914
L1	4.7 uH (molded)
L2	T37-2,21T
L3	T37-2, 8T
L4	T37-2,12T
P1	100K pot*.
P2	1K pot.*
R1,R2,R3,R14	1.3K
R4,R6,R7	10K
R5	3.9K
R8	2.2K
R9,R16	270K
R10	130K
R11	2.2 MEG
R12,R13,R19	30K
R14	4.7K
R18	1.2K
R17	1K
T1	T37-2; 2TP:S18T
TC1,TC2	5-60 pF trimcap
U1,U3	NE602AN
U2	CD4066
U4	74HC240
U5	NE5532A
VR1	7808CT
X1	22.1184 MHz Xtal
X2,X3	12.0 MHz Xtal (matched)

*Off board component, not in kit

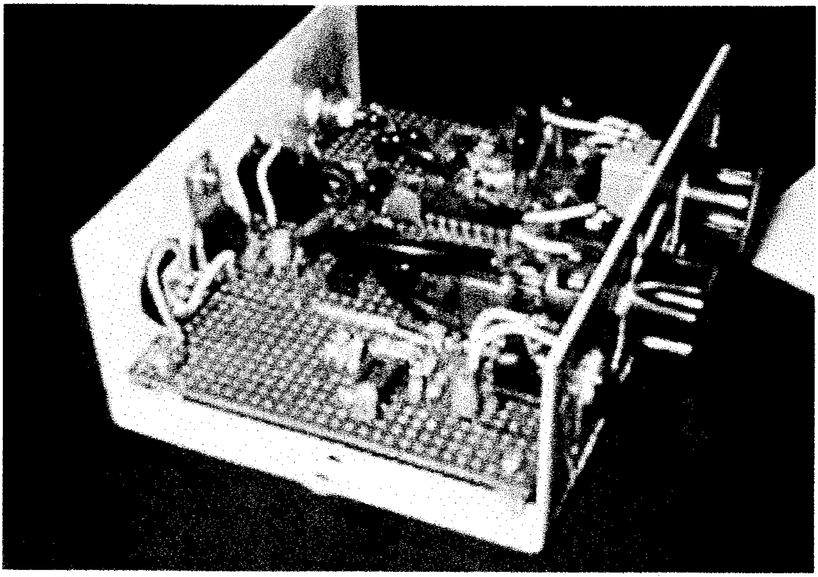
All caps are disk ceramic unless otherwise noted. All caps are in pF unless otherwise noted. All caps are 10% tolerance unless otherwise noted. All resistors are 1/4W, 10%. The schematic for the "38 Special" appears in the centerfold section of the magazine.

KITS

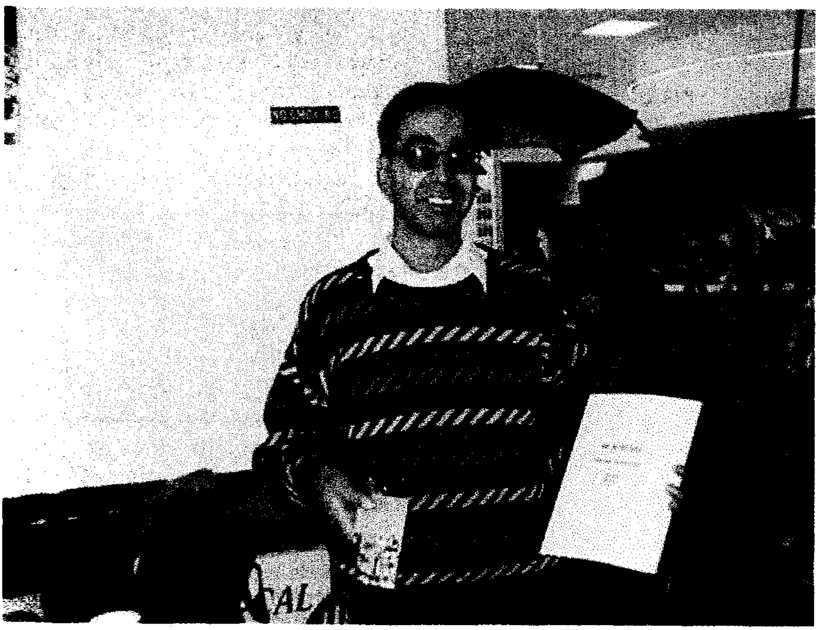
Parts Kits for the "38 Special" are available from:

Jim Cates
3241 Eastwood Rd.
Sacramento, CA 95821

Cost for the kit is $25 for the pcboard, board mounted parts, and instruction manual. Kit does not include connectors, controls, or case. Shipping and handling is $3 for US addresses, $5 for outside of US addresses. US funds only. Make checks or money orders out to Jim Cates, NOT NorCal.



Prototype of the "38 Special"



Ori Mizrahi-Shalom, AC6AN, designer of the "38 Special" with the prototype and his notes.

Mint Tin Rainbow SWR Bridge and Tuner

by Joe Everhart, N2CX
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The circuit described in the article really doesn't tune rainbows, but it does use a rainbow of sorts. It embodies the Spartan design philosphy exemplified by the 40-9er Transceiver. It combines a very basic antenna tuner with a simple-to-use accurate SWR meter. Intended to fit in the same type tin as the 40-9er, it can be built for under $25.00. As will be described below, the heart of the Rainbow Tuner is a user-friendly SWR indicator that can be used by itself in other homebrew projects.

The antenna tuning function is performed by L1 and C7 in Figure 1. In the configuration shown, they are connected as a parallel tuned resonant circuit with a tapped output. It is intended for use with a half wave end fed wire. The high impedance presented by the half wave wire is transformed to 50 ohms by taps on the toroidal coil. A compression mica trimmer is used to tune out any reactance presented by the antenna and inductor taps are selectable to give a close match to 50 ohm feedline. More detail will be given later about antenna length selection and tuneup.

A novel SWR bridge was written up in the June 1995 QST by K1KP. It used the familiar toroid type SWR bridge and replaced a meter with LEDs. It had no means of displaying actual SWR, merely a relative indication via brilliance of the its LEDs.

The Rainbow SWR indicator uses a bridge circuit more suited to QRP operation and a self-adjusting LED indicator that is slightly more complex than K1KP's but provides both relative indications for tuning and an exact final SWR reading.

The SWR bridge in Figure 1 consists of resistors R1, R2 and R3. R1 and R2 form a voltage divider with exactly half the input voltage present at their middle. This is rectified by D1 to produce a dc voltage proportional to forward RF power. The other half of the bridge is comprised of R3 and the output load, either an antenna or the tuner circuit, whichever is connected. When the load is 50 ohms, the voltage at the junction of R3 and the load is the same

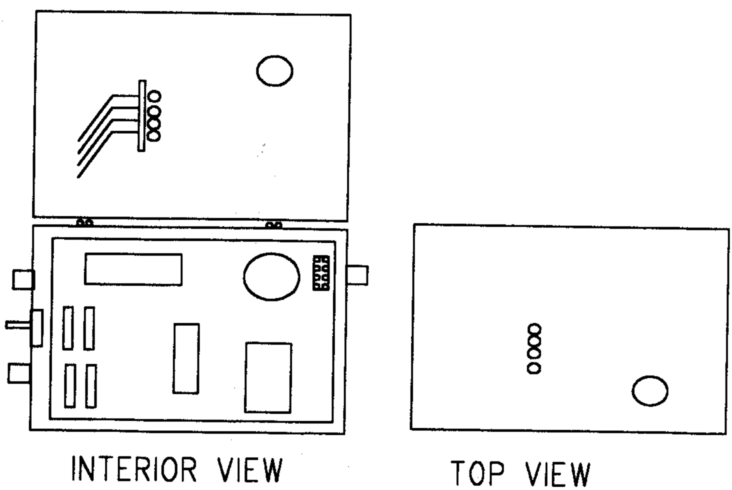


FIGURE 1

as at the R1/R2 junction. This corresponds to a 1:1 SWR and the voltage difference across the bridge arms is zero. When the load is not 50 ohms the difference voltage is proportional to the SWR. D2 rectifies the difference voltage to provide the reflected voltage.

Using resistors for the SWR bridge provides a real advantage when the Rainbow tuner is used with simple QRP rigs. Most SWR indicators pass their output SWR right on through to the rig driving them. Transmitters like the one used in the 40-9er and others misbehave with high SWR loads. At best, they become unstable and may oscillate generating off-frequency spurious signals. At worst, a high SWR load may destroy the final transistor. The absorptive bridge in the Rainbow tuner limits SWR that the transmitter sees to 2:1 maximum.

Most SWR indicators require the operator to adjust a meter or other indicator for full scale reading on forward power and then switch to a reverse power reading. The Rainbow tuner eliminates this complication. It uses the fact that in an SWR bridge, the reflected voltage is a fixed fraction of the forward voltage. For example with a 3:1 SWR, no matter what power level is used, the reflected voltage is *always* half the forward voltage. In Figure 1, the forward sample is connected to a voltage divider RX through RZ. The resistors are chosen to set a fraction of the forward voltage at comparator U1 inputs to correspond to 5:1, 3:1, 2:1 and 1.5:1. The other comparator inputs are fed directly by the reflected voltage. LEDS at the outputs of the comparators indicate SWR by lighting in response to the compared forward and reflected voltages.

The LEDs form the rainbow display. As shown in Table I, only the green LED is on only for SWR less than 1.5:1, both the green and yellow LEDs light with SWR between 1.5:1 and 2:1 and so on. Two levels of intensity are provided on the red LED for the highest SWR because I ran out of colors for cheap LEDs! No voltage regulator is needed by the comparator since it relies only on the resistive divider for accuracy.

Table I: Rainbow Display Interpretation

SWR	RED	ORG	YEL	GRN
> 5:1	O+	O	O	O
> 3:1	O	O	O	O
> 2:1	X	O	O	O
> 1.5:1	X	X	O	O
< 1.5:1	X	X	X	O

Note: O means LED is ON, O+ is higher intensity for RED LED. X means LED is OFF.

The SWR indicator is switched in or out of the circuit by S1. It is not connected at all times for two reasons. First, the tuner has a 6 dB loss even with a good match to the antenna. And secondly, power is required for the LEDs when the indicator is being used.

The tuner SWR indicator senses RF and turns itself on with less than 150 mW of RF. Q1 is a special MOSFET with a very low turn on voltage. I've measured a number of them and all have turned on with less than 1.5 volts.

The recommended battery, B1 has a rated milliampere hour capacity of only 33 mAH and the indicators draws about 10 to 50 mA, depending on how many are lighted. So battery life is prolonged by using the indicator only when needed. Longer life can be obtained with a 9-volt alkaline battery, but it won't fit into a a mint tin along with the tuner circuit board.

The tuner is sized to fit in a British mint tin with room for the SWR bridge selection switch and some small connectors - I used RCA phono jacks for their small size. The bridge has its own in and out jacks which can be connected to the tuner section with a short coax jumper. This way the tuner and SWR bridge can be used separately. If you want, you can use a small switch to go between the bridge and tuner sections and eliminate the extra connector and coax lead.

Figure 2 is a sketch of the tuner as installed in the tin. The printed circuit board fits into the tin and is insulated from the metal box by a piece of cardboard beneath it. The battery is installed in a holder for a type N cell. Access to the tuner variable capacitor is via a hole punched in the lid. 6-32 screws and knurled nuts are used for antenna wire and counterpoise board and wires soldered to them to go off-board.

Operation is very simple. To use just the SWR bridge, attach the rig and antenna cables to the proper connectors and set the switch to the "in-line" position. As soon as you transmit, the circuit will turn itself on and you can read the SWR using the LEDs. When the RF disappears the tuner shuts off dc power. Set the switch to "bypass".

The antenna tuner is intended for a

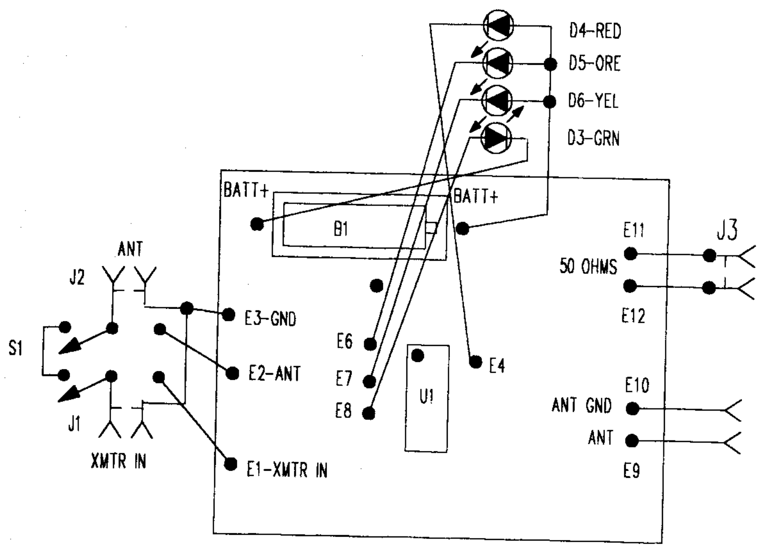


FIGURE 2

conections. Shoulder washers insulate the "hot" antenna wire hardware.

The display LEDs are plugged into a SIP (single inline socket) strip cut down to 8 pins. The LED leads are bent at right angles so that the socket can be glued inside the mint tin lid and the LEDs are visible through holes in the tin lid. A short piece of ribbon cable is soldered to the SIP socket and run to the printed circuit connections. I prefer to use pins in pc boards to connect extrnal wires so pins like the Vector T-44 types are soldered to the pc half-wave end-fed wire. An antenna of this type presents an impedance of 1000 to 10000 ohms or so. To check out the tuner and learn how it works, connect a non-inductive resistor in that range across the antenna and ground terminals and a coaxial jumper from the tuner phono jack to the SWR bridge ANTENNA jack. Use a 40 meter rig with an ouput of 150 mW to 1 watt to feed the RIG jack. Set the tuner tap jumper between between the LOW Z taps.

Set the switch to the IN-LINE

postition and keyup the transmitter while monitoring the LEDS. Adjust the tuner variable capacitor with a non-metallic tuning tool for lowest SWR. If it isn't below 1.5:1, try the next highest tap and repeat the tuning. You should be able to find a tap and tuning setting which lights only the green LED.

Tuning with an antenna is done the same way. Use a single wire about 67 feet long and at least one 33 foot counterpoise. Try to get the antenna wire at least 15 to 20 feet off the ground. Key up your transmitter and tune as you did with the resistor. Due to the tuner's limited adjustment range you may find it necessary to trim the antenna slightly to get minimum SWR. It is recommended that once you have found a wire length that tunes up well, always use that wire and counterpoise.

Parts List

B1	12V lighter battery, RS	
B2	"N" battery holder, RS	
C1,C2,C5,C6	.05 uF mono cap, DK	
C3, C4	1000 pF mono cap, DK	
C7	150pF mica trimmer, DSP	
D1, D2	1N34, RS	
D3	Green 3 mm LED, DK	
D4	Red 3 mm LED, DK	
D5	Orange 3 mm LED, DK	
D6	Yellow 3 mm LED, DK	
L1	T68-2, DSP	
Q1	VN10KM,DSP	
Q2	2N3906	Various
R1, R2, R3	51ohm 5%,1/2W, DK	
R4, R5	10K,1%, 1/4 W, DK	
R6	56.2K, 1%, 1/4 W, DK	
R7, R8	34K, 1%, 1/4 W, DK	
R9	26.1K, 1%, 1/4 W, DK	
R10	40.2K, 1%, 1/4 W, DK	
R11	10K, 5%, 1/4 W, DK	
R12	15K, 5%, 1/4 W, DK	
R13, R16, R17	1K, 5%, 1/4 W, DK	
R14, R15,	2K, 5%, 1/4 W, DK	
S1	Mini toggle switch, RS	
U1	LM339, DK or RS	
15	T-44 pins, DK	
3	RCA jacks, DK	
40"	28 ga. magnet wire	
3"	ribbon cable	
1	4 pos X 2 0.1 spaced terminal block	
1	8 pos SIP socket, RS	
Misc. hardware		

The parts shown are for maximum accuracy and performance. However some substitutions can be made with more avaialable components. Resistors R1, R2 and R3 directly affect bridge accuracy and power rating. 47 ohm 5% values can be used with only a slight effect on accuracy (the prototype used them!). The 1/2 watt values shown will be adequate for intermittent use with transmitter power up to 2 watts. Smaller wattage resistors will burn up at that power level. Of course 1 watt values will handle up to 4 watts and 2 watters theoretically can handle 8 watts. Prolonged transmit periods will cause excess component heating.

1% resistors are shown for R6 through R10 and R18 in the comparator circuit. 5% values close to these can be substitued but will result in degraded SWR accuracy. Besides, the Digikey resistors are cheap - only 54 cents for 5 of them.

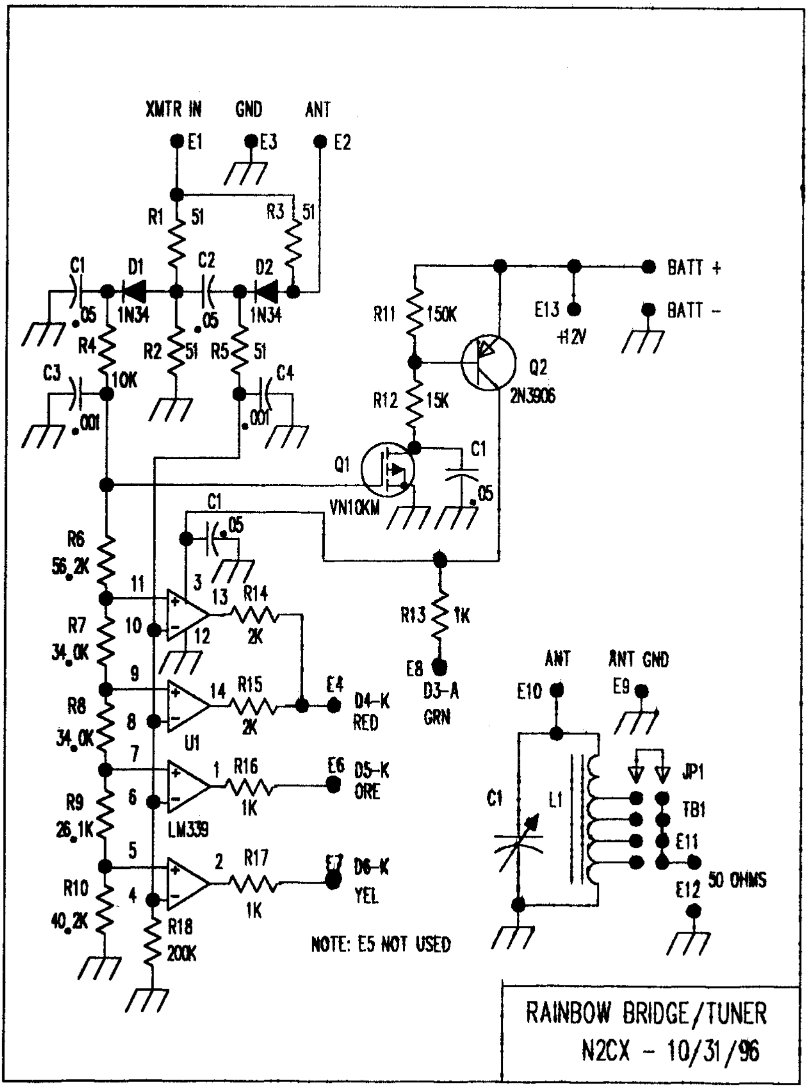
Q1, the MOSFET power switch is specially chosen to have a very low turn on voltage. I measured a sample of 8 devices and none of them took more than 1.5 volts dc gate voltage to turn on. In-circuit checks showed that none of them needed more than 150 mW of rf to activate the circuit. If you try a replacement, test it to be sure that it turns on at the power level you will use.

72/73, Joe Everhart, N2CX

Parts Kits for the Rainbow Tuner are available from the New Jersey QRP Club. The cost of the kit is $25, and includes the pcboard, board mounted parts, LEDs, sockets, but does not include the case or connectors. To order the kit send $25 plus

$3 shipping and handling for US addresses, $5 shipping and handling for non-US addresses. Make check or money order out to James Bennett, not NJ QRP Club. US Funds only. Send order to:

James Bennett, KA5DVS
309 Morrison Ave.
Hightstown, NJ
08520



Second Annual NorCal Dayton Building Contest

NorCal QRP Club is pleased to announce the second annual building contest in conjunction with the Dayton Hamvention. Builders may enter either or both of two projects; the "38 Special" or the "Rainbow Tuner" featured in this issue. True to NorCal tradition, the rules of this contest are simple: The project must work. Packaging is up to the builder, modifications are fine, we are interested in seeing your efforts. Chuck Adams, K5FO has agreed to be the judge again this year, and he will draft two assistants from the attendees to help. Prizes will be awarded to the first 3 places in each category for the projects judged to be the best by the judges.

Entrants may build their projects from homebrew parts, or they may purchase kits from NorCal for the "38 Special" transceiver and the New Jersey QRP Club for the Rainbow Tuner project. See page 7 for ordering information for the "38 Special" and page 11 for information on the Rainbow Tuner.

Judging for the contest will be Saturday night at 8:00 at the hospitality room sponsored by the QRP ARCI at the Day's Inn Dayton South during the Dayton Hamvention. Good luck and hope to see you there!

Homebrewing a Software Keyer

by Daniel Wee, 9V1ZV
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Introduction

Recently there has been some discussion about alternative keyers in the light of the demise of the venerated Curtiss 8044 keyer chip and its variations. From that discussion it appears that using small microcontrollers as keyers is becoming a fashionable trend, but also a powerful one that allows us to add features as we go along. However, it also came to light during that discussion that there is a shortage of source code available for those who would like to understand the workings of such a device. The lack of source code also means that those who would like to customize the code are unable to do so. This article is an attempt to shed some light in this area. Hopefully it is simple enough to be understood by non-programmers.

