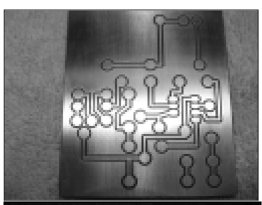
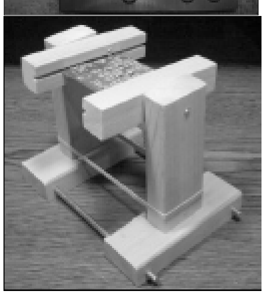
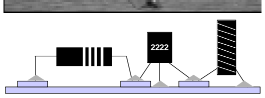
HOMEBREWER
Magazine



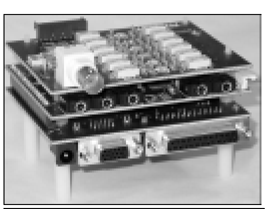
Pittsburg Style
... page 4



PCB Holder
... page 7



Manhattan Style
... page 20



SDR-1000
... page 27

Tuning Up
... page 56

Summer 2003

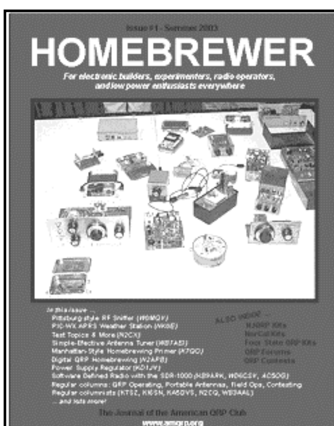
CONTENTS

Features

Columns

Odds 'n Ends

Advertisers



Our Cover ...

John Cawthorne, KE3S is renowned on the east coast for his expert homebrewing craftsmanship. He often displays his customized kits at club meetings and QRP weekends. Our cover this month spotlights the dazzling array of familiar homebrew projects from the KE3S workbench (in order from back left): PSK31 Warbler, Stinger Singer, NJQRP Islander Amp, Pixie, NorCal Epiphyte3, FDIM Power Meter, NorCal BLT Tuner, NJQRP Squirt Tuner, NJQRP Noise Source, KnightSmite, NJQRP Fireball 40, NJQRP SOP Receiver, NJQRP Rainbow Tuner, Marker Generator, FET Voltmeter, NorCal SMK-1, Kitchen Regen Receiver, K8IQY 4017 Transverter, Tuna Tin 2, Twinplex FET Regen Receiver, NJQRP PSK31 Beacon.

From the Editor

Welcome to the premier issue of HOMEBREWER. This exciting new publication, is the journal of the American QRP Club and was formed by the merger of QRP Homebrewer and QRPp magazines. We have some wonderful contributing authors with great material that we know you'll enjoy.

HOMEBREWER is intended to reach homebrewers and QRP enthusiasts alike. Our prime emphasis is naturally on home construction and electronics experimentation, but we also have generous doses of operator news and views, contests and field ops guidance from masters in each area.

In This Issue

We have a great line up of articles, ranging from the simple and fun-to-build, all the way to the advanced projects. K8IQY details construction of the NorCal Keyer project, and K7QO takes us through a primer on Manhattan Style construction techniques. We learn how to build a Class-E amp from W5JH, and how to modify the NB6M Miniboots amp for use with SSB. There's a fabulous discussion of Software Defined Radio and a corresponding technical review of the SDR-1000 transceiver. N2CX initiates his regular Test Topics column, and also provides a solid grounding in the basics of RF power measurement. Our regular columnists start off with a bang with operator news, contests and field operations. Overall, this is a stellar issue!

Our Format

We have several surprises for readers of HOMEBREWER magazine. As touted all along, we will be including a CD-ROM in every 4th issue of the magazine, starting with HB #5, containing electronic versions of the previous issues. In this way subscribers will have all issues conveniently at their fingertips.

We are maintaining an online version of the graphics and photos for all the articles. Each photo and graphic in the articles is presented online in full color and full resolution at www.amqrp.org/homebrewer/extra. What a great way to see additional detail and even new material related to an article you have interest in!

In the Next Issue

Unfortunately there's only so much room available in each issue. Despite the terrific material we've presented here in HB #1, we have just as many contributions that could not be squeezed into the pages this time. As a result our next issue, slated for mailing in November, is already nearly full. We have the second installments for the N2CX "Power Meter Cookbook" and the K7QO "Manhattan Style Primer". We have the entire "PIC-based APRS Weather Station" project from Dave Ek, NK0E, and the entire Digital QRP Homebrewing series from N2APB, including the major addition of the DSP Daughtercard on the Digital Breadboard project. WB7AEI brings us an ATU design, and WA5BDU brings us a piece on "Hacking the K8IQY PVXO". Our buddy from up in Maine, W1REX, has a wonderful piece on converting roadside junk into QRP enclosures. WA2DJN presents a simple universal power supply, while W4WIS illustrates his successes with an NVIS antenna. There is so much to look forward to!

It will take a few issues for our style and format to settle down. Please let us know how we're doing! We hope you enjoy HB #1.

~73, George Heron, N2APB, n2apb@amqrp.org

Introducing ... The American QRP Club

Dear Fellow QRPers,

This is a note from Doug KI6DS, George N2APB, Jim WA6GER, Joe N2CX and Paul AK1P announcing a major new organization specifically designed to enrich our hobby, increase the enjoyment we all get from QRP, and position us well for massive growth envisioned in the years ahead.

On June 4, 2003, we announced the merger of the NorCal QRP Club and the New Jersey QRP Club to form the American QRP Club.

Throughout the last decade NorCal has provided many tangible benefits to the entire QRP community. Over fifty novel and original projects have been designed, kitted and produced for QRPers around the world. NorCal defined and honed the concept of QRP weekends filled with informative and entertaining presentations during the days and fun-filled evening social sessions with the attendees (Pacificon). Further, they've published a quarterly magazine (QRPp) that provides many of us with project ideas, construction techniques and operating guidelines that have pulled newcomers into QRP and have allowed us all to grow over the years.

In many ways the NJQRP has been a sister club to NorCal, having adopted the same operational model during its eight-year existence. This guidance has enabled the NJQRP to grow and become the major east coast QRP presence, providing over thirty new designs and kits, a QRP forum weekend of their own (Atlanticon), a quarterly journal with a predominant homebrewing theme (QRP Homebrewer), and a dynamic and content-rich website that is unrivaled in QRP circles.

Even considering the close association NorCal and NJQRP have enjoyed over the years, much duplication and redundancy has naturally evolved, providing each of the leadership teams with added work, and replicated expenses. Those in our QRP community also pay for these duplication of efforts; for example with subscriptions to multiple QRP journals, overlapping feature material at the QRP forums, and kit designs that are needlessly overlapping and uncoordinated.

The formation and charter of the American QRP Club addresses each of these situations and provides an economy of scale that benefits everyone in QRP today.

COMBINED JOURNAL. We are producing a single journal on a quarterly basis called "HOMEBREWER" that is intended for "builders, experimenters, ham radio operators and low power enthusiasts", just as stated in the journal's subtitle. HOMEBREWER is a larger-format, increased content version of either QRPp or QHB magazine. It is at least a 60+ page magazine containing content-rich homebrewing and construction material, with additional sections dealing with operating, contesting and local club happenings throughout the country. On an annual basis we will issue a CD-ROM collection of the previous four issues, including bonus material: software, tools and reference material . The quality of journal is intended to be first class in every respect, including technical content, editing integrity and journalistic standards. We know the combined subscriber bases of QRPp and QHB will enjoy this publication aspect of the American QRP Club. Members of both clubs today will still receive all issues due – e.g., if one has two issues remaining in a QRPp subscription, and four issues remaining from a QHB subscription, six issues of HOMEBREWER magazine will be entered in the database for the individual. New annual subscriptions to HOMEBREWER cost $20 for US and Canada, and US$30 for DX subscribers. We have not seen price increases in our QRP magazines for many years and this new rate accommodates increased printing and mailing costs today, as well as covering for additional content. Payment should be made out to "American QRP Club" and sent to: American QRP Club, c/o Paul Maciel AK1P, 1749 Hudson Drive, San Jose, CA 95124. Be sure to indicate whether this order is for a new subscription or a renewal, as it will better enable us to record the transaction.

KITTING. The leadership of the American QRP Club has already started combining kitting operations to bring about the economies of scale. What this means is that we're capitalizing on Doug Hendricks's expertise in promotion and parts procurement. We are using and expanding the already-strong NJQRP kitting engine. We are relying on Joe Everhart for technical focus and direction. We are counting on George Heron for editorial strength, kit documentation and website communication from the club. Paul Maciel is the focus for funds and membership management. Jim Cates is providing us the time-proven QRP wisdom and guidance of the ages. We are creating a developer network that will focus and funnel new designs into the kitting operation to provide all QRPers with innovative and well-coordinated projects. Further along these lines, we're strengthening our alliances with our valued QRP vendors and working with them to identify product opportunities for us that fill in the gaps in their product lines and enable QRPers everywhere to best use their products and services.

QRP FORUMS. The American QRP Club will sponsor the highly-acclaimed and premier quality QRP weekends happening on an annual basis: Atlanticon and Pacificon. Each local group, NJQRP and NorCal, will continue to be responsible for planning and execution of their respective forums; however the American QRP Club will fund the activities based on the kitting and journal operations. Substantial guidance and administrative support will be available to each local club to help coordinate and synchronize activities, and to provide similar services and benefits where applicable – e.g., the "forum kit" concept that is so well-received at Atlanticon and Lobstercon will be next used at Pacificon. Arrangements and travel accommodations for guest speakers will be provided, as will be other unique event surprises we have up our sleeves. Going forward, other clubs will be encouraged to align with AmQRP for similar benefit. In fact, the first club to join up with NJQRP and NorCal under the AmQRP umbrella is the Four State QRP Group (4SQRP). They will be hosting OzarkCon next spring with the assistance from AmQRP. A national convention is currently being negotiated and planned. This coordination of these QRP weekends throughout the country is sure to reduce the individual costs of conducting them and will increase the value and benefit for the entire QRP community.

WEBSITE. Communication among all QRPers continues to be of paramount importance. Of course this statement is true by our very nature as RF-oriented hams, but also through our use of email technology and Internet services available to nearly everyone today. The American QRP Club will continue to use the QRP-L email reflector as its primary tool for information exchange and topic discussion. A website has been constructed to reflect the services, goods and technical/operational needs of all QRPers. You can visit our new home at www.amqrp.org. Each local club will of course continue to have their own website presence, as desired, to directly serve needs of that local club, and the AmQRP will be extending its roots here to offer services, kits, QRP forums and special programs to address the youth of America discover the joys of electronic experimentation and ham radio.

LOCAL CLUBS. Both NorCal and NJQRP will continue to exist as local clubs, serving the needs of the local members who gather for meetings, operate as a unit during field operations, have holiday parties together, and so on. The American QRP Club is structured as an overarching umbrella organization to these local clubs with the purposes of: reducing the redundancies of each constituent group, fostering a means for each to better achieve their localized goals of QRP awareness among the ham population, and introducing the youth of America to the joys of home construction and radio sport. This local QRP club scene is incredibly vibrant and is "where it's all happening". We will be encouraging and facilitating other local clubs to join the network of services and values offered by the American QRP Club.

AMERICAN QRP CLUB. We purposely selected the name of the organization as such because we are predominantly an American club, sharing the goals, dreams and passions of our great country. We also have many Canadian members in our club, and the name of our organization can also be extended to represent our valued North American neighbors. We want to be sure that they know that they are valued and welcomed members. The focus of the American QRP Club is on US and Canada, but we will always welcome members from DX countries, just as the G-QRP club welcomes members from the US and Canada to join their organization.

There is so much more that the American QRP Club will be offering over time – this summary merely scratches the surface. Our leadership team has the motivation, the track record, the enthusiasm and the vision to help evolve the QRP community as a whole and create something bigger than any of us have ever imagined. The youth of our population and the public as a whole are all fertile ground for the introduction to the benefits and value of low power ham radio. Education, service, value and enjoyment of radio are our goals. We hope that you'll join us in helping to create this enabling environment in the American QRP Club.

Sincerely yours,

The Leadership Team of the AmQRP …

Doug Hendricks, KI6DS email: ki6ds@amqrp.org
George Heron, N2APB, email: n2apb@amqrp.org
Jim Cates, WA6GER, email: wa6ger@amqrp.org
Joe Everhart, N2CX, email: n2cx@amqrp.org
Paul Maciel, AK1P, email ak1p@amqrp.org

Joe Porter, W0MQY

RF Sniffer *a la Pittsburg Style!*

Here's a variation of the now-classic Manhattan style homebrewing technique dubbed "Pittsburg Style" - - a blend of working with etched pc boards, yet retaining the free-form nature of mounting components. The champion of this technique demonstrates how it is used in this simple and useful project for the beginning QRP builder.

One of the most common elements binding us to this wonderful hobby is the construction of handy and useful ham shack projects. I have been licensed about fifty years so I have been through various methods of building electronic projects. The "good ole tube days" required metal working tools of a different nature. Looking back at the old chassis punch and comparing the punched aluminum chassis with today's "Manhattan Style" approach, you will see quite a difference between the two methods of producing a project. The main thrust of this article is to introduce you to a variation of the now very famous Manhattan Style of construction and to entice you to heat up the soldering iron and build something. The method we will use for this project was dubbed "Pittsburg Style" by my good friend Doug Hendricks, KI6DS and that term seems to have stuck. This method does require a little extra effort if you choose to make the board yourself but it will pay off in construction time and reduction of wiring errors. The American QRP Club has encouraged me to share this method and project with you.

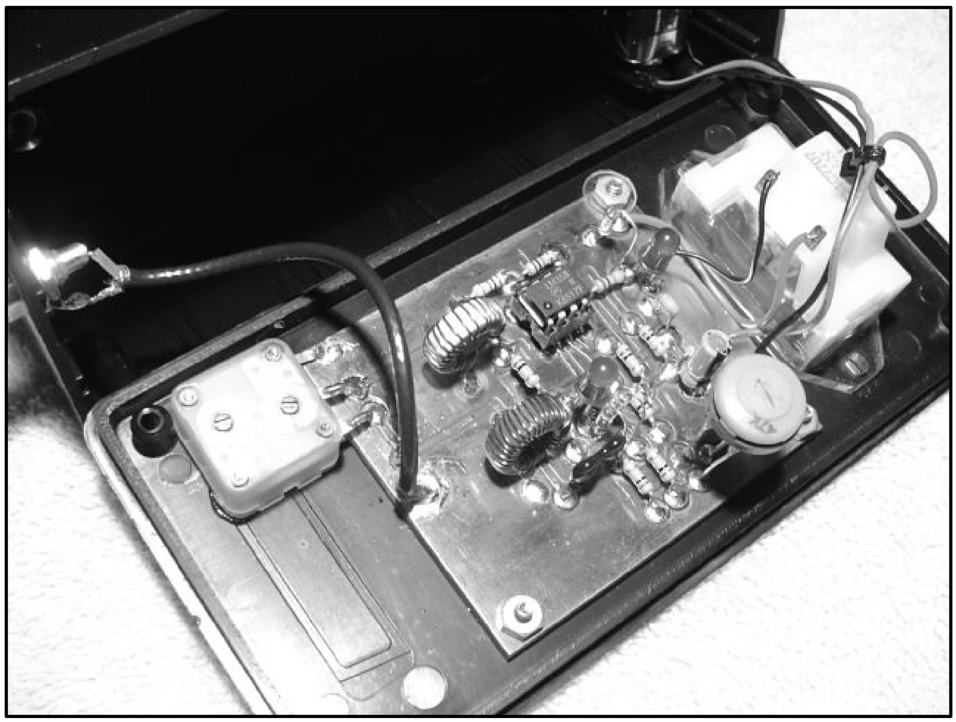


Figure 1 -- Inside view of the NJQRP "Sniffer" Field Strength Meter showing Pittsburg Style board with components mounted to the board.

Before You Begin

If you are new to building electronic projects, then I would recommend you purchase a few simple tools for the job. I prefer a small low wattage pencil type soldering iron in the 15 to 25 watt range, needle nose pliers, side cuts, small screw drivers, and a small roll of rosin core solder. You will of course need to purchase the kit of parts from NJQRP and download the assembly manual from the American QRP web site. A completed model is pictured on the front page of the manual giving you the chance to see the finished product. This classic and very effective way of building can be simplified a bit by using the Pittsburg Style of construction. You will notice from the photographs that the Pittsburg Style board requires no drilling or gluing of punched solder lands to the copper foil on the board. I want to say at this point that the Manhattan Style of building is more flexible for design changes because the solder lands can be removed with heat and repositioned. The Pittsburg Style board is a permanently etched design and not easily modified. I believe the Pittsburg Style board will be easier for the beginner who wants to get his or her feet wet and create a useful tool for the shack with their own two hands. It certainly is a "button popper" when someone looks at your project and says, " WOW, you built that !"

Now for Some Fun

One of the urges that will rise in you is to hurry through the project and get it done so you can turn it on and see it work. I want to warn you up front that "haste does make waste" and if this is your first build it yourself project, then plan to work slowly and carefully. When I begin a project, I always open the bag, lay out the parts and check them against the parts listed in the manual. I also take the manual to a copy machine and make a "working copy" of the parts list and the lay out of the circuit board. (More on this later.) Once a part is located, I take the highlighter and line through it on the working copy in the parts list so that I know that I have located it and what it looks like. This is not only a good method to prevent mistakes but it gives you the chance to get familiar with what the parts look like and how they are marked. I also highlight the part on the "working copy" of the circuit board layout when I solder the part in place on the circuit board. This may seem redundant, but believe me, it will save you many mistakes because it forces you to look at the board, identify the part, and check its orientation if it is polarized (has positive and negative leads). This highlighting method I use also has the advantage of marking your spot when the phone rings or when dinner is ready. It is very easy to come back and pick up where you left off because you can quickly see which parts are highlighted and which are not. I can't emphasize enough to work slowly and check your work. It is such a joy to flip the switch and, in the case of this kit, watch the meter move indicating something is happening.

Soldering Technique

One thing worth mentioning is that copper is pretty when it is shinny and clean but very ugly when oxidized. One method used by a member of our builders group, Jay K0ETC, is to clean and polish the copper circuit paths with fine steel wool and then spray the board with a clear coat of some acrylic product. Now I can just imagine what some of you purists are saying, "Oh my gosh, if you do that it will cause poor solder connections". Well, I tried it, and as Jay said to me "you can heat the land and solder right through the coating". This is only a suggestion to keep your project board pretty and shinny for months ahead and you certainly do not have to do this step it you do not want to. Also, some builders like to go over the entire board and "tin" all of the points that will have components soldered to them prior to actually soldering the components on the board. I tin and solder as I place the parts on the board but that is up to you and your style of building. I encourage you to experiment and see what works best for you. The main objective of course is to produce solder connections that look "wet" and that the solder flows freely indicating temperature is hot enough and that the connection was clean. Poor solder joints will more likely than not be your source of trouble when your project does not work properly. One advantage of the Pittsburg Style board for the beginner is that the land is not nearly as likely to come loose from excessive heat as with the Manhattan Style of gluing the pads on to the substrate surface. I want to emphasize that you should try both methods of kit building decide for yourself which method best suits your style of creating those cool projects.

Figure 2 Basic Tools to Construct the NJQRP RF Sniffer Kit

Finished NJQRP RF Sniffer

I have included a couple of photos here in this article, as well as on the project website (see Notes) to give you some ideas on how to construct your project. The housing for this project was purchased from a local electronic store and is nothing more than a simple plastic box measuring 3" wide by 6" long by 2-1/8" deep. The labels were made with a simple discount house label machine and while they are not professional looking; they do serve the purpose of identifying the operational aspect of the Sniffer. There are many labels available in office supply houses that you can print on with a laser printer in color with fancy fonts and the like if you are so inclined. There are many graphic programs that will do a respectable job of creating a front panel label that looks quite nice and allows you to bring our your artistic ability. The antenna is a random length of hookup wire from the junk box and seems to work quite well with only 6 inches of wire. More antenna would obviously make the instrument more sensitive but it does not seem to need it.

There are numerous ways to package your finished project and I chose this one which allows the unit to be opened for ser-

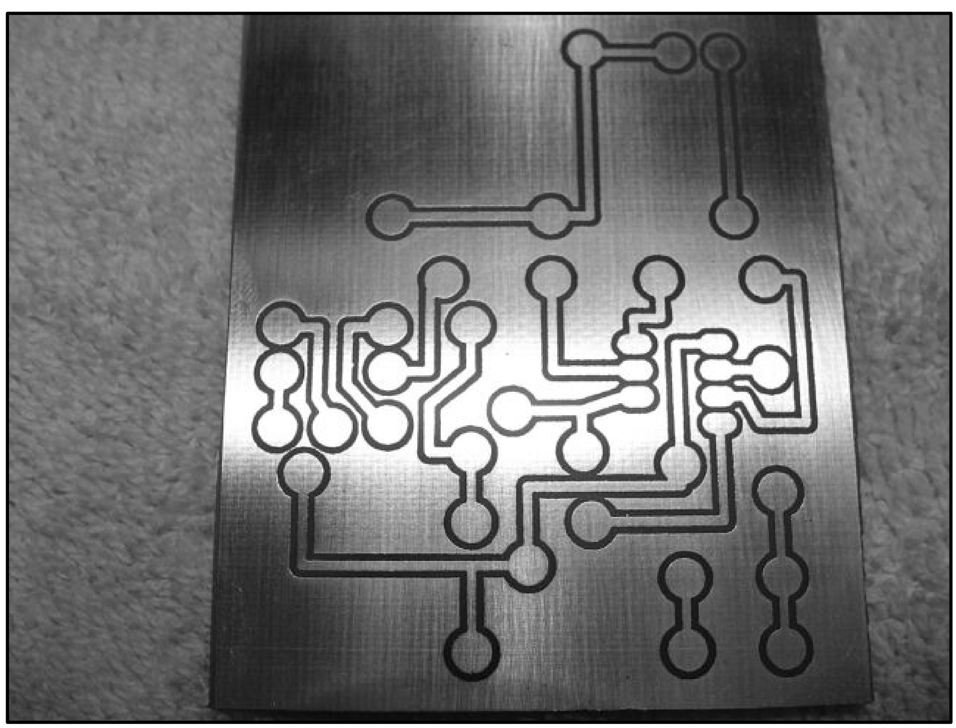


Figure 3 -- The Pittsburg Style RF Sniffer Circuit Board

vice or modification. You will undoubtedly want to create your own design to fit your mode of operation. The enclosure you choose whether it be a commercial one of your own design, will certainly mark the finished project as being your design. Many of you will probably purchase a commercial enclosure but for me there is a great deal of pleasure in creating an enclosure that is totally unique and one of a kind. Software available today makes the job of making smart and professional looking front panels a relatively easy job. I encourage you to give it a try.

You may want to vary your design from mine as the as the visual indicating LED does not show through the front panel. Also the adjusting pot (yellow knob) could be placed off the board and panel mounted so it would be accessible from the front panel. Needless to say, the design is limited only by your imagination and how you use this handy little tool.

Putting the RF Sniffer to Work

The "RF Sniffer" you see on the AmQRP webpage is used in my shack to monitor the output of my PSK31 rig. The little meter sits proudly on my operating table and jumps to life when the transmitter comes on. In the tune position of the PSK31 software, the Sniffer will respond by indicating a continuous tone is being sent to the mike jack of the transceiver. This steady tone allows you to peak the transmitter, adjust the antenna tuning and make sure your station is ready to go on the air. A bonus with this little RF Sniffer I like is that it gives you a visual indication of the tones changing phase by oscillating back and forth in addition to a signal strength reading. I can adjust how much audio drive to put into the transceiver by how much the needle oscillates. This is a very crude method of setting audio levels but on the air tests have proven that when the needle just oscillates slightly from its peak position, I will receive an IMD report in the –23 to –29 range. (Somewhere I heard that is supposed to be good.)

Additional tests have been made with the RF Sniffer by one of our builder's group members, Bill WB0LXZ. Walking around the yard with the RF Sniffer in hand under my trap dipole being fed with 5 watts, Bill reported that the varying degrees of field strength indicated by the Sniffer could be used for antenna pattern measurements.

Summary

Building something of your own is a very rewarding experience. Frustration will haunt you, mistakes will be made, and you will have projects that won't work right out of the box, but that is the way we learn and expand our knowledge of electronics in this great section of our hobby called "QRP". If you have never built anything before and want to try your hand at it, the "NJQRP RF Sniffer" is an excellent kit to get started with. You can develop your building skills with it because it has a minimum number of components, it's inexpensive, and it only requires a few hours of your time to complete. The end result is that you end up with new skills, knowledge, and a handy little tool for the shack. Hope you enjoy building this fine little kit and put it to good use in your shack.

A big thank you goes out to Joe N2CX, George N2APB, and Doug KI6DS for promoting and developing this project. I also want to thank the NJQRP club for the fine kits they produce. I appreciate the support of the American QRP Club in this endeavor.

Our motto at 4 State QRP is " Little Radios, Big Fun". Hope you have as much fun building your Sniffer as did I!

NOTES

1. *You may contact the author by email at w0mqy@mobil1.net or by postal mail at: 306 East Hudson, Pittsburg, KS 66762.*

2. *At the time of this writing, Pittsburg Style circuit boards for the RF Sniffer are available from the author for $5. It's best to check availability by email before submitting orders.*

3. *Information on the NJQRP Sniffer can be found on the Internet at www.njqrp.org/sniffer*

4. *Further information on the RF Sniffer, including the W0MQY "Pittsburg Style" Manual, may be seen on the Internet at www.njqrp.org/sniffer/pittsburg-style_pcb.html*

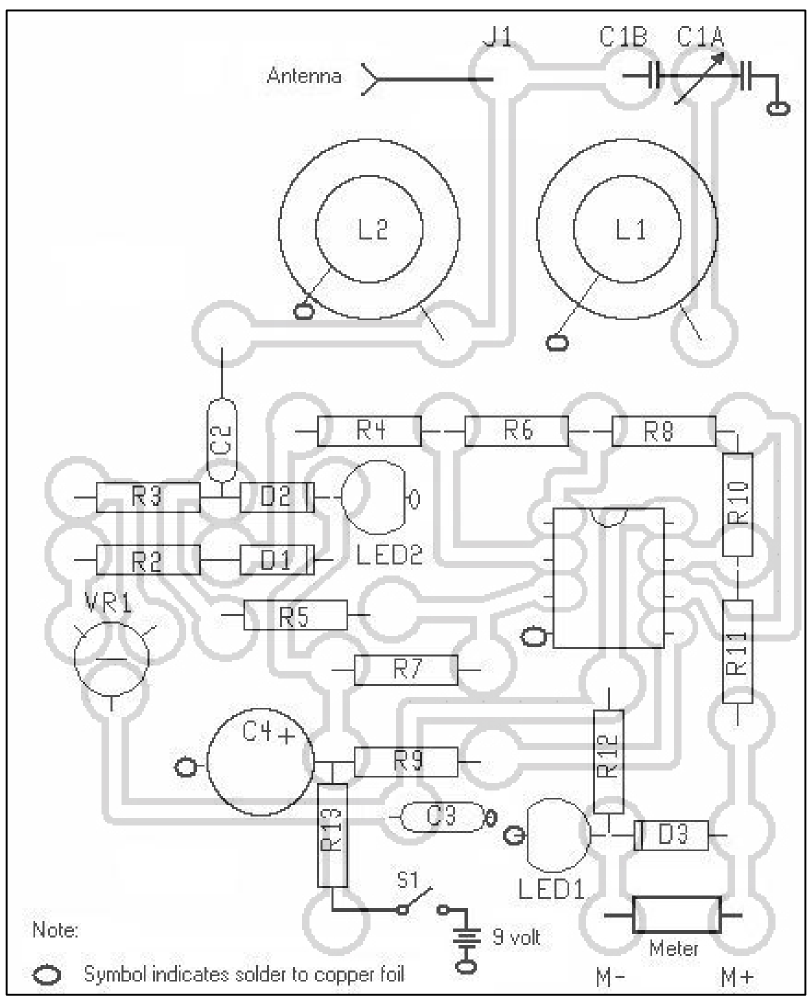


Figure 4: Layout for the Pittsburg Style circuit board used in the RF Sniffer

Steve Sellmeyer, WB0QQT

Homebrew Circuit Board Holder

Have you ever tried holding a pc board while tring to solder on some loose components? Or perhaps prop the pcb up on a screwdriver to get just the right light while looking through a magnifying glass? Here's a custom solution from the Four State QRP Group that's as much fun to make as it is to use.

I often run out of hands when trying to solder components to circuit boards on the bench. I usually need one to hold the pc board at a certain angle to keep the part aligned, another to hang onto the soldering iron, and yet another to feed the solder into the heated joint! It sometimes takes several shots at this procedure until I get the job done to satisfaction. So I figured there's got to be a better way!

Sure, I could get one of those 5-way mini-vises from Radio Shack, but I though I could build a better one that was customized to my needs.

I used common pine for my Circuit Board Holder. Refering to the sketches on the next page, the ¼-inch diameter dowels are of hardwood and a 36-inch dowel costs 49 cents. I bought a bundle of contractor's stakes for $5.97 at Menards; I only need one but I plan to use the rest for other projects. They measure 24 inches long by ¾ inch thick by ½ inch wide. Try to find one with as few knots as possible.

Cut five pieces of the dowel, each measuring 4 inches long by 1-1/2 inches wide. The piece that will contains the two grooves is cut lengthwise in half AFTER the grooves have been cut.

Drill all sliding/pivot point holes with a ¼-inch diameter bit. The holes in the end of the dowels have a 1/16-inch diameter. When drilling the ¼-inch diameter holes, try to be as accurate as you can to keep the holes in alignment and to ensure a smooth sliding operation. I found this not easy to do even when using a drill press. Not to worry though, as a little extra reaming with a hand drill opens up the holes quite nicely. I found that sanding the wooden dowels nice and smooth helps out a lot too. Any wobble or looseness is negligible once the rubber band is put in place.

You can vary the wooden dowel to whatever length you choose. I cut mine to 10 inches long and found that when the sides are fully extended (i.e., when the dowel ends are flush with the outer edges of the base) I have enough room to hold a circuit board up to 6 inches wide.

The main idea was to build something cheap (I know we QRPers are!), functional and simple to build with common tools. The final parts cost was under a buck and it wasn't too hard to make.

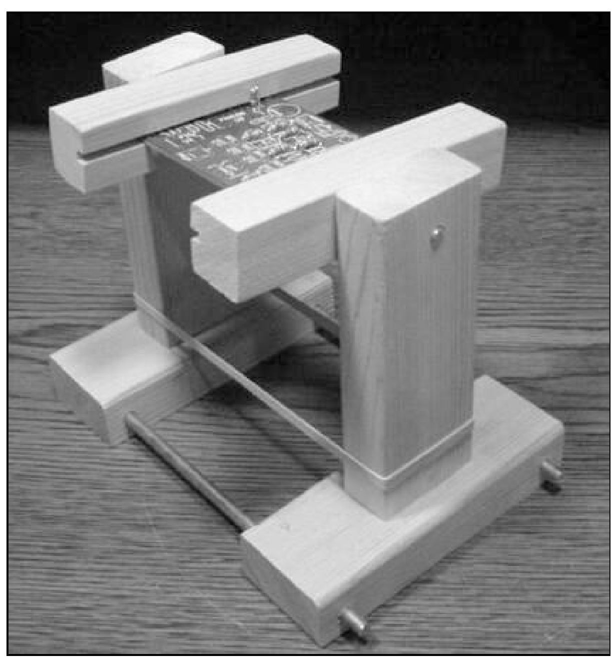
I used scrap pieces of wire through the holes in the end of the dowel. Use whatever you have handy.

After building three different variations of this Circuit Board Holder, I've come to realize that a person could modify the design in many ways to suit personal preference.

Give it a try and I'd love to see what you've come up with.

NOTES

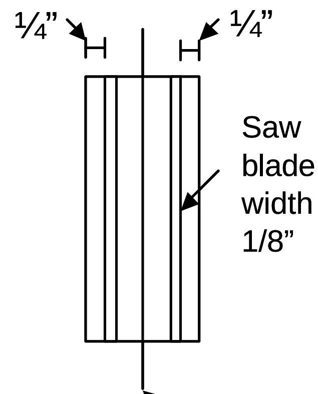
1. *You may contact the author by email at ssellmeyer@inebraska.com or by postal mail at: 5230 Colby St., Lincoln, NE 68504-3041*

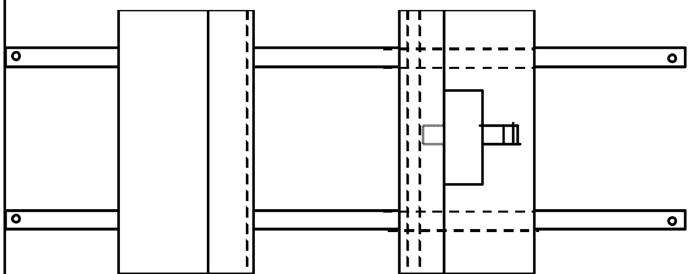


4SQRP Group Circuit Board Holder

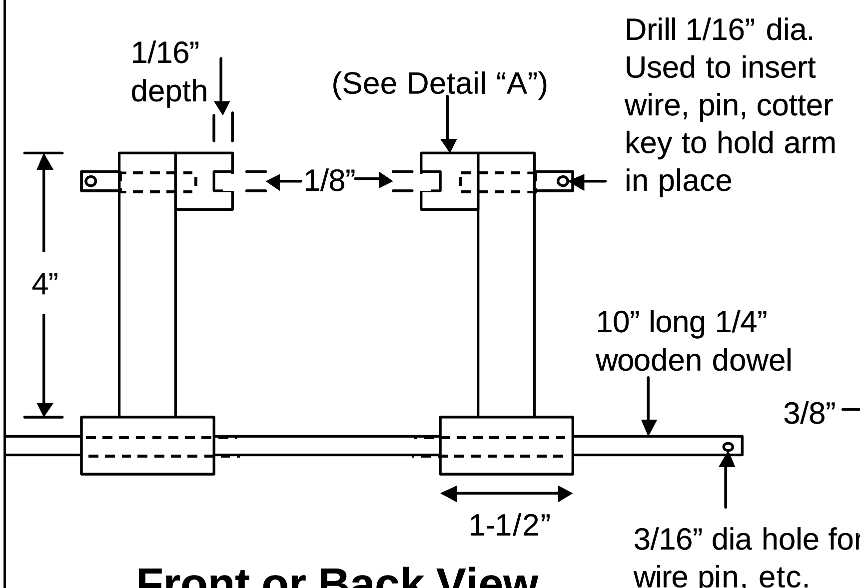
Steve Sellmeyer, WB0QQT

Detail "A"

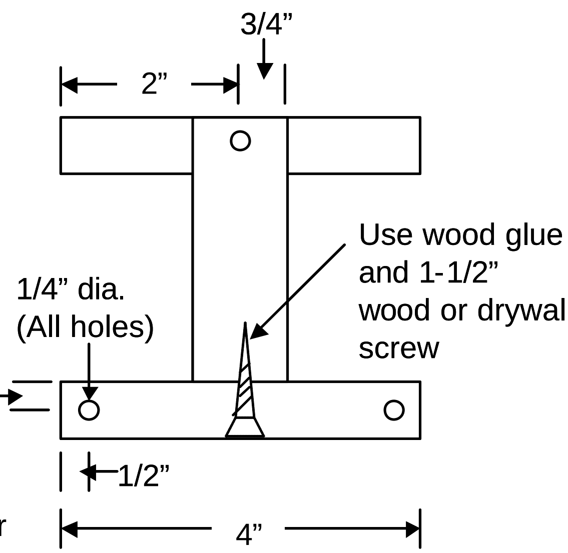




Top View



Front or Back View



Side View

Wayne McFee, NB6M

Modifying the Miniboots CW Amplifier for SSB Operation

On the face of it, turning a class C power amplifier intended for CW operation into a linear amplifier suitable for SSB mode requires nothing more than a biasing circuit that will allow the amplifier to be biased for class AB operation. But is it as simple as that? What are the practical considerations of making the change?

This article shows you how to modify my original Miniboots Amplifier design to be able to operate linear modes such as SSB and PSK31. NorCal kitted my design -- see Note 5 at the end of the article for technical details and information on how to obtain the kit.

As with any solid state circuit heat is the enemy, even though the transistor used in this case is the fairly rugged IRF510. Forward biasing the amplifier in order to place it in class AB operation necessarily raises the quiescent current through the device. In this case, the minimum current required to produce reliably linear amplification is 100 milliamps[1]. Will that change alone require a commensurate increase in size of the heat sink for the transistor?

In some published amplifier circuits[2], the biasing circuit is activated only during transmit, so that there is no current running through the amplifier during receive periods. Will that be necessary in this case, in order to reduce heating?

Will temperature compensation be required for the biasing circuit in order to prevent thermal runaway and destruction of the IRF510?

In order to reliably amplify an SSB signal, the amp needs to remain linear so that there is no discernable distortion of the signal. This means that both the quiescent current through the transistor and the temperature of the transistor need to be kept within practical limits.

In this case, the Mosfet used, the IRF510, is fairly rugged and is relatively immune to thermal runaway[3]. Temperature control of the device, and therefore quiescent current stabilization, is accomplished to a practical level by simply providing sufficient heat sinking. This means both providing a heat sink of sufficient size and paying close attention to details such as providing heat sink compound, ensuring that the transistor bolts tightly to the heat sink, and ensuring that there is full contact between the transistor, the TO-220 insulator and the heat sink in order to maximize heat transfer.