The Software and Hardware

The keyer software was originally written in C for the IBM PC compatible machines as part of my own logging software. It read the paddle status from the joystick port a-la the CT logger, and keyed either a serial port or a parallel port pin. The idea of having a keyer in software is particularly appealing because it made it possible to add all kinds of bells and whistles without making hardware changes. However, the initial concept was a little difficult to arrive at but once you got it, it is easy.

To put it simply, the software looks at the paddle status at fixed intervals, very frequently. It does this regardless of whatever else the machine is doing and in computer terms, we call this an interrupt driven routine. Essentially I re-programmed the PC timer to trigger off at much more than the 18 times a second it normally does. The frequency at which your program looks at the paddle determines:

A. The highest keying speed available

B. The resolution/steps of different speeds available

C. Reliability of the detection of paddling

This interrupt routine that looks at the paddle status is central to the keying program. Every time it checks to see if the paddle has changed status. If it has, then it proceeds to respond according to which paddle has changed. Since it looks at both paddles simultaneously, we can easily implement an iambic keying behavior.

The second part of this interrupt driven routine is to process current keying. The only difference between a dot and a dash and a space for that matter, as far as the software is concerned, is the length of the element and the keyed state (high or low). When a dash is started, the routine sets a countdown cycle to the length of that dash. Every time the routine is interrupted it reduces the count. Likewise a dot, and a space except that with a space the keyed state is reversed.

Also, after every element, there is a mandatory 'space' of the length of a dot before a second element is started. The computer buffers any paddle state changes during all this so that dot/dash memory is also implemented.

Changing the keying speed is a matter of changing the length of the elements, in fact the dot element in particular as everything else derives from this. The dash is three times (depending on weigthing) as long, and the space is the same length as the dot. Below is a C version of the routine that does the paddle checking and the keying:

The C Code:

```
unsigned int keyspeed = (WPMMAX
+WPMLIM)/2;
int dittime;
int nodittime;

void interrupt timer_interrupt()
      {

/* This is to keep calling the old clock in-
terrupt at the correct rate
*/
secrate++;

/* Here is where we actually keep track of
the state of the paddles. 'kstate' is the cur-
rent paddle status while 'kdot' and 'kdash'
are previously read status for the dot and
dash respectively. This routine compares
if there has been any change in either
states.*/
kstate=inportb(JPORT)&48;
if (!kdot && !(kstate & 32)) kdot=2;
if (!kdash && !(kstate & 16)) kdash=2;

/* This checks for the mandatory spacing
and looks to see if the spacing timer is still
counting down. If it is, no element genera-
tion is allowed until the countdown is com-
pleted. It also checks if an element counter
is currently counting down is the space
counter is not in force. If so, it will also
decrement the element counter and upon
reaching zero, it will unkey the output.*/
if (nodittime) {
      if (dittime) {
            dittime—;
            if (!dittime) {
//                nosound();
                  outportb
(keyport,keyoff);
                        }
                  }
            if (!dittime) nodittime—;
            }

/* If there are no space or element counters
in action this means that the condition is
clear to generated a new element. If there
has been no changes in the key state then
this section is skipped. Otherwise it will
generate an element depending on what has
been read from the paddle status.

      In order to implement the iambic
mode, and dot/dash memory, we have to
keep track of the different states that the
keyer is in. kdot=2 means that a dot is
pending but not started. kdot=1 means that
a dot is underway. And kdot=0 means that
no dot is present.

      Remember that we will only reach
here if all the counters have reached zero.
So if the routines finds that a dot was pre-
viously underway, it will now reset the sta-
tus to 0. Likewise for a dash. Also, if a
dot was detected while a dash was previ-
ously underway, then we will insert a dot.
Likewise for the otherway round.
   If both paddles are pressed then it will
alternate the elements.*/

else {
      if (kdot || kdash) {
            if (kdot==1) {
                        kdot=0;
            if (kdash==2) {
                  dittime=keyspeed*3;
                  nodittime=keyspeed;
                  kdash=1;
                  outportb(keyport,keyon);
//                sound(800);
                              }
                        }
                  else if (kdash==1) {
                        kdash=0;
                        if (kdot==2) {
                        dittime=keyspeed;
                        nodittime=keyspeed;
                        kdot=1;
                        outportb
                        (keyport,keyon);
//                      sound(800);
                              }
                        }
      else if (kdot==2 && kdash!=1) {
            dittime=keyspeed;
```

```
            nodittime=keyspeed;
            kdot=1;
            outportb(keyport,keyon);
//          sound(800);
                        }
      else if (kdash==2 && kdot!=1) {
            dittime=keyspeed*3;
            nodittime=keyspeed;
            kdash=1;
            outportb(keyport,keyon);
//          sound(800);
                        }
                  }

/* This next section is irrelevant to us.
*/
      if (secrate%DIVRATE==0) {
            asm {
                  cli;
                  }
            (*oldvec2)();
            }
      outportb(0x20,0x20);
      }
```

Summary of C Code:

As you can see, although the code is rather long, the basic idea behind it is quite simple. It does require us to do some parallel processing in our head to keep track of what is going on though. However, the sections are quite definite and each block deals with a specific condition. This makes it easier to understand.

Of course, there are many ways that a keyer can be implemented and this is the one I chose because I found it intuitive. Being interrupt driven also allowed the other parts of my program to do what they liked without affecting the quality and timing of the keying. When I originally implemented this as a loop, the timing was unsatisfactory. The drawback of this method is that keying speeds are constrained, by the frequency at which this routine is called.

Microcontroller Version 87C51

When I was building a microcontroller keyer for my ARK-20, I chose the 87C51 because:

A. It was easily available
B. I had the programmer for it
C. I had the DataBook for it
D. The CMOS version took up less power
E. It had plenty of horsepower for my application
F. It had many available I/O pins (32 altogether)
G. It had internal EPROM and RAM
H. It required only an external crystal and 2 caps to get going

There are many more reasons but these are among the more critical ones for me. I suppose I could have used some of the PIC's which are much smaller but I needed the extra I/O pins for the other part of my application which the PIC did not have. I did have to add a small 8-pin serial ADC to read the speed control potentiometer and a transistor for keying, although this is not strictly necessary. You can do away with the pot altogether if you prefer to use up/down buttons for the speed control but since the unit has no non-volatile RAM, you will always power up at the default speed. With the pot, it will read the speed setting on the port.

Also, the code is probably portable to the many variations of the 8051 family MPU's and is quite small by most standards actually.

With the microcontroller, I ported most of the C code into 8051 assembly language and made some modifications to make use of the more flexible interrupt structure available in the microcontroller. The basic blocks are still the same, however. You have a routine that generates interrupts at a high frequency that calls the interrupt service routine. The ISR (interrupt service routine) does most of what the above C routine does. Below is the code:

8051 Assembly Code for Keyer:

```
$Title(Port Blinker)
$Date(03-29-96)
```

```
$MOD51

defcnt equ     1600
definv equ     65535-defcnt+1
dchi   equ     definv/256
dclo   equ     definv-dchi*256
WPMMAX equ     10
WPMLIM equ     63
addr   equ   3 ; start-bit, ch0 single ended
stretch equ    33

keyport equ    P2
keyer  bit     keyport.7
stcon  bit     keyport.6
pdotk  bit     keyport.5
pdshk  bit     keyport.4

kst    data    20h
kdotk  bit     kst.5
kdshk  bit     kst.4

adcclk bit     keyport.3
adcdo  bit     keyport.2
adcdi  bit     keyport.1
adccs  bit     keyport.0

keymask equ    0FEh
ksdelay equ    50
inispd equ    (WPMMAX+WPMLIM)/2
stk_ptr equ    5Fh
divsr  equ   256/(WPMLIM-WPMMAX)

keyspd data    0Fh
noditt data    10h
ditt   data    11h
kdot   data    12h
kdash  data    13h
lastat data    14h
curstat data   15h
result data    16h

myflags data   21h
keytyp bit     myflags.0

       org     0000h
       ljmp    Start

       org     0003h
       reti

       org     000Bh
       clr     TR0          ; stop Timer 0
       ljmp    Timer_Int     ; service in-
terrupt

       org     0013h
       reti

       org     001Bh
       reti

       org     0023h
       reti

       org     100h
Start:
       mov    ie,#0     ; turn off all interrupts
       mov    sp,#stk_ptr    ; initialize stack

       mov       a,#07Fh ; initialize all
ports, except keyer
       mov       keyport,a
       clr       keyer

       clr    a    ; initialize keyer variables
       mov       kdot,a
       mov       kdash,a
       mov       noditt,a
       mov       ditt,a
       mov       myflags,a
       mov       lastat,a
       mov       a,#inispd
       mov       keyspd,a

       mov       TMOD,#01h ; Timer 0 as
16-bit timer
       clr       TR0   ; stop Timer 0
       mov       TL0,#dclo        ; pre-load
16-bit count
       mov       TH0,#dchi
       setb      ET0            ; enable Timer
0 interrupt
       setb      TR0         ; restart Timer 0
       setb      EA  ; start all interrupts
       acall     Ckstat
```

```
spdl1:
    clr     adcclk
    clr     adccs        ; chip-select,
start conversion
    mov     a,#addr
    mov     b,#3         ; number of bits
for address
loop1:                   ; send MUX address
    rrc     a
    jc      one
zero:
    clr     adcdi
    sjmp    cont
one:
    setb    adcdi
cont:
    acall   Pulse  ; read out data (1-3)
    djnz    b,loop1
;   acall Pulse          ; sync clock pulse (4)
    mov     b,#8
loop2:
    acall   Pulse  ; clock in ADC data
    clr     c
    jnb     adcdo,carry; read in ADC
                         data bit
    setb    c
carry:
    mov     a,result
    rlc     a  ; shift in MSB first
    mov     result,a
    djnz    b,loop2
    setb    adccs ; de-select ADC,
                    EOC

    mov     a,result; scale and convert
                    data
    mov     b,#divsr
    div     ab
    add     a,#WPMMAX
    mov     keyspd,a  ; update
                         keyspeed

    acall   Ckstat
    sjmp    spdl1

Pulse:
    setb    adcclk
    nop
    nop
    clr     adcclk
    ret

Ckstat:
    setb    stcon
    jnb     pdshk,tstk0; if either
                    paddle grounded
    jnb     pdotk,tstk0
    clr     ET0
    clr     TR0
    clr     stcon        ; setup for test
    jb      pdotk,tstk0
    setb    stcon
    setb    ET0
    setb    TR0
    mov     curstat,#0  ; nothing in
                         socket
    sjmp    tstk1
tstk0:
    setb    stcon
    setb    ET0
    setb    TR0
    mov     curstat,#1; something
                         plugged in
tstk1:
    mov     a,curstat
    cjne    a,lastat,chgtp1
    sjmp    chgtp2
chgtp1:
    mov     lastat,a ; update last plug
                    state
    jz      chgtp2
    clr     keytyp       ; assume paddle
    jb      pdshk,chgtp2 ; check if it
                    is straight key
    setb    keytyp
chgtp2:
    ret

Timer_Int:  ; Timer 0 ISR
    push    psw
    push    acc   ; save accumulator
    push    b     ; save divisor
    mov     TL0,#dclo ; reload 16-bit
                         count
    mov     TH0,#dchi
    setb    TR0 ; restart Timer 0
```

```
                        immediately
        mov     kst,keyport
;       mov     a,keyport
;       mov     kst,a
        jb      keytyp,strtk1; if straight
                                key
        jb      kdotk,til1      ; if (!kdotk
        mov     a,kdot          ; && !kdot)
        jnz     til1
        mov     kdot,#2         ; kdot = 2
til1:
        jb      kdshk,til2      ; if (!kdshk
        mov     a,kdash         ; && !kdash)
        jnz     til2
        mov     kdash,#2        ; kdash = 2
til2:
        mov     a,noditt
        jz      til3            ; if (noditt)
        mov     a,ditt
        jz      til4            ; if (ditt)
        dec     a               ; ditt—
        mov     ditt,a
        jnz     til4            ; if (!ditt)
                clr     keyer           ;
outport(keyport,keyoff)
til4:
        mov     a,ditt
        jnz     til5            ; if (!ditt)
        dec     noditt          ; noditt—
til5:
        sjmp    tilend
strtk1:                 ; straight keying
        jb      kdotk,strtk2
        setb    keyer
        sjmp    tilend
strtk2:
        clr     keyer
        sjmp    tilend
til3:
        mov     a,kdot
        orl     a,kdash
        jz      tilend  ; if (kdot || kdash)
        mov     b,#stretch;  percentage
                                stretch
        mov     a,kdot
        cjne    a,#1,til7       ; if (kdot == 1)
        clr     a
        mov     kdot,a          ; kdot = 0
        mov     a,kdash
        cjne    a,#2,tilend ; if (kdash == 2)
til11:
        mov     a,keyspd
        mov     noditt,a ; noditt = keyspeed
        add     a,keyspd
        add     a,keyspd
        mov     ditt,a ; ditt = 3 * keyspeed
        div     ab
        add     a,ditt
        mov     ditt,a
        mov     kdash,#1        ; kdash = 1
        setb    keyer;outport
                        (keyport,keyon)
        sjmp    tilend
til7:
        mov     a,kdash
        cjne    a,#1,til8       ; if (kdash = 1)
        clr     a
        mov     kdash,a         ; kdash = 0
        mov     a,kdot
        cjne    a,#2,tilend ; if (kdot == 2)
til10:
        mov     a,keyspd
        mov     noditt,a ; noditt = keyspeed
        mov     ditt,a          ; ditt = keyspeed
        div     ab
        add     a,ditt
        mov     ditt,a
        mov     kdot,#1
        setb    keyer ; outport
                        (keyport,keyon)
        sjmp    tilend
til8:
        mov     a,kdot
        cjne    a,#2,til9 ; if ((kdot == 2)
        mov     a,kdash
        cjne    a,#1,til10 ; && (kdash !=
                                1))
til9:
        mov     a,kdash
        cjne    a,#2,tilend ; if ((kdash ==
                                2)
        mov     a,kdot
        cjne    a,#1,til11 ; && (kdot != 1)
tilend:
        pop     b       ; restore divisor
        pop     acc     ; restore accumulator
```

```
    pop     psw
    reti            ; end of Timer_Int ISR

    end
```

Summary of 8051 Assembly Code

As you can see, this closely corresponds to the C code although there are some subtle changes. There is also included the routine which reads the National Semiconductor ADC0832 analog to digital convertor for the keying speed.

The code begins with some definitions and declarations. This is followed by initialization code at the beginning which initializes the variables and sets up the timers, interrupts and ADC. Start: begins the main loop. Ckstat: is the routine that checks the paddle inputs to see if the key type has changed. It uses a stereo socket for the paddle input and if a straight key is pulgged in, it will automatically change modes to straight keying mode. This does not work too reliably however, so I eventually checked the key type only at power up.

Timer_Int: is the routine that is called by the interrupts and is the complement of the C routine provided above. It differs in a few ways however. I added a 'stretch' variable to adjust the weigthing a little so as to make the feel a little better.

To fully understand this program, one would have to know quite a bit about the 8051 architecture and assembly language which I don't really want to get into here. There are many good books on this though and you can probably find it is any good bookstore since the 8051 is just about the most popular microcontroller ever.

This code is a fairly early incarnation but is straightforward to understand. I eventually incorporated other features which reduced the frequency at which is checked the ADC and other stuff so reduce QRM from the ADC mostly. I also added some protection resistors to the paddle inputs ince I accidentally damaged one MPU via the paddle port. A later version of this source code is included with the schematics at the end of this article.

Construction:

Below is a copy of what I originally wrote to describe the construction of the keyer plus some correspondence about it:

Whew! Finally got that keyer working. What keyer? Oh, the one I've been working on. Lately I've been thinking of adding a keyer to my ARK-20 which only accepts a straight key. It would be easy for me to whip up a very small Curtiss 8044 based keyer to put it inside BUT that would mean that I'll be stuck with a paddle and not be able to use the straight key. I toyed with the idea of adding a toggle switch to select the paddle/key but the idea did not seem terribly elegant. Finally, after much debating I decided to build a special keyer that would automatically distinguish the type of key in use. As there wasn't much space in the ARK-20, I had to look at a very compact solution. Hence my keyer project was born.

The keyer uses an 87C51 microcontroller and measures 6.5 by 2.8 cm (not inches!). Most of the parts sits in the space under the CPU in the space inside the CPU's 40-pin socket. The parts count is fairly low:

*1 87C51(Philips) 40-pin MCU

*1 ADC0832 (NS) 8-pin A/D convertor

1	78L05	5V regulator
*1	2N2222	driver transistor
5	0.1uF	mylar caps
*2	10uF/16V	electrolytic caps
1	4.7k/0.25W	resistor
*1	8.2k/0.25W	resistor
*1	11.0592 MHz	crystal
*2	22pF	ceramic caps
1	68mH	RFC
*1	40-pin	turn-pin socket
*1	50k variable resistor (off-board)	

It seems a lot, but remember, this includes the 5V regulated power supply, along with excessive decoupling and RF blocking parts. If you already have a 5V line and prefer to use that, then your parts count would be even lower. Likewise, if you remove excess decoupling capacitors, the parts count goes down even further. The '*' marks the essential parts. The rest are just there to play safe. I didn't want RF from the keyer getting into the RX front-end since they're mounted in the same enclosure. The 50k variable is not critical, since it only acts as a voltage-divider. I suppose even a 100k value would work here.

When assembled, 3-wires come off for the variable resistor. 2-wires for the keying. 4-wires for the paddle/key. The configuration is as follows:-

To original key port connections:

1 Keyer
2 Gnd

To speed control pot:

1 +5V to variable resistor (1)
2 Variable resistor wiper (2) speed control
3 Gnd to variable resistor (3)

To stereo socket with break sense connection:

1 Dot
2 Dash
3 Sense
4 Gnd

To power supply:

1 +7 to +12V power supply
2 Gnd

A lot of redundancy in the ground connections could be avoided in the actual installation but I just wanted to be consistent. There are also some optional connections.

To serial port for computer control (optional):

1 RX-serial
2 TX-serial
3 Gnd

To ARK-20 thumbwheel for frequency reading (future):

1-16 Data pins

To any analog voltage from 0-5V (optional):

1 Extra ADC channel
2 Gnd

I intend to evetually implement computer control for my ARK-20 using the format for the CI-V of ICOM radios. I haven't gotten round to this yet but the hardware is already in place.

After many rounds of program/debug/UV-erase/program/etc. I finally got the keyer to work correctly. Learned a lot about the 8051 along the way. This looks like it could be a very useful part.

I also picked up some Hitachi LCD displays really cheap at about US$3.00 each. I have a neat way of adding this to the ARK-20 in mind.

On the whole, I am very pleased with the result because of its small form-factor, and the possible new things I can implement in software without changing too much hardware. Furthermore, I believe this is the only auto-keytype-sensing keyer I have seen. You can pre-set the keying speed limits in the software without having to change any parts. I haven't actually installed it into my ARK-20 just yet but have tested it out quite thoroughly.

The 87C51 MCU has about 4K of EPROM space, of which I used just a few hundred bytes, leaving plenty of room for creativity. There are lots of unused (as yet) port lines. You could also try out the 89C1051 or the 89C2051 MCU's by Atmel which are code compatible and much smaller. I did not use these parts because I cannot find them locally, nor did I have a programmer for them. The total cost of parts (built on wire-wrap style bread-board) is about US$20 or so.

This is because I am using a UV part for the MCU. If you use an OTP part, it will be much cheaper. The single most expensive part
is the 87C51 which cost me some

US$14.00 or so. In the US this might be cheaper.

Below is the code I used in case any one is interested. You will notice that it is pretty short but it is all in assembly language. I'd be pleased to entertain any questions about the circuit.

A memory keyer is a definite possibility but you'd have to add one of those serial EEPROMs from Microchip so that the memory is retained even after power off. The additional hardware is trivial, most of the work will be in the software. You'd also have to put in a few more buttons but the rest is implemented in software, and running serials is okay provided you can think of a scheme to let the keyer know you'd like to have that inserted.

As a Memory Keyer:

This is a distinct possibility with the main obstacle being the inclusion of some form of non-volatile memory to the circuit. The easiest way to do this, as far as I can tell, is to use one of those 8-pin serial EEPROMs such as those made by MicroChip. This requires only a few lines to interface. The rest of it includes adding a few push buttons to the ports. The coding is a simple exercise in programming and should fit nicely into the rest of the 4k of unsed EPROM space. The reason I did not already do this was because my application was primarily as a keyer for the ARK-20 and in that case (literally) there was simply no space for any additional pushbuttons. Besides, I wanted to save the available port pins (a little over 16 unused as yet) for another purpose. There is nothing to stop anyone else from using these pins for their own purposes however.

As a Frequency Counter

Another easily implemented feature. The 87C51 has a externally triggerable counter. Someone responded that he had actually implemented just such a frequency counter. This could be something a lot of people might want for their little rigs. The coding for this is probably quite simple in view of the fact that the MCU hardware directly supports such functions.

As a Morse Code Decoder:

This can easily be done, with or without the help of an external PLL such as the NE567. The decoded output could be transmitted using the serial port on the MCU (which will require a MAX232 to convert to regular RS-232 levels if interfaced using normal RS-232 serial ports). Alternatively, you could pick up an LCD display (I got a few at US$3.00 each) and interface this to the MCU with 7 port pins. These are intelligent displays so nothing more is needed except perhaps a negative voltage source (may not be needed).

I have built quite a few morse decoders in my time and found their performance lacking usually and the operation of such devices finicky. As a result I have little faith in automatic morse decoders. What they say about the best decoder being the one between our ears is true.

However, the ease of interfacing an LCD to the MCU does raise new possibilities. If I were not so constricted for space, I would have added an LCD to display code speed, frequency, and perhaps some other info.

Using up/down speed control buttons instead of a variable resistor:

In fact I have another version of code which controlled the speed of the keyer using two push buttons (or one centered DPST spring loaded toggle switch). The reasons I went with the variable resistor version were:

1. I did not have space for the pushbutton(s). Actually I do but it was not the right size. The ARK comes with a hole pre-drilled for a variable resistor. I suppose if you really wanted to, you could put in a 2 position toggle switch with a centred normally open contact. This would avoid the need of the ADC.
2. The more pressing reason was that with the pushbutton scheme I had to set the button to my preferred speed upon every

power-up since my circuit did not include any non-volatile RAM. However, if we did choose this scheme, the space vacated by the ADC would nicely accept an 8-pin serial EEPROM. This was not availble on hand.

Avoiding the need of the 2N2222 driver transistor:

It was pointed out that in fact, if I used PORT-0 on the 87C51 to drive the keying circuit directly, I can avoid the need of a driver transistor. This is correct, due to the special fact that PORT-0 is an open collector output without pull-ups. In my case, I needed all the 8-pins of PORT-0 for some other purpose, and so I did not use PORT-0. The additional space used by the 2N2222 did not result in any increased board size.

Using pulse-width measurement to measure resistance instead of ADC:

This was a possibility I explored too. The idea is that I could use a port pin to charge up a known capacitance and to discharge it through the variable resistor at another pin. Upon charging up the capacitor, it presents a logic-1 to a third pin, which then starts a timer and the discharge circuit. After a period of time proportional to the resistance value, the charge of the capacitor would have dropped below the logic-1 threshold and the MCU now has a count proportional to the resistance of the variable reistor. This scheme requires only one capacitor and possibly one other resistor for calibration purposes and uses only 3 or 4 port pins. I was not sure of the stability of the measurements yielded using this method because the resolution would be proportional to the conversion time. To achieve good resolution would require substantially longer periods. Further more, since the keyer was interrupt driven, it may interfere with the timing of the pulse width, or vice-versa. Nevertheless, this is one possibility worth exploring further and the same technique could come in useful elsewhere.

The Spare ADC Channel:

The ADC0832 used actually has 2-input channels so you could easily use the other channel for your own purposes, such as another variable resistor, etc. without the need of adding any additional hardware.

Conclusion:

As you can see, the use of an MCU does greatly increase the number of features that can be included in a project for a relatively small increase in parts count. With the prices of today's MCU's it would be a sin for the QRP community to continue to ignore the hidden potential here. Many newer projects could actually employ serially driven PLL VFO's such as those made by Motorola, easily with an MCU in the rig. LCD displays also add to the professionalism of the final product.

Something that I realized was that there is a lot of flexibility in designing circuits with MCUs. For example, in my prototype board, the ADC was not under the MCU. In my final circuit, I decided to put it under the MCU. Doing this put the interface pins of the ADC directly next to some port pins. So instead of pulling wires from the original pin assignments to the new ADC position, I simply changed the source code to reflect the new pin assignments. The result, 4 wires less under the board. This kind of configurability is very handy when space is a constraint.

The 8051 and its relatives come in a variety of different flavors and sizes. Some come with a built in ADC/DAC, extra counters, higher speeds, more EPROM space, more internal RAM, etc. Some come in 20-pin packages, making them really small, and most require the least of external support circuitry to make them work. Furthermore, there are other parts such as the PIC 16Cxx parts by MicroChip, or the Basic Stamp by Parallax, all of which represent very easy to use controller parts which could greatly enhanced the features of any small homebrew rig, and possibly reduce the cost. The keyer I built cost about as much as a good Curtiss based keyer, plus I get to make it behave exactly the way I want it to behave and the option of adding other features to it.

The drawback of using microcontrollers in QRP rigs is primarily the lack of programming tools required to work with these parts. One would need to invest in a device programmer (which may vary from part to part) and perhaps a UV eraser, as the very minimum. The software can usually be obtained for free from the net. These would include cross-assemblers, simulators, etc. This problem can partly be circumvented by using parts which can download programs from the PC serial port, and thus not needing any specialized programming equipment.

The Parallax BASIC STAMP is one such part. You write your program in BASIC on the PC, compile it and down load it to the very tiny part. THE BSC-1 and 2 are so small you'd have to see it to believe it. They support serial port functions, accept BASIC programs, and has plenty of pins, and the BSC-1 comes in an SIP form so the foot print is exceptionally small. It is a little costly however.

A second problem involved with using microcontroller parts is the generation of RFI. Since there is almost always an oscillator involved, and the digital lines are mostly carrying square waves, you can and should expect lots of harmonics to be generated. This can usually be dealt with by careful PCB layout and screening, proper decoupling and careful part selection. One can also select a crystal frequency that does not interfere with the rig in question. Remember, most of the modern commercial rigs contain MCUs anyway, and they seem to have worked around this problem by and large.

Finally, remember that the most valuable asset of any homebrewer is his (or her) creativity. MCUs gave me a chance to be more creative, it could do the same for you.

Note:

1. The ADC0832 used is the 8-pin DIP variety. There is also a 14-pin SOP type which I have not tried. The pin-outs here are for the 8-pin DIP variety.
2. The value of the 50k speed control potentiometer is not critical. This simply works as a voltage divider and any suitable value will do. It should not be too extreme a value (1K or less, or 100K or more).
3. Not shown in the diagram above are decoupling capacitors for both the IC's. These are 0.01uF capacitors soldered across the power supply pins of the IC's to ground. Decoupling capacitors were also added on most of the 87C51 port lines to reduce RFI. Experiment.
4. The port pins can be reassigned to suit your board layout. Look at the source code and change the assignments in the code to suit your requirements.
5. The "Socket N.C." goes to the little tag on the stereo socket which is normally closed. Be sure to get a stereo socket with this if you wish to use the auto key detect feature.
6. As noted in the article, the keying transistor (any suitable NPN, 2N2222 or 2N3904) can be eliminated altogether if one of the Port 0 pins are used. This is not shown here.
7. The crystal marked Y1 is an 11.0592 MHz crystal. The value is probably not critical if you do not plan on using the serial port. In that case, a 12 MHz or 10 MHz crystal should do fine. You might have to scale it a little differently in the code. WPMMAX and WPMLIM may need to be tweaked to give you the speed control range you want on the potentiometer.
8. The 22pF capacitors around the crystal are tiny ceramic ones. I used NP0 but this is not necessary. The rest of the capacitors were small monolithic caps. I chose these for their size more than anything else.
9. Also not shown here is the 78L05 regu-

lator I used to convert the 12V from the rig into the 5V required by this circuit. Again, liberal use of decoupling and smoothing capacitors were used. In fact, I had a big valued inductor in the Vcc line from the 12V to the regulator to prevent QRM from flowing back into the rig.

10. My construction was on a matrix board which individual pads. Interconnections were made with wire-wrapped wires which I soldered point-to-point. This allowed me to cram most of the parts into the space in the 40-pin IC socket. This is the gap found under the 87C51. I had a few resistors on the solder side of the board as well but these were mostly because they were added as an after thought.

11. Many of the values in this circuit are non-critical. Resistors especially, and the keying circuit can be changed and/or improved.

12. The ADC032 can also be replaced with an ADC08032. Both are National Semiconductor parts.

13. The ADC can be eliminated altogether and replaced with up/down buttons for speed control. Some changes in the code must be done for this to work.

14. The 510 ohm resistors were added later to protect the I/O port pins of the MPU from destruction. Greater values are probably better as long as the paddle is being read properly.

15. The reset electrolytic, 2.2 uF, is not critical. It should be rated more than 6V at least. I picked the smallest one I could find. The value is also not critical. A 1 uF value will probably work just as well.

16. Observe that the keying circuit consists of an open collector transistor. Make sure that you don't try to key high voltage loops with this configuration. As it is, this is suitable for most QRP rigs. If you plan to key valved rigs, you'll have to incorporate a more robust keying section. You might want to add a reverse biased diode across the keyed output and ground to prevent damage from reverse polarity circuits. This is probably not necessary for QRP rigs but discretion should be used.

17. Since this circuit has a high frequency oscillator in it, be sure to keep all wires as short as possible. Use screening where possible. I made a screening cover out of some pieces of double-sided PCB cut and soldered together.

Below is the current source code for this keyer with lower-RFI enhancements. The CI-V computer control code is included but can be removed if not desired. This is simply two calls in the main loop, both of which are commented. This code was compiled with a public domain 8051 compiler called the Metalink Assembler and is available from many FTP sites.

Program: ML-ASM51.ZIP
Description: MetaLink's 8051 family macro assembler
Location:
ftp.pppl.gov : /pub/8051/signetics-bbs
ftp.funet.fi : /pub/microprocs/MCS-51/signetics-bbs

```
$Title(Port Blinker)
$Date(03-29-96)
$MOD51

      defcnt equ     1600
      definv equ     65535-defcnt+1
      dchi   equ     definv/256
      dclo   equ     definv-dchi*256
      WPMMAX equ     10
      WPMLIM equ     63
      addr   equ     3; start-bit, ch0 single
                       ended
      stretch equ    33

      ARK equ        027h; Machine
                       address

      lobcd equ      P0
      hibcd equ      P1
      rxen bit       P3.0
      txen bit       P3.1
```

```
kst     data    20h
kdotk   bit     kst.5
kdshk   bit     kst.4

keyport equ     P2
keyer   bit     keyport.7
stcon   bit     keyport.6
pdotk   bit     keyport.5
pdshk   bit     keyport.4

adcclk  bit     keyport.3
adcdo   bit     keyport.2
adcdi   bit     keyport.1
adccs   bit     keyport.0

keymask equ     0FEh
ksdelay equ     50
inispd equ (WPMMAX+WPMLIM)/2
stk_ptr equ     57h
divsr   equ     256/(WPMLIM-
                WPMMAX)

keyspd  data    0Fh
noditt  data    10h
ditt    data    11h
kdot    data    12h
kdash   data    13h
lastat  data    14h
curstat data    15h
result  data    16h
oldlo equ       17h
oldhi equ       18h
cmdlvl equ      19h
tmpsbuf equ     1Ah
curcmd equ      1Bh
latency equ     1Ch

myflags data  21h
keytyp  bit     myflags.0

org             0000h
ljmp            Start

org             0003h
reti

org             000Bh
        clr             TR0 ; stop Timer 0
        ljmp            Timer_Int ; service
                                interrupt

        org             0013h
        reti

        org             001Bh
        reti

        org             0023h
        reti

        org             0050h
Start:
        mov             IE,#0; turn off all
                                interrupts
        mov             IP,#0; normalize
                                priorities
        mov             SP,#stk_ptr; initialize
                                stack
        mov             a,#07Fh;initialize all
                        ports, except keyer
        mov             keyport,a
        clr             keyer

        mov             a,#0FFh; initialize
                        radio ports for input
        mov             lobcd,a
        mov             hibcd,a
        setb            rxen ; enable serial
                                receive
        setb            txen ; enable serial
                                transmit

        clr             a ; initialize keyer
                                variables
        mov             kdot,a
        mov             kdash,a
        mov             noditt,a
        mov             ditt,a
        mov             myflags,a
        mov             lastat,a
        mov             cmdlvl,a; serial
                                command level
        mov             a,#inispd
        mov             keyspd,a
```

```
        mov     a,#10; initial latency
        mov     latency,a

        mov     TMOD,#21h ; Timer
                0 as 16-bit timer;
                Timer 1 as 8-bit auto-
                reload

        clr     TR0 ; stop Timer 0
        clr     TR1; stop Timer 1

setb    PT0     ; prioritize keyer
setb    IT1     ; edge triggering
mov     SCON,#50h   ; Mode 1,
                8-data bits
mov     TH1,#0E8h; 1200 baud

mov     TL0,#dclo; pre-load 16-bit
                count
mov     TH0,#dchi
setb    ET0 ; enable Timer 0
                interrupt
setb    TR0 ; restart Timer 0
setb    TR1 ; restart Timer 1
setb    EA  ; start all interrupts
acall   Ckstat; check key type

mov     a,lobcd
mov     oldlo,a
mov     a,hibcd
mov     oldhi,a

lcall   sndstr
db  13,10,'Blink-CIV 1.2 01/08/96
Daniel Wee (c) 9V1ZV ARK-
20',13,10,0FFh

acall   send_md
acall   send_fr

spdl1:
    jb      keytyp,spdl2
    acall   Ckadc; check keyer speed
                setting
spdl2:
;   acall   Ckstat; check if key type
                has changed
mov     b,latency
```

```
blpul:
    acall   Ckfreq; check if frequency
                has changed
    acall   Ckcmd ; check if C-IV
                command received
    djnz    b,blpul
    sjmp    spdl1

Mydata:
    db  0FEh,0FEh,ARK,0E0h,0,0FDh

Pulse:
    setb    adcclk
    nop
    nop
    nop
    nop
    clr     adcclk
    ret

Ckadc:
    clr     adcclk
    clr     adccs ; chip-select, start
                conversion
    mov     a,#addr
    mov     b,#3  ; number of bits for
                address
loop1:      ; send MUX address
    rrc     a
    jc      one
zero:
    clr     adcdi
    sjmp    cont
one:
    setb    adcdi
cont:
    acall   Pulse  ; read out data (1-3)
    djnz    b,loop1
;   acall   Pulse ; sync clock pulse (4)
    mov     b,#8
loop2:
    acall   Pulse ; clock in ADC data
    clr     c
    jnb     adcdo,carry; read in ADC
                data bit
    setb    c
carry:
    mov     a,result
```

```
    rlc     a  ; shift in MSB first
    mov     result,a
    djnz    b,loop2
    setb    adccs; de-select ADC,
                     EOC

    mov     a,result ; scale and convert
                     data
    mov     b,#divsr
    div     ab
    add     a,#WPMMAX
    cjne    a,keyspd,ckad1
    mov a,latency
    cjne a,#50,ckad3
    sjmpckad2
ckad3:
    inc  latency
    sjmpckad2
ckad1:
    mov latency,#5
   mov   keyspd,a      ; update keyspeed
ckad2:
    ret

Ckstat:
    setb  stcon
   jnb   pdshk,tstk0    ; if either paddle
grounded
   jnb   pdotk,tstk0
   clr   ET0
   clr   TR0
   clr   stcon          ; setup for test
   jb    pdotk,tstk0a
   setb  stcon
   setb  ET0
   setb  TR0
    mov     curstat,#0      ; nothing in
socket
   sjmp   tstk1
tstk0a:
   setb  stcon
   setb  ET0
   setb  TR0
tstk0:
    mov     curstat,#1      ; something
plugged in
tstk1:
   mov    a,curstat
```

```
    cjne  a,lastat,chgtp1
    sjmp   chgtp2
chgtp1:
    mov   lastat,a ; update last plug state
    jz    chgtp2
    clr   keytyp  ; assume paddle
    jb    pdshk,chgtp2    ; check if it is
straight key
    setb  keytyp
chgtp2:
    ret

Ckfreq:
    mov a,lobcd
    cjne a,oldlo,ckfl1
    mov a,hibcd
    cjne a,oldhi,ckfl1
    sjmpckfl3
ckfl1:
    mov a,lobcd
    mov oldlo,a
    mov a,hibcd
    mov oldhi,a
    acall send_fr
ckfl3:
    ret

Timer_Int:  ; Timer 0 ISR
    push   psw
    push   acc   ; save accumulator
    push   b   ; save divisor
     mov     TL0,#dclo  ; reload 16-bit
count
    mov    TH0,#dchi
    setb   TR0           ; restart Timer 0
immediately
    mov    kst,keyport
;   mov    a,keyport
;   mov    kst,a
    jb    keytyp,strtk1   ; if straight key
    jb    kdotk,til1     ; if (!kdotk
    mov    a,kdot        ; && !kdot)
    jnz   til1
    mov    kdot,#2       ; kdot = 2
til1:
    jb    kdshk,til2     ; if (!kdshk
    mov    a,kdash       ; && !kdash)
    jnz   til2
```

```
        mov   kdash,#2        ; kdash = 2
til2:
        mov   a,noditt
        jz    til3            ; if (noditt)
        mov   a,ditt
        jz    til4            ; if (ditt)
        dec   a               ; ditt—
        mov   ditt,a
        jnz   til4            ; if (!ditt)
            clr       keyer                  ;
outport(keyport,keyoff)
til4:
        mov   a,ditt
        jnz   til5            ; if (!ditt)
        dec   noditt          ; noditt—
til5:
        sjmp  tilend
strtk1:                       ; straight keying
        jb    kdotk,strtk2
        setb  keyer
        sjmp  tilend
strtk2:
        clr   keyer
        sjmp  tilend
til3:
        mov   a,kdot
        orl   a,kdash
        jz    tilend          ; if (kdot || kdash)
        mov   b,#stretch      ; percentage
stretch
        mov   a,kdot
        cjne  a,#1,til7       ; if (kdot == 1)
        clr   a
        mov   kdot,a          ; kdot = 0
        mov   a,kdash
        cjne  a,#2,tilend     ; if (kdash == 2)
til11:
        mov   a,keyspd
        mov   noditt,a        ; noditt = keyspeed
        add   a,keyspd
        add   a,keyspd
        mov   ditt,a          ; ditt = 3 * keyspeed
        div   ab
        add   a,ditt
        mov   ditt,a
        mov   kdash,#1        ; kdash = 1
            setb      keyer                  ;
outport(keyport,keyon)
        sjmp  tilend
til7:
        mov   a,kdash
        cjne  a,#1,til8       ; if (kdash = 1)
        clr   a
        mov   kdash,a         ; kdash = 0
        mov   a,kdot
        cjne  a,#2,tilend     ; if (kdot == 2)
til10:
        mov   a,keyspd
        mov   noditt,a        ; noditt = keyspeed
        mov   ditt,a          ; ditt = keyspeed
        div   ab
        add   a,ditt
        mov   ditt,a
        mov   kdot,#1
            setb      keyer                  ;
outport(keyport,keyon)
        sjmp  tilend
til8:
        mov   a,kdot
        cjne  a,#2,til9       ; if ((kdot == 2)
        mov   a,kdash
        cjne  a,#1,til10      ; && (kdash !=
1))
til9:
        mov   a,kdash
        cjne  a,#2,tilend     ; if ((kdash == 2)
        mov   a,kdot
        cjne  a,#1,til11      ; && (kdot != 1)
tilend:
        pop   b               ; restore divisor
        pop   acc             ; restore accumulator
        pop   psw
        reti                  ; end of Timer_Int ISR

sndchr:                       ; transmit a se-
rial character
        clr   TI
        mov SBUF,a
sncl1:
        jnb   TI,sncl1
        ret

sndstr:                       ; send an FF ter-
minated string
        pop  dph
        pop  dpl
```

```
sndl1:
     clr   a
     movc      a,@a+dptr
     cjne a,#0FFh,sndl2
     sjmp sndl3
sndl2:
     acall sndchr
     inc   dptr
     sjmp sndl1
sndl3:
     clr   RI
     mov a,#1h
     jmp       @a+dptr

send_md:
     lcall     sndstr
     db
0FEh,0FEh,0E0h,ARK,04h,03h,0FDh,0FFh
     ret

send_fr:
     lcall     sndstr
     db
0FEh,0FEh,0E0h,ARK,03h,00h,0FFh
     mov       a,lobcd
     acall     sndchr
     mov       a,hibcd
     anl       a,#1Fh
     acall     sndchr
     lcall     sndstr
     db        014h,0,0FDh,0FFh
     ret

Ckcmd:         ; Check for C-IV
                    commands
     mov       dptr,#Mydata
     jnb       RI,ckcml1
     mov       a,SBUF
     clr       RI
     mov       tmpsbuf,a; store away
               received char
     mov       a,cmdlvl
     cjne      a,#4,ckcml3; is this
                    command position?
     mov       a,tmpsbuf
     mov       curcmd,a
     sjmp      ckcml5
ckcml3:
     movc      a,@a+dptr; compare string
                         position
     cjne      a,tmpsbuf,ckcml2
     cjne      a,#0FDh,ckcml5
     mov       a,curcmd
     cjne      a,#4,ckcml4; mode
               request?
     acall     send_md
     sjmp      ckcml2
ckcml4:
     cjne      a,#3,ckcml2; frequency
                         request?
     acall     send_fr
     sjmp      ckcml2
ckcml5:
     inc       cmdlvl; increase command
                    level
     sjmp      ckcml1
ckcml2:
     clr       a
     mov       cmdlvl,a
     mov       curcmd,a
ckcml1:
     ret

     end
```

Disclaimer:

This whole project is presented as is. I have done my best to make sure that everything is right but it should be noted that there is a very experimental nature to projects such as these. I can say that it works very well for me but many more enhancements to hardware and software can still be made. As with all projects, think of what you are doing. That should help prevent some major disasters. Good luck.

73 de 9V1ZV Daniel

Arizona ScQRPion Mini-Mag Paddles

by Floyd Smithberg, NQ7X

With all the paddles to choose from today at very nominal cost (?) why bother to even consider building one? Unless, perhaps like me, you get your kicks more from building than operating... or, also like me, you're somewhat 'financially deprived.' this little paddle, 1.5" x 1.5" x 3" without base) is the most recent of many attempts at making a small, cheap, easily constructed model from parts available at any hardware store and with simple hand tools e.g. electric drill, files, hacksaw, etc.

Earlier versions were: an electronic tube keyer with built-in paddle in 1952, spdt momentary key switches with modifications to limit trhow and provide positive stops, various mechanical bugs, etc. No doubt there will be others in due time.

The action on this one is controlled by a small magnet (3/16" x 3/16" x 7/8") embedded in the wooden base below and in contact with the 4-40 steel flathead machine screw. The two paddle arms are also steel and attracted by the vertically mounted screw.. they also provide the center ground contact. The fixed adjustment contacts are 2-56 round head machine screws to provide fine adjustment, with their tips filed to a point. The arm pivots were cut to approximate length from 1/8" steel rod then 'machined' to a point and length using a hand drill and file, and finally polished with emory cloth.