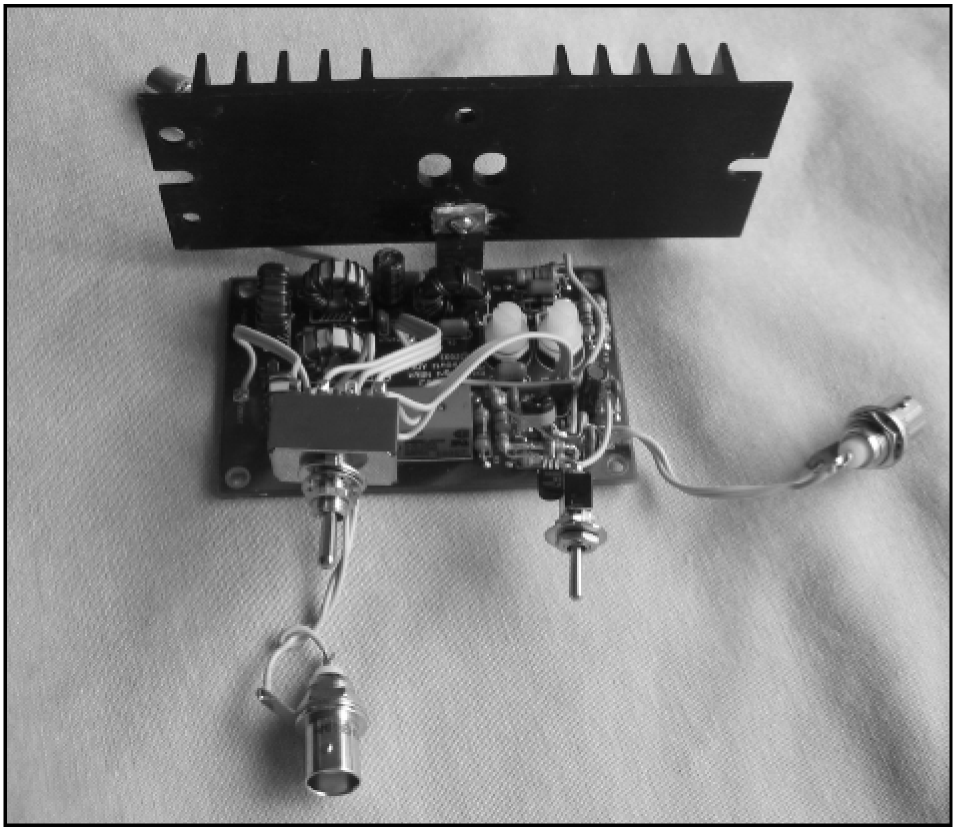


Figure 1: Miniboots SSB/CW Version, PSK-31 Ready

Simply bolting the transistor to an aluminum case, utilizing the insulator provided, is not going to be enough, especially if you want to operate the Miniboots amp in a 100% duty cycle mode such as PSK-31.

For initial testing, a simple biasing circuit, consisting of S1, R12, D5, RV3, and C20, was added to the Miniboots amp, as shown next in Figure 2.

In order to add the biasing circuit, the normally grounded end of R7 was lifted from the corresponding hole in the circuit

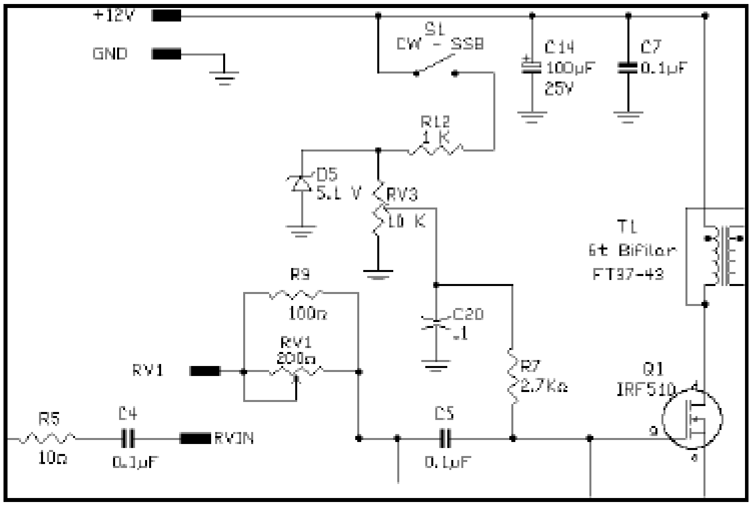


Figure 2: Simple biasing circuit is added to the Miniboots design

board and a short length of hookup wire was connected between the lifted end of R7 and the junction of C20 and RV3, as shown in below in Figure 3.

The additional components needed for the biasing circuit and T/R switching could be added to the Miniboots amp in a variety of ways, including making use of a small "daughter board", which could be attached to the inside of the case. I chose to use the "Ugly" method, as will be shown later.

A Milliammeter was connected in series with the DC supply line, and the quiescent current set at 100 milliamps.

In tests conducted both off and on the air, while monitoring both quiescent current through the amplifier and heating of the Mosfet, it was found that, with just one TO-220 type aluminum heat sink bolted directly to the transistor, in the open air, the quiescent current remained below 150 milliamps during reasonable length transmit periods, and returned to the 100 milliamp level during receive periods. This indicated that a larger heat sink might well keep device heating, and, therefore quiescent current, well under control.

Monitored audio quality of off the air tests indicated no distortion. All stations contacted in on-the-air testing were asked to make a critical report on audio quality, and all responded with favorable reports.

Once initial testing was done, Q3 and R13 were added to the circuit in order to have the bias circuit switched on and off for transmit and receive periods, respectively. By doing this, not only is current drain minimized, but cooling of the Mosfet is enhanced, by virtue of its not carrying 100 milliamps of quiescent current during receive periods, as shown in Figure 4.

Following the "Ugly" method of construction, the grounded ends of D1 and R4 were used as attachment points for the grounded end of RV3 and the grounded ends of C20 and D5. See Figure 5 on the next page for clarification.

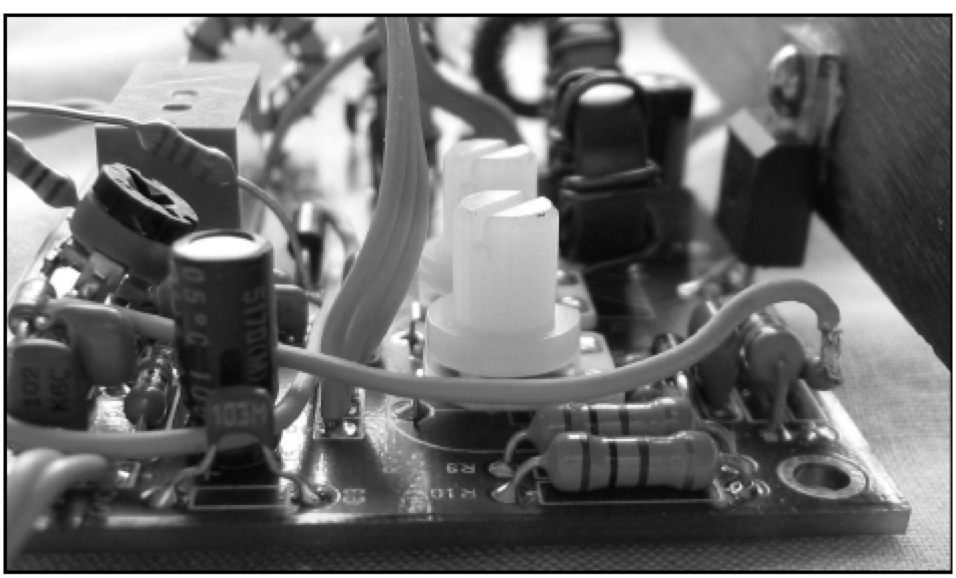


Figure 3: One end of R7 is lifted and connected by hookup wire to C20/RV3

Because of the low current requirements of the Mosfet biasing circuit, all resistors used are ¼ watt units, and RV3 is a subminiature trimpot.

As seen in the initial picture of the SSB/CW modified Miniboots, a relatively large heat sink was bolted directly to the metal tab of the IRF510. This was done to test the feasibility of operating the amplifier in PSK-31 mode.

This heat sink has a body that is .125" thick, is 1.75" high, over 4.0" wide, including its attachment wings, and with ten ribs which stand out .375" from the main body of the heat sink. This is a little bit of overkill, but what it did prove was that by using a large enough heat sink, the Miniboots Amp with the SSB Mod could be used as a linear for PSK-31 operation. The Mosfet only got detectably warm during long transmission periods in that 100% duty cycle mode.

The entire SSB Modified Miniboots circuit is shown in Figure 6.

As always, testing and modification will continue. If you choose to add this simple biasing circuit to your Miniboots Amplifier, I recommend first adjusting the output level for no more than 5 Watts. You should also perform enough testing to be sure that the heat sink you are using is up to the task of keeping the Mosfet at a reasonable operating temperature. This will help ensure that your signal remains undistorted and the transistor is protected from destruction.

I am pleased with the experimental results so far! It shows that the Miniboots can be a very useful addition to the QRP SSB voice and digital modes of operation as well as for CW. I hope your results will be as good as mine.

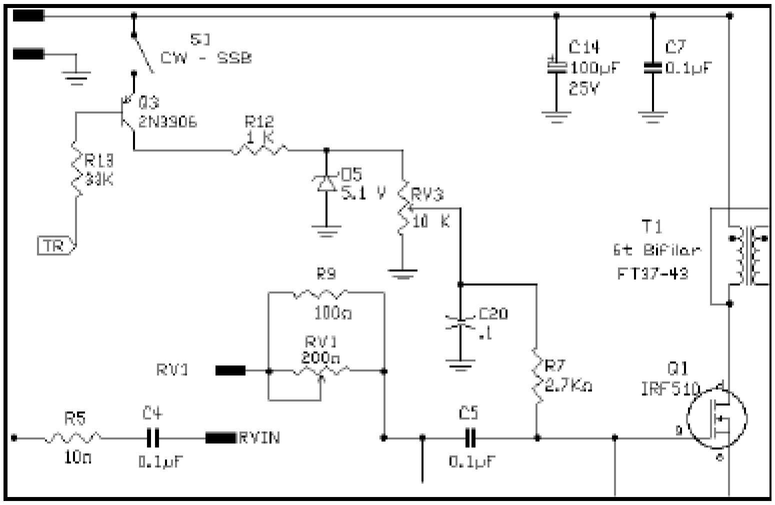


Figure 4: Q13, R3 and S1 added to allow switching bias circuit on/off during Tx/Rx periods

NOTES

__1.__ Hayward, Wes, W7ZOI, Experimental Methods in RF Design

__2.__ Hayward, Wes, W7ZOI, Lewallen, Roy, W7EL, DeMaw, Doug, W1FB, various publications

__3.__ DeMaw, Doug, W1FB's Design Notebook

__4.__ You may contact the author by email at NB6M@aol.com, or by postal mail at: 2379 Saint George Drive, Concord, CA 94520.

__5.__ The original Miniboots Amp Kit provides a full "QRP gallon" (5-Watt output) from a 750mW-to-1W input CW drive signal. It comes with BNC connectors, all board mounted parts and a high quality silk screened, solder masked, plated through hole pc board. All you have to add is the power connector of your choice and a case. See full kit details and ordering information on the AmQRP web site at http://www.amqrp.org/kits/miniboots/index.html.

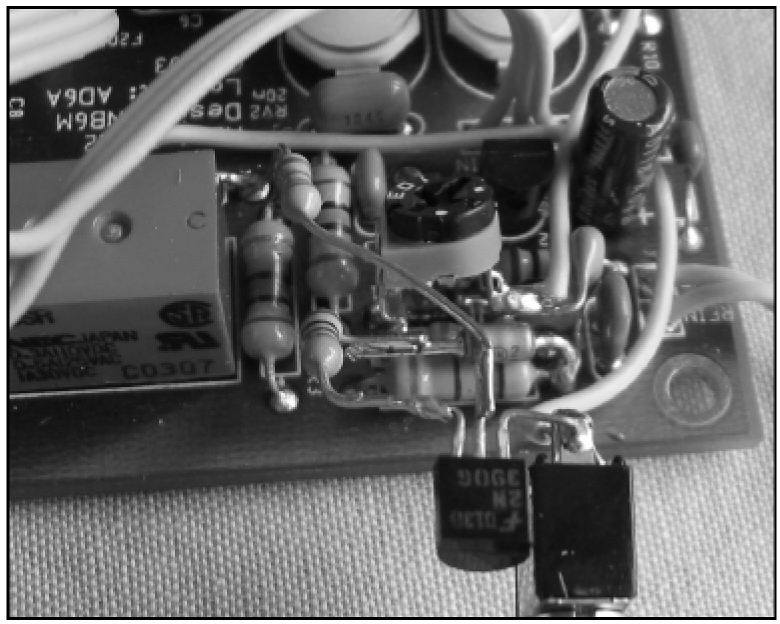


Figure 5: "Ugly" construction techniques shown here for D1, R4 and RV3. Also shown here is Q3 mounted by its emitter to the back of S1, with R12 connecting its collector to the junction of D5 and RV3, and with one lead of R13 shown connected to its base.

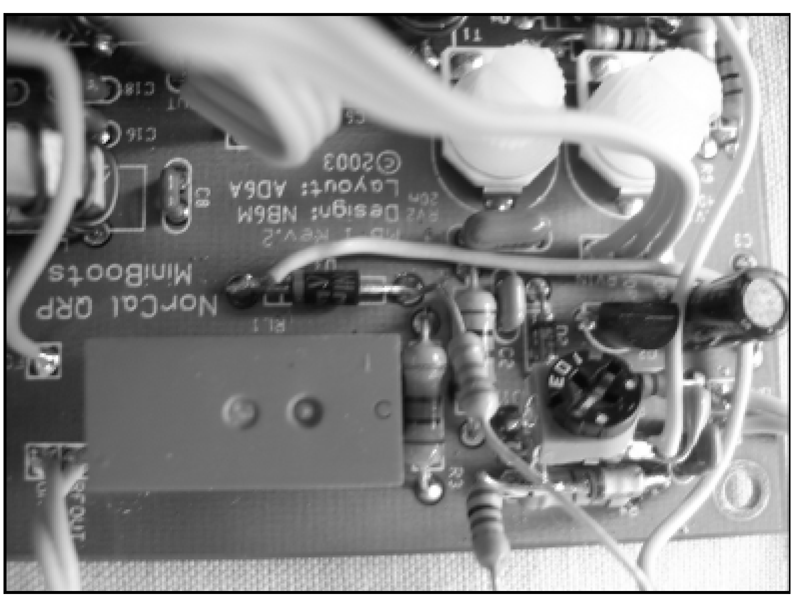
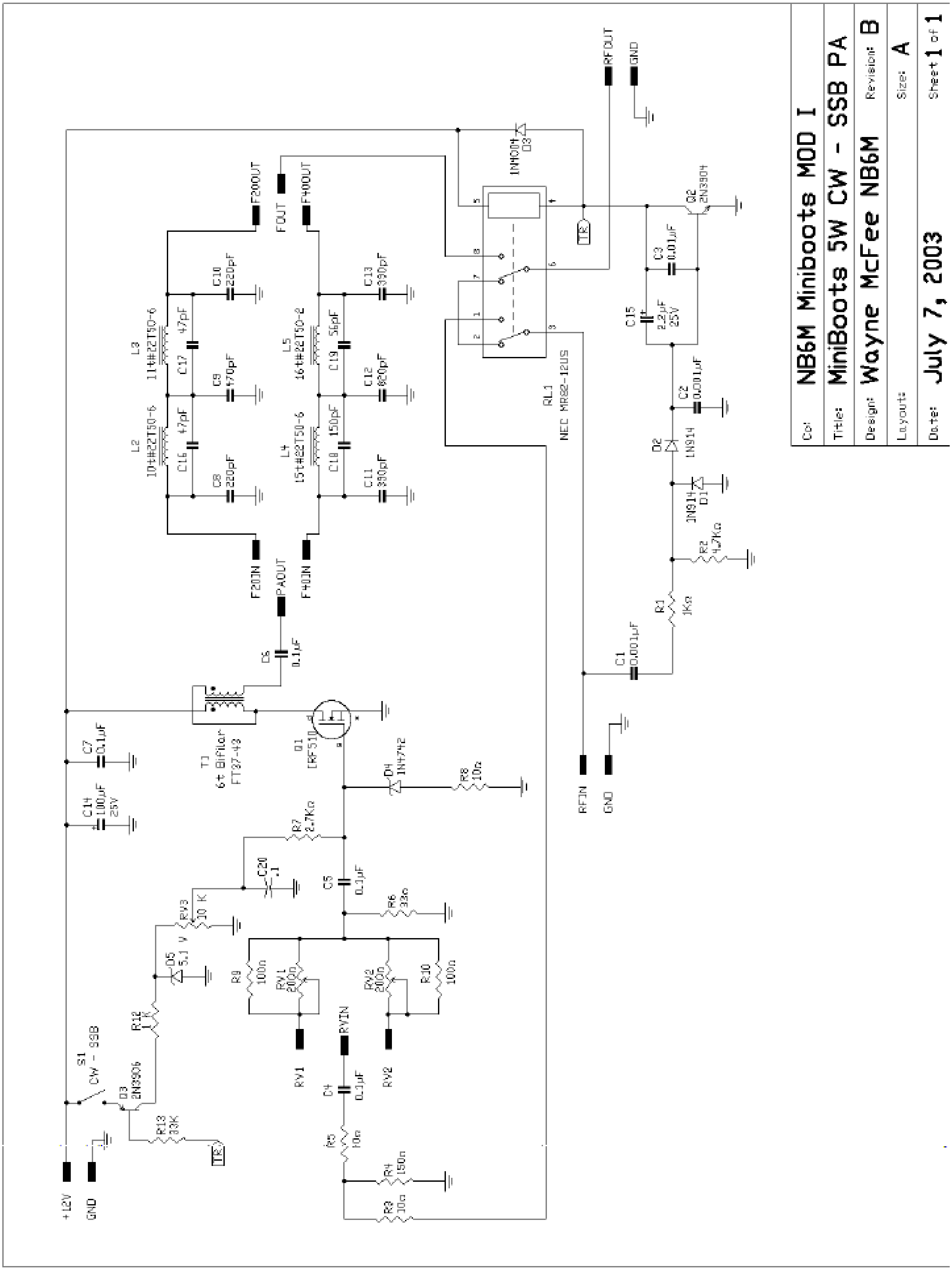
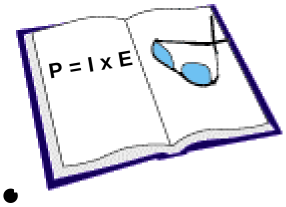


Figure 6: The cathode and anode of D3 were used as attachment points for the 12 Volt and T/R lines running to S1 and the base of Q3. This photo also gives another view of the attachment points of C20, the 0.1 cap in lower right, RV3, the 10 K trimpot, and D5, the silver diode below RV3. Also shown are R13, the 33K resistor connected from the anode of D3 to the base of Q3, and R12, which goes between the collector of Q3 and the junction of D5 and RV3.


NB6M Miniboots MOD I
Title: MiniBoots 5W CW - SSB PA
Revision: B
Design: Wayne McFee NB6M
Size: A
Layout:
Date: July 7, 2003
Sheet 1 of 1
RFOUT
GND
RFIN
+12V
F20OUT
F40OUT
FOUT
F20IN
F40IN
PAOUT
RL1 NEC MR82-12US
1N4004 D3
Q2 2N3904
Q1 IRF510
Q3 2N3906
T1 6t Bifilar FT37-43
D4 1N4742
S1 CW - SSB
RV1
RV2
RVIN

Joe Everhart, N2CX

RF Power Meter Cookbook Part 1: Measurement Techniques



Transmitted power is surprisingly tricky to measure -- especially so at QRP levels. N2CX starts us on a two-part exploration of this popular subject by overviewing basic techniques and nuances of low power measurement, with a generous dose of reference material for further study. Part 2 will present a unique working design.

This Cookbook is a two-part article that discusses a number of methods for RF power measurement. Part I outlines techniques that can be used and attempts to give a feel for which ones are practical when using different kinds of RF wattmeters. In a follow-on issue, Part 2 will present complete working circuitry with enough detail to duplicate the designs. The digital platform used for the design examples will be the Parallax BASIC Stamp 2 as employed in the NJQRP QuickieLab[19]. This is done to establish a baseline that is simple to understand. Sufficient detail of the underlying principles and software routines is given so that those familiar with simple microprocessors should be able to integrate the measurement circuitry with their microcontroller of choice.

Part 2 will also describe calibration methods that can be employed to assure functional circuits and to gauge their performance. The emphasis overall will be to provide descriptions and theory in enough detail that the average homebrewer can understand underlying principles. References will also be provided for those who want to dig deeper into the nitty-gritty details.

Back in the early days of radio, measurement of RF signal characteristics was difficult to do with accuracy and precision. Obtaining measurements was a complicated process that required special equipment and skills. Two important characteristics that fell in this category were operating frequency and power level. Digital and IC technology advances have now made short work of frequency measurements. In fact QRPers are familiar with single chip AFAs (Audible Frequency Annunciators) that combine frequency measurement with an audible Morse output.

Some of the same advances can also be used for RF power meters. In the pre-WW2 days hams often estimated transmitter output by feeding them to light bulbs and gauging filament brightness. No one knew or cared about SWR. Matching of a transmitter to a skywire was determined by measuring RF current in the antenna, or by using a costly hot-wire ammeter, or by observing the glow of a neon bulb held next to the antenna wire. In fact RF power measurement was so uncommon that FCC regulations specified DC power into transmitter final amplifiers rather than the RF power produced.

The Oak Hills Research WM-2 was designed specifically for the QRP operator. The unit operates from 300 KHz to 54 MHz. It will measure forward and reflected power at QRP levels down to 5mW. (See www.ohr.com)

Definitions

Let's look at definitions so that we can get started. More definitions will be given later as necessary. We'll hop right in and begin though things will be a little circular until the process is finished. Many of the terms are discussed in great detail in the ARRL Radio Amateur Handbook and Antenna Handbook, so if you want a complete understanding please refer to those references.

RF power will be assumed to be the usually sinusoidal output of a transmitter. A steady carrier or CW signal is easiest to measure although later on we will also look at methods of measuring the PEP, or Peak Envelope Power of SSB and AM transmitters. Though we will limit the discussion to QRP power levels of 10 watts or less, the same techniques can be scaled to higher powers.

We will be looking at two basic classes of RF power meters. The first is a **terminating wattmeter**. It contains circuitry to measure power and display results, in addition to having a resistive termination that takes the place of an antenna. This resistive termination is a power resistor or combination of resistors called a **dummy load**. For our purposes it will have a resistance of 50 ohms and a high enough power dissipation rating that it can handle the full power for which the meter is rated. Terminating wattmeters are commonly used to check power output when tuning up or troubleshooting a transmitter. Using a dummy load assures the proper termination for the transmitter and gives the ability to check output power without actually putting a signal on the air.

Terminating wattmeters are not common in commercial products due to their limited usage, the high cost of the dummy load, and the large amount of heat generated. Often the load is separate from the power meter as shown in Figure 1. Accurate power measurements depend on a known load impedance. It is quite practical and useful at QRP levels to combine them in one device.

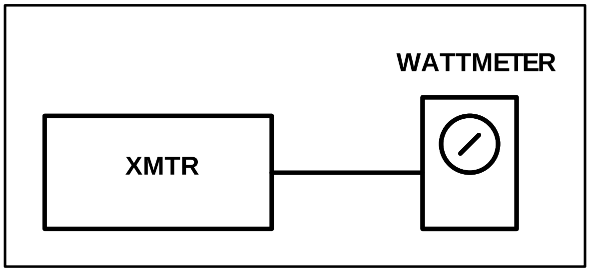


Figure 1 - Termination Wattmeter usage

The second type of wattmeter is called an **in-line** or **directional wattmeter**. In addition to measuring RF power, it also allows measurement of reflected power from imperfect loads to determine the degree of impedance matching. It can also be built as an SWR meter to give a numeric indication of the match or mismatch. In-line wattmeters are connected between the transmitter and load as shown in Figure 2. The load can be a dummy load, an antenna or some matching device connected to an antenna. The in-line wattmeter is generally used directly at the transmitter output to determine the quality of the match presented to the transmitter.

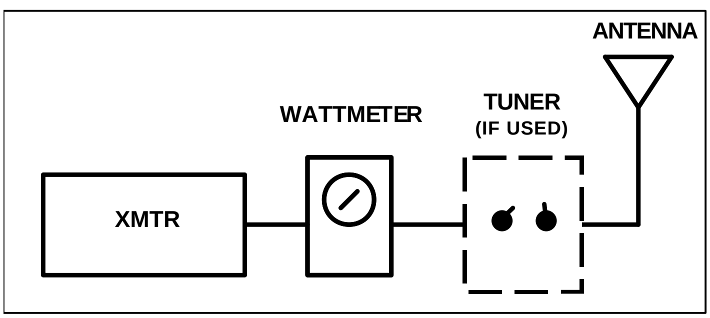


Figure 2 - In-Line Wattmeter usage

Impedance is the characteristic that relates voltage and current in a feedline or load. You can think of it as RF resistance, though things are a tad more complex (I know, bad pun…). We will concern ourselves with resistive 50-ohm loads and simply note that any deviation from this resistance or presence of any uncompensated inductance or capacitance in the load impedance will result in a mismatch.

SWR or **Standing Wave Ratio** is a measure of impedance matching. RF power sent up a transmission line from a transmitter is called **forward power** or **incident power.** If the feedline goes to a load whose impedance is matched to the feedline, that's the end of the story. However if the load is not an exact match, a fraction of the power is sent back down toward the transmitter. This is termed **reflected power** and the amount reflected is proportional to the degree of mismatch.

What happens is that the forward and reflected power add along the transmission line to form a stable standing wave of energy. Where the voltage of the forward and reflected power components are the same polarity, they add up to form a net voltage greater than the forward power alone could produce. At points were they cancel, the net voltage is lower. The ratio of the two voltages is called the **reflection coefficient** and given the Greek symbol *p* (rho). As we shall see later, the reflection coefficient is used to calculate the SWR. As an engineer, I have to say that this discussion is about voltage standing waves and strictly speaking we should talk about Voltage Standing Wave Radio. For simplicity we simply use the term SWR.

A perfectly matched load results in a 1:1 SWR, while increasing mismatch results a larger second number. A complete mismatch gives reading of 1:infinity, a not too useful situation since no power is transferred to the load!

RF Power Detectors

One of the most important elements of any RF power meter is the RF detector. One has a variety of choices here. Lab grade RF meters often use thermal and thermoelectric techniques that are very attractive for precision measurements. This is because their characteristics are based directly on physical principles and calibration is assured using techniques common in that environment. Examples of these conceptually-simple-but-sophisticated devices can be found in Reference 1.

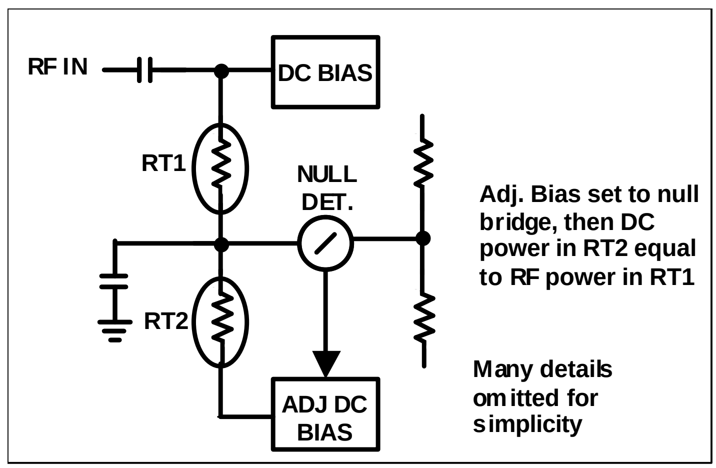


Figure 3 - Thermistor RF Power Detector

A short description will be provided here for the curious, however **much** more detail can be found in Reference 1. The first method uses matched thermistors in a bridge configuration. Thermistors are small resistive devices whose resistance changes with temperature; see Figure 3 for a conceptual sketch. One arm of the bridge (RT1) is fed both the RF to be detected and a DC bias. The other leg (RT2) is fed a DC bias only. The RF current and DC bias cause self-heating in the RF leg while the heating in the other leg is due only to the DC bias. The self-heating changes the thermistor resistance and the bias to RT2 is adjusted by meter circuitry so that the two resistance are equal, balancing the bridge. The DC power can be determined very accurately and if the bridge is constructed properly, the DC power in RT2 is exactly equal to the power in RT1. Calibration is done without the need for RF power sources since a known DC power can be fed to RT1 in place of the RF. Yet another advantage of this method is that since the RF is converted to power by the thermistor, the measurement is the average power applied to the sensor with no need to take into account signal modulation. The downside is that these sensors operate only at milliwatt levels due to their fragility and construction of thermistor bridges is difficult for the homebrewer.

The second method described in the reference is also based on simple physical principles. It passes the RF signal to be measured through a physically small resistor that is in close thermal contact with a specially constructed thermocouple. Actually a pair of resistors and thermocouples is used (See Figure 4). Each thermocouple consists of a junction where two dissimilar metals are in contact. The metals are chosen to generate a small DC potential directly proportional to the temperature of their junction. The voltage produced is very closely known and proportional to the power dissipated in the RF-powered resistors. The net DC voltage is taken from the RF decoupling capacitor. As with the thermistor method, the DC output level is directly proportional to the RF input power. Calibration is similarly quite exact in principle. Unfortunately the thermocouples are even more difficult to make without sophisticated manufacturing techniques. Even if they were available, the DC voltages produced are so low that exotic materials (gold conductors!) and very precise low drift amplifiers are required.

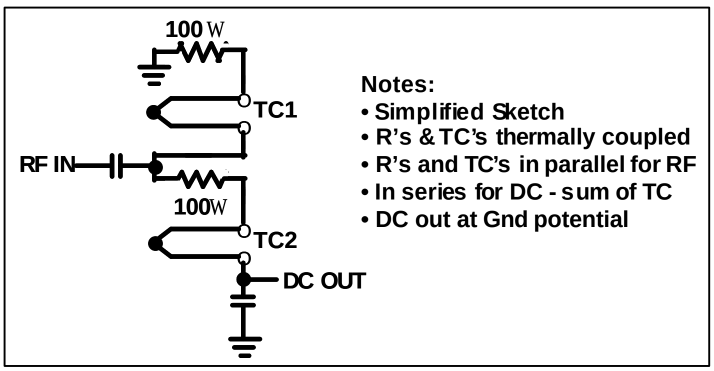


Figure 4 - Thermocouple RF Power Detector

A much more practical approach to RF detection is to use a semiconductor diode. Diodes have the characteristic that they conduct current easily when a positive voltage is applied to the anode and they do not conduct when the voltage is negative. Figure 5 shows the circuit and Figure 6 shows a plot of the forward current vs. applied voltage. If diodes were perfect, they would conduct exactly at the point where the voltage went positive and shut off with negative voltage. Unfortunately the perfect diode has yet to be built.

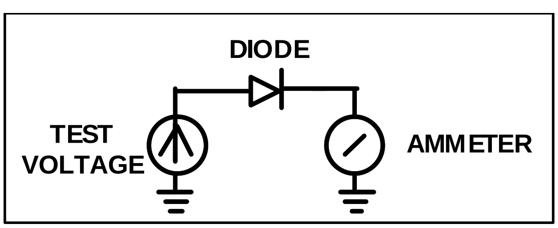


Figure 5 - Basic Diode Test Circuit

You can see in Figure 6 that there is a "knee" in the positive voltage part of the curve and a small leakage current flows with negative applied voltage. Germanium point contact diodes (e.g., 1N34) have a "knee" at about 0.2 volt and a reverse-bias leakage measured in microamps. Silicon junction diodes (e.g., 1N4148) exhibit a knee voltage of about 0.6 volt but their leakage is usually much better, measuring only in the nanoampere or picoampere region. Schottky diodes (e.g., 1N5711) are also constructed of silicon but their construction gives a knee that is intermediate between germanium and ordinary silicon junction diodes. Reference 1 also lists some specially-prepared Schottky diodes with even better conduction characteristics though they are much less common than the usual small signal Schottky devices.

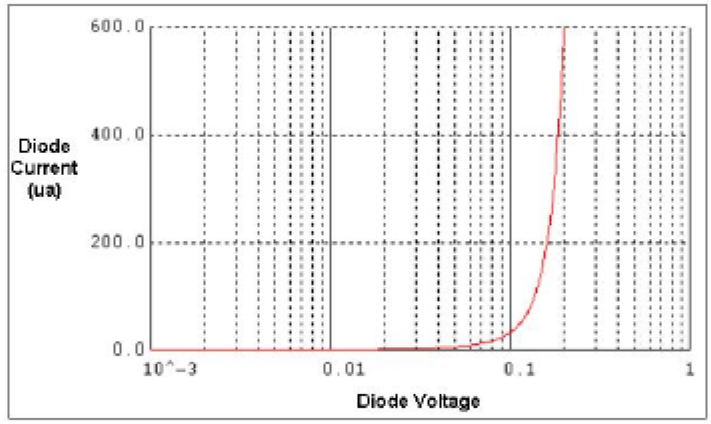


Figure 6 - Diode Current vs voltage

Even the conduction knee is less than perfect. At very low forward voltages the diode current increases exponentially as shown in Figure 7. This is a fancy way of saying that the current increases proportional to the square of the forward voltage. This is used to benefit in some metering circuits since this **square law** action means that the current increases proportionately to the power of the applied voltage.

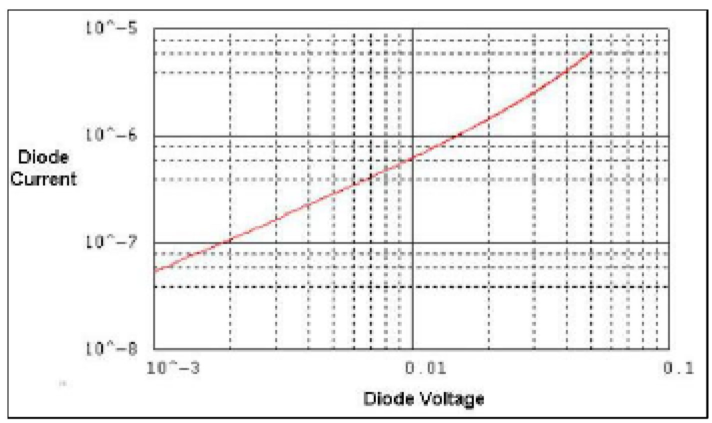


Figure 7 - Current vs voltage in square law region

As the diode voltage is increased, the forward voltage drop becomes a smaller fraction of the applied voltage. If we apply a voltage to the diode and look at the current using a load resistor (Figure 8), we see that the output voltage of this circuit follows the nonlinear square law characteristic at low levels. As the input voltage increases, the diode gradually changes from being nonlinear to operating almost linearly with several volts input. It is equal to the input voltage minus the several tenths of a volt diode drop. Most of the time we want to operate diodes in this region if possible since we usually think in terms of linear voltage changes rather than exponential. However the most interesting measurements are usually down in the range where diodes are nonlinear!

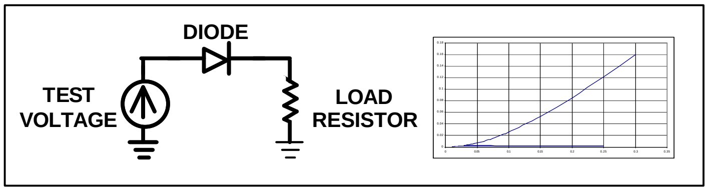


Figure 8 - Diode tester with load resistor

Although the circuit is shown with a DC input, it behaves the similarly as with RF inputs. Figure 9a shows a so-called **half-wave detector**. Since the diode conducts only on the positive portion of the sine wave, the output is the top half of the sine wave. Adding a capacitor across the load resistor (Figure 9b) smoothes out the waveform to give a DC output equal to the positive peak voltage of the input sine wave. Thus it can also be described as a **peak detector**.

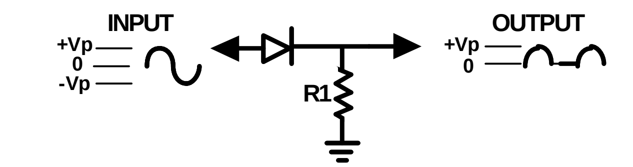


Figure 9a - Half-wave diode detector

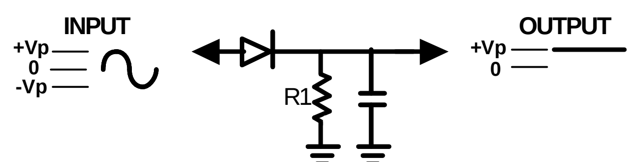


Figure 9b - Half-wave diode detector with filter capacitor

A clever way to linearize simple diode detectors at low input voltages was described by John Grebenkemper[2,3] and further explained by Roy Lewallen[4]. The scheme uses a simple diode detector as shown in Figure 10 and adds a compensation circuit consisting of an operational amplifier with linearizing feedback provided by a second diode and a resistor.

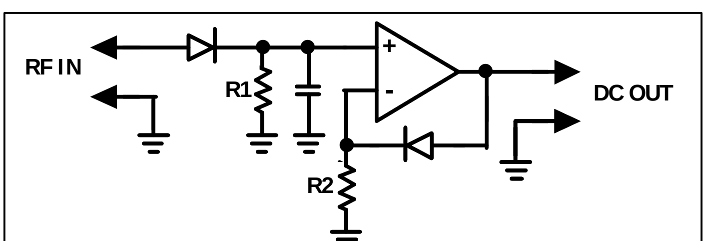


Figure 10 - Compensated diode detector

The whole process is described in detail in the references. The main idea is that by using a diode and properly choosing load resistor R1 and feedback resistor R2, diode nonlinearity is approximately cancelled over an AC voltage input range down into the tens of millivolts rather than something over a volt. This approximation holds for AC or RF signals only but this is what we want! It is interesting to note that this detector compensation was employed by both authors for directional power meters!

Integrated circuit development spurred by the personal communications industry recently resulted in some much-improved RF detectors. Several good examples are manufactured by Analog Devices Inc.[6] Figure 11 shows the AD8307, a precision log detector. Housed in a small 8-pin package it produces a DC output proportional to its input over a range of greater than –75 dBm to more than +10 dBm (31.6 nW to 10 mW) at frequencies up to 500 MHz. A homebrew analog RF power meter using this device was described recently by Wes Hayward[7]. The author of this article (RF Power Meter Cookbook) also designed a small automatic hidden transmitter sensor using this device as a field strength meter.

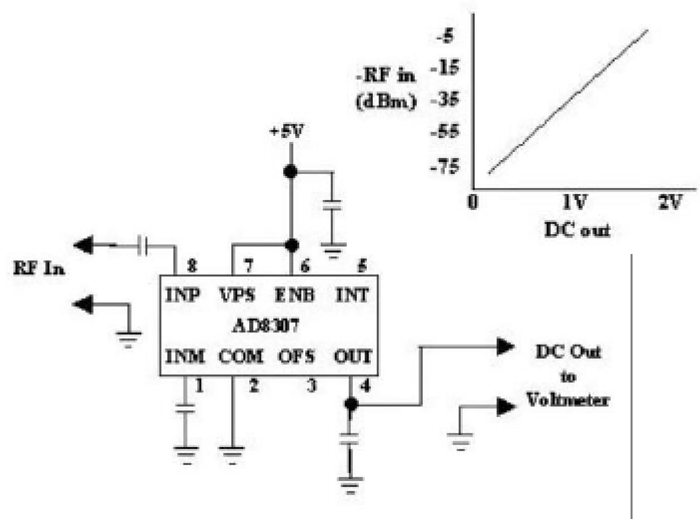


Figure 11 - IC Precision Log detector circuit

Yet another very clever device is the AD8361. It covers only power levels of –13 dBm to +5 dBm (50 uW to 3 mW) but it's capable up to 2.5 GHz! Internal circuitry accurately calculates RMS power for a wide variety of waveshapes. Most other types of detectors, including the AD8307, are accurate only with CW signals.

On the subject of determining the power of other waveforms, let's finish the discussion of detectors with a description of a PEP detection scheme. The simple diode detectors cited above are only accurate for single-frequency CW signals. Waveform distortion or modulation will result in inaccurate readings. This is adequate for CW rigs or others such as FM rigs that produce a continuous output. However SSB and PSK-31 rigs, and others, have a modulated output. The solution is to use a wattmeter that will measure the PEP (Peak Envelope Power) of a signal.

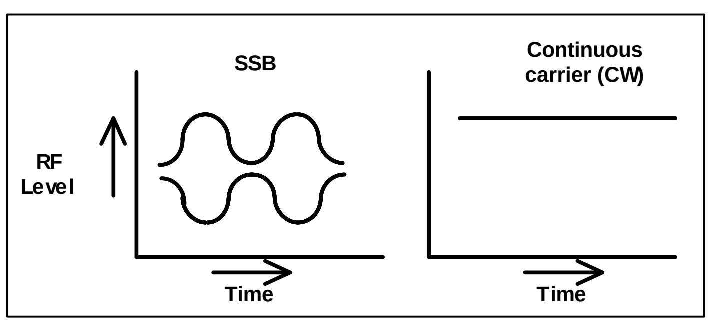


Figure 12 - Envelope of SSB and continuous carrier

Figure 12 shows the envelope of a steady carrier and an SSB two-tone signal. Since it is unchanging, the PEP of a steady carrier is equivalent to the average power. The SSB signal shown is a test case to show ideal characteristics. Generally, voice-modulated envelopes will not produce smooth patterns so the detected power will dramatically fluctuate.

If we use a circuit that captures the peak of the modulated waveform, this measurement provides the Peak Envelope Power. This is relatively easy to do by adding an RC circuit to the compensated detector as illustrated in Figure 13. The extra capacitor simply holds the highest voltage of the RF envelope and slowly discharges after the peak is over. Since it slows meter operation, the modification should be switched out when not making PEP measurements. Reference 7 describes this circuit addition to the OHR WM-1 and WM-2 wattmeters. This web reference is a reprint of a QRP Quarterly article by Larry East, W1HUE.

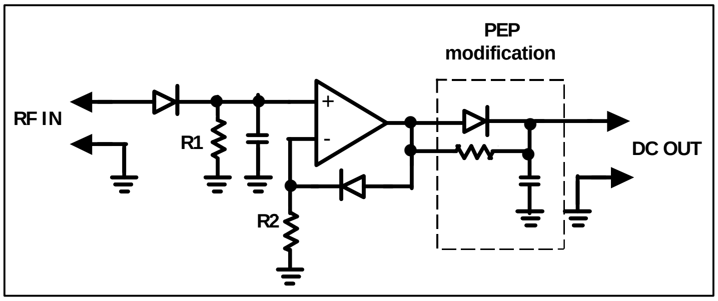


Figure 13 - Compensated diode detector with PEP modification

Terminating Power Meters

A terminating wattmeter simply combines in a single package some sort of RF detector with a terminating load. For QRP use, the termination or dummy load can be made by simply using resistors as shown in Figure 14. While QRP operation is normally confined to 5 watts of power or less, it is prudent to provide a higher dissipation load. Commercial low inductance resistors made especially for RF terminations are available but are probably overkill for homebrew use. A series-parallel combination of leaded carbon resistors is more commonly used.

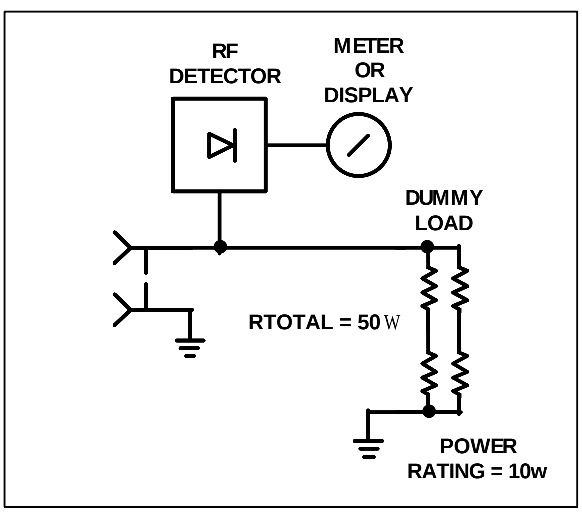


Figure 14 - Termination Wattmeter Block Diagram

Table I shows some possible combinations of resistors used to make a 50-ohm termination with adequate power rating. There are two important considerations. First, accuracy of the RF power meter is directly related to the accuracy of the 50-ohm load resistance. In the second part of this article, methods will be presented to make an accurate load resistance. The second consideration is that any physical resistor has associated stray inductance and capacitance that affects the net impedance at high frequencies. Layouts will be shown that will give accurate results up to at least 30 MHz.

Table 1 – Parallel Resistor Values for 50 ohm Dummy Load
(All resistors are 2W carbon comp or metal film)

Pwr Rating	R1	R2	R3	R4	R5	R6
2W	51	2550				
4W	100	100				
8W	200	200	200	200		
12W	300	300	300	300	300	300

TABLE I

A properly calibrated simple half-wave diode detector can give accurate readings at power levels of several watts. The simplest way to get improved accuracy is by using the compensated detectors previously described. Accuracy can be maintained down to at least the tens of milliwatts level. If lower levels are to be measured, the integrated circuit solution described in Reference 5 will work down into the microwatt region.

Operating power levels of the terminating wattmeter can be extended upward in several ways. A straightforward method is to use a high-power dummy load and a simple detector. Simple diode detectors are limited in the amount of power they can handle by the limited breakdown voltage of the detector diode. When the power levels are more than 10-15 watts the voltage applied to the detector needs to be reduced. A simple resistive attenuator network can be used to drop the voltage as shown in Figure 15. However this needs to be carefully evaluated if the attenuation becomes too large, since stray capacitance across the series resistor will affect accuracy. The amount of attenuation needs to be carefully controlled to preserve accuracy. Attenuation will also lessen measurement accuracy at low power levels.

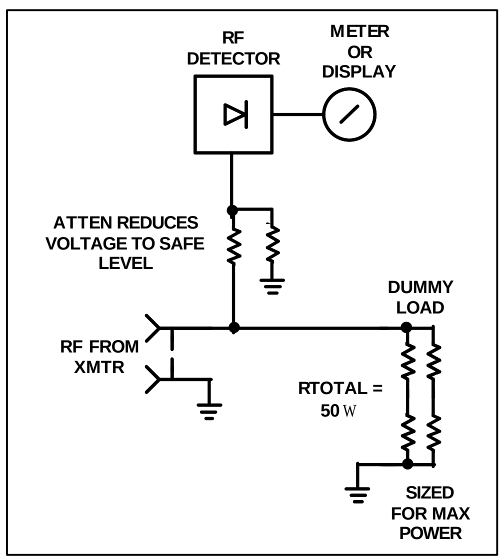


Figure 15 - High PowerTermination Wattmeter Block Diagram

Yet another method to extend to higher powers is to use a power attenuator to feed the terminating wattmeter. A 10 dB resistive pad can be made using multiple low power resistors to extend the power measurement range by a factor of 10. The resistors in the pad must be sized appropriately to dissipate 90% of the power fed to it by the transmitter; attenuation and impedance must be carefully controlled to preserve accuracy.

Directional Wattmeters

Most readers are probably familiar with one kind of directional wattmeter: the SWR meter. Up until the last 10 years or so the most common SWR bridge used closely coupled transmission lines to sample forward and reverse power. Pre-1990 ARRL Radio Amateur Handbooks all had examples of this type of SWR bridge. Reference 8 has a short discussion on it as well. This reflectometer has the advantage of being simply and inexpensively constructed. Its strong frequency sensitivity, however, limited usefulness to only SWR measuring. There are some commercial exceptions, including the popular Bird wattmeters[20] which employ compensated plug-ins covering various frequency ranges and power levels. Duplication by homebrewers is not practical.

The advent of inexpensive ferrite cores and wideband transformers has now resulted in easily duplicated directional wattmeters that operate accurately over wide frequency ranges and power levels. One such device was described in QST in 1959 by Warren Bruene[9]. Shown in Figure 16, it has both a forward and reverse sample port with independent DC outputs. While half-wave diode detectors are shown, accuracy at power levels can be extended by using the compensation described above. PEP modification can be added as well. Sensitivity and frequency response are set by adjustment of the variable capacitors on the input and output sides of the circuit. This circuit is still quite popular since it easily covers the HF range up to 30 MHz, it has a low parts count, and it is very reproducible. Examples are described in References 11 and 12.

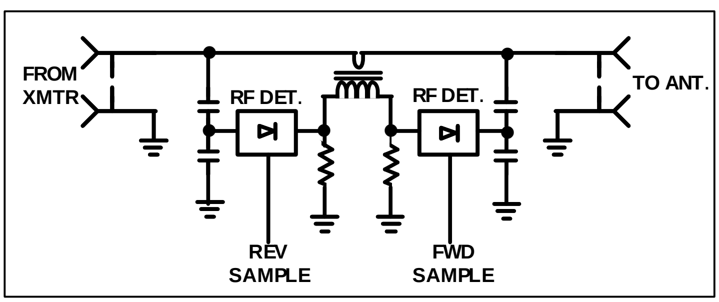


Figure 16 - Bruene RF Power Meter

Yet another broadband directional wattmeter is commonly called the “Stockton Wattmeter” in deference to a description in SPRAT[13] by David Stockton[2,8]. The circuit is quite simple, as shown in Figure 17. Two ferrite core transformers are used to sample transmission line voltage and current and to sum them in two resistors. The forward sample appears across resistor RF and the reverse on resistor RR. As with the Bruene bridge, half-wave diode detectors can be used to detect the RF signals. Compensated detectors can provide enhanced accuracy at low power levels as described in References 2 and 4. The wattmeter described in Reference 4 is available commercially as the Oak Hills Research WM-2[21].

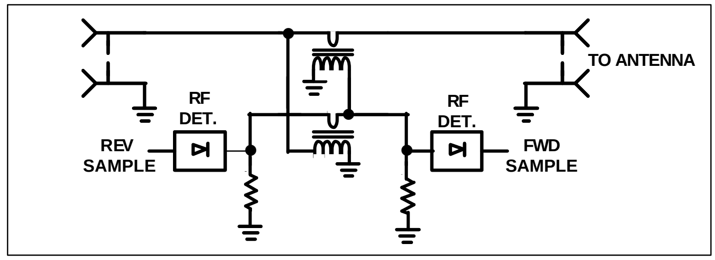


Figure 17 - Stockton RF Power Meter

The final type of “directional wattmeter” is an old favorite of mine. Though strictly speaking not a directional wattmeter, the resistive bridge can be utilized to give accurate forward and reverse samples that can be used for SWR measurements. It is really a familiar Wheatstone bridge (Figure 18) and has been described in a variety of references (8,11,12,14,15,16,17).

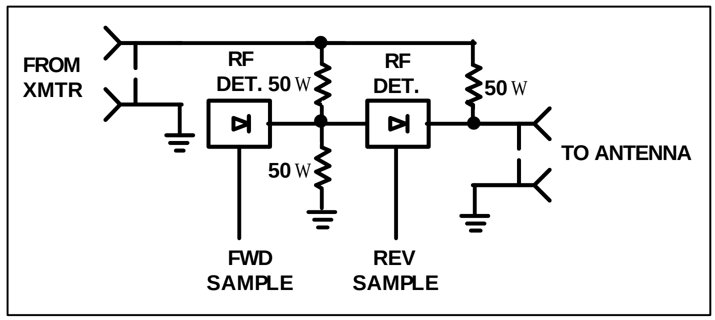


Figure 18 - Resistive Bridge Circuit

RF power is applied to the top of the circuit. Three of the legs are composed of 50-ohm non-inductive resistors while the fourth leg is the antenna or load impedance being measured. When the load resistance is exactly 50 ohms resistive, the bridge is balanced and the voltage across its center is zero. Deviating from this condition results in a voltage across the center whose magnitude and phase are proportional to the amount of mismatch. A good description of the process is provided in references 8 and 15. As with the other bridges simple half-wave detectors suffice for many purposes. Further, low-level operation is practical by employing compensated detectors[17].

When used with a transmitter, the resistors must be sized appropriately to dissipate the transmitted power. For a 5-watt transmitter, 2-watt resistors are adequate. High frequency operation is mainly limited by proper layout of the bridge to maintain symmetry. It can be used well into UHF region with stripline techniques and chip components.

Wrapping Up Part 1

I’ve presented a quick run-through of the basics. Please look into the references for more details of the underlying principles. Space in an article is limited and the topic of power meters could easily occupy a textbook or two! Next time, the concluding part of the article will present several working designs that can be built and calibrated by the average homebrewer.

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5. Jun 2001 QST p. 38, Simple RF-Power Measurement, Wes Hayward, W7ZOI

6. www.analog.com – use their search function with part numbers for technical data.

7. www.qrparci.org/east/MODS_WM1.html PEP wattmeter modification

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13. SPRAT, the journal of the G-QRP Club, www.gqrp.com

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15. ARRL Antenna Book

16. The Rainbow Bridge and Tuner, www.njqrp.org/Rainbow/rb_home.html

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18. Feb 1995 QEX P. 3, A UHF+ VSWR Bridge, Paul Wade, N1BWT

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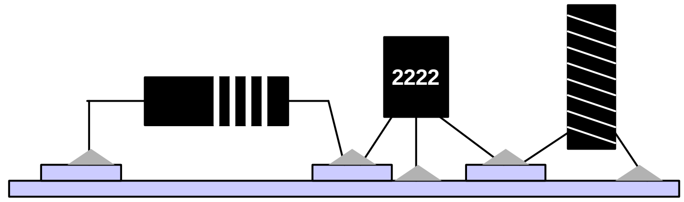
21. Oak Hills Reseach is at www.mtechnologies.com/kits.htm

22. The author may be contacted by email at n2cx@amqrp.org, or by US mail by writing to Joe Everhart, 214 New Jersey Road, Brooklawn, NJ 08030. If you'd like a response, please include an SASE.

Chuck Adams, K7QO

Manhattan-Style Building Techniques



What do you do when you don't have a circuit board and you don't want to build your project "ugly"? You do it "Manhattan Style" of course! Just glue down some pads and solder the components using the schematic as your guide. K7QO is one of the masters of this technique and he describes his tricks and techniques here in Part 1. Later in Part 2 he'll present some working circuits.

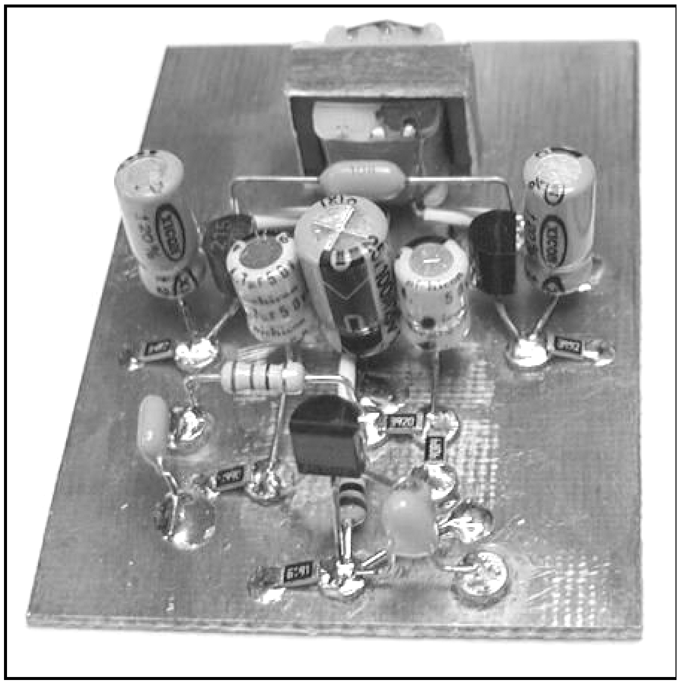
This article is intended to give you an overview of construction techniques for homebrewing and then give significant detail on what is called the Manhattan Style of construction. At the beginning of each section is a brief paragraph outlining the current topic.

I recommend that you read through this article several times before building and experimenting just to make sure that you have everything on hand before you get started. If you are like me, you hate to start on something, be interrupted and then have to find something that you are missing or have overlooked. Plan ahead and you will save a lot of valuable time. All the suggestions within this article are just that — suggestions. So feel free to add or take away where you have something that you have learned or want to use in place of my ideas or tools.

Introduction to Construction Techniques

This section gives a description and pointers on different construction techniques. In the reference materials you'll find some excellent ideas with figures and photographs to further your education and add to my discussion.

In the past few years there has been an increased interest in basic construction techniques and the "Manhattan Style" of construction in particular. It is my hope that this article will bring to light some basic understanding of just what is involved in building with this technique. To make this article of interest for all ages and building experiences, I ask or your patience while I start from the basics and work up to the more complex issues.



If you have a copy of the ARRL Handbook (www.arrl.org) for 1995 or later, please read the first part of chapter 25 on construction techniques.

You will note that Figures 25.10 through 25.22 illustrate the most popular techniques for building circuits. You can use these techniques for experimentation or for final components of a rig or for a complete receiver, transmitter, or transceiver. These techniques consist of:

- Ugly Construction
- Wired-Traces Construction
- Terminal-and-Wire Construction
- Perforated Board Construction or Perf Board for short
- Solderless Prototyping Board
- Perf Board and Wire-Wrap Construction
- Etched Printed Circuit Board
- Glued Copper Traces on Printed Circuit Board, which we will call Manhattan Style Construction.

Each technique is excellent for the construction of test circuits, etc. Don't let anyone whine and tell you that one is any better than the others or that they have never gotten one of the techniques to work and you won't either. I have used all of the above techniques and each works. Some techiques, however, do require more care in component placement and routing of critical signals and voltages.

I will cover the basics of the Manhattan Style of construction here. I would like to follow up this article with another using the Dave Benson's NN1G Mark II transceiver as a discussion for building a more complex design using Manhattan style construction and also as a tutorial for just how a transceiver works. Something that I have wanted to do for some time in an advanced construction and design article.

In the ARRL publication "QRP Classics" there are two articles that you should read at this time if you have a copy. This book is out of print and you should look for a copy at swapmeets and hope that you run across it. It is a collectors item. If you do not have a copy, then reference the original article in QST either in hardcopy or on the ARRL CDs.

The first is from the September 1979 issue of QST, page 30, written by Doug DeMaw, W1FB. The title of the article is "Quick-and-Easy Circuit Boards for the Beginner" detailing construction using what is referred to as dead bug or ugly construction. To support various component leads and connections that are not directly connected to ground he uses high resistor values on the order of several million ohms. The support resistors are soldered in a vertical position with one end to the printed circuit board and the upper lead is used to hold several connecting leads. This resistor provides good isolation from the ground point through a relatively high resistance. This upper resistor lead also provides a mechanical and electrical connection that gives excellent mechanical stability for the final circuit configuration. The problems with this technique are that I find is that you must have a supply of high valued resistors (on the order of 1 megohm or greater) and thus an additional cost to the completed circuit or project.

I find that the extra work to bind the leads together and solder them is time consuming and just too tedious to get a good and a nice looking connection. For my projects I figure that if I am going to spend the time and money in constructing something then I might as well do a good job and wind up with something that looks as nice as it works. It is much much faster and easier for me to make a nicer looking project using the Manhattan Style of construction.

In the same article by Doug DeMaw, Figure 3 shows the use of printed circuit board squares glued to the main printed circuit board. The squares are used to solder component leads to for common electrical and mechanical connections. This technique is attributed to Wes Hayward, W7ZOI, and Wes suggested using hot glue as a fixitive to hold the pads in place. Comments are made about the extra care needed as the hot glue softens each time a component is soldered to the pad(s).

I have yet to find a technique that repeatedly results in equal amounts of hot glue for each pad. I am not a fan of this technique for that reason and my favorite glue is Super Glue (cyanoacrylate glue) found at hobby shops and at many other stores for holding pads down. And because of my fondness for uniformity and order I prefer circular pads over rectangular or square pads.

The other article in "QRP Classics" is one also by Doug DeMaw from the September 1981 issue of QST page 11. The article "Experimenting for the Beginner" has some excellent circuits including the W7ZOI QRP transmitter that can easily be built using the Manhattan Style construction technique described in this article. In fact, if you have been collecting schematic diagrams and articles over the years or decades (and I know you have), then now is the time to start in building them and experimenting as you have hoped to do all this time. There are two main reasons why I suggest you do this now. You'll collect, if you haven't already, more projects than you will ever have time to build in one lifetime. Also, the parts are much easier to find now. At a later time the supply of some parts will disappear due to the nature of the electronics business and where it is going. And it naturally follows that the pricing will go up as the vendor must reserve valuable space for storing items and they must pass the added expense for this on to you. This increased cost of some items will increase your cost of doing a project.

Enter "Manhattan Style"

Now for some of the history as I know it for the term "Manhattan Style Construction".

At Dayton in May of 1998 there was a building contest sponsored by the NorCal QRP Club that consisted of building a complete transceiver using only 2N2222 transistors. The idea came from Wayne Burdick, N6KR. I was one of the judges for that contest at Dayton that year. The first place winner was Jim Kortge, K8IQY, with a 40 meter transceiver completely made up of only 2N2222 transistors with no IC chips to be found anywhere in the design. He built the rig using the Manhattan Style technique and he used the phrase which his son used in college in an engineering program where they built this way. Since the contest at least 16 of the K8IQY rigs have been built using the same construction technique and used on the air to make contacts and the number is growing. You can see Jim's work at www.qsl.net/k8iqy if you have Internet capabilities. It is worth the time and effort to visit the site. Jim is currently working on a several versions of the same rig with modifications and enhancements for other bands.

Jim Kortge is showing all his work online during the development and construction phases thus giving you insight into how he does rig design and testing.

Printed Circuit Board Material

In this section I will talk about printed circuit board material and tools for working with it to cut pieces to size for use in building circuits.

One thing that you are going to need first off is a supply of printed circuit board material. In some cities this is readily available from electronic surplus stores such as Tanner Electronics in Dallas, TX. Since leaving Dallas I have grown to appreciate such places that I no longer have readily access to here in Prescott, but life is a series of tradeoffs. Radio Shack stores have printed circuit board material but you will find it more expensive than if you can find it at swap meets or ask around for sources locally. And then there is always the search over the Internet for parts places. An excellent source of PC board material that I use is from The Electronic Golmine (www.goldmine-elec.com). Look through their catalog for PC board material and pick what you think is best for your planned projects.

It does not matter whether you use single sided or double sided material. Get that which is cheapest for you to obtain. I found some double sided board at Tanner Electronics in Dallas that is about 30cm by 60cm in size at a good price. It has a paper type dielectric and the copper coating is only 0.5 oz per square foot. But you don't care about the depth of the material for these projects. Printed circuit board material is rated by the density of the copper plating by 0.5, 1.0, and 2.0 oz per square foot. I use the 0.5 oz per square foot because it was relatively cheap and was the only thing that was in stock. The insulating substrate may be made of several different kinds of material. You do want something that you can use a nibbler or punch on rather easily.

Some of the epoxy or fiberglass based material may require a significant force on the punch to make the holes and pads. I use the term pads to refer to the circular material that comes out of the hole made by the punch. Any other time you would just throw the hole material away. Don't do that here. We want to keep all the hole material. I'd recommend that you experiment here to find the material and board thickness that works best for you to make pads. It doesn't even have to be the same printed circuit board material you are using for the substrate or area on which to build. There are no hard and fast rules here.

Once you get the board material the first thing that you want to do is to be able to cut it to the size required for each of your projects. This will require some planning on your part dependent upon what tools you have. Some builders use a hacksaw. Others use paper cutters (which will get dull rather rapidly on most printed circuit board material), metal cutting scissor-like tools, or a metal shear. Again I have done all three and my favorite is the metal shear. Harbor Freight Tools (www.harborfreight.com) had a combination 12" shear, brake, and slip roll which sold for $199.95 and has a part number of 35969-1VGA. You might check with them to see if a replacement has appeared, otherwise go to www.grizzly.com to look at their shears. I have not tried them and you may find other places in a search online. I know that this is an expensive item, but it has more than paid for itself in enjoyment and in doing some nice work on printed circuit board material that I could not do otherwise. I have also used it for making the final cases on a number of projects using aluminum sheets. I'll write a section at the end of this article on just how to make the case(s) from aluminum sheets or printed circuit board material for your projects.

I have also used a metal cutter made by Wiss with part number M-300 for cutting printed circuit board material. Be careful in buying this item as there are three cutters they manufacture and this particular one has orange handles and it will cut straight lines. The other two models are made to cut either right or left-handed curves and that is not what you want here. I bought my cutter at Home Depot, and it was priced at just under $15. I do not like using it for serious work as it leaves a small seratted edge on one side of the double-sided board, a minor nit if you want to save a lot of money on tools or start out slow before making the big leap and spend a lot of money on the higher quality tools used for homebrewing.

IMPORTANT NOTE. No matter what technique you choose to cut the board material be sure the first thing that you do after cutting a board is to run a sanding block with medium to fine grained sandpaper along all the edges of the board to remove sharp metal edges and other sharp points from the dielectric material. The formed edges of the copper can make razor sharp edges and you want to take all the safety precautions that you can in working with this stuff. Please do not skip or forget about this step. It is very important. And please don't do something stupid like run your finger along the edge to see if it is sharp. You should be old enough to know better than to ever do this. I bring it up because you need to be thinking at all times when working with tools and materials. I use an extruded aluminum sanding block that I bought at a hobby shop. I use spray contact cement to apply sandpaper and by using the contact cement on one surface I can peel the used sandpaper away fairly easily.

OK, you cut up the board to some rectangular size that you are going to build a circuit on. I recommend that you also make up several 5 cm x 5 cm boards for some experiments listed below just to get an idea of how to work with the construction techniques described here.

Cleaning the Printed Circuit Board Surface

In this section we come to the business of cleaning the copper plating on the printed circuit board.

Depending upon your source of printed circuit board material you may find it either new or old. The copper plating will tarnish and oxidize over a period of time and this will require that you clean it. I even go through the process of cleaning newly purchased board material just to remove the thin layer of oxidized copper. The best buy I have gotten on blank printed circuit boards was at Ft Tuthill a few years ago. The boards had some areas where it looked like they had been heated to a high temperature and were badly oxidized. This was most likely the reason why they were surplused out or rejected by someone. The cleaning technique discussed here does work and cleaned them up nicely.

Here is what I have found to be the best cleaning technique for printed circuit board material. I ran a number of experiments with the cleaning products listed below. I went to several grocery stores and looked in the cleaning supplies section and visited hardware stores and even antique stores looking for copper and brass cleaners.

My reasoning was that I needed some cleaning materials that were tested by a large population, certified over a period of time to be safe by both lawyers and the consumers, and would not harm me or the printed circuit board material for my projects. I'm sure if something would do damage it would have by now been pulled from the shelves. I wound up testing the following products:

- Goddard's Brass and Copper Polish
- Brasso
- Gillespie Old Brass
- Tarn-X.

The product that worked the best and the one that also was the least expensive was Tarn-X. You should be able to find it in any large grocery store chain in the household cleaning materials section. Read the label carefully and completely and follow the instructions. I use a cotton ball and clean both sides of the board with the Tarn-X. I get the cotton ball wet with Tarn-X and wipe all the copper material until it is clean. Then I immediately rinse with plain tap water in the sink and then dry with a paper towel, all the while holding the board by the edges and not touching the copper surface. Do not allow the board to air dry with water spots as they will leave obvious markings on the surface of the board.

You did sand the board edges, didn't you? You will always be handling the board by the edges. You will wind up with a shiny surface after cleaning the boards. I find that it doesn't seem to tarnish too rapidly. Just avoid touching the surfaces of the copper plating with your fingers, etc. I have a technique also for avoiding contact with the board during construction and that is described in the building steps paragraphs. You might also consider using 1" masking tape folded over the edges of the board to protect you and the board while handling it. You can remove the masking tape after you have completed building.

I prefer the Tarn-X as a cleaner as it is non-abrasive and works almost instantly upon contact. It doesn't require a lot of elbow grease, i.e. hard work or exercise, to get a clean surface without additional scratching. We are not trying for an optically flat surface but I don't like scratches produced by the abrasive compounds or steel wool. (Changed attitude in Dec 2002. See below.) I would show a before and after photograph of the cleaning results, but the results do not photograph well. I'll let you experiment on your own and determine for yourself just how well the process works.

In December of 2002 I happened to pick up some Scotch-Brite (TM) material at the hardware store. It comes in various types and the one that you want is brown colored for the removal of rust and tarnish from metals. It is not expensive and it seems to last a long time for copper. I use it to clean the board material and then use Tarn-X to add a final cleaning. Then I put a very very THIN coat of clear spray over the entire board. I can not emphasize how thin you need to get it. You are not painting this thing for show and tell.

I found that the layer protects the board and gives it a nice look. And with my 25W iron I am still able to solder the ground connections without a problem. With a bare board there was an area of discolorization around the ground solder points. But with the thin film of clear paint there is no such areas. A plus in my book. Tell them you heard it here first.

Wrapping up Part1

That's all the room we have in this issue, so we'll wrap up Part 1 for now. Next time we'll tackle the key to making good Manhattan Style projects - making pads, attaching them and mounting various components to them. Then, we'll build up some circuits using the techniques I've outlined.

I've provided a couple of previews of the projects we'll be working trhough next time. Hope you'll be following along with us on these.

Also, I've provided the full set of references so that you can get a head start on some of the reading material, even for the second installment.

So until the next time we meet, may all your projects work the first time and everytime!

73 es dit dit.

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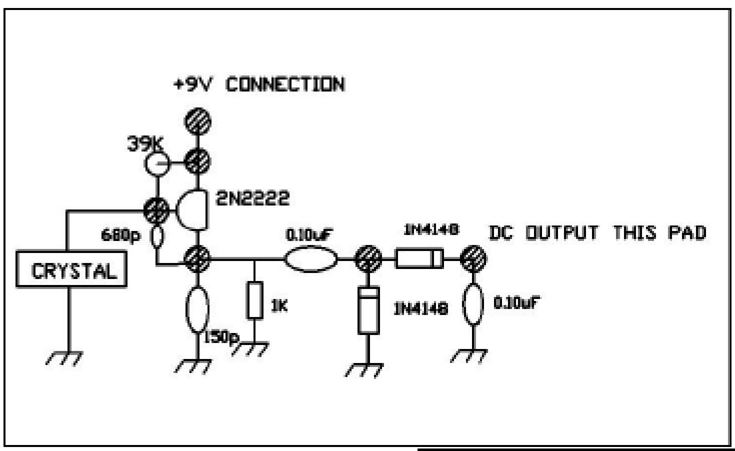
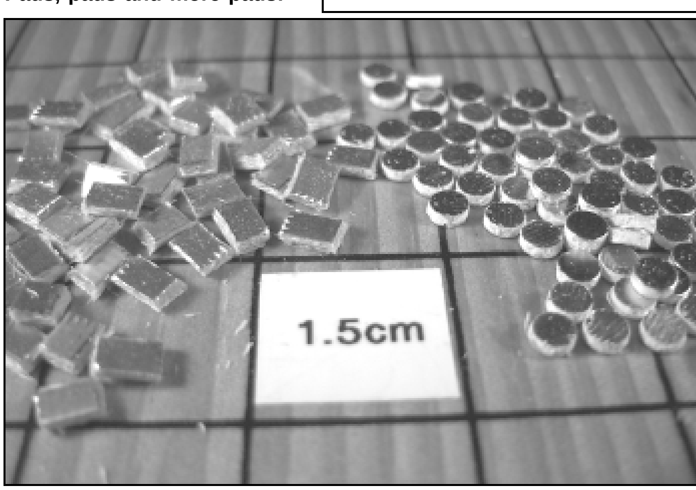
12. The author can be reached at k7qo@commspeed.net. His website is www.qsl.net/k7qo

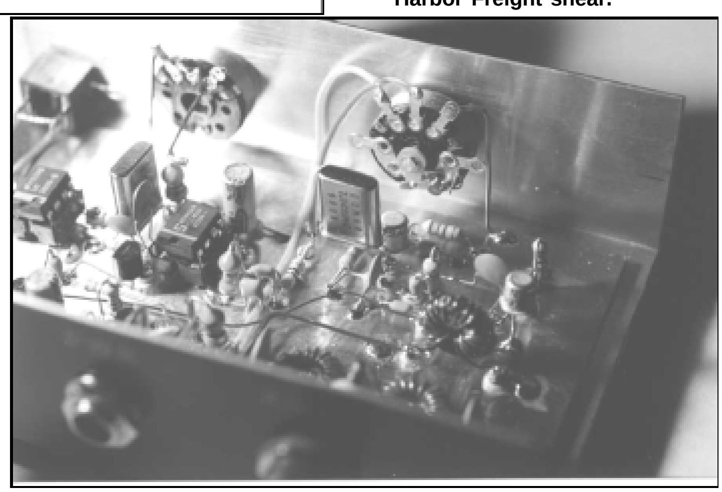
CRYSTAL CHECKER -- I use this critter quite frequently for testing unmarked crystals and crystals in kits to match them more closely. You will find it quite handy. Because it comes out so small (and you don't have to make yours look just like mine) I have to take care in putting it up somewhere so that it doesn't get lost in the clutter on the workbench.



Pads, pads and more pads!



MRX receiver from NorCal contest that was built Manhattan Style on same board with K7QO final PA Cheby filter and W7ZOI keying circuit. Also note homebrew K7QO case with 040 Al and use of Harbor Freight shear.



David S. Forsman, WA7JHZ, and Michael D. Tarola, KB7CP

Near-Field Electromagnetic Radiation Probes for Amateur Radio

If the FCC comes calling with a claim of excessive radiation levels in the neighbor's back yard from your 100 watt HF station, good luck! Build these simple 1.8 to 29.7 MHz electromagnetic probes to determine your FCC OET-65B near-field radiation compliance using a common multimeter. You can measure and demonstrate near-field RFR levels instead of simply predicting it with NEC antenna modeling programs or ARRL worksheets.

The DVM and probes are connected through special cables composed of twenty (each) 100 K ohm resistors spaced at 10 cm intervals, insulated with plastic tubing, and placed inside one-meter (1m) lengths of 1/2 inch PVC water pipe (see drawing below). These cables resistively isolate the probes from the DVM at radio frequencies, while also reducing their own parasitic antenna tendencies.

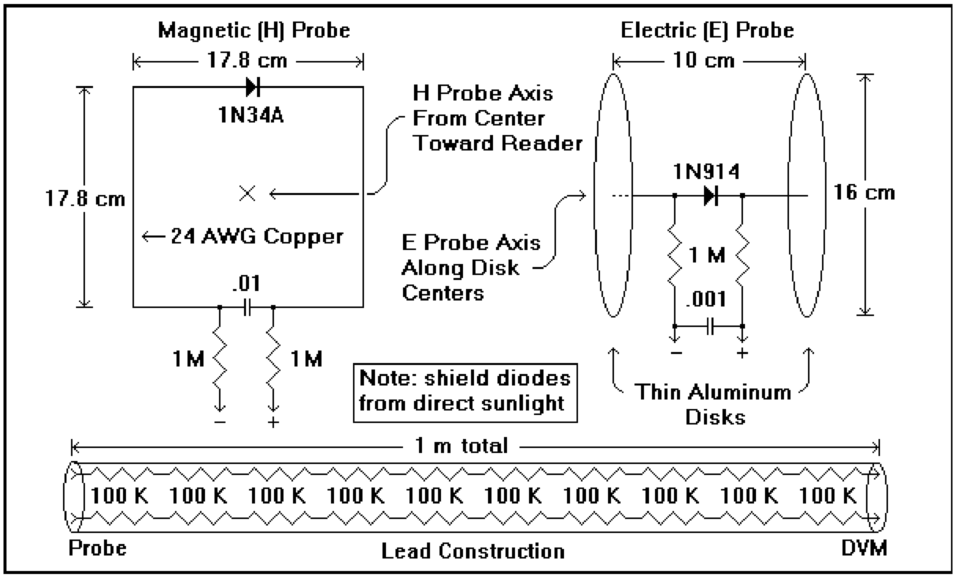
Pay careful attention to the use of the 1N34A germanium diode for the magnetic (**H**) probe and the 1N914 silicon switching diode for the electric (**E**) probe. The 1N34A diode gives excellent low-voltage sensitivity to the **H** probe while allowing it to measure in excess of 1.63 A/m, and the 1N914 provides low junction capacitance and high-voltage capability to the **E** probe, thus allowing it to measure a maximum (peak) level of 350 V/m. Avoid using substitute diode types, since they can severely alter the overall performance.

These probes measure both the magnetic (**H**) and electric (**E**) components of your antenna's near-field radiation in units of amps-per-meter (A/m) magnetic, or volts-per-meter (V/m) electric. The following formulas are used to convert your DVM's voltage reading (or Vdc) to initial **H** and **E** values: **H** (A/m) = 4(Vdc + 0.05)/f (f in MHz), and **E** (V/m) = 10(Vdc + 0.3). For example, if your magnetic (**H**) probe produced a Vdc reading of 1.5 volts on your DVM at 3.8 MHz, then your initial **H** field value would be 1.63 A/m (4 x (1.5 V + 0.05)/ 3.8mhz = 1.63 A/m). For the **E** probe, you would use the second formula—the **E** probe, within the amateur bands from 1.8 to 29.7 MHz, is not frequency dependent. We will cover the formula derivations in later paragraphs.