The top and bottom brass plates were cut to size with a hack saw from 1/16" x 1" brass stock and after laying out the location for the holes were clamped together and drilled through both plates to get exact alignment. Then to get precise alignment of the paddle arms and pivot, locate them on a piece of wood and use small brads to keep in place while soldering. I considered using silver plated contacts but after using these paddles with two versions of the KC-1, my CMOS III, TS850, and FT736 with no problems, it appears not to be necessary. However, in more corrosive environments than Phoenix, you might consider other contact materials.

Use the drawings and the pictures to duplicate this design. You should be able to do it with less than $10 in materials plus some time that you will enjoy. When you finish, you will have a set of paddles that are sturdy, tough, and work well. It works great for backpacking, mobile or home use. Please let me know if you come up with mods or improvements.

Construction:

Building the Arizona Scorpion MiniMag Paddles does not take any special equipment, but it does take care attention to laying out the pieces and making sure that the holes are drilled accurately. The following procedures will help you build a set of paddles that you can be proud of.

First measure and cut the brass stock for the bottom and top plates. These are made from 1/16" x 1" brass stock that is available from any hobby shop that sells model airplanes. Look for the K&S Brass display.

Now lay out the drilling holes on the brass. This is done by careful measurement from one end of the brass base plate. The best method to drill in metal is to use a process called step drilling. In this case, start all holes using a 1/16" bit, then finish the hole with the proper sized bit. You will find that your holes are much more accurate using this method. Use a drill press if at all possible, as the holes need to be vertical. Also, please use a center punch to mark the start of the drill, as otherwise your drill bit will tend to run on you. The holes for A & B are marked on Top Plate 1 and it is then clamped to the bottom plate and the holes are drilled at the same time. This assures perfect alignment. Next, mark the holes for Top Plate 2, and clamp it in position over the bottom plate. Again, drill with the proper size drill using a drill press if at all possible. Finally, mark the rest of the holes that are in the bottom plate and drill.

Turn the bottom plate over and counter sink the holes where required. Tap the threads for the hole at C. Lay these parts aside and find the steel 1/8" rod. Cut two pieces exactly 1 and 5/16" long. Put them in an electric drill held in a vise. Use a file to turn a point on each end of the rod, trying to keep them the same length as much as possible. Next, cut the contact arm to length. The covers for the slots in a computer are excellent for this. Lay the contact arm on a piece of wood, and hold it using small brads. Position the pivot on the arm, make sure that it is exactly perpindicular to the arm, and use brads to hold it in place. Solder the pivot to the arm, making sure that the positon of the pivot matches the dimensions in Figure 1.

The next piece is the base. This can be any material that you choose. Wood, plastic, steel, brass, aluminum, all will work well here. You will need to cut a cavity out of the base for the magnet. The easiest way to do this is to get a router bit and use it in your drill press. Take it slow, and it will work fine. Be sure to use guides to keep control of the work piece. Or you can drill a series of holes to the proper depth and use a wood chisel to finish the job. Don't worry how it looks, as it will be covered and won't show.

Finally, prepare the Nylon spacer. Tap both ends of the spacer for threads to fit the screws that will hold it on. Then lay the spacer on its side and drill a hole through the side. Tap for 2-56 threads.

Now we are ready to assemble the paddles. Assemble as shown in the drawing in Fig. 2. Use the screws at position B to adjust the bearing tension on the paddle pivots. Place the magnet underneath the screw at D, and adjust the play on the contacts on the nylon posts. Wire the paddles,. with the dits connected to position B in Figure 2 and the dahs connected to position A. The ground connection goes to position C. That is all there is to it. Good luck!

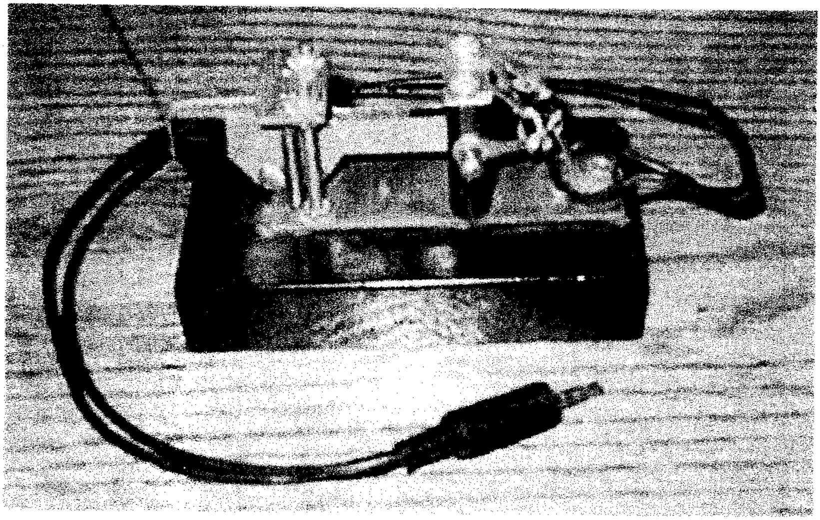
Parts List:

Bottom Plate	2 1/2 x 1 x 1/16" Brass
Top Plate 1	5/8 x 1 x 1/16" Brass
Top Plate 2	3/8 x 1 x 1/16" Brass
Magnet	3/16 x 3/16 x 7/8"
Contact Arms (2)	2.5 x .5 x .045 Steel
Pivots (2)	1/8 x 1 5/16" Cold Rolled Steel
FH Brass Machine Screws (2)	1.5" x 6-32
RH Brass Machine Screws (2)	1/4" x 8-32
FH Steel Machine Screw (1)	1" x 4-40
RH Brass Machine Screw (1)	1/4" x 6-32
FH Steel Machine Screw (2)	1/4" x 8-32
FH Brass Machine Screw (1)	1" x 6-32

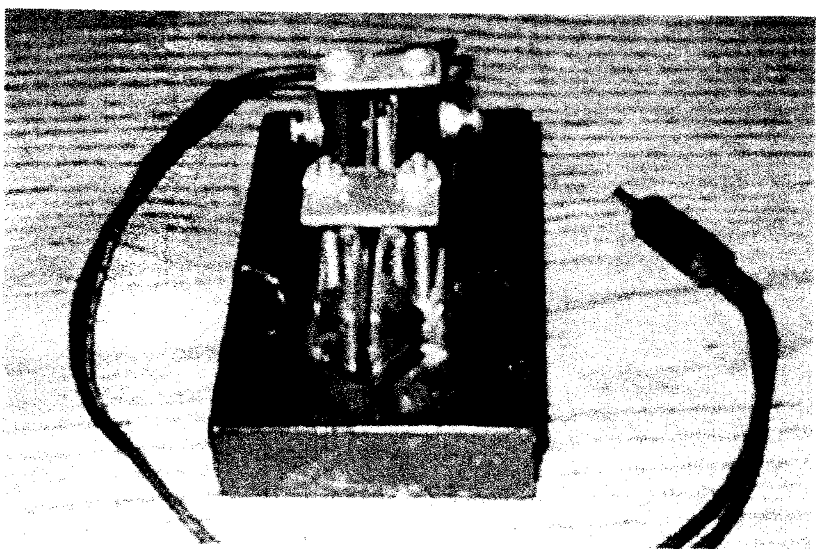
(3) Solder Lugs, (2) 6-32 Brass Nuts, Base Material

Note: The paddle may be made with the top as one solid piece, but if you choose this option, please note that you will have to make sure that the two front posts which connect to the paddle cable must be insulated from the top piece. The easiest way to do this is to use nylon mounting screws and nylon washers if you use metal for the front posts. Of course, if you use nylon standoffs, there is no problem.

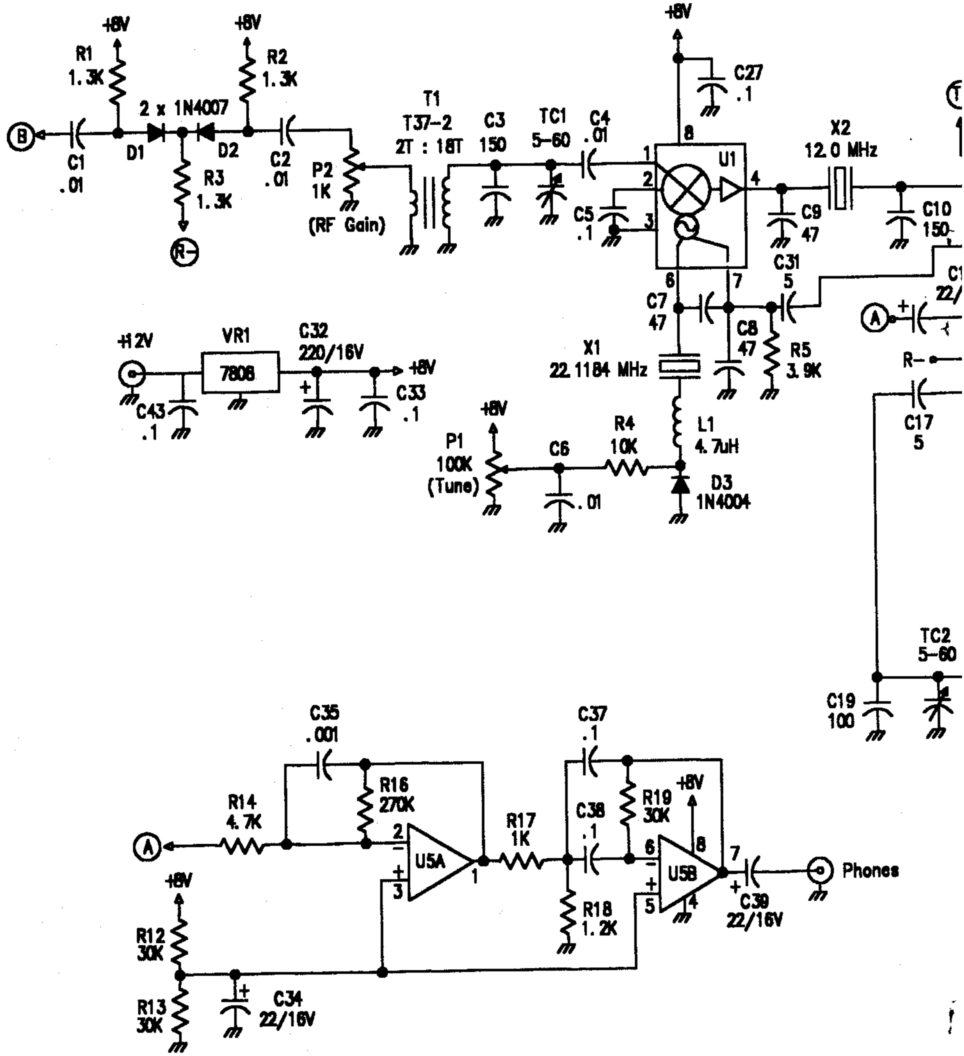
To use a one piece top, you will have to mount the top and then use a cut and try method for the bearings for the paddle arms.



Side View, NQ7X Version Arizona Scorpion Mini-Mag Paddles

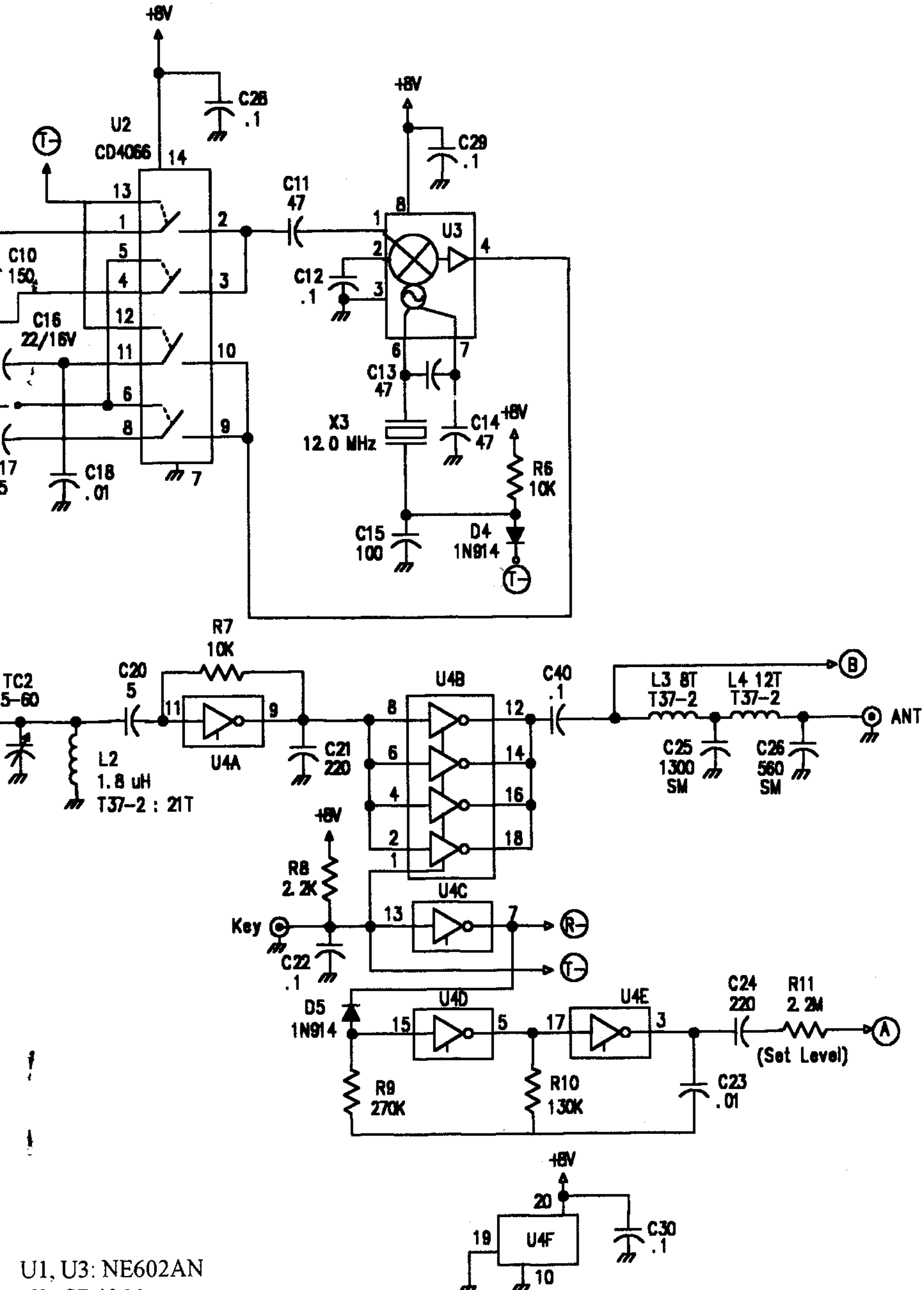


End View, NQ7X version of Arizona Scorpion Mini-Mag Paddles

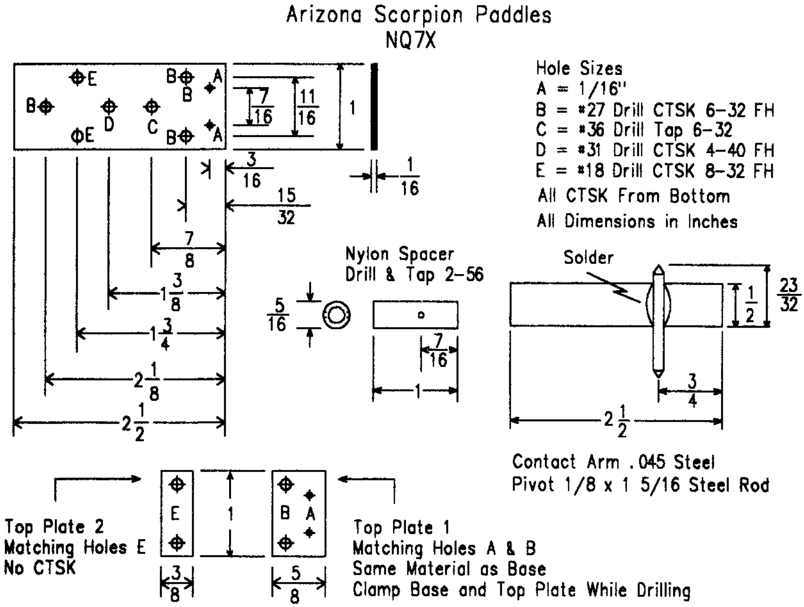


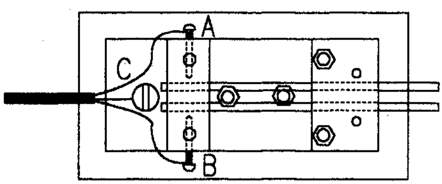
"38 Special"
30 Meter CW Superhet Transceiver
designed by Ori Mizrahi-Shalom, AC6AN
Winner of the 1997 Dayton Building Contest Design Contest
Rev. 1.0, Nov. 1, 1996

U
U1
U4
U1
D



U1, U3: NE602AN
U2: CD4066
U4: 74HC240
U5: NE5532
Decimal Caps are in uF, All others in pF

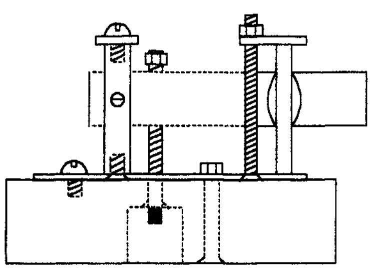




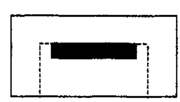
Top View

Refer to Fig. 1 for dimensions. Not all parts shown in all views for clarity.

Dark area in cutout represents magnet placement.



Side View



End View

Arizona ScQRPion Mini-Mag Paddles

A Mighty Fine Tuner

by John Spoonhower, KC2DU

Here's a quick and simple construction project for those of you that need an easy-to-build long-wire tuner. I was inspired by the post of Craig, WB3GCK, to QRP-L some time ago. I built the tuner he mentioned in a dead MFJ noise bridge that I picked up at the Rochester, NY hamfest this past spring. Hence the name....a Mighty Fine Tuner. The noise bridge board was in a pretty bad way, but the tuning capacitor and connectors were in good shape. So the board went into the junk box, and the other components and case were pressed into service for this little tuner. The tuner is ideal for backpacking/camping as it's quite small.

The tuner schematic is shown in Figure 1. With the switch in the "down" position, the tuner becomes an "L" circuit with the antenna wired at the capacitor/inductor junction. This configuration is good for matching wire antennas that are multiples of a half wavelength. With the switch "up", the inductor and capacitor are in series, and better suited to match quarter wavelength long wires. Nice and simple....

My version of this tuner is shown in Figure 2. I have to confess that I really don't like to do a lot of mechanical work in my construction projects. With the old MFJ box, even "mechanically-challenged" hams (like myself) can produce decent looking results without a lot of effort. Of course, any small enclosure (2 x 3-1/4 x 4 in) can be used here. Note that the controls for the inductor and capacitor are on opposite sides of the box. I was interested in minimizing drilling of the case and, hey, we 're camping anyway.....

The only drilling necessary in my case was to open up the diameter of the hole for the tuning capacitor a little bit. The capacitor is mounted to a small piece of plexiglass (perspex for you G-guys!) epoxied to the inside of the case. The shaft and mounting hardware for the capacitor cannot contact the case in this circuit. The capacitor has a value of roughly 300 pF in my circuit; Craig, WB3GCK, suggests 200 pF minimum. The inductor is hand wound #22 wire onto a 35 mm plastic film can. There are a total of 40 turns producing an inductance of 35 microhenries. The coil is tapped 8 times; a Radio Shack rotary switch selects the different tap points. I suggest you connect a counterpoise wire when using this tuner in the wild. I have a tie point mounted on the outside of the case to clip on such a wire with an alligator clip.

This is a really minimal-pain project that really useful results. It's about the easiest way to get started in homebrewing that I can imagine. If you're lucky enough to have a dead MFJ, well then you can REALLY minimize the pain!

72, John, KC2DU

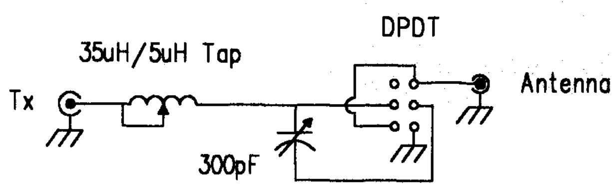
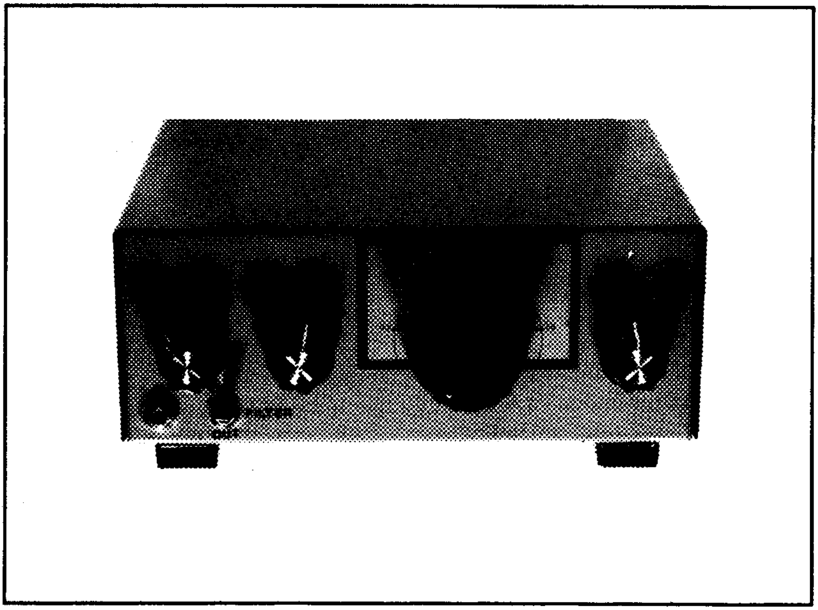


Figure 1



Fix the Thump in your NW80-20 Series Rigs

by Paul Harden, NA5N
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When I was at Dayton, I was approached by several people asking if I knew the cause of a "thump" on key-up on the EmTech NW series rigs. This was curious, as my NW40 does not exhibit any funny noises during keying. Finally, Preston Douglas WJ2V sent me his NW20 and NW80 ... which indeed are champion "thumpers." But they did allow me to finally find the problem(s) - which are applicable to other rigs as well.