The authors' H-probe (left) and E-probe.

Like a dipole antenna, these probes are polarized, in that they produce maximum Vdc readings when their axes are in the same polarity as that of the near-field. But most practical antennas exhibit a complex near-field. Because of this, a probe's Vdc value might have more than one maximum as its axis is aligned within a given field (the **H** probe's axis is an imaginary line passing directly through, and at right angles to, the imaginary plane of its open center, while the **E** probe's axis is an imaginary line passing directly through the centers of its two aluminum disks).

For "quick-method" measurements, while transmitting a continuous-wave (CW) signal (not Morse code), orient a probe at the measurement point to maximize Vdc on your DVM. This will require experimentally rotating the probe's axis through several different vertical and horizontal angles until you find Vdc max. Then, after calculating the conversion value from Vdc (and possibly f), multiply it by 1.732—the square root of 3. For single-element vertical antennas, it is easy to find the Vdc maximum—



but the quick-method often overestimates simple near-field values.

For a second approach, imagine a three-dimensional Cartesian coordinate set (x, y, z) with its origin centered at the measurement point (see drawing below); position and read a probe with its axis aligned once with each of the imaginary x, y, and z axes at the measurement point; calculate the initial conversion values (three total); and apply them to the root-sum-squared (RSS) formula, sqrt(a^2 + b^2 + c^2). This process adds the three vector magnitudes of the mutually orthogonal initial probe values. The result should fall between 57% and 100% of the quick-method value. This procedure, unlike the quick-method, should minimize the errors associated with complex fields, but it does require more work.

Since these probes are best at indicating the average value of the **H** or **E** level, it is necessary to make measurements with a CW (steady carrier) signal, and then apply "peak value" multipliers to the value(s) based on the desired modulation method—AM, FM, SSB, etc. For instance, if you arrive at a final **E** value of 100 V/m from a CW signal that represents the zero-modulation carrier level of an AM signal, you would multiply the 100 V/m **E** value by two (x 2). This would represent the AM peak **E** value at 100% modulation (2 x 100 V/m = 200 V/m @ 100% modulation). However, if the same CW level represents the peak value of an equivalent SSB signal, then no multiplier is necessary—the peak SSB **E** level would also be 100 V/m.

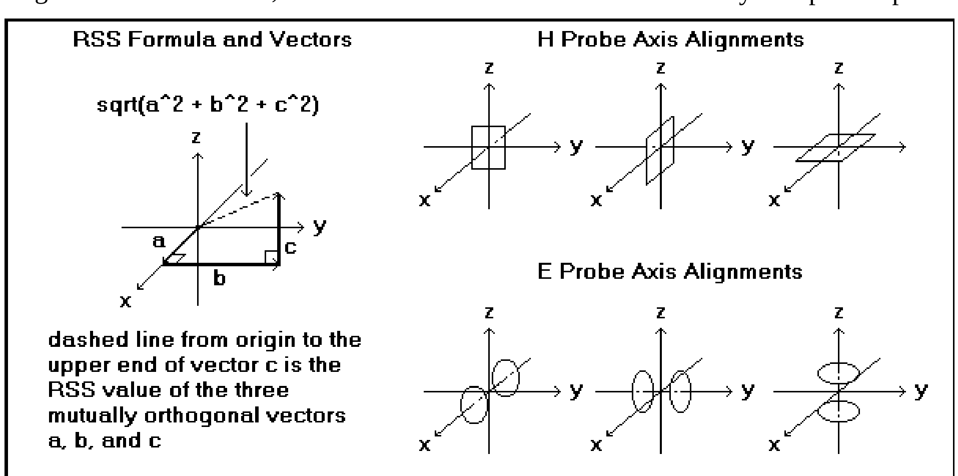
On the lower-frequency amateur bands (160-75 m), where higher **E** values are allowed, the 350 V/m limit of the **E** probe can be compensated for by doing the following: lower the CW power output of the test transmitter until the **E** value is either equal to, or less than, 350 V/m; square the value of the ratio of the maximum allowable **E** field and the actual **E** field; and multiply this quantity by the new power level to determine the maximum power level at the maximum allowable **E** level (((**E**max/**E**actual)^2) x Watts = Watts max).

For example, suppose we have to reduce our transmitter output to 100 Watts to get 300 V/m at 1.9 MHz (160 m). Since we are allowed a controlled level of 614 V/m on this band, we square the ratio of 614 V/m and 300 V/m, and multiply this by 100 Watts to get 418 Watts (((614/300)^2) x 100 = 418 Watts). As long as we don't exceed 418 Watts peak output on 1.9 MHz, our **E** value won't exceed 614 V/m. Remember, also, that the uncontrolled **E** level at 1.9 MHz is only 433 V/m. This would represent a maximum peak power level of 208 Watts (((433/300)^2) x 100 = 208 Watts). Regardless of calculation, 1500 Watts is the maximum allowable peak power level, and some bands are even less. But, you may still be asking, "What makes them work?"

The **H** probe's characteristics are defined by Vo = w**B**s (from Faraday's Law), where Vo is induced loop voltage; w = 2pf (f in Hz); **B** is magnetic field strength in Weber/m units; and s is loop area in square meters (Marshall 294). Since we prefer **H**, or magnetic field intensity in A/m units instead of **B**, we will use the definition **B** = m**H**, where m = 4p x 10^-7 henry/m (Units 3-12, 3-14). This then gives us Vo = wm**H**s = 2pf (4p x 10^-7 henry/m)**H**s. We can approximate this relationship as Vo = 7.896fHs, with f in MHz.

Solving for **H**, we get **H** = Vo/(7.896fs). For our 17.8 cm square probe, we get **H** = 4Vo/f. The resulting rectified DC voltage from the 1N34A is approximately 1.4 times the induced RMS Vo voltage, but the 4 M ohms of probe and lead resistance combined with the 10 M ohm DVM resistance give a voltage division of 1.4, so that Vdc could represent Vo, or Vdc = 1.4Vo/1.4. By substituting Vdc for Vo, we get **H** = 4Vdc/f. To compensate for low-signal 1N34A diode cutoff voltage error, we add 0.05 V to the Vdc value. This finally gives us **H** = 4(Vdc + 0.05)/f. Note, also, the importance of the **H** probe's 0.01 mF capacitor that attenuates unwanted **E** field response.

The **E** probe's characteristics are defined by Vdif = **E**d, where Vdif is the voltage differential between plates and d is plate spacing in meters (m). In an **E** field, this probe is a capacitive voltage divider, where the capacitance of its plates (1.8 pF) is designed greater than the junction capacitance of the 1N914 diode (less than 1 pF). In an **E** field, where electric field intensity is given in volt-per-meter (V/m) units, you would find a voltage differential, Vdif, equal to the value of **E** between any two points spaced



one-meter (1m) apart within the length of the field. Our probe is spaced at 10 cm (d = 0.1 m), so it intercepts one-tenth of the differential (Vdif = **E** x 0.1 m).

Solving for **E**, we get **E** = Vdif/d. For our 10 cm spacing (d = 0.1 m), **E** = Vdif/0.1 = 10Vdif. The resulting rectified DC voltage is approximately 1.4 times the RMS Vdif voltage, but, again, the 4 M ohms of probe and lead resistance combined with the 10 M ohm DVM resistance give us a voltage division of 1.4 so that Vdc can also represent Vdif, or Vdc = 1.4Vdif/1.4. By substituting Vdc for Vdif, we get **E** = 10Vdc. To adjust for the 1N914 cutoff voltage error, we add 0.3 V to the Vdc value, or **E** = 10(Vdc + 0.3).

The diode cutoff voltage error values for the 1N34A and 1N914 were made with empirical AC to DC voltage conversion measurements at 60 Hz. Using both a low-distortion audio oscillator and an adjustable autotransformer line voltage source, both diodes were individually fed with differing levels of 60 Hz voltage; their corresponding DC output voltages were then filtered by a 1 mF capacitor with the output coupled to a 10 M ohm Fluke model 75 DVM through a 4 M ohm resistor. This circuit models the dynamic conditions that the diodes would normally be subjected to in the probes, but at 60 Hz. Finally, the AC and DC voltage readings were compared to determine their voltage differences. The 0.05 V of the 1N34A and the 0.3 V of the 1N914 represent "worse case" error values that affect the accuracy—especially when measuring at low field intensity levels.

By giving our **H** probe only one turn, and using a 0.01 mF capacitor across its output, we avoid the need to electrically shield it from **E** fields. Though it does lack the sensitivity of multi-turn **H** probes, it is difficult to predict the characteristics of shielded multiple-turn **H** probes at higher frequencies because of the effects of distributed capacitance. By keeping it simple, our **H** probe (within limits) should better maintain the characteristics of its basic definition.

For the **E** probe, its simple fundamental design helps to overcome the detector diode's internal junction capacitance. An ideal E probe detector diode (or any diode) would have zero junction capacitance and cutoff voltage, plus infinite reverse voltage breakdown—but this is not yet possible. Some types of Schottky diodes have lower junction capacitances than the 1N914, but many have lower breakdown voltages. It should also be noted that neither probe can detect zero field intensity levels.

In conclusion, compare the measurements from your probes with probes of known accuracy—they are not replacements for certified laboratory grade models. At 950 KHz, with generally good results, these probes have been tested in **H** levels up to 1.55 A/m and **E** levels up to 742 V/m. Always follow good engineering and safety practices when constructing, and using, these devices. These probes are another valuable tool to help assure FCC OET-65B compliance.

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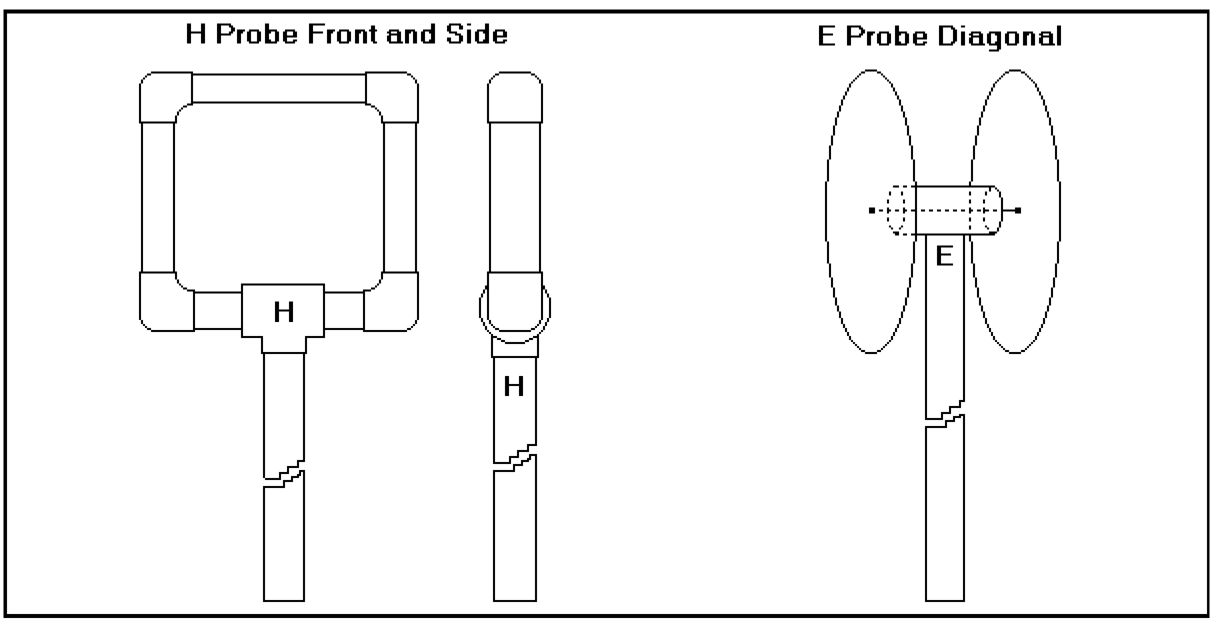
"Units, Constants, and Conversion Factors." Reference Data For Radio Engineers. 5th ed. Indianapolis: Howard W. Sams & Co., 1973.

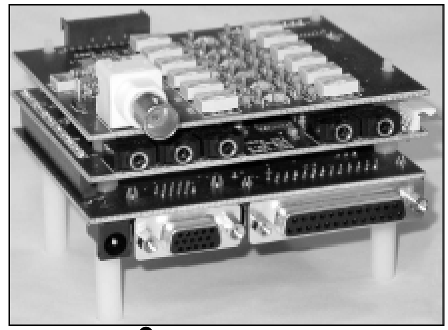
AUTHORS' NOTE

"Without exclusive rights, any amateur radio group or individual may post (publish) my schematic, diagram, text, and/or image files that I make available for such purposes."



Sketch of the authors' probes, shown in photo at beginning of article.

Martin Klaper, HB9ARK, and John Piri, WD6CSV



Homebrew Software Defined Radio with the SDR-1000 Transceiver

Over the last year, AC5OG published a 4-part series in QEX concerning “Software Defined Radio” - a radio architecture in which signal processing is accomplished with software. The series concluded with the presentation of the SDR-1000 transceiver, which is of great interest to homebrewers and advanced experimenters.

Gerald Youngblood, AC5OG[2] is pushing the state-of-the-art of homebrewing ham radio equipment to new heights by producing leading-edge technology within the reach of average hams. This article sheds light on the main features and architecture of his dc-65 MHz “SDR-1000”: a fully featured continuous receive, ham band transmit, all mode transceiver for experimentation and general use.

The SDR-1000 transceiver is an exciting radio to add to the ham shack. It brings state-of-the-art DSP capabilities to the ham and SWL user. The transceiver requires a 600 MHz PC (or faster) to run its large selection of powerful tools for receiving and transmitting. With 1 Hertz tuning steps from its DDS-VCO, the transceiver covers 12 kHz to 65 MHz in an ever-increasing number of bands.

The SDR-1000 is not an average computer controlled-transceiver. A minimal amount of hardware provides a DDS-VCO with a bi-directional I and Q mixer and a 2-watt PEP output amplifier. The PC does the rest. That includes sideband generation & demodulation as well as an array of AM & FM modes, soon to include PSK & RTTY. The PC also provides spectrum display and an array of filters and noise suppression options. By providing a high dynamic range input into the PC sound card, the computer can get to work and provide razor sharp DSP filtering to the signal that makes commercial hardware filters seem antique.

A complete description of the design can be found in a four part series in QEX[3]. Together with its numerous references, this series is a great tutorial on Software Defined Radio (SDR).

Software Defined Radio

Software Defined Radio is a radio architecture wherein nearly all signal processing is accomplished in software. This contrasts to other mainstream radios available today that use a microprocessor primarily for the user interface and perhaps some audio filtering. SDR radios also typically digitize and filter the last IF stage, e.g. at 40 kHz. In a basic sense, the A/D converter can be considered connected directly to the antenna. In this novel configuration the front end performs the sample and hold function on the signal to produce a continuous stream of time discrete values. The second step is accomplished by a sound card in the PC that uses a high-performance A/D converter to produce a true digital representation of the sampled signal. Everything after that is done by calculations in software.

Figure 1 shows a simplified system level block diagram. The left side of the diagram represents the SDR-1000 hardware

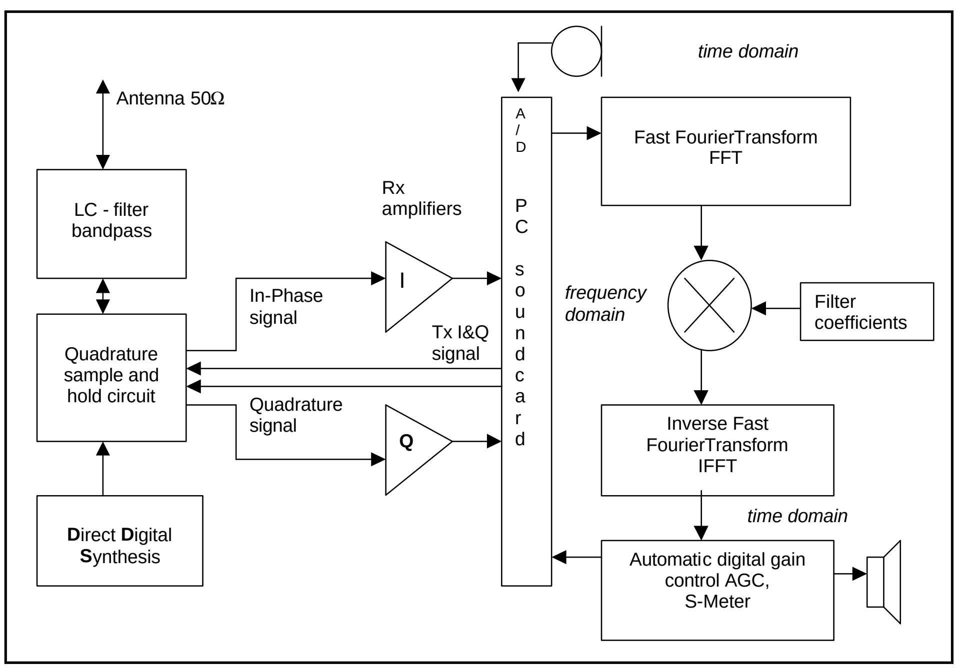


Figure 1: System block diagram of the SDR-1000

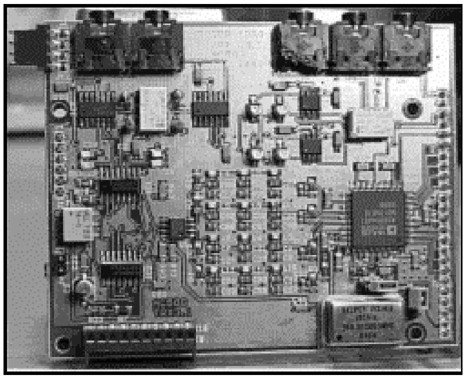


Figure 2: XTAL, DDS and downconversion

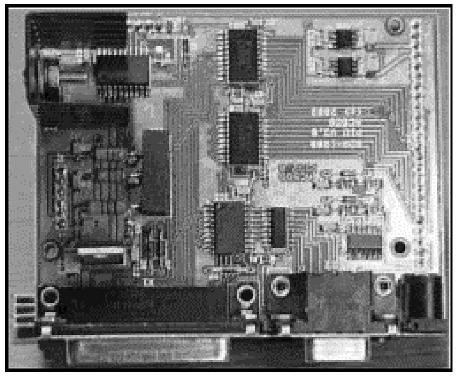


Figure 3: Power supply and control

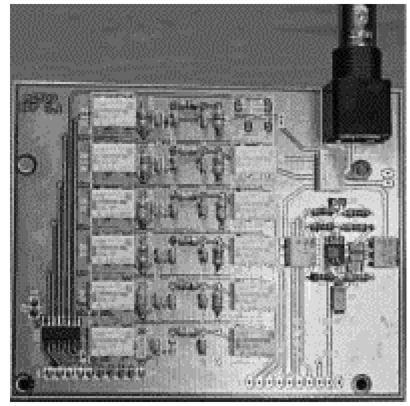


Figure 4: Octavefilters and 1 W PA

front end, while the right side shows the signal flow through the DSP software running in PC.

The SDR-1000 hardware front end consists of three boards. The heart of the system is on the first board which provides a novel direct conversion scheme using state-of-the-art Direct Digital Synthesis (DDS) and a high quality crystal master oscillator.

The second printed circuit board contains the 1-watt power amplifier and conventional L/C filtering. Output filters using L/C components are the best solution for price, simplicity and quality.

The third board contains the power supply regulators for +/- 15 volts and 5 volts. This board also contains the digital I/O latches that control the DDS frequency generation, and the relays that switch the filter banks and perform the Rx/Tx switching.

All in all, this stackable 3-board set is a neat little package measuring about 9cm x 7cm x10 cm (3.6" x 2.8" x 4").

What else do you need to become QRV? Well, an integral component in this SDR radio is a computer - either a desktop PC or a laptop. I use a Dell 8000 with an internal ESS Maestro 3 soundcard, which works well enough for me. Best results are achieved, however, when using a high quality soundcard like. the Turtle Beech Santa Cruz card. I still have to try this.

The boards require a 2 amp 12 volt power supply, as well as a 25 pin D printer interface connector and 1/8" phone jacks for computer left/right sound input and output. A BNC connector is provided for the antenna or external power amplifier.

User Interface

When I first saw the SDR-1000 User Interface, I felt very comfortable. It is immediately clear that it is a transceiver and not some esoteric piece of computer controlled equipment where one needs to study a 200+ page manual first and then practice regularly. Anyone who uses a conventional transceiver will be able to immediately operate the SDR-1000.

Most controls perform a single function. Some might say: "I am accustomed to using a tuning knob, but there's no tuning knob on my PC!" The SDR-1000 actually uses a unique mousewheel tuning control. It is amazing how many features Gerald has packed into the SDR-1000. Ten different bandwidth settings can be selected with a click of a button. The widest is 6 kHz and the smallest 25 Hz. Other selectable values are 4, 2.6, 2.1, and 1 kHz, and 500, 250, 100, 50, 25 Hertz. All filter bandwidths are available in the basic unit; there is no need to buy expensive crystal filters - it's all in the software. If you need a very special bandwidth setting, you can change the software for any bandwidth between, say, 10 Hz and 40 kHz. It is Open Software, you can make custom changes in the code using theVisual Basic source code provided with the SDR-1000.

The currently available operating modes include AM, which is nice to use for listening to medium or shortwave broadcasts and experimenting with different bandwidths. Single Side Band (SSB) is also available with selectable bandwidth on upper or lower sideband. Of course there is CW with selectable upper or lower sideband - i.e., true sideband selection. One of my favorite modes is CW with one of the narrow filters and the squelch usually set to a value of about 280. Then I get complete silence of the rx during pauses, and get just the desired CW signal when the other station transmits. This set up sounds like a code practice oscillator! Double sideband is another available mode; I suppose this is for binaural reception as described in the ARRL Handbook[5]. There is an experimental narrowband FM mode, although the only use of FM below 65 MHz is with the 10 Meter relays. This could prove useful in the future for a 2-meter undersampling receiver. But that goes beyond this general review. The last mode switches the SDR-1000 into a Digital Radio Mondial DRM[6] front end.

Of course there is a dual VFO with possibility of copying frequencies and working split mode in a pileup.

Tuning is accomplished in one of several ways. As an old fashioned ham I mostly use the mouse wheel "tuning knob" control to tune up and down the band. For a sked or when listening to a known broadcast frequency, I use the direct frequency entry method; I just type the number and hit return. A third tuning method is based on the spectrum analyzer display. Upon right-clicking the mouse, a fine crosshair appears and can be moved over the spectrum display. Then, with a click of the mouse, the transceiver is set to the actual signal[7] with the correct offset for the selected mode.

The audio frequency gain, intermediate frequency gain, microphone gain, transmission power and squelch controls are rather conventional. They are set either by numeric entry or by clicking on an up / down button. The same holds true for the receiver and transmitter incremental tuning (RIT, XIT).

The S-Meter displays the received signal strength in numerical and graphical form. It is possible to display the actual gain, a smoothed average of signal strength and the individual strength of the in-phase and quadrature signal of the so-called "analytical signal", which is the basis of digital signal processing.

The automatic gain control is accomplished in a fully digital manner and can be set in four steps: long, fast, medium and slow. This digital gain control eliminates a

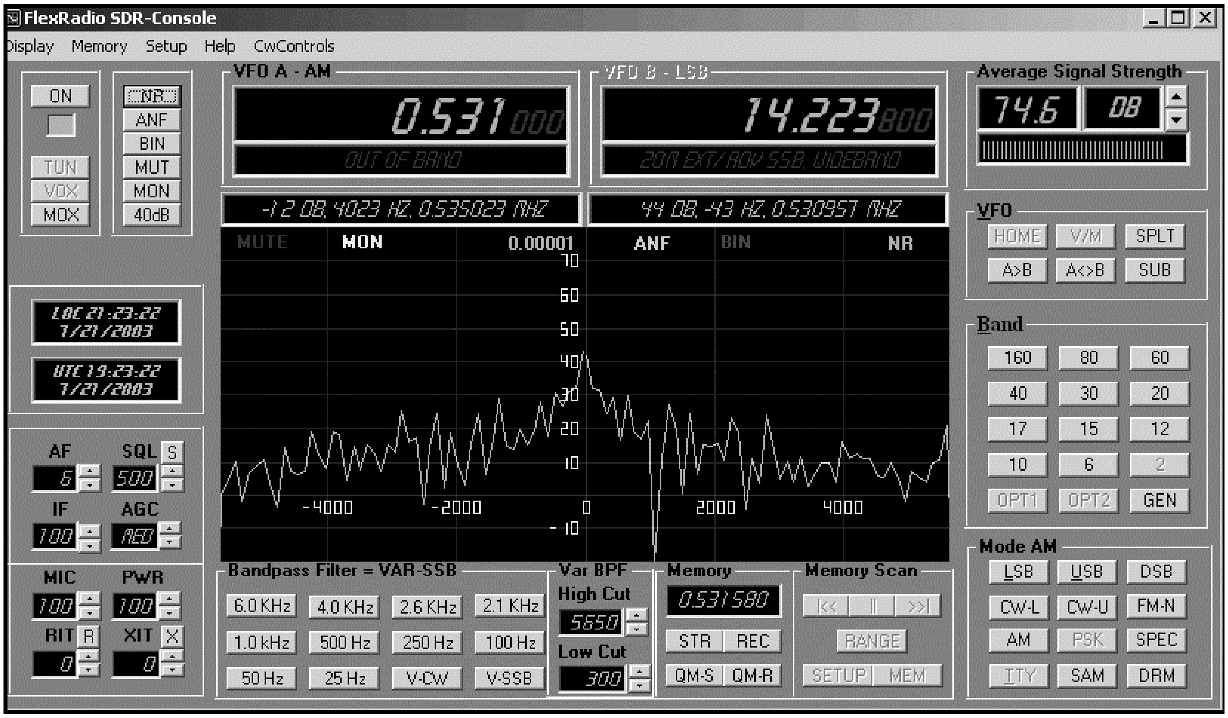


Figure 6: The SDR-1000 graphical user interface.

potential problem, which could easily arise in conventional receivers using a DSP[8] stage only after the last IF and then controlling the RF amplifier in the front end. All DSP stages introduce some delay on the signal and there is a tendency toward instability. The design of SDR-1000 avoids this.

We have not yet talked about the debug interface that appears when the main window of the SDR-1000 application is maximized. Using this dialog window, you can check the state of the I/O pins and the processing burden of the PC's CPU, which is about 21% (on an 800 MHz Pentium III processor) while listening to a CW station on 14.060 MHz. This is a quite useful feature for the software developer.

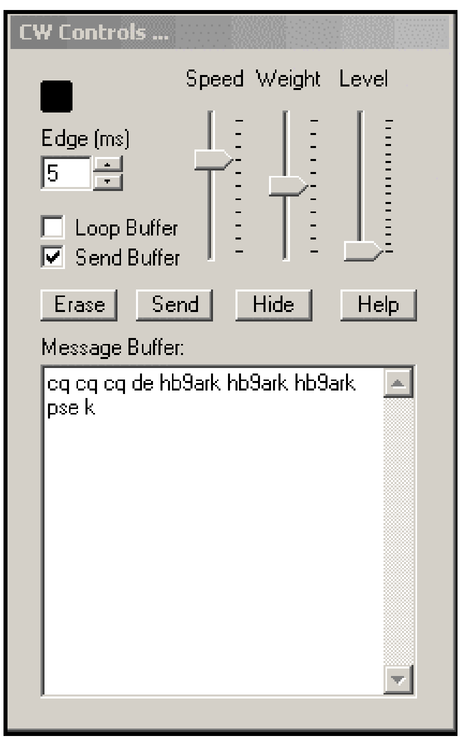


Fig.ure 7 - CW controls, a feature contributed by W5SXD.

Operating features, impressions

When I got my SDR-1000 a few weeks ago I was eager to immediately use it even without a housing, which is possible thanks to the stacked circuit board design. It looks like a cube, standing on four feet with all cables protruding on one side.

A comprehensive companion manual, excellent support by the manufacturer, and a growing number of hams push the development of the software foreward. A web forum exists for owners of the SDR-1000 to discuss use and further development of "our" SDR. The Internet is used for discussion, support and distribution of software and documentation.

W5SXD is the contributor of a keyboard to CW interface - a useful addition to the user interface.

Things to improve

The basic functionality is available now, but the development process is still going on. Many more modes are yet to come. New high tech noise reduction techniques are available in an experimental state. There is huge potential for further development.

Perfomance

At the moment only preliminary performance figures are available. The transmit signal seems to be clean. The selectivity of the receiver is excellent. The sensitivity is okay, but does not yet reach the figures of the top class receivers - a preselector and preamplifier may help.

The classic way to characterize an analog receiver's behaviour may not be appropriate for all aspects of SDR. New measurement practices still have yet to evolve.

Memories and scanning

Is it necessary to adjust bandwidth and mode after each change of frequency? Not at all! On each band, the last four settings are stored on a stack and with a simple click one can return to the last setting, which is very convenient. In addition to this context saving store, there is a practically unlimited database for storage and retrieval of frequency, modes and call signs. These can be retrieved by memory number or by a preset hotkey, such as the F2 function key. Database entries can be structured in different groups.

Among other things, a scanning mode is planned for the future. All the coming enhancements and new modes are purely software. You can either wait until someone implements your feature or you can try it yourself. All the source code is open, allowing users of the SDR-1000 to compile the

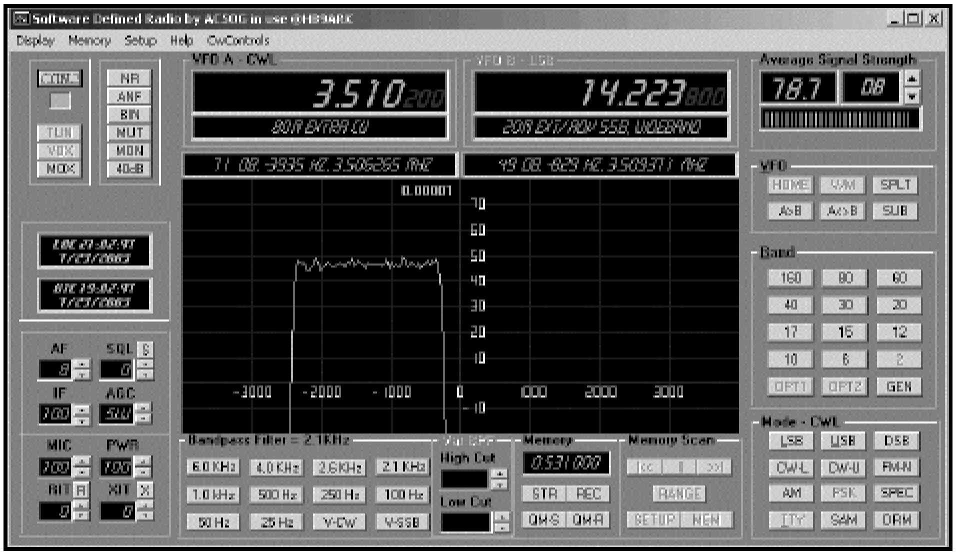


Figure 9: Fast convolution filter curve - 2100 kHz. A broadband noise generator[10] is connected directly to the SDR-1000's BNC antenna connector. The SDR-1000 is set to the desired bandwidth and the filter curve is immediately visible.

PC application program to create specialized user interfaces and custom modem processing.

A Homebrew Enclosure

The three-board transceiver can be temporarily operated without a case. However when it's time, a Jameco[11] chassis #208910CD makes a good case for the SDR-1000 board set and provides extra room for a cooling fan and power amplifier! The boards should be mounted with the voltage regulator and heatsink facing up. A 12 volt computer fan (Jameco part #212804CD) is attached to the vent holes close by the heat sync to keep the hardware cool. The 5-V voltage regulator generates a lot of heat and could cause the VCO reference oscillator to drift a lot if heat is allowed to build up in the box. A template is available for drilling the front panel.

In the WD6CSV installation a 20 watt Communications Concepts power amplifier was mounted in the back of the box for extra power. See Figure 13.

A 4 amp power supply is required to power the SDR-1000 together with the 20 watt power amp. The ADT 1.5 – 1 output transformer of the SDR-1000 1-watt amplifier needs a 200-ohm ¼-watt carbon resistor added across its output winding . This is to provide a constant load to the SDR-1000 1-watt amplifier when switching between bands. The AN779L 20-watt power amplifier was inserted between the output transformer of the SDR-1000 1-watt amplifier and the final relay to the BNC jack. This provided 20 watts of output power without additional relays for switching in and out of receive and transmit modes. When operated with a power amplifier additional filtering will be required to keep harmonics to acceptable levels.

An external 20 meter filter is used to keep harmonics at -80 dBc when using the 20 watt power amplifier on 20 meters. A relay and band filter board is under construction, which will provide harmonic filtering for all transmit bands used with the 20 watt power amplifier. The SDR-1000 provides a connector to switch the relays needed for changing the filters for the added power amplifier.

The SDR-1000 has already provided many out-of-state contacts on 20 meters at the 1-watt QRP level. It provides for interesting conversations on the Ham bands as operators try to understand the unusual capabilities and benefits of a PC-generated side band transceiver. With a 20-watt power amplifier the contacts have been very easy to come by. The razor sharp filters supplied by the PC software are most impressive. This rig has been an exciting adventure in homebrew and shows the added benefits of open source software on a community homebrew project! With software updates coming almost weekly it is mind boggling what a powerful transceiver this will be in another year!

Miscelleneous features

- A real time clock display shows UTC and local time, and date. The time is taken from the PC clock. If the PC clock is synchronized to an atomic clock, exact timing for weak signal modes is possible.
- The loop buffer in CW control permits automatically sending a beacon text.
- The display font can be selected between a standard Windows font and an LCD-like font.
- The HMI[9] software already has provision for controlling up to two transverters. The hardware I/O is present for controlling the transverters.
- Connections for an external power amplifier are available.

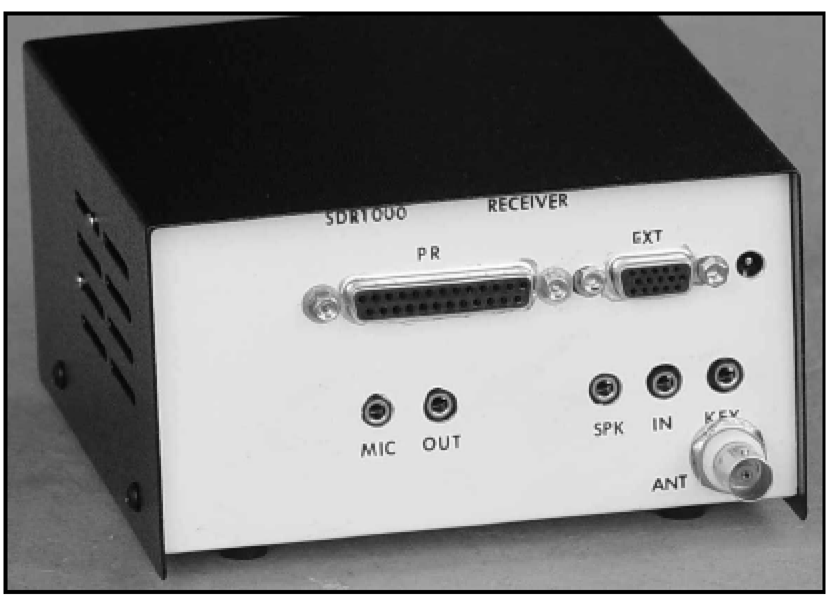


Figure 11: WD6CSV's SDR-1000 mounted in Jameco enclosure with transceiver connectors accessible on the rear panel. Others have used an empty K2 chassis.

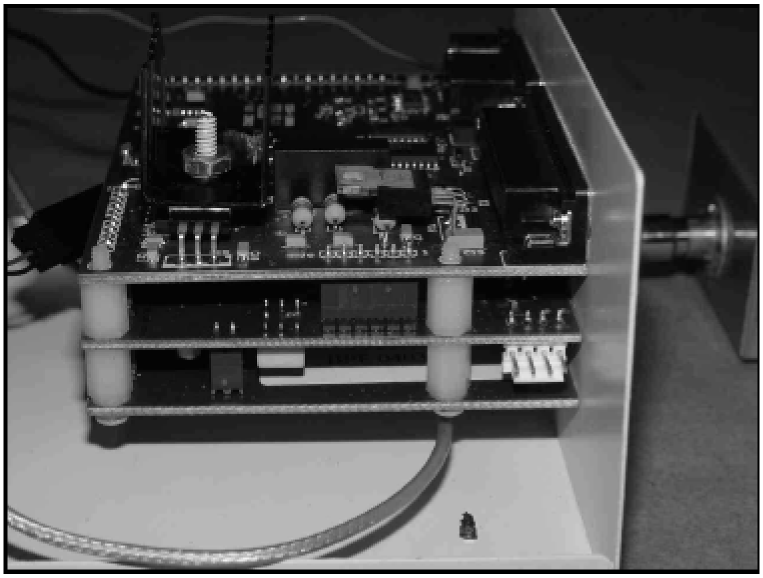


Figure 12: Board set and fan are mounted in the enclosure.

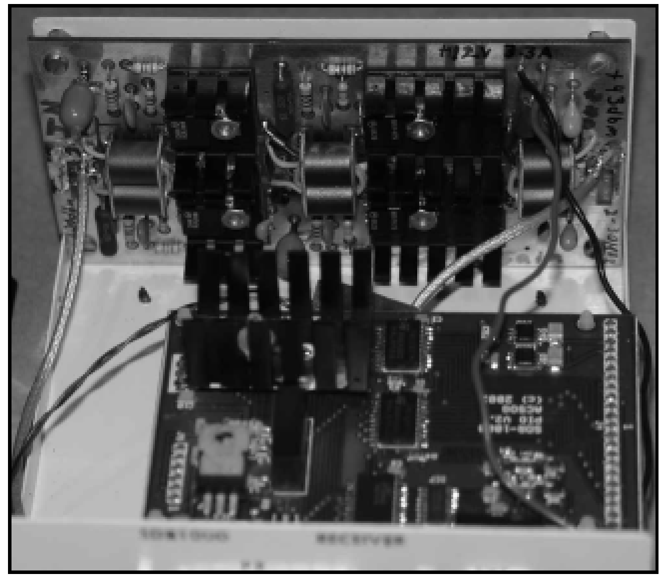


Figure 13: A Communications Concept linear amplifier board is mounted to the inside-rear of the enclosure.

More bells and whistles

Some of the leatest features added are a Synchronous AM detector (SAM) and a new forward Speech processor, a contribution by N4HY.

An elaborate spur reduction technique has been designed and implemented by N4HY.

If somebody really needs a physical tuning knob, Griffin Technologies has a great PowerMate control knob. There are many more valuable inputs from the SDR-1000 community -- too many to state them all explicitly, so check out the Flex-Radio BBS where all the users group messages are available.

Conclusion

The SDR-1000 gives the average ham access to leading-edge technology, allowing one to homebrew high performance ham radio equipment. The transceiver demonstrates modern digital signal processing at an understandable level of complexity. While it is a challenge to understand SDR, it is also a joy to be able to experiment with signal processing using this transceiver.

The SDR-1000 is fast on its way becoming a full-featured, multi-mode HF transceiver for experimentation and general everyday use. It demonstrates contemporary homebrewing at its best. Major thanks to AC5OG for bringing this project to us all!

NOTES

1) The authors can be reached as follows:
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2) Complete information on the SDR-1000 may be found on the Internet at FlexRadio Systems (http://www.flex-radio.com). The 3-board transceiver, including the open software, may be purchased online at FlexRadio Systems.

3) QEX is a regular publication of the ARRL. (http://www.arrl.org/qex/).

4) FlexRadio Systems is located at 8900 Marybank Drive, Austin, TX 78750

5) A binaural I-Q-receiver in the Receiver, Transmitter, Transceiver and Projects chapter of the 2002 edition of the ARRL Handbook, p. 17.109

6) DRM is "Digital Radio Mondial", a new broadcast modulation scheme producing near FM quality on shortwave channels. For further information see www.drm.org and www.drmrx.org

7) Similar to the PSK31 channel selection.

8) DSP means either "Digital Signal Processor" or "Digital Signal Processing"

9) Parts from Jameco may be ordered at www.jameco.com.

SIDEBAR ... *from Gerald Youngblood, AC5OG*

What a pleasure it has been to receive feedback from customers that the SDR-1000 has revived their excitement about experimentation in amateur radio. Their comments mirror my enjoyment as I worked on the Software Defined Radio (SDR) transceiver over the last four years. By opening the hardware and software design, customers are free to modify and contribute to product enhancements. It is fun to see that people much smarter than I are contributing code enhancements on a regular basis. Since introducing the SDR-1000 in April of 2003, a major enhancement has been made to the software almost every two weeks.

Just added recently by customer contribution were a CW keyboard keyer, DRM filtering, forward speech processing, AM modulation, synchronous AM detection, and PLL FM detection/modulation. A number of software enhancements are in the works, including an enhanced memory CW keyer, software noise blanking, and popular digital modes such as PSK31 and RTTY. It is truly exciting to have a radio that can be whatever you want it to be. I like to say, just dream it and code it. The cycle time from idea to reality with software enhancements can be minutes or hours, instead of days or months as it is with hardware.

Some customers have also ported the Linux based GNURadio to the SDR-1000. Others are using SM5BSZ's excellent Linrad software. One customer has even written his own version of the SDRConsole under .NET.

I am learning a lot about supporting the myriad of PC and sound card configurations that exist. It is essential to have a high quality sound card for use with the SDR-1000. Not all sound cards are created equal; in fact, most sound cards are of poor quality at best. The dynamic range and distortion products of the sound card will directly affect the quality of the SDR-1000 as a system. I recommend the Turtle Beach Santa Cruz as one of the best price/performance bargains on the market. Other excellent sound systems are the Creative Labs Audigy (PCI) and Extigy (USB). A reasonable performance PC is also required. I recommend a CPU speed of at least 600 MHz to run the latest software.

~Gerald, AC5OG email: gerald@flex-radio.com

*[**Editor's Note:** AC5OG recently received the ARRL 2002 Technical Excellence Award for his work with the SDR-1000. Congratulations!]*

George Heron, N2APB

NJQRP "DDS Daughtercard" ... a modular way to add stable signal generation to your next transceiver or VFO project

How many ways can you use a self-contained, high-precision dc-30 MHz signal source contained on a 1" x 2" plug-in circuit board? How about as a stand-alone VFO, a signal generator for your bench, a replacement LO for your Sierra or NC40 transceiver, or perhaps as the heart of an antenna analyzer! Control it with your favorite microcontroller, or even hang it off the parallel port of your PC. Any way you do it, you'll be generating quality signals for under $20.

Any homebrewer worth his/her salt can tell you that the Direct Digital Synthesis (DDS) chip captures the imagination and excitement like no other technology these days. Signal precision, accuracy, stability, programmability and RF output quality are all easily and inexpensively within one's grasp. But two quite formidable problems still remain.

The first problem is that these surface mount DDS chips are so tiny, with lead pitches as fine a 0.65 mm, that it's nearly impossible to homebrew with them using conventional techniques. Have you ever tried tack-soldering a fine wire onto one of these small SOIC package leads? Even soldering the chip onto a blank pc board that fans out the leads is going to take some precision soldering and a magnifying lens on your workbench lamp, and you'll end up with two layers of boards with this approach.

The second problem is that these DDS chips must be interfaced to a microcontroller that provides that frequency programmability. There are many projects around that control a DDS chip with a PIC, an Atmel controller, a BASIC Stamp, an SX chip, etc. I don't know about you, but the VFO I will ultimately need is likely to use a controller that I don't technically "know" and cannot program. This makes it tough to use the controller for anything but the DDS, thus raising the cost of the entire project, increasing the amount of board real estate needed, and raising the power needs for the entire project.

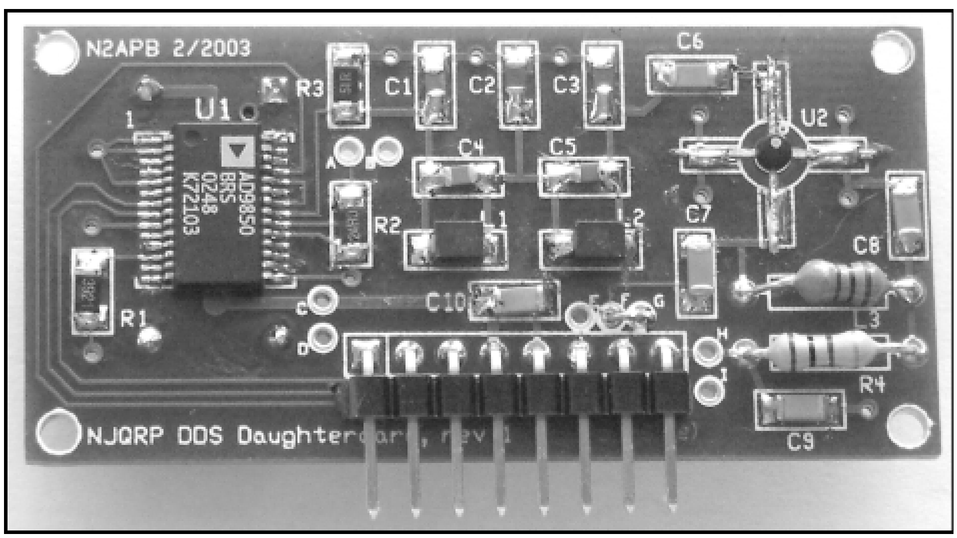


Figure 1: Close-up shot of DDS Daughtercard. Note use of SMT components to help in keeping size down.

Solution

The NJQRP has created a small pc board containing just the bare DDS essentials – an Analog Devices AD9850 DDS chip, a 100MHz clock oscillator, a 5th-order elliptic filter and a MMIC RF amplifier to boost the raw 0.4-Vpp DDS signal to a more usable 4-volt level. Additionally, a 5-V regu-

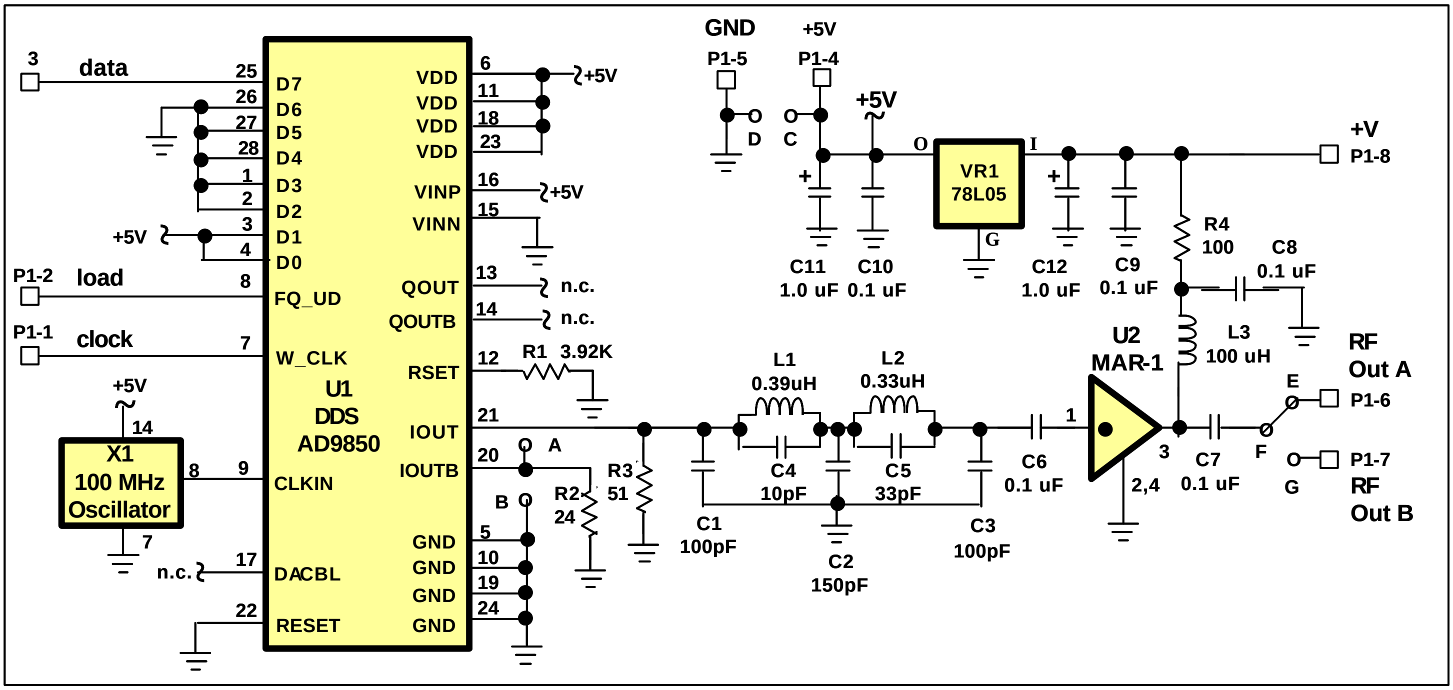


Figure2: Schematic for the DDS Daughtercard.

lator is provided so you only need provide a single 12-V battery or power supply. The three digital control lines, the power supply, and the output signal are all available on a pin header at the board edge. The simple schematic is shown in Figure 2.

The 8-position pin header at the board edge serves to allow DDS Daughtercard to be plugged into whatever project you might have on your bench, regardless of which microcontroller is being used. Thus you are not locked into using an Atmel device if your preferred controller is a PIC. Just provide a single strip socket (e.g., a 16-pin IC socket split lengthwise) on the project board and plug in the DDS pc board. Heck, you don't even need a microcontroller with this approach – just wire the pin header signals over to a cable on the parallel printer port of your PC and use public domain PC software to control the DDS board! See the sidebar section for a custom solution provided by NJQRP member Doug Quagliano, KA2UPW.

Once the 40-bit control word is serially loaded into the DDS, the raw waveform is presented to an elliptic filter that removes unwanted high-end frequency components, resulting in signal of sufficient quality to serve as a local oscillator for a transceiver. Refer to the AD9850 data sheets for signal purity specifications. This peak-to-peak signal is typically only about 400 millivolts, so we use a small 22 dB MAR-1 amplifier to boost that signal to about 7-Vpp, which is quite usable in a variety of applications. The amplified signal is then presented to P1-6 on the pin header when jumper E-F is in place.

The pc board was designed to present an interesting option for the homebrewer. The AD9850 DDS chip offers a complementary output at IoutB (U1 pin 20), which is sometimes uses to feed the low pass filter along with the primary output signal IoutA to produce an output signal of even greater spectral purity. (Refer to the AD9850 data sheets for these details.) However, this secondary signal is 90-degrees out of phase from the primary and may also be used as a "poor man's quadrature signal" with the primary. The chip is not officially specified to produce quadrature signals, as is done in the more expensive AD9854 DDS chip, but one could experiment and possibly find useful applications for it using this capability. If this IoutB signal is to be used, a low pass filter must also be used to clean up its output … and that's where the DDS Daughtercard's design options come into play.

If you wish to use the quadrature IoutB signal, you can populate a second Daughtercard pc board with only the LPF and MAR-1 amplifier components and mount it over the main 'card. You can electrically interconnect these stacked 'cards by jumpering pads of each at locations A, B, C, D and G. That is, solder a short stiff wire from pad A of the lower board to pad A of the upper board, and so on. The A and B jumpers bring the IoutB signal and ground up from the primary 'card so it can be injected to the LPF and amp on the secondary 'card. On the top (secondary) 'card, connect point A to the LPF input, and connect jumper E-G to bring the signal down to pin P1-7 on the pin header. Thus, one is able to get two filtered and amplified complementary signals at the same connector from the same DDS chip!

Building the Daughtercard

Although many of the components are surface mount devices, assembly of the pc board is still simple and straightforward. The board layout is fairly open and the components are all very accessible. You will need a fine-tipped soldering iron and some thin solder to best attach the components. You'll also likely need a magnifying lamp in order to see the small leads of the surface mount components.

A trick to soldering surface mount devices to pc boards is to (a) pre-solder on of the pads on the board where the component will ultimately go; (b) hold the component in place with needle nose pliers or tweezers on the tinned pad; (c) re-heat the tinned pad and component to reflow the solder onto the component lead, thus holding the component in place; and lastly (d) solder the other end of the component to its pad.

1) Attach DDS U1 – Following the technique described above, pre-solder pad for U1 pin 1, then carefully position the leads

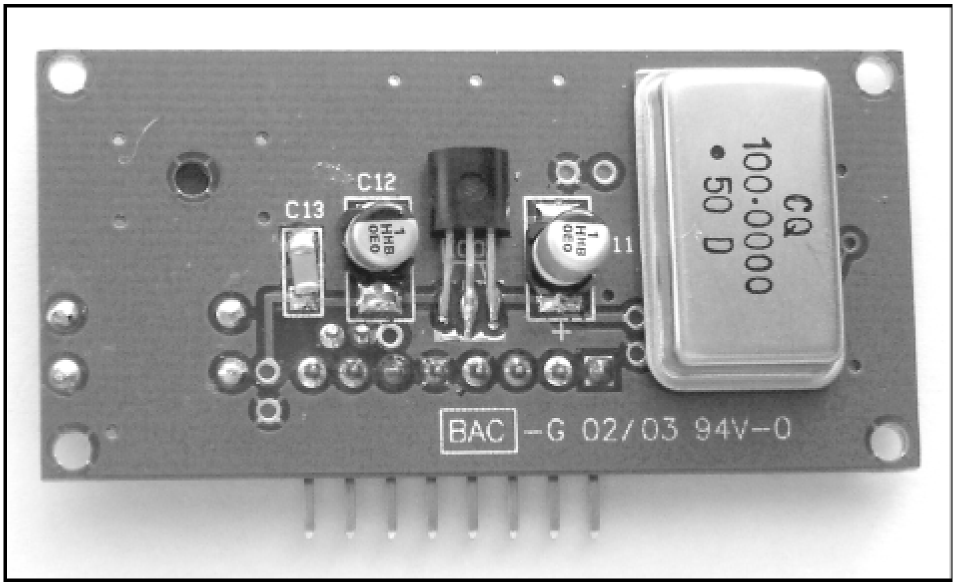


Figure 3: Back side of the Daughtercard showing the 5-V voltage regulator VR1 and its filter capacitors, and oscillator X1.

of U2 over the set of pads for this integrated circuit on the pc board and re-heat the solder of pad 1 to reflow the solder onto U1 pin 1. This should leave the IC attached by pin 1 and properly aligned over the rest of the pins. Solder each of the other pins to their respective pads, being careful not to bridge across any adjacent pads. If this does happen, grab some solder wick or a solder sucker and use it to draw off the excess solder, which should be fairly easy and clean because of the solder mask on the circuit board. (See Note 3 describing a resource that can be used if you need help attaching this IC to the pc board.)

2) Attach oscillator can X1 – Insert the metal oscillator can on the backside of the circuit board, carefully noting location of pin 1. Solder the leads in place and snip of the excess lead length.

3) Attach the surface mount capacitors (C1-C10), resistors (R1-R3) and inductors (L1 and L2) – Use the technique described at the start and you shouldn't have any problems. NOTE: Capacitor C13 on the back side of the board is not used.

4) Attach the VR1 voltage regulator to the pads on the back side of the board – Orient the flat side of the package against the board.

5) Attach the surface mount electrolytic capacitors (C11 and C12) – Align the negative side of the device (i.e., with the black mark) as shown in the photo.

6) Attach the axial lead components R4 and L3 – Bend each of the leads 90-degrees and insert into their respective locations as noted on the board silkscreen. Solder each lead to the pads and snip off excess lead length.

7) Attach the MAR-1 amplifier U2 – Drop the body of the device into the small hole provided for it, carefully orienting the dot on the package (denoting pin 1) closest to the dot on the silkscreen. Solder lead 1 to the pre-tinned pad, ensuring that the other three package leads are aligned over their respective pads. Solder those remaining three leads to the pads.

8) Attach pin header P1 – Insert the pin header as shown in the photo and solder all eight pins to the pads.

9) Insert jumper E-F – Using a piece of excess lead snipped off of a previously-inserted axial lead component, make a small "U" with the wire and insert it through pads marked E and F. Solder the pads and snip off excess length.

Powering up the Daughtercard

Apply 12-volts to P1 pin 8, and ground to P1 pin 5. The daughtercard will not generate any signal on its output until an external controller delivers a control word to the DDS, as described in the next section. However at this point you can ensure that proper voltages are present and that excessive current is not being drawn

Check to see that you have 5 volts on the output of VR1.

The board should be drawing about 100-ma. The voltage regulator, DDS, MAR-1 amplifier and its bias resistor R1 should all be warm to the touch, but not unbearably hot.

If you have an oscilloscope, you should see a 100 MHz signal being delivered from pin 8 of the oscillator can X1.

NOTE: If you intend on using the DDS Daughtercard with the NJQRP QuickieLab, you must cut the trace <u>on the QuickieLab board</u> that supplies 5 volts to the DDS Daughtercard socket. This is because the productyion version of the DDS Daughtercard produces its own internal 5-V supply and doesn't require that the QuickieLab supply it.

Controlling the DDS

The DDS chip needs to be sent a control word by an external controller before the Daughtercard is capable of generating a signal. No matter what controller you use, be it a PIC, a BASIC Stamp, a, HC908 Daughtercard or a PC, its software needs to serially send a 40-bit control word to the DDS Daughtercard on the DATA line (P1 pin 3). The controller clocks each bit into the DDS by the toggling the CLK control line (P1 pin 1). At the end of the sequence, the controller must load the accumulated control word into the DDS register by toggling the LOAD line (P1 pin 2), thus instructing the DDS chip to generate the frequency just loaded – then *bingo*, the new frequency appears on the output of the DDS board at P1 pin 8.

The AD9850 data sheet on the Analog Devices web site provides all the details on how to construct the control word with your microcontroller-of-choice. This information is also located on the NJQRP website, along with software programs for the HC908 and BASIC Stamp that control the DDS chip to serve as a basic VFO. These are great examples to adopt if you plan on using either of these processors in your own DDS Daughtercard project. They are also great examples on which you can model a software program using a different microcontroller.

The programming sequence is easily accomplished. Joe Everhart, N2CX, uses the following three lines to instruct a BASIC Stamp to produce a 7.040 MHz signal with the DDS Daughtercard plugged into the QuickieLab.

```
shiftout 7,8,0,[$02,$BC,$05,$12,$00]
out9 = 1
out9 = 0
```

The first instruction line shifts out the 40-bit value on port P7, using P8 as the clock. The second and third instruction lines toggle the LOAD pin going to the DDS.

Many Uses

There are many ways for you to use the DDS Daughtercard. The project is ready-made for plugging into the QuickieLab experimenter's platform provided by the NJQRP Club, with software that provides basic VFO functions. The daughtercard may also be used with the Antenna Analyzer II, coming in kit form later this year from the NJQRP. You may also plug the daughtercard into the HC908 Excerciser board described in the Digital QRP Breadboard project and use the software provided with that project to have it serve as a programmable VFO.

As described in the Sidebar, you can control the DDS Daughtercard from your PC. Just wire the daughtercard to the printer port cable and run some public domain software, or a custom program proivided by KA2UPW to have the PC serve as VFO controller.

Of course you can also design the DDS Daugtercard into your own custom project, using your favorite microcontroller chip as the "brains", be it a PIC, Atmel, Ubicom, or 8051-derivative processor. The possibilities are limitless!

This simple DDS Daughtercard project solves both of the problems described at the beginning of this article. It enables the homebrewer to easily take advantage of the positive attributes of the DDS chip to produce a high quality homebrew variable-frequency signal source. Let us know how you end up using your DDS 'card!

NOTES

1) The DDS Daughtercard Kit may be purchased for $18 from the NJQRP Club. The kit includes a silkscreened/soldermasked pc board and all components, except for the DDS chip (see Note 2 below). Make check or M.O. payable to "George Heron, N2APB" and send to: George Heron, 2419 Feather Mae Ct., Forest Hill, MD 21050. You may also order through PayPal by sending $18 to njkits@amqrp.org. Visit the NJQRP's DDS Kit website at www.njqrp.org/dds for further technical details, software programs and application information.

2) The AD9850BRS DDS chip is not provided because homebrewers can obtain two free samples from the Analog Devices website at http://products.analog.com/products/info.asp?product=AD9850. Just go to this Internet location, register with Analog Devices (i.e., give them your mailing address), and within a week or so you will receive two free samples of the DDS chip by mail.

3) The NJQRP has lined up a great resource to assist in soldering the DDS chip onto the printed circuit board. Once you've acquired your free AD9850BRS DDS chip from Analog Device, send the chip and your DDS Daughtercard circuit board, to Mike, WA6OUW, at "KitBuilders". For $6 he will attach this surface mount chip to the pc board and return it promptly by mail. It's not tested because at that point it's only the DDS chip on a bare pc board, but Mike does excellent work. (The NJQRP uses KitBuilders for assembly of the HC908 Daughtercard product, so we know the quality is there!) Just place your DDS chip, pc board and a $6 check or M.O. payable to "KitBuilders" into a padded envelope and send to: KitBuilders, 1630 San Miguel Canyon Road, Watsonville, CA 95076. You can contact Mike by email at wa6ouw@aol.com if you have further questions.

4) Details of the NJQRP QuickieLab project can be found at www.njqrp.org/quickielab.

5) Details of the HC908 Daughtercard project can be found at www.njqrp.org/hc908.

6) George Heron, N2APB may be contacted by email at n2apb@amqrp.org, or by mail at 2419 Feather Mae Ct, Forest Hill, MD 21050.

SIDEBAR ... Control the DDS Daughtercard from your PC

by Doug Quagliano, KA2UPW, email: dquagliana@aol.com

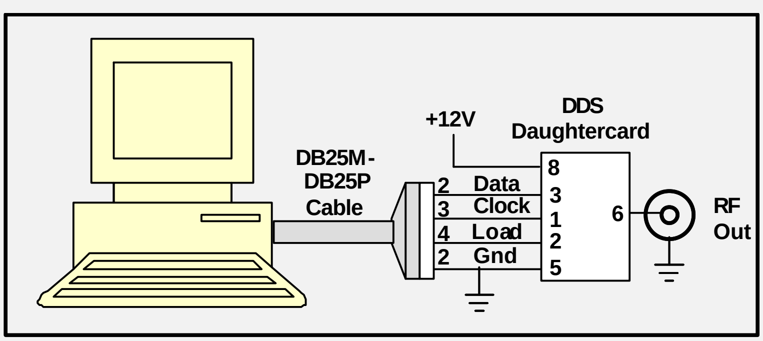
Here's a software program call "SetFreq" that I've been developing for my PC to control the DDS Daughtercard when connected to its parallel printer port. Using this set up, I'm able to use my PC to set specific frequencies with the daughtercard.

Set Frequency (Version 0.99) for Windows 95/98

1. Set "TTL Clock Freq" to your TTL oscillator frequency in Hertz.

2. Set "Output Freq" to the desired output frequency in Hertz from the DDS Daughtercard.

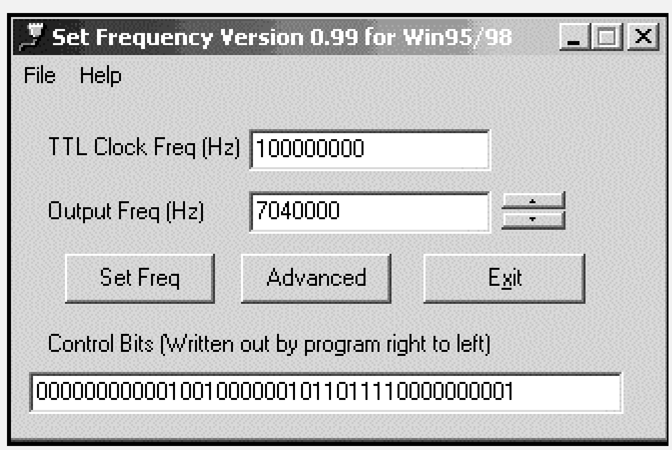
3. Click on "Set Freq" to send the control bits to the DDS. The program automatically writes data to DATA0 (zero or one), writes CLOCK to DATA1 (zero or one), and raises FQ_UD as DATA2.



Here's what the program does:

- Sets all pins low
- Computes and outputs the 32 tuning bits. Tthe program writes 01,03,01 for a one and writes 00,02,00 for a zero, then toggles the CLK line
- Outputs eight zeros for the control byte.
- Toggles LOAD (the program writes 04,00 momentarily raising this bit).

[SetFreq software is available on the Daughtercard web page.]



Jim Kortge, K8IQY

Building the NorCal Keyer Kit ... a construction guide for the beginning builder

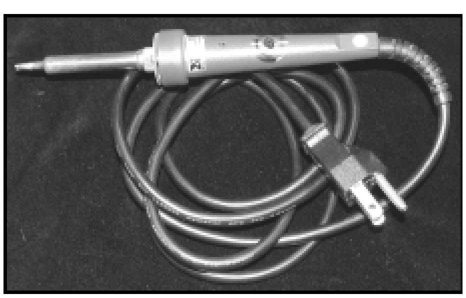
The NorCal Keyer is wonderful training project for beginning homebrewers. It's a programmable iambic memory keyer with beacon, straight key and bug modes, and variable speed control. Veteran elmer K8IQY takes us through construction of this useful kit.

This article covers the construction and packaging of the recently released NorCal Keyer Kit. It approaches these tasks as a learning exercise for new builders, so that they can develop proficiency and self-confidence. The kit itself is quite simple. It includes a printed circuit (PC) board, 7 capacitors, 4 resistors, 3 semiconductors, a small speaker, and a push button switch. One of the semiconductors is a PIC microprocessor, which provides most of the keyer's functionality.

A few user-supplied components are required too, including a small 100K potentiometer, jacks for input and output connections, a battery connector or box, and a case. The kit is designed for packaging in the ever-popular Altoids mint tin.

Basic Tools

To build this kit requires a few basic electronic hand tools. The first is a suitable soldering iron.



This iron is an inexpensive, adjustable 25-40 watt unit, and quite suitable for constructing this type of kit.

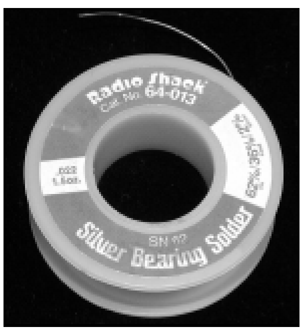
Anything between 25 and 40 watts is usable, with at least a 1/16-inch wide chisel tip. However, tips that are closer to 1/8-inch will provide better heating of the joint being soldered. While a temperature controlled soldering station is very nice, one can get by nicely with a much more modest solder iron setup.

If you have never soldered any electronic parts, a little practice before starting on your kit might be in order. Go to your local Radio Shack, or other parts store, and buy a few small resistors and capacitors. If they have any sort of perforated PC board material available, get some of that too. You can practice putting the parts through the holes, bending the leads slightly, and soldering them in. Do not clip off the leads; the parts can be unsoldered and reused for more practice. If you can't find any perforated PC board material, buy a piece of blank PC board material, and drill several holes in it spaced the lead width of the parts you have available, and use that for practice. Another approach might be to take apart an old wireless telephone and remove the existing parts by heating the PC board with a small torch and rapping it on a solid surface to knock them out. Wear eye protection when using this method for parts removal!

Soldering a part requires placing the tip of the soldering iron against the component lead and the PC board surface, heating it for a few seconds, and then adding a little bit of solder. If the joint is hot, the solder will flow quickly. Once the solder has flowed, remove the soldering iron and the solder, and let the joint cool. If the job was done correctly, the solder will have flowed smoothly, and the joint will look shiny. Later in this article are many examples of correctly soldered joints.

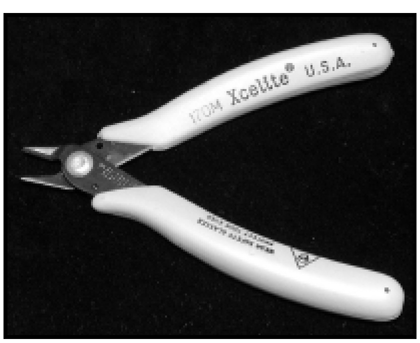
Solder plays a key role in electronics construction. The right kind will work well, and is easy to use. The wrong kind can be hellish! A suitable solder for electronics work will contain approximately 37% tin, and 63% lead. Anything around those two values, with a rosin flux core is suitable. Do not use “no lead” solders intended for plumbing; they will not work well. Nor will solders with acid flux cores. Also, stay away from solders with water-soluble (organic) fluxes. While they seem to work well while building, failure to remove all of the flux later will lead to corrosion where the flux remains. This is also true of any acid flux core solders.

The best solders also contain about 2% silver. This improves conductivity of the joint, and keeps it bright looking.



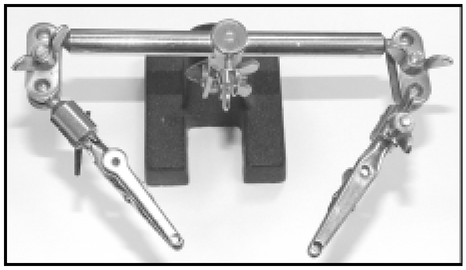
This photo shows a small roll of solder containing 2% silver, and readily available from Radio Shack. Kester also makes a similar product that is available from Mouser and DigiKey.

The other basic tool that one needs, especially when soldering a PC board, is a pair of side cutters. These are used to clip off the excess lead length of parts soldered into the PC board.



My favorite side cutters. These are made by Xcelite, and are available from Mouser, DigiKey, and others supply sources.

Another tool that is very handy to have, but not a necessity, is a “third hand” apparatus of some kind.



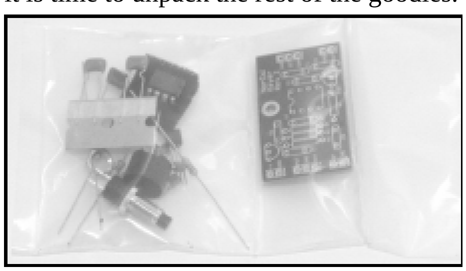
A commercial “third hand”. One of these will hold the PC board while parts are being soldered, or hold parts while leads are being attached. One could make the equivalent of this unit with a pair of “pincher” clothespins, a small block of wood, and a bit of fabricating.

Getting Started

Since the version of the NorCal Keyer kit I was asked to build included the “user supplied parts”, my kit came in a box instead of an envelope. On the very top of the stack were the instruction sheets. With the box (or envelope) opened, most builders are “chomping at the bit” to get building, and want to toss the documentation aside.

For a new builder, this information is important. It contains an overview of the kit, important construction information, parts lists, a schematic diagram, and a parts layout template for the PC board. My advice is to read it completely, at least once before beginning construction, and the “General Notes About Building”, “Construction Notes”, and “Parts List” a second time before going further. When you start unpacking your kit, you will have a good bit of sense regarding how the kit functions, and what parts were supplied.

Once the documentation has been read, it is time to unpack the rest of the goodies.



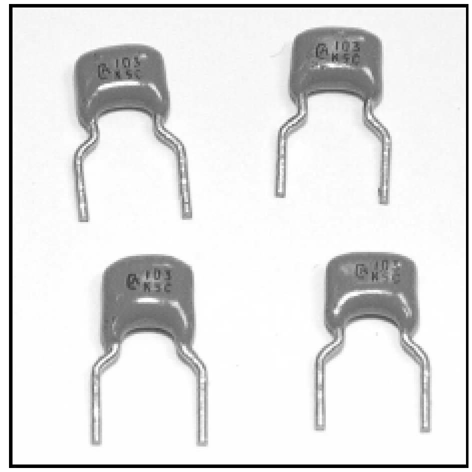
Inside the Altoids tin were the “normally supplied” kit parts, all sealed in plastic.

With the parts packet is opened, one should check its contents against the parts list contained in the documentation to make sure all of the parts are there. If any parts are missing, replacements can be obtained from the AmQRP Club.

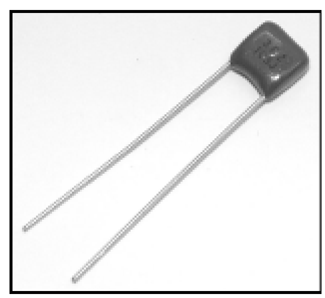
Keyer Parts Identification

When you have built several kits, knowing what a resistor is, and determining its value is almost taken for granted. When it is your first kit, however, recognizing resistors, capacitors, transistors, regulators, and PICs can be a bit daunting. Since this article is for beginning kit builders, a number of pictures were taken to help with this task. Using the parts list in the supplied documentation as a guide, all of the parts in this kit will be previewed, and their external features described.

Capacitors C1, C2, C3, and C5 – These four capacitors have a value of 0.01 uF, are blue in color, and marked as 103.



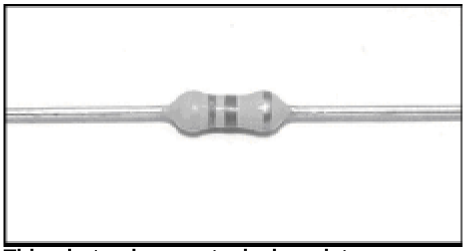
The 103 designator translates into 10,000 pico Farad, which is the same as 0.01 micro Farad.



Capacitor C4 – This capacitor also has a value of 0.01 uF, is brown in color, but has a different internal construction, making it stable with temperature changes.

Capacitors C6 and C7 – These capacitors are much like the set with C1, only 10 times larger in value. They have a capacitance of 0.1 uF, are also blue in color, and marked as 104. The 104 designator translates into 100,000 pico Farad, equivalent to 0.1 micro Farad.

This kit contains four resistors. The first, designated R1 has a value of 4.7 kilo Ohm (4700 Ohm), and is marked with colored bands of yellow, violet, and red. The first two colored bands provide the first two digits of the numeric value, the third band the multiplier, and the last band the tolerance.



This photo shows a typical resistor.

Resistor R2 is a 1 kilo Ohm (1000 Ohm) unit, with bands of brown, black, and red.

Resistor R3 is ten times greater in value than R2. It is a 10 kilo Ohm (10,000 Ohm) unit with bands of brown, black, and orange.

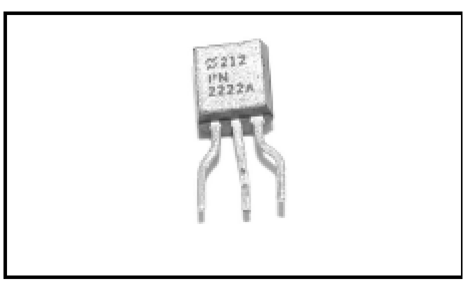
The last resistor is R4, whose value is ten time greater than R3. It is a 100 kilo Ohm (100,000 Ohm) unit with bands of brown, black, and yellow.

By now, you have probably figured out most of the resistor color code. Here it is in its entirety.

Color	Value
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

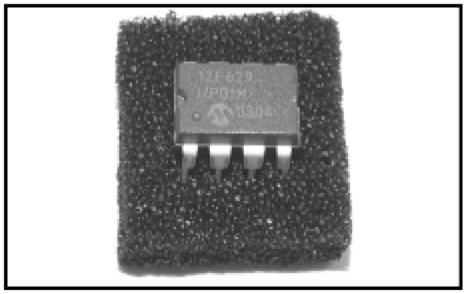
If you are curious about the tolerance bands, you might try researching that information on the Internet.

There are three active components in this keyer.



The first active componnt is a PN2222A transistor, designated as Q1.

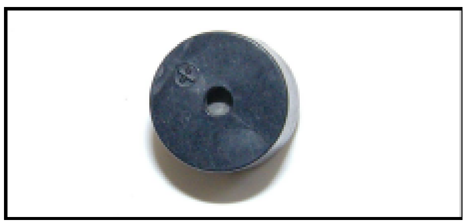
The next active component is designated as U1, and is the heart of the keyer. U1 is the PIC microprocessor, which comes with the software (actually firmware) already stored in the chip's memory area. This part provides all of the functionality provided by the keyer.



Notice that this 8-pin DIP chip is supplied with its leads pressed into conductive foam. This chip is sensitive to static charge, and keeping it plugged into conductive foam shorts all of its leads together so that it is not damaged by shipping or handling.

A five-volt regulator, designated U2, is the last active part supplied with the keyer. It is the same size and shape as the transistor. However, the printing on it, which is difficult to read, identifies it as a 78L05.