1. LEAKY DIODE D1 (1N4148). This is the keying diode that biases the FET audio mute switch. It is located next to the VFO tuning capacitor, behind the audio pot on the board. On two of the rigs I checked, this diode was leaky and not allowing the FET mute switch to go into full turn-off on key-down. REPLACE WITH A 1N4001. Roy at EmTech now supplies a 1N4001 for this diode in his kits. I just snipped D1 off the top of the board and soldered the 1N4001 on the remaining leads to avoid disassembly of the board from the enclosure. MORAL: Ensure your diodes are diod'ing. On a DVM, the forward resistance measured about 60K vs. almost nothing.

While this fix cured a couple of the NW thumps, it did not cure Preston's thump.

2. RF PICKUP ON AUDIO FILTER OUTPUT. There are two flavors of the NW rigs with enclosures. One where the CW filter on/off switch is on the LEFT side of the front panel, and the other where the switch is on the RIGHT side of the front panel. Where the CW filter switch is on the RIGHT side, the wiring from the CW filter board (left side of rig) runs across the board to the right side, right over the RF stuff. This wiring acts as an antenna and picks up a bunch of RF on key down. The induced RF is applied to the FET mute switch (audio input) and fed back to the CW filter op amps. On key down, this RF

charges up the filter output cap and the cap across the FET mute switch. On key-up, it takes 800mS for these caps to discharge sufficient to again pass audio. When the discharge occurs, there's a big appearance (thump) of audio.

PLACE A .1uF CAP ON THE CW FILTER AUDIO OUT TO GROUND. To avoid disassembling the rig, I mounted the .1uF cap on the CW filter on/off switch ... wrapped one lead around the switch shaft for ground, the other lead to the switch terminal that receives the audio from the CW filter board. This completely eliminates the thump; a .05uF was not quite enough. Your mileage may differ. A .05uF will cause less audio attenuatio if sufficient in your case ... although there's plenty of audio to spare.

The alternative is to add the cap on the CW filter board from the OUT terminal to ground. Works equally as well, but requires some disassembly.

Another approach on your NW rig may be to just route the wiring from the CW filter board to the switch by tucking it along the inside of the front panel so its not dangling in mid-air over the RF drivers. There was no thumping on those rigs with the CW filter on/off switch on the left, or just an inch from the filter board. MORAL: Be conscious of routing wiring in and around RF power stages. Bypass low-frequency or DC wiring if needed to keep the RF out.

I could not see this "thump" on the o-scope, making it even more frustrating. For your interest ... what I finally did is hooked up a square wave generator with a TTL (0v/5v) output to the key jack to key the rig. I slowed down the square wave generator until the thump appeared, which was around 12Hz. I triggered the scope off the square wave and used the 2nd trace to go probing around, mostly central to the FET mute switch. This is where I first saw the capacitor discharging 800mS later. Previously, I was probing around while tapping the key, and 800mS was just off the sweep, and because my "tapping" was asynchronous, was not able to see it. Triggering to a stable square wave, allows one to see what is happening many milliseconds (in this case, almost a second) later. At 20wpm sending the character "V", the thump would occur only after the "dah." However, the scope would trigger on the first dit and the problem occured long after the sweep finished. Slowing the sweep down to the "seconds" range, the discharge pulse was just too narrow to see. Thus is took a square wave generator triggering on the falling edge to see it. I offer this explanation due to the several emails I've received how people can hear the thump, but not see it on a scope.

I might add, both of Preston's NW rigs were well built, good solder joints throughout, tight toroids, etc. It was just a serendipitous routing of switch wiring that caused RF to be induced during transmit, and a leaky diode.

NW owners with the thumping ... check diode D1 for proper switching action and that the audio input to the FET mute switch is free of RF by bypassing as described above. This does seem to be specific to those using the CW audio fiter with the filter on/off switch located on the right side of the front panel. Once rid of the thump, you will also find the variable IF filter and the CW audio filter work much smoother together for tighter/quieter bandwidths! If you have any questions, feel free to email me about it, or the designer, Roy W6EMT at roygregson@aol.com.

Finally, though I misplaced his calls, I would like to thank Bob Barry for also discovering the leaky diode part of the problem with a rig or two on his end. While I had found the problem, I wrote it off as a once-in-a-lifetime failure. Through email, it became evident Roy had received a bum batch of diodes. The power of QRP-L and internet strikes again!
GL, Paul NA5N

Huff and Puff for the Epiphyte

by Ed Burke, KI7KW
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About a year ago, I started getting interested in SSB QRP. I quickly discovered that there is a fundamental difference between CW, which had been my previous sole focus, and single sideband. Specifically, I found I needed to watch my frequency much more carefully on SSB; a few hundred Hz. driftg, which would have gone unnoticed in a fifteen minute QSO on CW, drew vigorous complaints on phone.

So, I started getting interested in miniature frequency counters with 100 Hz. resolution, and so on. And frequency readout devices are great, but it still seemed a shame to be forced to make frequency corrections manually. After all, if the box knows enough about the current tranceiver frequency to display it, it could darn well take care of correcting the error! But no such luck, and I was considering modifying one of my conters to close the loop.

I also thought about the fact that one really did not need the whole frequency display to stabilize it. Arguably, the last digit would be enough. If you could freeze the last digit to a plus or minus one Hz. range then the job would be done, and the remaining digits would take care of themselves.

I subscribe to QEX, the ARRL experimenters journal, and I noticed an article in the February issue titled "Frequency Stabilization of L-C Oscillatgors" written by Klaas Spaargaren, PA0KSB. After reading the article, I decided that the techniques presented had a good chance of working successfully, and I stopped my own efforts at inventing a frequency stabilizer. My technical specialty is control systems,though, so the problem had a firm grip on me.

I participate in a QRP SSB net on 75 meters at 3760 kHz., and mentioned the article to Derry Spittle, VE7QK and Willie Murray, VE7YY. They told me that the article described the old "Huff and Puff" circuit, and that the basic idea had been around for ages. In fact Derry sent me a copy of an old article from an RSGB journal which described an earlier version of the circuit. So now you understand the source of the weird title for this piece.

At its core, the PA0KSB circuit is based on comparing the VFO to a reference frequency (conveniently generated from a crystal oscillator) using a high speed digital mixer. When the two frequencies are locked, nothing happens, but when the VFO drifts, it generates error pulses, which are summed up in an integrator circuit. The output of the integrator is used to vary the bias on a conventional varicap diode (such as an MVAM108) which corrects the VFO frequency to tune out the drift.

The correction is deliberately slow; it is intended to null out long-term thermal drift and will not control rapid transients. But with this circuit installed and operating in my Epiphyte 2, I have been able to routinely measure VFO stability of 5 Hz per hour. It ultimately depends on the stability of the crystal oscillator which is used as the reference.

Technically, the Huff and Puff is a frequency-lock-circuit with an "integral" characteristic. Integral control loops have the advantage that they drive the error reliably to zero, but htey have lousy dynamics, which is another reason why the response is deliberately glacial. Actually the slow correction is an advantage. When the transceiver is manually retuned to a different frequency, the change easily overrides the Huff & Puff's authority, so that I don't even notice that it is there.

The frequency correction response

looks a little like a saw tooth pattern (see figure 1). Using the example values in the QEX article results in a lock point every 11 Hz (marked "E"); that is, if the VFO is driven out of lock for any reason, it jumps to the next stable equilibrium point 11 Hz away. But only one half of that range is usable. If you assume a VFO which increases its frequency for increasing control voltage, then only the portions labeled "stable" are usuable.

As to practical details, I built in into an external mini-box (2"x2"x3") with a very short cable (about 3" long) and a four-pin connector to the Epiphyte case. It draws about 35 mA, so making it removable for low current battery operation seems desirable. The second version was built on a 2.5" x 2.5" piece of perf-board which resides on the inside of the lid of the transceiver. Surprisingly, there seems to be no serious interference between the Huff & Puff and the Epiphyte transceiver.

The design which was described in the QEX article used both 5 volt and 12 volt supplies, but the Epiphyte 2 uses only 5 vdc. So I made some changes to allow the circuit to run on 5 volts only, and those changes are shown in the sketches below. Let me summarize what I modified from the design published in the QEX article:

* The PA0KSB design uses an old RCA CMOS operational amplifier, the CA3140. For 5 volt supply I used one of Texas Instruments new "rail to rail" CMOS op amps, the TLC2272.

* The non-inverting pin of the op amp is biased to 2.5 Vdc using a pair of resistors (instead of 5 Vdc).

* I changed the input coupling circuit to one that I stole from Derry Spittle because I wanted more sensitivity and less load on the VFO.

* Transistor leakage is a big concern with the original design. The 2N3904 and 2N3906 transistors can be expected to leak significantly in the off state, and the leakage is unlikely to be matched. In the original version of the circuit, leakage has no place to go but into the tntegrator inputs, so I have added two low value resistors which return the current to a stiff 2.5 Volt level which has been made from an unused op-amp section.

* For the coupling back to the varicap circuit, the QEX article recommends a sensitivity of 1 kHz/V. I found best results with a sensitivity of 2 kHz/V, which is realized with a 200K resistor from the output of the Huff and Puff to the cathode of the varicap diode in the Epiphyte. I also tried an additional varicap diode for the Huff & Puff, and that works fine too.

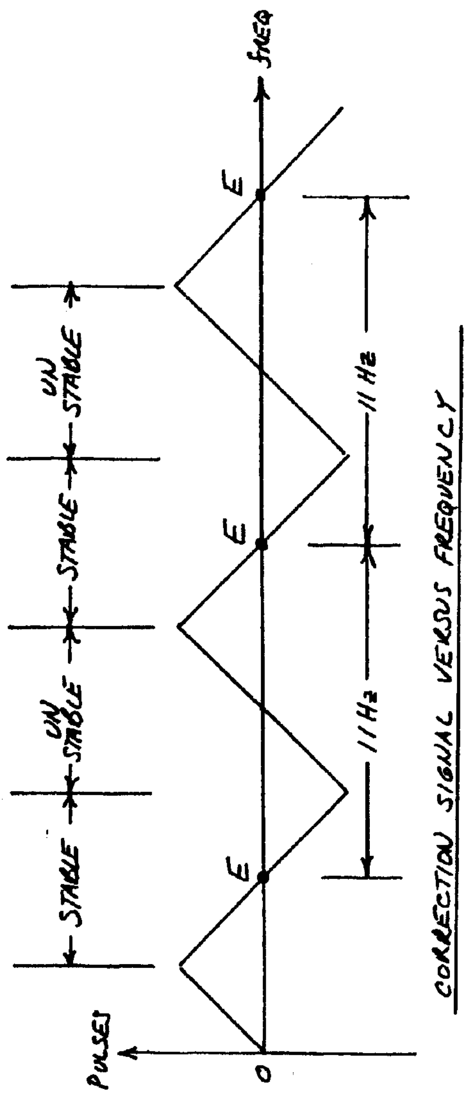
* The QEX article shows an example circuit with an overtone crystal oscillator at 48 MHz, but the usuable lock range (considering a VFO at 4.2 MHz) is only 5.5 Hz. the Epiphyte VFO tends to "rumble" a little, bouncing about 2 Hz up and down around its target frequency. So 5.5 Hz is too narrow a range. If you use an oscillator frequency of 35 MHz, that results in a lock range of more than 7 Hz, which works much better. By the way, consider using one of the minature DIP package crystal oscillators (see the Digi-Key catalog) in place of the 10 or so separate parts shown in the drawing; overtone oscillators can be touchy.

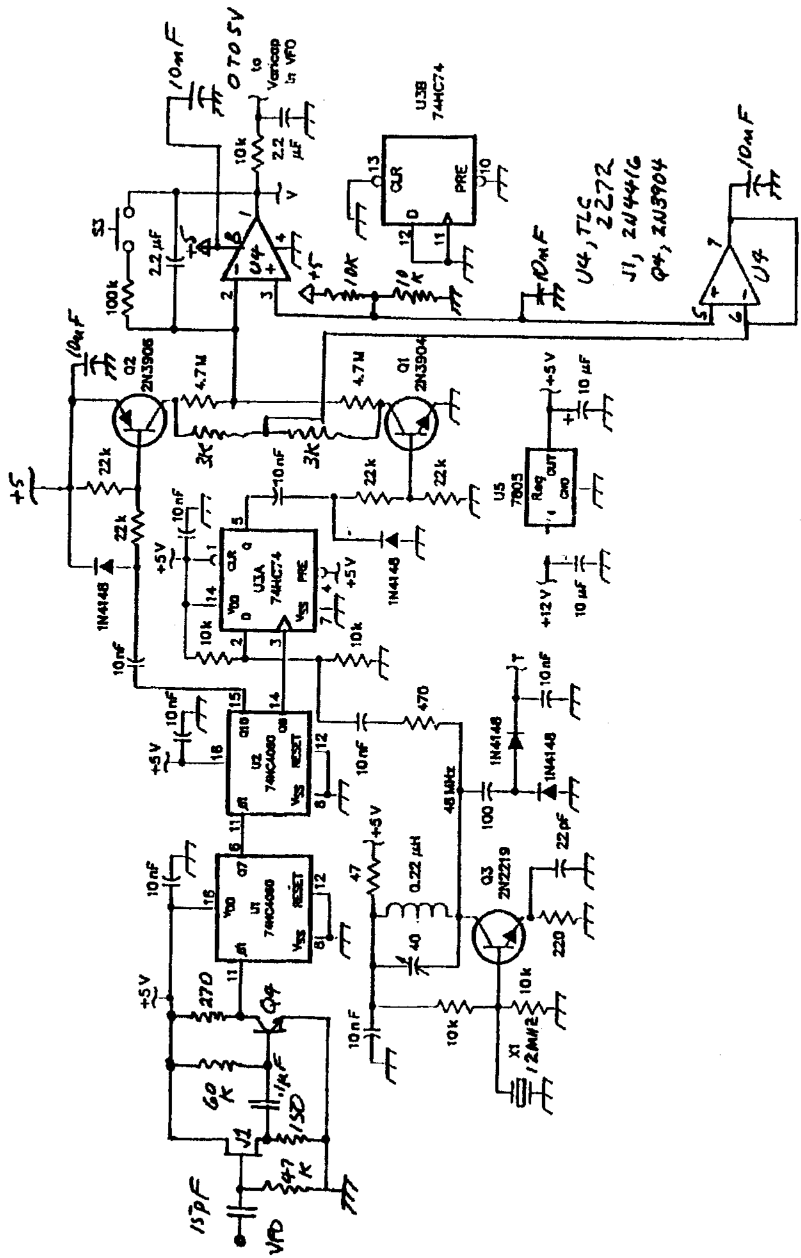
* Consider building the integrator portion of the circuit, which is very sensitive to stray currents at the nano-Amp level, using "ugly" or deadbug techniques, to avoid circuit-board leakage.

* Finally, be careful to use a VFO which is frequency stable over receive and transmit conditions. The VFO should have its own regulator, and even that may not be enough. In my Epiphyte, the 13.7 Volt input was pulled down to 13.5 Volts on transmit, and that change was enough to shift the VFO by 12 Hz and drive it out of lock. The cure is simple; use an additional regulator at 8 Volts, and have the 8 Volts feed the 5 Volt regulator (in cascade), then the VFO is rock solid when the little rig is

keyed.

If you would like the stability of your QRP rig to rival that of the typical 100 watt "appliance" with its crystal-controlled synthesizer chain, the Huff & Puff circuit is a good bet. Mine now works perfectly. Enjoy, Ed Burke, KI7KW




0 TO 5V
to Varicap in VFO
U3B 74HC74
U4, TLC 2272
J1, 2N4416
Q4, 2N3904
Q2 2N3906
Q1 2N3904
U3A 74HC74
U5 7805
U2 74HC4060
U1 74HC4060
Q3 2N2219
48 MHz
0.22 µH
X1 12MHz
1N4148
S3
VFO

Cascade Steel-Case Crystal Mod

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This mod applies ONLY to the last 50 kits sold. They contain different crystals than those in the first 200 kits. This situation was beyond Doug's control. The modification improves the performance of the crystal filter.

The first 200 kits sold by NorCal had aluminum cases. The second batch (50 kits) had nickel-plated steel cases with the "JK" label. This mod is for the kits with crystals having the "JK" label.

The mod is based on computer simulation using Wes Hayward's GPLA program. I have had excellent results using this technique in the past. No one has built a filter using this mod, although at least one VE7 may be doing so soon. The mod consists of replacing all but one of the capacitors in the crystal filter with new ones having different values.

Predicted-performance comparisons follow:

Stock Values:
Bandwidth (-6dB): 4.1kHz
Return Loss: Deep valley at 28dB, non-symmetrical.
Passband: Rounded top.
Modified Values:
Bandwidth: (-6dB): 3.0kHz
Return Loss: 18dB, symmetrical.
Passband: Flat top.
The capacitor changes follow:
Modified Values:
Change C78 and C80 to 68pF.
Change C77 and C81 to 91pF.
Change C82 and C83 to 130pF.
(C79 stays at 56pF)

I recommend using mica capacitors if possible, otherwise NP0 or C0G ceramic types. 72, Dave, W6EMD

A Piezo-Electric Key

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Asks the devil's advocate, "Why complicate something as simple as an on/off switch with a mess of electronics?". And, "Don't all keys with no mechanical motion have a poor feel?". Ok, that's the downside. The upside is ruggedness, small size and almost no weight. One of these keys could be taped down to the outside case of your rig. With appropriate insulating coating, it would work under water. d\ the simple electronics described later use next to no power. Doesn't that sound like an almost ideal key for a backpacking rig?

Ceramic piezo-electric benders are usually used as an audio alarm in smoke detectors, quartz clocks, games, beepers. But the piezo effect works in reverse too - a mechanical stress generates a voltage output. Like a crystal, a thin wafer of piezo ceramic has both sides coated with a conducting surface. Commercial units are available from 0.5 to 2 inch diameter for $0.50 to $3.00. Most come with one side bonded to a thin brass plate, slightly larger in diameter than the ceramic wafer. Overall thickness is 0.02 inch or less. One electrode is connected to the brass disc, the other can be soldered to the coating on the other surface.

A ceramic piezo element looks electrically like a capacitor at the very low frequencies that we are interested in - from D.C. up to about 20 Hz. Mechanical stress impresses a voltage across its two electrodes; positive when bent one way, negative when bent the other. Voltage magnitude is directly proportional to bending stress. Even light finger pressure can generate about a volt (depends on mounting) but there's no perceptible motion at any keying weight.

The brittle ceramic transducer should be mounted to a stiff, smooth surface. Fixing it down with solder is unwise: the ceramic will bend from thermal gradients, and possibly key the rig by itself. To counteract piezo voltages caused by temperature effects, a large resistance bleed was added in parallel. Secure the piezo down with celophane or electrical tape. But protect the coated surface - it may come off with the tape.

A high impedance amplifier connected across the electrodes is necessary to isolate a low impedance load, since load current would quickly discharge the stress-induced voltage. With piezo capacitance of about 0.01uf, an amplifier input impedance of much greater than ten MEGohm is needed at low keying speeds. The bleed resistor must be large too: 65 MEGohms allowed about three seconds keydown, plenty for very slow code.

The most simple interface would be a single enhancement-mode N- channel MOSfet like a BS170, VN10K, or IRF510 as in figure 1a. The zener diode protects the gate from overvoltage, since the MOSfet can withstand only +/-20 volts on its gate. The output at the MOSfet drain should be able to key most rigs - it seems to key a Norcal 40A cleanly. Keying may be too soft for some rigs - an amplifier with higher voltage gain may be required. Modern CMOS op-amps having input currents much less than 1 picoamp make ideal buffers, and can drive the logic gate inputs of a keyer, or a MOSfet keying transistor. Connect the transducer so that keying force gives a positive voltage on the gate. Otherwise, your key will work backwards.

Figure 1b shows a more exotic key. U1 is a CMOS op-amp, used as a comparator. Its output is either up at the supply voltage, or down at ground, depending on whether pin 3 voltage is above or below that of pin 2. Pot R2 adjusts the keying weight: a higher voltage requires more piezo stress to switch the op-amp output. U1 is a low-power device, requiring only 16uA from its supply.

Only one piezo element is needed for a keyer: "dot" force will generate a voltage of one polarity, "dash" force the opposite polarity. Figure 2 shows how two op-amps (used as comparators) could generate ouput voltages to drive the keyer dot and dash inputs. The piezo element is biased at half the supply voltage. R3 and R4 independently adjust dot and dash keying weights. To get enough keying weight range, this circuit may require a larger supply voltage: the rig's 12 volt supply should do. Some paddle users only apply keying pressure around the outside edge. That's not advisable with these piezo elements, since force near the middle gives highest voltage. Paddles could be added that would both re-distribute edge pressure to the center, and protect the transducer too.

Iambic keying needs two piezo elements which can be mounted on either side of a very stiff paddle. There is a danger that dot or dash stresses could bleed through to the opposing transducer. Two separate paddles with a transducer mounted on each would be safer. Each transducer would use the circuit of figure 1a or 1b.

What does it feel like? I doubt that anyone would prefer its feel over any other key. Feeling that contact "clunk" when a key closes is an important tactile aspect that is missing. Perhaps some will find novel mounting methods for mobile or portable use.

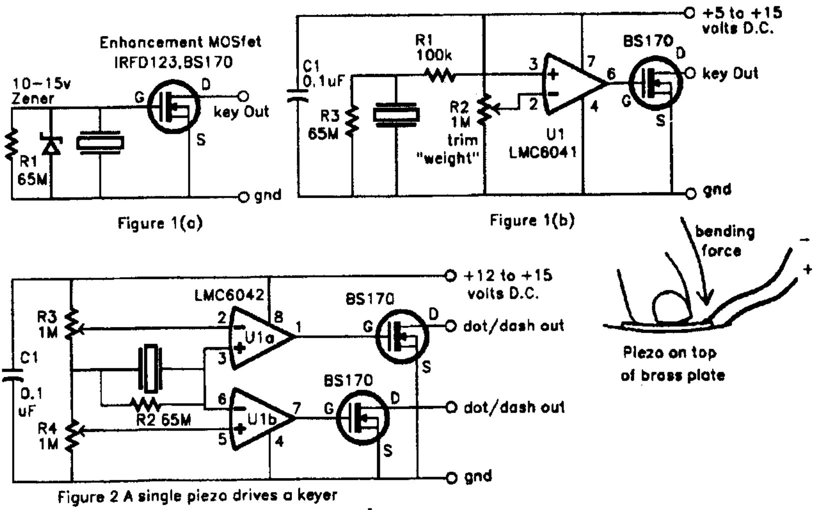
From ELECTROSONIC catalog (Willowdale Ont):

"Projects Unlimited" Piezo-ceramic benders:

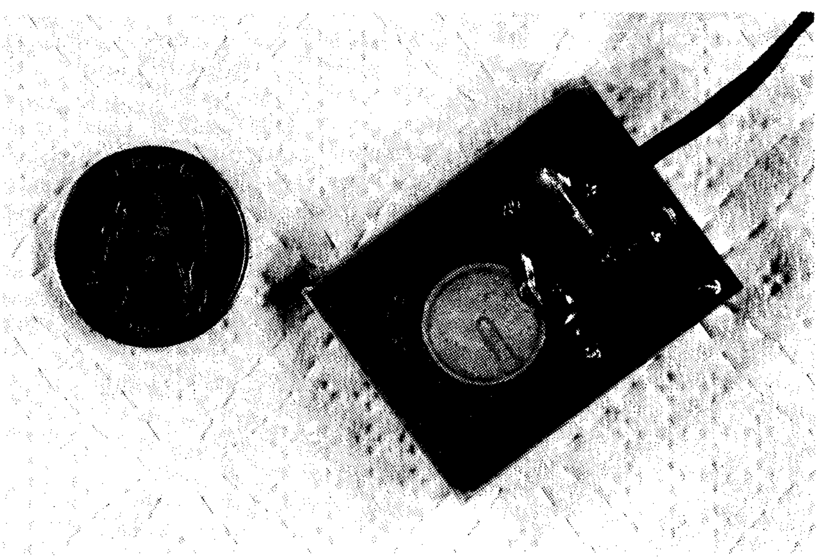
Cat #	outside dia.	piezo dia.	overall thickness	
KBI-1541	15mm	9mm	.23mm	$.80 Cdn
KBI-2048	20mm	15mm	.33mm	$.70 Cdn
KBI-2064	20mm	15mm	.43mm	$.50 Cdn
KBI-2744	27mm	20mm	.53mm	$.45 Cdn

Outside dimension is the diameter of the brass backing plate. Overall thickness includes the brass backing.

72, Glen Leinweber



Piezo Schematic



SIERRA POWER OUTPUT - REVISITED

By Bob Follett, WA7FCU
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The Sierra, designed by Wayne Burdick - N6KR, Kitted by NorCal, and now by Wilderness radio, is up to revision C, and has been the subject of many modifications in the QRP journals and on QRP-L. I constructed mine this summer in anticipation of the wonderful KC-2 "Swiss Army Knife" Keyer, frequency counter, watt meter and S-meter. Mine was assembled using the now-current instruction manual including recommended modifications, which will be covered later.

After testing the few band modules that I had assembled, I became concerned about the amount of RF output my WM-1 was recording. This lead me on a search for past Sierra modifications in the journals, e-mails with Wayne, Dave Meacham - W6EMD, and constant sharing of experiences with Preston Douglas,WJ2V and Bob Gobrick, VO1DRB. The manual's specifications state that power output (13.8V supply) is 2 to 3 watts on 1.8-14Mhz, and 1.5 - 2 watts above. However, Wayne, in a post to QRP-L, stated that his, essentially stock, Sierra puts out 3.5W on 160 & 80M, 3.0W on 40M, 2.3W on 20 though 15M, and 2W on 10M.

There are many reasons one may start the power output chase, and in my case, it was Wayne's post. I wanted my radio to work at least as well as his! Before going further however, it is important to state Wayne's design philosophy related to power output: "To precisely control drive level into each mixer takes many more components, raising the cost above the level where it is a viable kit. I opted to keep the cost down and accept compromise performance, especially since the rig is intended to be "low power" to be compatible with backpacking." Enough said.

There are two major classes of power seekers who may be interested in this collection of modifications: Those who are interested in only optimizing Wayne's design, and those, for whatever reason, want more output than the original design is capable of providing. Because of this, I will present the modifications from easy optimization, through "full tweak" optimization, to "beyond original design" modifications. So each potential modifier has an idea of return versus time invested, here is a table of my results (13.8V supply except for the last column).

BAND	INITIAL OUTPUT	FIRST CHGS	REDUCED PI INDUCT.	NEW PA	ALL CHANGES W/15.2V P/S
80	built initially		4.2W	4.2W	4.3W
40	2.5W	2.6	4.0	4.9	5.8
30	2.1	2.2	3.0	4.0	4.8
20	1.8	1.9	2.6	3.2	4.0
18	1.0	1.3	2.0	2.9	3.5

As you can see, the initial gains are small, but I recommend doing them before doing the more major changes. First, lets cover the modifications that Wayne has called for since release of board revision C.

1. Replace Q5, a J309, with a J310 which is "hotter"

2. Make sure you *really* have the trimmers peaked. This means making sure you re-peak C66 & C64 for max power out after peaking the XMIT BPF. Do your

trimmers all have 2 peaks in them as they are rotated 360 degrees? If not, remove or add inductance to the associated toroid until they do.

3. Place a ferrite bead, like a FB101-43 or FB101-64, on the base lead of the 2N2222A driver. This will both increase power 15M and up, and allow you to build 12M & 10M modules now offered by Wilderness Radio.

4. Ensure that the T2 primary winding has 11 turns, not 8 turns.

5. Replace the Output Filters, C47, C48 & C49 with Silver Mica, or Polystyrene capacitors. Large value Silver Micas are hard to fit on the board, so use Polystyrene for the lower band modules. I used Meacham's "Optimized Sierra Output-Filter Values" published in QRPp Sept. 95, but using his values requires re-winding most of the L5 & L6 Toroids. If you don't want to be bothered with tearing apart all your modules, certainly do the higher frequencies, from 30M and up.

6. Finally, change the zener protection diode, D7, to 43V instead of 36V. Also change R15 to 36 ohms to avoid exceeding the base-emitter breakdown voltage of Q7 due to excess drive. These changes are important if you run higher supply voltages.

With modification 6, you now have the ability to control output power by varying the supply voltage. Wayne suggests 12V in the field for reasonable battery drain, and 16V on the desktop for an approximate 50% increase in power output. Now, some unpublished final tweaks from Wayne for those that don't mind some work for 1/10 of a watt gain! (sample of one)

Wayne's instructions will take you through the Sierra TX strip, from the beginning to the Final to ensure proper signal levels:

1. Premixer

The pre-mixer has two inputs, VFO and crystal oscillator. 1A. Try putting another resistor in parallel across R22. Start with about 4.7K. This will increase VFO injection into the premixer. See if final output power goes up, stays the same, or goes down. If it goes down, you may actually have too much injection into the premixer, and should try reducing the size of R22.

1B. The crystal oscillator injection may be low. You can do two easy things to test this:

i. Vary C70 on the band module and see if power goes up or down. You may have had it set or very low capacitance, reducing oscillator level.

ii. Put another 47K resistor across R9. This increases oscillator bias.

2. TX mixer injection

There are two sources for mixer injection. The premix buffer output and the TX 4.915MHz oscillator.

2A. Parallel another 5pF cap across C29. Note if this makes power output go up, stay the same, or go down. If it goes down, injection may be too high, and you may need to reduce the size of C29.

2B. Try adding a 22K resistor from U8 pin 7 to ground. This will increase TX mixer oscillator output.

By making all these tests, I found my Sierra was close to optimum, but with a little padding here and there, I picked up 1/10 Watt. Unless your Sierra is not performing "up to spec", I would not suggest these tests unless you really enjoy tweaking.

The next modification requires some explanation and some qualifications. As Dave Meacham pointed out in his "Variable-Power Caveat" article in QRPp, Sept. 95, The output filters for the PA are designed for a specific termination resistance, usually 50 ohms. When one changes the collector voltage, the filter becomes mismatched to the PA, which, among other things, may reduce the attenuation of harmonics. Keep in mind that most qrp rig designers give you a drive control for the express purpose of adjusting the power output. When you crank the power down to 1 watt, you are also making the same kind of mismatch to the PA output filters. For any given power level therefore, there is an optimum value for the output filter.

Having stated Dave's warning and ignoring it, I modified the LPF filter by reducing inductance on each module's L5. Why? Because early Sierra tweakers found that the PA really would like to see about 35 ohms, not 50 ohms. Wayne gives Bob Warmke credit for being first to report power increase by tweaking his LPF inductors. I removed 2T from L5 on 80 & 40M, and 1 T on the rest. You can see from my chart that this change represents the largest power gain I found.

Wayne, however, states that the right way to adjust the matching is to replace the collector choke with a 2:1 transformer. He says that he knows at least two Sierra builders that have done this, but further states that "the only problem may be that the higher bands roll off even more now than they did before". I have not tested his recommended approach.

As the last caveat for this particular modification, no one, to my knowledge, has run harmonic output tests to let us know what changing the PI filter to the PA collector does. Wayne's guess is "It's liable to be significantly different, most likely worse, but probably legal".

The final modification, clearly not part of the original design, is to replace the PA. In my case, I was on a roll with all these tests, and egged on by Preston Douglas and Bob Gobrick. I ordered a MRF237 from MCM for $11 plus change. No components changes are needed for this swap, but the pin-outs are reversed. This means you need to fold the base lead across the case, without touching it, and place its offset with the E & C on the other side of the case. (You have reversed the E & C connections). No other changes are required, though you might consider a "high output" heat sink. Some correspondents thought I might see a small change, Wayne predicted "0 to 20% higher output depending on the band", but as you can see by my chart, I picked up substantial power on several bands.

There you have it. A full range of tests and modifications from which you can choose to increase Sierra output. But again, do keep in mind that the easiest way to increase power is to increase supply voltage. That, in conjunction with several of these modifications give you a wide range of qrp levels to chose.

Pacificon 96: The First Annual West Coast QRP Symposium

by Doug Hendricks, KI6DS
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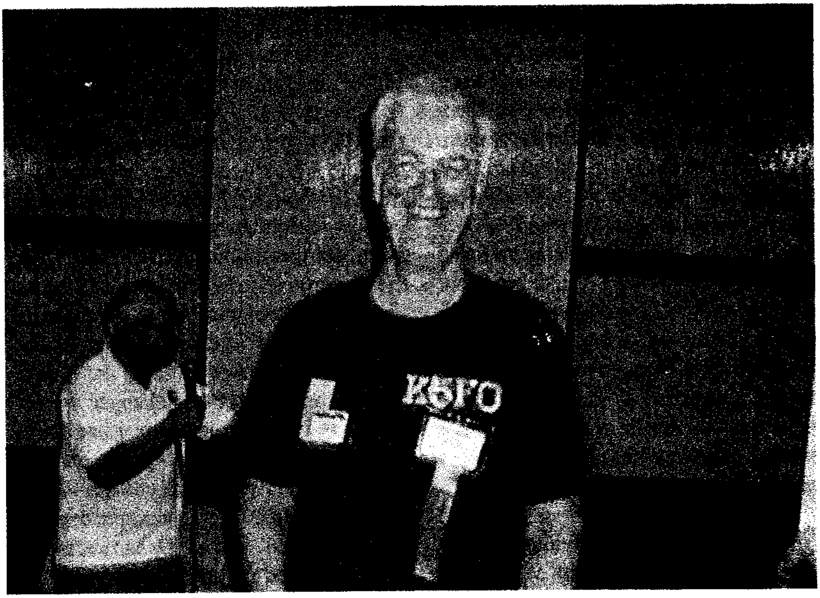
Jim Cates and I sat down after Pacificon 95 to discuss NorCal's participation in the event. We had a booth, and we sponsored 2 QRP forums, one on Saturday and one on Sunday. Jim suggested that we expand our presence in 1996, and one of the ideas that he came up with was to fly in several more speakers from other areas and to have a "West Coast QRP Symposium". We had such a suggestion from one of our speakers, Derry Spittle, VE7QK. Derry had mentioned that Dayton was a long way for QRPers on the west coast to travel to, but most of them could get cheap air fares up and down the coast.

We decided to contact the Pacificon people and see if they would be ameable to the idea. We would require 6 sessions, plus a room to host the QRP Open House session on Saturday night. I contacted



Chuck Adams, K5FO at Pacificon

Dick Brown who put me in touch with Greg Estep, who was in charge of the sessions for the 1996 Pacificon ARRL Pacific Divison Convention.

Greg listened to our proposal, but was not too enthusiastic, as the number of rooms and sessions were full, and it didn't seem to be possible for us to have the 4 extra sessions and the open house. We were disappointed, but understood. Then, about a month later, Greg contacted us and said that we could have 4 afternoon sessions if we were willing to use the room that was vacated by the VE testing team at noon. The room would seat about 100, and it was perfect for our needs.

The West Coast QRP Symposium was on! Now we needed to contact the speakers and get them confirmed. We wanted to provide a variety, as we have learned that one thing that our members seem to like is variety. Jim and I talked and decided on the following speakers; Chuck Adams, K5FO, Eric Swartz, WA6HHQ, Stan Goldstein, N6ULU, Derry Spittle, VE7QK, Ed Burke, KI7KW, Bob Tellefsen, N6WG, Paul Harden, NA5N, and Doug Hendricks, KI6DS.

The speakers all agreed to come and we were in business. All that was left to do was to arrange transportation and hotel accomadations, which was simple to do.

We advertised the event on the internet via the QRP-L group and the NorCal Web Page and in the September issue of QRPp. The NorCal local members made plans to attend, and we had several out of area members who made arrangements to attend. I received several messages on the internet, and felt that the event would be a success. But I had no idea as to the response we would have. Every session was standing room only, and very well received. All of the attendees commented that the QRPers were sure having a lot of fun in their sessions. This was due to the humor in the presentations and QRPers natural tendency to have fun.

The first presenter was Chuck Adams, K5FO. Chuck is perhaps the most recognizable QRPer in the United States today due to his involvement in so many

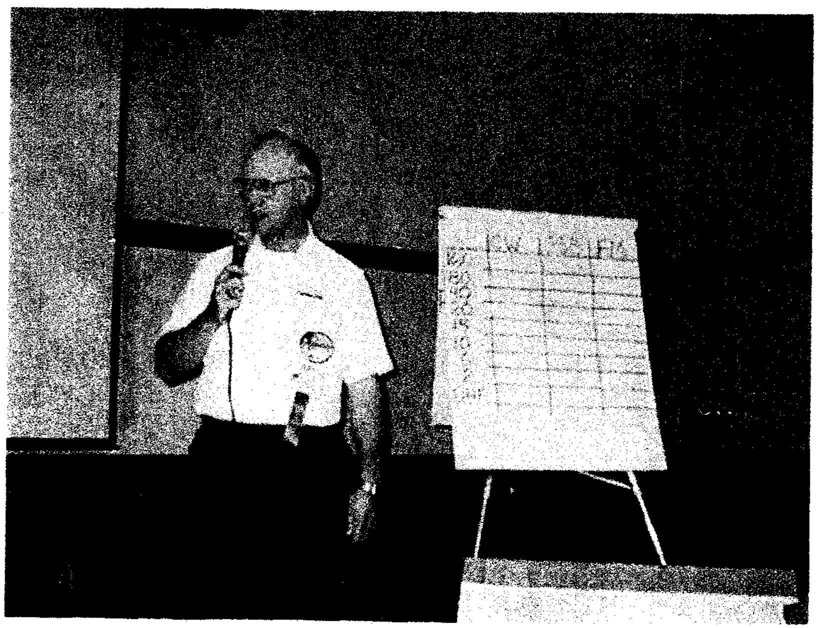
QRP Activities. Chuck writes many articles for QRP journals, was the founder of the QRP-L group on the internet which now has over 1300 subscribers, and also started the Fox Hunt contest and the 30 and 80 meter propagation study.

Chuck Adams may be the perfect person to open a QRP Symposium. He is a very entertaining and personable speaker who knows his subject extremely well. Chuck gave the audience a brief history of QRP and then gave us a picture of where we are today and where he thinks that we are headed in the future. Chuck's main message was that it was iimportant for all QRPers to get on the air and operate to increase their skills, improve their knowledge and advance the state of the art.

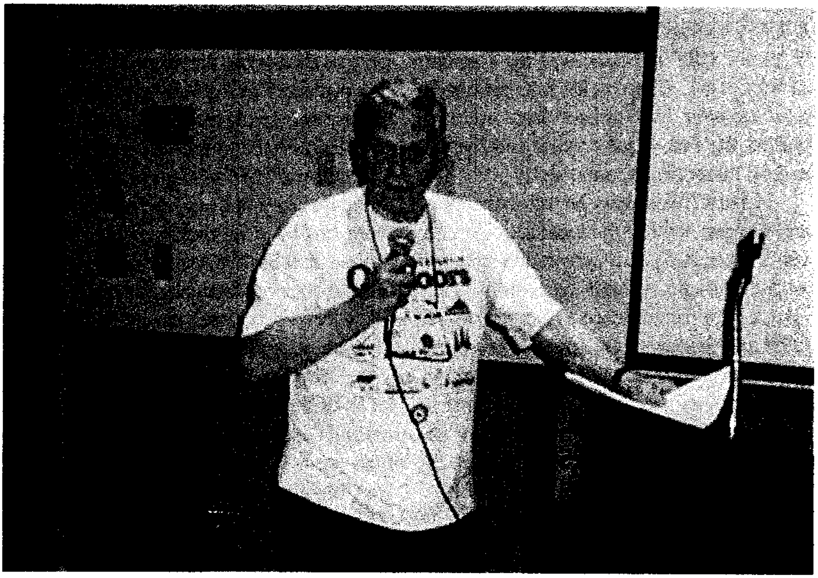
The next speaker was Bob Tellefsen, N6WG, who may have been the best kept secret in QRP Field Day circles before the WCQRP Symposium, but now the cat is out of the bag. Bob is the leader of the Alemeda County FD group that has won their category for the past 11 years! Bob gave us the secrets and hints as to how his group made 1253 QSO's at the bottom of the sun spot cycle this past June.

Bob's secrets include using female operators on SSB, having a full contingent of operators for every rig, and keeping them staffed at all times, planing, having pre-cut and built antennas so that all you have to do is put them up, and making sure that everyone is familiar with the rigs that they are going to be using.