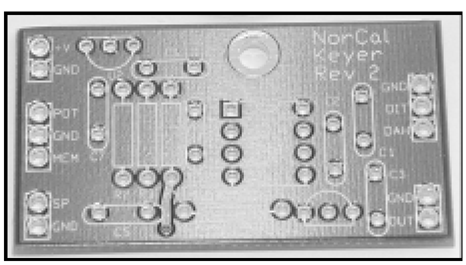
Two non-PC board mounted parts are also included. One is a small piezoelectric speaker, called out as SP1.



This is the same kind of speaker used in modem cards.

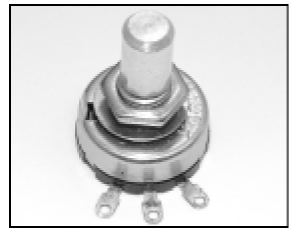
The other kit supplied off board part is a small push button switch, designated as SW1 on the schematic diagram.

Not mentioned in the Keyer Parts List is the supplied printed circuit board. This is a high quality, double sided board, with plated through holes, solder mask, and silk screened parts labels.



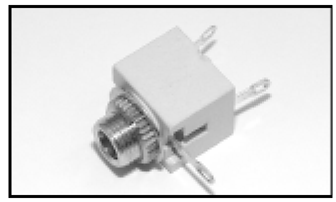
The component side of the PC board is shown here.

Four "user supplied" electronic parts are also needed to complete the keyer, along with a suitable case for packaging the unit. The first of these parts is a 100 kilo Ohm (100,000 Ohm) linear potentiometer, which controls keying speed.



The potentiometer used for this article. It is a 17-mm diameter pot with a ¼-inch shaft, and can be obtained from Mouser Electronics, their part number 31CN501. Other smaller, but more expensive pots are also available from this source.

The next part needed is a 1/8-inch, stereo jack for connecting the paddles to the keyer.



This stereo jack is also available from Mouser as part number 161-3501. It might also be available from your local Radio Shack or electronics parts store.

A 1/8-inch mono jack is also required. This jack connects the keyer output to your transceiver, if the keyer is being used "on the air", instead of as a code practice oscillator. This jack is Mouser part number 16PJ137, and may also be available at a local electronic parts store.

As designed, the keyer is powered from a 9 volt battery, and so a battery connector is needed

Mouser carries this battery connector as part number 123-6004. Radio Shack also carries this type of connector.

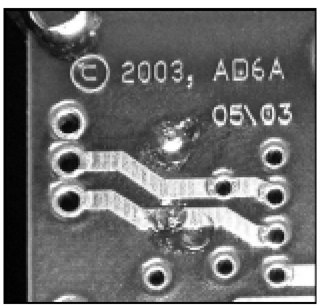
The last part needed is a suitable case. This one is easy! The keyer was designed to fit into an Altoids tin. Most grocery stores and pharmacies carry these mints, in a variety of flavors. Buy the flavor(s) that you like, eat them, and you have the case.

(P7190007) The "Wintergreen flavored" Altoids case makes a fine enclosure for this project

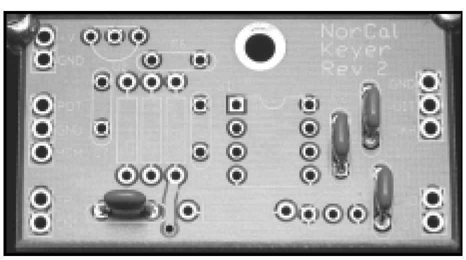
Keyer PC Board Construction

Enough of the basics; it is time to build! We will begin by soldering the parts (also called "stuffing") into the printed circuit board. Generally, it is best to start with passive parts, the resistors and capacitors, and follow those with the active parts. This approach ensures that circuitry exists around the leads of static sensitive components, which protects them when they are soldered. Another good general rule to follow is to solder in the smallest parts first. This prevents a larger part from obscuring a smaller neighbor, which would make stuffing and soldering more difficult. As the parts are added to the PC board, the parts list can be used as a "checkoff" sheet to assure nothing is missed.

Following this approach, the first part to be mounted is C1, one of the 0.01 uF, blue colored capacitors. This parts leads are placed through the appropriate holes in the PC board, and bent slightly outward on the bottom side of the board to hold the part in place. The leads are soldered, one at a time, and the excess lead length clipped off with the side cutters,



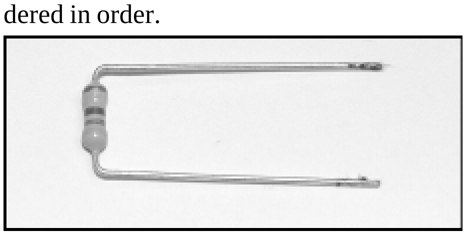
After soldering in C1 the bottom of the board looking like this.



In like manner, capacitors C2, C3, and C5 can be soldered in place, resulting in a PC board which looks like that shown here.

With these parts soldered in place, check them off on the parts list.

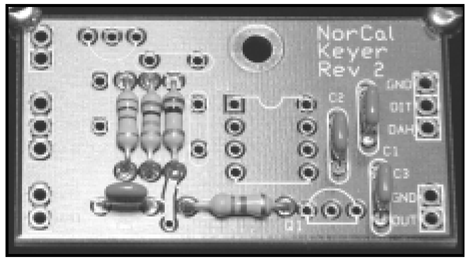
Resistors R1 through R4 are next soldered in order.



Starting with R1, bend the leads close to the body, so that it looks like this.

Fingers work well for this task, as do a small pair of long nose pliers. Slip the part into the PC board so that the body of the resistor lays on the surface.

Bend the leads outward. Solder the leads to the pads and clip off the excess lead lengths.

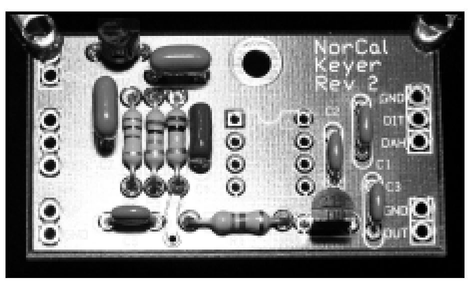


When the remaining three resistors (R2 through R4) have been mounted using the same steps as before, the board will look like this.

Check these parts off on the parts list also.

Following the smaller part, larger parts approach, C4, the brown 0.01 uF capacitor is now soldered in place. This part can now be checked off on the parts list. In like manner, solder in C6 and C7, the blue 0.1 uF capacitors. Check off these two capacitors on the parts list.

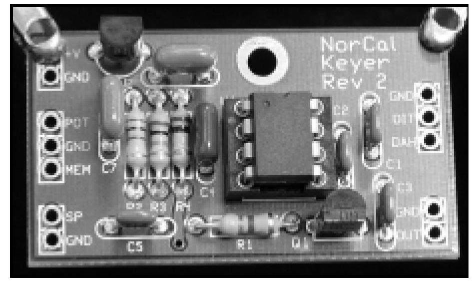
Now that all of the PC board mounted parts are in place, the active components can be placed. Start with Q1, the PN2222A transistor. Make sure the leads are straight, and spaced apart to match the mounting holes. Follow this part with the installation of U2, the 5-volt regulator.



With Q1 and U2 installed, the board will look as shown here.

Finally, solder in the PIC chip, or preferably, an 8 pin socket for the chip. Using a socket allows one to easily remove this device should it fail, or replace it if an updated version becomes available. Make sure the device or socket is oriented properly before soldering, and only solder two opposite pins initially. Recheck the orientation again before soldering the remaining pins. It is much easier to remove the chip or socket with only two pins soldered, than with all eight. Check off these three active parts on the parts list.

Finally, if you have opted to use a socket for U1, bend the leads to fit, and plug in the chip.



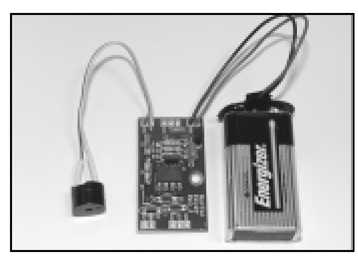
The completed board.

With the PC board finished, one more optional operation can be performed. Using some isopropyl alcohol and an old tooth brush, clean the flux off the solder side of the PC board. While this step is not necessary, since the rosin flux is nonconductive, cleaning the board makes it look much nicer.

Keyer External Parts Construction

Before the PC board can be initially tested, two of the external parts must be attached. First, the piezoelectric speaker, SP1 must be wired in, followed by the battery connector. Solder a pair of small gauge insulated wires (#26 is a good choice) about 4 inches long to the speaker leads. A good choice for wire are small sections of multiconductor cable available from electronic supply houses. Solder the other end of this pair to the appropriate holes in the PC board. Solder in the leads from the battery connector also.

With these connections made, attach the battery. The keyer should send "FB" (short for "Fine Business") in Morse code at 16 words per minute (WPM).

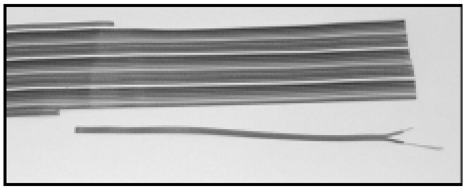


The keyer set up to perform the initial tests.

If it does not send "FB", follow the trouble shooting steps in the provided documentation. Assuming that "FB" is heard, disconnect the battery so that the remaining external parts can be connected.

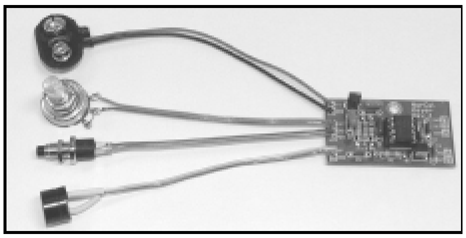
Prepare a set of 4-inch leads for the potentiometer, VR1, as shown on the next page.

Solder these to the potentiometer terminals. Prepare another set of leads and solder these to switch, SW1. Solder the leads



for these parts into their respective holes in the PC board.

Repeat these steps for preparing leads for the two jacks, using three leads for the stereo jack, and two leads for the mono jack. Solder the leads to each jack. Solder the respective ends to the correct holes in the PC board.

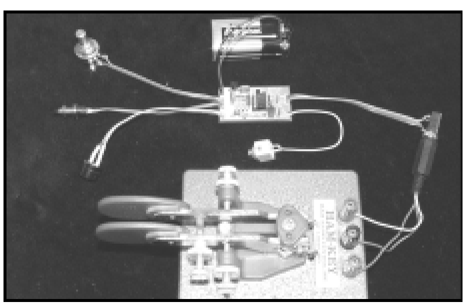


The PC board and external components will look like this.

The keyer is complete now, and ready to be fully tested, and then mounted into an appropriate case. Those steps are next.

Keyer Functional Checkout

Beginning on page two of the supplied documentation is an “Operation” discussion. Follow what is written there to check out all of the full functionality and capability of the keyer.



This photo shows the keyer, with paddles attached, during this testing.

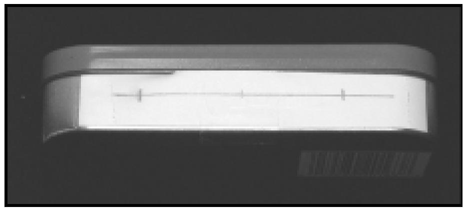
Once satisfied that everything is working correctly, disconnect the battery, and move on the packaging phase of this project.

Packaging the Keyer

This section assumes an Altoids tin will be used to house the keyer. All controls are mounted on the front and back surfaces of the tin, to preserve the graphics on the lid and bottom. If another type of case is used, follow the general approach that is described, with appropriate changes to accommodate what you have selected. Here are the steps that can be used.

1) Apply paper, using clear tape, over the areas where holes will be created.

2) Mark the affixed paper where the centers of the holes are needed, and note the required hole sizes on a sheet of paper.



This photo shows the front of an Altoids tin, at this stage in the process.

3) Punch or drill holes of the appropriate size at the required locations. Punching holes works better than drilling if the tools are available, as the very thin metal in an Altoids tin tends to tear while drilling. If drilling is the only option available, clamp a piece of wood beneath the area to be drilled, for support.

4) Mount all of the external controls in their respective holes. The output jack was mounted on the rear panel of the tin, just below the hinge location.

5) Attach to PC board to the case floor with two small strips of 1/8-inch thick double sided foam tape. Super glue can be used to affix the speaker to the case top, making sure that its leads will pass by the right edge of the PC board when the case lid is closed.

Attach the 9 volt battery to the floor of the case using a small strip of Velcro (hook and loop) tape, so that it can be easily removed and replaced when dead. This arrangement will also allow the battery to be removed, if the power connector cannot be snapped off when the battery is installed. Note that no power switch is used; disconnecting the battery fulfills that function.

With the battery installed, the keyer looks like this.

As a final packaging touch, small rubber feet were placed on the bottom surface at each corner to elevate the keyer approximately 3/16-inch above its resting surface. This provides easier access to the controls and jacks.

This photo shows the completed keyer from the front. No control labeling was applied due to time constraints. Rub on or P-Touch ™ type labels could be applied to the blue areas on the front and rear surfaces of the lid, above the controls, if desired.

Final Comments

It took about two days to build this keyer, including all of the photography that accompanies this article. For a beginner, that same time frame would make sense, or perhaps a day longer. The key is to proceed slowly and carefully, to minimize making mistakes. Those take an inordinate amount of time to undo, and are very frustrating for beginning builders. Remember to read the documentation before you unpack all of the parts, and reread the critical sections before you start building.

This keyer is an excellent beginning builders project. It is logical to assemble, well documented, and modestly priced. In addition, it works wonderfully well, both for sending CW “on the air” or in use as a code practice oscillator setup. Either way, it is another winner from NorCal!

Hopefully, you find the information presented informative and useful. If you have comments or questions, please let me know.

72 and happy building!

NOTES:

1) The author can be contacted at:

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Fenton, MI 49430-0108
jokortge@prodigy.net

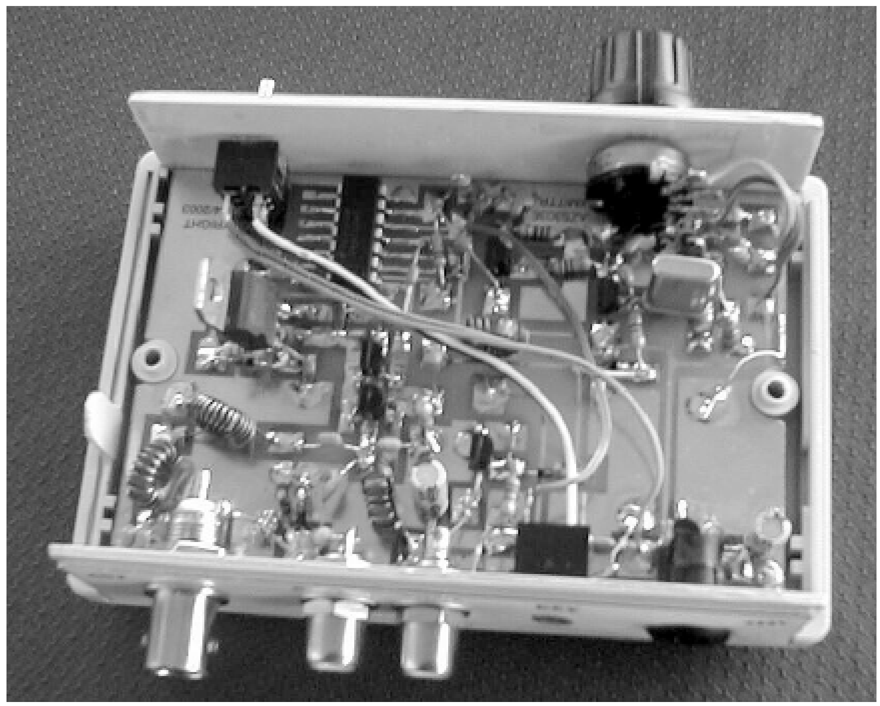
2) An expanded version of this article, including color photos, will soon appear on the NorCal Keyer project website (www.amqrp.org/kits/NCkeyer).

3) The NorCal Keyer Kit is available from the NorCal QRP Club. Write $15 check or M.O. payable to “Doug Hendricks” and send to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

Jerry Haigwood, W5JH

The AZ ScQRPions AZSX-303E Transmitter

Build this easily constructed, stable-frequency and low-cost 3-5 watt Class-E transmitter for use on 40-30-20 meters. With efficiencies greater than 95%, what more could you want!



QRP transmitters have not progressed much in the last 10 years. Most QRP transmitters for CW use are classic Class-C designs achieving 50-65% efficiency with most around the 50% mark (some *below* 50%). Recently, several designers have been experimenting with Class-E transmitters. Paul Harden, NA5N, discussed Class-E transmitters at the 2002 Pacificon gathering as well as writing several articles on the same subject. Steve Weber, KD1JV, has designed several Class-E transmitters and documented them on his web page <www.qsl.net/kd1jv>. Nathan Sokal, WA1HQC, wrote an excellent article titled "Class-E RF Power Amplifiers," which appeared in the Jan/Feb 2001 issue of QEX magazine. All of these authors/designers have reported similar results. Using Class-E designs, efficiencies as high as **95%** have been reported. High efficiency means lower current for a fixed output power – just what we want for to-the-field battery operation.

What is Fort Tuthill?

Every year during the last weekend in July, the Arizona ScQRPions radio club sponsors a QRP gathering at the ARRL Arizona State Convention held at Fort Tuthill near Flag Staff, Arizona. This gathering is commonly referred to as simply "Fort Tuthill." At this QRP gathering, there is usually a building event. In the past we have built different kits, and had a couple of years of "junk box wars." This year, I suggested we design and build a Class-E transmitter. Since I suggested the transmitter, I was asked (volunteered!) to design the kit. Dan Tayloe, N7VE, volunteered to help with the design and act as a consultant. Dan and I set out to design a simple, *universal*, 3-5 watt Class-E transmitter.

Some of the design goals included:

- Class-E final using MOSFETs
- Universal design able to operate on 40, 30, 20 meters
- Stable frequency control
- Easy to build/duplicate
- Low cost

Steve Weber's work on Class-E transmitters was the inspiration for much of our design. Refer to the schematic for the AZ ScQRPion AZSX-303E transmitter.

The Circuit

For discussion purposes, the transmitter can be broken down into four sections. These are:

- Voltage regulator
- VXO
- Keyer/Squarer/Mute
- Final Amplifier.

The Voltage Regulator

The transmitter was designed to use battery voltage (12.5 V). It is capable of operating down to 9 V with some reduction in output power. With this transmitter, you will not have to QRT when your battery voltage drops to below 12 V. In order to stabilize the VXO and to use 74AC logic, the battery is regulated down to 6 V. That is the job of U1, an L78L06ACZ voltage regulator. This part requires a margin of approximately 1.8 V. So, operation down to 7.8 V is possible although the efficiency may suffer since the output tank circuit is designed for 12.5 V operation.

The VXO

The VXO is a Colpits design using a 2N4401. C6 and C7 provide the feedback to start the oscillation. RFC1, C5, and diode D1 along with R1-R3, and C4 are used to pull the frequency of the crystal X1. The range of pull is approximately 3.5-4 kHz. The frequency of X1was chosen to be near the QRP watering holes (7.040, 10.116, and 14.060 MHz). Norcal crystals are used. The oscillator is keyed by applying 6 V to the anode of D2. The output of the oscillator is buffered and amplified by another 2N4401 to approximately 3 Vpp.

The Keyer/Squarer/Mute Circuit

A 74AC02 quad 2 input nor gate was selected as the keyer/squarer circuit. Only 2 gates of the 4 available are used. The key connects directly to the inputs of both gates (U2A and U2B). A debounce circuit consisting of R10 and C11 helps reduce any key contact bounce. Upon key down, the output of gate 1 (U2A) provides 6 V. This keyed 6 V is used to turn on the mute switch Q3, bias on the oscillator, set a 3V bias on the gates of the final transistors and key the transmitter on through Q6. Key down also allows the oscillator to pass through U2B causing the oscillator to be squared up into a 0-6 Vp-p square wave. This 0-6 Vp-p signal is applied to the final transistors to switch them on/off.

The Final Amplifier

The final amplifier is a Class-E design using a pair of TO92 style plastic MOSFETs. No heat sink is required for normal use. The efficiency is high enough that at 4 watts output, the MOSFETs are operating well within their normal ratings. The final MOSFETs are biased at 3 V at key down. Also, as explained above, a 6-Vpp signal is applied to the finals. Since the MOSFETs start to conduct at 1.8 V, the 6 V will alternately drive the MOSFETs into saturation and then off. Current will only flow for the short time that the MOSFETs are turned on. Capacitors C19-C21, along with the internal capacitance of the final transistors and inductors L2 and L3, form a classic Class-E tank circuit. Much has been written in the past few years about the Class-E tank circuit. However, Nathan Sokal's article titled "Class-E RF Power Amplifiers," which appeared in the Jan/Feb 2001 edition of QEX magazine, provides more information than any other single article I have seen. It is definitely recommended reading. The values for the Class-E tank circuit were calculated using the formulas developed by Mr. Sokal. Dan Tayloe developed an excellent Excel spreadsheet of Mr. Sokal's equations making the calculation of Class-E tank circuits a breeze. C22, L4, and C23 form a PI matching circuit/low pass filter to match the 15-to-18-ohm output impedance of the Class-E tank circuit to a 50-ohm load. C19, D6-D9, and RFC2 provide a QSK switch for the receiver.

Building the Transmitter

The Arizona ScQRPions QRP club is offering this transmitter as a kit. All board mounted parts and R1 (potentiometer) are included along with an etched Manhattan style PCB.You will need to provide a box, connectors, knob, and switch. The kit sells for $20 postpaid. Contact Bob Hightower, NK7M, <nk7m@extremezone.com>, for more details.

If you prefer to "roll your own," most all of the parts are available from Mouser Electronics <www.mouser.com>. The crystal can be obtained from Norcal <www.amqrp.org>. Before building the transmitter, you must decide which band the transmitter will be built for. The parts list shows both universal parts and band specific parts. Be sure you select the correct band specific parts for the band of your choice. The transmitter can be built manhattan style using a board size of approximately 2.5 x 4 inches. The board can be divided into four sections. The upper left section can hold the regulator and mute circuit. The lower left section can hold the VXO and buffer. The upper right section can hold the final amplifier.The lower right section can hold the keyer/squarer. The build and test method of construction is the best method I have used. I build a small section (e.g., the regulator/mute circuit) and then test it before moving on to do another section. Using this method, problems can be found and fixed before moving on.

Tune up/Operation

Very little tune up of this transmitter is required. You will need to connect the transmitter to a dummy load and provide some method of monitoring the output power. I use a scope connected across the dummy load for this purpose. You will also need to monitor power supply current. Connect the dummy load, power supply or battery, and key to the transmitter. Key the transmitter and measure the power output and power supply current. The efficiency of the transmitter is the output power divided by input power. If it is putting out 3.5-4 watts at an efficiency of 80% or more, you don't need to do anything. If the efficiency is down or power output too high or low, squeeze or spread the windings on inductors L3 and L4 one at a time. Re-measure the output and efficiency. You are shooting for 3.5-4 watts output at 80% efficiency or greater. I have measured this as high as 90%. The 20 meter version may have a slightly lower efficiency but it still should be 75% or better. This transmitter is capable of putting out 6-8 watts; however the final transistors won't last very long at that level and the efficiency may suffer. This transmitter was designed for 3.5-4 watts using a 12.5V power supply and that is where it should be operated.

Operation of this transmitter is no different from any other transmitter. Just hook up the receiver, mute line, antenna, key and power. You should exercise caution while adjusting any antenna or transmatch. Use of the Dan Tayloe SWR indicator is highly recommended, as it will keep the SWR seen by the transmitter to a maximum of 2:1 while adjusting the transmatch.

Conclusion

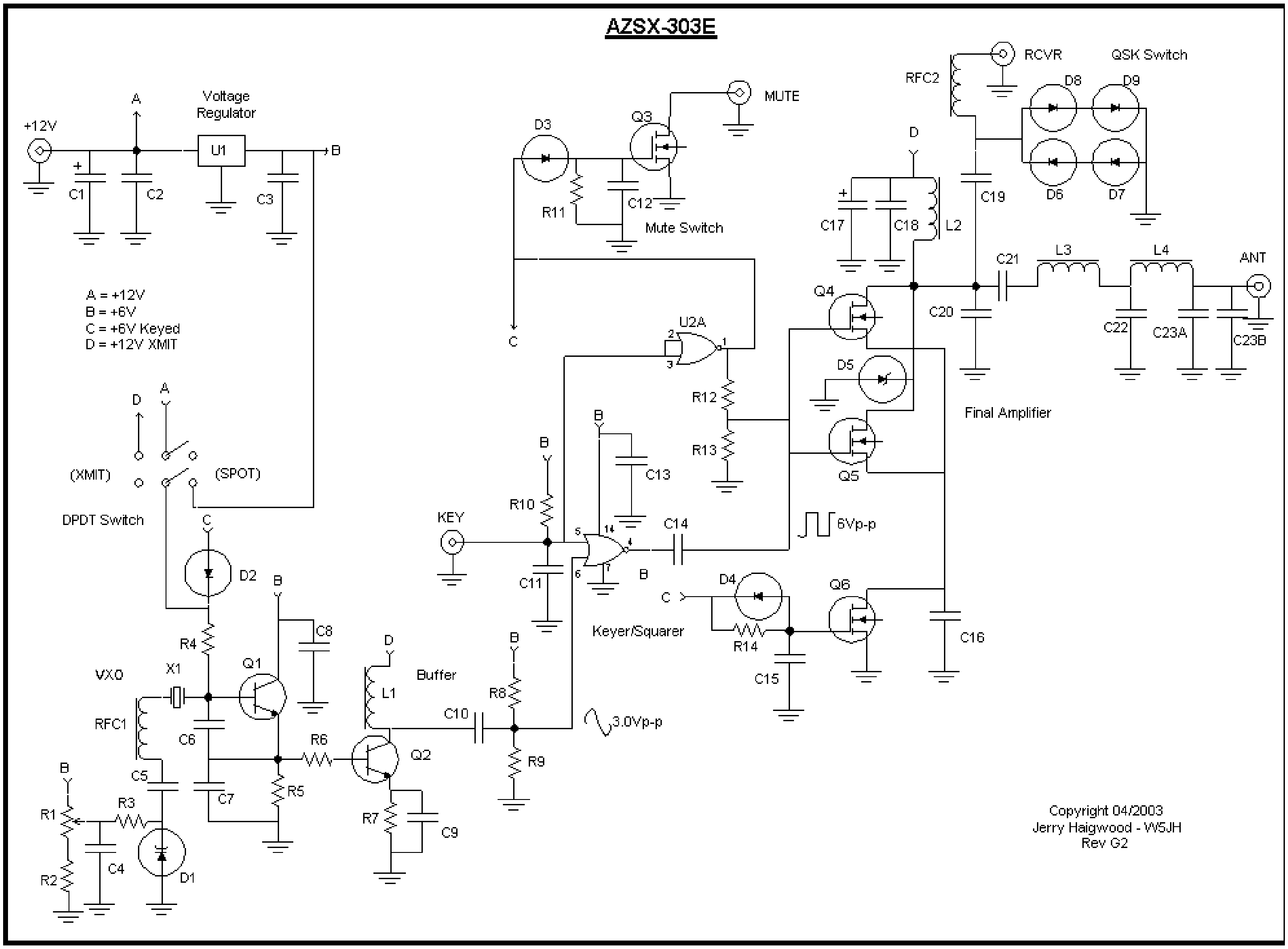
This Class-E transmitter met the design goals. This transmitter is a great platform for experimenting with Class-E amplifiers. Some things that could be done include:

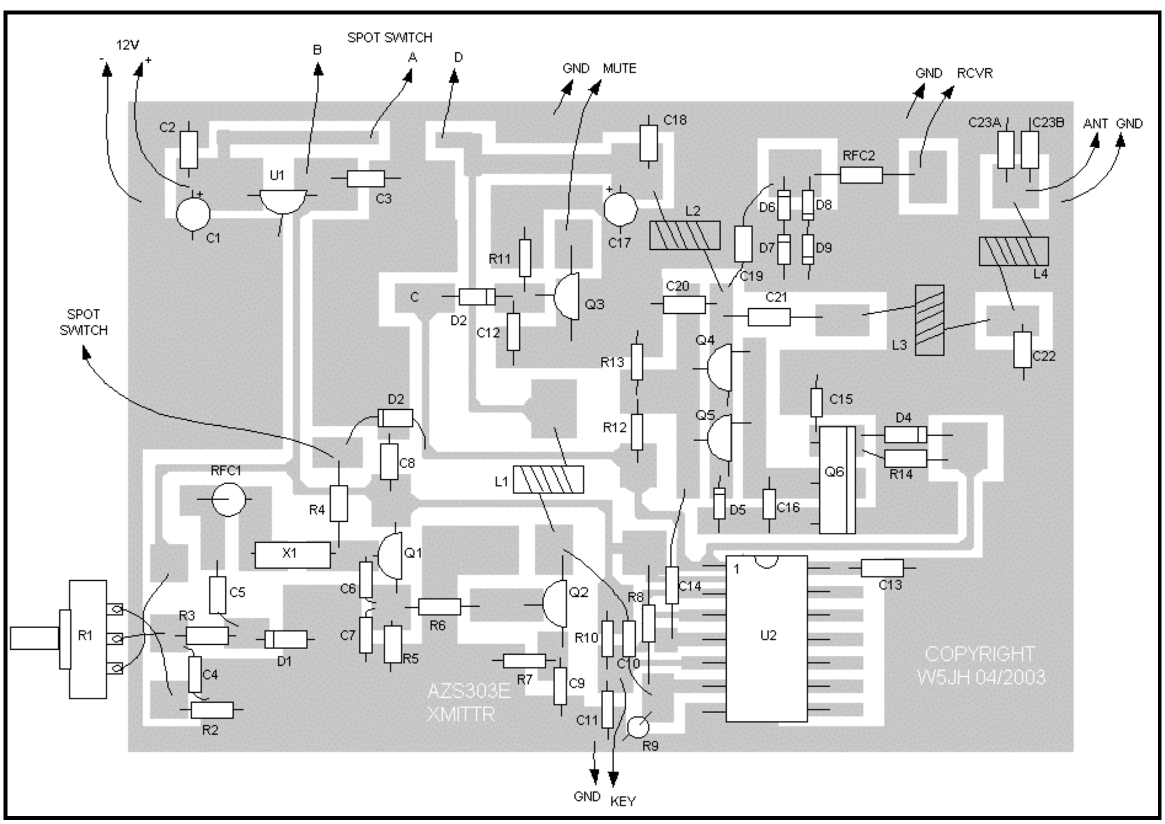
- R1-R3, C4-C5, and D1 could be replaced with a 10-100 pF variable capacitor. The variable would probably increase the frequency range of the VXO. One of the plastic polyvaricon type capacitor would probably work well.
- The final transistors (Q4, Q5) could be replaced with different MOSFETs. Maybe you can find a pair that will exceed 90% efficiency. Try to find a MOSFET with low input and output capacitance and a low RDSon.
- A VFO could be added to provide greater frequency coverage.
- A companion receiver could be added.
- Add a sidetone oscillator. A twin-T oscillator turned on by the 6V would work well.
- You could replace the voltage regulator with a low drop out type, redesign the tank circuit and PI network and operate the transmitter on 7.5V (5 or 6 AAA batteries).

The opportunity for experimentation is plentiful. It is my hope that this simple transmitter will spur new high efficiency Class-E designs in future QRP radios.

Jerry Haigwood, W5JH

email: w5jh@arrl.net


AZSX-303E
+12V
A
Voltage Regulator
U1
B
C1
C2
C3
A = +12V
B = +6V
C = +6V Keyed
D = +12V XMIT
(XMIT)
(SPOT)
DPDT Switch
D3
Q3
MUTE
R11
C12
Mute Switch
U2A
KEY
R10
C11
C13
C14
6Vp-p
Keyer/Squarer
D2
R4
Q1
C8
VXO
X1
RFC1
C6
C7
C5
R1
R3
R2
C4
D1
R5
R6
Q2
R7
C9
L1
Buffer
C10
R8
R9
3.0Vp-p
RFC2
RCVR
QSK Switch
D8
D9
D6
D7
C19
C17
C18
L2
Q4
D5
Q5
R12
R13
C20
C21
L3
L4
ANT
C22
C23A
C23B
Final Amplifier
D4
Q6
R14
C15
C16
Copyright 04/2003
Jerry Haigwood - W5JH
Rev G2


12V
SPOT SWITCH
GND
MUTE
RCVR
ANT
SPOT SWITCH
KEY
AZS303E
XMITTR
COPYRIGHT
W5JH 04/2003

AZSX-303E Transmitter Parts List

Designator	Value	Notes
C1	47uF/16V	Electrolytic
C2	.1/50v	Axial Ceramic
C3	.1/50v	Axial Ceramic
C4	.1/50v	Axial Ceramic
C5	.01/50v	Ceramic Disc
C8	.1/50v	Axial Ceramic
C9	150pF/50V	Ceramic Disc
C10	.1/50v	Axial Ceramic
C11	.01/50v	Ceramic Disc
C12	.1/50v	Axial Ceramic
C13	.1/50v	Axial Ceramic
C14	.1/50v	Axial Ceramic
C15	.1/50v	Axial Ceramic
C16	.1/50v	Axial Ceramic
C17	47uF/16V	Electrolytic
C18	.1/50v	Axial Ceramic
D1	1N4007	Diode (Black)
D2	1N4148	Diode (Glass)
D3	1N4148	Diode (Glass)
D4	1N4148	Diode (Glass)
D5	1N5263B	56V-.5W Zener Diode (Glass)
D6	1N4148	Diode (Glass)
D7	1N4148	Diode (Glass)
D8	1N4148	Diode (Glass)
D9	1N4148	Diode (Glass)
L1	200uH	26 turns #28 on FT37-43 core
Q1	2N4401	NPN
Q2	2N4401	NPN
Q3	2N7000	MOSFET
Q4	BS170	MOSFET
Q5	BS170	MOSFET
Q6	IRF520	MOSFET
R1	50K	Potentiometer
R2	4.7K-1/8W	Resistor
R3	100K-1/8W	Resistor
R4	82K-1/8W	Resistor
R5	390-1/8W	Resistor
R6	1K-1/8W	Resistor
R7	220-1/8W	Resistor
R8	100K-1/8W	Resistor
R9	100K-1/8W	Resistor
R10	10K-1/8W	Resistor
R11	33K-1/8W	Resistor
R12	47K-1/8W	Resistor
R13	47K-1/8W	Resistor
R14	47K-1/8W	Resistor
U1	L78L06ACZ	Voltage Regulator
U2	74AC02	Quad 2 input NOR gate

Designator	Value	Notes
	40 Meter Specific Parts	
C6	470pF/50V	Ceramic Disc
C7	470pF/50V	Ceramic Disc
C19	47pF/100V	Ceramic Disc
C20	220pF/500V	Ceramic Disc
C21	330pF/100V	Ceramic Disc
C22	1000pF/500V	Ceramic Disc
C23A	680pF/500V	Ceramic Disc
C23B	180pF/50V	Ceramic Disc
L2	50 uH	13 turns #26 on FT37-43 core
L3	1.7 uH	21 turns #26 on T37-2 core
L4	.623 uH	12 turns #26 on T37-2 core
RFC1	22 uH	Molded choke
RFC2	10 uH	Molded choke
X1	7.040 MHz	Norcal Crystal
	30 Meter Specific Parts	
C6	330pF/500V	Ceramic Disc
C7	330pF/500V	Ceramic Disc
C19	30pF/50V	Ceramic Disc
C20	120pF/500V	Ceramic Disc
C21	270pF/500V	Ceramic Disc
C22	680pF/500V	Ceramic Disc
C23A	470pF/500V	Ceramic Disc
C23B	120pF/500V	Ceramic Disc
L2	35 uH	11 turns #26 on FT37-43 core
L3	1.2 uH	17 turns #26 on T37-2 core
L4	.433 uH	10 turns #26 on T37-2 core
RFC1	10 uH	Molded choke
RFC2	8.2 uH	Molded choke
X1	10.116 MHz	Norcal Crystal
	20 Meter Specific Parts	
C6	220pF/50V	Ceramic Disc
C7	220pF/50V	Ceramic Disc
C19	27pF/50V	Ceramic Disc
C20	68pF/100V	Ceramic Disc
C21	180pF/500V	Ceramic Disc
C22	470pF/500V	Ceramic Disc
C23A	330pF/500V	Ceramic Disc
C23B	100pF/500V	Ceramic Disc
L2	26 uH	9 turns #26 on FT37-43 core
L3	.86 uH	15 turns #26 on T37-2 core
L4	.311 uH	9 turns #26 on T37-2 core
RFC1	8.2 uH	Molded choke
RFC2	4.7 uH	Molded choke
X1	14.060 MHz	Norcal Crystal
	Optional Items	
misc	Box	
misc	Connectors	various types
misc	knob	
SW1	DPDT Switch	

TEST TOPICS ... *AND MORE!*

Joe Everhart, N2CX

To those who have followed this column regularly in the QRP Quarterly, welcome to the new home of TTAM. It's been a fun four years in QQ and the column has been well received. Now it's time to swing over to the AmQRP Homebrewer journal. Welcome too to those who have not read TTAM before. Let's start off by a description of what it's all about.

As the title indicates the main subject is mainly measurement techniques and circuits related to Ham radio and homebrewing. Of course those who know me are familiar with my overwhelming curiosity. In keeping with that trait I will occasionally stray from strict test-related topics if I find something else interesting to write about.

I'll try not to be too droll and serious - maybe even include a story or an outrageous pun to get a point across. In the "And More" category sometimes the projects described will be something just for the fun of it! So you don't get too tired of me, a guest author will be featured who has a different slant or some special expertise on a particular topic.

Generally the coverage will concentrate on useful, good quality and above all practical ways to perform common measurements. Projects will be described that can be duplicated and calibrated by the average homebrewer with minimal access to expensive or hard-to-find laboratory test gear or components. All projects will definitely be designed to work as advertised.

Emphasis will be made to carefully define the accuracy and performance that can be expected of projects described in this column. In line with this goal, the theory of operation will be presented as applicable. Further, every attempt will be made to provide references for those who want more detail or background information.

An important resource as a supplement to the column is the "TTAM Online" web page on the AmQRP web site located at www.amqrp.org/ttam. The TTAM Online pages will provide material such as additional figures, drawings and computer programs listing that cannot be included in the printed TTAM printed column due to the space limitations. Errata notes will first appear there so readers won't have to wait several months for them to appear in the printed HOMEBREWER Magazine.