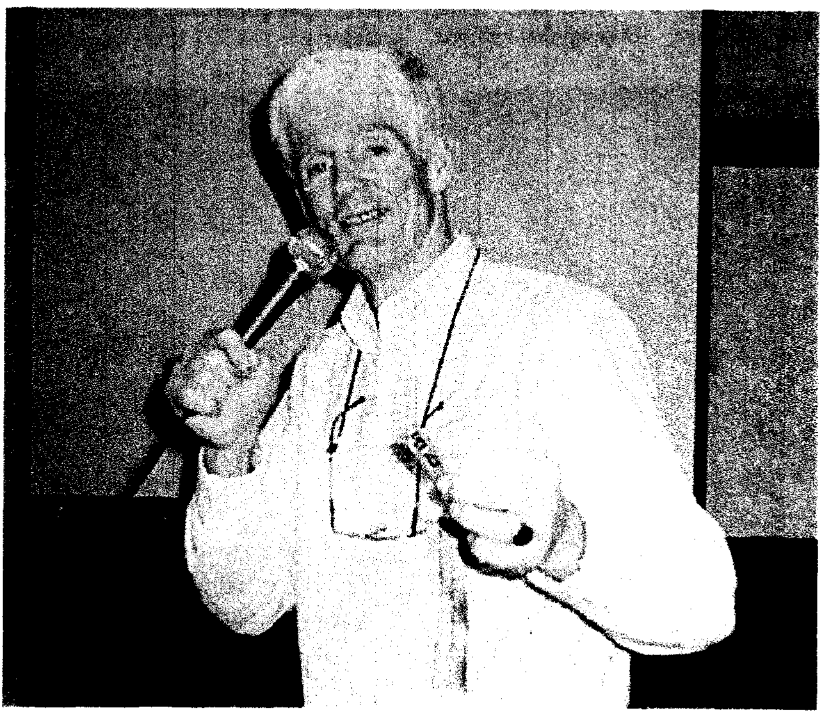
Derry Spittle, VE7QK, and Ed Burke, KI7KW are two of the better known builders and designers of SSB QRP rigs on the west coast. Derry is from Vancouver, British Columbia and Ed lives near Portland, OR. They routinely carry on a nightly schedule on 75M with the homebrew QRP rigs that they have built. They shared their experiences in solving some of the problems of QRP SSB operation. The surprising message that came out of their presentation was that 75 Meters was a better



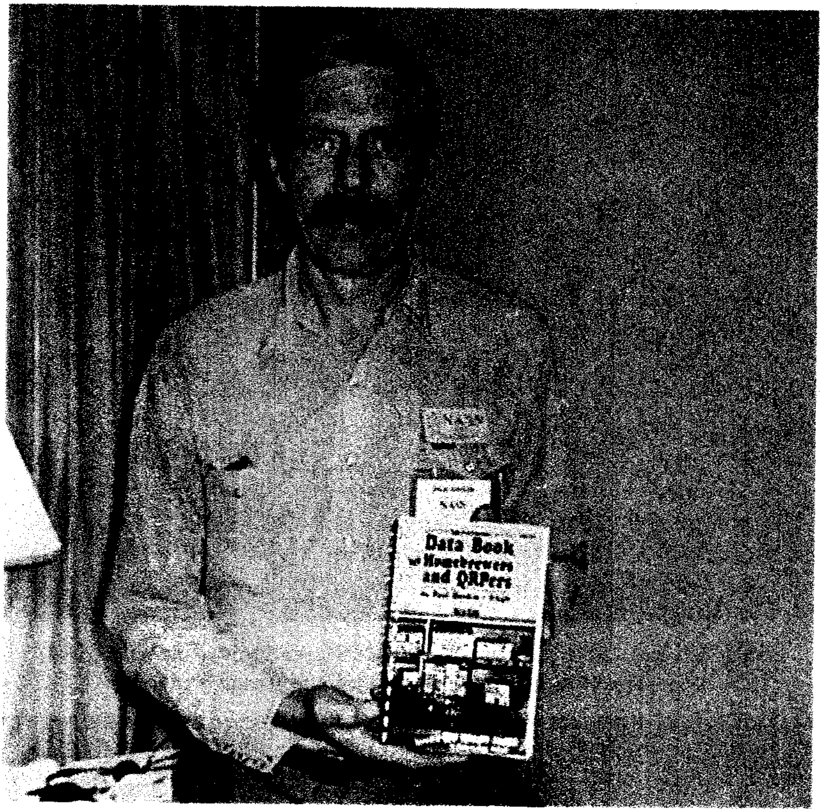
Bob Tellefsen, N6WG "Preaching to the Choir about QRP FD, Pacificon 96"



Derry Spittle, VE7QK, QRP SSB Pioneer Designer



Ed Burke, KI7KW, talks about QRP SSB



Paul Harden, NA5N and his new book, Handbook for QRPers & Homebrewers

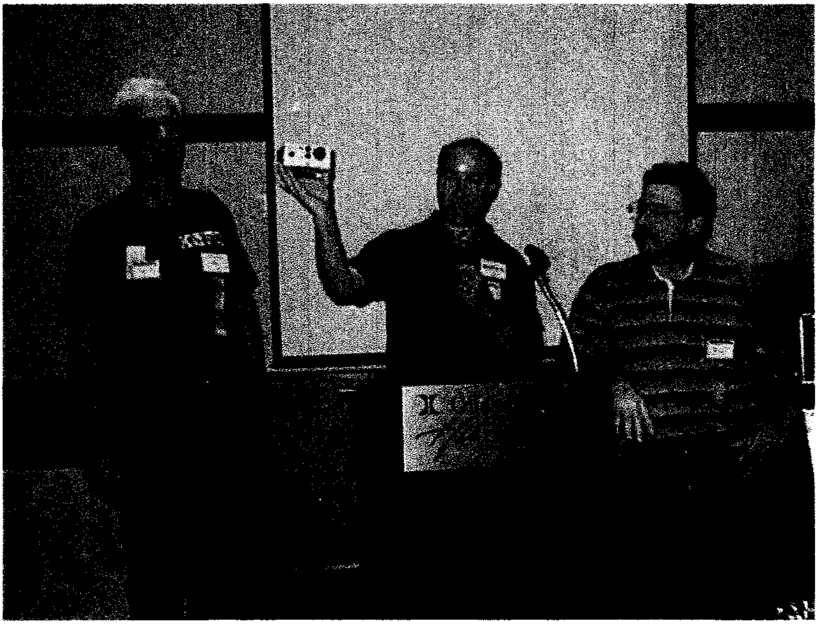
band for QRP SSB than 20 Meters

Paul Harden, NA5N, from Socorro, NM was flown in for the conference to repeat his presentation at Dayton for the NorCal Open House during FDIM. Paul's presentation was a true work of art. He explained how the designers design the various features into the QRP rigs that we are all so familiar with. Paul had a handout that featured the schematic of the NorCal 40, MFJ 90XX series, and the NW 8040 rigs. He then explained to the audience how each designer used different and similar circuts to make the radios work.

The final forum presentation on Saturday was a panel of DX and Contest QRP operatiors featuring Stan Goldstein, N6ULU, who has DXCC #1 with a NorCal 40 and now has 130 countries with the NC40. Stan also was the first year Fox champion in the fox hunt, and then last year he won as a hound in the second year of the contest. Eric Swartz, WA6HHQ, was the second member of the panel, and he has plenty of credentials too. Eric has NC40 DXCC #2, and works just about every DXpedition that comes up by using QRP and a great antenna system. Chuck Adams, K5FO was the third member of the crew, and rounded out the panel.

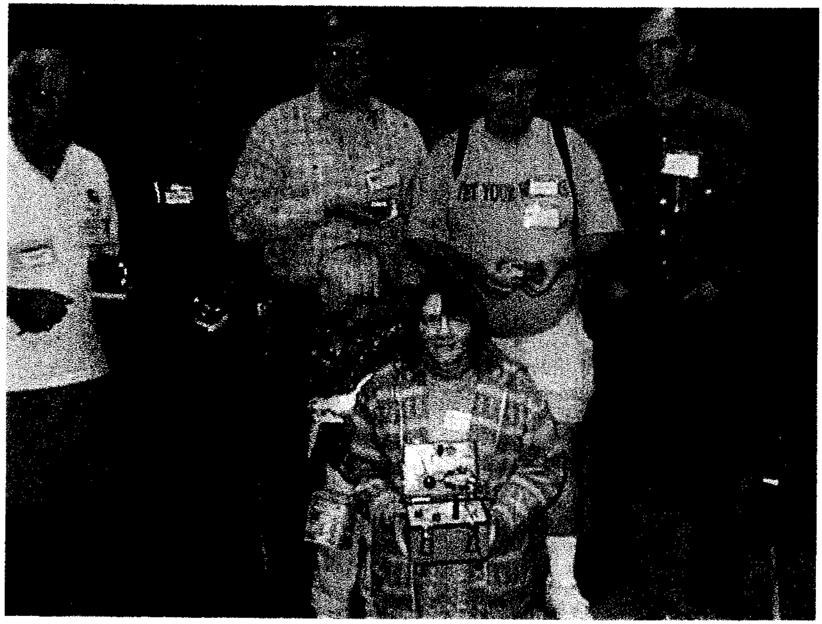
The audience was again full as the NorCal members listened with rapt attention to Chuck, Stan and Eric talk about how they find DX, work it an the tricks that they use to do so. Many secrets were shared, some of them surprisingly simple, yet effective.

We took a two hour break after the



Chuck Adams, K5FO, Eric Swartz, WA6HHQ, & Stan Goldstein, N6ULU
1996 West Coast QRP Symposium Contest and DX Panel

Dennis Utley; Jim Cates, WA6GER, Monte Stark, KU7Y and the crowd.



The 49er Contest winners. L-R: Doug Hendricks, Darrel Jones, Mike Gipe, Vern Wright, Wayne Burdick. Front L-R: Jessica Gipe & Winner Debra Blanke.

afternoon session for dinner, and then all of the Symposium attendees returned for a QRP Open House/Show and Tell session at the hotel. This was the first time that we have done the symposium, and Jim and I wanted to try and capture the flavor of the ARCI sponsored hospitality rooms at Dayton.

It didn't take long for the members to get into things. When I walked into the room at 7:00, it was full of QRPers, all talking in small groups, sharing ideas, and proudly showing off their latest projects. The speakers were all there, and it was a wonderful opportunity for the members to get to meet and know the "famous QRPers".

One of the feature attractions of the open house was the West Coast edition of the 49er building contest. Their were 6 entries this year, and all were very well done. The results were:

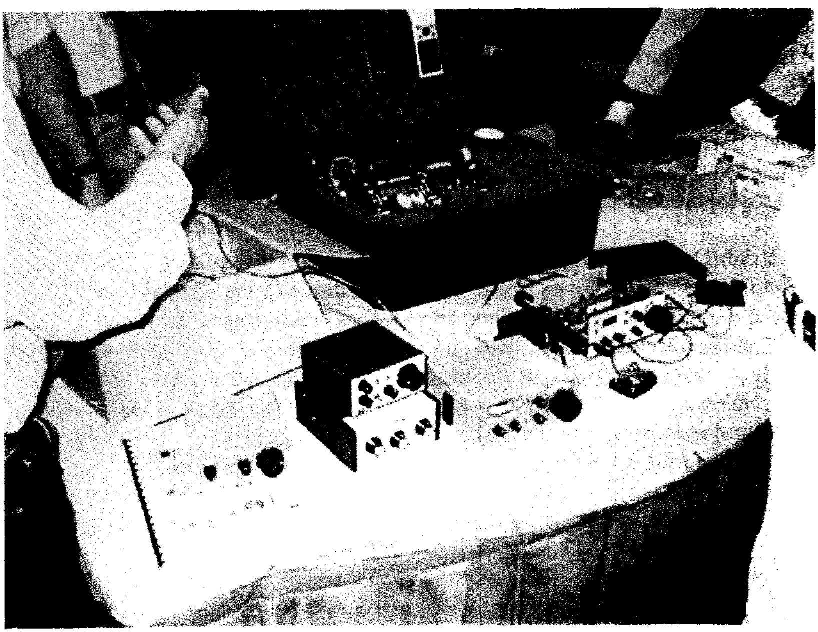
1st	Debra Blanke
2nd	Vern Wright
3rd	Mike Gipe
4th	Darrell Jones
5th	Jessica Gipe (paper 49er)
6th	Doug Hendricks

The first 4 places won new SST transceiver kits that will be the next NorCal club project and is being designed by Wayne Burdick, N6KR. Prizes will be awarded when the kits are available. The SST will be featured in the next issue of QRPp. Jessica deserves special mention,as she is only 5 years old! She was watching her Dad build his entry and decided to enter the contest too. Her prize were two bags of M&M's, plain and peanut, as the judge was not sure of her preference.

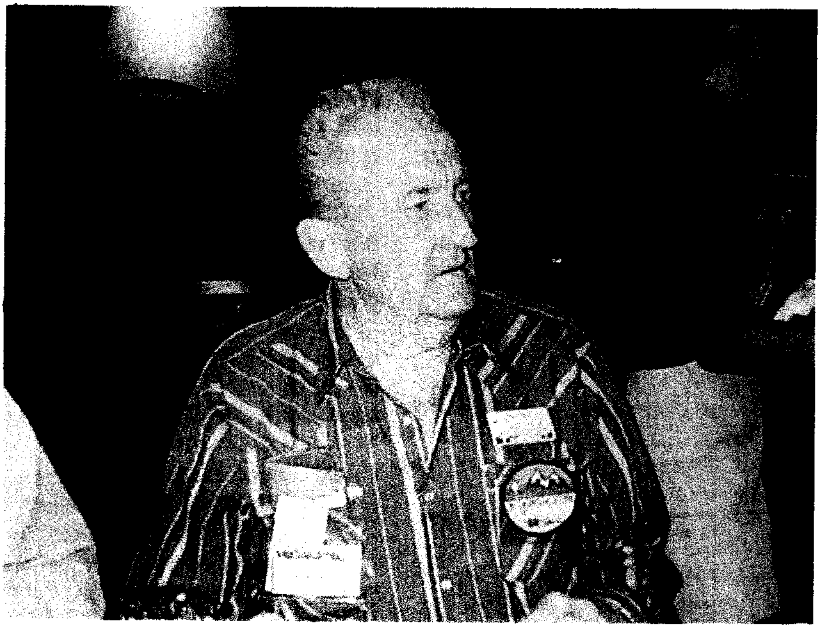
Chuck Adams, KF50 did a great job of judging, and has promised to return next year to judge the "38 Special" and Rainbow Tuner entries. I don't know what time the party broke up, as I went to bed at midnight and it was still going strong.

Sunday morning, I was the speaker for the 10:00 AM session, which has usu-

Jessica Gipe and Derry Spittle, VE7QK shared QRP stories at the Open House



A small portion of the many rigs on display



Monte Stark, KI7Y, Editor of the QRP ARCI was a special guest at the NorCal West Coast QRP Symposium.

ally bee rsely attended. My subject was how to get started in QRP. I was pleasantly surprised to see a very good crowd in attendance. QRP is really growing. I explained what QRP is, and how easy it is to do.

One of the main things that I tried to impart was that it is fun and easy to build. Many new builders are afraid to build because they have heard two myths of building; one that parts are hard or next to impossible to find, and two that toroids are horribly difficult to wind. I explained that the kits suppliers today have eliminated the first problem, and gave a toroid winding demonstration using a roll of toilet paper as a toroid and some RG174 as the wire to get rid of the second myth.

After the presentation, we all said goodbye to our friends and made plans to attend next year. Jim and I both agree that the West Coast QRP Symposium was a lot of fun and well worth doing again next year. Our emphasis is on having fun, and doing things the right way. We feel that we succeeded and hope that you will be there next year to share in the fun. Mark your calender for the 3rd weekend in October as the time to meet in Concord, California for QRP fun. We will bring another group of quality speakers from throughout the country. On behalf of Jim and the NorCal membership, I would like to thank the speakers who gave of their time to give us outstanding presentations.

Many people have asked me why QRPers seem to have so much fun when they get together. I don't know for sure, but I think the reason is that QRPers do things, and they don't mind helping others. We certainly proved that at Pacificon.

Let me close by saying thank you to Jerry Parker and Dennis Utley for the great photos in this article. See you next year. 72, Doug KI6DS

Figuring Sheet Metal Allowances

by Vic Black, AB6SO

If you've ever tried to bend up a sheet metal box or cover for one of your projects you may have wondered why the part didn't fit after bending. Maybe you forgot to include an allowance for the bend. A galnce at Figure 1 shows that when a piece of sheet

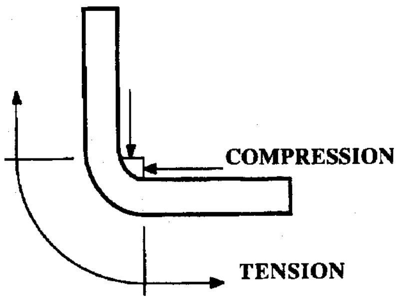


FIGURE 1

metal is bent, the inside surface is shortened (or squeezed) by compression and the outside surface is lengthened (or stretched) by tension. Someplace in between is a neutral axis where neither shortening nor lengthening takes place. The sheet metal in the bend is true length only along the neutral axis.

The total length of sheet metal must be calculated. An example of a simple angle bracket is shown in Figure 2. The bracket is to be 1 inch long on each side with a bend radius of 1/16 inch (0.063)

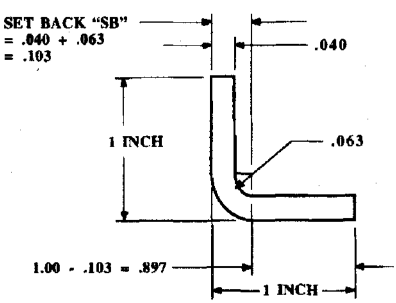


FIGURE 2

and metal thickness of 0.040 inch.

The first step is to figure out the set back (SB) which is the sum of the bend radius (BR) and the metal thickness (MT). In this case the set back equals .063 +.040 = .103 inch. The set back is subtracted from the overall side dimensions to find the lengths of straight, unbent legs of the bracket.

The next step is to add the bend allowance (BA), or length of the neutral axis in the bent portion, to obtain the overall length of the flat pattern for the bracket. This is the tricky part. We'll digress for a bit and discuss the geometry of curves.

The circuference of a circle is equal to 2piR. Since there are 360 degrees in a circle, it follows that the circumferential length for one degree is equal to (2 pi R)/360 or (pi R)/180. Solving for (pi R)/180 we get (0.0174 x R) inch per degree of bend on the **inside of the bend** (that's on the compression side). Since sheet metal has a finite thickness, a constant must be added to move out to the neutral axis. We'll use 0.0078 times the metal thickness. this gives us a final formula for the bend allowance as follows:

Bend Allowance = BA = (angle of bend) x [(.0174 x BR) + (.0078 x MT)].

Solving the formula for our example above (Figure 2), we get:

BA = (90) x [(.0174 x .063) + (.0078 x .040)]

BA = (90) x [(.0010962) + (.000312)]

BA = (90) x (.0014082)

BA = .127 inch

This makes the final flat blank look like Figure 3.

The calculations may look complicated, but a simple 4-function calculator with a memory makes them easy to do. Incidentally, since this method is based on the geometric properties of the shape, this method works regardless of what dimensioning system you use so long as all dimensions are in the same system. That means that you can use metric rather than English dimensions in the formula and still get the same results.

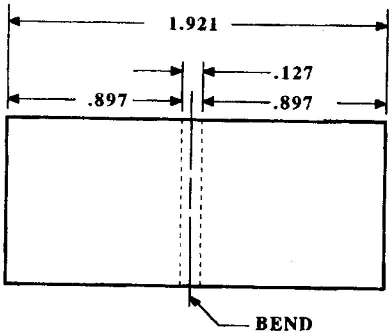


FIGURE 3
(FLAT DEVELOPMENT OF FIGURE 2)

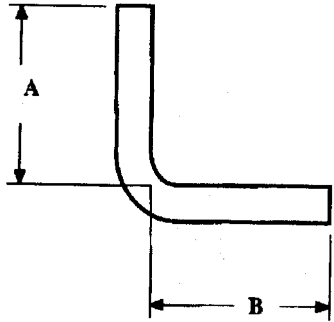


FIGURE 4
(ALTERNATE METHOD)
TOTAL FLAT LENGTH =
A + B + CORRECTION FACTOR

KC-2/Cascade Installation

by Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062
ddm@datatamers.com

Coupling the KC-2 to the VFO in the usual manner doesn't work well in the Cascade. The Hartley circuit seems to be more susceptible than the usual Colpitts to a pulse signal that comes OUT of the KC-2 at the VFO input. That signal is the KC-2's "10Hz VFO-sample-interval timer" pulse. It modulates the VFO, causing a "warble" at 10Hz. The following mod solves the problem.

Changes for the Cascade/KC2 installation:
1) Change C8 in the KC-2 to 100pF.
2) Run RG-174 from the KC-2 to U7 (I use about 4.5 inches of it).
3) Couple the center conductor to pin 7 of U7 with a 15pF C0G or NP0 cap.
4) Ground the coax near U7. Leave the coax shield at the KC-2 end disconnected.

(This mod adds an additional buffer between the KC-2 and the VFO.)

In normal SSB operation I don't hear any evidence of the 10Hz pulses. If I zero beat a strong carrier I hear it weakly (also near zero beat). Wayne pointed out that the AGC is not working under these conditions, so there is lots of gain. I'm happy with it as is, and its a simple mod.

KC-2 Connector for J3

I am using a connector that fits the KC-2 (J3) very well. Thought I'd pass along the Digi-Key part numbers:

Item	Digi-Key Part Number
18-pin header	S2011-09-ND
18-pin-connector housing	WM2526-ND
Female "pins"	WM2513-ND

The only problem, a minor one at that, is that there is no locking gizmo nor any other kind of polarizing thing. A tiny dot of red nail polish on the housing and on the header should do the trick.
72, Dave, W6EMD

XIT Mod for the Sierra

by Eric Swartz, WA6HHQ
eric@cruzio.com

I mentioned during my talk at Pacificon that I used XIT on my Sierra to help work DX stations. Many have asked for a copy of the circuit, so here it is. Enjoy.

1. Remove S1, and use S1 holes for points "B" and C".

2. Add S2, (Note: up position uses lower pins.)

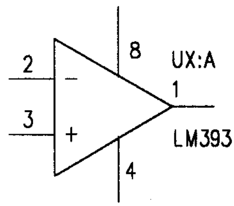
   S2 up = XIT
   Center = Off
   S2 Down = RIT

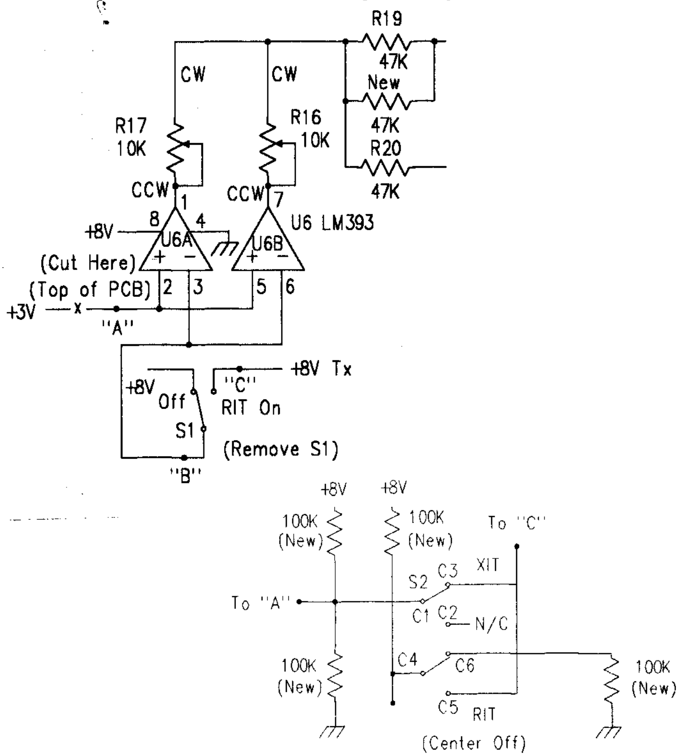
3. Add a 47K resistor in parallel with R19 to increase the RIT/XIT tuning range.

4. Change R16 to a 10K Pot (set at mid range.)

(Note: changing R16 to a 10K Pot allows moving the center of the RIT/XIT range. I typically set it to + 6 kHz, -1 kHz at band bottom).

Notice that the LM393 comparator has an open collector output. When Pin 2 (-) voltage is greater than pin 3 (+); output is Grounded. When Pin 3 (+) voltage is greater than Pin 2 (-); output is Open.





Convert a 49er to a 39er

by Jeff Anderson, WA6AHL
1607 Bonita Ave.
Mountain View, CA 94040
jeffa@ix.netcom.com (Jeff Anderson)

Here is a simple way to convert a stock 49er kit to operation on 30 Meters. Have fun.

C17: change from 270 pf to 470 pf
C18: change from 470 pf to 560 pf
C20: change from 150 pf to 68 pf
C21: change from 5 pf to 22 pf
RFC5: change from 2.2 uH to 0.82 uH
RFC6: change from 15 uH to 10 uH
X1: change from 7.040 MHz to 10.116 MHz

That's it. RFC5 & RFC6 are molded "solenoid" inductors similar in style to those currently used in the 40-9'er. 73, - Jeff

FYBO Winter QRP Field Day

by Joe Gervais, KC7NEV
PO Box 1822
Goodyear, AZ 85338.
vole@primenet.com

Hear Ye, Hear Ye!

Here it is folks, the formal announcement of the event which will prove once and for all that "QRP is not for Sissies." Yes, it's the FYBO (Freeze Your B____ Off) Winter QRP Field Day, sponsored by the Arizona ScQRPions.

1) The words "winter" and "field day" may not seem compatible to some of you. You're thinking of staying home by a warm fire and listening to your Louis Armstrong collection while picking off QSO's. That's fine! But please consider just a few hours in "the field". A park, a patio on the side of ski lodge, whatever. Bring a warm coat, some hot chocolate, the spouse and kids, the dog, whatever helps make it fun and comfortable. Build a snowman to make it a multi-op station. Whatever! (We southern Arizona types have to build our snowmen from tumbleweeds - oh the hardship!)

2) To reward those who venture into the great outdoors (or those with unheated ham shacks), we've added a temperature multiplier. Please note that this is for the temperature AT THE OPERATOR'S POSITION. Stick a thermometer by your keyer, and there you have it. Indoor operators report indoor temperature. Please be fair.

3) We've tried to benefit the Novice/Tech Plus types. One common problem is that nobody spends time in the Novice portion of the band, because there aren't enough signals there, because nobody spends time there, because.... You get the idea. So, all QSOs made in the Novice sub-bands are worth extra points, regardless of who you contact. But if you actually work a Novice/Tech, you get big points. So get ahold of any Novice/Techs you know, sit 'em in front of a QRP rig, and hopefully they'll end up having the time of their lives. This is an experiment that I hope will work.

4) The key word here is FUN. To that end, and to spice things up for all, we've added a random drawing from all logs received. This way even the "little guys" with marginal antennas or rusty skills have a chance at winning something. And that something is a Ten-Tec QRP Xcvr kit, band of your choice. But logs will be cross-checked where possible, so no fair faking one if you don't participate.

Remember, "If it ain't fun, you aren't doing it right!" Cheers de KC7NEV, Joe, vole@primenet.com, AZ ScQRPions #7

QRP CONTEST ANNOUNCEMENT

FYBO Winter QRP Field Day

Sponsored by the Arizona ScQRPions

**** SAFETY FIRST! Please respect the weather and your own limitations. ****

When: 1700Z Feb 22 - 0500Z Feb 23
QRP Only.
Modes: CW, Phone.
Bands: HF, standard QRP calling freqs (no WARC). For Novice portion of bands, suggest 3.710, 7.110, 21.110, 28.110. Work stations once per band.
Exchange: RS(T), state/province/DXCC country, power output, and temperature (Fahrenheit) at OPERATOR'S POSITION. Indoor stations must report indoor temperature.
Example: "RST 579 AZ 2W 58F". Novices sign with /N, Techs sign with /T.
Points:
- 5 pts/QSO with a Novice/Tech ham (i.e. contact a Novice/Tech, get 5 pts).
- 2 pts/QSO in Novice portion of bands with General class or higher ham.
- 1 pt/QSO all other.

Example: W1AW (Extra) completes QSO with KD6PRD (Novice).
W1AW gets 5 pts. KD6PRD gets 2 pts.
Multipliers:
- States/provinces/DXCC countries
- Field Location = x 4
- Alternative Power Source (battery/solar/wind/etc) = x 2
- QRPp (less than 1w) = x 2
- Lowest temperature recorded at OPERATOR'S POSITION while on the air:
  60+ F = x 1
  50-59 F = x 2
  40-49 F = x 3
  30-39 F = x 4
  20-29 F = x 5
  Below 20 F = x 6

Final Score:
QSO points x Multipliers.
Awards/Prizes:
- Lowest operating temperature.
- Most Novice/Tech stations worked.
- Highest score (single op, multi op, Novice/Tech).
- Random drawing from logs received.
- Send 9x12 SASE with log for certificate.

Email vole@primenet.com for more information.
Send logs by Mar 21 to Joe Gervais, KC7NEV, PO Box 1822, Goodyear, AZ 85338.

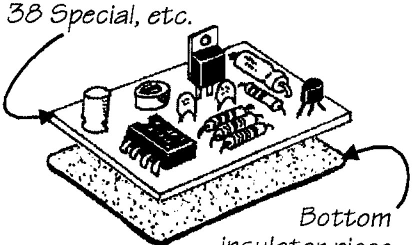
QRP HINTS & KINKS

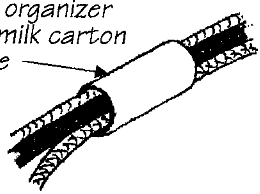
A NorCal Exclusive

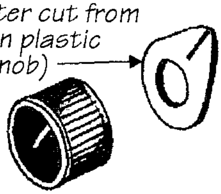
Illustrated by Paul Harden, NA5N

#2 USING HOUSEHOLD ITEMS

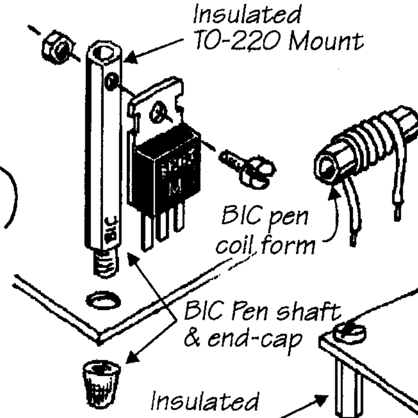
USES FOR MILK CARTONS



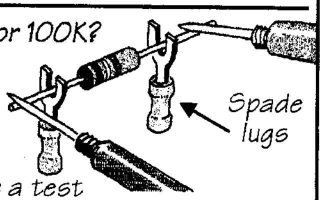




USES FOR "BIC" PENS



10K or 100K?

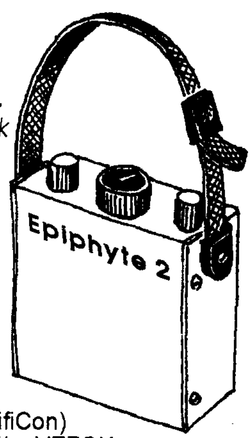


Make a test saddle by mounting spade lugs on solid surface; makes testing components quick & easy.

From Vic Black, AB6SO

EQUIPMENT HANDLES ...

can be made from cloth or nylon adjustable straps sold at many clothing stores, sporting goods, and at stores specializing in camping and hiking supplies. Also back-pack replacement straps which includes mounting brackets and slip buckles.



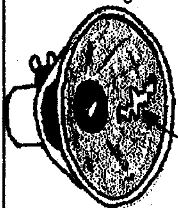
(As seen at PacifiCon)
From Derry Spittle, VE7QK

More QRP Hints & Kinks

Some SPEAKER Hints & Kinks

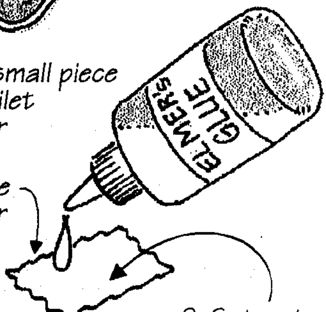
HOW TO REPAIR A TORN SPEAKER
(In the privacy of your home)

This technique works quite well in repairing torn speakers. Some low frequency response might be lost, but hardly noticeable for CW or SSB reception.



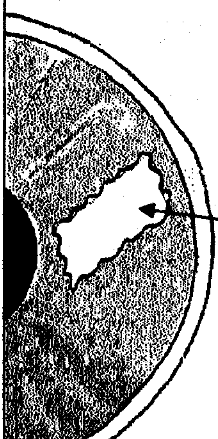
Rip, tear, puncture wound, etc.

1. Cut small piece of toilet paper



tissue paper

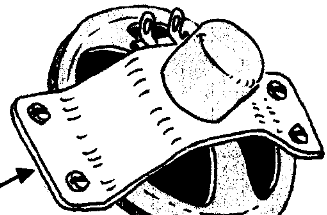
2. Saturate with wood or paper glue



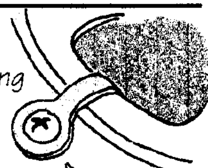
3. Place soaked tissue paper over damaged area like a bandage

4. Repeat for other side of speaker if the damage is severe

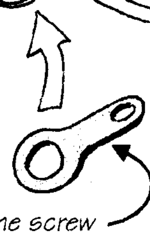
MOUNTING ROUND SPEAKERS (no flanges)



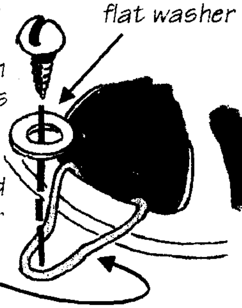
Form mounting "saddle" from milk carton plastic or thin metal from a "soup" can.



Form mounting clips from solder lugs. Be careful to not "poke" the speaker cone.



#6 Solder lug for #6 woodscrew or 6-32 machine screw



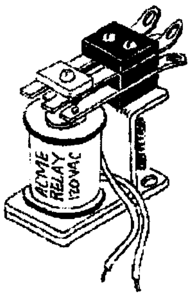
#6 or #8 flat washer

Form 3-4 mounting clips from solid buss wire and secure with wood screws or machine screws.

Send your ideas to:
Paul Harden, NA5N (NA5N@Rt66.com) or Doug Hendricks, KI6DS

More QRP Hints & Kinks

WEEKENDER PROJECT -- Build a nifty cheapie set of keyer paddles



This set of paddles is made from the contacts of an AC relay or old phone jack. Contacts are rearranged, mounted on a base, & secured to table top with suction cups.

Inspite its simplicity, they work well and have an excellent feel!!!

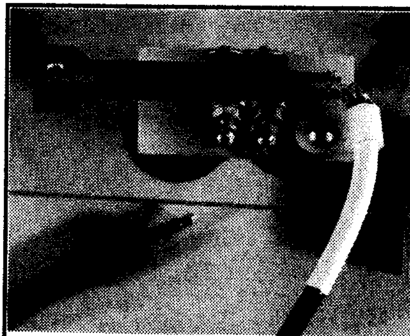
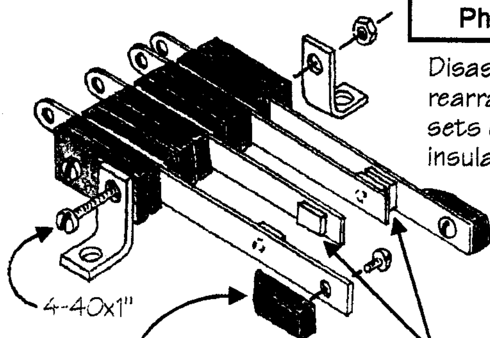


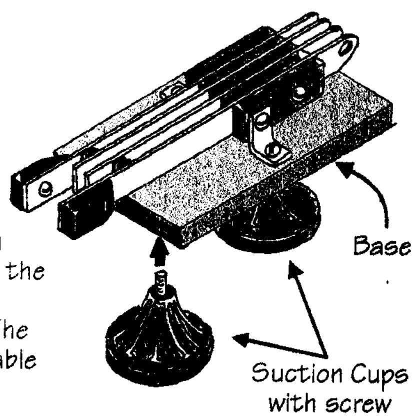
Photo of W6MMA's paddles

Disassemble relay contacts and rearrange as shown, using two sets of contacts and the insulating wafers. Bolt together with long 4-40 machine screw and nuts. Place bracket on one set of bolts for mounting to base.



Form "paddles" with piece of plastic, wood, rubber, etc. to shape & size of preferrence.

Mount completed unit to an insulated base (wood, fiber glass, plastic, etc.) with the brackets. Mount suction cups by drilling and tapping a hole in the base to match threads on the suction cups. Heigth can be adjusted to suit one's "feel." The suction cups secures key to table top for long periods of time.

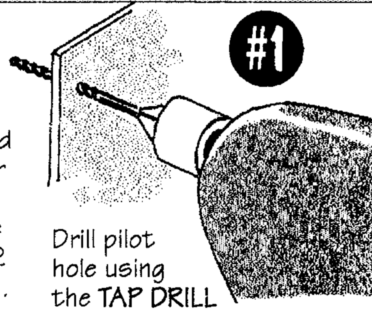


Submitted by: Vern Wright, W6MMA, Placerville, CA

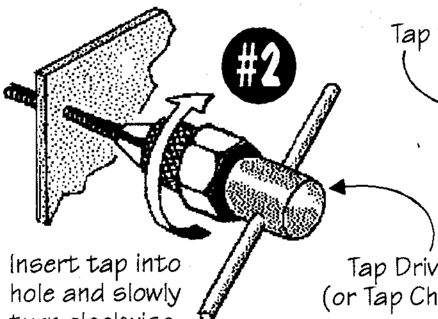
QRP Hints & Kinks

WORKSHOP PRACTICES
Tapping Holes

Buying a couple of tap drills, taps and a tap driver can greatly enhance your metal-working capabilities. The most common sizes for electronic work are 4-40 and 6-32. Drills are $1, taps $2 and a tap driver $5-10.

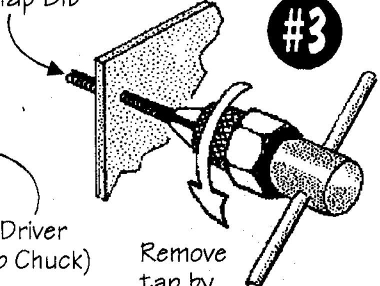


Drill pilot hole using the TAP DRILL

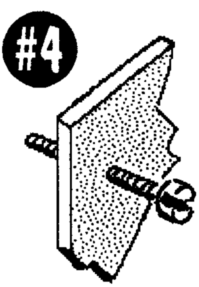


Tap Driver (or Tap Chuck)

Insert tap into hole and slowly turn clockwise. Tap will thread the hole. Use proper tap drill ... a smaller sized drill can cause tap to jam and snap-off.



Remove tap by turning CCW. Remove any burrs on far side that might jam tap.

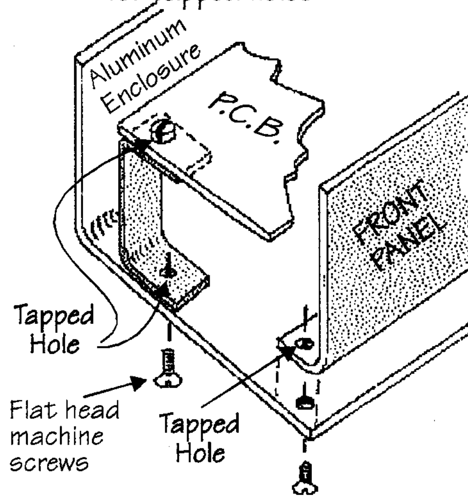


Machine screw can now be threaded into tapped hole.

DRILL SIZES

Size	Tap Drill	Thru Drill
2-56	.070" #50	.086" #44
4-40	.089" #43	.116" #32
6-32	.107" #36	.144 #27

A couple of applications for tapped holes



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Back issues of QRPp are available in bound issues only. Please do not request individula issues, as they are not available. The back issues are printed as sets, and it is just not possible to break up sets.

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1993	Volume I	3 Issues	140 Pages	$10.00	$3
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DX shipping is $5 per issue, with 2 or more issues $10, shipped to Europe, Africa and South America airmail. Shipping to Asia and Australia is $5 per issue, with 2 or more issues $10 shipped surface. Airmail shipping is $10 per issue, with 2 or more $20 for Asia and Australia.

All 4 issues, 1993-96, $60 postage paid, shipped priority mail in the US. $65 Europe, $75 Asia and Australia, Airmail.. US funds only, please make checks and moneyorders out to Doug Hendricks, NOT NorCal. Send orders to:

Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620

Crystals

NorCal has made a bulk purchase of crystals. We now have the following frequencies available: 7.040 MHz., 7.122 MHz (Novice Band), and 10.116 MHz.(30 Meters) the price is $3 each, postage paid. Make checks or money order out to Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620.

QRPp is published at Dos Palos, California 4 tiems per year; March, June, September and December. Subscriptions fee is $10 for US addresses, $15 for Canada and $20 DX per year. To join the NorCal QRP club, send your name, call sign, and address to: Jim Cates. There is no charge for membership to NorCal QRP Club. To receive QRPp, you must subscribe and pay the fees which entitle you to receive 4 issues of QRPp. Send your money (US FUNDS ONLY) to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Please make checks and money orders out to Jim Cates, NOT NorCal.

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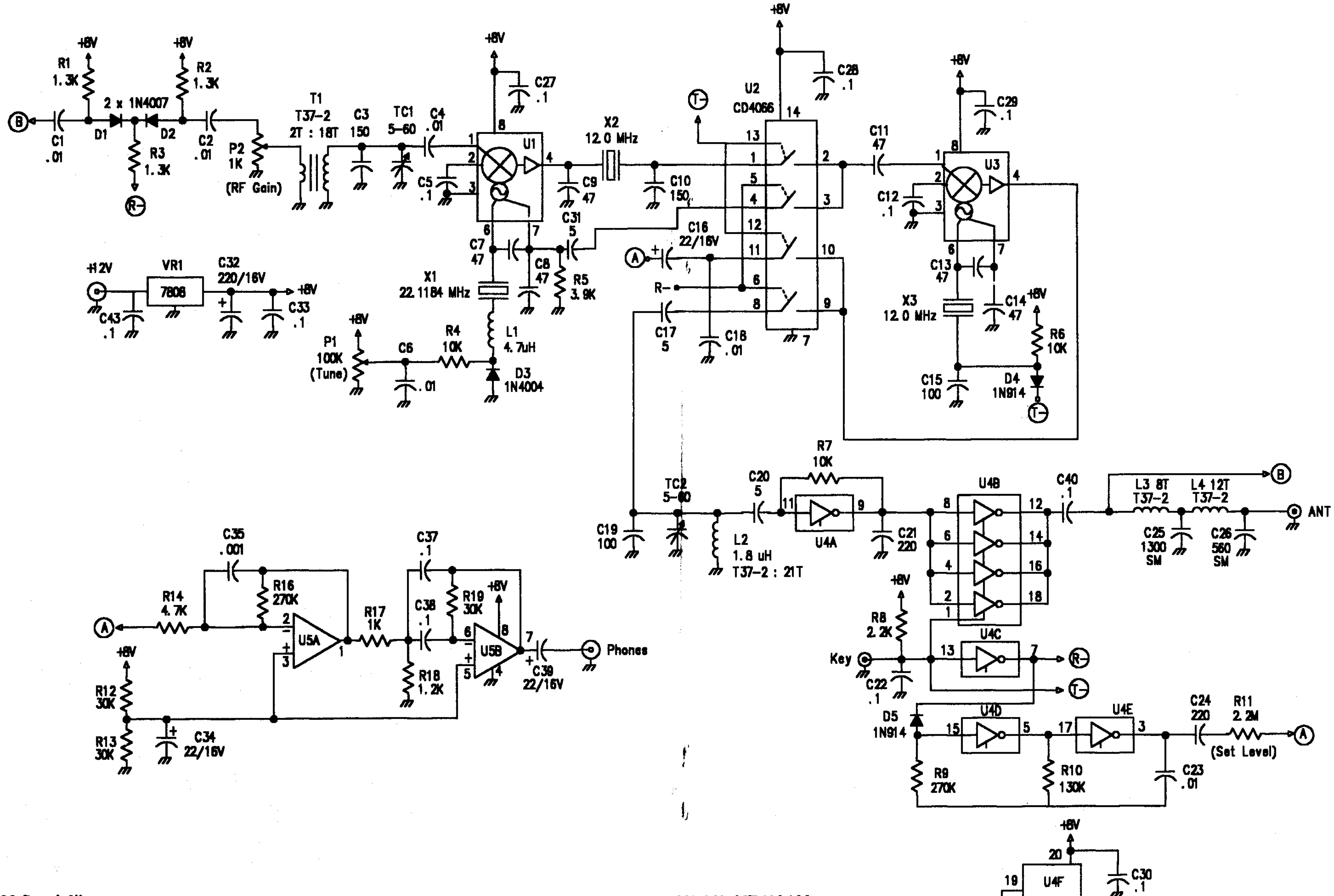

"38 Special"
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Winner of the 1997 Dayton Building Contest Design Contest
Rev. 1.0, Nov. 1, 1996

U1, U3: NE602AN
U2: CD4066
U4: 74HC240
U5: NE5532
Decimal Caps are in uF, All others in pF