Three Sections in Each Issue

TTAM is based on three sections, although this may vary as space permits. The sections are:

Coming To Terms – This section defines a test-related term. Most often the term will be something that has to do with a "theme" for the column.

Designed For Test – This section contains the meat of the column. It describes either a test technique or a particular circuit design. In the past I've usually presented a complete working project.

· **Stimulus and Response** – This wrap-up section answers specific questions or provides clarifications requested by the readers. It is my punful way of driving home the fact that most test activities involve applying some sort of signal - a stimulus - to a given circuit and measuring the result - a response - to the input. To paraphrase a familiar vendor's motto: "You've got stimulus, I've got response!"

Okay, so much for background. Let's get on to some meat now!

Coming to Terms

Those of us greybeards who have been in electronics since transistors wore short pants (thanks to Glen, VE3DNL for that!) are familiar with the term "ringing out a circuit". However its origins are shrouded in the mists of time. The reason for the term is quite simple. In days past, before printed circuit board and multifunction integrated circuits, constructing electronics projects required lots and lots of wiring. Quite often the wiring harnesses became so complex that it was necessary to check the wiring for continuity. Of course we are familiar with using an ohmmeter to do this. But when a large multiconductor cable is being checked for continuity (and shorts between adjacent conductors) it's much easier to use a test method that doesn't make you have to take your eyes off what you are doing. The answer was quite simple – the continuity tester was a bell or buzzer connected in series with a battery and test leads. Continuity between a lead being checked and the test leads completed the circuit making the bell or buzzer sound. Though it seems almost trivial, this simple tester made for very fast cable testing. But don't even **think** about using an electromechanical sounder with modern semiconductor circuits. The inductive "kick" it produces will fry semiconductor junctions faster than you can say "Oops!"

Designed For Test

There are several modern counterparts to the simple buzzer for continuity checking. The first is a direct replacement, a piezo "buzzer" as shown in Figure 1. A 9-volt battery supplies the power and leads with suitable clips, either alligator or "ball grip" are used to connect to the conductors being checked. Be sure to use a piezo device that includes an internal oscillator such as the Radio Shack ™ device shown or you will get no sound! In addition to continuity the tester can be used to check diodes. It will sound when the (+) lead is on a diode anode and (-) on the cathode. Be careful with microwave semiconductors, though since the full 10 ma operating current for the buzzer flows through the test leads.

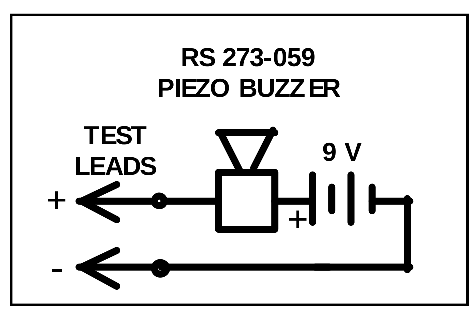


Figure 1: Piezo buzzer and battery serve as continuity tester

My friend Tony, WA3CAO uses a tester that is a tad more complex but is much more versatile. Figure 2 shows the circuit. I've described the circuit several years back in Joe's Quickies for several different applications so you can see that it's one of my favorites! As you can see in the schematic diagram, the test leads are in series between the 10k base bias resistor and ground. The circuit draws no current until there is continuity so no on-off switch is needed. When a connection is made, the oscillator is biased on, sounding a tone.

Diodes can also be checked with the tone oscillator continuity tester. This circuit is gentler, though, passing no more than 1 ma through the test leads. Furthermore it can be used to check electrolytic capacitors. The oscillator pitch will start high and decrease rapidly as it charges the capacitor, going silent once charging is complete. But if the capacitor is leaky it will still pass current and the tone will not stop. And finally, the tone pitch will vary if there is resistance present in the connections or leads being tested so you can judge whether or not a good connection is being made.

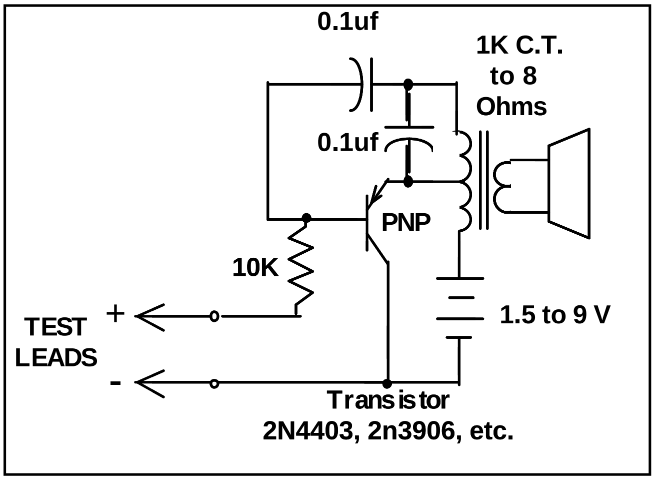


Figure 2- Tone Oscillator Continuity Tester

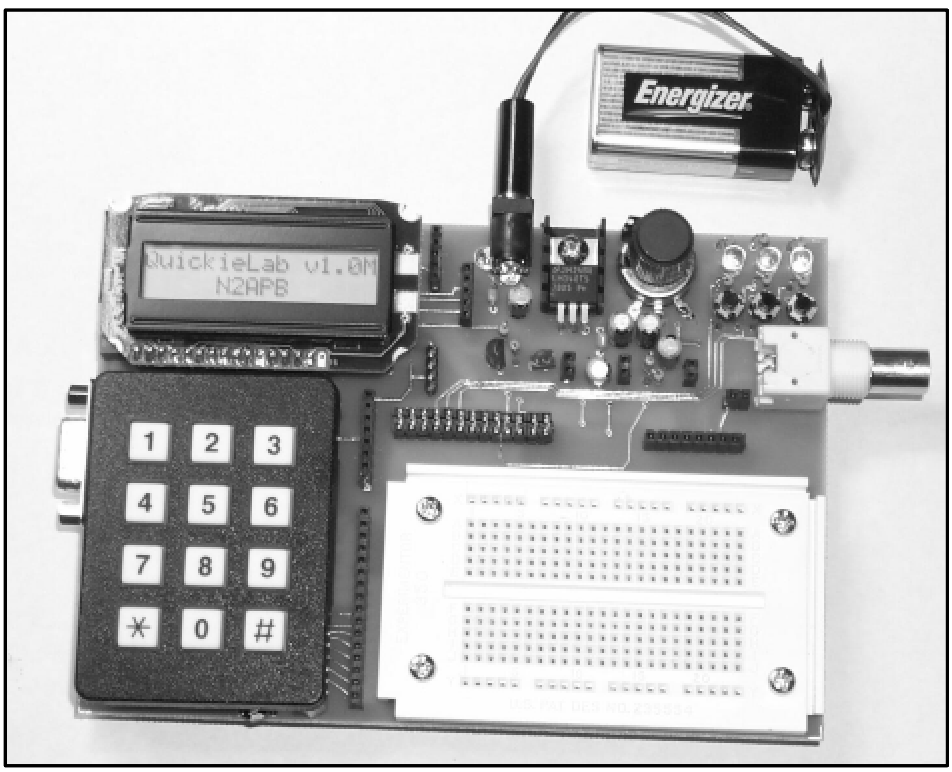


Figure 3: The NJQRP QuickieLab is a powerful and flexible test platform that we'll build onto here in future issues of the TTAM column. We can't go wrong with its built-in capabilities for RF generation, frequency measurement, A/D input, tone generation, LCD display, keypad data entry, and an experimenter's plugboard to allow any extra circuits we might want to try out! Further, software programs that I provide can be downloaded from the TTAM Online web pages to the QuickieLab's BASIC Stamp microcontroller, allowing your test platform to serve many purposes over time.

Stimulus and Response

I've received several queries from folks wondering why recent TTAM columns have presented test circuits based on the NJQRP QuickieLab (see www.njqrp.org/quickielab for Quickielab details and projects).

The answer is really quite simple ... the QuickieLab is a very versatile and reprogrammable board that lends itself to simple-but-powerful projects. The several designs described recently provide basic building blocks for a whole family of measurement instruments that can be built and made to work by any homebrewer. Those who may have seen my presentation on the QuickieLab at the Atlanticon QRP Forum this spring know that I have a whole cadre of other QuickieLab projects lined up for development.

So the bottom line is that until this list is whittled down a bit, many of the test devices I'll present in this column will use the QuickieLab. On the other hand, not all of the will be as simple as the continuity tester in this issue.

Please feel free to ask questions about anything in this column or other test and measurement topics. If you send me e-mail, I will answer directly. However if you send me snail mail please include an SASE for any reply. And with your permission, I'll also reproduce some of the pertinent queries and responses in future columns to share the info will all.

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Brooklawn, NJ 08030
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NOTES

1. *"The Quickie Tone Oscillator" Joe's Quickie #30, in the Idea Exchange column in QRP Quarterly for July, 1999.*

2. *"Quickie Bargraph Meter" Joe's Quickie #46, Idea Exchange in QRP Quarterly for Summer 2003.*

3. *Full details about the QuickieLab can be found on the NJQRP website at www.njqrp.org/quickielab. A partial kit of parts is also available for purchase from the NJQRP (pc board, LCD, IOX controller chip.)*

A Message To NJQRP and NORCAL

George Heron, N2APB   email: n2apb@amqrp.org
Doug hendricks, KI6DS   email: ki6ds@amqrp.org

Many in the QRP world took notice of the email and web page announcements over the summer: *"On 4 June 2003, the NorCal QRP Club and the New Jersey QRP Club merged to form The American QRP Club."* But what does this mean to the membership of these two local clubs? What's changed since the merger of the two clubs? Read on to understand the vision from N2APB and KI6DS.

N2APB addresses members of the NJQRP …

Here's a sincere "Thank You" to the New Jersey QRP membership for the hearty and positive support voiced during the formation of the American QRP Club this summer. There are so many exciting things already in progress -- it's going to be a wonderful time ahead for everyone.

It's important for the NJQRP members to understand a fundamental concept... the club isn't going anywhere at all. We're staying font-and-center with the same email listserv, with our web page, with our monthly meetings, with our club-sponsored QRP outings like Field Day, and QRP To The Field, and with projects that we work on together as a local group. This holds especially true for our continuing to be responsible for the annual Atlanticon QRP Forum weekend each spring. Nothing changes in these regards.

What does improve is our ability to do our various wide-reaching "national" projects ... like the printed journal, the kitting operations and the relationships with all our friendly QRP designers and vendors. We'll be working with an increased staff, so to speak, with our parent organization: the American QRP Club. We'll be contributing kitting operations for the benefit of QRPers everywhere, and extending those operations to soon include unique projects developed under the AmQRP umbrella. In return we'll be getting some financial support and guidance back from AmQRP so can put on even better Atlanticons, better-coordinated showings at local hamfests, and even more interesting mini-projects that we tend to do at our local meetings in Princeton, NJ.

We'll also have a chance to further a very important initiative that we see crucial for the hobby ... the introduction of America's youth to ham radio, electronics homebrewing and experimentation. As a team, we've really honed these technical areas over the years and it's now time to start taking the initiative to extend them to the public. That's really why we're all here. Sure it's fun to play radio and build kits, but we're all here on this earth to help others in the variety of ways we can ... and this is our group's way. It will be a blast, I assure you!

Vince WA2ECP, the original founding father of the NJQRP Club, is working to maintain all the NJ-specific website material — club meeting recaps, member directories, local projects, meeting notices, field operations, local announcements, et al — and be the webmaster for the NJQRP website. It will have the same look-and-feel, and Vince is committed to be as responsive as I have been over the years in evolving it. Of course I'll be right here to help him, and everyone else involved, be successful in this.

I have already taken the "national aspects" of our NJQRP website, along with those of the NorCal website, and formed the official website of the American QRP Club (www.amqrp.org). It has a different face on it from either the NJ or NorCal web pages, and we'll be dealing with the "national" issues, projects, operations, weekend forums, and more. This too should be fun, and it will be closely linked with the NJQRP website.

Another major change is that publication of our QRP Homebrewer magazine has merged with NorCal's QRPp magazine to form HOMEBREWER. It's been a great ride over that past three years of publishing QHB and we broke some new ground with our efforts. QHB Extra! online graphics has been a great success due to the quality contributions of many in the club. Because the merger of the clubs and pooling of the resources working on the many activities has freed up some of my time on other matters, I'll be able to extend my focus on the printed journal to evolve both QHB and QRPp even beyond the successes achieved thus far.

So stay … le of your life!

KI6DS addresses the NorCal membership …

Ten years ago, Jim Cates and I took a trip to Dayton to find out what the rest of the world was doing in QRP. Boy did we have our eyes opened. We had a fabulous time, and as you all know, we decided on the plane ride home to form a QRP club in California. Jim came up with the name and the meeting place, both of which we still have today. Our goal when we started was to encourage

QRP operation by any and all means available to us. We did that, and recently we celebrated our 10th anniversary with a very nice party at the California Burger. The club has been successful beyond our wildest dreams, yet we knew that something was missing.

George Heron and I met many years ago, and I have taken great pleasure in watching him and the NJQRP Club grow. NorCal assisted NJQRP in getting started, and our efforts have been rewarded with the emergence of NJQRP into a national power among QRP clubs. We remained close friends through the years, and I always sought George's counsel when there were problems or difficult decisions to make for NorCal. His advice and friendship has been invaluable to both Jim and me, and to NorCal. Last March, I had the opportunity to spend a few days with George at his home in Maryland after Atlanticon. We spent most of the time talking about QRP, as QRPers often do. George told me of his dream to have a truly national QRP organization, where NorCal and NJQRP would merge together to form one big club, yet each club would keep its own identity and events -- the combined club would make the sum bigger than its parts. George pointed out that there was a tremendous amount of duplication involved in the operation of the two clubs and that if we were to merge, we could share the work and both clubs would benefit. I told him I was interested but wanted some time to think about it and discuss it with Jim.

As you all know, the merger of the two clubs came about on June 4th, of this year. The Amercian QRP Club came about due to the combining of the two clubs. What does this mean to you, the average NorCal member?

Will NorCal go away? No, we will still have all of the local activities that we have always had, monthly meetings at the California Burger, local get togethers for pizza when famous and not so famous qrpers come to town, Pacificon, QRPTTF, all will remain the same.

What will change? QRPp and QHB have ceased publication. They are now replaced by a much better journal, HOMEBREWER, which is a full sized, 8.5 x 11" publication with 60+ pages, and a full color cover! The cost of subscribing has gone up. It will now cost $20 per year to get the journal. We tried to hold the line, but postage and publishing costs are out of sight, and our subscription base for QRPp had dropped dangerously low, below 700. You really need at least 1000 subscribers to get a decent break on the publishing costs, and we were going to have to raise costs with or without the merger.

QRPacificon. Due to an agreement reached during the merger, we decided that we would charge a fee for the QRPacificon forum this year. NJQRP has done this for the past few years, but they certainly give value for the money! This year your $10 registration fee for QRPacificon will entitle you to attendance at all the events, plus you will receive a special name badge, the QRPacificon kit (which will be mailed to all in advance so that it can be built and brought to QRPacificon to use in the operating event Saturday night), and a compendium of all of the speaker presentations.

NorCal has always encouraged and helped local and regional QRP clubs. We have not advertised that because we do not want the credit nor do we want to cause any problems for anyone or any event. We will continue to do that. But it will be a little more visible, due to the fact that we are now a national organization and have goals to reach. Down the road, I can see the American QRP Club helping to host QRP Forums like Pacificon and Atlanticon in all regions of the country. In fact, we have already started down that road, having just recently announced that we will be affiliated with the Four State QRP Club, who will be putting on Ozarkcon next spring with our help in Joplin, MO.

Our Duties. George Heron will be the Editor and publisher of the club journal, HOMEBREWER. Joe Everhart will be in charge of the technical activities of the club. Paul Maciel will be the treasurer and all orders for kits and subscriptions will be going to him eventually. Doug Hendricks will be the project manager for the club kits. Jim Cates will be helping to mail NorCal kits, and will act as our mentor and club advisor.

We feel that exciting times are ahead for QRP and for the American QRP Club. Please judge us by what we do. Let our actions speak for us. I want to thank you for all of your support the past 10 years, and I want each and every one of you to know that NorCal needs your continued support and participation to remain a viable entity. As the leadership team of American QRP Club, George, Joe, Paul, Jim and Doug look forward to serving you and promoting QRP in the future. Thank you.

Introducing ... The Az ScQRPions

John Stevens, K5JS ***email: john.stevens@honeywell.com***

The Az ScQRPions had its genesis back in early December of 1994. An escaped Texan by the name of Dave Little, AF5U, stirred the local QRP crew to organize in a similar fashion to the NorCal QRP club. Dave was a long-time associate of Chuck Adams, K7QO, then also of Dallas, so you can see something was bound to happen. In true Texan fashion, however, Dave started something he couldn't finish and he hightailed it back to Dallas leaving behind a very active QRP group.

The ScQRPions, like many other QRP groups, has activities including sponsorship of operating events such as FYBO and BUBBA and participation in other QRP operating activities. Camping or other outdoor activities are often organized around these operating events – weather and fire conditions permitting, that is! Kits provide the financial support for the group, with the latest being a Class E transmitter kit, described in an article in this issue. The success of our kits has allowed the ScQRPions to sponsor top quality QRP programs since 1995 at the Arizona State ARRL Convention at Ft. Tuthill (in Flagstaff, AZ) at the end of each. These kits are also made available at no cost to other QRP groups as prizes for QRP programs and conventions.

Meetings are held at 10:45 am on the first Saturday of the month at the Fuddrucker's Hamburger restaurant just off I-17 North at the Dunlap Exit in Phoenix. Show and Tell sessions to show off our latest projects are a highlight. Members drive from as far as Tucson, Prescott and Kingman to attend. No officers, no dues – just show up and you're a member. Let us know when you are coming to town and we might have a meeting just for you!

QRP Operating

Richard Fisher, KI6SN

Monty Northrup, N5ESE, reports from Austin, TX, that recently he "had a couple very pleasant 40-meter surprises while playing 'portable radio' from my brother-in-law's place on Lake Travis in the Central Texas hill country.

"We got there after dark and I slung an 87-foot wire up over a 30-foot oak tree to a cedar about the same height up the hill a bit. Then laid down the usual 4 X 32 foot and 2 X 16 foot radials and attached both to the (Elecraft) K1 sitting on the front seat of the car – and running on internal AA batteries.

"After a couple of short contacts on 20, I switched to 30 meters and happened upon ol' **Wilford 'Doc' Lindsey, KØEVZ,** who was portable in Albuquerque, operating from a hotel.

"Now, it was amazing enough that his (Elecraft) K2 was loading up the 17 foot downspout next to his hotel window, but what was even more astounding was that his signals were bouncing between S-9 and 10 over.

"We chewed the fat for about a half hour until the path began to deteriorate, and I jokingly vowed to go to Home Depot and buy some rain gutter.

"Then, (the next) morning, still portable, we had a number of QSOs on 40, some with a lot of difficulty because the QRG around 7.040 MHz was crowded and getting more crowded by the moment.

"Suddenly, I lost **Henry Cox, AG4OG,** of Decherd, TN, and all the QRM disappeared, too. I called Henry for a few minutes but got no answer, then tuned down frequency where I heard **ZL6FF** (the FISTS CW Club Downunder club station) calling CQ.

"I don't generally call DX, but his signal was 57 / 99, and nobody else called him, so I signed **'N5ESE / QRP.'** Imagine my surprise when Nigel – whom I've never worked before – comes back with 'GM MONTY KNW UR CALL UR RST 339 IN OTAKI.' On 40 meters? Too cool!

"We exchanged FISTS numbers, and he wanted to know all about my portable setup and extracted the promise of a QSL .

"In 35+ years, I've never actually completed a QRP QSO with a ZL, so this was exciting. But believe me, all the credit goes to the receiving operator on that one.

"Part of this goes back to the 85-foot end fed – mine is more like 87. I think these anecdotes will vouch for it. Incidentally, worked as an Inverted L against makeshift radials, the K1's ATU readily tuned to 1:1 on all four bands (40/30/20/15)."

* * * * * * * * * *

N5ESE's operating experience fit well into the context of a recent discussion on the Internet mail group QRP-L. Operators from all over the country were chiming in with suggestions, comments and questions about the merits of using an 80+ foot end-fed wire as a multi-band antenna – with various combinations of radials or counterpoises.

For many QRPers, including me, the conversation had a ring of familiarity. Back in the 1930s, H.J. Siegel, W3EDP, came up with an end-fed design employing an 84-foot radiator and a 17-foot "counterpoise." It has been kicking around for years. And as N5ESE's experience illustrates, 'EDP's fundamental design has gone through lots of tinkering and modification over the last 60+ years.

With the Adventure Radio Society's Flight of the Bumblebees contest looming last July, I decided to honor W3EDP's work by reproducing his original design as faithfully as I could. And what better forum than a nationwide contest to try it out?

Much has been written about the theory of the W3EDP, so we won't delve into that very deeply here. The Cliffs Notes story on the KI6SN version, though, is this: The 17-foot "counterpoise" actually serves as a parallel feedline with 6-inch spacing and an impedance of 500-800 ohms – thus the need for a tuner. Doing the arithmetic, 17 subtracted from 84 is 67 feet for the flat-top, non-feedline portion of the antenna.

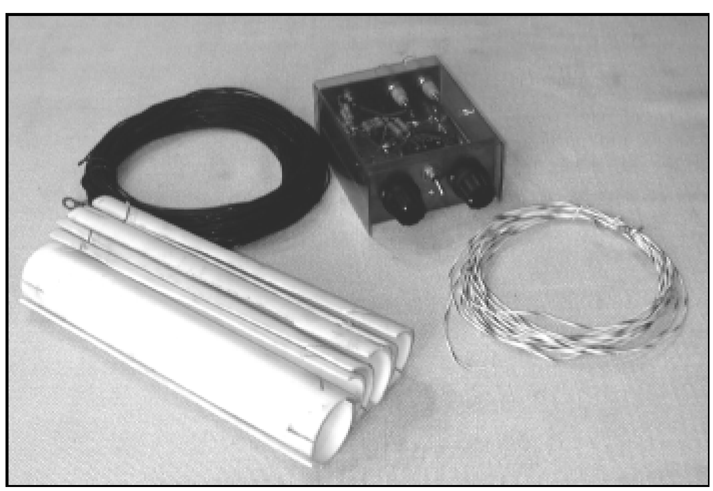
An end-fed Zepp – from which the W3EDP is derived – will work on its fundamental frequency and on harmonic frequencies – odd or even.. In this case, the antenna has been used successfully on 40, 20, 15 and 10 meters.

In root form as shown in the accompanying diagram, it's an 84-foot-long wire with a 17-foot wire hanging under it.

Its simplicity of design, and needing only one support at the end of the flat-top radiating portion of the antenna, make it ideal for portable operation.

That prompted the urge at KI6SN to give the W3EDP a try during this year's Flight of the Bumblebees.

Preliminary tests of the antenna strung about 5 feet off the ground on trees and bushes in the back yard, proved that even a low W3EDP will tune easily on 40- and 20 meters using a NorCal BLT antenna tuning unit, available from AmQRP in kit form. For details about this Z-match tuner, visit the club's web site: www.AmQRP.org



The PVC spreaders, BLT tuner and 84- and 17-foot wires can be rolled up into a tidy, lightweight antenna package for carrying into the field.

I used seven spreaders to create the 17-foot portion of the antenna's feedline. They were designed by **Charles Lofgren, W6JJZ**, one of today's leading authorities on antenna matching and design.

Made from styled pieces of 1-inch-diameter PVC, they took about a half hour to cut, slot and de-burr. The only other pieces of the antenna are two single wires: one 17-feet long and the other 84. Just about any light-gauge insulated stranded hook-up wire can be used – right off the shelf at Radio Shack, if you'd like. The portion of 84-foot radiator nearest your tuner and rig is threaded through slots on one side of the spreaders; the 17-foot parallel wire that creates the feedline on the other.

For details on the antenna's theory and more specifics on making the spreaders, as described by W6JJZ, visit the Adventure Radio Society's web site: www.ARSqrp.com

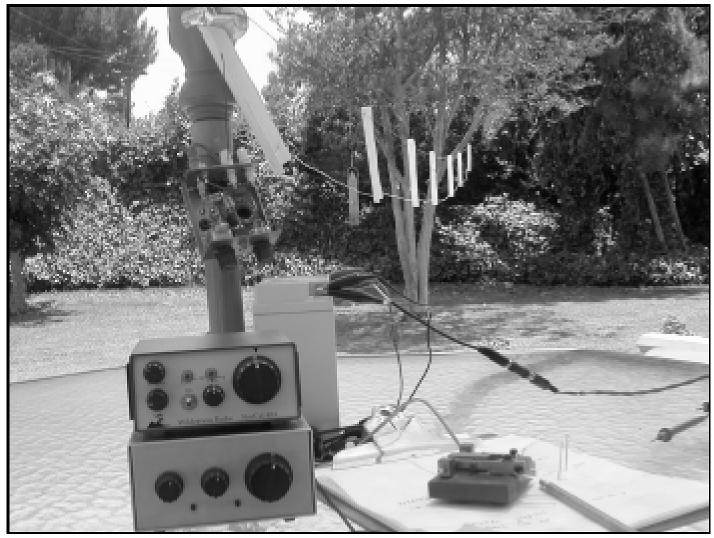
Enter *The ARS Sojourner*, click on *ARS Archives*, click on *Cumulative Index*, click *Antenna Techniques* and search the list for W6JJZ's excellent article "The FFD Antenna: A Field-Friendly Doublet, with Notes on Related Designs."

During July's Flight of the Bumblebees, the W3EDP end-fed antenna with 17-foot "feeder" comported itself admirably at **KI6SN / BB**.

Using the NorCal BLT tuner, a gel-cell powered NorCal-20 transceiver on 14 MHz running 2 watts, a NorCal-40A transceiver running 1 watt on 40 meters, and the classic W3EDP antenna, just about every station that was heard was worked.

Operating on the edge of the California desert between Los Angeles and Palm Springs, the W3EDP was hung on low brush and trees. At its droopiest, the wire was about three feet above ground.

By the end of the four-hour sprint, six U.S. states had been worked between operation on 40 and 20 CW. Reports ranged from 589 to 339 in band conditions that from this location were at best marginal.



Two transceivers and the NorCal BLT tuner, which was literally hanging from the end of the W3EDP end-fed's parallel feedline, were used for initial testing of the antenna at KI6SN.

If you're interested in trying an easy-to make and use antenna system that can work well both at home and in the field, I'd highly recommend the W3EDP.

And if you've had experience with the antenna I'd like to hear about it.

NOTE

The author may be contacted at:

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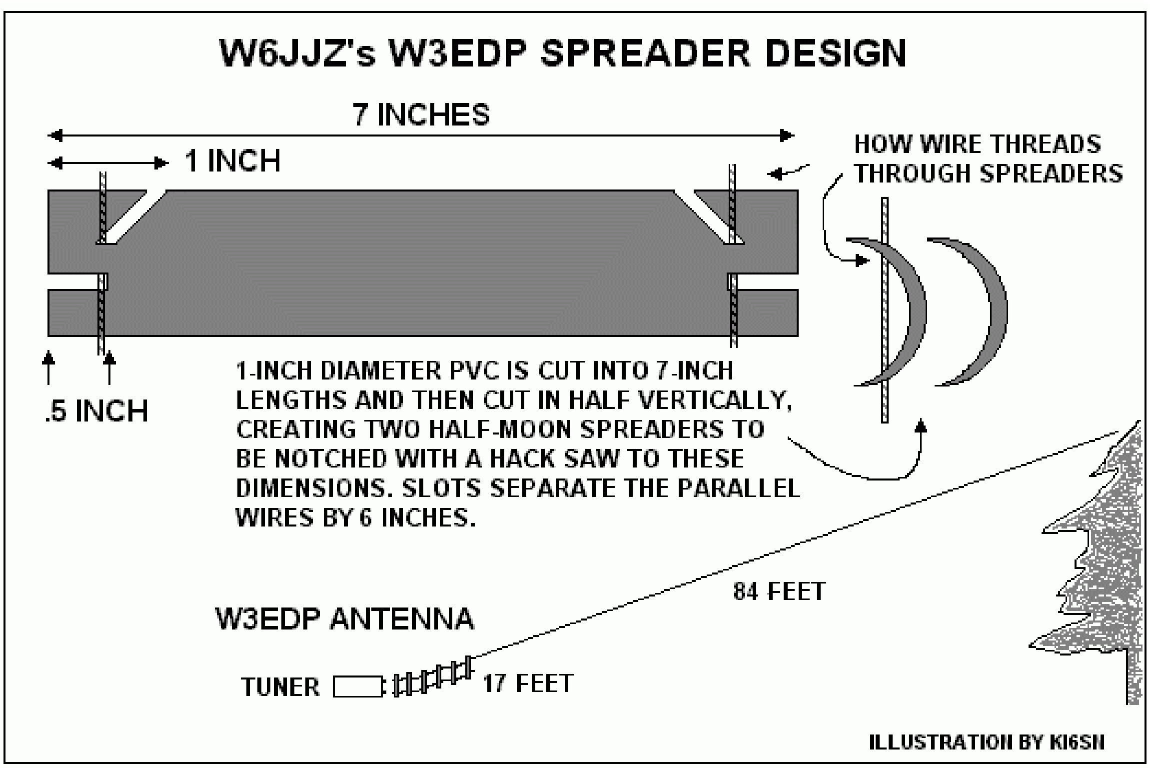


Radio To Go

James Bennett, KA5DVS/6

This column is titled "Radio to Go" and will cover aspects of portable ham radio operation. Portable being defined as any operation away from a fixed station. Most of us travel at one time or another whether for vacation, to visit family and friends or for business. Taking a radio along for portable operation can be a great way to relax and pass some time. Some of us even strap on a backpack containing a radio, battery, and antenna and walk around making HF contacts an activity that has come to be known as "pedestrian portable". To learn more about this fun group of folks, see the HFPack website: www.hfpack.com. It contains a wealth of information about the fun and challenges of portable operation. Operating portable is a great way to combine radio with visiting beautiful locations.

Photo 1: Operating on the beach.

I have been a ham for approximately 25 years. I am interested in VHF weak signal, QRP, portable operation and designing and building antennas. Over the past few years, I have developed an interest in developing lightweight and efficient antennas for portable operation. The PAC-12 vertical/dipole design is a result of this interest.

My job requires frequent business trips often of extended duration. Having my amateur radio equipment along on the trip helps to pass the time in less than exotic destinations. My radio of choice is the Yaesu FT-817. I also own and use an Elecraft K2 as well as a Yaesu FT-301S several 10M and mono-band QRP rigs. However, as a testament to its compactness and versatility, the 817 is now the radio that follows me on most trips. I do not however intend to create an impression that the FT-817 is the only game in town. Recent offerings such as the Elecraft K1, SGC 2020, and the new Icom 703 have capabilities we could only dream about a few years ago. As the saying goes " These are amazing times in which we live".

If you are reading this column, you are already interested in the challenges of low power operating and I encourage you to add the further challenge of putting together a portable station. Whether for travel, fun or emergency preparedness, having a portable station "in a bag" is good goal. Portable antennas are a favorite subject and will frequently show up. Other topics may include how to find a good location when traveling or, what to say to curious bystanders and or legal officials who may question what you are doing with all that suspicious equipment. Along the way, we will build some projects, and hopefully learn a few things.

Traveling with Ham Radio

With increased security since 9/11, traveling with radio equipment on an airplane is not as simple as it once was but is not too bad if one is properly prepared. For example, I pack all of the antenna hardware and bits in a small bag that goes into my checked baggage. The FT-817 fits nicely into a spare pocket in my laptop bag. I usually take the 817 out for x-ray along with my laptop and find no problems with security. On occasion, I have had to explain that it is a "radio". I do not volunteer information that it is an amateur radio, there is no need and the security personnel probably do not care in most cases. I do recommend carrying a copy of your FCC license and the radio manual just in case you need to answer questions.

Traveling by car or other land based modes of transportation do not have the same level of restriction for obvious reasons. Depending on the mode of travel, a small QRP rig can also be packed in its own bag. There are commercial options but there are also good choices in the surplus market. I ran across a surplus Iomega Jazz drive bag that fits my 817, battery pack and accessories quite nicely.

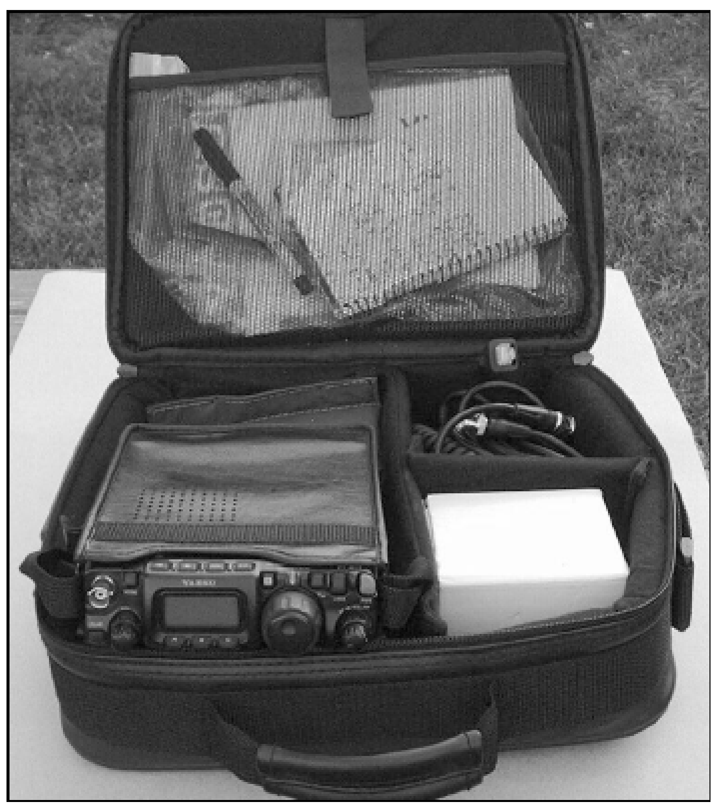


Photo 2: FT-817 in bag

This bag is padded and has compartments to separate the radio and components. It even has a mesh pocket perfect for a notepad and the radio manual.

Power to go

When at home, an ac power supply for the radio is probably easily accessible and battery packs can be easily recharged when needed. However, when away from home, a bit of planning is required. Unless you have access to reliable solar, wind, water, or nuclear power, some form of storage battery is needed. The FT-817 has the option of internal batteries either AA alkaline or rechargeable packs. I use the Maha internal NiMH pack in mine and tend to use it as a UPS with an external battery pack or supply. In this case, the internal pack is used only when the external batteries are exhausted or when I do not want to connect them. While the pack is perfectly capable of providing power for limited operation, I prefer the flexibility and extended operation time of external battery power.

For travel, both AC and battery power capabilities are nice to have. This means a power supply in conjunction with a battery pack or packs.

One option when ac power is available is a switching supply such as Radio Shack 22-503 or similar. This supply is not too bulky and supplies sufficient current to run the 817 or other QRP rig. It has a lighter socket and push terminals for connection. This supply can also be used in a hotel or other location to charge gel cell or other batteries.

Photo 3: Radio Shack power supply

This works well but I am always looking for a smaller option. I ran across the Radio Shack 22-505 which is a very small switching supply about the size of a small dc wall wart type supply. It is capable of up to 1A of current at 12V

While this is not sufficient current to run a typical 5W qrp rig, it is perfect as a supply for receiving and for recharging batteries when AC power is available.

For a battery pack there are several options. I use a gel cell camcorder battery of approximately 2.5 AH capacity along with a lighter socket adapter that also serves as a charging cord. These were sold in the days of larger VHS camcorders and can often be found on the surplus market.

Photo 4: Small Radio Shack power supply

Photo 5: Camcorder battery and cord.

This system does work well and has the advantage of recharge capability from any 12 lighter socket. I use the Radio Shack 22-505 1A switching supply to recharge this battery when traveling. Airlines in some cases may not allow gel cell batteries. I have heard of cases of them being removed from checked baggage for security but I have not yet experienced it personally.

One of the best ideas I read recently on the QRP-L email reflector. The idea is to buy a 8- D-cell holder and fabricate a connector for your radio. Be sure to include a fuse somewhere in the wiring. The holder is light and packs easily with the rest of the radio gear. Once at the destination, purchase an 8 pack of D cell batteries. This will give a 12V pack with somewhere around 15 amp hour capacity, plenty to run for a few days of intermittent use. Once the trip is complete, the used cells may be properly disposed leaving only the battery holder to transport home.

Another option is to use AA cell batteries. A 12V battery pack can be fabricated from a holder or holders and 8AA batteries. To ensure safety, be sure to add a fuse in the circuit to protect your radio. Batteries can either be transported or purchased at the destination. An alternate is to use rechargeable NiCd or preferably NiMH cells. With capacities in the NiMH now up to 2.3+ AH, this is a nice way to go. For 12V, 10 cells will be required. I managed to find some 10-cell holders, which include a 9V-type battery snap connection, imported by Philmore. See http://www.philmore-datak.com for a list of distributors in your area.

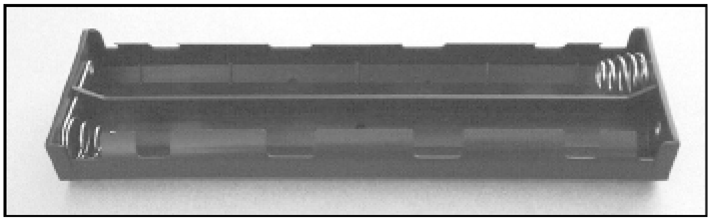


Photo 6: D cell pack

AA batteries can be recharged with a quick charger such as the Maha MH-C204F. This charger can be purchased with a car cord and along with the RS 22-505 mini switching supply makes a great way to charge AA cells.

In addition to commercial packs, a wide range of battery packs can be homebrewed for portable operation. Here is an example of a homebuilt battery pack that can be built from radio shack or surplus components

Photo 7: Batterypack

For more details on this homebrew pack, see the following website: http://www.qsl.net/kf6whk/projects.htm#BatteryPack.

Solar power is in many cases a viable power source for portable operation. Some of the new generation flexible solar panels are easy to transport and can provide enough power for some QRP rigs. With the addition of a small battery pack, the panel can provide continuous charging while the battery supplies the higher current needed when transmitting.

Don't forget about one of the best sources that while not exactly portable is mobile. This is of course the car you are driving. The car battery is a great source of dc power, just make sure to leave sufficient power to start the car for your return trip.

Next Time

In the next issue, I will look at choices for antennas when operating portable. Also, if you have an idea for anything related to portable operation, please drop me an email, including a description and digital photos if possible, and I will try to include it in future columns.

Thanks for reading my column and I hope to hear you on the air from wherever you roam.

73

James Bennett
KA5DVS/6
Email: ka5dvs@arrl.net

QRP in the Great Outdoors

Ron Polityka, WB3AAL

A few days after the creation of The American QRP Club, the AmQRP guys asked me if I would like to write a column about operating in the outdoors. Well if you know anything about me, you can guess that I could not say no. So let me introduce myself to everyone and tell you what I have planned for the column.

* * * * * * * * * *

I was attending a Vocational School studying Electronics back in the late 1970s. After my first year in the electronics class, I joined a study group at a local church to learn Morse code. Since that time I have been hooked and I still like operating CW. I would like to say thank you my elmer, K3BFA - Charlie did a great job teaching us the code. I was first licensed back in the summer of 1975 as WN3AAL. I made several QSOs the first month running 75 watts until I became bored with running high power. That is when the QRP bug hit me and I have been hooked ever since.

I was a ham for only two months before I made my first trip out to the Appalachian Trail. I toted an HW-7 and a car battery to the top of the Pinnacle near Hamburg, PA. This location is the highest spot in Berks County. I had a blast and I will never forget my first QSO from the Appalachian Trail. I worked a station on 15-meters running 3-watts into a 200-foot long wire. Now twenty-eight years later, I am still hiking on the Appalachian Trail with my radios. I have been out on the trail once a month with my K1 since March 2000. I often will take a short day trip or hike in a few hundred yards from the road. I go out in all kinds of weather - even in the winter with 10°F temperatures.

Lately, I have been running special event stations on board the USS Torsk, USS Coast Guard Cutter Taney and the Lightship Chesapeake in Baltimore, MD. If you thought setting up an antenna in the woods is hard, try hanging one on a steel ship! It is a real challenge trying to stay clear of the steel mast and guide wire lines while not compromising the performance of the antenna.

* * * * * * * * * *

In this column, I plan on reporting on those who play with radios outside their normal operating environment. So if you like to hike, camp, canoe or take a drive and operate from the field, please drop me an e-mail at wb3aal@verizon.net. Send me information about your upcoming trip or where you have been. Send me information about when you operated one of the many QRP contests or sprints that have an outdoor theme. If you have taken any pictures, you can send them along in the e-mail. When submitting an outdoor report, please send all the details about how you got to the location, what equipment you used (rig, key, power supply, antenna / transmission line, etc.), and the number of QSOs made while outdoors. Please let us know which QSO was special for you, and mention the critters you encounter while out there.

* * * * * * * * * *

The EPA QRP Club is proud to be the Association Manager designate for the SOTA program for PA, DE and MD. The area is better known as the W3 Land Call Area. We are in the process of verifying the summits in Pennsylvania and Maryland. The EPA QRP Club will make an announcement when the program is up and running in those states.

The program is very popular across the pond as well. Visit www.n3epa.org and click on SOTA-PA-DE-MD to see more information and the link to the SOTA in Europe.

* * * * * * * * * *

Ed, WA3WSJ and I have for some time been hiking across Pennsylvania on the Appalachian Trail. The weather is usually an important factor in our plans when going out for an overnight trip. Unfortunately, the rain stopped us from making any trips in the spring this year. We are still hoping to make a few day trips or possibly some overnight trips this year. It would be great to make the half waypoint in PA. The Appalachian Trail in PA runs on a NE-toSW route for a total of 220 miles. Much of the hike is on ridge tops and through state game lands. The main obstacle hiking the AT in PA is the rocky landscape. Millions of years ago the retreating ice glaciers deposited tons of rock on our mountains. They can range anywhere from the size of a baseball to something as large as a ranch home.

At the end of the outbound hike on the AT you will set up your tent and station. It is very enjoyableto have someone come back to your CQ while you are looking across a valley. This is the greatest reward after a long day's hike!

At the moment, I am using a 66-foot dipole with 450-ohm ladder line through the K1's antenna tuner. This does work, but Ed uses a very portable / light weight vertical. He can set it up and be on the air in five minutes. Ed is working on a four-band version of this antenna. When he perfects this vertical, I will be in QRP heaven and I might just take the K1's antenna tuner out of the rig. After a long hike the last thing you want to do is struggle with trying to hang a 66-foot dipole in the air.

Always be prepared when outdoors. If you plan on a day hike, you need to take some water and food. You should have a first aid kit and some duct tape. Don't laugh - duct tape was invented for the military back in 1942 for the wartime activities. I always have some wrapped around an old medicine bottle with other supplies. You just never know when you will have to become "McGiver" when out on a trip.

When out on the AT, please be aware of what is going on around you. Listen to the sounds. There have been many bear and rattlesnake sightings on the AT in the northern part of PA. The last thing you want to do is stumble on a rattlesnake and meet up with a mother bear and her cubs. Watch the sky, it is just a good idea since the weather changes happen on a minute by minute basis.

Please do not leave any trace that you were there. I collect any trash I personally generate and bring it back with me to the car at the end of the hike. If I see any other trash along the way, I will try to pick it up and dispose of it properly.

Always remember to be safe and use your head. This way you can go out another day to enjoy QRP in the great outdoors!

73, Ron WB3AAL
email: wb3aal@verizon.net

Tuning Up

Rich Arland, K7SZ

Welcome to my first column in the inaugural issue of the **HOMEBREWER**. I was truly honored when editor George Heron, N2APB, contacted me and asked if I could do a regular column in this new quarterly QRP magazine. Upon hearing the news that the two most active QRP clubs in the U.S. merged to form ***American QRP Club***, I was surprised. Then I realized that this was a golden opportunity for QRPers, since it would produce an outstanding organization based upon two very active clubs whose overall emphasis was building and enjoying the low power aspects of the radio hobby. At this time I'd like to thank George and Doug Hendricks, KI6DS, for the opportunity to actively participate in a truly new and unique QRP experience.

Resurrecting a QRP Classic

Without a doubt, finding a classic QRP rig like a Ten-Tec PM Series or Heathkit HW-7 or HW-8 at a flea market can be a very fulfilling experience. However, many of these classic QRP rigs have been "chopped and channeled" (to borrow an old hot rodder phrase) by previous owners and either barely work or don't work at all. It is a shame, since many of these flea market treasures are relegated to the dumpster after being lugged around to several ham fests without anyone showing any interest in buying them.

The HW-7

Over the years I have lost count of the Ten-Tec PM rigs and HW-8s I have owned. However, the two HW-7s I remember vividly! My first HW-7 was bought in 1973 while stationed at Lajes Field, the Azores. Using this rig was a lot of fun, especially with my CT2BH callsign. At that time there was only a handful of licensed radio amateurs in the entire Azores archipelago, so we were considered rare DX, especially on CW. Although the HW-7 had a dreadful receiver, I really didn't notice it much except on 40-meters at night or when CUW-20, the base MARS station, fired up on any frequency near 14 MHz! A lot of QRP contacts were made with my first HW-7 and, despite its flaws, I had a lot of fun with that old rig..

My current HW-7 came to me by way of Canada, and John Grow, VE2EQL. This rig was the topic of a ***QRP Power*** column in ***QST*** several years ago. This rig was in outstanding shape and only had one modification: an AF filter board had been added on the inside of the case. I cleaned it up, aligned the rig and added a NoGAPIG voltage protection circuit (available form the North Georgia QRP Club: www.noga.org) to ensure that I would never suffer a reverse polarization of the power leads to the radio. Over the last several years, I have fired the HW-7 up and made some contacts, but there is a 1 kilowatt AM radio station about two miles away that really paralyzes the receiver.

The HW-8

My newly-procured HW-8 came to me by way of Dave Hollander, N7RK, in Arizona. Dave advertised the rig for $125 on the Glowbugs list (glowbugs@piobaire.mines.uidaho.edu). I just couldn't resist buying it, especially after seeing a series of external and internal photos that Dave was kind enough to send. This was a classic HW-8 with excellent cosmetics and was also in unmodified condition! Now, that is a find!

This rig had apparently escaped the normal cutting, boring and sloppy solder modifications associated with its heritage. Upon receiving the rig there were a couple of small things that needed attention. First, the transmitter motorboated during key down on all four bands. Thankfully, Mike Bryce, WB8VGE, (prosolar@sssnet.com) had just completely rewritten and published his second edition of "**HW-8 Handbook",** which is ***the*** source book for everything you ever wanted to know about the HW-7, HW-8 and HW-9 series of Heathkit QRP rigs. If you own any of the Heath QRP rigs, *you need this book.* There are two fixes outlined for this problem. One requires adding a battery bias to the switching diodes D1-D4 on the main PC board. This is rather cumbersome to do, so I declined. The other solution basically does the same thing but there are only two parts to add. In order to improve isolation, a reverse bias of 3.6-V is placed on all the non-selected bandswitching diodes (D1-D4) by lifting the low end of RFC1 and placing a parallel RC circuit (formed by a 390Ù resister in parallel with a .01 µF ceramic disc cap) in series with the RFC and ground. This effectively reverse biases all non-selected switching diodes and eliminates the motorboating. Problem solved.

Audio selectivity is a lot better on the HW-8 than on the HW-7. Both rigs use a direct conversion (DC) receiver. If you have never used one of these, you are in for a bit of a learning curve. First of all, there is no intermediate frequency (IF) strip as in the classic superhet receiver. Instead there is a *direct conversion* from RF to audio (AF) done in one mixing stage. In other words, the RF signal comes into one port of the mixer (in this case an MC-1496G, which, of course, is no longer manufactured) and is mixed with the output of the VFO/HFO. The output is audio - neat and simple. All the selectivity of the receiver now depends upon audio filtering. In the case of the HW-7 a combination of the mixer (an RCA 40673 dual gate MOSFET) coupled with passive audio filtering made for more than a few problems. AM detection from nearby broadcast transmitters, susceptibility to AC hum and severe microphonics all

My newly acquired HW-8 with the Radio Shack DSP unit on top. This is a great way to enhance the audio selectivity without resorting to excessiverewiring inside the rig. Basically any outboard AF filter will work, including the SCAF by OHR or a CWF-3 in a separate box.

caused particularly sizable headaches.

The Heath design team remedied these problems on the HW-8 by using a MC-1496G IC as a product detector, and running the VFO at 8 MHz. The VFO was mixed with a bandswitched heterodyne frequency oscillator (HFO) and that output was applied to the MC-1496G, yielding a DC receiver that was vastly superior in AM rejection, hum and microphonics. Audio selectivity was accomplished by using a dual bandwidth active audio filter that was switchable from the front panel.

As good as it was, the HW-8's AF selectivity definitely needed improvement. The "wide" position is much too wide for a CW receiver and the "narrow" position is not narrow enough for most operators. The traditional cure was to add a multi-stage active audio filter like the MFJ CWF-3 in place of the stock filter. This requires some rewiring; although I had a CWF-3, I decided to increase my audio selectivity using an old Radio Shack DSP filter unit I had lying around. The additional bonus of using the DSP filter was the inclusion of an audio amplifier and speaker. Besides, I didn't want to bore any extra holes and do a massive rewiring of this HW-8.

I had made up my mind that should I desire to do any mods on my new HW-8 they would be "no-holes" mods and they would be fully reversible in order to preserve the pristine condition of this rig. Therefore, the RS DSP unit nicely filled the bill for added selectivity and an external amplified speaker. Problem solved.

Arland Makes Shame

It was bound to happen. It had been many, many years since previously done, but I managed to do it once again. While preparing to align the rig, I reversed-polarized the power cable and turned on the radio! No smoke, no audio, no nothing. Dang, I had made shame and I was in total shock! I had just managed to turn a cherry HW-8 into a non-operational hunk of junk! Woe is me! (Background sounds of beating of breasts and rending clothing!)

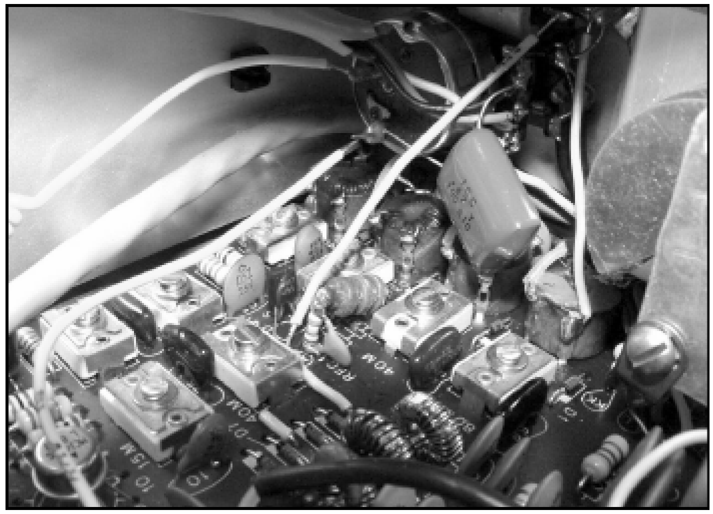
I started looking over the rig's schematic trying to find the logical active devices that would need replacement. First, of course, was the no-longer-manufactured MC-1496G. Then there was the LM3900N along with the PA transistor and, naturally the overvoltage SWR protection diode from the PA collector to ground. The more I started wandering around the schematic, the more things I found that connected directly to the Vcc supply line that I had reverse-polarized. Man, this was definitely not a good day! I was bummed.

I was mad and tired. Driving home from work I was in a daze. I stopped by the church to talk with Father DeXtra, our family priest. He was holding confessions so I took my place in line and waited. Upon entering the confessional, I started my spiel: "Forgive me Father for I have sinned. It has been 2 years since my last confession".

"Go ahead my son", replied Fr. DeXtra.

I started down the list of my sins. You know, things like claiming only 900 mW during a QRP contest when I was *really* running 999 mW. When I got to the part about reverse polarizing the HW-8 he screamed "Enough! Wait here", and I heard him leave the confessional.

He returned after what seemed an eternity, and said, "For this last transgression I have had to contact Rome. It is their opinion, as



This is a close up of the RFC/parallel RC mod that will reverse bias any non-selected bandswitching diodes (D1-4). This mod is easily reversed. It definitely tames the motorboating on the transmitted signal.

well as mine, that in order for you to atone for this most grievous sin, you will be exiled to the 12th level of Purgatory upon your death. Mark my words, you have a long way to go to reach Heaven!"!

"Woooffff! Dang, Herbie, quit that!" Herbie, my Maine Coon Cat, had launched himself from his permanent perch atop the GPS-90 receiver in my shack and landed directly on my chest, awakening me with a start. Apparently, after driving home I had fallen asleep in the shack chair and had a very bad dream! While I wasn't in the 12th level of Purgatory, I still had a very dead HW-8 on my hands.

The Resurrection

I called Mike Bryce and explained the situation. He stopped laughing after about five minutes (on my dime, of course) and asked me what I had done in the way of troubleshooting. First I outlined that the power supply was going into overload protection, indicating that something inside the HW-8 had shorted and was still shorted, pulling the power supply down. I listed my observations: severely overloaded power supply when turning the rig on, no audio and no smoke (thank God). I had pulled the Vcc line from point "D" on the circuit board and the short still existed.

Mike suggested the first place to look was ZD_2 and Q_9, since these two devices were directly connected to the Vcc line they were the most likely candidates to short and load down the supply line. He also encouraged me saying that if I was lucky, *really* lucky, the zener diode had shorted first, taking out the PA transistor, and the rest of the rig had not suffered a similar fate.

I removed ZD_2 and checked it: dead short. One down, one to go. After removing the 2N4427 PA transistor, I checked it and it was shorted between collector and base. OK, two for two. I powered up the HW-8 without these two devices and was rewarded with audio and an active receiver! WHEW! I had dodged that bullet! The MC-1496G was fine, as was the LM3099N. After replacing the zener diode and the PA transistor with a NTE 488, I tried the transmitter and found that everything worked! I was beginning to feel better.

After briefly checking out the HW-8's receiver with an antenna connected, I found that it was cooking along with no problems. A transmitter alignment followed, since the NTE replacement transistor was a higher-powered device. The rig now put out just under 3-watts on 80, 4.25-watts on 40 and 20 and 2.75-watts on 15-meters. Not bad for a 30 year old radio.

The Care and Feeding of an HW-8

This entire fiasco with reverse-polarizing the HW-8 power connector got me thinking about replacement devices in older gear. The product detector is no longer manufactured, which means if you blow one up, you must find some new old stock (NOS) parts somewhere or buy another HW-8 as a parts rig. Thankfully, my local electronic parts supplier, Moyer Electronics in Hazelton, PA, happened to have about eight RCA SK3233 devices ($4 each) which are a direct replacement for the MC-1496G. I bought two spares. Likewise, I found the NTE-488 PA transistor ($13) along with the ECG-222 dual-gate MOSFET used in the HW-8 as a mixer amplifier (Q_4, Heath part number: 417-240). Dual-gate MOSFETs are getting harder to find, so I picked up two at $11/each. As long as I was on a fishing expedition, I figured that I'd pick up an NTE 133 (use for the RF amp, Q_1, and the VFO, Q_2, Heath part number: 417-169 at $1 each) and a NTE 159 (keying transistor Q_{11}, Heath part number 41-116, and the relay driver, $Q_{13,}$ Heath part number 417-201 also about $1 each). The rest of the active devices in the HW-8 are run of the mill small signal NPN transistors that will sub with a NTE-123AP, 2N2222, or 2N3904.

Finally, I had placed a 1N4001 silicon diode in reverse bias across the power leads coming in to the power connector for reverse polarization protection. In typical "locking the barn door after the horses got out" fashion, I accomplished this immediately after I had reversed the power leads. Well, at least I *did* it, so I wouldn't reverse polarize the HW-8 again.

Until Next Time ...

I hope you have enjoyed the column this time. We'll do something like this again in the next issue. In the mean time, have fun with QRP and I hope to work you on the bands.

Rich Arland, K7SZ
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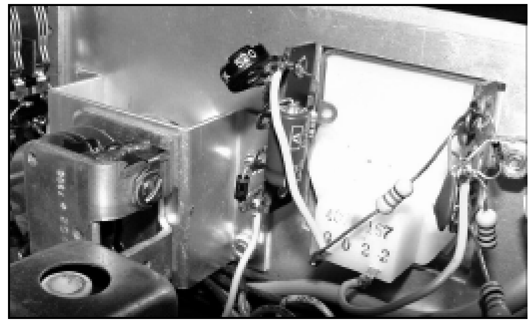

The audio derived S-Meter is built on a terminal strip that is attached to the left side of the meter on the inside of the case. Run a wire to the top side of the volume control and the output of this circuit solders onto the positive side of the relative output meter to provide a nice S-Meter for the HW-8. Again, this mod can be easily removed to render the rig back to stock condition.

Introducing ... the Four State QRP Group

Dave Bixler, W0CH *email: qrp@netins.net*

The Four State QRP Group is one of the newest QRP clubs, having started just last year. The idea of forming the group germinated over cokes at ArkieCon where a few of us from the four state area noticed how much fun there was at Ft. Smith. We wondered if we too could get together around home to talk QRP. A posting to QRP-L and a few direct e-mails were sent out in April inviting the guys to have a Saturday lunch at a local eatery in the small town of Seneca, Missouri. Who in their right mind would want to drive to Seneca, population 2100, and talk QRP? I thought maybe two or three of us would have lunch and that would be it. Well, at the initial meeting 13 hams showed up! We have been growing ever since.

Where is the Four State area? If you refer to a map, you will observe that the four states of Arkansas, Oklahoma, Kansas and Missouri meet within a few miles of each other. Originally, we thought that we were just a local club, but we quickly discovered that QRPers from all over the midwest were interested in participating. Some dedicated hams drive hundreds of miles to attend our gatherings!

Modeled after the successful NorCal club, we don't have any officers, no rules, no membership dues or boring business meetings. Our monthly get-togethers are very casual, with a good lunch being a very important priority. Usually there are several home-built projects, QRP magazines or QSL cards for show and tell to pass around. Occasionally we have a "share the wealth" raffle drawing where components or other choice items find new homes.

After lunch, we usually adjourn to the Seneca city park where antennas are launched into the trees and we put several stations on the air. New rigs get demonstrated here or new antennas get field tested.

Three times a year we have an outdoor camp-out, cook-out and field operation at Twin Bridges State Park near Wyandotte, Oklahoma. Our "Spring Fling" in April is the weekend of the NorCal QRP to the Field contest. In June, we operate the ARRL Field Day and in September, the Four State "Ham-Out" is the weekend of the New England club QRP Afield contest. It's lots of fun and fellowship, plus our members are getting practical experience in operating QRP portable stations from the field.

Homebrew is big in the Four States group. Our members have been building all kinds of projects -- and we've discovered that Manhattan style construction is easy to do and that beginners can build very nice projects. Several of the Four State guys are very talented builders and have helped instruct and inspire the others. I'll have more highlights of some of our projects in future issues of the Homebrewer.

The most exciting news has been saved for last. The Four State group, in cooperation with the American QRP Club, will be hosting OzarkCon 2004 next April. This will be the major QRP convention for mid-America. Scheduled for April 9 & 10th, OzarkCon will be held in Joplin, Missouri. Funded in part by sales of the KD1JV "Tenna Dipper" kit, this should be a fun weekend. Stay tuned for more details on this exciting event!

More information about the Four State QRP Group is available on the web at: http://4sqrp.com Better yet, drop in for lunch sometime!

N2CQ QRP Contesting Calendar

Ken Newman, N2CQ

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Ten-Ten SSB Contest
Aug 2,0000z to Aug 3, 2400z - www.ten-ten.org

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TARA "Grid Dip" PSK/RTTY Contest
Aug 2,0000z to 2400z - www.n2ty.org

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North American CW QP
Aug 2, 1800z to Aug 3, 0600z - www.ncjweb.com

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RUN FOR THE BACON
Aug 4, 0000z to 0200z - http://fpqrp.com/

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ARS Spartan Sprint (CW)
Aug 5, 0100z to 0300z - www.arsqrp.com

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Maryland/DC QSO Party
Aug 09, 1600z to Aug 10, 0400z &Aug 10, 1600z to 2359z
www.w3cwc.org

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North American SSB QP
Aug 16, 1800z to Aug 17, 0600z - www.ncjweb.com

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Hawaii QSO Party
Aug 23, 0700z to Aug 24, 2200z - www.karc.us

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Ohio QSO Party
Aug 23, 1600z to Aug 24, 0400z - www.mrrc.net

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BUBBA Sprint
Aug 23, 1600z to 2200z - www.extremezone.com/~nk7m/

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CQC Summer QSO Party
Aug 24, 1800z to 2359z - www.cqc.org/contests/

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Labor Day Sprint
Sep 01,2300z to Sep 02,0300z - www.qsl.net/miqrpclub

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ARS Spartan Sprint
Sep 02, 0100z to 0300z - www.arsqrp.com

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AGCW Straight Key Party
Sep 06, 1300z to 1600z - www.agcw.de

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NA CW Sprint
Sep 07, 0000z to 0400z - Www.ncjweb.com

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End of Summer PSK-31 Sprint
Sep 07, 2000z to 2400z - www.qrparci.org

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2nd Class Opr Club Marathon
Sep 13, 1800z to 2400z - www.qsl.net/soc

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NA SSB Sprint
Sep 14, 0000z to 0400z - www.ncjweb.com

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Tenn. QSO Party
Sep 14,1800z to Sep 15,0100z - www.k4ro.net/tcg.html

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Scandinavian CW Activity Contest
Sep 20, 1200z to Sep 21, 1200z - www.sk3bg.se/contest/sacsc.htm

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QRP Afield
Sep 20, 1500z to Sep 21, 0300z - www.qsl.net/wq1rp/

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Washington State Salmon Run
Sep 20, 1600z to Sep 21, 0700z & Sep 21, 1600z to 2400z
www.wwdxc.org

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NJ Homebrewer Sprint
Sep 22, 0000z to 0400z - www.njqrp.org
Frequencies: QRP CW and PSK31 frequencies on 80 - 10 meters, CW and PSK31 are considered separate bands.
Exchange: RST + SPC + Output Power.
QSO Points: Commercial Equipment--2 pts, Homebrew Xmtr or Rcvr--3pts, Homebrew Xmtr and Rcvr (or Xcvr)--4 pts, Homebrew PSK31 station--5 pts. Kits ok as homebrew.
Power Multiplier: 0-250 mW = x 15, 250 mW>1W = x10, 1>5W = x7, >5W = x1
Score: QSO Points x SPC (counted once per band) x power multiplier. For more information: www.njqrp.org/data/qrphomebrewersprint.html . Logs due 30 days from the contest to n2cq@arrl.net (text format) or Ken Newman, N2CQ, 81 Holly Drive, Woodbury, NJ 08096.

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Tesla Cup
Sep 27, 0000z to 2400z (SSB) & Sep 28, 0000z to 2400z (CW)
http://members.aol.com/k3bu

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Scandinavian SSB Activity Contest
Sep 27, 1200z to Sep 28, 1200z
www.sk3bg.se/contest/sacsc.htm

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Texas QSO Party
Sep 27, 1400z to Sep 28, 0200z &
Sep 28, 1400z to 2000z - www.k5vuu.com/tqp/?

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Louisiana QSO Party
Sep 27, 1400z to Sep 28, 0200z &
Sep 28, 1400z to 2000z - www.tchams.org

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Alabama QP
Sept 27, 1800z to 2400z - http://web.dbtech.net/~dxcc

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German Telegraphy Contest
Oct 3,0700z to 1000z - www.agcw.de/

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TARA PSK31 Rumble
Oct 4, 0000z to 2400z - www.qsl.net/wm2u/

California QSO Party
OCT 4, 1600z to Oct 5, 2200z - www.cqp.org/

RSGB 21/28 MHz SSB Contest
Oct 5,0700z to 1900z - www.rsgbhfcc.org/

ARS Spartan Sprint
Oct 7, 0100z to 0300z - www.arsqrp.com

Ten-Ten Day Sprint
Oct 10, 0000z to 2400z - www.ten-ten.org

Pennsylvania QSO Party
Oct 11 - 1600z to Oct 12 - 0500z &
Oct 12 - 1300z to Oct 12 - 2200z - www.nittany-arc.org/

FISTS Fall Sprint
Oct 11, 1700z to 2100z - Www.fists.org

North American RTTY Sprint
Oct 12, 0000Z to 0400Z - www.ncjweb.com

QRP ARCI Fall QP
Oct 18, 1200z to Oct 19, 2400z - www.qrparci.org

Worked All Germany Contest
Oct 18, 1500z to Oct 19, 1459z
www.darc.de/referate/dx/fedcg.htm

RSGB 21/28 MHz CW Contest
Oct 19, 0700z to 1900z - www.rsgbhfcc.org/

Illinois QP
Oct 19, 1800z to Oct 20, 0200z
http://my.core.com/~jematz/rams.html

Zombie Shuffle
Oct 24, Local Sundown to Midnight (Any 4 hour period)
www.norcalqrp.com/

CQ WW PH DX Contest
Oct 25, 0000z to Oct 26, 2400z - http://cqww.com/

Ten-Ten QP
Oct 25, 0001z to Oct 26, 2400z - www.ten-ten.org/

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070 Club 160m Great Pumpkin Sprint
Oct 26, 2000z to Oct 27, 0200z
http://podxs.com/html/070_club.html

Fox Hunt
Oct 31, 0200z to 0400z - www.cqc.org
Truffle Hunt - 30 min before Fox Hunt - http://fpqrp.com

HA-QRP Contest
Nov 1, 0000z to Nov 7, 2400z -
www.sk3bg.se/contest/haqrp.htm

Ukrainian DX Contest
Nov 1, 1200z to Nov 2, 1200z - www.qsl.net/ucc/

ARRL CW Sweepstakes
Nov 1, 2100z to Nov 3, 0300z - www.arrl.org

Running of the QRP Bulls
Nov 1,2100z to Nov 3,0300z - www.qrparci.org

High Speed Club Contest
Nov 2, 0900z to 1100z and 1500z to 1700z
www.morsecode.dutch.nl/hscc.html

ARS Spartan Sprint
Nov 4, 0200z to 0400z - www.arsqrp.com

Fox Hunt
Nov 7, 0200z to 0400z - www.cqc.org
Truffle Hunt - 30 min before Fox Hunt - http://fpqrp.com

OK/OM CW DX Contest
Nov 08, 1200z to Nov 09, 1200z -
www.okomdx.radioamater.cz/uvnitr_en.htm

Fox Hunt
Nov 14, 0200z to 0400z - www.cqc.org
Truffle Hunt - 30 min before Fox Hunt - http://fpqrp.com

ARRL Phone Sweepstakes
Nov 15, 2100z to Nov 17, 0300z - www.arrl.org

HOT CW Party
Nov 16, 1300z to 1500z (40m) & 1500z to 1700z (80 m)
www.qrpcc.de/

Fox Hunt
Nov 21, 0200z to 0400z - www.cqc.org
Truffle Hunt - 30 min before Fox Hunt - http://fpqrp.com

Fox Hunt
Nov 28, 0200z to 0400z - www.cqc.org
Truffle Hunt - 30 min before Fox Hunt - http://fpqrp.com

CQ WW CW DX Contest
Nov 29, 0000z to Nov 30, 2400z - www.cqww.com/

Also see www.amqrp.org/contesting for monthly listings and active links.

72,
Ken Newman, N2CQ
email: n2cq@comcast.net

PACIFICON QRP FORUM

October 17, 18 & 19 2003

The Pacificon QRP Forum is a weekend of QRP fun, presentations and social gathering sponsored by the American QRP Club each year in the fall. QRPers from all over the US, and internationally, show up for this annual event held in San Ramon, California, and hosted by the NorCal QRP Club.

QRP presentations all day Saturday

About 300 QRPers usually show up for Pacificon and on Saturday get treated to QRP seminar topics presented by acknowledged leaders and experts in our hobby. These are hour-long audio/visual presentations made by knowledgeable hams in fields of transmitter design, antenna analysis, homebrew construction, electronic simulation, operating from the field, microcontroller hardwrae & software design, and more. Each attending QRPer gets a bound copy of the QRP presentations in the form of the Pacificon Proceedings. These Saturday QRP seminars are one of the great highlights of the weekend.

QRPacificon Speakers for 2003

Joe Everhart, N2CX, Wayne McFee, NB6M, Randy Foltz, K7TQ, George Heron, N2APB & Steve "Melt Solder" Weber, KD1JV.

The "QRPacificon Kit"

We are starting a new custom for Pacificon, a special "QRPacificon Kit" for all those who pre-register for the QRP Forum at Pacificon. This is a small, but very useful project that you'll be able to use in the shack for years to come. But even more important, it serves as the basis for the Friday evening fun & games we have planned. We'll tell more about the kit on the AmQRP and NorCal web pages as we get closer to Pacificon.

When

Pacificon is held the third week in October – this year it's the weekend of October 17, 18 & 19. It is sponsored by the Mt. Diablo Amateur Radio Club, and this year we're moving to a bigger and better venue in San Ramon, California. It is the regular site of the ARRL Pacific Division Convention, and NorCal has sponsored the QRP Forums for the past 9 years. This year's forum is sponsored by the American QRP Club, and hosted by the NorCal QRP Club.

Hotel

The "Pacificon hotel" is the San Ramon Marriott , which is offering convention attendees and exhibitors a special PACIFICON room rate of only $79 for each night (single/double). To get this rate, reservations must be made before October 3, 2003. Call the Marriott at 1-800-228-9290 and ask for the PACIFICON 2003 rate.

PACIFICON 03 MDARC SAN RAMON CA
AMATEUR RADIO CONVENTION

www.pacificon.org

Friday Evening

Pacificon starts at 6:30 on Friday night with a social evening where we meet up with old friends and make new ones. We start the evening by going out *en masse* to a local restaurant where we have a "no host dinner". We then return to the host hotel where vendors and QRPers alike often show their projects at tables around the large banquet room in which we meet, right up until 11pm.

Saturday

This is the main event, wherein the illustrious QRP speaking staff delivers the presentations on Saturdy. We break for individual dinnertime cuisine at local restaurants and reconvene at 7:30 for an evening of wild QRP fun - a homebrew building contest and a special Pacificon Event are the usual activities for Saturday evening. We normally go until 11pm and then many of us then carry on in the hotel bar, quenching the insatiable QRP thirsts.

Sunday

Sunday morning finds most QRPers hustling over to the hamfest for a morning of looking for that gem of a deal during the last hours of the 'fest.

Registration

You can register for the American QRP Club's QRPacificon Forum to be held in San Ramon, California at the Marriott Hotel by writing a check or money order for $10 payable to the "American QRP Club" and sending it to:

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

You may instead register through PayPal by sending the funds electronically to amkits@amqrp.org. (Visit www.paypal.com.) You will receive your QRPacificon Kit in the mail prior to the event so you can prebuild it. All attendees will receive a compendium of the speaker presentations at the registration table plus a personalized name badge.

Over 300 QRPers normally attend these Pacificon weekends ... sure hope you too can join us for our very special QRP extravaganza this year in October. Mark your calendars and make your travel reservations early to get the good rates and we'll see you there!

72/73, Doug, KI6DS and Jim, WA6GER

AmQRP .org

www.amqrp.org

Nor-Cal QRP Club

www.pacificon.org

NJQRP KITS

SOP Receiver Kit -- www.njqrp.org/sop
Direct Conversion receiver for 80m/40m. Easy assembly, easy to mod. Good manuals.
Basic SOP Receiver kit ... $38 (DX + $8)
Audio Frequency Dial ... $10 (available only with Basic kit)
Controls & Jacks Option ... $10 (available only with Basic kit)

HC908 Daughtercard -- www.njqrp.org/hc908
*Self-contained, in-circuit programmable microcontroller for QRP Digital Breadboard, Antenna Analyzer II, HC908 Commander, etc ... **$35** (DX + $8)*

"Sniffer" Field Strength Meter Kit -- www.njqrp.org/sniffer
*Self-contained, in-circuit programmable microcontroller for QRP Digital Breadboard, Rainbow Antenna Analyzer, HC908 Commander, etc ... **$25** ($35 after Jan 1st) (DX + $8)*

"Badger" SmartBadge Kit -- www.njqrp.org/badger
*Morse-sounding ID badge with customized faceplate ...**$20** (DX + $5)*

"Islander" Pad Cutter -- www.njqrp.org/islanderpadcutter
*Diamond-tipped end mill cuts 5mm isolated pads in copper pcb..... **$9** (DX + $3)*

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

PSK31 Audio Beacon Kit -- www.njqrp.org/psk31beacon/psk31beacon.html
*Board generates PSK31 audio tones from programmed character string, suitable as input to transmitter or decode with DigiPan PSK31 PC software ..... **$25** (DX + $5)*

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

NK0E "Serial Sender" Kit -- www.njqrp.org/palmserialsender
Electronic keyer and interface between Palm PDA running GOlog contest logger and rig, keys rig with contest info, software for plug-in paddles, includes enclosure ... $34 (DX + 5)

Atlanticon Proceedings -- www.njqrp.org/atlanticon/proceedings.html
Bound sets of QRP articles and technical material on homebrew projects and operating practices, with fold-out schematics and block diagrams from past Atlanticon QRP Forums.
*Atlanticon 2002 .... **$15** (DX + $3)*
Atlanticon 2003 .... $10 (DX + $3)

NJQRP Website-on-CDROM, Volume 1 -- www.njqrp.org/cdrom
CD-ROM contains all projects, kit info, articles, meeting recaps & photos ever published on the NJQRP website over its 5 year history. Great for quick 'n easy reference. ... $10 (DX+3)

ORDERING:
Shipping is free to US & Canada. DX orders: add extra as indicated. Write check or MO payable to "George Heron, N2APB" and send to:
George Heron, N2APB
2419 Feather Mae Ct
Forest Hill, MD 21050

4SQRP KITS

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

NORCAL KITS

NorCal Keyer — www.amqrp.org/kits/NCKeyer
*Memory keyer, with 3 programmable 40-character memories, iambic A & B mode, straight key and bug mode, 2 beacon modes, and variable speed control by either a 100K pot or the paddles themselves **.... $15***
Order by sending check/MO to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

MiniBoots Amp -- www.amqrp.org/kits/miniboots
*A full "QRP gallon" (5-Watt output) from a 750mW-to-1W input CW drive signal. Comes with BNC connectors, all board mounted parts and a high quality silk screened, solder masked, plated through hole pc board. All you have to add is the power connector of your choice and a case ... **$34 for US & Canada*** (DX add $2)
Order by sending check/MO to Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821

Resistor Kit -- www.amqrp.org/kits/resistor
*A resistor kit of 2000 1/4-watt carbon film resistors with 25 of each of the common values ... **$25 for US & Canada** (DX add $4)*
Order by sending check/MO to Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821

BLT Tuner -- www.amqrp.org/kits/blt
*A simple Z-Match antenna tuner for QRP use on 10m-40m. Includes new aluminum case! ... **$39 for US & Canada** (DX add $6)*
Order by sending check/MO to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

NorCal Crystals -- www.amqrp.org/kits/crystals
*Crystals for QRP calling freqs on 20, 30, 40 and 80 meters ... **$3 each** for 7.040, 10.116 and 14.060, and **$.25 each** for 3.579*
Order by sending check/MO to Doug Hendricks, 862 Frank Ave, Dos Palos, CA 93620.

About ... HOMEBREWER Magazine

WHAT IS HOMEBREWER?

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

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

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

FORMAT

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

ANNUAL CD-ROM

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

"HB Extra!"

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

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

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

QUALITY

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

HOW MANY ISSUES DO YOU HAVE?

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

SUBSCRIBING TO HOMEBREWER

Annual subscriptions to HOMEBREWER cost $20 for US and Canadian addresses, or US$30 for DX addresses. One-year or two-year subscriptions will be accepted.

Subscriptions are accepted electronically via PayPal. Send funds to homebrewer@amqrp.org.

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

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

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Subscription status may be checked online by visiting www.amqrp.org/homebrewer/substatus.html. Enter any unique part of a name, callsign or address and immediately see the subscriber record. "Issues Remaining" indicates the number of issues left in the subscription. If you have questions or wish to update the subscription information, please contact Paul Maciel, AK1P at ak1p@amqrp.org.

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